INQUIRIES OF HEAVEN

IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA , AUGUST 20 - 31, 2012 MONDAY, AUGUST 20, 2012 DAY 1

WELCOME TO THE IAU GA 2012

IAU President ROBERT WILLIAMS

Distinguished Research Scholar and former director of the Space Telescope Science Institute, and Cerro Tololo Inter-American Observatory in Chile.

Welcome to Beijing and IAU General Assembly XXVIII. Although the world economic situation continues to show stress the science of astronomy is flourishing on many fronts. True, we are not immune to the negative effects of sharply reduced funding for projects and positions, yet our domain sees increased international collaboration, pioneering facilities and techniques in development, and significant discoveries that are changing the way humanity thinks about the universe and our place in it. Programs that the IAU has undertaken such as the United Nations International Year of Astronomy 2009 and the creation of the Office of Astronomy for Development in Cape Town have been hugely successful.

The IAU is going through a period of transition from an organization that historically has maintained a largely internal focus emphasizing meetings and events for its members to one that is becoming more involved in education and outreach to the general public. We are also making efforts to foster international collaboration on large facility projects. Several changes to the Statutes are being proposed that will allow broader input and oversight from members on issues such as membership and finances. And most importantly we are proposing for the future that scientific resolutions be presented and discussed at the GA and on the IAU website but that voting be open to all members and conducted electronically following the GA. In addition, the Executive Committee is recommending a change to the divisional structure of the IAU that should organize the divisions more in line with current major research themes in astronomy.

As the first large astronomical meeting of this nature to be held in China the present General Assembly is a historic occasion for Chinese astronomy. It represents the tremendous growth in science in this country and increased funding that has enabled new projects and departments, and has attracted large numbers of students to undertake post-graduate studies in astrophysics. We will see evidence of this activity in the talks and posters, of which many will be authored by young investigators.

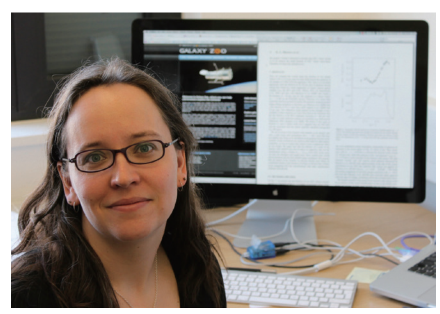
The astronomical community in China has joined together to create an excellent venue and program of activities that make the General Assembly an ideal place to exchange ideas. There is the old and the new. The ancient traditions and scientific advances of past dynasties have provided a solid foundation for China's innovative projects LAMOST, FAST, and AMiBA. You can experience excellent examples of both the old and the new in one place that you must visit while you are at the GA: the Beijing Planetarium. It combines the most modern facilities for astronomy education and outreach with a stunning collection of ancient instruments from the Han and Ming dynasties that long pre-date the instruments of Tycho Brahe on the island of Hven. Like many attractions in the Beijing area, it should not be missed. You should also take the opportunity to make the 10-minute walk over to the Chinese Academy of Sciences compound off Datun Road to visit the National Astronomical Observatories of China.

The "Inquiries of Heaven" daily newspaper will provide useful information for GA attendees. In addition to the daily schedule it will call attention to opportunities that you may find interesting, in addition to posting official information needed for official business meetings.

It is a pleasure to thank our Chinese colleagues who have worked to make the GA a success, and we look forward to a scientific program that will cause you to leave here full of ideas and enthusiasm. ■

TODAY'S INVITED DISCOURSE (18:00 – 19:30, PLENARY B)

A ZOO OF GALAXIES



Karen Masters

Research Fellow working at the Institute of Cosmology and Gravitation at the University of Portsmouth and winner of the IAU Fellowship (funded by the Peter and Patricia Gruber Foundation).

We live in a universe filled with galaxies with an amazing variety of sizes and shapes. One of the biggest challenges for astronomers interested in galaxies is to understand how all these types relate to each other in the context of an expanding universe. In my invited discourse, I will talk about how our knowledge of the different types of galaxies has evolved since we first understood they were objects outside our own Milky Way galaxy, and how it continues to change today.

Beautiful barred spiral galaxy NGC 1300. Credit: Hubble Heritage Team, ESA, NASA

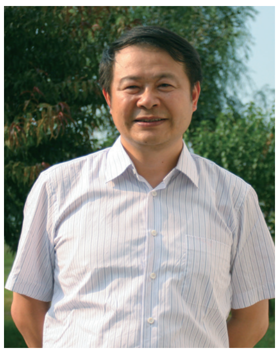
Modern astronomical surveys (like the Sloan Digital Sky Survey) have revolutionized the field of extragalactic astronomy, by providing vast numbers of galaxies to study. The sheer size of these databases made traditional visual classification of galaxies impossible and in 2007 inspired the Galaxy Zoo project (www.galaxyzoo.org). This started the largest ever scientific collaboration by asking members of the public to help classify galaxies by type and shape. Galaxy Zoo has since shown itself, in a series of now more than 30 scientific papers, to be a fantastic database, adding crucial information to the study of galaxy evolution. The project now includes not just local galaxies but also much more distant galaxies with images from the Hubble Space Telescope. I will talk about some of my contributions to the research using information from Galaxy Zoo, including studies of the rare, but possibly important red spiral galaxies, and the effect that bars seem to have on spiral galaxy properties.

Galaxy Zoo is also a fantastic tool for outreach about extragalactic astronomy, and science in general, and its success inspired the creation of the "Zooniverse" of online citizen science based projects (www.zooniverse.org). Zooniverse projects are required to have both strong science/research justifications and a clear need for human input to large data sets. Over 650,000 people have now signed up for accounts and have contributed their time to help scientific research in several areas of astronomy (e.g. Moon Zoo, Planet Hunters, Milky Way project), as well as projects in climate science, zoology and even ancient history. Anyone is invited to propose a new Zooniverse project, and several are currently in the development process, including a relaunch of Galaxy Zoo. ■

Welcome to Beijing

It is a great honor and pleasure for us, as co-chairs of the Local Organizing Committee (LOC), to welcome you to attend the XXVIII General Assembly (GA) of the International Astronomical Union (IAU). This year marks the 90th anniversary of the first IAU GA and the founding of the Chinese Astronomical Society. Holding the triennial assembly in Beijing has far-reaching significance.

China has long been one of the major cradles of human civilization. With over 4000 years of development, Chinese ancient astronomy experienced a brilliant period of productivity. This rich history not only established a foundation for the development of Chinese astronomy and is a priceless legacy, but also serves as an otherwise unavailable source of records for modern astronomical research. With the rapid economic growth of the country, the past 30 years, especially the last decade, have witnessed great advances in astronomical studies in China. China has invested in several major facilities, for example, the Guo Shou Jing Telescope (formerly called LAMOST), the Five-hundred-meter Aperture Spherical Telescope (FAST), and the ambitious Antarctic astronomy project. As the largest developing country in the world to launch its own spacecraft with a crew, China has



Jun Yan

Co-chair of the LOC of GA, the Director-general of NAOC

Gang Zhao

Co-chair of the LOC of GA

achieved steady progress in addressing scientific and technical challenges, and is ready to build and launch space- and lunar-based telescopes.

It is reassuring to find that our effort and progress are acknowledged and welcomed by our international colleagues, as reflected by Beijing's successful bidding for hosting the XXVIII IAU GA, the first time for China. This will no doubt drive the development of astronomy, and raise its profile and visibility in the country with one fifth of the world's population.

The XXVIII IAU GA scientific program includes, but is not limited to, four invited discourses, eight symposia, seven joint discussions and eighteen special sessions. Astronomers from around the world will report on and discuss highlighted topics, latest research results and discoveries from every field of contemporary astronomy. We believe this broad spectrum of topics should satisfy and pique the interest of any attendee, and the GA will serve as a platform for stimulating exchanges of views, to consolidate existing collaborations and initiate new high-level research partnerships. In particular, the "Women in Astronomy Meeting (WAM)" will discuss the status and issues affecting women in astronomy, focusing on strategies for increasing gender equality, promoting diversity, and improving the working environment of the field.

The GA also offers fascinating social events. As a city with a history of 3000 years, Beijing is known for its heritage of architectural, historical and cultural treasures. The Great Wall, the Summer Palace, the Forbidden City, and the Temple of Heaven have been designated as world heritage sites by UNESCO. As a fast-growing, dynamic international metropolis and the capital of the country, Beijing is also a showcase of the modernization of China.

We believe the Beijing GA will be a memorable General Assembly and wish you a scientifically and socially productive experience. Welcome to Beijing! ■

Celebrating the 90th Anniversary of Chinese Astronomical Society

This year is the 90th anniversary of the founding of the Chinese Astronomical Society (CAS).

In 1911, when Dr. Yat-sen SUN led a revolution overthrowing the Qing Dynasty, the Central Observatory was set up by Sun's government. Dr. Lu GAO (1877-1947), who graduated from Brussels University in Belgium, was appointed as the director. GAO realized that development of modern astronomy in China needed the joint efforts of more people who loved astronomy. Dr. GAO and his colleagues started to compile and publish some astronomical journals, and often gave astronomical lectures in Peking University. In 1919, the founding of the IAU and the May 4th Movement occurring in Beijing made Dr. GAO realize that the time was right for establishing CAS. In 1922, Dr. GAO and his colleagues called for establishing CAS to promote development of astronomy in China. Their appeal received a positive response. On Oct. 30, 1922, more than 40 scholars and celebrities held the meeting at the Beijing Ancient Astronomical Observatory to found CAS. In the meeting the Society's constitution was formulated, and Dr. GAO was elected as president. At that time it only had 47 individual members and 6 group members.

The purpose of CAS, according to its constitution, was to promote: (a) Advancement of professional astronomy in China; (b) Popularity of astronomy knowledge. During the early period of CAS, it accomplished two tasks: First, to build Purple Mountain Observatory (PMO); Second, to adhere to the IAU. PMO, the biggest observatory in East Asia then, was built in 1934. The next year, the fifth IAU General Assembly was held in Paris, and China became a member of IAU represented by the Chinese Astronomical Committee from Nanjing. Dr. Lu GAO, Qing-song YU (1897-1978) and Bing-ran JIANG (1883-1966) became the earliest IAU individual members from China. But Japanese invasion interrupted the advancement of astronomy in China, and the staff of PMO and the Astronomical Institute at Nanjing had to retreat into Yunnan province until the end of the war against the Japanese invasion.

On Oct. 1, 1949, The People's Republic of China was founded. A new period of developement in sciences, including astronomy, then started. With the development of astronomy, CAS has become more influential year by year. In 1957, the first General Assembly of CAS since 1949 was held in Nanjing, and the director of PMO, Dr. Yu-zhe ZHANG (1902-1986), who returned from Yerkes Observatory in 1929, was elected as president of CAS. He then guided CAS until his death in 1986.

Now, CAS has more than 2300 individual members, and of them 401 astronomers are IAU members. Also, there are 23 group members and 16 Local Astronomical Societies. CAS has set up a Secretariat hosted by PMO in Nanjing, with 11 Specialized Committees and 6 Working Committees. An annual Scientific Meeting is held every year by CAS. The president and the Council of CAS are elected at the GA, which is held once every four years. The ZHANG Yu-zhe Prize and the HUANG Shou-shu Prize have also been established by CAS to reward outstanding astronomers. A collection of astronomical journals, such as Research in Astronomy and Astrophysics, are published by CAS jointly with other observatories or organizations. We believe CAS will continue to thrive in the future.

To read more about CAS, visit http://english.astronomy.pmo.cas.cn (in English) or http://astronomy.pmo.cas.cn (in Chinese). ■

Cheng-qi FU

Research Professor of Shanghai Astronomical Observatory, CAS

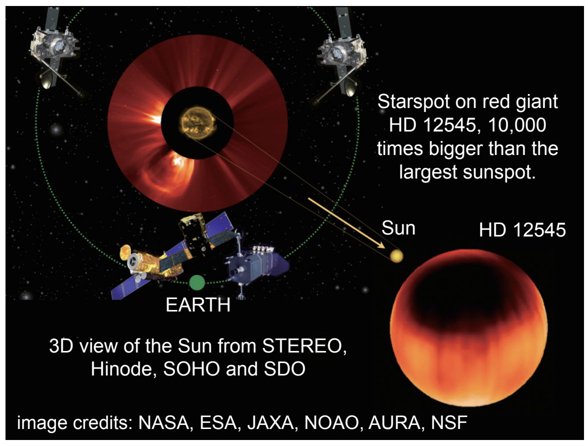
The First general assembly of Chinese Astronomical Society held in Beijing, 1923.

3D Views of the Cycling Sun and Other Active Stars

With a fleet of spacecraft and ever-improving ground-based observing facilities in operation, we are able to observe unprecedented details of a star: our Sun. At the same time, observations and simulations of other active stars are being enabled by ground breaking missions such as Kepler and ground-based robotic telescopes. We invite communities interested in solar and stellar activity to take part in this Joint Discussion (JD3) where we hope to create a forum and inspire collaborations between colleagues studying the Sun and other active stars.

The twin STEREO spacecraft, which have been drifting away from the Earth since their launch in 2006, are 115 degrees behind and 123 degrees ahead of the Earth today, the first day of the IAU GA (see the figure). Combined with observations from other spacecraft around the Earth (SOHO, Hinode, SDO), and ground-based observatories we are provided with a full 3D view of our Sun. This was voted greatest NASA achievement of 2011 by the public. We live in a unique time in the history of stellar physics, giving us a 3D view of the Sun for the next 6 years. For an image of today's Sun visit: http://stereo.gsfc.nasa.gov/.

Solar activity is on the increase following the deepest and longest solar minimum of the space age. This long minimum period was monitored in great detail, allowing the study of the heliosphere without added complexity from solar transients. Then, as the solar activity rose, the increasingly disturbed heliosphere was monitored from three vantage points.



The program of JD3 can be found at: http://www.mssl.ucl.ac.uk/iau_c10/iau28ga_jd03.html

SDO is showing us breathtaking details of the active Sun, with temporal resolution of tens of seconds. As solar activity has nearly reached the maximum of Cycle 24, we have obtained unprecedented observational details of various active phenomena, ranging from microflares and penumbral jets through quiet-sun mini-eruptions to the largest filament eruptions and coronal mass ejections (see the figure).

Having observed the evolution of activity and solar magnetic fields during the ascending phase of the cycle, we now have a clearer view of Solar Cycle 24 and are able to provide a more accurate forecast of solar activity for the next decade and perhaps beyond. After much speculation, it seems that the Sun will not enter a Maunder minimum-like phase in the coming centuries, though the modern Grand Maximum has definitely ended.

The General Assembly of the IAU provides us with an opportunity to share our excitement and new insights into the workings of our active star with colleagues from other disciplines in astronomy. Solar and stellar talks are presented side by side on state-of-the-art observations and modeling of activity patterns, flares and CMEs, 3D views of the Sun and active stars from their interiors to their atmospheres and astrospheres, including highlights from the Kepler mission. ■

Lucie Green
from UCL-MSSL, one of the speakers at JD3

Lidia van Driel
UCL-MSSL, Paris Obs. and Konkoly Obs., the President of IAU Commission 10 (Solar Activity) and Editor of Solar Physics

New horizons for young astronomers

The Young Astronomers Events at the XXVIII General Assembly

The Young Astronomers Events (YAE) were first introduced at the 2006 IAU General Assembly, with the aim of stimulating networking opportunities between senior astronomers and those at the start of their careers. Following a successful second series of YAE in 2009, it has become a valued regular in the GA programme.

This year, the first YAE event is a "Young Astronomer Lunch-Debate", sponsored by the US National Academy of Sciences, the National Science Foundation and the Norwegian National Academy of Sciences and Letters, which will take place on Thursday, 23 August from 11:00 to 13:30. At the event, around 250 young astronomers will have the opportunity to meet with members of the IAU Executive Committee and astronomers from prestigious institutions around the world. The invited senior astronomers have a wide range of expertise and areas of interest. They will give advice, exchange ideas and discuss opportunities for postdoctoral positions, as well as other career and employment opportunities.

This is a closed event, which required prior registration. The attendees (both young and senior astronomers) can claim their vouchers at the booth of the Office of Astronomy for Development (OAD) in the exhibition area before closing time on 22 August. Latecomers can request to be added to the waiting list.

The second event, "Young Astronomer Consulting Service"(YACS), is open throughout the GA to all young astronomers attending the GA. Through YACS, young astronomers can contact a senior astronomer at the conference from their research field and seek practical advice and assistance. Young astronomers wishing to use this service can make an appointment at the Office of Astronomy for Development (OAD) booth. ■

Michele Gerbaldi *(gerbaldi@iap.fr)*, **Vivien Reuter** *(vreuter@iap.fr)*, **Kevin Govender** *(kg@astro4dev.org)* **and the Young Astronomers Supporting Team**

Very Massive Stars in the Local Universe

While Very Massive Stars (VMS) with over 100 solar masses have been claimed to exist in the very early Universe, recent studies indicate the existence of such stars in our local Universe. The presence of objects up to ~300 times the mass - and 10 million times the brightness - of the Sun came as a big surprise to many workers both inside and outside the field.

Before the full implications of these findings can be explored, we need to discuss the evidence for VMS in the local Universe. Therefore, we are holding a Joint Discussion at the IAU General Assembly to discuss the determination of both the current and final masses of the most massive stars. The aim is to reach a broad consensus between observers and theorists.

For decades it was a struggle to form stars over 10 solar masses. The reason is that the standard "disk growth" scenario - commonly applied to solar-mass stars - may not work for massive stars, as radiation pressure may halt the inflows onto the newly forming star. Because of this problem, astrophysicists have been creative in forming massive stars by collisions in dense clusters. Very recent disk inflow simulations have however shown that massive stars might form via disks after all.

In light of recent claims for the existence of 300+ solar-mass objects in dense clusters, we shall redress the issue of forming VMS in extreme environments.

The fate of very massive stars is dominated by how much mass is lost into space. We will discuss the mass-loss rates for objects up to 300 times the mass of the Sun, and consider the possible occurrence of so-called "pair-instability explosions", where entire stars become disrupted. This type of explosion may have been dominant in the very early Universe. ■

Jorick S. Vink
Senior research astronomer at the Armagh Observatory in Northern Ireland, UK

Proposed Modifications to Statutes and Bye-Laws of the IAU

(Only the chapters modified are included here; see the complete version in the IAU Information Bulletin IB110 [http://www.iau.org/science/news/161/])

Proposed Modifications to Statutes

~~Rio de Janeiro, Brazil, 4 August 2009~~
Beijing, 21 August 2012

VII GENERAL ASSEMBLY

13. The General Assembly consists of the National Members and of Individual Members. The General Assembly determines the overall policy of the Union.

13.a The General Assembly approves the Statutes of the Union, including any changes therein.

13.b The General Assembly approves Bye-Laws specifying the Rules of Procedure to be used in applying the Statutes.

13.c The General Assembly elects an Executive Committee to implement its decisions and to direct the affairs of the Union between successive ordinary meetings of the General Assembly. The Executive Committee reports to the General Assembly.

~~13.d The General Assembly appoints a Finance Committee, consisting of one representative of each National Member having the right to vote on budgetary matters according to §14.a., to advise it on the approval of the budget and accounts of the Union. The General Assembly also appoints a Finance Sub-Committee to advise the Executive Committee on its behalf on budgetary matters between General Assemblies.~~

13.d The General Assembly appoints a standing Finance Committee to advise the Executive Committee on its behalf on budgetary matters between General Assemblies, and to advise the General Assembly on the approval of the budget and accounts of the Union. The Finance Committee consists of not more than eight members of different national affiliations, including a Chairperson, proposed by the National Members, and remains in office until the end of the next General Assembly.

13.e The General Assembly appoints a Special Nominating Committee to prepare a suitable slate of candidates for election to the incoming Executive Committee.

~~13.f The General Assembly appoints a Nominating Committee to advise the Executive Committee on the admission of Individual Members.~~

13.f The General Assembly appoints a standing Membership Committee to advise the Executive Committee on its behalf on matters related to the admission of Individual Members. The Membership Committee consists of not more than eight members of different national affiliations, including a Chairperson, proposed by the National Members, and remains in office until the end of the next General Assembly.

14. Voting at the General Assembly on issues of a primarily scientific nature, as determined by the Executive Committee, is by Individual Members. Voting on all other matters is by National Members. Each National Member authorises a representative to vote on its behalf.

14.a On questions involving the budget of the Union, the number of votes for each National Member is one greater than the number of its category, referred to in article §10. National Members with interim status, or which have not paid their dues for years preceding that of the General Assembly, may not participate in the voting.

14.b On questions concerning the administration of the Union, but not involving its budget, each National Member has one vote, under the same condition of payment of dues as in §14.a.

14.c National Members may vote by correspondence on questions concerning the agenda for the General Assembly.

14.d A vote is valid only if at least two thirds of the National Members having the right to vote by virtue of article §14.a. participate in it by either casting a vote or signalling an abstention. An abstention is not considered a vote cast.

15. The decisions of the General Assembly are taken by an absolute majority of the votes cast. However, a decision to change the Statutes requires the approval of at least two thirds of all National Members having the right to vote by virtue of article §14.a. Where there is an equal division of votes, the President determines the issue.

15.a **To enable the widest possible participation of Individual Members the Executive Committee may decide that voting on certain issues of a primarily scientific nature, as determined by the Executive Committee, shall be open for electronic voting for not more than 31 days counting from the close of the General Assembly at which the issue was raised.**

15.b **The Executive Committee shall give Members not less than 3 months notice before the opening of the General Assembly of the intention to open certain issues to electronic voting after the General Assembly.**

16. Changes in the Statutes or Bye-Laws can only be considered by the General Assembly if a specific proposal has been duly submitted to the National Members and placed on the Agenda of the General Assembly by the procedure and deadlines specified in the Bye-Laws.

XII BUDGET AND DUES

~~23. For each ordinary General Assembly the Executive Committee prepares a budget proposal covering the period to the next ordinary General Assembly, together with the accounts of the Union for the preceding period. It submits these, with the advice of the Finance Sub-Committee, to the Finance Committee for consideration before their submission to the vote of the General Assembly.~~

23. For each ordinary General Assembly the Executive Committee prepares a budget proposal covering the period to the next ordinary General Assembly, together with the accounts of the Union for the preceding period. It submits these to the Finance Committee for advice before presenting them to the vote of the General Assembly.

23.a The Finance Committee examines the accounts of the Union from the point of view of responsible expenditure within the intent of the previous General Assembly, as interpreted by the Executive Committee. It also considers whether the proposed budget is adequate to implement the policy of the General Assembly. It submits reports on these matters to the General Assembly before its decisions concerning the approval of the accounts and of the budget.

23.b The amount of the unit of contribution is decided by the General Assembly as part of the budget approval process.

23.c Each National Member pays annually a number of units of contribution corresponding to its category. The number of units of contribution for each category shall be specified in the Bye-Laws.

23.d A vote on matters under article 23 is valid only if at least two thirds of the National Members having the right to vote by virtue of article §14.a. cast a vote. In all cases an abstention is not a vote, but a declaration that the Member declines to vote.

23.e National Members having interim status pay annually one half unit of contribution.

23.f National Members having prospective status pay no contribution.

23.g The payment of contributions is the responsibility of the National Members. The liability of each National Members in respect of the Union is limited to the amount of contributions due through the current year.

XV FINAL CLAUSES

26. These Statutes enter into force on ~~4 August 2009~~ 21 August 2012.

27. The present Statutes are published in French and English versions. For legal purposes, the French version is authoritative.

Proposed Modifications to Bye-Laws

~~Rio de Janeiro, Brazil, 4 August 2009~~
Beijing, China, 21 August 2012

I MEMBERSHIP

1. An application for admission to the Union as a National Member shall be submitted to the General Secretary by the proposing organisation at least eight months before the next ordinary General Assembly.

2. The Executive Committee shall examine the application and resolve any outstanding issues concerning the nature of the proposed National Member and the category of membership (§ VII.25). Subsequently, the Executive Committee shall forward the application to the General Assembly for decision, with its recommendation as to its approval or rejection.

3. The Executive Committee shall examine any proposal by a National Member to change its category of adherence to a more appropriate level. If the Executive Committee is unable to approve the request, either party may refer the matter to the next General Assembly.

~~4. Individual Members are admitted by the Executive Committee upon the nomination of a National Member or the President of a Division. The Executive Committee shall publish the criteria and procedures for membership, and shall consult the Nominating Committee before approving applications for admissions as Individual Members.~~

4. Individual Members are admitted by the Executive Committee upon the nomination of a National Member or the President of a Division. The Executive Committee shall publish the criteria and procedures for membership, and shall consult the Membership Committee before admitting new Individual Members.

II GENERAL ASSEMBLY

5. The ordinary General Assembly meets, as a rule, once every three years. Unless determined by the previous General Assembly, the place and date of the ordinary General Assembly shall be fixed by the Executive Committee and be communicated to the National Members at least one year in advance.

6. The President may summon an extraordinary General Assembly with the consent of the Executive Committee, and must do so at the request of at least one third of the National Members. The date, place, and agenda of business of an extraordinary General Assembly must be communicated to all National Members at least two months before the first day of the Assembly.

7. Matters to be decided upon by the General Assembly shall be submitted for consideration by those concerned as follows, counting from the first day of the General Assembly:

7.a A motion to amend the Statutes or Bye-Laws may be submitted by a National Member or by the Executive Committee. Any such motion shall be submitted to the General

Secretary at least nine months in advance and be forwarded, with the recommendation of the Executive Committee as to its adoption or rejection, to the National Members at least six months in advance.

~~7.b The General Secretary shall distribute the budget prepared by the Executive Committee to the National Members at least eight months in advance. Any motion to modify this budget, or any other matters pertaining to it, shall be submitted to the General Secretary at least six months in advance. Any such motion shall be submitted, with the advice of the Executive Committee as to its adoption or rejection, to the National Members at least four months in advance.~~

7.b The General Secretary shall distribute the draft budget prepared by the Executive Committee to the National Members at least eight months in advance. Any motion to modify this budget, or any other matters pertaining to it, shall be submitted to the General Secretary at least six months in advance. The Executive Committee shall consider whether or not to adopt any such motion in a modified budget, which shall be distributed to the National Members at least four months in advance. Should the Executive Committee decide to reject the motion it shall also be submitted to the General Assembly with the reasons for its rejection.

7.c Any motion or proposal concerning the administration of the Union, and not affecting the budget, by a National Member, or by the Organising Committee of a Scientific Division of the Union, shall be placed on the Agenda of the General Assembly, provided it is submitted to the General Secretary, in specific terms, at least six months in advance.

7.d Any motion of a scientific character submitted by a National Member, a Scientific Division of the Union, or by an ICSU Scientific Committee or Program on which the Union is formally represented, shall be placed on the Agenda of the General Assembly, provided it is submitted to the General Secretary, in specific terms, at least six months in advance.

7.e The complete agenda, including all such motions or proposals, shall be prepared by the Executive Committee and submitted to the National Members at least four months in advance.

8. The President may invite representatives of other organisations, scientists in related fields, and young astronomers to participate in the General Assembly. Subject to the agreement of the Executive Committee, the President may authorise the General Secretary to invite representatives of other organisations, and the National Members or other appropriate IAU bodies to invite scientists in related fields and young astronomers.

III SPECIAL NOMINATING COMMITTEE

~~9. The Special Nominating Committee consists of the President and past President of the Union, a member proposed by the retiring Executive Committee, and four members selected by the Nominating Committee from among twelve candidates proposed by Presidents of Divisions, with due regard to an appropriate distribution over the major branches of astronomy.~~

9. The Special Nominating Committee consists of the President and past President of the Union, a member proposed by the retiring Executive Committee, and four members selected by the representatives of the National Members from up to twelve candidates proposed by Presidents of Divisions, with due regard to an appropriate distribution over the major branches of astronomy.

9.a Except for the President and immediate past President, present and former members of the Executive Committee shall not serve on the Special Nominating Committee. No two members of the Special Nominating Committee shall belong to the same nation or National Member.

9.b The General Secretary and the Assistant General Secretary participate in the work of the Special Nominating Committee in an advisory capacity, and the President-Elect may participate as an observer.

10. The Special Nominating Committee is appointed by the General Assembly, to which it reports directly. It assumes its duties immediately after the end of the General Assembly and remains in office until the end of the ordinary General Assembly next following that of its appointment, and it may fill any vacancy occurring among its members.

V SCIENTIFIC DIVISIONS

17. The Divisions of the Union shall pursue the scientific objects of the Union within their respective fields of astronomy. Activities by which they do so include the encouragement and organisation of collective investigations, and the discussion of questions relating to international agreements, cooperation, or standardisation. They shall report to each General Assembly on the work they have accomplished and such new initiatives as they are undertaking.

18. Each Scientific Division shall consist of:

18.a An Organising Committee, normally of 6-12 persons, including the Division President and Vice-President, and a Division Secretary appointed by the Organising Committee from among its members. The Committee is responsible for conducting the business of the Division.

18.b Members of the Union ~~appointed~~ accepted by the Organising Committee in recognition of their special experience and interests.

19. Normally, the Division President is succeeded by the Vice-President at the end of the General Assembly following their election, but both may be re-elected for a second term. Before each General Assembly, the Organising Committee shall organise an election from among the membership, by electronic or other means suited to its scientific structure, of a new Organising Committee to take office for the following term. Election procedures should, as far as possible, be similar among the Divisions and require the approval of the Executive Committee.

20. Each Scientific Division may structure its scientific activities by creating a number of Commissions. In order to monitor and further the progress of its field of astronomy, the Division shall consider, before each General Assembly, whether its Commission structure serves its purpose in an optimum manner. It shall subsequently present its proposals for the creation, continuation or discontinuation of Commissions to the Executive Committee for approval.

21. With the approval of the Executive Committee, a Division may ~~appoint~~ establish Working Groups to study well-defined scientific issues and report to the Division. Unless specifically re-appointed by the same procedure, such Working Groups cease to exist at the next following General Assembly.

VI SCIENTIFIC COMMISSIONS

22. A Scientific Commission shall consist of:

22.a A President and an Organising Committee consisting of 4-8 persons elected by the Commission membership, subject to the approval of the Organising Committee of the Division;

22.b Members of the Union, ~~appointed~~ accepted by the Organising Committee, in recognition of their special experience and interests, subject to confirmation by the Organising Committee of the Division.

23. A Commission is initially created for a period of six years. The parent Division may recommend its continuation for additional periods of three years at a time, if sufficient justification for its continued activity is presented to the Division and the Executive Committee. The activities of a Commission are governed by Terms of Reference, which are based on a standard model published by the Executive Committee and are approved by the Division.

24. With the approval of the Division, a Commission may ~~appoint~~ establish Working Groups to study well-defined scientific issues and report to the Commission. Unless specifically re-appointed by the same procedure, such Working Groups cease to exist at the next following General Assembly.

VII ADMINISTRATION AND FINANCES

25. Each National Member pays annually to the Union a number of units of contribution corresponding to its category as specified below. National Members with interim status pay annually one half unit of contribution, and those with prospective status pay no dues.

Categories as defined in article 10 of the Statutes

I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	2	4	6	10	14	20	27	35	45	60	80

number of units of contribution

26. The income of the Union is to be devoted to its objects, including:

26.a the promotion of scientific initiatives requiring international co-operation;

26.b the promotion of the education and development of astronomy world-wide;

26.c the costs of the publications and administration of the Union.

27. Funds derived from donations are reserved for use in accordance with the instructions of the donor(s). Such donations and associated conditions require the approval of the Executive Committee.

28. The General Secretary is the legal representative of the Union. The General Secretary is responsible to the Executive Committee for not incurring expenditure in excess of the amount specified in the budget as approved by the General Assembly.

~~29. The General Secretary shall consult with the Finance Sub-Committee (cf. Statutes § 13.d.) in preparing the accounts and budget proposals of the Union, and on any other matters of major importance for the financial health of the Union. The comments and advice of the Finance Sub-Committee shall be made available to the Officers and Executive Committee as specified in the Working Rules.~~

29. The General Secretary shall consult with the Finance Committee (cf. Statutes § 13.d.) in preparing the accounts and budget proposals of the Union, and on any other matters of major importance for the financial health of the Union. The comments and advice of the Finance Committee shall be made available to the Officers and Executive Committee as specified in the Working Rules.

30. An Administrative office, under the direction of the General Secretary, conducts the correspondence, administers the funds, and preserves the archives of the Union.

31. The Union has copyright to all materials printed in its publications, unless otherwise arranged.

VIII FINAL CLAUSES

32. These Bye-Laws enter into force on ~~4 August 2009~~ 21 August 2012.

33. The present Bye-Laws are published in French and English versions. For legal purposes, the French version is authoritative. ■

THE ULTRAVIOLET EMISSION OF EARLY-TYPE GALAXIES

Sugata Kaviraj

SOC Chair of JD4, Senior Research Fellow at Worcester College of Oxford, winner of Imperial College Research Fellowship, 1851 Fellowship at Imperial College London, and the Royal Astronomical Society's Winton Capital Award, and will start a faculty position at the University of Hertfordshire in 2013

While our understanding of galaxy evolution has been heavily shaped by the optical wavelengths over the past few decades, modern instrumentation is rapidly opening up new wavelength windows, giving us novel insights into the evolution of the visible Universe. One such wavelength window is the ultraviolet (UV) spectrum, shortward of 3000 angstroms. With the advent of GALEX and deep optical surveys, rest-frame UV analyses of galaxies have now become routine over a wide range in redshift.

The presence of enhanced ultraviolet emission in early-type galaxies, traditionally considered to be old, passively-evolving systems, has been a puzzle for more than 40 years. The observed UV flux plausibly contains contributions from both evolved stars (traditionally referred to as the "UV upturn" phenomenon) and young stars. While the UV upturn is well-characterised observationally, a firm understanding of its origin still eludes us. Similarly, while recent results from GALEX and deep optical surveys strongly indicate the presence of young stars at low and intermediate redshift, the exact mechanism (stellar mass loss, minor mergers, etc.) that drives this star formation is not fully understood. The role of active galactic nuclei in regulating the low-level star formation at late epochs also remains relatively unexplored in galaxy formation models.

This joint discussion meeting will deliver a review of each of the topics outlined above. We aim to discuss the observational evidence for the UV-upturn, for example its correlation with other bulk galaxy properties such as metallicity, and to explore the various theories of its origin. Primarily, these are single-star channels (e.g. stars on the extreme horizontal branch and the post-asymptotic giant branch) and binary stars, both with complex distributions. In addition, recent results on globular clusters suggest that Helium enhancement may play a key role in shaping the horizontal branch and thus the UV-upturn in the host galaxies.

New UV results that demonstrate the presence of young stars in early-type galaxies will be explored, especially in the context of the principal driver of this star formation. Traditional recipes for AGN feedback, which typically truncate star formation in massive galaxies at early epochs, will have to be revisited to accommodate the low levels of star formation observed in nearby early-type galaxies. The discussion will review the role of AGN feedback in the evolution of early-type galaxies and examine how the most recent UV results can further constrain the feedback recipes employed by the models.

With the recently renewed capability of HST (via the Wide Field Camera 3) to image the UV with a high spatial resolution and a wide field-of-view, many exciting results are expected over the next few years. For example, recent star formation should result in UV "fine structure" on small spatial scales, as opposed to the smooth light profile expected from the UV upturn (since it is produced by the old, underlying stellar population). With the advent of the JWST and the extremely large telescopes, it will be possible to trace rest-frame UV-optical emission in early-type galaxies both to unprecedentedly high redshift and at higher spatial resolution than is possible with current instruments. The time is therefore ripe to revisit the old issue of UV emission in early-type galaxies in a new light, with a view to preparing the ground for more definitive studies with forthcoming instrumentation. ■

IAUS 290: FEEDING COMPACT OBJECTS

ACCRETION ON ALL SCALES

It is now widely recognized that accretion is an important factor in displaying the extreme phenomena of compact objects, e.g. white dwarfs, neutron stars, and stellar mass black holes in binary systems, and in producing the most luminous electromagnetic radiations from active galactic nuclei (AGNs). The emissions mainly cover the energy range from radio and optical bands to X-rays and gamma rays. Currently a large number of high-energy space missions and ground facilities provide the best tools to study these diverse accreting behaviors. Although for a long time these high-energy emissions have been the focus of study on accretion flows, it is now clear that the accretion process on all scales is intimately connected to powerful jets. The jets of AGNs have been well known, but the long time scales involved do not allow detailed studies of the connection between accretion and ejection. In the past two decades, the discovery of jets from X-ray binaries has opened a way to study these phenomena in real time, down to time scales as short as hours or even minutes.

The fundamental properties of accretion are expected to be the same for all these objects, with some scaling. It should be possible to identify the basic properties that link together systems of widely different mass, from AGNs to X-ray binaries to cataclysmic variables. The so-called fundamental plane of AGNs and black-hole binaries links the radio and X-ray flux of accreting objects over more than 10 orders of magnitude. Neutron star binaries have been added, although they appear to be under-luminous in radio. This picture, originally developed for black-hole binaries, has been extended to neutron-star binaries and AGNs, and recently to cataclysmic variables, where only a few observations of this type are available. On the side of variability, the mass scaling properties have long been hidden because of the effects due to changes in mass accretion rate, but they have now been discovered: black-hole binaries and AGNs do display properties that can be scaled with mass, while neutron-star binaries present slight differences that are most likely related to their individual peculiarities (mass, magnetic field).

Symposium 290 aims at connecting the lines of research from different classes of objects by bringing together scientists from parallel fields. The main emphasis will be given to common aspects across systems. Different approaches to the measurement of fundamental parameters such as black hole masses and spins will be discussed and compared. These are inevitably linked to accretion models and most likely to the hitherto unknown mechanism for the ejection of relativistic jets, which is ubiquitous and seems to be inhibited only by the presence of a strong ordered magnetic field. ■

Chengmin Zhang

Research professor of astrophysics at NAOC

Astrophysics from Antarctica

The XXVIII General Assembly of the International Astronomical Union kicks off with a symposium with a difference - Astrophysics from Antarctica (IAU Symposium 288, August 20-24, 2012, www.phys.unsw.edu.au/IAUS288), the very first to be sponsored by the IAU in this field of endeavour.

Antarctica presents a land of extremes and one very different from everyday experience, even for astronomers used to working in the deserts of the Atacama or from the peaks of volcanoes. It is also a very different place from what you might imagine from reading about the exploits from the heroic era of Antarctic exploration, a century ago when humans first reached the South Pole. Certainly Antarctica is cold, but the blizzards described in these legendary tales are largely a coastal phenomenon. On the Antarctic plateau, where the ice sheet reaches over 4,000 m above sea level, we find the driest and most stable conditions on our planet, as well as the coldest. This presents remarkable opportunities for a wide range of frontier astronomical observations. Of course, it also presents a challenging locale for humans to work. Technology is, however, pushing back those challenges and making Antarctica a place where frontline astronomical investigations can be conducted.

The first published science in our discipline arising from Antarctic data resulted from the discovery of the Adelie Land meteorite on December 5, 1912. It was to be more than 50 years before another was recognised, but today more meteorites have been found in Antarctica than from the rest of our planet put together. A little over 30 years ago the first optical measurements were conducted from the South Pole.

Today the Pole is home to range of sophisticated experiments in cosmic microwave background (CMB) and neutrino astronomy. Over the past decade, pioneering observatories have been established by several nations at sites on the summits of the Antarctic plateau, where the conditions are at their best for observations from infrared to millimetre wavelengths. China has established Kunlun station at Dome A, the very highest location on the Antarctic plateau, and has announced ambitious plans to build a frontline observatory there. With the GA coming to Beijing, it is an appropriate time for the IAU to mark the coming of age of the field with the staging of the first Symposium about the astronomy being conducted in Antarctica.

Michael Burton

The chair of the IAU's working group for the Development of Antarctic astronomy, with research expertise in star formation and the excitation of molecular clouds

This Symposium runs for the first week of the GA. The opening plenary session, the very first at the GA, provides an overview of the field by John Storey, whose pioneering efforts over the past two decades have done so much to make astronomy on the Antarctic high plateau possible. We then follow with two sessions which discuss our knowledge of the Antarctic environment as it pertains to conducting astronomical observations, presenting the results of comprehensive site testing programs conducted from the high plateau sites of Domes A, C and F as well as the South Pole and a newly established site at Ridge A.

The most remarkable scientific results to have emerged from astronomy in Antarctica come from measurements of the CMB, and the next two sessions discuss these experiments. They include landmark results such as the first clear demonstration that the geometry of the Universe is flat, the first measurements of polarization in the CMB, and the highest resolution measurements yet obtained of its angular power distribution. The plenary presentation here is being given by Nils Halverson, and is centred on the achievements of the 10 m South Pole Telescope.

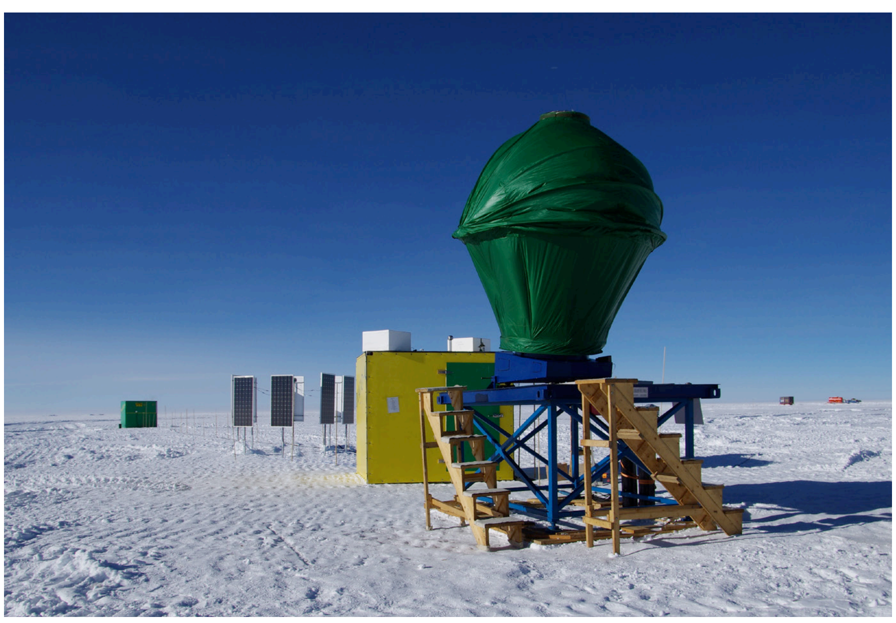
Neutrino astronomy has received the biggest investment of any scientific experiment to be conducted in Antarctica, culminating in the recent completion of the IceCube neutrino observatory, a cubic kilometre array of detectors embedded deep beneath the ice at the South Pole. The first two sessions on August 22 discuss the projects underway on the continent involving neutrinos, with the plenary presentation on IceCube itself being given by Tom Gaisser.

The Symposium also has sessions devoted to cosmogenic signatures found in the ice (such as meteorites), and on traditional observational astronomy in the optical/IR and the sub-mm/THz bands. Here the new opportunities arise from the lowered sky background because of the cold, the sharper imaging and the photometric stability over long time periods arising from the stability of the air, and from the improved transmission through the extremely dry atmosphere.

No developments can take place in Antarctica without extensive logistics and infrastructure to support them. Over the past decade there has been significant investment by the USA, China, France, Italy and Japan at stations spread over the high Antarctic plateau. We have two sessions with presentations from directors of national Antarctic programs about these developments. This also includes long duration high altitude balloon flights, which can provide a sub-orbital platform for an experiment. The plenary presentation here is given by the SCAR Vice President, Sergio Marennsi, on the overall science programs being conducted in Antarctica. SCAR, the Scientific Committee for Antarctic Research, is the peak international body for Antarctica, the IAU's sister ICSU organisation. Finally, we also hear what it is like to actually winter-over in Antarctica and operate a frontline experiment from a scientist who has done just that.

Not to be completely outdone by the southern hemisphere, the Arctic offers conditions that parallel Antarctica in a number of areas, and a session is devoted to the Arctic analogue, and the opportunities for astronomy from the highest peaks of Arctic Ocean islands. Finally the Symposium winds up with two sessions devoted to future facilities and grand visions for what Antarctic astronomy might be able to deliver should major telescopes be built there. We hear from proponents of telescopes proposed for Domes A, C and F and beyond.

The full program for the IAU Symposium can be found at the meeting website www.phys.unsw.edu.au/IAUS288. Each discipline area begins with a talk setting the scene for some of the big questions to be addressed in it, and then follows with presentations about past and current experiments and the results they have obtained. We are sure you will find it a special experience to come and hear about the astronomy taking place at the very ends of the Earth! ■



The AST3-1 (Antarctic Survey Telescope) installed at the Chinese Kunlun station at Dome A. This is the first of three 0.5 m wide-field imaging telescopes to be deployed, and contains an i-band camera with 5,000 × 10,000 pixel CCD and field of view 1.5° × 3.0°. The telescope itself is wrapped in fabric to protect against wind-blown snow, with the hemispheric structure at the top open to expose the telescope to the sky. The yellow and green buildings are the Australian-built PLATO laboratory, providing instrument control and electrical power, respectively, for the Observatory. Photo courtesy Nanjing Institute of Astronomical Optics and Technology.

INQUIRIES OF HEAVEN AND QU YUAN

天问 (translated as *Inquiries of Heaven*, *Heavenly Questions*, *Questions to Heaven*, *Questions into the Universe*) was written about 2,300 years ago by QU Yuan, one of the greatest poets of ancient China. The official newsletter of IAU GA 2012 takes 天问 (*Inquiries of Heaven*, IH) as its title, since the poem represented the very early thoughts of a human being about the cosmos.

IH is special in ancient Chinese verse due to its structure, skepticism and description of myths and ancient cosmology. It is only composed of 173 questions about the cosmos, nature, history and myths, but without answers. How does such a poem fit within the context of the narrative style of Chinese verse, the harmony between mankind and heaven in Chinese philosophy, and the shamanism of Chu culture? This represents an interesting aspect in the study of Chinese culture (To read the whole version of Inquiries of Heaven, please visit http://www.astronomy2012.org/ih).

From Questions 1 to 26, the first canto of *Inquiries of Heaven* concerns cosmic history, the scale and structure of the Universe, the alternation of day and night, the relation between heaven and Earth, and so on, which could even be a research program for a modern astronomer. In this canto, QU reflects on heaven with some of the most universal and fundamental cosmological questions. For instance, "Whoever has convey'd to us stories of the remotest past?" Have you tried to reply to this problem before? "Who can verify the shapeless beginning time has overcast? Who can confirm the world had been a mass without darkness and light? If th' universe was but chaos, what evidence is there in sight?" As an astronomer, you must be familiar with these questions that QU raised.

QU Yuan was living in 340-278 BCE. Before 221 BCE, China was divided into different states, including Chu and Qin. QU Yuan was a noble official descended from a branch of Chu's royal clan. For him insisting on protecting his motherland against the invasion of the State of Qin, he was slandered by corrupt political opponents and exiled twice after 304 BCE. Eventually he drowned himself in the Miluo River. According to legend, *Inquiries of Heaven* was written in the Chu ancestors' temple after one of the two exile trials. The Chinese Dragon Boat Festival is related to memorializing him.

In the Spring-and-Autumn period (771-476 BCE) and Warring States period (476-221 BCE), the Chinese ancients had accumulated abundant knowledge about astronomy, sometimes mixed with myths. After the unfair trial, QU Yuan began to doubt his inherited knowledge and the justice of heaven in his faith, which led him to write *Inquiries of Heaven*. The foundation for him to understand the world began to change from religion to rationality. When I read these inquiries of heaven written thousands of years ago, QU Yuan's skepticism could still resonate in my mind. ■

Yunhao Wu
Assistant research fellow of NAOC, Center of Ancient Chinese Astronomy, editor of Chinese National Astronomy magazine.

TRAVEL TIPS

- **Scams to Avoid**

If you visit a tourist area, especially around the downtown like Wangfujing or Tian'anmen Square, people claiming to be students will often approach you. They are most likely scammers. Examples include people who claim to be art students who bring you to their exhibition and pressure you to buy art at insanely inflated prices. Tea sampling is another scam. It is not uncommon to get a bill for ¥2000, supported by an English menu with the extortionate prices for sampling. In a similar way, young attractive females also claiming to be students try to lure male tourists to shops, restaurants or night clubs. The prices at such places can be extremely high for basically nothing. If you are outside the tourist areas then your chances of being scammed drop substantially.

On the other hand, there are many Chinese tourists who come to Beijing for the first time, and they are genuinely curious about foreigners, especially since foreigners are extremely rare outside of China's major cities. Being asked to have your picture taken is very common. Be friendly, but do not feel pressured to go somewhere you had not originally planned to go.

- **Beijing Subway**

The subway is a good way to quickly reach the conference venue and almost all tourist sites. It is probably the means of transport most suitable for you. Single tickets cost ¥2, regardless of the distance traveled or the number of changes. The only exception is the Airport Express, which requires a separate ticket (¥25). Tickets are only valid on the same day from the station they were purchased, so do not buy many tickets at a single station expecting that they will be useful at different places around the city. Simply buy one ticket for one trip. You will need to keep your ticket during the trip because it opens the exit gate when you want to leave the subway station.

Chinese Classics

xue er shi xi zhi, bu yi yue hu? you peng zi yuan fang lai, bu yi le hu?
学而时习之，不亦说乎？有朋自远方来，不亦乐乎？

Is it not pleasant to learn with a constant perseverance and application?
Is it not pleasant to have friends coming from distant quarters?

Confucius (551-479 BCE)

DAY 1: PROGRAM SUMMARY

PLENARY LECTURE BY JOHN STOREY (8:30 – 10:00):
Astrophysics from Antarctica

INVITED DISCOURSE BY KAREN MASTERS (18:00 – 19:30):
The Zoo of Galaxies

IAUS288 Astrophysics from Antarctica	Understanding the Antarctic Environment & Cosmic Microwave Background
IAUS290 Feeding compact objects: Accretion on all scales	Accretion onto black holes, neutron stars and white dwarfs
IAUS291 Neutron stars and pulsars: Challenges and opportunities after 80 years	Discoveries of pulsars & current theoretical investigations of formation and properties
IAUS292 Molecular gas, dust and star formation in galaxies	Formation and properties of molecular clouds, star formation and outflows
SpS1 Origin and complexity of massive star clusters	Observational evidence of multiple stellar populations
SpS2 Cosmic evolution of groups and clusters of galaxies	Cosmology & Detailed description of clusters
SpS3 Galaxy evolution through secular processes	Overview of secular processes & bars and spiral patterns
SpS4 New era for studying interstellar and intergalactic magnetic fields	New generation of instruments & turbulence and ISM dynamics

JD1 The highest-energy gamma-ray universe observed with Cherenkov telescope arrays
JD2 Very massive stars in the local universe
JD3 3D views of the cycling Sun in stellar context
JD4 Ultraviolet emission in early-type galaxies

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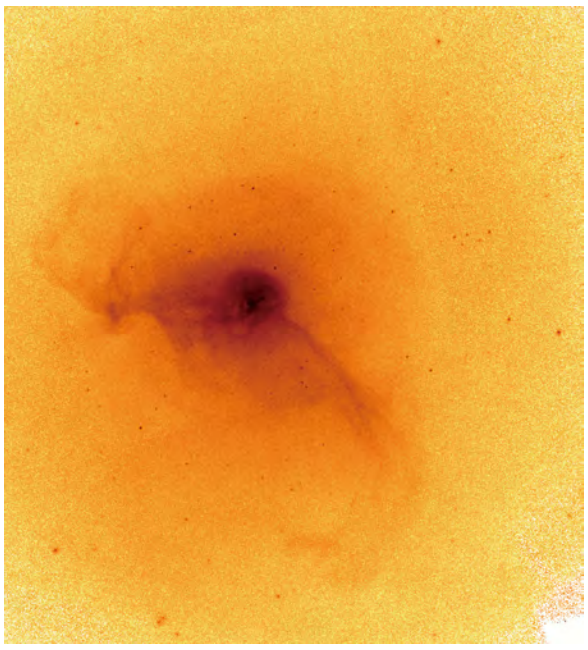
INQUIRIES OF HEAVEN

IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA , AUGUST 20 - 31, 2012 TUESDAY, AUGUST 21, 2012 DAY 2

SpS2: Cosmic Evolution of Groups and Clusters

Understanding how galaxies form and how the large scale structure of the Universe evolves have been long standing questions in astronomy. During the past decade observations across the electromagnetic spectrum have led to a significant advance in the understanding of galaxy clusters and their far more abundant smaller siblings, groups. X-ray observations by Chandra and XMM-Newton have shed light on the astrophysics in cooling cores and cluster mergers and discovered new phenomena such as shocks, cavities and sound waves produced by AGN outbursts and cold fronts produced by sloshing of the central galaxy and cluster mergers. IR, radio and UV observations have illuminated the fate of the cooling gas in cluster cores. Sunyaev-Zel'dovich surveys are now producing statistical samples of clusters out to moderate redshifts. The IAU General Assembly in Beijing presents a great opportunity to bring together observers, theorists and modelers to summarize our present understanding of this field. Four main themes are covered in SpS2:

(1) Groups and Clusters of Galaxies as Cosmological Probes. How large scale structure forms and evolves is now well established through observations on scales of galaxies to large filaments and supported by numerical simulations. Since clusters are extreme objects, the evolving mass function of clusters is very sensitive to the underlying cosmological parameters. Results from X-ray and Sunyaev-Zel'dovich cluster surveys will be presented along with their cosmological implications. Results will also be presented on cluster evolution through mergers based on both observational and theoretical studies.



Chandra image of M87 illustrating the many effects AGN outbursts have on the surrounding cluster gas, including the generation of hydrodynamic shocks, inflated cavities and long filaments of cooler gas.

(2) Cooling Cores and AGN Feedback. Chandra and XMM-Newton observations show that there is a strong feedback mechanism between the central AGN and hot gas in groups and clusters of galaxies. While a significant fraction of the hot gas is prevented from cooling due to AGN feedback, X-ray spectroscopy shows that there is some residual cooling. This has led to a resurgence in studies of cold gas and star formation in cooling cores to determine the fate of the cooling gas. Results will be presented on recent observations of molecular gas, ionized gas and star formation derived from optical, IR and UV observations.

(3) Non-thermal Properties of Clusters. Extended radio emission in galaxy clusters provides insight into cluster parameters otherwise difficult to access, such as magnetic field strength and relativistic particles. Presentations will focus on recent radio observations of clusters and the implications regarding the origin and re-acceleration mechanism of the relativistic particles and other non-thermal phenomena.

(4) The Effects of Environment on Galaxy Evolution. The variety of galaxy morphologies arises in part from interactions with other galaxies and their environment. With current advances in large surveys this area is making rapid progress. These sessions cover a wide range of topics from galaxy evolution in groups, formation of central dominant galaxies, quenching of star formation and galaxy morphologies in high redshift clusters. ■

Laurence P. David

Astrophysicist, Harvard-Smithsonian Center for Astrophysics

Jan M. Vrtilek

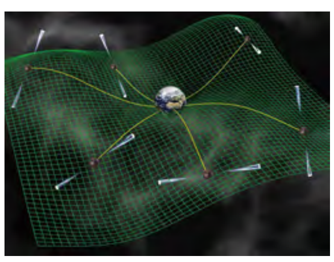
Astrophysicist, Harvard-Smithsonian Center for Astrophysics

IAUS 291: Pulsar Symposium

Symposium 291 "Neutron Stars and Pulsars: Challenges and Opportunities after 80 Years" will be held in Room 311 from Monday August 20 to Friday August 24.

The year 2012 is significant for neutron star and pulsar science, marking the 80th anniversary of both Chadwick's discovery of the neutron and Landau's idea of stars formed of matter at nuclear density. Just two years after this discovery, in 1934, Baade and Zwicky suggested that formation of neutron stars resulted in supernova explosions. With the discovery of pulsars by Hewish and Bell 33 years later, these ideas were finally given a firm observational basis.

The topics chosen for this symposium reflect the great diversity of neutron star and pulsar research and the many manifestations of neutron stars which have become apparent since these initial discoveries and ideas. Pulsars are extremely stable clocks and their timing allows a wide range of investigations including studies of neutron-star interiors, the interstellar medium and binary systems and their evolution. Pulsar timing arrays may give us the first direct detection of gravitational waves and have already enabled the definition of a pulsar-based reference timescale that has a stability comparable to the best terrestrial timescales based on atomic clocks.



Gravity waves cause deviation in the timing residuals of pulsars (Credit: David Champion)

Current radio, X-ray and gamma-ray observations are uncovering new types of objects which blur the distinctions between magnetars, high-magnetic-field radio pulsars and X-ray-detected neutron stars. The symposium program reflects the huge advances made in the last year or so with new discoveries from radio telescopes and especially with the Fermi Gamma-ray Space Telescope. It also looks forward to developments in the upcoming years with the completion of large new instruments such as LOFAR, the European low-frequency radio telescope array, and the 500-m Arecibo-like FAST radio telescope, currently under construction in Guizhou province of China.

- Pulsar searches and discovery
- Pulsar genesis and neutron-star structure
- X-ray and gamma-ray emission from pulsars
- Pulsar diversity – millisecond pulsars, magnetars, XINS, CCOs, RRATs
- A census of Galactic neutron stars – Galactic distribution and evolution
- Magnetospheric structure – pair creation and currents, magnetic decay
- Non-thermal emission physics – radio, X-ray and gamma-ray emission
- Binary pulsars – eclipsing systems, post-Newtonian physics, stellar masses
- Pulsar Timing Arrays – gravitational waves and time standards
- Pulsars as probes of the interstellar medium
- Future facilities - LOFAR, SKA Pathfinders, FAST, SKA

The oral program has 40 invited presentations and 35 contributed presentations covering these topics and more. More than 90 poster presenters have registered and there will be a "1 min/1 slide" oral session for them in the last session on Monday afternoon. Symposium 291 has a Plenary Session on Thursday morning with three excellent speakers, Scott Ransom, Nanda Rea and Michael Kramer, presenting highlights of recent pulsar astronomy and astrophysics. On Friday afternoon there will be a Forum Discussion "Future Facilities, Future Discoveries and Big Questions" introduced and moderated by Jim Cordes, Vicky Kaspi and Dong Lai. Finally, Jocelyn Bell-Burnell will wrap up the Symposium with the Closing Summary. ■

Richard (Dick) Manchester

Professor at the CSIRO Astronomy and Space Science (Sydney, Australia). He is a Fellow of the Australian Academy of Science.

SpS3: Galaxy evolution through secular processes

The idea that galaxies continue to evolve morphologically long after they are fully formed has gained great interest in recent years. Secular evolution, where a galaxy slowly changes its radial and vertical structure, stellar content, even mass distribution over time through subtle internal component interactions or environmental effects, is thought to be the dominant process of change. Bars have long been implicated as the most effective engines of secular evolution because the presence of such non-axisymmetric structures in galactic disks produces gravity torques that move gas radially and affect not only morphology, but also radial abundance gradients. However, exactly how secular evolution takes place, and what processes are most important for it, is still being worked out.

IAU SpS3 is designed to explore the major questions of galactic secular evolution: How do we recognize the secular evolutionary relationships between different galaxy types? In what directions does secular evolution take place (for example, from late to early Hubble types, from barred to non-barred, from pseudo-ringed to ringed, from no bulge to pseudo-bulge)? How does secular evolution affect star formation and radial mixing of stellar populations? What structures do we see in galaxies that are likely end-products of secular evolution (for example, lenses)? What are the lifetimes of bars and spirals? Are such features transient patterns or quasi-steady modes? What roles do collective effects and stellar mass migrations play on galactic transformations? How drastically can secular evolution change the type of a galaxy? How does halo evolution affect a galaxy's structure? What role do resonances play on the structure and evolution of galactic disks?

The goal of the meeting is to examine the idea of secular evolution as a major new framework for understanding the basic properties of galaxies. Both the Milky Way and nearby disk galaxies will be the focus of the meeting, and secular evolution over a wider redshift range will also be discussed. The meeting is the first major conference focused on secular evolution, and is timely because of the significant progress that has been made in the field during the past few decades. The meeting is expected to also have major implications on our understanding of galaxy evolution and cosmology in general. ■

Ron Buta

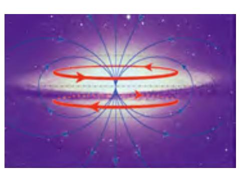
SOC co-chair of IAU SpS3. He is a Professor of Astronomy at the University of Alabama. His main interests are in the morphology and dynamics of galaxies.

SpS4: for studying interstellar and intergalactic magnetic fields

Magnetic fields in the Universe critically affect many physical processes such as the dynamics of the interstellar medium, propagation and acceleration of cosmic rays and transfer of heat. Recent years have seen a tremendous boost in magnetic field research due to simultaneous advances in instrumentation and significant developments in numerical techniques. New radio facilities like LOFAR and EVLA have started running, and new high-quality polarization data spanning the electromagnetic spectrum will be available (e.g from Planck, SMA, ALMA, MIMIR etc). Observers, theorists and computational astrophysicists converge to discuss the results and plan for a new epoch of observing interstellar and intergalactic magnetic fields. SpS4 has 34 invited talks, 20 contributed talks and 23 posters, together with a session for open discussions, covering the topics of:

- Magnetic fields by a new generation of instruments
- Magnetic fields in molecular clouds and star formation
- Magnetic fields and dynamics in the interstellar medium
- Magnetic fields and turbulence
- Magnetic fields in the diffuse Galactic medium
- Magnetic fields in diverse nearby galaxies
- Magnetic fields in the intracluster medium
- Magnetic fields in cosmic structure and in the early universe

Magnetic fields dominate the balance of energy in the Universe on a wide variety of spatial scales; preserving life on Earth from extinction by cosmic rays, influencing star formation in giant molecular clouds, enhancing the enrichment of the intergalactic medium by galactic winds and possibly controlling the growth of individual galaxies and filaments of galaxies. The structure of magnetic fields is determined by ubiquitous astrophysical turbulence and critically affects transport processes, including propagation and acceleration of cosmic rays and transfer of heat. Turbulent magnetic fields play an important role in magnetic field generation via dynamo processes, and must be understood to separate galactic foregrounds from the Cosmic Microwave Background (CMB) signal.



Schematic diagram of the magnetic field in the Galatic halo; notice the ring-like fields with reversed directions below and above the plane.

Despite their importance and ubiquity, magnetic fields remain one of the most poorly understood components of the cosmos due to the challenges involved in both their measurement and theoretical description.

Recent years have been marked by two significant developments. First of all, advances in instrumentation, both in the more traditional radio frequency portion of the spectrum, and in the sub-mm, and even the near-IR and optical, are dramatically advancing our knowledge of the incidence, strength and topology of magnetic fields in astrophysics. For the first time, there is clear evidence for an all-pervasive intergalactic magnetic field according to HESS/FERMI observations. Second, but equally important, significant advances in numerical techniques provided possibilities to simulate magnetized plasmas with realistic turbulent structure and to test theoretical models of how turbulent magnetic fields interact with fully and partially ionized gases and cosmic rays. Combined with progress in the development of techniques to compare numerical and observational data, this makes the field ripe for a breakthrough in understanding of astrophysical magnetic fields, their properties and effects on key astrophysical processes. ■

Jinlin Han

Professor at the National Astronomical Observatories of China (NAOC). His main research interests include magnetic fields of our Milky Way and pulsars.

Public Lecture: (12:30-13:30 August 21 & 12:30-14:00 August 29)

Sky-Gazing and Season-Granting:

Astronomy in Ancient China

The most advanced science in ancient China, and the one which seems to shed the most light on Chinese civilization, is astronomy. The recently discovered Taosi site is perhaps the earliest astronomical observatory in China, dated 4000 years before present. The Chinese had invented many astronomical instruments, culminating with the invention in the eleventh century of the water-powered astronomical clock tower which combined observation, demonstration of celestial movements, and time-reporting into one automatic system. Calendar-making was one of the top priorities of the Chinese rulers. The Chinese calendar provided numerical methods for predicting celestial events such as eclipses and planetary motions. By the eleventh century in China, the accuracy in prediction of planetary motions reached the same level as that in sixteenth century Europe. Portent astrology was of utmost importance to the state because it indicated the ruler's performance in governing. That is why the Chinese had maintained the longest continuous records of celestial phenomena, some of which prove to be unique and provide invaluable data for modern astronomy. Sky-gazing and season-granting were the two major themes of ancient Chinese astronomy, which have constituted an eternal Chinese theme for bringing Heaven and Man into a harmonious unity. ■

Sun Xiaochun

Professor of the History of Science at the Institute for the History of Natural Science (CAS). He is studying archaeoastronomy in prehistoric China and the reconstruction of Su Song's Water-powered Astronomical Clock Tower of the eleventh century China.

Restructuring the IAU:
ONE VISION, FOUR REFORMS

The purpose of this article is to explain the reasons, context, and implications of the Executive Committee Resolution B4, "On the restructuring of the IAU Divisions", presented orally this Tuesday, and proposed to the vote of the GA participants next week. An early version has been presented to the community last February ("Information Bulletin"IB109, p. 37, Feb. 8, 2012: see http://www.iau.org/science/news/146/), and Resolution B4, with a timeline for implementation, can be found in the "Information Bulletin" IB110, pp. 28-29, July 16, 2012 (see http://www.iau.org/science/news/161/).

WHY...

... restructuring the IAU Divisions ? As a brief historical note, the Divisions were created nearly 20 years ago. At that time, they were introduced as administrative "umbrellas" to put the 40 IAU Commissions into a limited number of more or less similarly topical "baskets". The 12 resulting Divisions had their own "Organizing Committees", chaired by a President and a Vice-President. Their structural role, as defined in the statutes, was to monitor the evolution of their Commissions over limited time scales, starting with six years, then renewed if justified for three more years (Bye-laws, Art. 23). But the fact is that, in spite of the tremendous evolution of astronomy over this period, and except for very minor changes, the 12 Divisions and the 40 Commissions did not really evolve, even though most of them were indeed active, producing reports, recommendations, etc., and, perhaps more visibly, selecting IAU Symposia each year.

This situation has long been thought to be unsatisfactory, and after the huge and extraordinarily successful effort of the International Year of Astronomy (IYA) which culminated in 2009, the year of the last GA in Rio de Janeiro, the newly elected Executive Committee (EC) decided to attack this problem. An "EC Task Group on Division Restructuring" ("TG" for short in what follows), chaired by T. Montmerle, was established at the EC meeting in May 2010, with the goal of presenting to the Division Presidents (DPs), at the following EC meeting in Spring 2011, arguments for a new Division structure.

The vision underlying the new structure, as proposed by the TG, was entirely different from the initial approach. Instead of being purely administrative structures, the new Divisions had to reflect the scientific policy of the IAU, and to promote its adaptation to a rapidly changing world on two grounds: astronomy (for professional scientists), as well as society (for the public, to follow up on the IYA).

The first draft of the restructuring consisted not only of a reduction in the number of Divisions, but also in the creation of Divisions of a different nature (more below). This draft was strongly supported by the DPs, who immediately urged the TG to continue its work and reflect on the opportunity to also reexamine Commissions and Working Groups.

To make an almost three-year story short, the TG worked very closely with the DPs and the EC, refining the names and scope of the Divisions, and preparing suggestions for the future evolutions of Commissions and Working Groups. The result is Resolution B4, discussed at the last EC meeting, and proposed for a vote, following the Statutes (Art. 20) which stipulate that any modification of the Divisions should be approved by the GA.

WHAT...

... are the proposed changes? The main change is a new Divisional structure, where the number of Divisions is reduced from twelve to nine. The following table is the "official" one that will be submitted to the GA vote (it is identical to those already published in IB109 and IB110, and is reproduced here for the sake of completeness):

New Division		Estimated membership (*)
Division A	Space & Time Reference Systems	800
Division B	Facilities, Technologies, & Data Science	1400
Division C	Education, Outreach, & Heritage	800
Division D	High Energies & Fundamental Physics	800
Division E	Sun & Heliosphere	1000
Division F	Planetary Systems & Bioastronomy	1200
Division G	Stars & Stellar Physics	2100
Division H	Interstellar Matter & Local Universe	1300
Division J	Galaxies & Cosmology	1900

(*) The Division membership is estimated from a preliminary rearrangement of the existing Commissions within the proposed Divisions. The fact that the sum of the new Division members exceeds the total IAU membership results from multiple Commission memberships. Division names have been agreed to by the current Division Presidents. Div."I" does not exist, to avoid confusion with the present Div.I "Fundamental Astronomy".

We can call this "Reform #1", the one upon which the whole new IAU structure is proposed to rest. When compared with the current Divisions, some obvious "mergers" have been made, e.g., "Stars" (Div. IV) and "Variable Stars" (Div.V), along with other more or less important modifications.

The two most notable changes are the introduction of a large (but not the largest) Division related to Instrumentation in the broadest sense, from laboratory to observation and interpretation (Div.B: "Facilities, Technologies & Data Science"), and a new Division promoting "Education, Outreach & Heritage" (Div.C).

Div.B indeed has a very broad scope. Its ambition is to be the common "forum" where large facilities, multiwavelength instrumentation (without explicit distinction between ground and space), large surveys and databases (data mining, astrostatistics, etc.), as well as computer science and mathematical methods, etc. can be discussed and expertise exchanged.

Div.C is meant to be the structure where the community will be encouraged to discuss new educational and outreach methods, as well as preserving astronomical heritage (historical sites, dark sky issues, etc.). The introduction of this Division should be put in the context of the IAU Strategic Plan, adopted at the Rio de Janeiro GA in 2009, which called for the creation of an Office of Astronomy for Development (OAD). The OAD is now off and running, with three recently established "Task Forces"("Universities and Research", "Children and Schools", and "Public"; see http://www.iau.org/science/news/157/). The OAD is based on an EC initiative, funded by the IAU and essentially focused on developing countries. In contrast, while a good coordination with the OAD is mandatory, Div.C is a place where many other initiatives (Working Groups, etc.) can come directly from the community (for instance, concerning developed countries; research on teaching and pedagogy for science; links to Virtual Observatories, etc.).

Altogether, in essence the proposed Divisions will be the visible backbone of the IAU. Their scientific role will be much increased compared to that in the existing structure. With the help of the newly established "Division Steering Committees" (see below), the Division Presidents will be the natural points-of-contact between the community and the EC: as a result, they will collectively constitute a de facto "Advisory Committee" to the EC. This is the approach that was already adopted in practice by the TG and DPs in the present reform initiatives, and it has proved to work very successfully.

In view of the GA vote, a slate of new DPs and DVPs, with significant "new blood", is being presented by the EC to National Representatives for approval. These colleagues are committed to making the proposed Restructuring successful. (Another, different slate is also being presented to National Representatives in case the new structure is not adopted, so the IAU activities will continue whatever the result of the vote.)

HOW...

... will the restructuring be implemented ? Should Reform #1 be adopted, the proposed timeline is presented in IB110. One can see that a positive vote on the new Divisions implies other important structural reforms.

- Reform #2: the "main membership" of the IAU will be by Divisions (one or more), not by Commissions. Membership of Commissions will come next, but it will be perfectly acceptable to belong to a Division, and not to a Commission, if those existing Commissions are not relevant to one's research or activity. This is a good incentive to create new ones (likely starting by a Working Group)! The procedure will be by e-voting (see "Proposed Modifications to the Statutes and Bye-Laws", Arts. 15a and 15b, in IB110, and also published in yesterday's issue of "Inquiries of Heaven").

- Reform #3: election of "Division Steering Committees" (DSCs), organized by the DPs and DVPs of the new Divisions. Their exact composition will be discussed between DPs and with the EC, on a case-by-case basis. They are expected to have a much more scientific role than the current "Organizing Committees".

- Reform #4: as the name implies, once elected the DSCs will have the primary task of "steering" the evolution of the Divisions, in particular of its Commissions (reexamining their role, goals, issues, etc.), under EC supervision. Note that in the proposed structure a Division will be larger than the sum of its Commissions (contrary to the founding definition of Divisions). Other related internal problems (like, if necessary, a change of name) may also be addressed, subject to approval by the EC.

As stated in the timeline presented in IB110, the goal is to have a preliminary version of the new structure (including Commissions) in place by Spring 2014, and running hopefully smoothly for the 2015 GA in Honolulu. ■

Thierry Montmerle
IAU Assistant General Secretary;
Professor at IAP (Paris)

SpS1: Formation of Massive Star Clusters

In the last few years, numerous observational studies have provided us with strong evidence that star clusters host multiple stellar generations and subverted the standard view according to which these systems were the prototype of 'simple stellar populations'. These findings have raised a number of fundamental questions on the origin and evolution of massive star clusters:

- What is the sequence of events that led to the presence of multiple stellar populations?
- What is the source of polluted gas out of which second generation stars formed?
- What is the age difference among different stellar populations?
- What are the clusters' initial properties (mass, structure, stellar IMF) necessary to allow the formation of subsequent stellar generations?
- If indeed, as suggested by several models, the current mass of second generation stars requires that globular clusters were initially significantly more massive, what is the relation between these objects, dwarf galaxies and dwarf galaxy nuclei?
- Nuclear star clusters also show evidence of multiple stellar generations. Do nuclear clusters and globular clusters share any fundamental step in their formation history?
- If the currently observed globular clusters were initially significantly more massive, what are the implications for their contribution to the Galactic halo formation history?
- Can the different populations be used as tracers to understand the role played by massive star clusters in the Galactic halo assembly?
- What are the differences and the similarities between the chemical properties of stars in globular clusters, dwarf galaxies and in the Galactic halo? And what can be learned from these about possible differences and similarities in their origin?
- Are there young star clusters currently undergoing the sequence of events that led to the presence of multiple stellar populations in old massive star clusters? Can observational evidence of multiple stellar populations be found in young and old extra-galactic stellar systems?
- What are the long-term dynamical implications of the initial conditions required to form multiple stellar populations?

The expertise of observational and theoretical researchers working on stellar evolution, nuclear astrophysics, hydrodynamics, stellar dynamics, photometric and spectroscopic observations is absolutely crucial in any attempt to make progress toward an answer to these complex questions.

The goal of Special Session #1 (SpS1) is to address these issues and bring together scientists spanning the necessary broad range of expertise.

SpS1 will facilitate the exchange of ideas among scientists working in different fields which do not often overlap and who do not usually communicate with each other. SpS1 will also allow specialists in different fields to have a global view of all these topics and to better appreciate the network of constraints and implications coming from observations and theoretical studies of these issues.

SpS1 will surely play an important role in facilitating the formation of new collaborations and, more in general, in guiding the future research in all the different aspects of the study of massive star cluster formation. ■

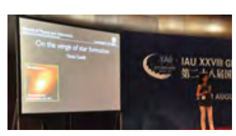
Giampaolo Piotto

Co-chair SpS1 and Professor at University of Padova. His main scientific insterests are: stellar populations in star clusters, search for exoplanets

Enrico Vesperini

Co-chair SpS1 and Assistant Professor at Indiana University. His scientific interests: stellar dynamics; dynamical evolution and formation and evolution of multiple stellar populations in globular clusters

Scenes from the first day of the IAU



Day 2: Program Summary

Plenary lecture by Mordecai-Mark Mac Low (8:30 – 10:00): From gas to stars over cosmic time

Lunchtime lecture by Xiaochun Sun (12:30 – 13:30) : Chinese Ancient Astronomy

IAUS 288	CMB
IAUS 290	Multi-wavelength coverage (radio to gamma rays)
IAUS 291	Pulsar diversity
IAUS 292	Gas in galaxies
SpS1	Multiple populations (photometry)
SpS2	Cluster simulations and theory
SpS3	Barred and early-type galaxies
SpS4	Magnetic fields in molecular clouds and star formation

JD1, JD2, JD3 and JD4 will continue

Inaugural Ceremony

Senior government officials will attend the Inaugural Ceremony and give the opening speech. A great honor for us and for the Chinese astronomical community, but it has forced a change to the advertised schedule and increased the levels of security within the CNCC on Tuesday afternoon, at least until the officials leave. The security will entail photo id on registration, no access to Level 4 from 13:00 on Tuesday, and controlled access to Plenary Hall B.

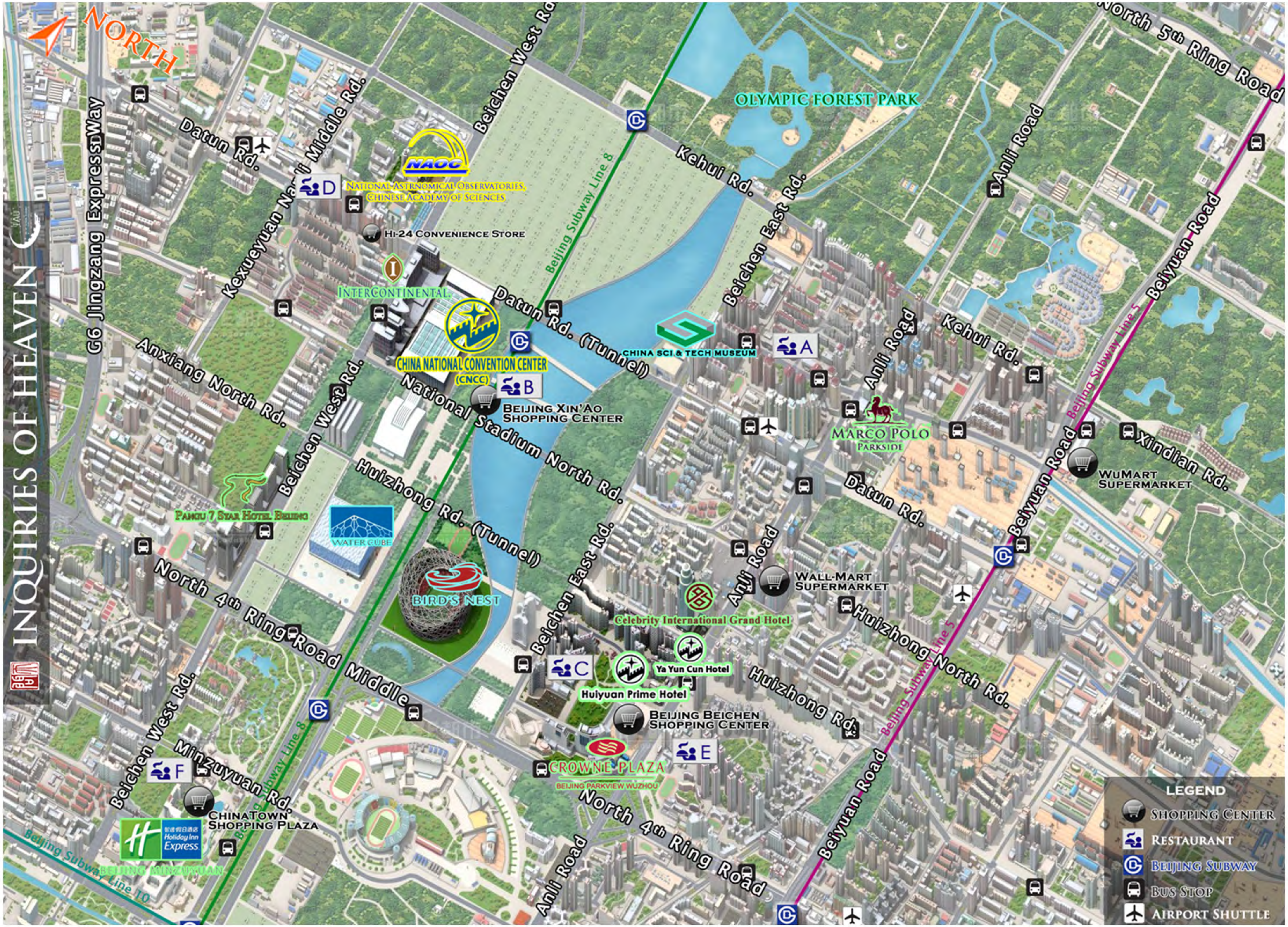
- Please bring official identification (passport or ID) when coming to the CNCC on Tuesday, 21 August
- Only delegates wearing a General Assembly badge with picture identification and stamp will be allowed in Plenary Hall B. The stamp and picture can be obtained in the registration area.
- The doors to Plenary Hall B will open at 13:00
- The doors to Plenary Hall B will be closed at 14:50 and there will be no access to the plenary room until after ~15:15
- No luggage will be allowed inside Plenary Hall. B. Laptops and handbags are allowed. Free storage will be provided by LOC staff on floor 3.
- Please keep your belongings with you at all times

The revised schedule for Tuesday afternoon, as agreed with the LOC, is attached. The points to note are:

- Xiaochun Sun's presentation on Ancient Chinese Astronomy is moved forward to 12:30
- Thierry Montmerle's presentation of the proposed Divisional structure changes is now at 13:30 and does not form part of the First Session.
- Dov Jaron from ICSU will speak immediately after Thierry's talk.

We appreciate your collaboration and apologise for any inconvenience.

INQUIRIES OF HEAVEN (天 问) **is the official newspaper of the IAU General Assembly 2012. Online version**: www.astronomy2012.org/ih **Contacting email:** heaven@nao.cas.cn. It is published by Research in Astronomy and Astrophysics in collaboration with China Features of Xinhua News Agency, Amateur Astronomer, and Chinese National Astronomy. **Advisor:** Thierry Montmerle; **Editor and Associate Editors:** Jingxiu Wang, Xiaowei Liu, Shude Mao, Shuang-Nan Zhang, Yongtian Zhu; **Editorialists and Language Editors:** Peter Anders, Thijs Kouwenhoven, Sarah Reed, James Wicker, Marcel Zemp; **Art and Technical Editors:** Yangyang An, Geng Li, Jian Li; **Managing Coordinator:** Suijian Xue; **Secretary:** Lan Wang; **Editorial Assistant:** Jingyi Huang.


NORTH
INQUIRIES OF HEAVEN
OLYMPIC FOREST PARK
North 5th Ring Road
Datun Rd.
Kexueyuan Nanli Middle Rd.
G6 Jingzang Expressway
Beichen West Rd.
NAOC
NATIONAL ASTRONOMICAL OBSERVATORIES, CHINESE ACADEMY OF SCIENCES
D
Beijing Subway Line 8
Kehui Rd.
Beichen East Rd.
Anli Road
Beiyuan Road
HI-24 CONVENIENCE STORE
INTERCONTINENTAL
Datun Rd. (Tunnel)
CHINA NATIONAL CONVENTION CENTER (CNCC)
B
CHINA SCI & TECH MUSEUM
A
Kehui Rd.
Anxiang North Rd.
National Stadium North Rd.
BEIJING XIN'AO SHOPPING CENTER
MARCO POLO PARKSIDE
Xindian Rd.
WUMART SUPERMARKET
Beijing Subway Line 5
Huizhong Rd. (Tunnel)
PANGU 7 STAR HOTEL BEIJING
WATER CUBE
BIRD'S NEST
Datun Rd.
WALL-MART SUPERMARKET
Celebrity International Grand Hotel
Huizhong North Rd.
North 4th Ring Road Middle
C
Ya Yun Cun Hotel
Huiyuan Prime Hotel
BEIJING BEICHEN SHOPPING CENTER
Huizhong Rd.
E
CROWNE PLAZA
BEIJING PARKVIEW WUZHOU
Beichen West Rd.
Minzuyuan Rd.
F
CHINATOWN SHOPPING PLAZA
Holiday Inn Express
BEIJING MINZUYUAN
Beijing Subway Line 10
North 4th Ring Road
Anli Road
Beiyuan Road
LEGEND
SHOPPING CENTER
RESTAURANT
BEIJING SUBWAY
BUS STOP
AIRPORT SHUTTLE

IN THE SURROUNDINGS

INSTRUCTIONS FOR MAP

The logos are denoted by colored edges with three different colors:

Yellow edge – Meeting Place
Green edge – Accommodation
Blue edge - scenic spot

RESTAURANTS

- Listed prices are average consumption, just for reference.
- Tips are NOT necessarily paid in any restaurants.
- More delicious food can be found by yourself!

AREA A

Meizhou Dongpo Restaurant (Sichuan dish)	¥70 RMB /Person
Golden Jaguar Restaurant (Seafood buffet)	¥210 RMB /Person
ShunFeng Restaurant (Guangdong dish)	¥350 RMB /Person
Wuming Restaurant (Jiangsu dish)	¥270 RMB /Person
Western Region Restaurant (Xinjiang dish)	¥93 RMB /Person

AREA B

Charlie Brown Coffee	¥37 RMB/Person
Roasting House Coffee	¥40 RMB /Person
McDonald’s	¥30 RMB /Person
Huguosi Refreshments (Beijing dish)	¥20 RMB /Person
Yanji Grim (Korean dish)	¥30 RMB /Person
Nadu Spicy Hot Pot (Sichuan dish)	¥70 RMB /Person

AREA C

Daole Japanese Restaurant	¥170 RMB /Person
UBC Coffee	¥60 RMB /Person
Xiangjiang Beishang (Hunan dish)	¥60 RMB /Person

AREA D

Dayali Roast Duck (Beijing dish)	¥60 RMB /Person
Mingchao Restaurant	¥45 RMB /Person
Daqinghua Dumplings (Beijing dish)	¥50 RMB /Person

AREA E

Wangpin Taishuo Steak (Western food)	¥300 RMB /Person
West Hunan Dish	¥75 RMB /Person
Brazilian Churrascos	¥175 RMB /Person

AREA F

China Town Plaza Seafood Buffet	¥104 RMB/Person
Master Kong Beef Noodle (Taiwan dish)	¥40 RMB /Person
Duck King Roast Duck (Beijing dish)	¥125 RMB /Person
Aola Spicy Chaffy Dish	¥70 RMB /Person

INQUIRIES OF HEAVEN

IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA , AUGUST 20 - 31, 2012 WEDNESDAY, AUGUST 22, 2012 DAY 3

Exploring the vast universe hand in hand, Working together toward a better future for humankind

– Speech at the opening ceremony of the 28th IAU General Assembly

Dear honored chairman, ladies, gentlemen, and friends,

Today, more than 2000 astronomers from all over the world gather together in Beijing to attend the 28th General Assembly of the International Astronomical Union. This is a grand event for astronomy. It is the first time for China to host an IAU General Assembly since China joined the IAU in 1935. On behalf of President HU Jintao, the Chinese Government, and the Chinese people, I am here to express our warm congratulations to this General Assembly, and express our sincere gratitude and cordial welcome to all attendants.

Astronomy, as the science to explore the universe, is one of the most important and the most active scientific frontiers that has pushed forward natural sciences and technology, and led to the advances of modern society. It has tremendously important influences on the progress of other branches of natural science and the development of technology. The vast expanse of space always stirs the curiosity of human beings on the earth, fascinates them, and has attracted generations after generations to devote themselves to the exploration of the universe. As the science to study the position, distribution, motion, morphology, structure, chemical composition, physical properties, origin, and evolution of the celestial bodies and matters in the universe, astronomy occupies an important position in the humans' activity of understanding and transforming the world. As we see, every major discovery in astronomy has deepened our understanding of the mysterious universe, every significant achievement in astronomy has enriched our knowledge repository, and every breakthrough in the cross-disciplinary research between astronomy and other sciences has exerted both immediate and far-reaching impacts on fundamental science and even human civilization.

As one of the ancient civilizations in the world, the ancient Chinese used to work after sunrise and rest after sunset, and started to gaze at the starry sky from very early on. At the end of the Warring States period more than 2300 years ago, the great romantic poet Qu Yuan in his "Inquiries of Heaven" queried "Whoever has conveyed to us, Stories of the remotest past? Who can verify the shapeless, Beginning time has overcast?" Our ancestors already built their astronomical observatories as early as 13th century BCE or even earlier, and we have kept the longest and most comprehensive records of astronomical phenomena in the world. Modern astronomy in China started 90 years ago, with the Chinese Astronomical Union being founded in 1922, the Chinese Astronomical Research Institute founded in 1928, and the Purple Mountain Observatory built in 1934. Since the founding of the People's Republic of China, especially since its reforming and opening up, Chinese Academy

Xi Jinping
Vice President, the People's Republic of China

has established the systematic operating mechanism of modern astronomical observatories, after building the large sky area multi-object fiber spectroscopic survey telescope (LAMOST), now is constructing the five-hundred-meter spherical radio telescope (FAST), and is also making progress in space astronomy and Antarctic astronomy.

The advancement of astronomy is the result of the efforts of all humankind, and manifests the wisdom of humanity. The history of its development has offered us very valuable and profound enlightenment.

First, the development of science and technology is the driving force for humankind's exploration and transformation of the materialistic world. Science and technology are the most active, most revolutionary factor in eco-social development. Every grand advancement of human civilization is closely related to the revolutionary breakthrough in science and technology. The development of science and technology has profoundly changed the way people live and work, and science and technology are becoming the main driving forces for eco-social progress. To achieve sustainable eco-social development and wholesome development of human beings, it is critical to rely on scientific progress and technological innovation.

Secondly, the development of science and technology requires persistent exploration and long term accumulation. The exploration of the mysterious universe, just like the explorations of other science branches, should be endless. Science and technology, as the achievements of humankind in their exploration and transformation of the world, are the creative products of scientists only after their persistent exploration and long term accumulation. Only working in full devotion, exploring with never-ceasing steps, furthering continuously on the shoulders of giants, can one reach the pinnacles of science and drive the progress of humankind.

Thirdly, the development of science and technology requires to continuously emphasize and strengthen basic research. Astronomy as an observational science is a very crucial field of basic research. Such a field requires strategic plans for deployment in advance, with full respect to the internal logic of research activities and their long-term benefits. We will make larger and larger investments in such a field and ensure their execution, provide long-term and stable support to scientists, so that the scientists can discover, invent, create, and advance constantly, and make more and more achievements that will benefit humankind.

Fourthly, the development of science and technology requires broad and sound support from the public. Science and technology are a noble course that both benefit and rely on society, and the full development requires not only public understanding from all sides, but also the active participation of the public. Public outreach should be given equal emphasis as scientific research to educate the public, so as to create a positive atmosphere for the public to respect, love, learn and use science, and to inspire the creativity for science and technological innovation among the public.

Fifthly, the development of science and technology requires extensive international cooperation. Science and technology have no nationality! The vast expanse of space is the common home of all humankind; to explore this vast universe is the common goal of all humankind; astronomy in fast development is the shared fortune of all humankind. Nowadays the challenges for science and technology are more and more globalized, and all humankind are faced with the same problems in energy and resources, ecological environments, climate change, natural disasters, food security, public health, and so on. Both basic research such as astronomy and these common problems require scientific and technological exchanges and cooperation in various forms between different nations and districts, in order to push forward science and technological innovation, human civilization, sustainable development, and to benefit all humankind.

Today's world is an open world, and countries are depending on each other more and more heavily. In the past 30 years, China opened its gate not only for economic development, but also for exchanges and cooperation in science and technology. Especially since the advent of the 21st century, China has hosted a series of important international conferences in natural sciences and engineering disciplines, such as the international congress of mathematicians and the World's Engineers' Convention and so on. This has greatly broadened the international horizon of the Chinese science and technology community, deepened the world's understanding of China, promoted mutual exchanges and cooperation between the Chinese and international science and technology communities, and created favorable conditions for the Chinese community to make their contributions to the world.

The convening of the 28th IAU General Assembly in China, I believe, will certainly promote the friendship between Chinese astronomers and astronomers from other countries, promote the exchanges and cooperation between the Chinese and international astronomy communities, and promote the development of China's astronomy and other related sciences. This convention, I believe, will inspire curious youngsters from all over the world including China to cast their attention and desire to the vast universe, and motivate them to devote themselves to the observations and studies in astronomy, and to science and technological innovations.

Finally, I wish this General Assembly a great success, and wish astronomers from all countries to explore the vast universe hand in hand, and to work together toward a better future for humankind.

Thank you, all! ■

Interview with the Nobel Prize Laureate Brian Schmidt

Q: How has the Nobel Prize changed you?

A: Well it certainly made my life very busy. I get to do all sorts of interesting things, but the fundamentals are the same. It's just the amount that I get to do is much larger.

Q: Your discovery opened up the field of dark energy. What is the future of this field?

A: It's unclear. It requires very large experiments. I think we see big experiments continuing on supernovae, but also things like baryon acoustic oscillations are very exciting. A somewhat unexpected thing for me was the weak lensing of the cosmic microwave background. Then there is weak lensing in general through optical galaxies. I was asked once if I could put all my money in one place, where would I put money to solve the questions of dark energy. I'd have to put it into theory, because the evidence is that dark energy is very similar to a cosmological constant. I suspect that's why we are doing experiments. Also, there's a big survey of the southern sky building on the success of the Sloan Digital Sky Survey.

Q: What advice do you have for young astronomers? What are the key skills to form a successful career in Astronomy?

A: You need to be very flexible, in all sorts of things. You do not need to worry about the future so much as to concentrate on what you want to do and learn how to work with other people to accomplish your scientific goals. I think it is very important to say this is what I want to achieve, this is the question I want to do, and go for it. Rather than trying to invent everything yourself, it's very collaborative. Bring the people you need along with you with your vision of where you want to go. That is more or less what I did, and it works very well. Ultimately worrying about the future and being very cutthroat about your science is not going to do you any good in the long term. I think the key is to make sure to do the best you can and accept the fact that there is a random part of what allows you to be a research scientist. Be positive and go for it or be negative and try to take out other people. I always believe in the positive bit. Realize that it is a privilege to do astronomy and our skills are such that we can use them for anything. Revel in the opportunity you have now and the future will take care of itself one way or another.

Q: Astronomy is becoming increasingly international. How do you see China's role in the international scene?

A: I'm familiar with China working in at least three areas in a very serious way. One is LAMOST. This big Galactic archeology project is technically challenging. It will be a new challenge for them. I think it was a bold project. Taking leadership in a project like that is good. I think it will be a challenging project because China has grown up around the site, but it was the right project to do, and that was good. I see China taking a leading role in the Thirty Meter Telescope (TMT). That is a piece of infrastructure in the future, and that is an international collaboration. I see China taking a very strong role in the SKA, and China is leading the way in optical astronomy in Antarctica. Boldly going with a vision where you lead by bringing others with you, I think this is what happens in all these things. Australia is involved with China in Antarctica and that's great! Maybe other countries can be involved as well. LAMOST has scientific input from lots of people. TMT is a massively international project. I see China having huge amounts of people developing technical expertise with amazing ability to do all sorts of manufacturing required in these new telescopes. In 10 or 15 years, you're going to have more astronomers than any other country and I see China being a real leader in astronomy. ■

Interview with the Gruber Prize winner Charles Bennett

Q: What are the scientific highlights of WMAP?

A: In the biggest picture, we now have, really for the first time, a standard model for cosmology. We have set tight limits on the shape of space and determined the expansion history of the universe. It's amazing that we can even rule out specific textbook models of inflation.

Q: What are you working on now?

A: There are still many unanswered questions by WMAP. The one I find most fundamental and fascinating is about inflation. We have from WMAP and some other experiments upper limits on the gravitational wave (B-modes) emitted during inflation. We really want to detect that because the amplitude of that polarisation pattern tells us the energy level of inflation. So I am leading a new experiment called CLASS, designed to detect B-modes from inflation. When completed, it will be deployed in the Atacama desert in Chile.

Q: Will there be future space experiments on polarisation?

A: If we start getting hints of detections on the ground, that will strengthen the call for doing this from space to measure the power spectrum more precisely. Space missions cost a lot and we would like to know there is going to be a signal there to measure. Working from the ground is a much better way to develop the technology and the approach to use later for space missions.

Q: You have worked at NASA for a long time, what are the lessons you have learned?

A: Space missions are very difficult to do, and it takes a lot of people to do them. No person is perfect. Everyone makes mistakes, and there has to be a systematic process to find mistakes. You have to put in various levels of reviewing, double checking, and testing the hardware.

Q: Another issue for any community is: how to reach consensus? You just had the decadal survey in the US?

A: It's a very difficult problem because there are many good things to do. One of the flaws of the decadal survey is that something really has to serve a lot of people for it to get recommended. But if you look at some of the things that have been most important – and I would count for example the Sloan Digital Sky Survey and WMAP – they were NOT recommended by decadal surveys. There was however a program that allowed for things like that to happen. And so these smaller, focused things that are for a smaller group of people – it's very difficult for them to get selected in a big consensus group of scientists. But the consensus group did recommend that there would be an explorer program. I think putting into place several programs that are competitive is a very good thing to do. Then we have a faster turnaround. If something exciting comes up you don't need to wait for another decadal survey or something. We already have a program that can handle it in principle. I'm a very big fan of the explorer program. Both COBE and WMAP were explorer missions. But in that program not everything has to be approved by the entire scientific community. It just has to have a proposal that beats other proposals that time around. I think that's a good thing to do. On the other hand, we would never do the big expensive things if it wasn't for the decadal survey. So I think that's the way to get a balance between the big and expensive things that appeal to lots of people and the smaller focused things that are very important by making sure that the community agrees that there should be these programs. ■

Interviewed by Prof. Shude Mao (NAOC & Manchester). Full transcripts of both interviews will be available online.

Welcome address

I am very honored to welcome you all to the IAU 28th General Assembly (GA) in Beijing on behalf of the Chinese Astronomical Society (CAS).

The Society is very happy to host this GA for the first time in China, especially in this festival year to celebrate the 90th anniversary of the establishment of the CAS.

CAS started to make preparations for the GA in August 2006 when it succeeded in its bid for this meeting. In 2007, associated committees were established to secure the preparation. The collaboration with IAU leadership and staff and experiences from two previous GA meetings have been of great help to us.

I would like to express our sincere gratitude to international counterparts for their continuous support, in particular to Robert Williams, President of IAU, and Ian Corbett, General Secretary of IAU.

I would also like to acknowledge many Chinese scholars and students for their hard work in the preparation, the public for their enthusiasm, and the government for the serious concern and extensive support.

CAS was established in October 1922 and has experienced rapid development, since the founding of the People's Republic of China, and China's opening to the world. At present, CAS consists of 17 Science Committees and has ~2000 members coming from relevant research institutions and universities all over China. Meanwhile, it has over 400 IAU members since it joined the IAU in 1935.

Every year, CAS holds a national Annual Meeting and various kinds of astronomical activities. It has played a vital role in promoting scientific exchange and public awareness of astronomy.

This IAU GA will provide us an opportunity to exchange views extensively with international counterparts. Hopefully, it will promote the development of Chinese astronomy, and provide a platform for international cooperation in astronomy.

Welcome to the IAU 28th General Assembly, and welcome to Beijing. We hope the meeting will be a great success for all of you, and wish you a pleasant stay in Beijing. ■

CUI Xiangqun
Academician of CAS, President of the Chinese Astronomical Society

Understanding Astronomy in China through Recent Major Projects

Dear colleagues,

When I was President of the Chinese Astronomical Society, our application to host the IAU 28th General Assembly in Beijing became successful. Today I am glad to attend the opening ceremony of this GA.

China learned its modern science and technology from the West. However, any nation with some self-respect is not satisfied with always following advanced countries. We hope that one day we can catch up with them, and even surpass them in some fields.

Today I will introduce major projects of Mainland China since 2006. These projects include the following: the Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST), the 21 Centimeter Array (21CMA), the Chinese Spectral Radioheliograph (CSRH), Shanghai 65m Steerable Radio Telescope, the Five-hundred-meter Aperture Spherical Radio Telescope (FAST), the Hard X-ray Modulation Telescope (HXMT), Dark Matter Particle Explorer (DAMPE), Chinese Antarctic Survey Telescope AST3-1, Near-Earth Object Survey Telescope (NEOST), New Vacuum Solar Telescope (NVST), Optical and Near-Infrared Solar Eruption Tracer (ONSET), Deep Space Solar Observatory (DSO), Space Variable Object Monitor (SVOM, a Chinese and French joint mission), and Gamma-ray Burst Polarization Observation Experiment (POLAR). Half of these projects are completed; the others are being developed. Most of these projects have one or more of the following characteristics: 1) they contain important innovations; 2) they are the first projects of their respective types in the world; 3) they give the best performances among projects of their respective types.

For the future, the following projects are being planned or conceived: Antarctic Astronomical Observatory (including a 2.5m optical-infrared telescope and a 5m THz telescope), 20-30m Optical-Infrared Telescope, 110m Steerable Radio Telescope, Large Solar Telescope, LAMOST South, 2m Space Optical Survey Telescope, X-ray Timing and Polarization Mission, etc.

At present China is not yet one of the leading countries in astronomy, but it is approaching this goal. ■

SU Dingqiang
Academician of CAS, Advisor and former president of the Chinese Astron. Society

National Astronomical Observatories, Chinese Academy of Sciences

The National Astronomical Observatories (NAOC) is headquartered in Beijing and has four subordinate units. NAOC operates several observing stations and a wide variety of instruments across the country. In addition, NAOC participates in operating an observation station in South America and is developing a station in Antarctica.

Distribution of NAOC, CAS

Here we will exclusively describe the headquarters (NAOC hereafter). Aiming to be at the forefront of astronomical science, NAOC conducts cutting-edge astronomical studies, operates major national facilities, and develops state-of-the-art technological innovations. Applying astronomical methods and knowledge to fulfill the national interests and needs is also an integral part of the mission of NAOC. In recent years, four National Awards have been granted to researchers at NAOC for excellence in astronomy research.

The Guo Shou Jing Telescope (Large Sky Area Multi-Object Fiber Spectroscopic Telescope, LAMOST) and the Five-hundred-meter Aperture Spherical Telescope (FAST) will be introduced separately in the series, and we will only pinpoint the highlights here. The technology development for LAMOST (active optics for both thin mirrors and segmented mirrors on the Schmidt corrector MA, with a parallel controllable positioning system for 4000 fibers) makes it feasible to fulfill the requirements of a large aperture and a wide FOV simultaneously. FAST uses the unique Karst depression at the site and will be the world's largest single-dish radio telescope when finished.

The Solar Multi-Channel Telescope (SMCT) is a unique video magnetograph that can simultaneously measure the solar 2-dimensional magnetic field and velocity field with different spectral lines.

The 21 Centimeter Array (21CMA) consisting of 80 pods with a baseline of 3 km, which allows us to reach high angular resolution and sensitivity, and provides a unique tool for study of reionization histories and 3D matter distribution at high redshifts. In addition, the 21CMA has also proved to be an efficient neutrino detector.

The Chinese Solar Radio heliograph (CSRH), a radio telescope dedicated to solar observations with high temporal, spatial and spectral resolution, will be implemented to study fundamental problems of energy release, particle acceleration and transportation associated with solar activities, such as solar flares, and coronal mass ejections.

NAOC is also involved with and plays an important role in China's Lunar Exploration Program. NAOC obtained China's first lunar image, the 7-meter resolution full-coverage images of the Moon's surface.

NAOC has also made steady progress in space mission programs. NAOC initiated the Chinese-French Space Variable Object Monitor (SVOM) mission, a multi-band Gamma-Ray Burst (GRB) project. It is designed to detect about 80 GRBs of all known types per year, including those at very high redshift. NAOC is advancing the deep-space Solar Observatory (DSO).

Equipped with a suite of instruments, NAOC participated in the project to quantitatively measure and evaluate astronomical observing conditions, and conduct astronomical research at Dome A.

During the last decade, NAOC has experienced enormous advances. Future large astronomical projects will put even more emphasis on international collaborations, and we are expecting invaluable perspective and advice from our international colleagues. ■

IAU-Gruber Foundation Fellowship 2012 Awarded to Anna Lisa Varri

During the Inaugural Ceremony of the XXVIII IAU General Assembly, the IAU-Gruber Foundation Fellowship 2012, a cash prize of USD 50,000 was awarded to Anna Lisa Varri for her work on stellar dynamics. The winner was born and raised in Milan, Italy. Her interest in astrophysics sparkled during high school when she came across the subject almost by accident in a science textbook. She decided to drop humanities for what it was and enrolled in physics. She was introduced to astrophysics by her supervisor Giuseppe Bertin, working for her master thesis on non-spherical stellar dynamics.

She obtained her Ph.D. from the Universita' degli Studi di Milano (Italy) where she graduated a month ago. Her research focused on understanding the structure and dynamics of globular star clusters using analytical models and numerical simulations. As a Fulbright Visiting Student Researcher, she also spent time at Drexel University, under the supervision of Enrico Vesperini and Stephen McMillan, primarily performing numerical simulations designed to investigate the dynamical stability and the long-term evolution of rotating dense stellar systems.

After having met a previous Gruber Foundation Fellow at Northwestern University and noticing the announcement on the IAU website, Anna Lisa decided to apply for the Gruber Foundation Fellowship. After finding out that she was the winner of the 2012 round, she started her postdoctoral appointment as a Gruber Foundation Fellow at the Department of Astronomy at Indiana University, where the study of Galactic and extragalactic star clusters is a long-standing and prominent research theme, both from the theoretical and observational point of view. Together with Enrico Vesperini (Indiana) and Steve McMillan (Drexel) she will focus her attention on four open problems in this field: the effects of angular momentum in the early formation stages, the dynamical characterization of multiple stellar populations, the role of internal rotation in the kinematics of the central regions, and the interplay between internal rotation and external tidal fields. Congratulations, Anna Lisa! ■

Thijs Kouwenhoven
Professor, Kavli Institute for Astronomy and Astrophysics

Microsoft Research at the General Assembly of the International Astronomical Union in Beijing

Astrophysics is one of the oldest science disciplines and remains one of the most inspirational areas of scientific discovery. In the "big data" era, the IAU 2012 gathering includes researchers and educators not only in the traditional fields of astronomy and astrophysics, but also informatics, data science, and computer science.

Microsoft Research has a long history of working with the astronomical community. The data- and information-intensive problems presented by the All-Sky Surveys and the Virtual Observatory (VO) have stimulated many innovative software science and engineering ideas at Microsoft Research (MSR). One of the most successful outcomes of the collaboration between MSR and the astronomical community is the WorldWide Telescope, WWT.

WWT was originally created as an educational tool, but it has rapidly become the very best example of the all-sky "Virtual Observatory" research astronomers have been working toward since the advent of the Internet. Today, WWT is the single richest source of astronomical imagery and links online, and it is loved by educators and researchers alike. - Alyssa Goodman, Professor of Astronomy, Harvard University

WWT enables a computer to function as a virtual telescope and more. The WWT software aggregates the best data and imagery from all the main space- and ground-based telescopes in the world; connects seamlessly to the information behind the imagery; allows users to lay their own data on top of the common sky and the Earth imagery; and enables users to tell stories with data very easily. Since the first release in early 2008, WWT has gained millions of users worldwide. For many astronomical professionals, especially educators, WWT has made a fundamental difference in their career. With an exponentially growing community, WWT will continue to serve the users and contribute to the advance of computational astronomy research and science education.

At the IAU 2012, Microsoft Research is proudly presenting the WorldWide Telescope at exhibition booth #46. Together with the WWT Ambassadors from Harvard University, academic collaborators from the National Astronomical Observatory of Chinese Academy of Sciences and China Central Normal University, we are ready to impress and engage with IAU 2012 attendees and create more successful stories of WWT.

"I am immensely impressed with WWT as a teaching and outreach tool and what MR has done to make it both appealing and practical. The IAU has recently commenced a large global program to use astronomy as a tool for education and technology development and I believe that WWT should be a key element in that entire effort." - Bob Williams, President of the International Astronomical Union (IAU)

WWT has set forth a successful example for Microsoft to develop mutually beneficial collaborations with academia. In addition to WWT, we are looking forward to introducing visitors at our booth to other cutting-edge Microsoft technologies, including Layerscape, Microsoft Translator, and Kinect for Windows. ■

Yan Xu
Senior Research Program Manager, Earth, Energy, and Environment at Microsoft Research

JD5: From Meteors and Meteorites to their Parent Bodies:

Current Status and Future Developments

Joint Discussion 5 will be held from 22 to 24 August. The aim is to share the latest knowledge on the small Solar System bodies and also the possible parent bodies of meteors, meteorites and interplanetary dust from as wide a perspective as possible. Latest results will be presented from several international campaigns of ground-based observations, space missions to comets and asteroids (HAYABUSA, DAWN, EPOXI, Post-Stardust, Rosetta, etc.) and meteorite falls and recoveries. Together with dynamical studies, these new results will shed light on physical and chemical relationships between such small bodies. Intensive discussion will create effective strategies for future cooperative work, not only in meteor and meteorite studies, but also in related fields. The meteor showers, meteorite falls, and comet appearances recorded in the Far East over the centuries will also be revisited by modern researches. We expect twelve invited and sixteen contributed talks along with sixteen poster presentations. This JD will be dedicated to the late Brian Marsden, who served as a leader of the Central Bureau for Astronomical Telegrams of the IAU for a considerable time; an invited talk by D. Green on August 23 will review his important role in this field. This JD is coordinated mainly by Commission 22 "Meteors, Meteorites, and Interplanetary Dust" in Division III, and is supported by Commissions 4, 6, 8, and 15 in Divisions I and XII. ■

Leonid meteor storm appeared over Japan in 2001 (Credit: M. Tsumura). This storm provided new insight to the evolution of meteor showers.

Junichi Watanabe
President of Commission 22 IAU; Vice-director general of NAOJ

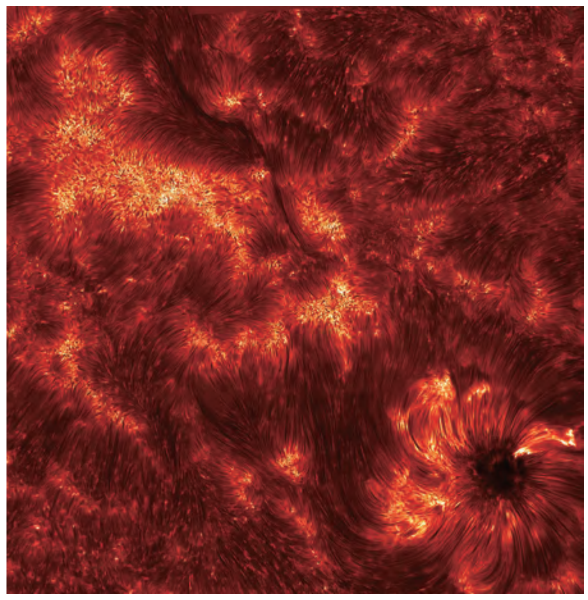
The Age of Large Solar Telescopes

In a drive comparable to that of night-time astronomy towards "Extremely Large Telescopes," several innovative solar telescopes have recently been proposed by the international community.

For many decades, solar telescopes have been built with evacuated optical paths in order to reduce the degrading effects of diurnal seeing, thus keeping their apertures around or below the 1 m limit. However, thanks to technological developments including the feasibility of air-cooled open telescopes for day-time astronomy, and advanced adaptive optic systems, times are now finally ripe for the operation of ground-based solar facilities with much larger apertures.

Newly commissioned telescopes of the 1.5 m class (e.g. NST at Big Bear; GREGOR at Tenerife) are paving the way for many other ambitious projects, including the 4 m US Advanced Technology Solar Telescope (ATST), now under construction in Hawaii and scheduled for first light in 2018, and the 4 m class European Solar Telescope (EST), currently in the design phase. The Chinese community is evaluating the feasibility of an annular solar telescope of 8 m diameter.

Such infrastructures hold promise of a quantum leap in our observational capabilities of the Sun. On the one hand, the increased resolving power of those new facilities will address spatial scales of the order of a few tens of



A solar active region observed in the core of the CaII line at 854.2nm with the IBIS imaging spectrometer.

km at the solar surface (less than 0.1" as seen from Earth), which are predicted by theory to be of fundamental relevance in the structuring of the solar atmosphere. Equally important, the much enhanced collecting power will allow both high cadence and highly accurate spectro-polarimetric measures, necessary to derive precise information about the atmospheric solar magnetic field, an important "player" even under quiet-Sun conditions. Finally, it is remarkable that most of these ongoing projects - from the ground but also from space - are planning to operate their instrumentation as a synergic "suite," capable of addressing the whole solar atmosphere as one seamless system, coupled through the presence of the magnetic field.

The Special Session 6 "Science with Large Solar Telescopes," taking place during this General Assembly, will present and discuss many of these projects and the science that they will enable. An important part of the discussion will be devoted to the new challenges that will accompany operation of these facilities. These challenges include the enormous data streams that the new telescopes will produce (pushing up to 100s of TB/day), as well as the new theoretical and interpretative tools that are needed, especially in the area of spectro-polarimetry, in order to properly interpret the new observations. We envision the Special Session as a starting point for a community-wide discussion on these and other critical issues, for the best exploitation of facilities that will be at the forefront of solar astrophysics for the next decades.

Special Session 6 will take place over 2.5 days starting from the afternoon of Wed. Aug 22, in Room 302A+B. ■

Gianna Cauzzi
Astronomer at the Arcetri Astrophysical Observatory (INAF). She is chairing SpS6 together with Alexandra Tritschler (NSO, USA) and Yuanyong Deng (NAOC).

Astronomy Libraries and You

Are you unsure what your librarians do for you? Would you like to make suggestions about services that could better serve your needs? Come to the sessions organized by the Working Group on Libraries of Commission 5 to find out and to make your ideas known! On Thursday and Friday, August 23. and 24., in Room 409, we are hosting a series of discussions and talks focusing on issues related to the challenges facing astronomy libraries and the role they play in supporting astronomical research. At 08:30 on the 23. we begin with a panel discussion, "Scientists' Need for Libraries in the Age of the Internet." Panelists include astronomers Paul T.-P. Ho (Taiwan), Ray Norris (Australia), and Pieter Degroote (Belgium), and librarians Christina Birdie (India), Eva Isaksson (Finland), and Sally Bosken (USA). Audience participation is encouraged! A particularly timely presentation on "Open Access Publishing in Astronomy" by Uta Grothkopf and Silvia Meakins (Germany) follows at 10:30. The afternoon sessions on Thursday include topics such as tracking publications and the H-index. On Friday at 08:30 Jill Lagerstrom (USA) will discuss bibliometrics, followed by presentations on document preservation and e-books vs. paper books. The Friday afternoon sessions begin at 13:00 and include the topics of digital scholarship and the value of historical books. The day concludes with an open discussion of best practices for institutional bibliographies. Please join us for these sessions, which will undoubtedly bring forward some thought-provoking ideas and should help you to appreciate the complex and rapidly changing environment of scholarly publishing that our astronomy librarians are helping us to navigate.We would like to thank our generous sponsors, IOP, IEEE, SPIE, and Elsevier as well as the IAU LOC, especially Katherine Chen, for outstanding support of the Working Group Libraries. ■

Marsha Bishop
Marsha Bishop (NRAO/USA), Robert Hanisch (STScI/USA), co-chairs, Commission 5 Working Group on Libraries

Commission 14 science meeting

Friday August 24, 14:00-18:00 hr, room 405

Following a brief business meeting, there will be a series of short talks on recent results in atomic and molecular spectroscopy relevant for astronomy as well as data needs from projects such as Herschel and ALMA. Speakers include Mashonkina, Zhao, van Dishoeck, Menten, Caselli and Kwok. The program also contains two guest speakers from the world-renowned Chinese Dalian Institute for Chemical Physics who will highlight state-of-the-art experimental techniques and theoretical methods to study astrophysically relevant reactions. For the full program, see http://home.strw.leidenuniv.nl/~sanjose/IAU_General_Assembly_Commission14. ■

Ewine van Dishoeck
Professor, Leiden Observatory

A Message from Division II

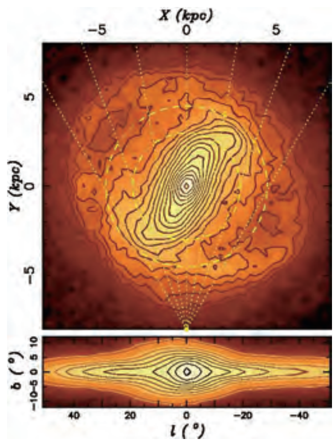
Division II, Solar and Heliosphere, of the International Astronomical Union hosts a Working Group on "International Collaboration on Space Weather" (ICSW). Analogous to the weather in Earth's lower atmosphere, Space Weather involves the changing environmental conditions in near-Earth space or the volume of space from the Sun's surface to the Earth. Space weather can also involve the interactions of solar activity with other planets or at deep-space spacecraft. Much of space weather is driven by energy carried through interplanetary space by the solar wind from solar activity such as flares and coronal mass ejections. The main goal of this WG is to provide a clearinghouse of information on space weather organizations and activities in countries around the world. There will be a meeting of this WG at the General Assembly on August 23 from 8:30 am until noon in Room 403 at the Conference Center. Please see the Chair, David Webb, of the ICSW working group if you wish to give a short presentation about your country's space weather activities. ■

David Webb *Chair, Working Group on "International Collaboration on Space Weather"*

The Milky Way in the age of large surveys

These are exciting times for Milky Way astronomy. Not only are we eagerly awaiting the launch of ESA's Gaia satellite next year, which will measure distances, velocities, and spectral properties for a billion stars, but also many on-going and planned surveys with telescopes all over the world are, and will be, giving us unprecedented new data. Together with the models needed for their interpretation, these data are already bringing about a new era of understanding of the structure and formation of our home galaxy.

The Milky Way, or also "the Galaxy", is one of numerous spiral galaxies, similar to many that can be observed in our local universe. Together with its neighbour, the Andromeda galaxy M31, and a number of smaller systems, it forms the Local Group, a sparse association of galaxies in the outer reaches of the Virgo cluster. Most of the stars in the Milky Way, including the Sun, are found in a rotating thin disk emitting about sixty billion solar luminosities. The central bulge, a three-dimensional system of old stars, contains about 20% of the total light. However, the dominant component by mass is the Milky Way's dark matter halo, reaching



Top: Face-on view of one simulation snapshot, scaled to the Milky Way. Bottom: edge-on view of the same snapshot.

a distance of at least 100 kpc and containing about ten times more mass than all the stars and gas put together.

In its motion around the Galactic centre and up and down in the disk, the Sun is currently inside the layer of gas and dust in the Galactic disk's mid-plane. Therefore much of the inner Galaxy is obscured by dust, and thus it has taken some time to understand that our Milky Way is a barred galaxy with a central box-peanut bulge. Recent sensitive near-infrared surveys penetrated the dust and have made it possible to observe the detailed structure of the bulge, including a characteristic X-structure predicted by galactic evolution models. In these models, such a boxy bulge forms through bar-buckling instabilities in the disk. It has a characteristic cylindrical rotation pattern, and is surrounded by a flatter elongated bar in the disk extending to about twice its radius. Large spectroscopic studies of bulge stars and star counts have verified these predictions and have also given us the first evidence for different evolutionary components in the bulge, characterized by their element abundance distributions and vertical scale-heights. The disk instability in the Milky Way must have occurred long ago. We know this because no young or intermediate-age stars are seen in Baade's Window. If the instability had occurred recently, it should have scattered younger stars up into the bulge.

As for the bulge, we are learning a lot about the Milky Way's stellar and dark matter halo, and about its main baryonic component, the disk. The stellar halo is a small part of the Milky Way, containing only about 2% of the stars. A number of small satellite galaxies and streams have been discovered recently, showing evidence that much of this component may have been accreted from outside as predicted by the hierarchical model of structure and galaxy formation. Recent large spectroscopic surveys of halo stars have also made it possible to measure the mass and extent of the dark matter halo much more accurately than previously possible, resulting in a relatively small total mass for the Milky Way compared with model predictions, about 10^{12} solar masses. A new large survey beginning next year will measure detailed element abundances for a million stars mostly in the disk, and will attempt to group these stars in abundance space in order to learn about their formation environments.

Only in our Milky Way can we obtain detailed information for many individual stars. The results will inspire us about what to look for in external galaxies. What we will learn about the formation of our Galaxy from Gaia and the ground-based surveys- will enlighten our quest to understand galaxy formation in general. ■

Ortwin Gerhard
Professor at the Max-Planck-Institute for extraterrestrial physics (MPE) in Garching, Germany

C41/ICHA Activities at GA

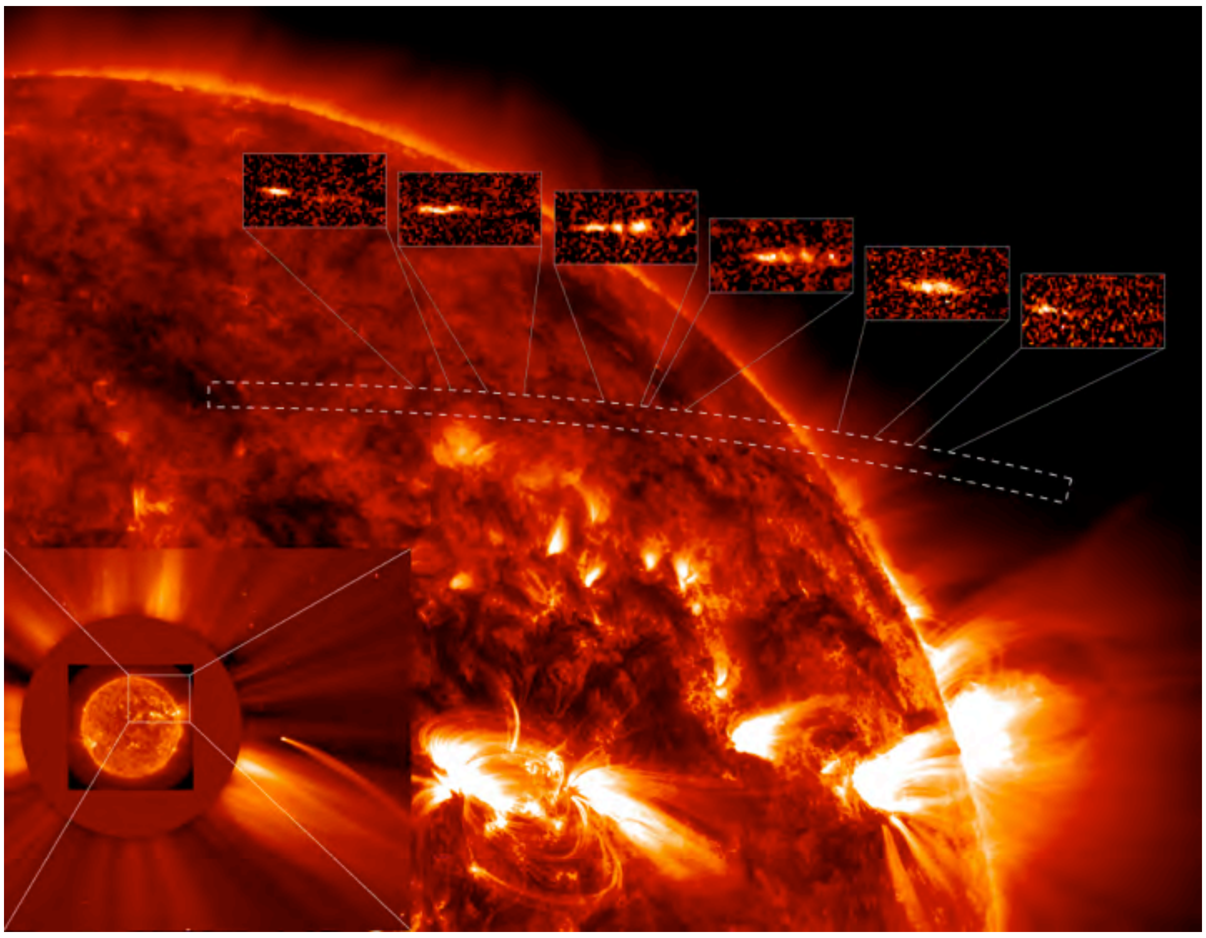
The Commission and its Working Groups have planned a number of business and science meetings at the 2012 IAU General Assembly. As these were not included in the scientific sessions program book, as a service to the general membership of the IAU, we include those for August 22 and 23 in this issue.

Wednesday, August 22 Room 402B
Session 3 (14:00 – 15:30) C41/ICHA Business Meeting
Session 4 (16:00 – 18:00) Invited keynote lecture: "When the Chinese met the West: A Review of the Dissemination and Influence of Indian, Arabic and European Astronomy and Astrology in the Imperial China," by Prof. Shi Yunli, Department of the History of Science, University of Science and Technology of China.followed by … C41/ICHA Science Meeting 1: Field Expeditions (organised by Rajesh Kochhar, Sara Schechner and Jay Pasachoff) Rajesh Kochhar, Chair
16:30 – 16:48 Vitor Bonifácio: The mid 19th and early 20th century pull of a nearby eclipse shadow path
16:48 – 17:06 Françoise Le Guet Tully and Santiago Paolantonio Observatories in South America: from astronomical expeditions to the foundation of national observatories
17:06 – 17:24 Ian Glass: La Caille's expedition to the Cape of Good Hope 1751–1753
17:24 – 17:42 Emanuel S. Mumpun and Bambang Hidayat: Social Impact of the Solar Eclipse in Indonesia: a comparative study
17:42 – 18:00 Discussion

Thursday, August 23 Room 402B
Session 1 (09:00 – 10:30): Sara Schechner, Chair
09:00 – 09:18 Ramesh Kapoor: Did Ibn Sina observe the Transit of Venus of 1032 CE?
09:18 – 09:36 Rajesh Kochhar: Transits of Venus and modern astronomy in India
09:36 – 09:54 Lu Lingfeng: Science news or astrological debating: Chinese records of the transit of Venus of 1874
09:54 – 10:12 J. McKim Malville and John Pearson: The eclipse expeditions of the Lick Observatory and the beginnings of astrophysics in the US
10:12 – 10:30 Jay Pasachoff: Expeditions to death and disaster: Chappe d'Auteroche and Charles Green at the 1769 transit of Venus
Session 2 (11:00 – 12:30): Jay Pasachoff, Chair
11:00 – 11:18 Gennadiy Pinigin and Zhanna Pozhalova: The value of the astronomical expeditions to West Spitsbergen, 40 years later
11:18 – 11:36 Sara Schechner: Astronomy behind enemy lines: Colonial American field expeditions, 1761–1780
11:36 – 11:54 Gudrun Wolfschmidt: Solar eclipse expeditions of Hamburg Observatory
11:54 – 12:12 Chris Sterken: Houzeau's visual magnitude estimates in Jamaica in 1868
12:12 – 12:30 Discussion

Discovery and Classification in Astronomy
Session 3 (14:00 – 15:30): Ken Kellermann, Chair
14:00 – 14:30 Ron Ekers: The Reclassification of Pluto as a Dwarf Planet
14:30 – 15:00 Steven Dick: A General Framework for Discovery and Classification in Astronomy
15:00 – 15:30 Martin Harwit: Discovery and the Search for the Design of the Universe

Session 4 (16:00 – 18:00): Steven Dick, Chair
16:00 – 16:30 Barry Madore: Cognitive Astrophysics
16:30 – 17:00 David DeVorkin: "A Desideratum in Spectrology": an Editor's Lament in the Great Correlation Era
17:00 – 17:30 Ken Kellermann: The Overdue Discovery of Quasars and AGN
17:30 – 18:00 Ray Norris: Mining the Observational Phase Space ■

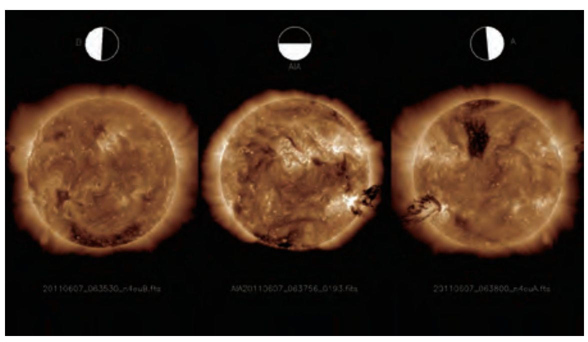


On 2011/07/06 AIA on the Solar Dynamics Observatory observed, for the very first time, the destruction of a Sun-grazing comet C/2011 N3 (SOHO) within the solar corona, by Wei Liu (Stanford Univ & Lockheed Martin Center).

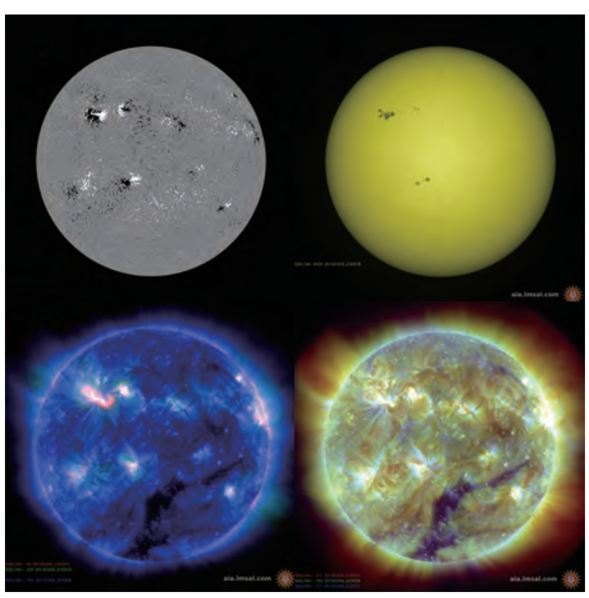
A NEW RENAISSANCE FOR SOLAR AND SOLAR AND HELIOSPHERIC PHYSICSS

In the three years since the last IAU General Assembly much has changed for solar and heliospheric physicists. They are being deluged with multiple terabytes of observational material each day. They achieved global coverage of the nearest star and can image ejections from the Sun to beyond the Earth (with STEREO perspectives since early 2011). They are receiving glimpses of the outermost reaches of the heliosphere (from the Voyagers, after 35 years in flight). They are seeing a revival of solar activity after an unusually low sunspot minimum and associated weak heliospheric field. The analysis of their data and the numerical experimentation throughout the vast and diverse solar-heliospheric realm are supported by computers that continue to grow in capacity in step with Moore's law. The Kepler spacecraft is providing information on tens of thousands of Sun-like stars and their planetary systems, thus complementing the observations of hundreds of similar stars being made by ground- and space-based spectroscopic observatories.

Solar physics continues to be strongly rooted in observations, but in some ways these developments enable it to approach experimental physics. The ever-growing archives of solar observations allow us to find other events occurring under similar yet distinct conditions. The growing stellar database allows us to look for dependencies of processes on surface gravity, rotation rate, chemical composition, or the effects of stellar and perhaps even close-in planetary companions. Virtual observatories in state-of-the-art computers facilitate studying the effects of physical processes from radiative transport to partial ionization, from environments with weak to those with strong magnetic fields, and even to learn about the internal magnetohydrodynamics of a star validated through helioseismic observations. These developments continue to make the Sun and the heliosphere important touchstones to test our emerging approximate physical descriptions prior to applying them to astrophysical conditions for which observations are much more limited.



Three perspectives of a massive solar ejection on 2011/06/07, captured by the AIA/SDO (center) and by the STEREO behind (left) and ahead (right) of the Earth, revealing long-range couplings between magnetically-driven phenomena. Image by Ralph Seguin (Lockheed Martin)



Views of the Sun obtained with the AIA and the Helioseismic and Magnetic Imager on SDO on 2012/03/07, hours before a major X5.4 flare. Clockwise from the top left: magnetogram, visible light image, and two EUV 3-channel composites: 211A/193A/171A (characteristic of 0.8MK-2.5MK) and 94A/335A/193A (2MK-5MK). Images for other dates can be found at http://sdowww.lmsal.com/suntoday/.

Seeing the Sun and inner heliosphere in action from all angles has made us realize that many of the explosive and eruptive events that we observe are influenced not only by local conditions, but also by distant processes, sometimes a full hemisphere away: flares and coronal mass ejections draw their energy from the local electromagnetic field, but the timing of their occurrences, and the details of their evolutions, are influenced both by the gradual change of the large-scale surrounding field and by the details of distant explosions that distort that field on short time scales. As a result, we see "sympathetic flaring" in a new light, aided by the interpretation of numerical experiments that show how sets of flux ropes can cascade into instability as the high field is pulled out of shape like sticky caramel.

The research community is learning how to deal with the rapid increase in data volumes: the growth in the research community of less than a factor of two is no match for the thousand-fold increase in data rates from our observatories over the past decade. Often, finding the data is no longer the primary problem, but rather processing or transportation is. Work is underway to automate feature finding and to enable data analysis tools to work at the archive rather than to move data to the analyst's environment.

As elsewhere in science, the questions are shifting as fast as the answers come in to the preceding set. With local dynamo action now viable in the computer, how do we tackle and validate full-sphere simulations from the Maunder minimum to the 2009 sunspot sabbatical? With transient and partial ionization coming in reach in chromospheric simulations, how do we deal with energetic particle populations escaping from the corona? With climate modeling confirming that global climate in recent decades is insensitive to solar variability, how do we understand regional resonances between weather patterns and the sunspot cycle? As we begin to form a comprehensive picture of space weather from its origins to geospace, how do we establish how to develop defenses for our ever-growing electrical and electronic infrastructure? As we uncover evidence that the most powerful flares seen on young stars no longer happen on the star we live with, how do we validate the tantalizing findings that the societal impact associated with the relatively modest solar events is much larger than we realized?

Solar and heliospheric physics are vibrant, relevant, and exciting fields. Join us in SpS6, SpS10, JD3, or IAUS 294 to see solar and heliospheric science in action. ■

Karel Schrijver
Incoming president of IAU Commission 10 (Solar Activity). He is a senior fellow at Lockheed Martin's Advanced Technology Center

The Opening Ceremony:
From High-Profile Guests to High-Flying Performances

There was a full house in Plenary Room B yesterday for the Opening Ceremony of the General Assembly (GA). While the programme promised fascinating scientific talks, a display of Chinese acrobatics and other entertainment, the main draw for GA delegates was the welcome address by a Senior Government Official. As the ceremony began, the delegates were asked to stand to welcome the arrival of Robert Williams, President of the IAU, and the highly anticipated VIP guest, who was revealed to be Xi Jinping, Vice President of the People's Republic of China.

In his welcome address, Williams spoke of the rich history of Chinese astronomy and the "perceptive studies of the cosmos that were being made 2,000 years ago [in China] that still remain valid today". Looking forward, Williams gave an overview of the many modern astronomical facilities constructed by Chinese institutes, such as LAMOST. These facilities were later discussed in greater detail by invited guest speaker Su Ding-qiang, an Academician of the Chinese Academy of Sciences.

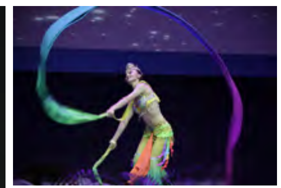
Before handing the podium over to Xi Jinping, Williams commented how the attendance of such a Senior Government Official at the Opening Ceremony demonstrates the high value that the country's government attaches to science.

Indeed, Xi Jinping, who studied chemical engineering at Tsinghua University in Beijing, spoke of the important role that astronomy plays in society. "Astronomy, as the science to explore the Universe, is one of the most important and the most active scientific frontiers that has pushed forward natural sciences and technology, and led to the advances of modern society," he said.

In his speech, Xi Jinping also discussed the importance of disseminating scientific research: "Public outreach should be given equal emphasis as scientific research to educate the public, so as to create a positive atmosphere for the public to respect, love, learn and use science." In closing, he discussed how convening the IAU GA in Beijing will promote international cooperation between astronomers in China and the rest of the world. Xi Jinping left the room to a standing applause of gratitude and appreciation for his inspiring welcome address.

The next order of business at the Opening Ceremony was the 2012 Gruber Prize presentations. Anna Lisa Varri, Università degli Studi di Milano, was announced as the 2012 Gruber Fellow, and Charles Bennett and the rest of the WMAP team were awarded with the 2012 Gruber Cosmology Prize. During his acceptance speech, Bennett thanked his family for their understanding for his "obsessive devotion to the WMAP mission" and added a lighthearted note that, despite his new honour and recognition, he will "continue to do [his] chores and take out the trash".

The magnitude of Bennett and the WMAP team's work in understanding our Universe


Performances at the Opening Ceremony

was later highlighted by Jocelyn Bell-Burnell, during her presentation that looked at how astronomy has changed in the past 100 years, and where it may take us in the next 100.

Given this is likely to be the biggest ever GA, with 3,300 people already registered, it was only fitting that the finale of the Opening Ceremony had an Olympic feel to it. First on the line up was a Chinese drum performance, followed by several traditional dances and a musical instrument performance. And while in other instances the incredibly skilled silk acrobatics would have stolen the show, to an audience of astronomers, it was the mock-up of radio telescopes using silver umbrellas by staff and students from the NAOC that carried favour.

The final word went to Xiangqun Cui, President of the Chinese Astronomical Society, who commented that preparations for this GA started six years ago. Based on the first two days and the wonderful Opening Ceremony, it already promises to have been worth the hard work. ■

Sarah Reed *IAU Public Outreach Coordinator / NAOJ*

Chinese Classics

有物混成，先天地生。寂兮寥兮，独立而不改，周行而不殆，可以为天地母。吾不知其名，强字之曰道，强为之名曰大。

There is a thing integratedly formed and born earlier than heaven and earth. Silent and empty. It relies on nothing. Moving around for ever. We may regard it as the mother of all things. I do not know its name. So I name it as the "Tao", And further name it as the Great.

Lao Zi (c. 6th-5th century BCE)

Day 3: Program Summary

Plenary Talk by Andrew Fabian (8:30-10:00):
Probing General Relativity using accreting black holes

Gruber Lecture by Charles Bennett (12:45-14:00)

Invited Discourse by Brian Schmidt (18:00-19:30):
Supernovae, the Accelerating Cosmos and Dark Energy

IAUS 288	Neutrinos & sub-mm observations
IAUS 290	Jets and outflows & Probing General Relativity
IAUS 291	Binary pulsars & Vibrations and emission & Pulsar timing and testing gravitational theories
IAUS 292	Gas in galaxies & Cooling flow, high-redshift and reionisation
SpS1	Sources of polluting gas & Formation and evolution of globular clusters
SpS2	Cooling Flows and AGN feedback & Cold gas and star formation
SpS3	Stellar populations & The Milky Way
SpS4	Micky way & Diverse galaxies
SpS 6 "Science with large solar telescopes"	Key scientific questions

JD2, JD3 and JD4 continue. JD5 "From meteors and meteorites to their parent bodies: Current status and future developments" starts.

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INQUIRIES OF HEAVEN

IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA , AUGUST 20 - 31, 2012 THURSDAY, AUGUST 23, 2012 DAY 4

THE IR VIEW OF MASSIVE STARS: THE MAIN SEQUENCE AND BEYOND

Though multiwavelength astronomy was born over fifty years ago, the wide-spread use of multiwavelength diagnostics is a more recent phenomenon. Even in the last decade, astronomers continued to rely on the optical domain for the bulk of their analysis. However, this is certain to change, as most of the current and future instruments are increasingly dedicated to observations in the infrared, from the near- to the far-infrared bands.

While the infrared domain is well established in research on low-mass stars, especially the very low-mass ones, the enormous potential for the study and analysis of infrared emission from high-mass stars has yet to be realized. Many advantages of the infrared must however be acknowledged, like its strong potential for circumstellar material and atmosphere diagnostics, and its insensitivity to obscuration. This is important when one considers the typical distances one works to locate massive stars, often in the plane of our Galaxy. The use of infrared diagnostics is particularly relevant with regards to the first generation of stars, thought to be very massive.

This Special Session provides an opportunity to discuss the results obtained for massive stars from existing infrared facilities (VLTs/VLTI, Spitzer, Herschel, CRIRES, GAIA,…) as well as tools for interpreting infrared data (e.g. atmosphere modeling) and observing capabilities of future facilities (ELTs, JWST,…). It is split into three topics.

Carina Nebula in IR (c) ESA
http://www.esa.int/esaMI/Herschel/SEMBCE2XN2H_0.html

The first topic of this Special Session will deal with obscured and distant clusters. To improve the knowledge of the (rare) massive objects, the infrared domain is crucial as it reveals obscured and/or distant clusters, like those close to the Galactic Center. Such studies, by providing many new objects to work on, enable us to better understand the massive stars as a population and to reveal the strong impact of massive stars on the environment and clusters themselves, thanks to the eroding effect of their energetic radiation and dynamical interactions.

The Session will continue with presentations on the determination of stellar and wind parameters of (mostly evolved) massive stars, which remain poorly constrained. However, new wind diagnostics extended to include infrared data are being developed. They provide additional leverage to select between competing wind models (including different clumping scenarios). Metallicity studies also benefit from access to infrared wavelengths, particularly with regards to tracing the chemistry of circumstellar environments.

Finally, the third topic of this Session will consider matter ejection by massive stars (winds, LBV eruptions, supernovae). With the recent reduction in "observed" mass-loss rates (by a factor of about 3), episodic matter ejection represents crucial, but poorly understood mechanisms needed for understanding the evolution of massive stars. ■

Yaël Nazé
Research Associate FNRS, University of Liege, Belgium

Margaret M. Hanson
Professor of Physics, Associate University Dean, The University of Cincinnati, Ohio, USA

JD6: THE CONNECTION BETWEEN RADIO PROPERTIES AND HIGH ENERGY EMISSION IN AGN

Accreting supermassive black holes (SMBH) at the centers of galaxies are responsible for various forms of activity observed in galactic nuclei (AGN).

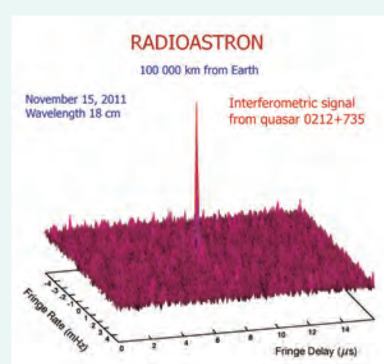
Perhaps the most spectacular is the presence, in a significant percentage of cases, of powerful radio emitting jets which can sometimes be traced from small (milliarcsec/parsec) to large scales (100 kpc and more).

In this JD we would like to discuss: the AGN population as seen in the radio and gamma-ray bands, core and jets properties from high resolution data using a multiwavelength approach, and data variability information.

Moreover we will discuss jet physics and the role of spin and accretion of SMBHs.

Among results that will be presented and discussed at the JD, we quote the following:

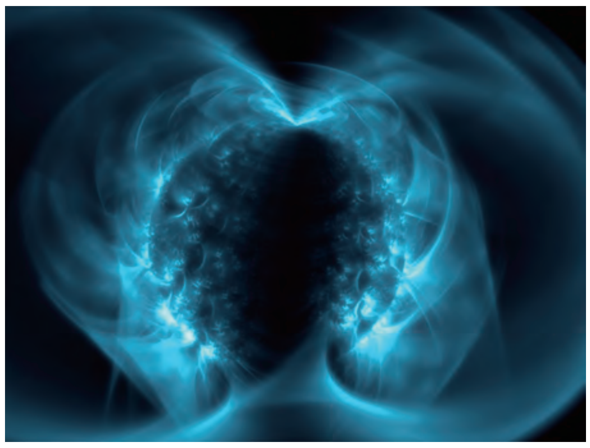
- the first results from the Radioastron Space VLBI mission with the detection of powerfuls Blazars with space-ground baselines;
- the results from the jet kinematics analysis of nearly 200 radio and gamma-ray selected jets by the MOJAVE team indicating that a significant acceleration has occurred after the ejection of pc-scale jet features in high-spectral peaked BL Lac jets;
- theoretical scenarios proposed to understand the short variability (about 10 minutes) in the very high energy (up to 400 GeV) in PKS 1222+216
- accurate models of black hole outflows and the importance of rapidly spinning prograde black holes for energy extraction from SMBHs. ■



Gabriele Giovannini
Full professor in Astrophysics at the Astronomy Department of the Bologna University (Italy)

Magnetars: Neutron Stars with Magnetic Storms

The properties of matter under the influence of magnetic fields and the role of electromagnetism in physical processes are key areas of research in physics, biology, bioengineering, chemistry, geology and many other branches of science. Important technological advances in the past century involve magnetic fields-matter interaction (e.g., NMR, magnetic levitation trains, microwaves, induction burners, many medical tests and radio-therapies). However, despite decades of research, our ignorance of many physical processes related with strong magnetic fields is clear: we only need to note that the strongest steady magnetic field achieved in terrestrial labs is up to hundreds of Tesla, only several thousands of times stronger than a common refrigerator magnet. To test our theoretical predictions for new physical processes and the state of matter under the most extreme magnetic conditions, we have only one possibility: we need to turn to astronomical observations. Among the many different classes of stellar objects, neutron stars provide a unique environment where we can test (at the same time) our understanding of matter with extreme density, temperature, and magnetic field. In this more general contest, in the past few decades, we have just started to approach the research on the most magnetic objects in the Universe, a small sample of neutron stars called "magnetars". Today we know of about twenty of such objects, characterized by an intense



Radio magnetar fractal

X-ray emission thought to be powered by their strong magnetic field (about 10^{14} – 10^{15} Gauss). This powerful X-ray output is usually well modeled by a thermal emission from the neutron star's hot surface (about 3.5×10^6 Kelvin) reprocessed in a twisted magnetosphere through resonant cyclotron scattering, a process favored only under these extreme magnetic conditions. Very weak or no emission is generally observed at other wavelengths. On top of their persistent X-ray emission, magnetars emit very peculiar flares and outbursts on varying timescales (from a fraction of a second to many years) emitting large amount of energy (10^{40}-10^{46} erg). Although far from having a complete picture, from the few well-monitored events, we are starting to understand how those eruptive events are produced. They are probably caused by large-scale rearrangements of the surface/magnetospheric field, either accompanied or triggered by fracturing of the neutron-star crust, a sort of stellar quakes (see *Mereghetti 2008, A&A Rev. 15, 225; Rea & Esposito 2011, ASSP 247* for recent reviews).

However, exactly when we thought to be on the right path on the understanding of these intriguing cosmic magnetars, recent discoveries have prompted new questions on our current knowledge on magnetars. The discovery of a source showing all magnetar-like activity and typical X-ray emission, but having a dipolar surface magnetic field in line with a normal neutron star (a few 10^{12} Gauss; *Rea et al. 2010, Science, 330, 944*) has left us astonished, and eager to understand more about these puzzling sources. The study of the large high-energy emission, and the flares from these strongly magnetized neutron stars, provides crucial information about the physics involved under these extreme conditions, reserving us many unexpected surprises. ■

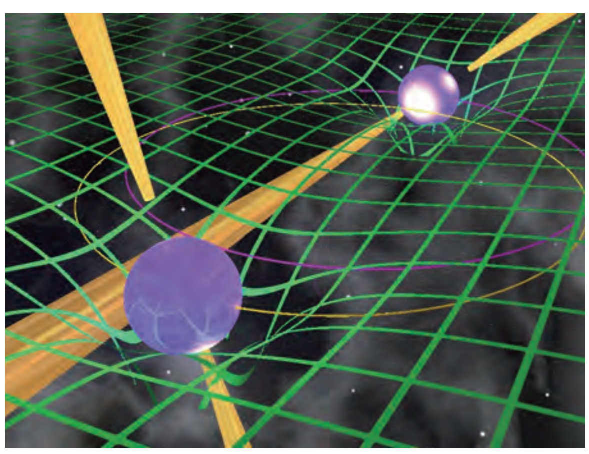
Nanda Rea
Consejo Superior de Investigaciones Cientificas (ICE-CSIC, IEEC), Barcelona, Spain

Probing Gravitation with Pulsars

We are only three years away from celebrating the centenary of Einstein's theory of general relativity (GR). Nearly a hundred years later, efforts in testing GR and its concepts are still being made by many colleagues around the world, using many different approaches. To date, GR has passed all experimental and observational tests with flying colours, but in light of recent progress in observational cosmology, in particular, the question whether alternative theories of gravity need to be considered is as topical as ever.

Many experiments are designed to achieve ever more stringent tests by either increasing the precision of the tests or by testing different aspects. Some of the most stringent tests are obtained by satellite experiments in the solar system, providing exciting limits on the validity of GR and alternative theories of gravity. However, solar-system experiments are made in the gravitational weak-field regime, while deviations from GR may appear only in strong gravitational fields.

We are all very much looking forward to the first direct detection of gravitational waves with ground-based (and hopefully, eventually, space-based) detectors, which not only open a completely new window to the Universe but which will also provide superb tests of GR. Meanwhile, it happens that nature provides us



Artistic impression of Double Pulsar (Image: M.Kramer)

with an almost perfect laboratory to test the strong-field regime - in the form of binary radio pulsars.

While, strictly speaking, the binary pulsars move in the weak gravitational field of a companion, they do provide precision tests of the strong-field regime. This becomes clear when considering that the majority of alternative theories predict strong self-field effects which would clearly affect the pulsars' orbital motion. By "simply" measuring the arrival time of pulsars moving in the curved space-time of their companion, we can locate their position in the orbit with an uncertainty as little as 20-50 m! Hence, tracing their fall in a gravitational potential, we can search for tiny deviations from GR, providing us with unique precision strong-field tests of gravity.

We can detect the effects of the curvature of space-time, the gravitational slow-down of clocks, relativistic spin-precession or the shrinkage of the orbit due to an energy loss by the radiation of gravitational wave energy.

We can also measure them with high precision, and achieve this in a theory-independent way. Our laboratories are pulsars with other pulsars, other neutron stars or a white dwarf. Global efforts are ongoing to find pulsars around black holes (e.g. also in the Galactic centre) or to also use pulsars as gravitational wave detectors. This would finally close the loop - pulsars being emitters as well as detectors of ripples in space-time. Einstein would have liked it. ■

Michael Kramer
Max-Planck-Institut fuer Radioastronomie, Bonn, Germany

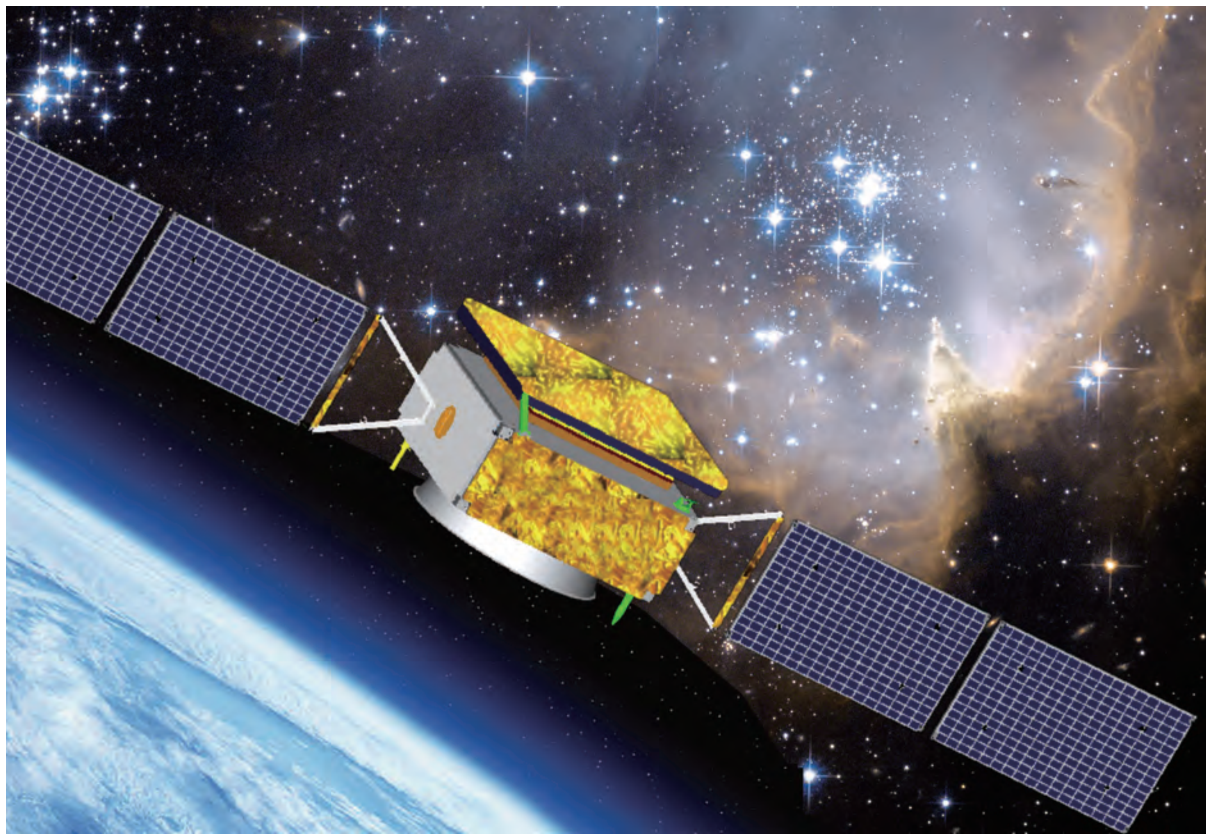
A New Dawn for Chinese Space Astronomers

China's manned space program has won admiration for its engineering prowess. Soon, China's basic researchers will take a star turn. Over the next several years, the country plans to launch nine scientific missions. In addition, scientific payloads are being assembled for the orbiting Tiangong 1 module and for two more modules to be launched in the next 3 years. And scientists are designing experiments for the future space station.

"When I look at astronomy textbooks, none of the discoveries were made by people working in China. I don't see a single photo taken by a Chinese telescope. It's very frustrating," says Zhang Shuang-Nan, an astrophysicist at the Institute of High Energy Physics (IHEP) of the Chinese Academy of Sciences (CAS) in Beijing. "We feel more and more pressure, not just from the top, but also from the bottom, to produce knowledge," adds Wu Ji, director general of CAS's National Space Science Center (NSSC).

Heralding a new era for space science, on 3 May 2011, Wu announced that CAS will undertake five scientific missions in the coming years. CAS has budgeted $554 million over 5 years for the missions and established NSSC last year to oversee the burgeoning program.

Astrophysics is set to take center stage. First off the blocks should be the Hard X-ray Modulation Telescope (HXMT), conceived nearly 20 years ago to observe black holes, neutron stars, and other objects based on their X-ray and gamma ray emissions. HXMT, China's first astronomy satellite, could be launched as early as 2014 and will be the first of three instruments in China's Black Hole Probe Program. Another mission is the lead probe in China's Dark Matter Detection Program. The spacecraft, being designed by CAS's Purple Mountain Observatory in Nanjing, aims to register gamma rays generated when dark matter particles annihilate each other. More missions that have passed preliminary reviews would considerably build up China's clout in space-borne astrophysics. The goal is to get them launched in the next 5-year plan, beginning in 2016. One is the X-ray Timing and Polarization (XTP) telescope, conceived by CAS's IHEP. As the lead facility in the planned Diagnostics of Astro-Oscillations Program, XTP would be "a much more powerful mission that goes far beyond HXMT," says Zhang, the project's leader. XTP would have a larger collection area and powerful mirrors to collect more photons — and thus observe fainter objects and scrutinize them in greater detail, he says. Astrophysicists around the world have been clamoring for just such a telescope, but early last year NASA and ESA canceled plans for an International X-ray Observatory, and a scaled-down version called Athena lost out to a Jupiter probe in an ESA competition which concluded last month.XTP would study X-ray emissions from matter spiraling into a black hole, or X-ray signatures of frame-dragging generated, for instance, as a spinning black hole tugs at spacetime. "We'll look at the physics of extreme conditions," Zhang says.



An artist's conception of the dark matter probe

As the centerpiece of the Portraits of Astrophysical Objects Program, China intends to invest its long-standing expertise in VLBI in new space radio telescopes. China's plan calls for spacecraft that would operate in tandem or as arrays with ground dishes, mimicking a huge radio telescope whose effective diameter is the maximum distance between the instruments.

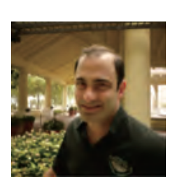
China's proposed array would initially consist of two long-millimeter-wavelength antennas, each 10 meters wide, says Hong Xiaoyu, director of the Shanghai Astronomical Observatory, which is designing the system and is open to international collaboration. The top priority would be to map the fine structure of supermassive black holes that inhabit the center of galaxies and their accretion disks, which are believed to be the power source for active galactic nuclei. Ten years after the first array, Hong says, his team hopes to launch millimeter-wave antennas. Longer baselines and shorter wavelengths produce a higher resolution of radio sources.

The success of the Shenzhou 9 mission in June, featuring China's first crewed docking, opens a new realm for Chinese scientists. The ability to perform docking maneuvers in space will allow China to ferry equipment to Tiangong 1 and add up to two more modules.

A bevy of experiments are now being readied for Tiangong. Astrophysicists also have reason to cheer. Among the approved projects, China and Switzerland are teaming up on POLAR, a gamma ray burst (GRB) detector slated to fly on Tiangong 2 in 2014 as part of the Black Hole Probe Program, which should help scientists determine the structure of a GRB jet's magnetic field, Zhang says. That, in turn, may shed light on the origin of GRBs. One hypothesis is that they are unleashed when a massive star collapses at the end of its life; another is that they are generated when neutron stars or black holes merge. "Each model predicts a different structure of the magnetic field," Zhang says.

Tiangong is a steppingstone to a 60-ton space station China announced last December that it would build by 2020. China Manned Space Engineering Office is expected to approve the first payloads; among those vying for space are a suite of astronomy experiments called the Cosmic Lighthouse Program. One of two proposed large instruments is the High Energy Cosmic Radiation Detection Facility to study dark matter and cosmic rays.

The other instrument would allow China to play a major role in the coming era of large-scale astronomical surveys — and possibly help unravel the nature of dark energy. With its high angular resolution and multiple bands covering optical and near-ultraviolet wavelengths, China's wide-field optical telescope would complement planned instruments elsewhere, such as the Large Synoptic Survey Telescope (LSST), an 8.4-meter dish to be built in Chile that could see first light in 2018, says team member Zhan Hu, a cosmologist at the National Astronomical Observatory of China.If the survey mission passes muster, Zhan is confident that Chinese scientists will have new knowledge to contribute to science. "With surveys, you always find something unexpected," he says. "Current physics cannot explain dark energy. We have an opportunity to discover some revolutionary physics." ■



Richard Stone

Asia editor of Science Magazine. He lives in Beijing.

Next-Generation Solar Telescopes

Open-telescope designs and adaptive optics are paramount for the new generation of solar telescopes going beyond the 1-meter aperture limit of traditional, evacuated solar towers. Two new facilities of this kind, the US New Solar Telescope (NST) and the German GREGOR solar telescope have now seen first-light, and are paving the ground for even more ambitious projects such as the 4-meter US Advanced Technology Solar Telescope (ATST) and the European Solar Telescope (EST).

The New Solar Telescope (NST) in Big Bear (California) is a modern, off-axis 1.6-m clear aperture telescope (http://www.bbso.njit.edu/nst_project.html). The NST saw first light in 2009, and obtained diffraction limited, AO-corrected observations from 2010. First vector magnetograms were produced in 2011. The NST is a pathfinder for the off-axis 4-m ATST and the much larger Giant Magellan Telescope (GMT), which will be composed of seven 8.4-m segments (optically, the NST is a one-fifth scale version of the latter, with a single primary mirror). Fig. 1 shows an image of the chromosphere obtained with NST in the blue wing of the HeI 1038 nm line, showing a previously unseen ultrafine structure in the magnetic loops.

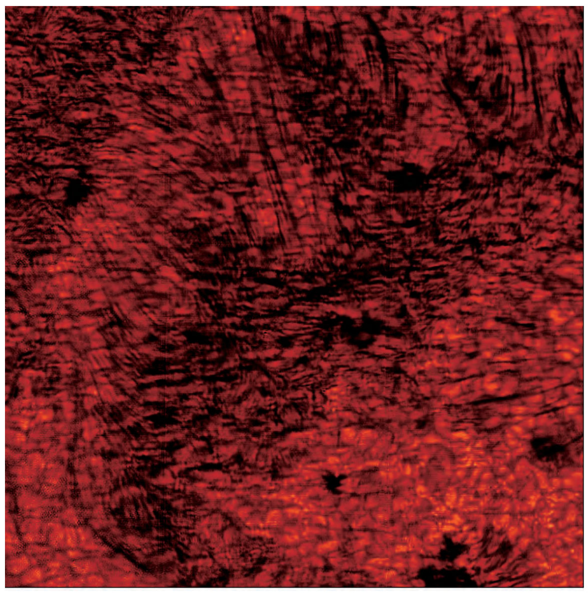


Fig. 1: Narrowband filtergram obtained with NST in the blue wing of the HeI 1083 nm line (0.05 nm passband), in the vicinity of a small active region. The image clearly reveals ultrafine structure in the chromospheric magnetic loops, whose width of about 100 km is close to the diffraction limit of the 1.6 m telescope at this wavelength.

The 1.5-meter GREGOR solar telescope (www.kis.unifreiburg.de/index.php?id=163&L=1) is located at Observatorio del Teide (www.iac.es/eno.php?op1=3&lang=en) of the Instituto de Astrofísica de Canarias, where it is operated by a German consortium under the leadership of the Kiepenheuer-Institut für Sonnenphysik in Freiburg, with the Leibniz-Institut für Astrophysik Potsdam and the Max-Planck-Institut für Sonnensystemforschung in Katlenburg-Lindau as partners. The inauguration of GREGOR, currently Europe's largest solar telescope, took place on 2012 May 21 (Fig. 2). The telescope is equipped with three first-light instruments: the broad-band imager (BBI), the GREGOR Fabry-Pérot Interferometer (GFPI), and the Grating Infra-red Spectrograph (GRIS).

Fig. 2: Inauguration of the 1.5-meter GREGOR solar telescope at Observatorio del Teide, Tenerife, Spain on May 21, 2012. The bright spot in the center of the picture is a reflection from the heat-stop rejecting all sunlight except for a small field-of-view of about 150 seconds of arc in diameter.

Results from scientific campaigns with NST and first results from the GREGOR science verification tests will be presented at Special Session 6, "Science with Large Solar Telescopes", on Thursday August 23 (room 302A+B). ■

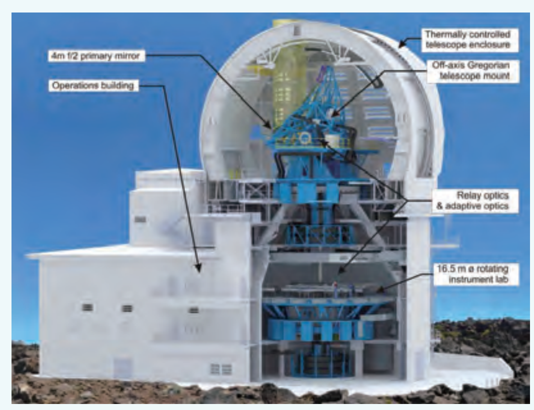
Gianna Cauzzi

Advanced Technology Solar Telescope:
the World's Largest Solar Telescope

The 4-meter Advance Technology Solar Telescope (ATST) currently under construction on the 3000 meter peak of Haleakala on Maui, Hawaii will be the world's most powerful solar telescope and the leading ground-based resource for studying solar magnetism. The solar atmosphere is permeated by a 'magnetic carpet' that constantly re-weaves itself to control solar irradiance and its effects on Earth's climate, the solar wind, and space weather phenomena such as flares and coronal mass ejections. Precise measurement of solar magnetic fields requires a large-aperture solar telescope capable of resolving a few tens of kilometers on the solar surface. With its 4 meter aperture, the ATST will for the first time resolve magnetic structure at the intrinsic scales of plasma convection and turbulence. The ATST's ability to perform accurate and precise spectroscopic and polarimetric measurements of magnetic fields in all layers of the solar atmosphere, including accurate mapping of the elusive coronal magnetic fields, will advance ground-based solar astronomy by a leap as big as those of Galileo and Hale. In addition, the Sun serves as an important astro- and plasma-physics "laboratory" demonstrating key aspects of omnipresent cosmic magnetic fields.

The ATST construction effort is led by the US National Solar Observatory. State-of-the-art instrumentation will be constructed by US and international partner institutions. The technical challenges the ATST is facing are numerous and include the design of the off-axis main telescope, the development of a high order adaptive optics system that delivers a corrected beam to the instrument laboratory, effective handling of the solar heat load on optical and structural elements, and minimizing scattered light to enable observations of the faint corona. The ATST project has transitioned from design and development to its construction phase. The project has awarded design and fabrication contracts for major telescope subsystems. Site construction is expected to begin in October 2012 pending the successful conclusion of the site permitting process.

The ATST science goals and project status will be presented in session SpS6 "Science with large solar telescopes" on August, 23, 2012 and in session SpS9 "Future Large Scale Facilities" on August, 28, 2012. ■



Facility View, Cutaway, ATST

Thomas Rimmele

Director and Principal Investigator of the Advanced Technology Solar Telescope. He is an Astronomer at the National Solar Observatory in Sunspot, NM, USA. His main scientific interests are high resolution studies of solar magnetic fields and the development of solar adaptive optics.

Thomas Berger

ATST Project Scientist and an Associate Astronomer at the National Solar Observatory in Sunspot, NM, USA. He has a background in tunable filter design and development for both space- and ground-based solar spectroscopic imaging and polarimetry applications.

Purple Mountain Observatory, Chinese Academy of Sciences

Purple Mountain Observatory (PMO), which is part of the Chinese Academy of Sciences, was established on May 20, 1950 in Nanjing. Its predecessor was the Institute of Astronomy, Academia Sinica, founded in February 1928. PMO is the first modern Chinese astronomical research institution, and has been named the "cradle of modern astronomy in China" .

The main research fields at PMO are astrophysics and celestial mechanics. The goal is to become an internationally advanced and leading domestic research base for space astronomy, with dark matter particle detections as its core mission. PMO also aims to address important scientific problems in astronomy by becoming a research base for Antarctic astronomy, which is supported by Tera-Hertz (THz) detection technology. In addition, PMO aims to become a research center for space object and debris observation, filling the need of a national strategy using artificial celestial dynamics and detection technology, and to become a planetary science research center for deep space exploration with Near Earth Object (NEO) detection.

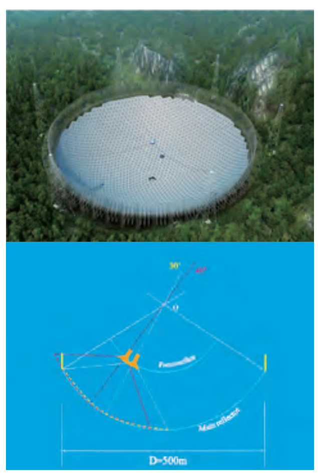
In recent years, PMO has made a series of important scientific achievements: A high-energy space probe that made a major breakthrough and found possible evidence for the existence of dark matter particles; equipment for debris observation was proposed by Chinese researc as an independent innovation, thereby accomplishing a series of major national goals and establishing relevant national standards.

THz superconducting detection technology obtained a series of breakthroughs and was used in a large international instrument, which helped the major national scientific research equipment development project of a "superconducting imaging spectrum analyzer" to be successfully installed at the 13.7-meter telescope. The NEO astronomical telescope was built, and its equipment was at the forefront of similar international stations. Antarctic astronomy layouts and Antarctic Observatory medium-and long-term blueprints at PMO provide a new goal for the development of ground-based observational astronomy in China. ■

Five-hundred-meter Aperture Spherical Radio Telescope (FAST)

FAST is an ongoing national mega-science project and a flagship facility of the Chinese astronomical community. When finished, it will be the world's largest single-dish radio telescope with a collecting area 30 times larger than a standard football pitch.

FAST is an Arecibo-type telescope with three specific innovations: a karst depression with suitable scale and depth is selected as the site to host the 500-meter antenna and allow a zenith angle of 40 degrees; the shape of the illuminated reflector is instantaneously corrected for spherical aberration to achieve a full polarization and a wide band; the feed cabin driven by cables and servomechanism, together with a parallel robot as a secondary adjustable system, achieves high-precision movement. The advantages deriving from these innovative technologies include saving the workloads and expense of earthwork by the utmost utilization of the topography, avoiding complex feed systems by the adoption of the active main reflector, and reducing the weight of the feed cabin by the application of the cable-parallel robot feed support system. These in turn facilitate fulfilling the technical specifications and requirements imposed by scientific motivations and incentives. Consequently FAST boasts an unprecedented sensitivity and sky coverage, with an improvement by a factor of 2 to 3 compared with Arecibo. The surveying speed is an order-of-magnitude higher.



Three-dimensional model and geometry of FAST

The superiority and prominence in capabilities promise a formidable tool for astronomical discoveries. The key science goals, highlights of which will be showcased below, cover a broad spectrum of topics on scales from planets, stars, galaxies, and to the Universe. Surveying the Galactic ISM in HI at an angular and spectral resolution comparable to the current large scale CO surveys will serve as tracer for Galactic structure and evolution of ISM. Discovering ~5000 new Galactic pulsars and searching for the first extragalactic pulsars will provide a unique laboratory for studying gravitation and strong interaction. Detecting tens of thousands of HI galaxies and individual massive galaxies up to z~1 will offer valuable information for galaxy evolution.

The official ground-breaking ceremony and the laying of the foundation stone of FAST took place in late 2008. The construction officially commenced in March 2011. Currently, the earthwork and site construction is in full swing, and the subsystems of the project are at the final stage of design optimization. The facility is planned to be commissioned in 2016. ■

School of Astronomy and Space Science

Nanjing University

The School of Astronomy and Space Science of Nanjing University was established in March 2011, and its predecessor, the Department of Astronomy, was founded in 1952. It has the longest history and a high reputation among the astronomy departments in China. The school has trained a large number of astronomers who are currently active in the astronomy society in China.

The school includes several laboratories: Central Laboratory for Teaching, Solar Tower Laboratory, Center for Nonlinear Sciences, Key Laboratory of Modern Astronomy and Astrophysics of the Ministry of Education, and Planetary Science and Deep Space Exploration Laboratory. It also has the national first-level key discipline of astronomy, including two national second-level key disciplines, Astrophysics as well as Astrometry and Celestial Mechanics. A new undergraduate program on Space Science and Technology has been established in order to train qualified researchers in this field to meet the fast development of Chinese space programs. Current research activities in the school include high-energy astrophysics, solar physics, galaxies and cosmology, extra-solar planets, aerospace dynamics, astrometry and space science. The school offers both Ph.D. and post-doctoral programs in all related research fields.

The school consists of about 40 faculty members, including 18 professors, with 4 academicians of the Chinese Academy of Sciences. Sponsored by many National Science Foundation of China and national key fundamental research programs, the school has obtained fruitful academic achievements and won a number of national and provincial awards. The school has close communications and collaborations with domestic and international academic institutes in Astronomy.

Recently, Nanjing University, Purple Mountain Observatory and Nanjing Institute of Astronomical Optics & Technology signed an agreement to build a joint Center for Astronomy and Space Science in the Xianlin campus of Nanjing University. The purpose is to establish a new collaboration mode between universities and observatories. To this end, the school will construct a new building in two years, covering more than 1000 square meters, for scientific researches, experiments, teaching and academic activities. It will meet the needs for the school's development in the following decades. ■

Nanjing University Observatory

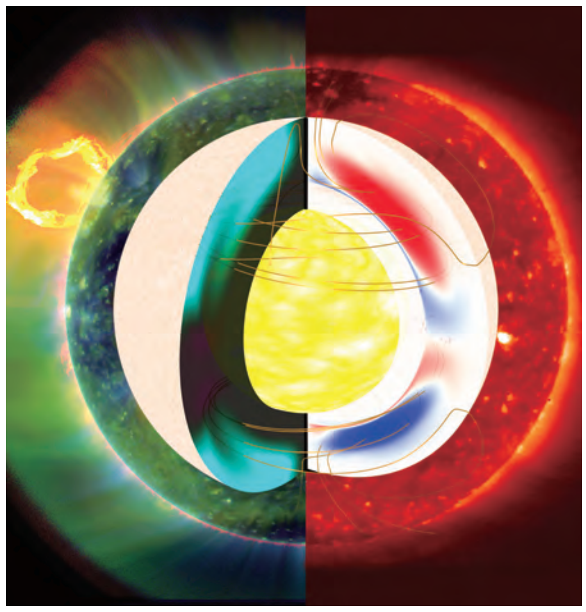
SURPRISES IN THE SOLAR CYCLE FROM THE SUN TO BEYOND THE HELIOSPHERE

Sunspots, or lack of them, have kept solar physicists busy trying to understand processes in the Sun and predict its future activity. The Sun did eventually wake up from a deep slumber following cycle 23. The minimum between cycle 23 and 24 was characterized by the highest number of spotless days in almost a century and unprecedented heliospheric conditions. Cycle 24 had a slow start and if it continues at the same pace, it may be the weakest cycle in the space age. This has led to discussions of the possibility of a Maunder-like grand minimum in some communities. Unusual heliospheric conditions during the recent minimum have motivated studies exploring the impact of solar variability on our space environment and planetary atmospheres in other forums.

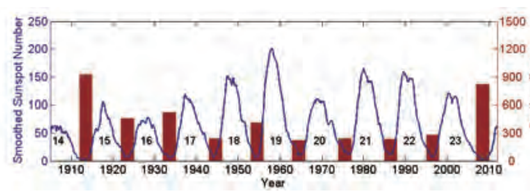
All this excitement is bringing together scientists with diverse expertise, e.g., solar and stellar physics, heliospheric physics, atmospheric physics, climate physics and planetary sciences, spurring the growth of the interdisciplinary field of Heliophysics – a system-wide approach to understanding the origin and impact of solar variability.

Stellar activity cycles are produced by a magnetohydrodynamic dynamo mechanism that relies on interactions between internal plasma flows and magnetic fields. These fields manifest as star spots on the surface and are dispersed in the surrounding space through stellar winds. Variation of this magnetic output contributes to radiative and particulate variability in the star's neighborhood. Transient events such as magnetic storms originate within stellar magnetic structures and generate extreme conditions that perturb astrospheres. Planetary atmospheres and climate are driven by the parent star's radiative energy, thus creating a physical bond across space and time.

Observations of the Sun's magnetic cycle provide a window to the plasma universe in general, and to stellar magnetism in particular. Sunspots have been systematically observed over the last four centuries. These observations show that solar magnetic output is roughly periodic with large fluctuations in its amplitude. Following cycle 23 and before the onset of cycle 24, the Sun went into a prolonged minimum with the highest number of sunspot-less days in the space age. One has to go back to 1913 to find a minimum which was this deep! Although relatively long-lived, such periodic minima should not be confused with episodes such as the Maunder minimum between 1645 and 1715 AD. Reconstructions of solar activity based on cosmogenic isotope records provide evidence that "Grand Minima" have also occurred in the distant past.



Simulated magnetic fields of the dynamo in the solar interior (center), and the corona during the long minimum in activity (right) and at an active phase following the minimum (left), including a solar storm. Image and simulation data courtesy of: NASA/Goddard/SDO-AIA/JAXA/Hinode-XRT; Nandy, Muñoz-Jaramillo and Martens.



Sunspot cycles over the last century (blue curve), with the cumulative number of sunspot-less days in between successive cycles (red bars). Cycle 23-24 minimum had the highest number of spotless days in the space age, but was comparable to cycle 13-14 minimum. Figure courtesy: Andrés Muñoz-Jaramillo.

During the long stretch of the minimum of cycle 23, some wondered whether we are about to enter a Grand Minimum. We find that the solar cycle has definitely recovered, but the future is somewhat uncertain. Cycle 24 is plausibly going to be fairly weak. Will it also result in a very weak global solar dipolar field which may then lead to an even weaker cycle 25, and will this trend continue? Although short-term solar cycle predictions based on the dynamical memory of the dynamo mechanism are a distinct possibility, such forecasts are unlikely to be accurate beyond one cycle. Simply stated, this means that at present we cannot say whether the trend of weaker cycles will continue.

The myriad of ways in which stellar activity influences astrospheres and planetary atmospheres was on full display during the minimum of solar cycle 23. A very weak global solar (dipolar) field resulted in the weakest interplanetary magnetic field and solar wind recorded in the Space Age. Solar irradiance levels stayed low for an extended period of time. At the same time the cosmic ray flux at Earth was at record highs. The Earth's upper atmosphere shrunk, resulting in an increased lifetime (and risk) of space debris. Such episodes of very low activity provide an opportunity to critically assess solar forcing of the heliosphere and a multitude of studies are now establishing important links between solar activity and environmental conditions in space, and here on Earth.

Studies of the intimate relationship between the parent star, its astrosphere and planets that it hosts have reached a certain level of maturity within our own solar system – fueled both by advances in theoretical modeling and a host of satellites that observe the Sun-Earth system. With this maturity has come the realization that we still have a lot to learn in order to create a knowledge base that is relevant for going beyond our solar system. Applying such Sun-Earth knowledge to other star-planet systems will be relevant to studies of planetary habitability, and can potentially guide future searches for Earth-like planets within habitable zones. These are exciting times and the future of this field looks sunny. ■

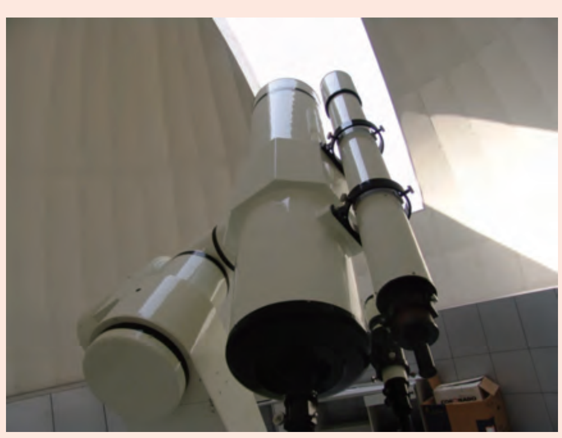
Dibyendu Nandy
Astrophysicist at the Indian Institute of Science Education and Research.

Sarah E. Gibson
Senior Scientist at the High Altitude Observatory (NCAR).

David F. Webb
Senior Research Physicist at the Institute of Scientific Research at Boston College, former President of the IAU Division II.

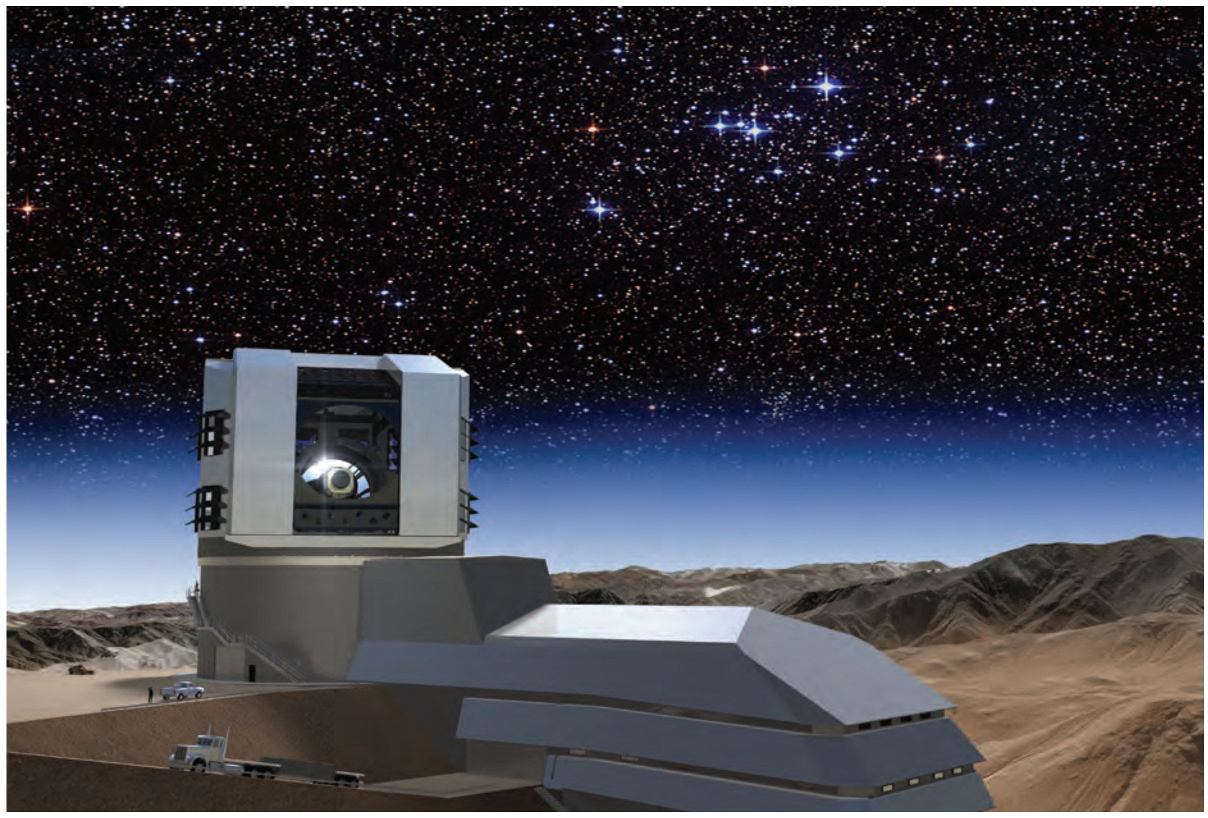
DEPARTMENT OF ASTRONOMY, UNIVERSITY OF SCIENCE AND TECHNOLOGY OF CHINA

The department was established in 2009, based on the Center for Astrophysics founded in 1978. Currently the department has about 20 faculty members including 2 academicians of CAS and 12 full professors. It enrolls about 20 undergraduates and 10 postgraduates annually. The department has a 40 cm optical telescope, mainly for teaching students to do observations and data reductions. In 2008, it was granted to set up a Key Lab for Galaxy and Cosmology of CAS, jointly with Shanghai Astronomical Observatory.



The department and the Center for Astrophysics were among the first set of institutions in China that initiated researches in modern astrophysics, and have obtained many research achievements. The research interests include: active galactic nuclei and normal galaxies; relativistic and high-energy astrophysics; cosmology; extra-solar planets. The groups in the department are participating in various big astronomical projects, including the Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST) and the World Space Observatory-Ultraviolet (WSO/UV). ■

Cosmic Inquiries LSST



A colorful night sky provides a background for the LSST facilities building on Cerro Pachón. (2011, Image credit: Todd Mason, Mason Productions Inc. / LSST Corporation)

Major advances in our understanding of the Universe frequently arise by observing the sky in new ways, driven by progress in technology. Aided by rapid advancement in information technology, current sky surveys are changing the way we view and study the Universe. The next-generation Large Synoptic Survey Telescope (LSST) will maintain this revolutionary progress, building on developments in microelectronics, software, and large optics fabrication.

Expected to be on the sky by 2020, the Large Synoptic Survey Telescope system will produce a 6-band (0.3-1.1 micron) wide-field deep astronomical survey of over 18,000 square degrees of the southern sky using an 8.4-meter ground-based telescope. LSST will obtain multiple images covering a wide swath of sky visible from its location on Cerro Pachón in northern Chile. Each patch of visible sky will be visited more than 800 times during the 10-year survey. The LSST leverages innovative technology in all subsystems: the camera (3200 megapixels, which will be the world's largest digital camera), telescope (simultaneous casting of the primary and tertiary mirrors; two aspheric optical surfaces on one substrate, a 9.6 square degree field of view with excellent image quality), and data management (30 terabytes of data nightly, and nearly instant alerts issued worldwide for objects that change in position or brightness). This innovation on all fronts has attracted more than 35 institutional members and hundreds of scientists in eleven science collaborations.

Members of the team building the LSST, a large survey telescope being built in Northern Chile, gather to celebrate the successful casting of the telescope's 27.5-foot-diameter mirror blank, August 2008. (Image credit: Howard Lester / LSST Corporation)

Many fundamental problems in astrophysics, from planetary science to cosmology, can be addressed through similar data sets consisting of rapid multiple exposures in superb seeing, in a number of standard passbands, to very faint magnitudes over a large area of sky. The key insight leading to the LSST is that data from a single active optics telescope with sufficient etendue (the product of aperture area in square meters and field of view in square degrees) can address all of these scientific missions simultaneously. In addition, by providing unprecedented sky coverage, cadence, and depth, the LSST makes it possible to attack high-priority scientific questions that are far beyond the reach of any existing facility. The 30 terabytes of data generated each night will open a new window on the deep optical universe - the time domain - enabling the study of variability both in position and time. This enables control of systematics required for precision probes of dark energy. Rarely observed events will become commonplace, new and unanticipated events will be discovered, and the combination of LSST with contemporary space-based missions will provide powerful synergies.

The wide area, deep, high-time-resolution coverage of LSST will increase sample sizes by the largest factor ever achieved in optical astronomy. The LSST will have unique survey capability in the faint time domain. The LSST design is driven by four main science themes: probing dark energy and dark matter, taking an inventory of the Solar System, exploring the transient optical sky, and mapping the Milky Way. Derived calibrated data products and access to computation on the 40-50 petabyte database will be available with no proprietary time delay to US and Chilean astronomers, and to additional affiliates supporting a small share of operations.

The LSST telescope and camera will allow about 10,000 square degrees of sky to be covered at any one time, visiting each patch of sky with a pair of 15-second exposures, twice per night every three nights on average, with typical 5σ depth for point sources of r ~ 24.5 magnitude (AB) in a single visit. The system is designed to yield high image quality as well as superb astrometric and photometric accuracy. The total survey area will include 30,000 square degrees with δ < +34.5°, and will be imaged multiple times in six bands: ugrizy. About 90% of the observing time will be devoted to a deep-wide-fast survey mode which will uniformly observe a 18,000 square degree region over 800 times (summed over all six bands) during the anticipated 10 years of sky survey operations, and yield a coadded map to r ~ 27.5 magnitude. These data will result in a database including 10 billion galaxies and 10 billion stars, and will serve the majority of the primary science programs. The remaining 10% of the observing time will be allocated to special projects such as a Very Deep and Fast time domain survey.

LSST was the top ranked new ground-based facility recommended by the US National Research Council's 2010 Decadal Survey of Astronomy and Astrophysics, "New Worlds, New Horizons." The LSST project is currently on schedule to begin regular survey operations by 2021. Fabrication of the LSST optics began in 2007 with private support, primarily Charles Simonyi and Bill Gates. This has also enabled site preparation in Chile. Two US funding agencies, the National Science Foundation and the Department of Energy, have supported LSST research and development, and have recently moved the project closer to construction. Support from affiliated institutes worldwide will be an important contribution to survey operations.

This new view of the sky will be of interest to curious minds of all ages. The goal is to make LSST public outreach data products available worldwide — everyone will be able to view and study a high-definition color movie of the deep Universe.

The effort to build the LSST is led by the LSST Corporation, a non-profit 501(c)3 corporation formed in 2003, with headquarters in Tucson, AZ, USA. LSST project activities are supported in part by the US National Science Foundation and the Department of Energy with additional contributions from private donations, grants to universities, and in-kind support from LSST Institutional Members. In 2011, the LSST construction project was established as an operating center under management of the Association of Universities for Research in Astronomy (AURA). ■

Tony Tyson
Distinguished Professor of Physics at University of California, Davis.

IAU Office of Astronomy for Development:

Achievements of its First Year and the Way Forward

The IAU Office of Astronomy for Development (OAD) is organising a Special Session (SpS11) at the General Assembly (GA) on 27-28 August. This is the first GA to take place since the OAD was launched in April 2011 and offers an opportunity to learn about the latest developments in implementing the IAU's Strategic Plan 2010-20, Astronomy for Development.

The OAD's two-strong team is based in Cape Town, South Africa, and supported by a global network of volunteers. "The OAD will act as a central point of contact for the volunteers, offering strategic advice and coordinating resources so that they can be used to maximum effect," says Kevin Govender, Director of the OAD. More than 400 astronomers have already registered as volunteers on the OAD website (www.astro4dev.org), about half of whom are IAU members.

To date, the bulk of the OAD's work has focussed on setting up its organisational structure. A major milestone took place in May 2012, when the OAD established its three 'Task Forces' – committees of experts in various fields from around the world that will help to drive its mission. These Task Forces are 'Astronomy for Universities and Research', 'Astronomy for Children and Schools' and 'Astronomy for the Public'. During SpS11, members from each Task Force will give further details about their role and inform delegates about a new open call for proposals to access funding for development projects.

The next step is the announcement of the OAD's Regional Nodes, which are being set up to ensure local input from each continent into strategic planning. On Tuesday 21 August 2012, the IAU signed an agreement at the GA with a consortium of Chinese institutes to establish the Regional Node for East Asia. This is the first Regional Node to be announced so far. The main institutes involved in the consortium are the Kavli Institute for Astronomy and Astrophysics (KIAA, Peking University), Beijing Planetarium and Yunnan Astronomical Observatory. Various partner organisations will support the consortium, including the National Astronomical Observatories of the Chinese Academy of Sciences (NAOC), the East Asian Core Observatories Association (EACOA), and Pyongyang Astronomical Observatory (PAO).

The agreement to establish the OAD Regional Node for East Asia was signed at the IAU General Assembly.

Aside from the internal organisation, there are many OAD pilot projects that are already underway. For example, a workshop was held in April 2012 in Cape Town about using Microsoft's WorldWide Telescope (WWT) in the classroom, and science 'hack days' have taken place, in which coders developed new tools for the OAD during programming marathons.

The OAD is also working in collaboration with the Royal Astronomical Society and the Netherlands Organisation for Scientific Research to organise visiting expert programmes for developing countries. The first of the expert visits will take place in September 2012, with a UK-based astronomer visiting Sierra Leone. There will also be a suite of collaborations with the International Centre for Theoretical Physics, which will be launched during the GA.

Furthermore, the OAD is developing a 'match-making' website, called astro glocal, which will display the location of its volunteers on a map that can be filtered by various categories, such as areas of expertise and languages spoken. "There are many astronomers who are eager to contribute to development projects, both at home and when they are travelling. This website will help to match volunteers to the most suitable projects more efficiently, and also acts as a networking tool for astronomers," says Govender. The website is not public yet, but GA delegates can view its progress by visiting the OAD booth in the exhibition area. This booth will also be used as a central point of coordination for the Young Astronomers Lunch event and the Young Astronomers Consulting Service.■

Sarah Reed
IAU Public Outreach Coordinator / NAOJ

Travel tips

- **Taking the taxi**
  Although the subway is probably your preferred mode of transport, the taxi is also a convenient way to get around. Since most taxi drivers do not speak English, think about how you will explain where you want to go. Make sure to take the hotel's card (and a map) that lists the hotel's address in Chinese. This is very useful if you get lost and need to get back via taxi. A regular city map with streets and sights in Chinese will also help. As elsewhere in the world it is really hard to find a taxi during rush hour or when it rains.

- **Taxi pricing**
  The taxi fare is displayed on the meter, and consists of a ¥10 starting fee, plus ¥2/km after the first 3 km. A trip to the airport will cost you roughly ¥100 from the conference area or from the Beijing University area. At the end of your trip, ask for the receipt by pointing at the meter. You can use this receipt to trace back the driver, in case you accidentally left something in the taxi.
  All taxis have license plates beginning with " 京 B", and are recognizable as taxis. Illegal taxis have different license plates; they are normal cars with a small red light, and should be avoided. The vast majority of the taxi drivers is honest, but if the taxi driver "forgets" to switch the taxi meter on, remind him by politely by pointing at the meter box. If you have any short of trouble, write down the taxi's registration number (or take a photo), which can be found on the plaque in front of the passengers seat.

Day 4: Program Summary

"Young astronomers' lunch" Banquet

Plenary talks (8:30-10:00):

"Pulsars are cool - seriously" by Scott Ransom
"Magnetars: neutron stars with magnetic storms" by Nanda Rea
"Probing gravitation with pulsars" by Michael Kramer

IAUS 288	Sub-mm observations & stations
IAUS 290	Time variability & Large scale properties
IAUS 291	Pulsar timing & Pulsars and ISM & Distribution and evolution
IAUS 292	ISM diagnostics & Dust
SpS 1	Extragalactic and nuclear star clusters & Dwarf galaxies
SpS 2	Ellipticals and galaxy groups & Non-thermal cluster properties & Environmental impact
SpS 3	Radial mixing & Morphology & Environmental effects
SpS 4	Intracluster medium & Cosmic web and early universe
SpS 5 "The IR view of massive stars: the main sequence and beyond"	Obscured and distant stellar clusters & Stellar parameters and wind parameters
SpS 6	Key scientific questions & Existing and planned facilities

JD5 continues. JD6 "The connection between radio properties and high-energy emission in AGNs" starts.

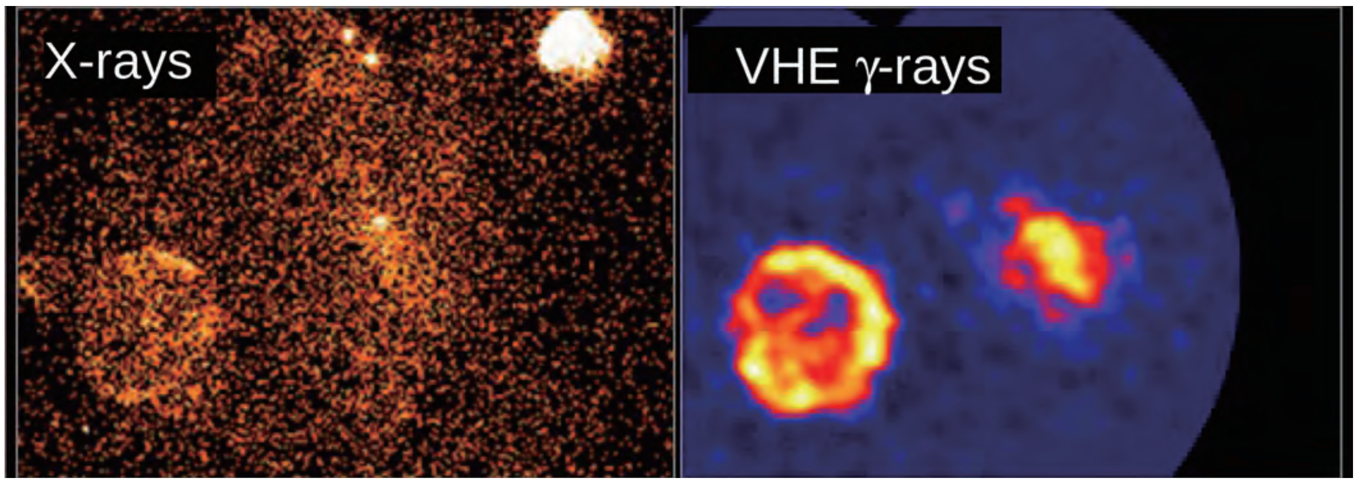
Inquiries of Heaven (天 问) is the official newspaper of the IAU General Assembly 2012. Online version: www.astronomy2012.org/ih **Contacting email:** heaven@nao.cas.cn. It is published by Research in Astronomy and Astrophysics in collaboration with China Features of Xinhua News Agency, Amateur Astronomer, and Chinese National Astronomy. **Advisor:** Thierry Montmerle; **Editor and Associate Editors:** Jingxiu Wang, Xiaowei Liu, Shude Mao, Shuang-Nan Zhang, Yongtian Zhu; **Editorialists and Language Editors:** Peter Anders, Thijs Kouwenhoven, Sarah Reed, James Wicker, Marcel Zemp; **Art and Technical Editors:** Yangyang An, Geng Li, Jian Li; **Managing Coordinator:** Suijian Xue; **Secretary:** Lan Wang; **Editorial Assistant:** Jingyi Huang.

INQUIRIES OF HEAVEN

IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA , AUGUST 20 - 31, 2012 FRIDAY, AUGUST 24, 2012 DAY 5

JD1: High Energy Gamma-Ray Universe

On Monday morning the General Assembly took off with JD1 on very-high-energy gamma-rays, the latest window of the electromagnetic spectrum available for astronomical research. Based on the spectacular successes of current experiments in this field, the science perspectives of the Cherenkov Telescope Array (CTA) were the subject of a lively Joint Discussion bringing together astronomers from all wavelength ranges and many fields of astrophysics to discuss this new infrastructure and the prospects of interaction with other fields of astronomy. The Cherenkov Telescope Array, shall consist of nested arrays of 100 telescopes of different sizes, improving sensitivity, resolving power, energy coverage and field-of-view of the existing facilities HESS, MAGIC and VERITAS and truly complementary to the performance of the AGILE and Fermi satellites.



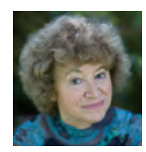
Matching X-ray and VHE γ-ray views of the shell-type supernova remnant RXJ 0852.0-4622 (left) and the pulsar wind nebula Vela-X (right)

The broad interest in this facility was demonstrated by the wide attendance. About one-hundred participants enjoyed an excellent set of reviews describing the status and prospects of the field including many of the key science themes that shall be pursued and on the many relations between gamma-rays and radio-, infrared and X-ray astrophysics.

The reviews covered the latest highlights including fast flares detected in the Crab Nebula, the detection of pulsed emission up to energies of 100 GeV with ground-based instruments, an increasing population of extended Galactic gamma-ray sources, and extragalactic sources from starburst galaxies to luminous quasars. Talks also covered the science potential of CTA including searches for dark matter and the ability to directly resolve the acceleration region of Cosmic Rays in supernova shock-fronts.

Other talks covered the CTA as well as current and future instruments, including the Chinese Cosmic-Ray facility LHASSO.

The conclusions highlighted the relevance of these observations to a very wide range of questions. We are thus confident VHE-gamma-rays will be featured frequently in future IAU meetings. ■



Catherine Cesarsky
IAU past president, CEA, Saclay, France

Stefan Wagner
Landessternwarte Heidelberg, Germany

"Hot Topics" for Friday 24

A Massive, Cooling-Flow-Induced Starburst in the Core of a Galaxy Cluster

In the cores of some galaxy clusters the hot intracluster plasma is dense enough that it should cool radiatively in the cluster's lifetime, leading to continuous, massive (~1000 Msun/yr) "cooling flows" of gas sinking towards the cluster center, yet no such cooling flow has been observed. The low observed star formation rates (a few Msun/yr), and cool gas masses for these "cool core" clusters suggest that much of the cooling must be offset by astrophysical feedback to prevent the formation of a runaway cooling flow. In this talk, I will present a newly-discovered galaxy cluster which appears to be much closer to fulfilling these early predictions. This galaxy cluster, dubbed the "Phoenix Cluster" is the most X-ray luminous, strongest cooling (several thousand Msun/yr) galaxy cluster in the known Universe. At a redshift of z = 0.6, it is one of the only known high-redshift cool core clusters, and is amongst the most massive known clusters. The central galaxy in this cluster is forming stars at an astonishing rate of 740 Msun/yr, suggesting that feedback from the central supermassive blackhole is unable to completely halt runaway cooling in this system. This large star formation rate implies that a significant fraction of the stars in the central galaxy of this cluster may form via accretion of the intracluster medium, rather than the current picture of central galaxies assembling entirely via mergers. ■

Ref.: *McDonald, M. et al. 2012, Nature, 488, 349-352*

Michael McDonald
Hubble Fellow, MIT Kavli Institute for Astrophysics and Space Research

First Galaxies and Supermassive Black Holes

Understanding the formation of first galaxies and supermassive black holes is a paramount question in modern astronomy. The two orders of magnitude improvement in sensitivity at submillimeter/millimeter wavelengths afforded by ALMA, at sub-arcsecond spatial resolution, open a new window on the earliest galaxies through the observation of the (rest-frame FIR) atomic fine structure lines, the dominant ISM gas cooling lines. In our recent ALMA observations, we have detected [C II]158 micron fine structure line emission from the host galaxies of four z~6 quasars that were previously detected in strong FIR dust continuum and molecular CO line emission. The detections of [C II] line emission, as well as the dust continuum and CO lines, provide strong evidence for active star formation in the host galaxies, implying coeval formation of supermassive black holes (SMBH) and their host galaxies within 1 Gyr of the Big Bang. The [C II] line velocity maps of three sources at ~0.6" spatial resolution show clear velocity gradients along the major axis, consistent with gas-rich, star-forming disks over the central a few kpc region of the quasar host galaxies. These results provide critical constraints on the distribution of nuclear star formation and the dynamical properties of the cool atomic gas in the most distant quasar host galaxies -- key ingredients in the study of the growth of the first SMBHs and their host galaxies close to the epoch of first light and cosmic reionization. ■

Ran Wang
Jansky Fellow, NRAO, University of Arizona and Peking University

Interview with Professor Simon White, Director of the Max Planck Institute for Astrophysics

Q: What kind of particles are possible candidates for dark matter?

A: The only known particles with weak enough interactions to be the dark matter are neutrinos, but their early thermal motions result in large-scale structure inconsistent with what we see. Once such hot dark matter was excluded, people began to think up new kinds of particles for which these early thermal motions would be weaker (warm dark matter) or effectively absent (cold dark matter).

Q: Can we tell whether cold or warm dark matter is better for explaining what we see?

A: Warm and cold dark matter behave similarly on scales that make galaxies like the Milky Way, but on substantially smaller scales there are differences. Cold dark matter predicts that much dark matter to be in halos which are too small to contain any observable galaxy. These might be detectable in the images of gravitationally lensed quasars. Such very small structures are absent for warm dark matter, leading also to different predictions for the structure of dwarf galaxies which actually seem to agree better with recent data than those for cold dark matter.

Q: What do you think the chances are that we will detect dark matter through non-gravitational effects in the coming years?

A: Well, of course, this depends on what it is made of! Supersymmetric models suggest that neutralino collision rates could be measurable in a laboratory, provided one can build a sufficiently low-noise detector, and many underground experiments around the world are currently searching for a signal. Indeed, at least three seem to have detected something, but their results appear mutually contradictory and appear to disagree with upper limits established by other experiments. Axions would interact resonantly with photons in a precisely tuned microwave cavity, but it is hard to cover the full allowed range of masses. Pairs of neutralinos may also annihilate producing gamma-rays which could be then detected by the Fermi satellite. Unfortunately, although current experiments are working in a regime where detection is plausible, parameters are also possible for which the effects would be unmeasurably small.

Q: How do you see astrophysics developing over the coming years and what role do you think China can play?

A: Astrophysics is an opportunistic and technology-driven science. As new technical capabilities become available, new (and often unexpected) areas suddenly become the centre of activity. The push towards more powerful technology results in fewer and more expensive facilities, so in some areas only a single global telescope is now feasible, just as there is now only one supercollider, the LHC. China, with its major and increasingly technically oriented share of the world's economy, clearly has a pivotal role to play in future global collaborations, both technically from its industrial base and intellectually from its enormous pool of highly educated scientists and engineers. Of course, science ultimately makes progress primarily through human creativity, and here China certainly has a lot to offer. ■

Interviewed by Dr. Qi Guo (NAOC). Full transcripts will be available.

The Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST)

The Guo Shou Jing Telescope (Large Sky Area Multi-Object Fiber Spectroscopic Telescope, LAMOST) is a quasi-meridian active reflecting Schmidt telescope. LAMOST breaks through the "bottleneck" of large scale spectroscopic survey observations with both large aperture (average clear aperture of 4.3m) and wide field of view (5 degrees). It is an innovative active optics-controlled reflecting Schmidt configuration, achieved by changing the mirror surface continuously to get a series different reflecting Schmidt systems in different moments. The active optics applied on it is with a combination of thin deformable mirror active optics and segmented active optics. Its primary mirror (6.67 m × 6.05 m) and active Schmidt mirror (5.74 m × 4.4 m) are both segmented, and composed of 37 and 24 hexagonal sub-mirrors respectively. By using the parallel controllable fiber positioning technique, the focal plane of 1.75 m in diameter can accommodate up to 4000 optical fibers. LAMOST will be the telescope with the highest spectral acquisition rate. Also, LAMOST has 16 spectrographs with 32 CCD cameras. Each CCD chip is a scientific CCD sensor with 4096 by 4136 active pixels. As a national large scientific project, the LAMOST project was proposed formally in 1996, and approved by the Chinese Government in 1997. The construction was started in 2001, completed in 2008 and passed the official acceptance in June 2009.

Photo of LAMOST

The LAMOST pilot survey started in August 2011 and the spectral survey will launch in September 2012. Up to now, LAMOST has released more than 480,000 spectra. LAMOST will make important contributions for understanding the large-scale structure of the universe, structure and evolution of the Galaxy, and the cross-identification of multi-wavelength data of celestial objects. ■

Nanjing Institute of Astronomical Optics & Technology, Chinese Academy of Sciences

Nanjing Institute of Astronomical Optics & Technology (NIAOT), Chinese Academy of Sciences (CAS) was established in April 2001. It had evolved from the Research and Development (R&D) units and Mirror Laboratory of Nanjing Astronomical Instruments Research Centre (NAIRC) which was founded in 1958.

NIAOT specializes in research and development of new astronomical technologies, professional astronomical telescopes and instruments. It has developed approximately 60 astronomical telescopes and instruments, including LAMOST and the 2.16-meter optical telescope as well as 30 ones exported to foreign countries. It has been granted 58 National and Provincial awards. Now it possesses the capability to research and develop on the world-class observing instruments and facilities.

NIAOT has 8 R&D departments, which includes New Technology of Telescope Research Department, Astronomical Spectra and High-resolution Image Research Department, Mirror Lab, Solar Instrument Research Department, Optical Technology with Large Aperture Research Department, Astronomical Telescope Engineering Center, Antarctic Astronomical Technology Center and Key Laboratory of Astronomical Optics & Technology of CAS. It hosts 200 staff, including over 20 professors specialized in astronomical telescopes and instruments, more than 70 senior engineers as well as a skillful and efficient supporting team.

Meanwhile, NIAOT is offering post-doctoral, Ph.D. and master degree programs in relevant research fields, with around 50 postgraduates totally. It is also in collaboration with a number of internationally renowned astronomical observatories and institutes in training young scientists.

In the coming decade, NIAOT will focus on the research of the Antarctic Astronomical Facilities, key technologies for the ground-based optical/infrared Extremely Large Telescope, and the detection of exoplanets as well as national space missions. Meanwhile, it will mainly develop new technologies in astronomical high-resolution imaging, key technologies of astronomical telescopes in extreme environments and advanced manufacturing for large aspherical mirrors. Through promoting innovation of astronomical high-technology in China and actively carrying out international cooperation, NIAOT aims to become a first-class institute in China and play an important role in the international astronomical community. ■

Nanjing Institute of Astronomical Optics & Technology, Chinese Academy of Sciences
http://www.niaot.cas.cn

Star Formation in Galaxies

We have seen tremendous progress in our understanding of star formation in galaxies. This is contributing to a deeper understanding of the physics of star formation itself, and to the understanding of the formation and evolution of galaxies.

From the observational side the most important driver for this progress has been a steady stream of new multi-wavelength observations. The Galaxy Evolution Explorer (GALEX), AKARI, Wide-Field Infrared Survey Explorer (WISE), and Planck space missions have surveyed most or all of the sky at ultraviolet or infrared wavelengths, providing the capability of measuring dust-corrected star formation rates (SFRs) for hundreds of thousands of galaxies. These support a multitude of deeper surveys carried out with the Spitzer and Herschel missions. Complementing these are new surveys of atomic and molecular gas in galaxies, carried out with several ground-based single-dish and interferometric facilities. Of special note are ongoing wide-field blind HI surveys of the nearby Universe (e.g., ALFALFA, APERTIF), which will probe the star formation vs gas connection in galaxy samples that are free of traditional optical selection biases. A similar multi-wavelength observational revolution has come to studies of the Galactic disk, enabling for the first time studies of the properties of star-forming clouds and clusters with large samples and sample volumes. This is making it possible to study the Milky Way as a star-forming galaxy, compare it directly to other nearby galaxies, and combine astrophysical insights gained from within and outside of our Galaxy.

These new data have transformed the landscape of the subject. They have enlarged the potential set of galaxies with measured integrated SFRs from a few hundred a decade ago to hundreds of thousands (and soon millions) today, allowing parameter studies that can only be carried out meaningfully with large populations of objects. These samples are no longer limited to nearby galaxies either; large samples are now extend from the local Universe to redshifts of 6 and beyond. Yet another benefit of the multi-wavelength observations has been to extend the study of star formation to the extremes observed in the Universe, from exceedingly low levels seen in many elliptical, lenticular, and dwarf galaxies, to the most actively star-forming infared-ultraluminous and submillimetre-luminous galaxies. The range of routinely observed SFRs now extends over more than eight orders of magnitude, from $<10^{-5}$ to >1000 solar masses per year. The new observations have also impacted on the quality of the SFR measurements. The ability to combine observations in the UV/visible with the infrared provides for robust SFRs corrected for dust attenutation, dramatically reducing one of the key systematic uncertainties in earlier work.

So what are we learning from this cornucopia of new data? Even a summary would require an entire review paper (see for example the article by Kennicutt & Evans in this fall's issue of the Annual Review of Astronomy Astrophysics), so I mention just a few highlights. Perhaps the most important recent unifying developments have been the recognition of the bimodal nature of SFRs per unit mass in galaxies (SSFRs) as a function of galaxy mass – the red and blue sequences – and the strong correlations between the surface density of star formation and the cold gas surface density – the Schmidt law and its corollary relations. The bimodality in the SSFR, first quantified for local galaxies with the Sloan Digital Sky Survey, has now been seen to extend over much of past cosmic time, with the characteristic SSFR (and absolute SFRs) in the blue sequence increasing with increasing redshift. This bimodal star formation behaviour mirrors an underlying bimodality in gas fractions of galaxies, and a major aim of the many HI and CO surveys is to understand the physical processes that drive this evolution. Observations from Spitzer and Herschel have made major inroads in our understanding of extreme starbursts – both in the local and distant Universe – and the impact of energy and momentum flows from this star formation into the interstellar medium (ISM).

The discovery of a tight Schmidt law relating the global SFRs and gas surface densities of galaxies has stimulated a broad set of follow-up studies. Extension of the global measurements to actively star-forming and starbursting galaxies at high redshift (z ~ 1-3) shows that they trace a similar Schmidt law, but with suggestions of a systematic offset between galaxies with extended and dense circumnuclear star formation. The offset depends critically however on how one converts CO luminosities to molecular hydrogen masses in the different classes of objects, underscoring the importance of better understanding molecular gas and SFR diagnostics for interpreting the observations. Another major area of progress has been the use of multi-wavelength imaging of galaxies to study the Schmidt law on a spatially-resolved basis. These observations reveal that on the sub-kiloparsec scale the onset of efficient star formation is closely (and perhaps uniquely) associated with the formation of molecular gas. In a similar vein, studies of individual molecular clouds in the Milky Way offer evidence for a threshold density for "molecular clumps" in which Young Stellar Objects are preferentially found. Many of these observations point to a picture in which the SFR scales in direct proportion to the molecular gas mass/density, a result which needs to be reconciled with the apparently non-linear behaviour of the Schmidt law on larger scales and higher surface densities. Other outstanding issues include delineating the roles of the key physical processes in initiating large-scale star formation (e.g., molecule vs. cool phase vs. bound cloud formation), the bimodality issue mentioned above, and – as always it seems – the role of systematic variations in the IMF in influencing any of these interpretations.

In summary, this is a subject in rapid growth and transformation, with much recent progress but with many questions and challenges remaining. The advent of new facilities including ALMA and an array of optical IFU surveys should bring new and potentially transformational results at future IAU meetings. I close by acknowledging the many colleagues who contributed to the work summarised here. ■

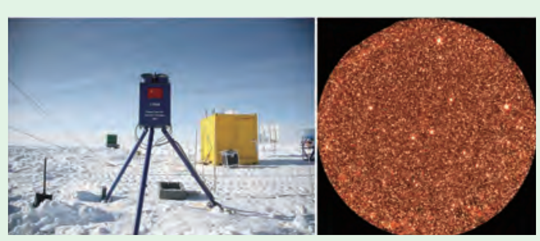
Robert Kennicut

Plumian Professor of Astronomy and Experimental Philosophy and Head of the School of the Physical Sciences at the University of Cambridge.

Chinese Astronomical Activities in Antarctica

The Dome A site in Antarctica was first visited by the Chinese Expedition Team in January 2005. It is expected to be the most favorable site for astronomical observation on the Earth. The Chinese Small Telescope Array (CSTAR) has been in operation on Dome A since January 2008. The first telescope of the AST3 array was successfully deployed at Dome A in January 2012 and started a sky survey in March 2012.

CSTAR is a Schmidt-Cassegrain wide-field (4.5° in diameter) quad-telescope of g, r, i or open filters, each with a pupil entrance aperture of 145 mm and a 1 K × 1 K frame transfer CCD with a plate scale of 15"/pix. Its primary goal is to quantify



CSTAR by combining 2,800 i-band images obtained during a 24-hour period of exceptionally good conditions

the properties of the sky brightness and transmission at Dome A Antarctica. More than 250 variables were detected around the polar region, which is six times as many variables as previous surveys (45 variables detected by ASAS or GCVS) with similar magnitude limits.

AST3 consists of three telescopes matched respectively with g-, r- and i-band filters. Each telescope is a catadioptric optical telescope with an entrance pupil diameter of 500 mm, and an f-ratio of 3.73. AST3 is equipped with a 10 K × 10 K CCD with a field of view of 4.3 square degrees. Major science goals include supernova discovery and exo-planet search.

Chinese astronomers are also planning to build a 2.5-m Kunlun Dark Universe Survey Telescope (KDUST) and a 5-m Dome A THz Telescope (Date5) in the coming years. ■

Phase Closure Achieved on Multiple ASKAP PAFs

System verification tests on three ASKAP antennas, installed with CSIRO's innovative new phased array feed (PAF) technology, have achieved first fringes and successfully demonstrated phase closure on the three baseline system.

Phase closure is an important step in calibrating the antennas in preparation for interferometry with ASKAP by demonstrating the proper functioning of the antennas and their electronic systems. Fringes had been achieved in previous on-sky commissioning tests at the MRO, but now performing the correlation using a three-PAF baseline as a triangle removes phase offsets in observations and ensures a more accurate imaging process.

The Systems Commissioning (SCOM) team at the MRO used the strong compact astronomical source Virgo A to perform the correlations, using data captured simultaneously from the three beamformers and processed in real time. The three baselines were then combined to form the closure phase, the results of which were encouragingly close to zero degrees for both polarisations.

The software correlator developed by the Computing team allows for captured signals from multiple ASKAP antennas to be processed in real time and is crucial for end-to-end system testing in this configuration. The system uses "raw data capture" from memory on beamformer cards, capable of handling data from 16 bands, each 1 MHz, spanning 300 MHz bandwidth to produce measurement sets just like a full correlator.

"There is a significant level of excitement among ASKAP team as a whole," says ASKAP Project Director Ant Schinckel, "Obtaining phase closure on a three baseline system reinforces that our systems work as expected, and confirms that our plans for BETA commissioning are on track."

This first demonstration of phase closure on three ASKAP antennas will be followed by delivery and commissioning of the next three antennas making up the full Boolardy Engineering Test Array (BETA), and commissioning of the six-antenna BETA hardware correlator.

CASS Director Dr. Phil Diamond will be talking about ASKAP in SpS9 Future Large Scale Facilities at 10:55 on August Monday 27 in Room 307A+B. ■

Young Astronomers Gain Valuable Insights Over Lunch

How to network effectively at scientific conferences was the hot topic at the Young Astronomers Lunch, which took place yesterday at the General Assembly.

In his opening remarks at the event, IAU President Robert Williams said the two most important things that astronomers need are creativity, in order to come up with new ideas, and the ability to communicate effectively. "Networking, to me, is the magic word for a successful career in astronomy. No matter how creative you are, or what observations you get, if you are unable to communicate these to other people, it is meaningless," said Williams.

Following the welcome presentations, the 240 young astronomers at the event, who were assigned to tables in groups of eight, then had the opportunity to talk informally with two senior astronomers. Around the hall, the importance of networking came up several times, with some young astronomers commenting that they often find it difficult to find scientists whom they've never met before at large conferences. "Go and find someone from the same country as the scientist and ask if they know the person that you're looking for," suggested John Baruch from the University of Bradford, UK, to a group of astronomers on one table.

After the event, PhD student Hannes Breytenbach from the University of Cape Town, South Africa, said: "The challenge of choosing a particular career path is often daunting. The advice offered by the senior astronomers is therefore truly invaluable. Many thanks to all you!" ■

Sarah Reed *IAU Public Outreach Coordinator / NAOJ*

Day 5: Program Summary

Film (12:45 - 14:00): Saving the Hubble

IAUS 288	Arctic possibilities & Facilities
IAUS 290	Magnetic environment & Multi-wavelength coverage & Instrumentation
IAUS 291	Emission & Future facilities
IAUS 292	Star formation & Feedback
SpS1	Chemical properties and structure of the halo
SpS2	Environmental impact & Galaxy evolution
SpS3	Cosmological context
SpS5	Stellar parameters and wind parameters & Ejection and feedback
SpS6	Existing and planned facilities & Future science and telescope operation
SpS18	Hot topics

JD5 and JD6 continue.

Announcements

Working Group on Historical Radio Astronomy
August 27, 2012

Session I: 08:30-10:00: Business Meeting and Contributed Papers
Richard Wielebinski: *Albrecht Unsöld - A pioneer in the interpretation of the origin of the cosmic radio emission*
Richard G. Strom: *The Dutch effort to observe the HI line: some little-known details*
M. Ishiguro, W. Orchiston, and R. Stewart, *The IAU Early Japanese Radio Astronomy Project: A Progress Report*

Session III: 14:00-15:30: Biographical Reports on Recently Deceased Radio Astronomers

Session IV 16:00-18:00: Radio Source Counts and Cosmic Evolution
David Jauncey: *Early Radio Source Counts: Differentiating the Data and Integrating the Implications*
Ron Ekers: *How Fred Hoyle reconciled radio source counts and the Steady State Cosmology*
Jasper Wall: *Eddington, Ryle and Hoyle: How a major 20th century discovery was lost in confusion and noise*

IAU Commission 51 Bioastronomy business meeting is on Monday, August 27 at 18:30-19:30 at the National Astronomical Observatories of China.

The C51 science session is on Wednesday, August 29 at 8:30-10:00 in VIP4-4 in the CNCC.

Heritage Activities at the GA
The programme of C41/ICHA and its Working Groups continues today with a full day of sessions organised by the Astronomy and World Heritage Working Group. As these were not included in the scientific sessions programme book, we list them here as a service to the general membership of the IAU.

Friday, August 24 Room VIP 4–3
Session 1 (09:00–10:30):
09:00–09:30 WG business meeting
09:30–10:30 Presentation and public launch of the UNESCO–IAU Astronomical Heritage Web Portal

Session 2 (11:00–12:30): Presentation of the IAU Extended Case Studies of key astronomical heritage sites

Sessions 3 (14:00–15:30) & 4 (16:00–17:30) Conservation and protection of different categories of astronomical heritage—common issues: A Joint Science Meeting of the Astronomy and World Heritage Working Group and the Historical Instruments Working Group

INQUIRIES OF HEAVEN

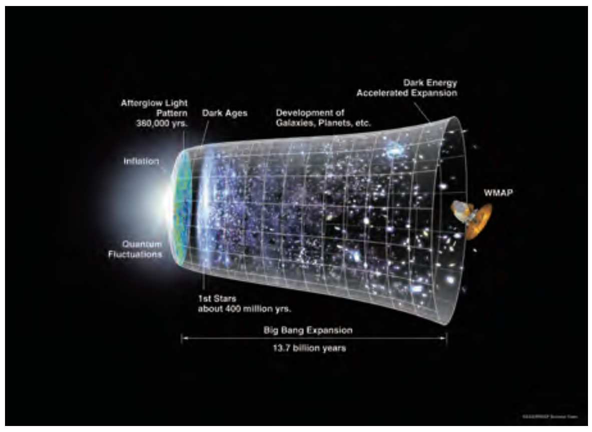
IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA, AUGUST 20 - 31, 2012 MONDAY, AUGUST 27, 2012 DAY 6

IAUS 289: Advancing the Physics of Cosmic Distances

Knowing the distance of an astrophysical object is key to understanding it: without an accurate distance we do not know how bright it is, how large it is, or even when it existed. But astronomical distance measurement is a challenging task: the only information we have about any object beyond our Solar System is its position (perhaps as a function of time) and its brightness (as a function of wavelength and time).

In 1997, the Hipparcos space mission provided – for the first time – a significant number of absolute trigonometric parallaxes at milliarcsec-level precision across the whole sky, which had a major impact on all fields of astrophysics. In addition, during the past ten years, ground-based 8–10m-class optical and near-infrared telescopes and space observatories have provided an unprecedented wealth of accurate photometric and spectroscopic data for stars and galaxies in the local Universe. Interferometric radio observations have achieved 10 micro-arsecond astrometric accuracy. Moreover, stellar models and numerical simulations are now providing accurate predictions of a broad range of physical phenomena, which can in principle be tested using accurate spectroscopic and astrometric observations.

Symposium 289 will highlight the tremendous amount of recent and continuing research



Different scales of the Universe at different stages of history.

into a myriad of exciting and promising aspects of accurately pinning down the cosmic distance scale. Putting the many recent results and new developments into the broader context of the physics driving cosmic distance determination is the next logical step. This will benefit from the combined efforts of theorists, observers and modellers working on a large variety of spatial scales and contributing a wide range of expertise.

This is a very exciting time in the context of this Symposium: VLBI (very long baseline interferometry) sensitivity is being expanded allowing, for example, direct measurement of distances throughout the Milky Way and to Local Group galaxies. The field will benefit from expert input to move forward into the era of Gaia-, optical-interferometer- and Extremely Large Telescope-driven science, which (for example) will allow us to determine Coma-cluster distances without having to rely on secondary distance indicators, thus finally making the leap to accurate distance measurements well beyond the Local Group of galaxies.

On our journey from the solar neighbourhood to the edge of the Universe, we shall encounter stars of all types, alone, in pairs and in clusters, their life cycles, and their explosive ends; the stellar content, dynamics, and evolution of galaxies and groups of galaxies; the gravitational bending of starlight; and the expansion, geometry and history of the Universe. As a result, the Symposium will offer not only a comprehensive study of distance measurement, but a tour of many recent and exciting advances in astrophysics. We aim to provide a roadmap for future efforts in this field, both theoretically and observationally. We therefore particularly encourage you to attend the Symposium's introductory plenary lecture by Wendy Freedman (Monday 27 August at 08:30). ■


Richard de Grijs
Associate Director and Professor at the Kavli Institute for Astronomy and Astrophysics at Peking University.

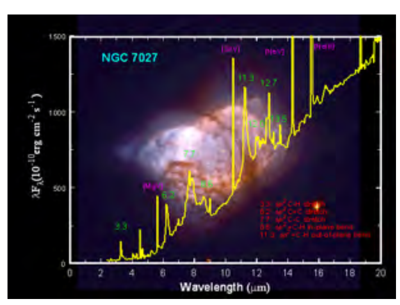

Giuseppe Bono
Associate Professor of stellar astrophysics at the Department of Physics at the University of Rome Tor Vergata.

SpS16: Unexplained Spectral Phenomena in the Interstellar Medium

There are several outstanding mysteries in interstellar medium spectroscopy which have remained unsolved after decades of effort. The diffuse interstellar bands (DIBs) have been known for almost a century. Although more than 400 bands from the near UV to near infrared have been detected, none of them have been identified. In the Milky Way Galaxy, DIBs have been seen towards over one hundred stars. DIB carriers in the interstellar medium of external galaxies can be probed by supernovae, and have been detected in galaxies with redshifts up to 0.5.

The 217.5 nm extinction feature has been known for about 45 years. It was extensively observed by the IUE and is found to have remarkable constancy in its peak wavelength of 217.5 nm. This is not just a local phenomenon as the feature has been detected in galaxies as distant as z>2.

A family of unidentified infrared emission (UIE) features was discovered over 30 years ago and the number of features has been expanding as the result of infrared spectroscopic observations from ISO and Spitzer. The UIE phenomenon includes aromatic bands at 3.3, 6.2, 7.7, 8.6, and 11.3 μm, aliphatic features at 3.4 and 6.9 μm, broad emission plateaus at 8, 12, and 17 μm, as well as a host of weaker features that are too broad to be atomic or molecular lines. Although the



A number of unidentified infrared emission bands can be seen in this ISO spectrum of the planetary nebula NGC 7027. The background image is an HST image of the object.

UIE phenomena have been widely attributed to polycyclic aromatic hydrocarbon molecules, other forms of carbonaceous materials have also been discussed.

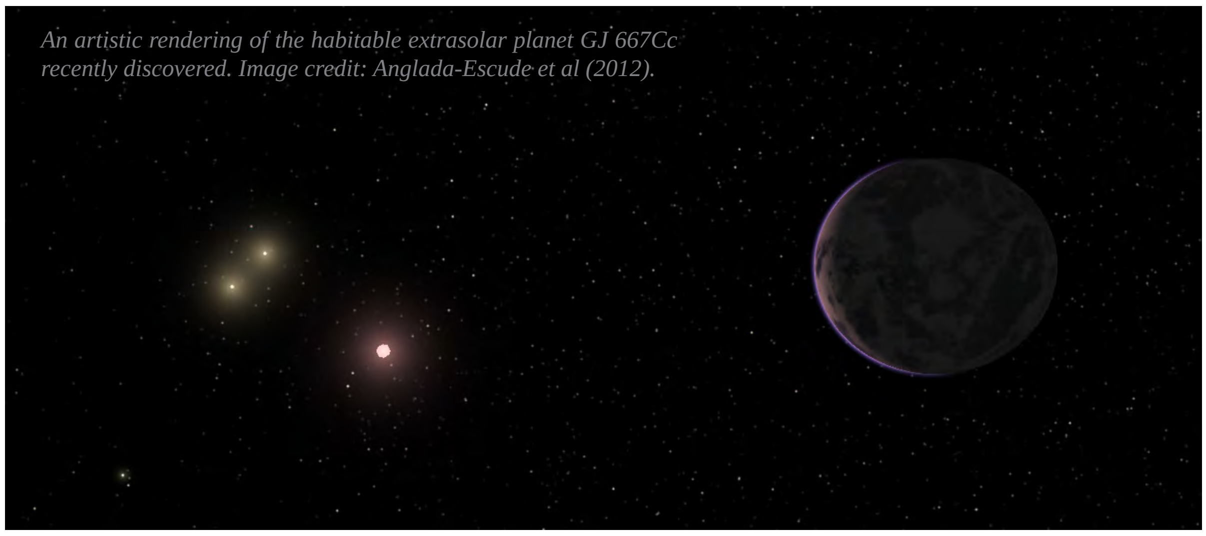
The observation of the Extended Red Emission (ERE) also goes back 30 years. ERE is commonly seen in reflection nebulae but has also been detected in dark nebulae, cirrus clouds, planetary nebulae, HII regions, the diffuse interstellar medium, and in haloes of galaxies. Other than the fact that it is likely due to photoluminescence, the exact nature of its carrier is still unknown.

The 21 and 30 μm unidentified infrared features are generally associated with objects in the late stages of stellar evolution. Candidates that have been suggested include hydrogenated fullerenes, nanodiamonds, titanium carbide nanoclusters and a thiourea functional group associated with aromatic/aliphatic structures.

It is interesting to note that these phenomena have been observed not only in the ISM, but also in circumstellar environments, in the galactic halo, and in external galaxies. In some cases they have been observed in galaxies with redshifts > 2 suggesting that the carriers responsible for these features were already present in the early Universe. Due to the ubiquitous nature of these spectral phenomena, their carriers must be substances made of common elements, most likely carbon. There is an increasing consensus that the carriers are organic compounds unfamiliar to us in the terrestrial environment. The recent detections of C60 and C70 in planetary nebulae and reflection nebulae have also raised interest in other carbon allotropes in the ISM. In this Special Session, we bring together observers and laboratory spectroscopists with the goal to gain a better understanding of the origins of these long standing mysteries. ■


Sun Kwok
Chair Professor of Physics at the University of Hong Kong. He currently serves as the Vice President of Division VI (interstellar Matter) of the IAU, and is the incoming Vice President of IAU Commission 51 Bioastronomy.

IAUS 293: Formation, Detection, and Characterization of Extrasolar Habitable Planets


An artistic rendering of the habitable extrasolar planet GJ 667Cc recently discovered. Image credit: Anglada-Escude et al (2012).

The detection of planets around other stars is undoubtedly one of the triumphs of modern astronomy. Not only did these planets prove that our solar system is not unique, they also revealed many new physical and dynamical characteristics that were unseen among the plants of our solar system and were unexplainable by the conventional theories of planet formation and dynamics. The challenges associated with these discoveries made astronomers revisit planetary theories and reinvigorated our understanding of the formation and evolution of planetary systems.

Almost two decades after the discovery of the first extrasolar planet, and with now over 700 of these objects discovered and over 3000 candidates identified, these challenges still continue. On the observational front, despite breakthroughs such as imaging giant planets (e.g. HR 8799), a major shift has been made towards a more challenging task: detecting Earth-sized planets or super-Earths in the habitable zones of solar-type and smaller stars. Several large ground-based surveys such as HARPS, MEarth, M2K, and LCES, have already detected potentially habitable super-Earths and are producing promising results. The successful operation of the CoRoT and Kepler space telescopes has also made significant contributions by detecting many planets including the most prominent transiting super-Earth, CoRoT7b as well as Kepler 16b, the first circumbinary planet, and Kepler 22b, an Earth-sized planet in the habitable zone.

On the theoretical front, the challenges are even larger. Despite more than a decade of work on the formation and dynamical evolution of extrasolar planets, many fundamental issues are still unresolved. As in our solar system, it is not clear how extrasolar giant planets are formed. Nor is it fully understood how some of these planets acquired high orbital eccentricities, why some have very large semi-major axes, and in regard to the formation of terrestrial/habitable planets, it is not evident how the migration of giant planets affects the formation of smaller bodies in those systems. With the discovery of several super-Earths during the past few years, fundamental theoretical work is also underway to understand the interior dynamics of these bodies, as well as their atmospheres and magnetic fields, and the connections between these properties and the habitability of super-Earths and the possibility of the detection of their biosignatures.

The IAU symposium 293 brings together scientists from around the globe to address these fundamental questions. This symposium that is held on the second week of the general assembly (August 27—31), focuses on the advancements made in extrasolar planetary science, in particular on the formation and detection of terrestrial and habitable planets. The symposium has a diverse scientific program covering topics related to habitability and the challenges associated with the formation and detection of habitable planets. The program includes a series of invited talks and contributed oral and poster presentations through which participants present the current state of research on the habitability of Earth and the progress made towards its associated challenges, and discuss the implications of this research for detecting similar planets around other stars. www.ifa.hawaii.edu/iau293 ■


Nader Haghighipour
Faculty and Associate Astronomer at the Institute for Astronomy and NASA Astrobiology Institute, University of Hawaii-Manoa.

JD7: Joint Discussion on Space-Time Reference Systems for Future Research

Division I (Fundamental Astronomy) with the support of Division III (Planetary Systems Sciences), Division IX (Optical & Infrared Techniques), Division XI (Space & High Energy Astrophysics), and Division XII (Union-Wide Activities) is coordinating the Joint Discussion on Space-Time Reference Systems for Future Research. The topics include space-time reference systems compatible with general relativity, accurate planetary ephemerides and time references for space missions and pulsar investigations, development of radio reference frames for space missions and astronomy, and development of optical reference frames for exoplanet investigations.

Future astronomical, astrophysical and geophysical research will demand reference systems of the highest accuracy. Benefits of recent improvements include the determination of the masses of planets from pulsar timings, determination of PPN parameters, accurate stellar distances, and dynamics of the Earth's motion. The validity of the most promising investigations can be limited by the reference frames, models and algorithms used to make the required observations and to analyze the results. The goal of this Joint Discussion is to coordinate ongoing efforts in this field and to develop effective strategies for future cooperative work to ensure that the reference systems will be sufficiently accurate to meet the future needs of the international astronomical and space sciences communities.

Investigations of exoplanets and near-Earth objects demand highly precise reference frames. Future space missions and pulsar-timing projects will require the development of relativistic time transfer algorithms and highly accurate planetary ephemerides. Investigations of terrestrial phenomena such as the rise of ocean levels require the most precise reference frames to enable the required astro-geodetic measurements.

Past efforts in the development of reference systems have already enabled unprecedented advances in these areas. These advances have, in turn, spurred new investigations that demand even higher accuracy reference systems. This Joint Discussion therefore will review currently planned projects devoted to improving reference systems and the links between the various reference frames.

On Monday 27 August Session 1 (10:30-12:30) is devoted to theoretical aspects of reference systems. Session 2 (14:00- 15:30) will deal with reference timescale requirements, and Session 3 (16:00-18:00) will deal with topics in celestial mechanics.

On Tuesday 28 August Session 4 (10:30-12:30) will discuss space mission requirements and Session 5 (14:00 – 15:30) will be concerned with future requirements for planetary ephemerides. Session 6 (16:00-18:00) will be devoted to relating reference systems.

Finally on Wednesday 29 August Session 7 (10:30-12:30) will conclude the Joint Discussion with a general discussion and potential recommendations regarding such topics as a redefinition of the astronomical unit, leap seconds and pulsar time scales.

Full details can be found at: http://www.referencesystems.info/iau-joint-discussion-7.html ■


Dennis McCarthy
U. S. Naval Observatory (retired), President of IAU Division I, Co-Chair of JD7 along with Nicole Capitaine and Sergei Klioner.

IAUS 295: The Intriguing Life of Massive Galaxies

The IAU Symposium 295 is dedicated to the formation and evolution of massive galaxies. Massive galaxies live an exciting and eventful life. Most of them are "dead" by today and their morphology is typical of early-type galaxies. But they might have looked very different in the past. While their predecessors in the very early Universe might well have been small, they must have soon become massive, vigorously star forming objects. Just shortly after this violent phase, possibly triggered by galaxy mergers, star formation in massive galaxies got quenched, followed by a long phase of passive evolution. Following their genealogical/merger tree, they get quenched and rejuvenated, they get strangulated, they starve, they cannibalise their smaller neighbours and merge with their peers. Massive galaxies are responsible for most of the chemical enrichment in the Universe, and many eventually end their lives clustered together. The most amazing fact about massive galaxies is that they constitute, today, a surprisingly homogeneous class of objects. Today's massive galaxies are almost featureless with elliptical morphology, they have little or no gas, and show no signs of significant star formation activity, while their cores are often characterised by surprisingly complex kinematics.

Visible light image of the supergiant elliptical galaxy M87.

We know little about the significance of transitions in the formation and evolution of massive galaxies. Clearly, star formation activity needs to be quenched somewhere along the evolutionary path of a galaxy and its progenitors. But what is the physical mechanism for this quenching? What are the relative roles of feedback from supernovae and super-massive black holes? Where does the environment and galaxy mergers come in? If we want to understand the intriguing life of massive galaxies, we need to map their entire evolution over cosmic time, and this requires very different observational and theoretical approaches. However, the links between the various research groups that study different evolutionary stages of massive galaxies at different redshifts are loose.

After the overwhelming progress in galaxy evolution over the past decade, recent and near-future advances in telescope technology and computer power for large-scale simulations, as well as the launch of massive galaxy surveys will lead to a further leap in our understanding of galaxy formation. Finally, revolutionary new observatories such as the James Webb Space Telescope or the next generation of ground-based Extremely Large Telescopes will be within reach, and it will be exciting to discuss both theoretical predictions and expected advances in observational astronomy.

The IAUS 295 will bring together observers and theorists to discuss recent progress in the field and to plan ahead for future challenges. The symposium will cover the life of massive galaxies from the formation of the first galaxies in the early Universe, through their evolution with redshift to massive galaxies in the local Universe touching upon all kinds of issues relates to the life of massive galaxies including gas accretion and star formation, feedback and quenching, black hole growth, mass assembly, galaxy mergers and interactions, chemical enrichment and stellar populations, dark matter, galaxy environment, galaxy haloes, and satellite accretion both from a theoretical and observational perspective. ■

Daniel Thomas
Reader in Astrophysics at the Institute of Cosmology and Gravitation at the University of Portsmouth, UK.

Re-Definition of the Astronomical Unit

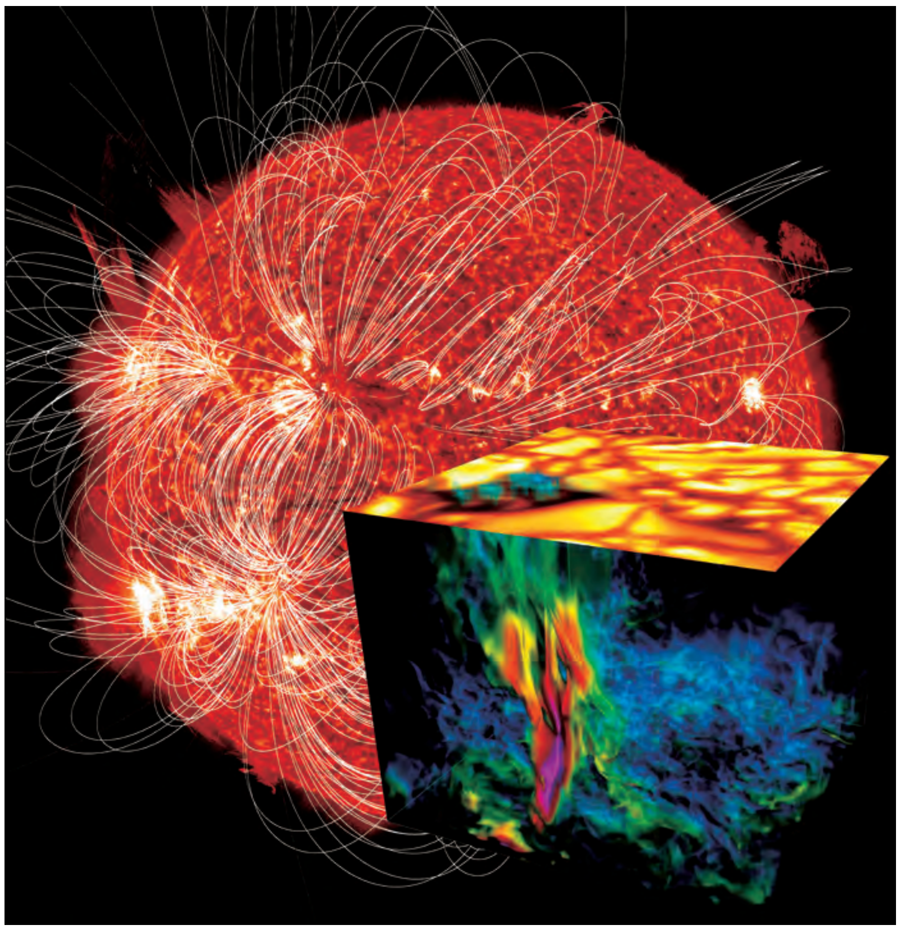
Division I of the International Astronomical Union (IAU) proposes that the astronomical unit (au) be defined as a fixed number of meters. Traditionally, the astronomical unit has been considered to be a measure of the mean distance between the Earth and the Sun. Originally it was regarded as the length of the semi-major axis of the Earth's orbit. Officially since 1938, and unofficially since the 19th century, the astronomical unit has been a unit of length such that the Newtonian gravitational constant G is equal to the square of the Gaussian constant k, and $G=k^2=0.000\,295\,912\,208\,285\,591\,102\,5$, provided that the mass of the Sun and the length of the day are taken as the units of mass and time, respectively. The value of k=0.017 202 098 95 was first proposed by Carl Friedrich Gauss in his 1809 work *Theoria motus corporum coelestium in sectionibus conicis solem ambientium* ("Theory of Motion of the Celestial Bodies Moving in Conic Sections around the Sun"), and was retained in the IAU 2009 system of constants. This definition also made the au equivalent to the radius of an unperturbed circular Newtonian orbit about the Sun of a particle having infinitesimal mass, moving with an angular frequency of 0.017 202 098 95 radians per day, or the length for which the heliocentric gravitational constant (the product GM_{sun}) is equal to $(0.017\,202\,098\,95)^2\ au^3/day^2$. The value of GM_{sun} in Système International (SI) units (i.e. meters) would then be determined from the expression, $GM_{sun}= au^3k^2/day^2$.

The concept is similar to other cases when a unit is defined indirectly by fixed values of some natural constants (e.g., for the geometrized units). This style of definition was useful for many years because the lack of precise distance measurements in the Solar System created the need for a specific scale unit in planetary orbit analyses. However, the accuracy of modern ranging observations is now high enough that this is no longer a consideration. Current ephemerides are capable of providing direct estimates of GM_{planet} and GM_{sun} in SI units, and we expect to be able to detect observationally the variation with time of the solar mass parameter GM_{sun} in the near future caused by the mass loss of the Sun. An additional concern is the need to consider the effects of general relativity in defining the au. In its original definition no thought was given to this aspect. Now its interpretation through the motion of the Earth around the Sun is not only problematic, but it is also necessary to account for the time scale being used.

Therefore, a new definition of the astronomical unit of length is proposed in 2012. Specifically, the recommendations call for the astronomical unit to be defined to be a conventional unit of length equal to 149 597 870 700 m exactly, and that this definition be used with all time scales such as Barycentric Coordinate Time, Barycentric Dynamical Time, Geocentric Coordinate Time, Terrestrial Time, etc. This eliminates possible conflicts with SI units, dependence on theories of motion, and requirements for additional conventions within the relativistic framework. It also makes it possible to determine directly the variation with time of the solar mass parameter GM_{sun}. The issue mainly concerns those in the field of high-accuracy Solar System dynamics. The astronomical unit does define the parsec and thus the whole astronomical distance ladder, but the relative difference between the old and the new definitions will not exceed a fraction of one in 10^{10}, so there is no significant effect, considering the relative errors of cosmic distances outside the Solar System. ■

Dennis McCarthy
U. S. Naval Observatory (retired)
President of IAU Division I

IAUS 294: Solar and Astrophysical Dynamos and Magnetic Activity



Among the key topics of IAUS 294 are the global magnetic structure of the Sun, illustrated by the He II 304Å image and magnetic field lines from the Solar Dynamic Observatory, and the mechanisms of formation of sunspots, illustrated by a snapshot of a subsurface turbulent magnetic structure from numerical simulations (courtesy of I.N. Kitiashvili).

The origin of magnetic fields is one of the great, fundamental mysteries of astrophysics. Global magnetic fields in planets, in the Sun and other stars, in spiral galaxies and galaxy clusters are believed to be generated and maintained by a hydromagnetic dynamo, a process that converts turbulent kinetic energy into magnetic energy. The dynamo processes operate on drastically different scales, but are associated with common physical mechanisms, involving the complex interactions of rotation, turbulence and MHD instabilities.

The 20 years following the first IAU Symposium dedicated to dynamo processes (IAU Symposium 157 “The Cosmic Dynamo”, Potsdam, 1992) have witnessed the founding of a new field of astronomy; ideas developed by solar astronomers have been successfully applied to other stars and astrophysical objects, and entirely new magnetic activity phenomena have been discovered. Solar physicists have used helioseismology to greatly constrain the mechanisms that generate magnetic fields inside the Sun. High-resolution observations of surface magnetism and coronal dynamics have provided new knowledge about magnetic relaxation processes in astrophysical conditions. The connection between the interior dynamo processes and the outer magnetized coronae is a new, cross-disciplinary aspect to the solar-stellar magnetism investigations. The theoretical framework for solar activity has proven to be a surprisingly robust framework for discussing the activity of other stars, accretion disks, galaxies, and interstellar medium. However, the number of new questions, that new observations have given birth to, is much larger than the number of questions previously answered.

The Sun and stars exhibit a variety of enigmatic phenomena that continue to be inscrutable and defy our understanding. We do not understand how the magnetic fields are generated within the Sun and stars, how the Sun’s intense magnetism is concentrated into sunspots as large as the Earth, how the dynamo-generated magnetic fields trigger solar and stellar activity, how the ubiquitous small-scale magnetic fields are organized on larger scales and relate to the dynamo process, how we can predict the solar and stellar activity cycle, and, in particular, why the dynamo produces the solar and stellar activity cycles with long activity minima. The unusual long minimum and slow onset of Solar Cycle 24 defied theoretical predictions and posed new challenges for solar-cycle dynamo theories.

The vastly different physical conditions in planets, stars and galaxies can help to shed light on the dynamo processes. Substantial progress has been made in Doppler imaging and spectro-polarimetric techniques to study the stellar magnetism. Planets with liquid cores produce magnetic fields by a dynamo mechanism. This mechanism is currently best understood among all the astrophysical dynamos thanks to advanced numerical simulations. The simulations have been able to explain the great variety of planetary magnetic fields and have provided an understanding of how the observations connect to the dynamo models. On galactic scales, the role of the dynamo is much less understood. Radio observations of polarized synchrotron emission provide important three-dimensional maps of the strength, structure and turbulent properties of the magnetic field in galaxies, clusters and interstellar medium. Such observations are very challenging but will provide unobstructed views of the dynamo operating on a large cosmic scale.

Thus, important lessons can be learned from the cross-disciplinary discussions of the dynamo mechanism in such vastly different astrophysical conditions. This symposium will make an important step towards solving the great puzzle of the origin of cosmic magnetic fields. ■

Alexander Kosovichev
Senior Research Scientist, W.W. Hansen Experimental Physics Laboratory, Stanford University.

Commission 5 Meetings to Focus on Issues Related to Data and Documentation

On Monday and Tuesday August 27 and 28, Commission 5 (Astronomical Data and Documentation) will hold both its general business meeting and meetings of its various Working Groups. We encourage all those with an interest in the challenges of data management, documentation, and related activities to attend!

The general business meeting is Monday, 10:30-12:30, in Room 403. In addition to a review of activities since the prior General Assembly, we will discuss the new organization of the Commission and the Working Group structure. At 14:00-15:30, also in Room 403, the Working Group on Virtual Observatories, Data Centers, and Networks will convene. This session will include presentations by A. Kembhavi (India), chair of the International Virtual Observatory Alliance, and C. Cui (China) on virtual observatory activities in China. The Working Group on Nomenclature meets at 16:00-18:00 in Room 403 and promises an interesting discussion about the challenges of maintaining consistent naming conventions in astronomy.

On Tuesday the Working Group on Astronomical Data meets at 8:30-10:00 in Room 403. A key discussion topic will be whether or not to absorb the activities of this WG into Commission 5 itself. The Working Group on FITS (the Flexible Image Transport System) convenes at 10:30-12:30 in Room 402B. FITS continues to be the lingua franca of astronomical data, but other formatting standards such as HDF5 are starting to be used, particularly in radio astronomy. We will hear from M. Wise (Netherlands) about HDF5, and A. Rots (USA) will provide a summary of FITS developments over the past triennium. The Working Group on Preservation and Digitization of Photographic Plates will meet at 16:00-18:00 in Room 408. This WG focuses on the challenge of preservation our vast heritage of images and spectra obtained by photographic means. ■

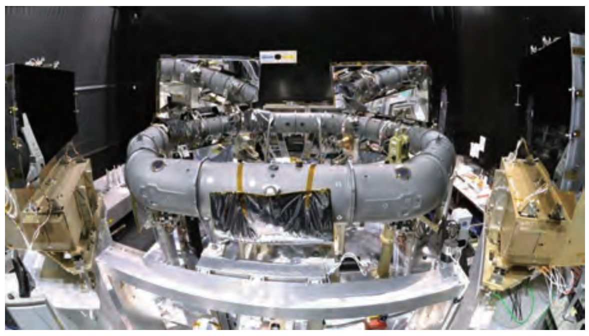
Masatoshi Ohishi
Chair of Science Organizing Committee

Robert Hanisch
Member of Science Organizing Committee

Europe's Next Space-Astrometry Mission: Gaia

Gaia (http://www.rssd.esa.int/gaia) is the next astrometry mission of the European Space Agency (ESA), following up on the success of Hipparcos. Gaia will survey the sky and repeatedly observe the brightest 1,000 million objects during its 5-year lifetime. Gaia's data comprise astrometry and low-resolution spectro-photometry (http://www.rssd.esa.int/index.php?project=GAIA&page=Science_Performance). Spectroscopic data will be obtained for the brightest 150 million sources. Parallaxes will be measured with standard errors less than 10 micro-arcsecond (muas) for stars brighter than 12-th magnitude, 25 muas at magnitude 15, and 300 muas at magnitude 20. Photometric standard errors are in the milli-magnitude regime. The spectroscopic data allow measurement of radial velocities with errors of 15 km/s at magnitude 17. Gaia's science goal is to unravel the structure and evolution of the Milky Way. In addition, Gaia's data will touch many other areas of science, e.g., stellar physics, variability studies, solar-system bodies, fundamental physics and exo-planets.

The spacecraft is currently in the integration and testing phase. With a launch foreseen in the fall of 2013, the final catalogue is expected in 2021. The first intermediate data are planned to be released two years after launch. Science alerts, for instance on supernovae, will be released from launch plus one year onwards.



The Gaia payload in the cleanroom during alignment of the telescopes (January 2012). Image courtesy EADS Astrium SAS, Toulouse, France. Image taken from http://www.rssd.esa.int/index.php?project=GAIA&page=IG_20120213b

The European science community, organised in the Data Processing and Analysis Consortium (http://www.rssd.esa.int/gaia/dpac), is responsible for the processing of the data, 350 million astrometric measurements, 80 million spectro-photometric measurements, and 10 million spectra every day. The Consortium has recently successfully concluded the first of a series of operation rehearsal campaigns. The software readiness review is planned for spring 2013.

In preparation of the scientific exploitation of the data, the European Union and European Science Foundation are funding the Gaia Research for European Astronomy Training (GREAT) initiatives (http://www.great-esf.eu and http://www.great-itn.eu). These science-driven infrastructures will facilitate exploitation of the Gaia data over the coming decade. Check out stand 21 in the exhibition hall!

Gaia at the General Assembly

- Monday 27 August, 14:00-14:30, Symposium 289, Direct distance determination using parallax: Techniques, promises, and limitations by Lennart Lindegren (member of the Gaia Science Team)
- Monday 27 August, 14:40-15:05, Special Session 9, Gaia by Timo Prusti (Gaia Project Scientist)
- Tuesday 28 August, 11:00-11:15, Joint Discussion 7, Status of Gaia and early operation by Francois Mignard (DPAC Executive Chair)
- Wednesday 29 August, 16:00-16:20, Commission 8 Science Meeting, Astrometry with Gaia: what can be expected? by Jos de Bruijne (Gaia Deputy Project Scientist) ■

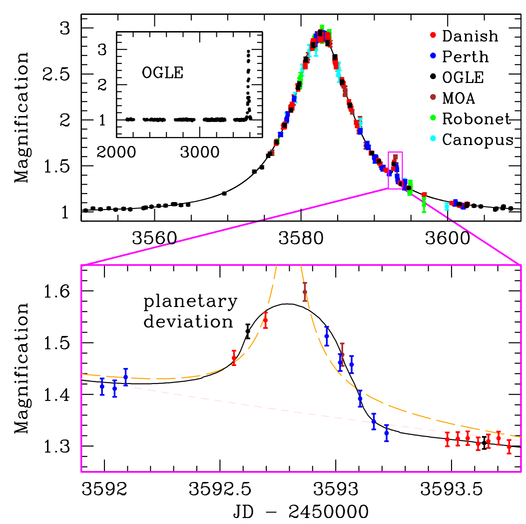
Jos de Bruijne
Gaia Deputy Project Scientist, European Space Agency, ESA/ESTEC, Noordwijk, The Netherlands, jos.de.bruijne@esa.int

Gravitational Microlensing as a Way to Detect Extrasolar Planets

Gravitational microlensing was proposed by Bohdan Paczynski in 1986 as a novel method to detect objects that are too faint to be observed directly. It uses background (source) stars as "light bulbs". Characteristic bell shaped brightening and fading lasting weeks or months occur when a foreground (lens) star passes in front of the source.

Microlensing is very rare: it affects less than one per million Galactic bulge star light curves at any time. The current observing strategy is thus split into two levels. First, wide-field imagers operated by the Microlensing Observations in Astrophysics (MOA) and the Optical Gravitational Lensing Experiment (OGLE) groups both conduct microlensing surveys toward the Galactic bulge. Then, follow-up collaborations such as the Probing Lensing Anomalies Network (PLANET), the Microlensing Follow-Up Network (μFUN), RoboNet or MiNDSTEp monitor selected candidates at a very high rate to search for very short-lived signals, using global networks of telescopes.

In the past twenty years, many planetary systems have been discovered by different techniques, that fill complementary regions of the mass-orbit discovery diagram. Microlensing has established itself as the leading method to detect very low mass planets in wide orbits. Until recently, however, still little was known about the frequency of planets - do most stars have planets or does planet formation require rare or specific boundary conditions? A recent statistical analysis of microlensing data gathered in 2002-07 revealed that on average, there is more than one bound planet per Milky Way star in the orbital range 0.5-10 AU, with masses between 5 Earths and 10 Jupiters. It indicates that on average, one in six stars hosts a Jupiter-like gas giant as a companion planet, about half are orbited by a Neptune-like ice giant, and two-thirds of the stars host a super-Earth (2-10 times as massive as the Earth). It confirms that little planets are much more frequent than giant planets.



An example of a microlensing event showing the detection of a planet.

Do these abundance estimates account for all possible planets in the Galaxy? In young star-forming regions, there is some evidence that a few unbound (or "free-floating") objects with masses 3-15 Jupiter masses exist. In its current phase, MOA-II carries out a photometric survey of 50 million stars in bulge fields with a cadence of 10-50 minutes, which can reveal unbound objects below 3 Jupiter masses. This strategy enabled MOA-II to detect, in a two-year time, ten very short events with durations of less than 2 days, thus pointing to planetary-mass objects. Statistical analyses indicate that these discoveries are only the tip of the iceberg of a large population of unbound or wide-orbits (greater than 10 AU) Jupiter-mass objects that are as common as main-sequence stars. Constraints from direct imaging furthermore suggest that most of them are not bound to any host star. These objects may have formed as a tail of brown dwarfs, or in proto-planetary discs and were later scattered away into unbound or distant orbits.

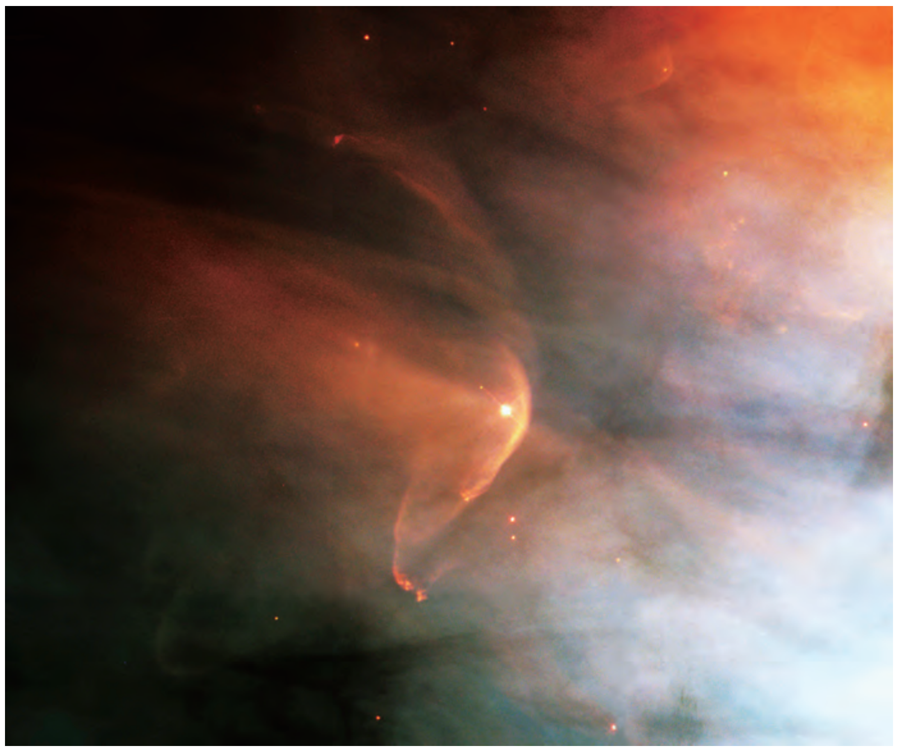
Hence, microlensing data lead researchers to conclude that planets in the Milky Way are the rule, rather than the exception. Future satellite missions such as Euclid (ESA) or WFIRST (NASA) will be able to detect a large number of planets and free-floating planets, thus providing unique constraints on their mass functions down to the mass of Mars. ■

Arnaud Cassan
Associate professor in Astrophysics at Institut d'Astrophysique de Paris at Université Pierre et Marie Curie, France.

Takahiro Sumi
Associate professor in Astrophysics at the Department of Earth and Space Science at the Osaka University Japan.

SPS10: Dynamics of the Star-Planet Relations

AIMS
This Special Session aims to foster cross-disciplinary studies of Heliophysics and Asterosphysics: the physics of the sun and stars and their environment in the interstellar medium. It raises the question: What can the knowledge we gained in heliophysics bring to the quest for understanding extra-solar systems and the fundamental physical processes in the Asterospheres. And, in return, what can the studies of other stellar systems in our galaxy bring to our understanding of our own stellar system, the Heliosphere. It will review the state-of-the-art of the theoretical, numerical modeling, and space-borne and ground-based observational studies of the dynamics of Sun-Earth relation, Sun-planet relation, and extrasolar star-exoplanet relation, and identify the key problems in these fields to be addressed by astronomy, astrophysics, and space physics communities in the coming years.



Bow shock around LL Orionis (credit NASA and the Hubble Heritage Team).

TOPICS
- Perspectives of the dynamics of the Sun-Earth and star-planet relations
- Fundamental physical processes in the stellar-planetary environment
- Stellar-solar variability
- Sun-Earth and star-planet interactions
- Stellar-solar winds: Physics of the asterospheres and the heliosphere
- Interactions of stellar-solar winds with the local interstellar medium

Public Forums (see the announcement on Page 8) - A unique chance to discover two leading Universities in Beijing: Peking University and Tsinghua University. ■

Jean-Louis Bougeret
Director Emeritus of Research with CNRS, at LESIA, Observatory of Paris, PSL.*
Other authors are **A. Chian, X. Feng,** *and* **M. Opher.**

Announcement

Women in Astronomy
Lunch Meeting

Monday 27 August, 12:30 – 14:00; Plenary Hall A on Level 4. Hosted by the IAU Working Group on Women in Astronomy.

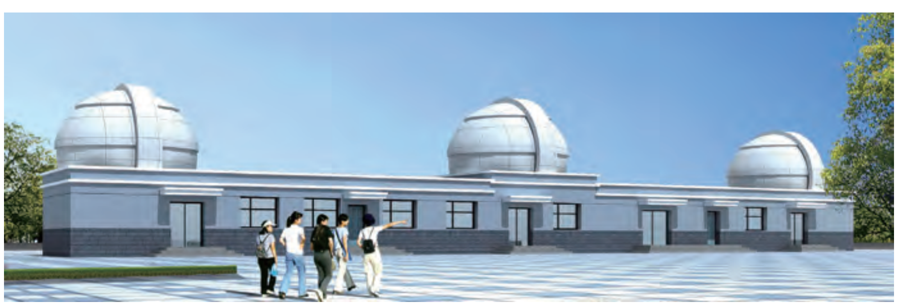
Thanks to the U.S. National Academy of Sciences, the U.S. National Science Foundation and the IAU for sponsoring the lunch, plus the LOC for their support of this lunch meeting.

Keynote speaker Prof Xiangqun Cui (President of the Chinese Astronomical Society and former Director of the Nanjing Institute of Astronomical Optics and Technology) will give a summary of the current situation for women in astronomy in China. Break out groups over lunch will focus on the current status of women in astronomy and recommend future actions to improve the environment for all astronomers. ■

SONG: A Global Optical Telescope

In an era of extremely large telescopes there is still a need for time-domain astronomy, securing long and ideally uninterrupted observations of particular objects. Key examples are studies of stellar variability, including pulsations, and the search for transient events. Such observations can be made from Space, but at great expense. Ground-based observations require dedicated facilities with a global distribution, which are still much cheaper than space missions. Such projects are clearly only possible in the framework of strong international collaboration.

The Stellar Observations Network Group (SONG) project is an effort, with a strong Chinese participation, to establish such a facility. The key scientific aims are to carry out asteroseismology with radial-velocity observations of the pulsations of bright stars, and to study extrasolar planetary systems using radial velocity and gravitational microlensing. The goal is to set up a network of 7 – 8 one-meter telescopes with a global distribution, to secure coverage of the whole sky. Each telescope will be equipped with a high-resolution spectrograph for radial-velocity observations and a so-called lucky-imaging camera for precision photometry in crowded fields, needed for the microlensing observations. In addition the nodes will be equipped with two Chinese-supplied 50 cm telescopes for coordinated photometry in wider fields.



Artist's impression of the Chinese SONG project building at Delingha which is now under construction. The three domes are for different components of the SONG-China project, from left to right: 50BiN prototype (50 centimeter binocular network), the Chinese SONG node 1 meter telescope, and auxiliary instruments. The whole system will be in operation around May 2013.

A prototype of such a network node has been established at the Izaña Observatory, Tenerife, by the Universities of Aarhus and Copenhagen, Denmark, in collaboration with Instituto de Astrofísica de Canarias. The first results obtained, observing the Sun as a star with the spectrograph, are extremely promising. The noise level achieved in radial velocity is comparable with that obtained with the GOLF instrument on the SOHO satellite.

A second node is currently being established at Delingha radio observatory site in west China, with instrumentation being built at the National Institute of Astronomical Optics and Technology of the Chinese Academy of Sciences, Nanjing. The node will start operations and coordinated observations with Tenerife around May 2013.

With just these two nodes, dedicated to asteroseismology for extended periods of time, we already expect a great improvement over existing results. However, this is obviously still far from securing the required nearly continuous data and full coverage. Thus we hope that, on the strength of these early results, other partners will be found who are interested to contribute to the project, in both hemispheres. In addition to the scientific value, we see the project as a way to strengthen the collaboration between participating institutions throughout the World in broader areas of research and, not least, in the training of the new generation of astrophysicists, in the spirit of the International Astronomical Union. ■

Jørgen Christensen-Dalsgaard
Chair of the SONG Steering Committee, Professor, Aarhus University, Denmark.

Licai Deng
Member of the SONG Steering Committee, Professor at National Astronomical Observatories, China.

Other authors are **Frank Grundahl** *and* **Hans Kjeldsen.**

Developing a pulsar-based time standard

Atomic frequency standards and clocks are now the basis of terrestrial time keeping. The various local atomic timescales are combined by the Bureau International des Poids et Mesures (BIPM) to form the International Atomic Time (TAI). TAI is the basis for both Coordinated Universal Time (UTC) and Terrestrial Time (TT).

After publication, TAI itself is never revised, however the BIPM also publishes post-corrected realizations of TT. Even though a large number of clocks are used in forming TAI, stability over decades is difficult to measure and maintain. In our recent work we have shown that the rotational stability of pulsars provides an independent check on any realization of TT. This new pulsar scale, measured using an ensemble of pulsars, is based on macroscopic objects of stellar mass (in contrast to atomic clocks that are based on quantum processes) and this scale will be continuous for far longer than any clock that we can construct.


The CSIRO Parkes Radio telescope used to develop a new pulsar-based time standard.

We make use of observations of 19 pulsars that have been observed using the Parkes radio telescope as part of the Parkes Pulsar Timing Array project. We analyse measurements of pulse arrival times. Any errors in the terrestrial time standard will cause the pulse times-of-arrival for all pulsars to arrive earlier or later than predicted. We therefore search for correlations between these arrival time measurements for different pulsars.

Using this technique, we have successfully (and independently) recovered features that were known to affect the frequency of International Atomic Time. However, we have not detected any errors in the most recent post-corrected realization of terrestrial time. This work will be described in JD7 on Monday 27 August. ■

George Hobbs
CSIRO Astronomy and Space Science, Australia.

SpS13: All new insights into stars across the H-R diagram

A huge benefit from dedicated missions like CoRoT and Kepler is the rich array of science progress they enable that goes beyond the core mission goals. Both missions have provided continuous photometric observations of large fields for long periods. The range of science enabled by pushing the limits of precision to very different levels is spectacular and is the focus of Special Session 13, "High-precision tests of stellar physics from high-precision photometry."

Over the five days of the second week of the General Assembly, Special Session 13 will offer reviews targeted to all astronomers, not just specialists. The single biggest advance made possible by these missions is the application of asteroseismology to a large number of and types of stars. Helioseismology revolutionized solar physics by providing critical constraints on the solar interior, to the extent that the combination of helioseismology and improved solar models forced the realization that the neutrino has a finite mass. We cannot get as much information on other stars because we do not resolve their surfaces, but even the low-order modes that are revealed by precise photometry can provide key insights into physical processes in all kinds of stars.

Some of the topics and questions we'll address in Special Session 13 include:

• Does the Sun really have lower CNO abundances than the traditional values?
If so, there are significant problems with current solar models. What is the resolution of this controversy?
• Precise photometry enables the study of rotation in stars in older clusters, enabling tests of our understanding of stellar spindown and the calibration of rotation as an age indicator.
• CoRoT and Kepler have found many eclipsing binaries of all masses that enable tests of stellar models.
• Kepler has revealed many G stars that exhibit white-light flares, in addition to flaring K and M stars. What might that mean for our Sun?
• Kepler and CoRoT were built to find transiting planets, but those transits also reveal things about the stars. What has been learned?
• Is the Sun really typical? These observations now provide information on such properties as surface granulation, helium abundances, differential rotation, and activity cycles.
• Massive and intermediate-mass stars have also been observed? What's new there? Well, pulsations, mixing, diffusion, for example.
• How can we apply new knowledge of G and K giants to improve their use as probes of the Galaxy?

All astronomers need to hear what's new in stellar physics, and Special Session 13 offers you a chance to catch up. Join us! ■

David R. Soderblom
Astronomer at the Space Telescope Science Institute, In Baltimore, Maryland, USA.

SpS15: Data-Intensive Astronomy

On Tuesday August 28 through Thursday August 30, Special Session 15 will cover the highly timely topic of Data-Intensive Astronomy. Large-scale surveys are expanding our coverage of the sky both spatially and temporally, and are yielding imaging, spectroscopic, time-series, and catalog data of unprecedented scope and scale. How do we manage these data efficiently and effectively? How do we enable use of these data for maximum discovery potential? How do we assure that these data will remain available indefinitely? What are the science drivers and most likely scientific insights to arise from such data collections? These and other challenging issues will be addressed by an illustrious set of invited speakers, contributed papers, and poster papers. Eight oral sessions are scheduled starting at 1400-1535 on Tuesday August 28 in Room 306B. Session 1 focuses on the Scientific Impact of Past and On-Going Large-Scale Observations and Surveys in Astronomy. Sessions 2 and 3 cover Current Status and Challenges of Future Large-Scale Observations and Surveys. Data Management and Data Access are the focus of Session 4, and Session 5 covers Advanced Data Analysis in the Era of Data-Intensive Astronomy. Session 6 examines the Synergy of Data-Intensive Astronomy with Other Fields, and Session 7 explores the Expectation for Scientific Insights in the Era of Data-Intensive Astronomy. The program concludes in Session 8 with Education and Public Outreach Related to Data-Intensive Astronomy.

A full agenda is available at http://www.adc.nao.ac.jp/SpS15/program.html and appears in the Full Program booklet starting on p. 65. ■

Masatoshi Ohishi
Chair of Science Organizing Committee

Robert Hanisch
Member of Science Organizing Committee

Announcement

Meet-a-mentor evening session

A following evening meet-a-mentor session will be held on Monday 27 August in the Function Hall on level 1 of the NAOC, from 18:30 until 20:00. The focus is to discuss career issues which female scientists find important. A number of mentees will receive comments and guidance on specific input from more senior mentors. Tea, coffee and biscuits will be provided thanks to the generous support of NAOC. Numbers of 150 are limited and registration is requested. If you have no ticket, please do registration before 10:30 on 27 August at the registration desk. ■

SOFA – Standards for Fundemental Astronomy

IAU Division I provides astronomers with software that can be used with space-time reference systems via SOFA—Standards for Fundamental Astronomy. The SOFA software forms an authoritative set of algorithms and procedures that implement standard models and support IAU resolutions. The outlet for the software is the SOFA Center at www.iausofa.org.

SOFA is operated by the Board, an international panel whose members come from a wide range of Commissions and Working Groups of the IAU and who have the knowledge and skills that go into providing and maintaining the software and website. SOFA was instigated in 1994 by the Division I Working Group on Astronomical Standards, chaired by Toshio Fukushima.

The SOFA software is available as Fortran or ANSI C source code and is freely available to all users. Individual routines may be viewed or copied or, alternatively, the whole library may be downloaded, complete with build procedures and validation tests. Documentation comprises detailed per-routine commenting, but there is also a summarising manual and two "cookbooks", SOFA Tools for Earth Attitude and SOFA Time Scale and Calendar Tools.

There are 187 routines in the current release, featuring astronomy routines in the following categories: calendars, time scales, Earth rotation and sidereal time, ephemerides (low and medium precision), precession-nutation and polar motion, the fundamental arguments used in nutation, transformations between geodetic and geocentric systems, and transformations of star positions between FK5 or Hipparcos systems and the International Celestial Reference System. There are also utility routines for dealing with vector/matrix manipulation and conversions for time and arc, etc.

Visit us at the JD7 "Space-time Reference Systems for the Future" posters to obtain further details about this service or contact us directly at sofa@ukho.gov.uk. ■

Catherine Hohenkerk
Chair, IAU SOFA Board. In HMNAO, formerly with RGO and now with UKHO.

General Assembly Banquet: Astronomers Enjoy a Night of Stadium-Gazing

After four days of enjoying views of the Bird's Nest from afar, the GA delegates had the opportunity to dine in the Olympic stadium last Thursday at the conference banquet.

The long and narrow dining area spanned over one side of the stadium, with windows offering spectacular views of the impressive stadium. Xiangqun Cui, President of the Chinese Astronomical Society, spoke proudly about this Beijing landmark in her welcome speech.

She then explained the love story that is told to celebrate the Qixi Festival – often known as 'Chinese Valentine's Day' – which coincided with the date of the GA Banquet. In the story, the Milky Way is formed to separate two lovers on opposite sides of the 'river'. But during the Qixi Festival, the lovers are allowed to cross the river and meet.

Getting into the spirit of the festival, IAU President Robert Williams took the opportunity to declare his love for his wife, his "Valentine for 51 years". Later, Nario Kaifu, the IAU President-Elect, encouraged delegates to write a wish on the paper decorations hung on a bamboo plant, which had been handcrafted by staff from the National Astronomical Observatory of Japan. (The festival is also celebrated in Japan, where it is called "Tanabata".)

While the delegates enjoyed the delicious dishes, Xiangqun Cui visited each table to request that everyone took part in the celebration by giving a singing or dance performance on the stage. A few courageous astronomers took up the challenge and sang their hearts out for everyone to enjoy. As you can probably tell, this was a relaxed affair. ■

Sarah Reed *IAU Public Outreach Coordinator / NAOJ*

Day 6: Program Summary

"Women in astronomy" lunch (12:30-14:00)

Public forum Peking University (19:30-22:00): The star-planet relations

Plenary talk by Wendy Freedman by Wendy Freedman (8:30-10:00): Advancing the physics of cosmic distances

IAUS 289 Advancing the physics of cosmic distances	Resolved stars in the Milky Way
IAUS 293 Formation, detection and characterization of extrasolar habitable planets	Planet detection
IAUS 294 Solar and astrophysical dynamos and magnetic activity	Observations and theory
IAUS 295 The intriguing life of massive galaxies	First galaxies (theory and observations) & First few Gyrs
SpS8 Calibration of star-formation rate measurements across the electromagnetic spectrum	Multi-wavelength SFR calibrations
SpS9 Future large scale facilities	Ground-based radio and high energy projects & Space projects & Ground-based UVOIR projects
SpS10 Dynamics of the star-planet relations	Overview & Physical processes in the environment
SpS11 IAU Strategic Plan and the Global Office of Astronomy for Development	Astronomy for universities, schools and the public
SpS12 Modern views of the interstellar medium	Observations of the ISM
SpS13 High-precision tests of stellar physics from high-precision photometry	Overview & Brown dwarfs and stellar masses & Star clusters
SpS16 Unexplained spectral phenomena in the interstellar medium	Overview & Observations

JD7 Space-time reference systems for future research starts.
The business meeting of Commission 51 has been moved to room 405. The time remains unchanged (Monday 18:00).

The Sun-Planet Relations

As part of the public outreach activities of the XXVIII IAU General Assembly, a Public Forum is organized by SpS10 at Peking University. It will be chaired by Prof. Suiyan Fu of Peking University, Dr. J.-L. Bougeret, and Prof. A. Chian, for SpS10. A panel of six astronomers: S. Brun (France), C. Y. Tu (China), S. Solanki (Germany), J. Richardson (USA), J. Linsky (USA), and H. Takabe (Japan) will provide a state-of-the-art view of this subject.

Location: Kavli Institute for Astronomy and Astrophysics (KIAA-PKU), 10-15 min walking from East Gate of Peking University, Metro line 4: East Gate of Peking University (North-West exit), after entering the PKU campus northwards, i.e. to the right. Taxis can get inside the Campus.

A second Public Forum on "The star-planet relations" will take place at Tsinghua University on Wednesday, 29 August. Further details will be published in the Inquiries of Heaven. ■

Inquiries of Heaven (天 问) is the official newspaper of the IAU General Assembly 2012. Online version: www.astronomy2012.org/ih **Contacting email:** heaven@nao.cas.cn. It is published by Research in Astronomy and Astrophysics in collaboration with China Features of Xinhua News Agency, Amateur Astronomer, and Chinese National Astronomy. **Advisor:** Thierry Montmerle; **Editor and Associate Editors:** Jingxiu Wang, Xiaowei Liu, Shude Mao, Shuang-Nan Zhang, Yongtian Zhu; **Editorialists and Language Editors:** Peter Anders, Thijs Kouwenhoven, James Wicker, Marcel Zemp; **Reporter:** Sarah Reed; **Art and Technical Editors:** Yangyang An, Geng Li, Jian Li; Yijie Zhang; **Managing Coordinator:** Suijian Xue; **Secretary:** Lan Wang; **Editorial Assistant:** Jingyi Huang.

INQUIRIES OF HEAVEN

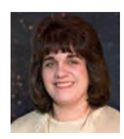
IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA, AUGUST 20 - 31, 2012 TUESDAY, AUGUST 28, 2012 DAY 7

The second place winner in the Against the Lights category is Luis Argerich for his photo "Lights or Stars". The panoramic photo from Argentina displays the Milky Way and the Magellanic Clouds from a countryside location where the sky is fairly dark but the horizon is dominated by increasing lights of nearby towns and far away cities. The contest is part of the international "Earth and Sky" photo contest, held each April as part of Global Astronomy Month and hosted by The World at Night, Astronomers Without Borders and the US National Optical Astronomy Observatory. See: www.twanight.org/contest

SpS17: Out of the Light and into the Dark

The issue of light pollution is a major concern of the International Astronomical Union. During the IAU General Assembly in Rio de Janeiro in 2009, a resolution was unanimously adopted (Resolution B5) to support the need to preserve the night sky and the right to see stars. With the increasing use of artificial light at night posing a growing threat to the visibility of the night sky, a Special Session (SpS17) at the 2012 General Assembly will highlight technical aspects of astronomical site protection and the educational aspects of increasing global awareness on issues concerning light pollution. To do this, experts have been brought together from many walks of life: people involved in media, planetaria, schools, amateur astronomy organizations, dark sky campaigns, dark sky organizations, dark sky reserves, astro-tourism, dark sky measurements, observatory site monitoring, related legislation and industry. Hot topics in artificial blue-rich sources, astronomical input to lighting industry development and an action plan for implementing IAU Resolution B5 will be highlighted.

More information on the dates and times of the session can be found at iau.iteda.org. Those in attendance at the session will receive a ticket to admit them to a social event at the Beijing Planetarium. The world debut of "Losing the Dark" (a 6-minute Public Service Announcement on light pollution) will be shown, and possibly the award-winning film documentary, "The City Dark". Telescope viewing and light refreshments will be provided. ■



Constance E. Walker

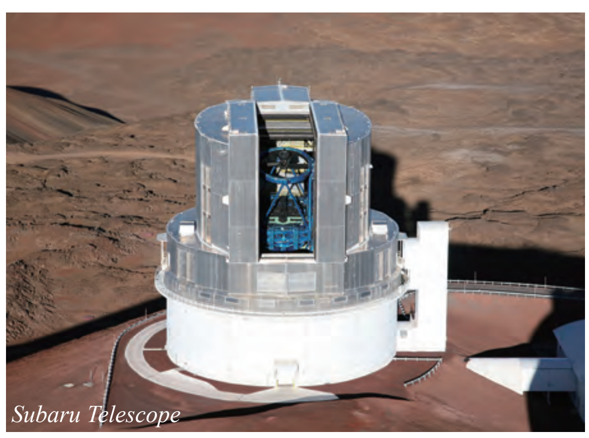
Associate Scientist & Senior Science Education Specialist, NOAO; Director, GLOBE at Night campaign (www.globeatnight.org)

Subaru Telescope Explores the Farthest Reaches of the Universe

The Subaru Telescope explores as wide a range of astronomical phenomena as possible to gain an accurate, deep understanding of the Universe. Located above 4200 m (13,700 ft) atop Mauna Kea on the Island of Hawaii, the Subaru Telescope probes the Universe with its large, 8.2 m single-piece mirror and suite of nine instruments mounted on one of its four foci (prime, Cassegrain, Nasmyth optical, and Nasmyth infrared). With its superb light-collecting and resolving power, the telescope can make observations spanning a wide range of wavelengths from the optical to the mid-infrared. Operated by the National Astronomical Observatory of Japan, the telescope is entirely financed by Japanese taxpayers and offers open use to scientists worldwide.

Research using the Subaru Telescope has contributed substantially to astrophysics since the telescope's first light in 1999. In tandem with contemporary scientific theory and findings, Subaru Telescope currently concentrates its research on a) discovering exoplanets and far-distant galaxies and b) revealing principles of planet, star and galaxy formation.

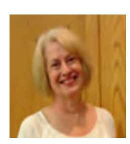
Observations with the High Contrast Instrument for the Subaru Next Generation Adaptive Optics (HiCIAO) has yielded a series of stunning findings that include the discovery of an exoplanet candidate around a Sun-like star as well as direct and sharp images of protoplanetary disks around stars that



Subaru Telescope

reveal how planets may have formed within them. Research using the High Dispersion Spectrograph (HDS) indicated that inclined orbits may be typical rather than rare for exoplanetary systems. Subaru Telescope's distinctive prime focus camera (Suprime-Cam), with its wide field of view, has captured images of the most distant protocluster of galaxies and the most distant galaxy yet discovered. Most recently, observations using the Faint Object Camera and Spectrograph (FOCAS) were able to indicate the shape of supernovae and reveal that a clumpy 3D scenario is a more plausible explanation for supernovae explosions than the widely accepted bipolar explosion scenario.

All press releases of scientific results as well as specifics about the technical aspects of the telescope's operation are available at the Subaru Telescope's website (www.subarutelescope.org). ■



Suzanne G. Frayser

Press Officer, Subaru Telescope
+1-808-934-5022, frayser@naoj.org

Message from Africa

The President of the African Astronomical Society (AfaS), Professor P.N. Okeke, heartily thanks the President, as well as Executive and National representatives of the IAU for admitting the Ethiopian Astronomical Society as a full member of IAU at the 28th General Assembly in Beijing, China. The President sincerely congratulates the Ethiopian Astronomical Society on this occasion of their admission and wishes more African countries will be admitted in the future. ■

Photo of AfAS President: Prof. P. N. Okeke

Lulin Observatory, National Central University

Established in 1992, Lulin Observatory administered by National Central University (NCU) is the first graduate program in Taiwan. There are eight full-time faculty members, working in diverse research fields, ranging from merging galaxies, AGNs, GRBs, X-ray binaries, star formation, star clusters, Galactic structure, to solar-system bodies. Currently there are about 20 students in the PhD program and about the same number in the MS program. A diverse curriculum in astronomy and astrophysics is offered by the faculty, both at the graduate level and at the undergraduate level together with the physics and space science majors.

The institute operates the Lulin Observatory, hosting a one-meter, a 40-cm, and a 35-cm telescope. These facilities serve the faculty and students for education and basic research uses. With an elevation of 2862 m above sea level, Lulin is located at the geometric center of the island, amid the central mountain range, with a west Pacific longitude particularly apt for observing celestial events. The Lulin One-meter Telescope (LOT) is open to the international community, and is equipped with a standard CCD imager, a low-dispersion spectrograph, and an optical tri-color simultaneous imaging polarimeter. A near-infrared imager will be available by the end of 2013. The Lulin Observatory also hosts the Taiwanese-American Occultation Survey (TAOS), which has an array of four telescopes, each with a 50-cm aperture and a field of 2.7 deg in diameter. This array monitors stellar brightness for chance occultation events by Kuiper-belt objects. A two-meter telescope is being planned at Lulin. In addition to competitive access to telescopes such as the CFHT, UKIRT, Subaru, Gemini, VLT, SMA, ALMA and other ground-based facilities, our faculty and students also make use of Fermi, Swift, Suzaku, and Chandra space instruments.


Lulin Observatory

NCU is a member of the international scientific consortium of the Panoramic Survey Telescope And Rapid Response System (Pan-STARRS). Its prototype, PS1, is located in Haleakala, Hawaii. The 1.8 m telescope, equipped with a giga-pixel camera that can render a 7 square degree field, patrols the entire visible sky several times a month at multiple optical wavelengths up to 1 micron. Objects changing brightness (transients, variable stars) or positions (solar-system objects) will be winnowed out, and very deep static sky data are accumulated. Together with several university groups in Taiwan, NCU partners with PS1 institutes, in the USA, Germany, and UK, to pioneer studies on cosmic variability. We are also negotiating to have data access to the Palomar Transient Factory (PTF) project, a time-domain sky survey led by the California Institute of Technology.

The Institute celebrates its 20th anniversary this year, and the international faculty, postdocs and students continue to challenge frontier scientific topics and cutting-edge instrument developments. The institute maintains a vigorous visitor program. Please refer to http://www.astro.ncu.edu.tw for more detailed information about the insitute. ■

Wen-Ping Chen
Professor of Physics at National Central University

Peking University – Department of Astronomy

Peking University (PKU) offers astronomy courses since the 1920s, and in 1960 the first astronomy major was offered by the Department of Geophysics. PKU and the Chinese Academy of Sciences (CAS) signed an agreement in 1998 to jointly establish the Department of Astronomy (DoA) at PKU, with academician Jiansheng Chen as the head of department. In 2001, the DoA was incorporated into the School of Physics and given the status of National Key Discipline, after which it expanded substantially. During its 50-year history, Peking University has trained hundreds of astrophysicists. Its alumni include three academicians, five observatory directors, and six NSFC Distinguished Young Scholars. The DoA established intensive collaboration with the National Astronomical Observatories (NAOC). Peking University and NAOC share teaching of the graduate curriculum, student supervision, and resources to complement research activities. The DoA employs 11 full-time faculty and over 10 domestic and foreign scholars as adjunct faculty and visiting professors.

The goal of PKU-DoA is to train high-quality astrophysicists. The DoA recruits students at all levels, with an average annual intake of 30 undergraduates, 10 doctoral students and 5 postdoctoral researchers. For undergraduate students there are two four-year programs: astrophysics and astrophysical technology. The subsequent Master's degree lasts three years and the Ph.D. degree lasts four years. Students are encouraged to take part in exchange programs, and each year many graduate and undergraduate students are sent to prestigious institutes abroad for joint training, in order to get involved in the forefronts of astronomical research at an early stage.


A scene from the campus of PKU.

The PKU Department of Astronomy focuses on a wide variety of research fields, including cosmology and galaxy formation, particle astrophysics and high-energy astrophysics, interstellar medium, stars, and planetary systems. The DoA promotes exchanges and cooperation in the construction of international academic exchange platforms and cultivates innovative talents with a global perspective.

Kavli Institute for Astronomy and Astrophysics

As one of 16 high-profile international research institutes under the umbrella of the Kavli Foundation, the Kavli Institute for Astronomy and Astrophysics (KIAA) aims at promoting basic research of the highest international standards in China. Daily scientific and administrative life at the KIAA is organized according to well-established international models. An advisory committee composed of senior scientists from around the world advises as regards proposed academic and visitor programs and offers assistance with major issues such as the research direction, review of proposed appointments, and performance evaluation. The institute, which saw completion of its building in the campus of Peking University in late 2008, hosts both mainland Chinese and Taiwanese, as well as other international (British, Dutch, German, Italian, Japanese, and American) faculty and postdocs. It is designed as a forum for global scientific exchange, an incubator of innovative projects, and a training canter for international postdocs and students. KIAA and its faculty organize a variety of academic activities and programs to stimulate research and promote interdisciplinary interactions, in close collaboration with the Department of Astronomy.

The Kavli Foundation was founded by Norwegian physicist and industrialist Fred Kavli in 2000. Dedicated to the advancement of basic sciences for the benefit of humanity, the foundation supports research in the fields of astrophysics, nanotechnology and neuroscience. Since the founding of the first Kavli Institute for Theoretical Physics at the UCSB in 2001, the Kavli Foundation has thus far funded 16 Kavli institutes at major universities in the USA, Europe and Asia. The institutes are led by world-class scientists. Amongst them three are Nobel laureates while others are members of eminent organizations, including the American National Academy of Sciences, the American Academy of Arts and Sciences and the Royal Society of the UK. The Kavli Foundation also honors scientific achievement and promotes public understanding through high-profile Kavli prizes in these fields. ■

Shanghai Astronomical Observatory, Chinese Academy of Sciences

Shanghai Astronomical Observatory (SHAO) of the Chinese Academy of Sciences, was established in 1962 following the merger of the former Xu Jiahui and Sheshan observatories, which were founded by the French Mission Catholique in 1872 and 1900, respectively.

The headquarters of SHAO is located in Xu Jiahui district of Shanghai. The observational site is in Sheshan County. The present director, Professor HONG Xiaoyu took office in 2005.

A 40 cm double astrograph was built in 1900 on top of Sheshan hill which was the largest telescope in East Asia at that time. In the 1980s, SHAO built a 25 m radio telescope, used as a station for the VLBI network, in addition to a 1.56 m optical telescope and a 60 cm satellite laser-ranging system. These three facilities are still in frequent use today and a brand new 65 m radio telescope is under construction.

Distant view of Sheshan Observatory, part of SHAO.

SHAO currently has more than 150 scientific and technical personnel, including one academician of CAS and one academician of Chinese Academy of Technology (CAT).

SHAO has four research departments: Shanghai Center for Astro-geodynamics Research (SCAR), Center for Galaxy and Cosmology (CGC), Division of Very Long Baseline Interferometry (VLBI), and Division of High Technology Laboratories.

The SCAR engages in measurement and analysis of technonic plate movement, the rotational and orbital motions of the Earth, and researches their related dynamical mechanisms, using modern space geodesy techniques.

The CGC's main research fields include star clusters and Galactic structure, formation and evolution of galaxies, large scale structure of the Universe, high energy astrophysics, the theory of black hole accretion and X-ray binaries.

The VLBI division, consisting of Sheshan VLBI station and the VLBI laboratory, manages the Chinese VLBI Network (CVN), which has contributed greatly to the Chinese Lunar project "Chang E-1“.

The Division of High Technology Laboratories is composed of the time and frequency research center which is investigating high accuracy hydrogen masers and their applications, and the astronomical optical instrumentation group which is designing various astronomical equipment. ■

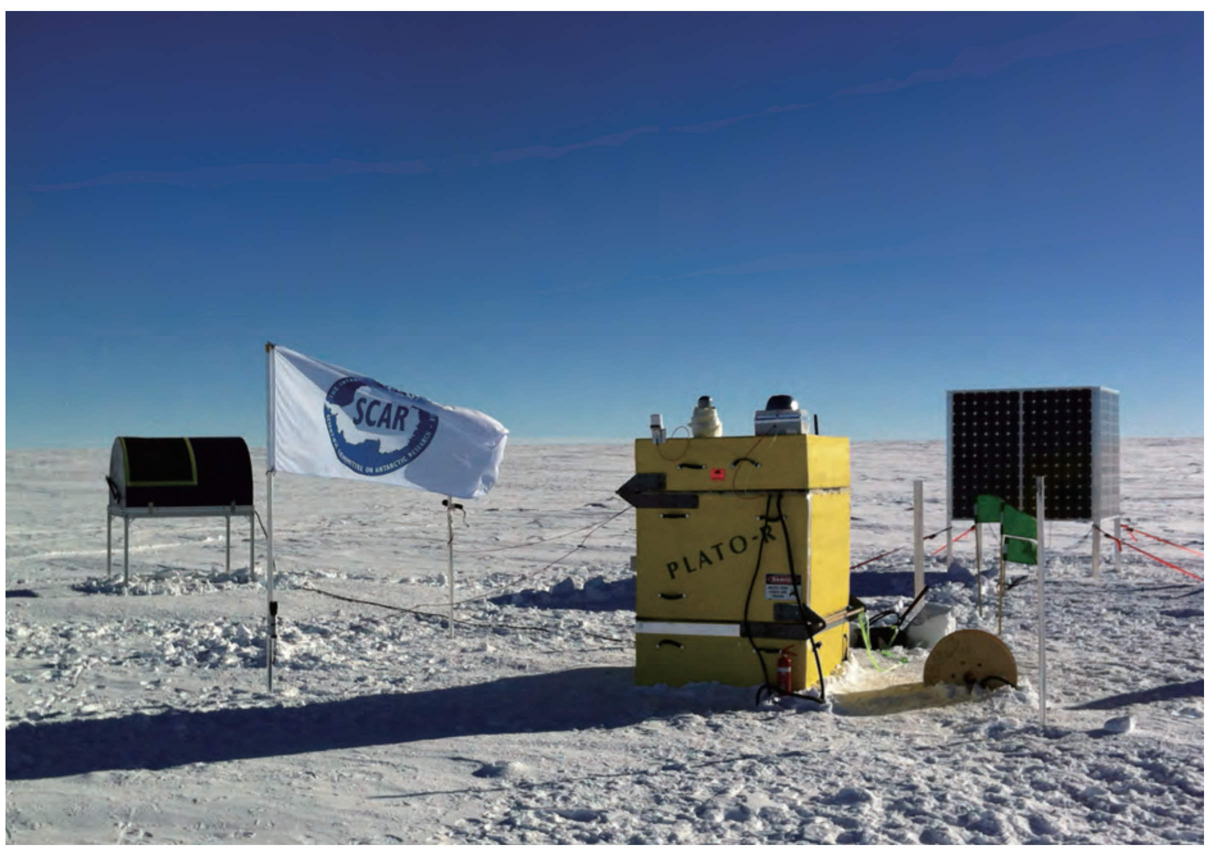
Terahertz Astronomy from the Antarctic Plateau

The terahertz spectral regime, with wavelengths from about 50 microns to 0.5 mm, is one of the least explored regions of the electromagnetic spectrum. This is a consequence of the earth's poor atmospheric transmission, largely the result of water vapour, and is unfortunate since many interesting molecules (OH, CH, HD, H_2O) and atoms (C, N, O and their ions) radiate significantly in the terahertz. For example, the [CII] line at 158 microns is an important cooling line, and can be the brightest line emitted by a galaxy.

By travelling to Antarctica, where most of the water vapour has frozen out as snow, it is possible to make terahertz observations from the ground. This is the goal of the High Elevation Antarctic Terahertz telescope (HEAT), a 0.6 metre aperture instrument built by Craig Kulesa and colleagues at the University of Arizona.

However, it isn't sufficient to go just anywhere in Antarctica. The exponential improvement in transmission with lowering water vapour leads you to the very best sites, believed to be within a couple of hundred kilometres of Dome A, the highest point on the plateau at 4093 metres. These sites are currently only possible to visit over summer, and so require a completely robotic observatory to provide electrical power, heat, and satellite communications. These requirements were met by the PLATO-R facility, designed and built at the University of New South Wales.

So, in mid-December 2011, a team of four from UNSW and three from the University of Arizona set off to Antarctica to install PLATO-R and HEAT at a remote "deep-field" site called Ridge A, 160 km from Dome A, and 930 km from the US Amundsen-Scott South Pole Station. Ridge A had never been visited by humans before! We spent a week at McMurdo Station taking various courses, including "Happy Camper School", to prepare us for the three-day camp at Ridge A, where we needed to be able to work at an altitude of 4035 metres and temperatures down to -42C. In late December 2011 we began a month at the South Pole station, both to begin altitude acclimatization and to bring PLATO-R and HEAT together for the first time.

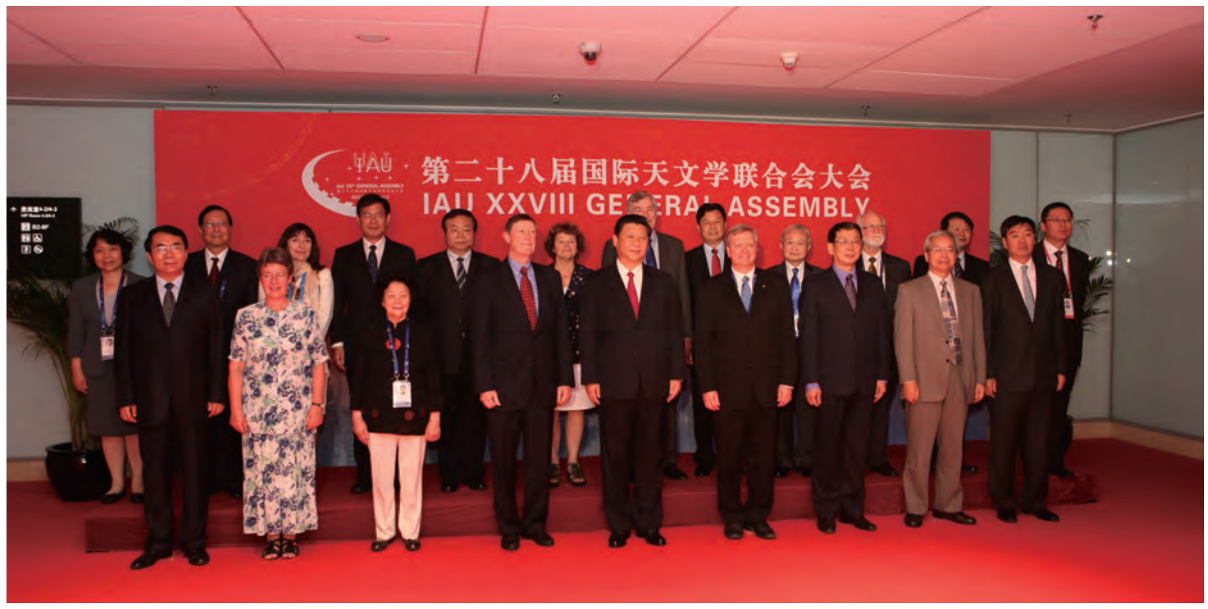


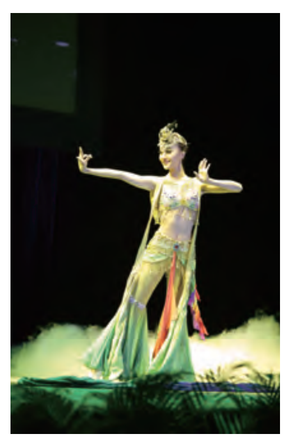
PLATO-R at Ridge A, January 2012. The PLATO-R Instrument Module is the yellow box, the HEAT telescope is the black object at left, on stilts. The black object at right is a solar panel array, and consists of eight 195W panels arranged in a cube. On the roof of the Instrument Module you can see various Iridium satellite aerials, webcameras, and an all-sky camera called HRCAM3. The Engine Module, providing power when the Sun is down, is 60 metres away and not visible in this image (credit: Craig Kulesa).

PLATO-R/HEAT were taken to Ridge A on three Twin-Otter aircraft flights, and became operational on 23 January 2012. Over the next four months, until the initial supply of Jet-A1 fuel ran out, HEAT verified the extraordinarily good observing conditions at Ridge A, and successfully mapped about 10% of the Galactic Plane in CO and [CI] at 0.8THz, and a velocity resolution of 1 km/s.

Come and hear about HEAT and the first ever expedition to Ridge A at IAU Symposium 288, "Astrophysics from Antarctica", in the future facilities session on the final day of the Symposium (session 4, Friday August 24)! ■

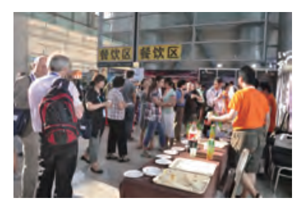
Michael Ashley
University of New South Wales

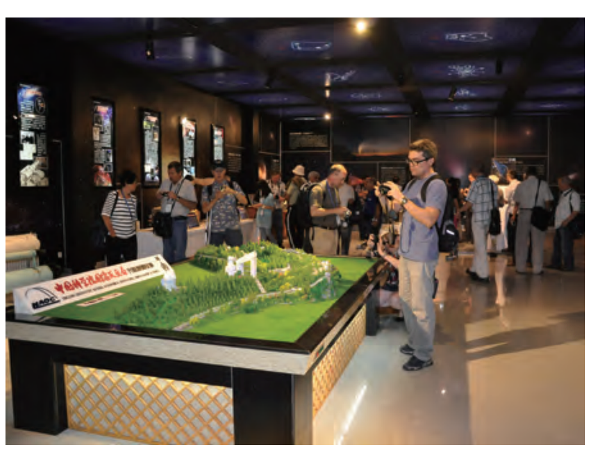




Opening Ceremony & Scientific Sessions

VOLUNTEERS AT WORK, SIDE ACTIVITIES, SITE VISIT, REGISTRATION DESK & WORKING ON INQUIRIES OF HEAVEN

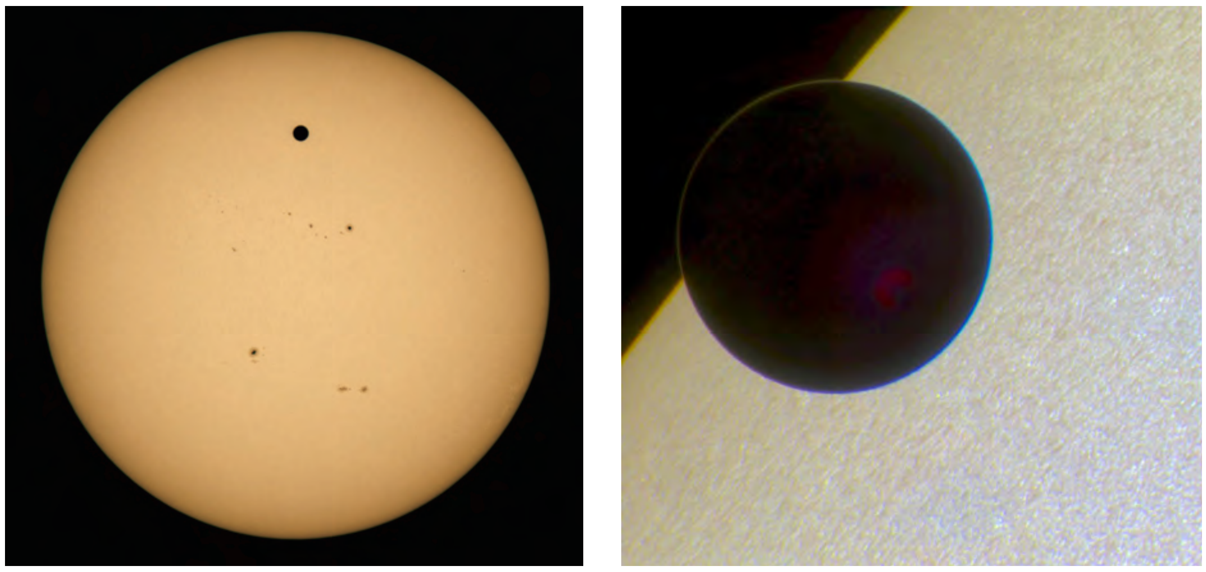




Science at the 6/5 June 2012 Transit of Venus

The transit of Venus that was visible from China and elsewhere in Asia on June 6 and in the U.S. on June 5 provided an unusual opportunity for such an event to be observed both to study Venus' mesosphere and as a terrestrial analogue to the exoplanet transits now so widely observed from Kepler, CoRoT, and earthbound telescopes. For over six hours on that date, Venus' silhouette was visible against the Sun, larger than any sunspots.

Johannes Kepler missed predicting the transit of 1639, leaving it to be predicted and seen only by Jermiah Horrocks and one correspondent. Transits of Venus as seen from Earth come in pairs separated by 8 years, with alternate gaps of 105.5 and 121.5 years between pairs. The 1761/1769 pair saw hundreds of expeditions around the world to attempt to determine the solar parallax, arguably the most important question in astronomy of the time, given that distances of the planets were known only proportionally from Kepler's third law. The 1874/1882 pair saw photography added. Timing at all those transits was compromised by the black-drop effect, blackness joining Venus' silhouette with the sky outside the solar limb. Glenn Schneider and I showed from a transit of Mercury observed with NASA's TRACE spacecraft that the entire effect is explained by a combination of the solar limb darkening and the telescope's point-spread function, correcting a widespread misunderstanding that Venus' atmosphere played a role.



(left) A mid-transit image taken from Haleakala, Maui, Hawaii, showing not only Venus but also sunspots. (Image by Ron Dantowitz and Jay Pasachoff); (right) Venus entering the solar disk during the 17 minutes between first and second contacts. Venus's atmosphere on the part of its limb outside the solar disk refracts sunlight toward us, making a faint arc. The image was taken with the Solar Optical Telescope (SOT) aboard the Japanese Hinode spacecraft, with its 0.2 arcsec resolution, making the image the finest ever taken from the vicinity of Earth showing Venus's atmosphere.

We have now seen the 2004 and 2012 pair of transits. The earlier one, though observations were optimized for the black-drop effect, turned out to show Venus' atmosphere appearing as an arc silhouetted against the sky between the first two and again between the last two contacts, as Venus' atmosphere refracted sunlight toward Earth. Observations of the 2012 transit were therefore optimized for studying this refracted arc, taking advantage of the launch subsequent to the previous transit of NASA's Solar Dynamics Observatory, with its Atmospheric Imaging Assembly and Helioseismic Magnetic Imager, and of the Japan Aerospace Exploration Agency's Hinode, with its Solar Optical Telescope (SOT) and X-ray Telescope (XRT). Further, French colleagues provided a matched set of nine coronagraphs spaced around the world as the Venus Twilight Experiment (https://venustex.oca.eu), with my own at Haleakala, Maui, Hawaii, at 3000+ m altitude, and sites in Arizona, Japan, India, the Marquesa Islands; Australia, and Svalbard. We even imaged Venus' atmosphere refracting sunlight toward us minutes before first contact. Comparisons with in situ observations from ESA's Venus Express could help untangle disparate evaluations of Venus' superrotating winds. Measurements of total solar irradiance showed the 0.1% drop that matched the geometrical coverage and revealed the solar limb darkening.

Though the next transits of Venus will not be visible from Earth until 2117 and 2125, we have arranged for NASA's Cassini spacecraft in orbit at Saturn to view a transit of Venus on December 21, 2012. The 0.01% effect and a broadband spectral-difference could be, we calculate, detectable with extensive averaging over time, providing an analog in our solar system of exoplanet transits. ■

Jay M. Pasachoff
Chair of the IAU Working Group on Solar Eclipses of Division II. Field Memorial Professor of Astronomy at Williams College, Massachusetts.

Historical Astronomical Instruments, Observatories and Sites

Commission 41: Tuesday 28 August 2012, Room 405
Historical Astronomical Instruments, Observatories and Sites

Session 3 (14.00 - 15.30) Sara Schechner, chair
14:00-14:20 Tsuko Nakamura: Octants and Sextants before the 1860s Preserved in Japan
14:20-14:40 Shi Yunli: On two newly discovered instruments unearthed from the tomb of the 2nd Marquis of Ruyin who died in 165 BCE
14:40-15:00 Kim Sang Hyuk, Lee Yong Sam, Lee Min Soo: Restoration model research of Heumgyeonggaknu in Sejong era
15:00-15:20 Wayne Orchiston and Boonrucksar Soonthornthum: The French Jesuit Mission to Thailand in the 1680s and the Establishment of a Major Astronomical Observatory
15:20-15:30 Discussion

Session 4 (16.00 - 18.00) Wayne Orchiston, chair
16:00-16:20 Fernando B. Figueiredo: The Astronomical Observatory of the University of Coimbra (1772-1799): Its Instruments and Scientific Activity
16:20-16:40 Gennadiy Pinigin, Zhanna Pozhalova: Nikolaev (Mykolayiv) Astronomical Observatory as the Object of the Ukrainian Tentative List WH UNESCO
16:40-17:00 Liliya Kazantseva: New Life for Astronomical Instruments of the Past at the Astronomical Observatory of Taras Shevchenko
17:00-17:15 Lee K.-W., Mihn B.-H., Ahn Y. S., and Choi G.-E: Analysis of Time Data in Chinese Astronomical Almanacs of the Late 18th Century
17:15-17:30 Svitlana Kolomiyets: Kharkiv Meteor Radar System (The XX Age)
17:30-17:45 Wenjing Jin, Gennadiy Pinigin, Zhenghong Tang, Alexander Shulga: The collaboration between SHAO and NAO
17:45-18:00 Discussion

POSTERS
Azam Noor: Kajian artifak astronomi islam di Brunei
Mihn, Byeong-Hee, Lee, Ki-Won, Kim Sang Hyuk, Ahn, Yong Sook and Lee, Yong Sam: Analysis of observational records of Dae-gyupyo(大圭表) in Joseon Dynasty
Yura Nefedyev: 110 anniversary of the Engelhardt Astronomical Observatory

Possible Threat to the Green Bank Telescope and the Very Long Baseline Array

An International Perspective

Many colleagues at the IAU General Assembly have expressed concern about the recent Portfolio Review recommendation that both the Green Bank Telescope (GBT) and the Very Long Baseline Array (VLBA) be divested from the astronomy portfolio of the U.S. National Science Foundation (NSF).

We share our colleagues' surprise about the threat to two unique, forefront observatories used by astronomers from many countries, recognizing the loss to world science that would result from their closure.

- GBT is the world's largest fully steerable radio antenna, vital to many areas of current research. With its unblocked aperture and active surface, it is perhaps the most "high-tech" single dish telescope in the world. The power of the GBT for pulsar studies has been demonstrated in multiple talks at IAU Symposium 291 Neutron Stars and Pulsars.
- VLBA is the world's primary tool for cm-wave very long baseline interferometry (VLBI); the only facility dedicated to imaging, astrometry and spectroscopy at the highest spatial resolutions. The VLBA also plays a critical role in defining the international celestial reference frame and establishing earth orientation parameters. Several projects based on VLBA precision astrometry, e.g. Local Group parallaxes and megamaser distances, are presented in IAU Symposium 289 Advancing the Physics of Cosmic Distances.

The range of major scientific projects presently underway with the GBT and VLBA is enormous; most would be crippled if the facilities were indeed to close. However, it is important for the international community to know that the report only makes recommendations; no decisions have been taken to close facilities.

Closeup of GBT

It is NSF and the US Congress that have the ultimate responsibility for this. We – the National Radio Astronomy Observatory and Associated Universities, Inc., NRAO's managing organization – will be working closely with NSF and the community in coming months, to provide more information and to ensure that all stakeholders have an opportunity to comment. We will do everything in our power to keep the facilities operating.

The future of astronomy depends on a steady investment in scientific, technical and human capital, and we have invested heavily in new instruments and capabilities for GBT and VLBA during the past decade. Besides the loss of research capabilities, closing such facilities while they are still at the height of their power would be a waste of this investment and would eliminate unique opportunities for training new scientists and engineers.

Presentations at the IAU General Assembly demonstrate that astronomy's advance relies on an international network of diverse capabilities. GBT and VLBA, part of this network, reflect current US leadership in some areas of radio astronomy, but they are part of the wonderful balance of cooperation and competition that characterizes modern research. Several countries already share in VLBA's operating costs. Removing centimeter-wavelength VLBI and all-sky single dish capabilities from the US portfolio would mean removing unique, fundamental capabilities from world astronomy as a whole.

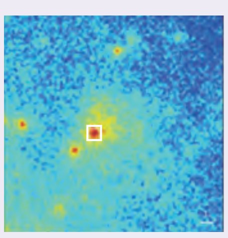
As Vice President Xi Jinping stated in his opening remarks, the advancement of astronomy is the result of the efforts of all humankind, and manifests the wisdom of humanity. He emphasized that the development of science and technology requires extensive international collaboration. We are proud of our scientific collaborations with China, and are grateful that China is contributing to VLBA operations. We look forward to continuing cooperation and collaboration between the international and U.S. communities through the continued availability of both VLBA and GBT. ■

Ethan J. Schreier

President and CEO of Associated Universities, Incorporated (AUI), and Adjunct Professor in the Department of Physics and Astronomy at The Johns Hopkins University.

SpS12: Modern Views of the Interstellar Medium

The interstellar medium (ISM) plays an important role in the formation and evolution of a galaxy. The ISM provides the material to form stars. In turn stars inject radiation, metals, and mechanical energy into the ISM, altering the physical conditions, abundances, and distribution of the ISM and affecting future generations of star formation. It is thus essential that we understand the physical structure of the ISM, the physical processes that operate in the ISM, and the interplay between stars and ISM.



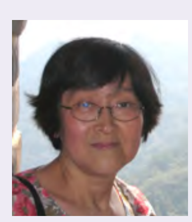
Fermi LAT γ-ray (200 MeV – 20 GeV) image of a 20° × 20° region centered on LMC are used to study the production and diffusion of cosmic rays. The white square marks the location of the 30 Dor giant HII region.

The physical structure and processes of the ISM are best studied in the Galaxy and nearby galaxies. Many large-scale surveys of different components of the ISM are available: HI - the International Galactic Plane Survey (IGPS) and The HI Nearby Galaxy Survey (THINGS) maps out the HI in nearby galaxies; dust - Spitzer, Herschel and Planck surveys of the Galactic plane and the Magellanic Clouds, Bolocam Galactic Plane Survey (BGPS), and the APEX Telescope Large Area Survey of the Galaxy (ATLASGAL); HII - the Wisconsin H-Alpha Mapper (WHAM) survey of the distribution and velocities of warm ionized gas in the Galaxy; 10^6 K gas - Chandra and XMM-Newton observations; cosmic rays - Fermi Gamma-Ray Observatory's whole sky survey.

During the past one and a half decades, considerable progress has been made in the numerical modeling of local and global conditions of the ISM, its morphology and its time-dependent evolution, owing to a rapid development of suitable hardware and software. It is now possible to follow the full non-linear evolution of a plasma by solving the hydro- or MHD equations in high resolution simulations with adaptive mesh refinement. One of the key results of the past years was to recognize, and quantitatively describe, the role of compressible turbulence in the ISM. Its impact on the distribution of gas into phases, on the mixing of chemically enriched material, on the volume and mass filling factors of the ISM plasma, on its heating and cooling history, in addition to other aspects, were studied in detail.

SpS12 "Modern Views of the ISM" is organized to update people on recent advances in the ISM observations and theories. The key topics include (1) physical structure and phase distribution of the ISM in a galaxy, (2) multi-wavelength observations of ISM in the Galaxy and nearby galaxies, (3) recent theory/MHD simulations of ISM in a galaxy, (4) interstellar disk-halo connection in galaxies, and (5) interplay between stars and ISM: star formation and feedback.

SpS12 is dedicated to the late Professor John Dyson (1941-2010), the Div VI president in 2003-2006. John pioneered the dynamical interactions of stellar winds and outflows with the interstellar gas. He authored the book "The Physics of the ISM". His enthusiasm and vision has guided many of us in the study of interstellar dynamics. He is sorely missed by all of us. ■



You-Hua Chu

President of Div VI IAU, Professor of Astronomy at the University of Illinois.

A Reconstruction of the World's "First Astronomical Clock Tower" is on Exhibition

Sun Xiaochun is explaining to viewers the reconstructed clock tower.

A 1:3 scale reconstruction of Su Song's water-powered astronomical clock tower from eleventh century China is on exhibition on the ground floor of CNCC during this IAU General Assembly. The reconstruction is made by Prof. Sun Xiaochun and his team that includes researchers from National Astronomical Observatories of China, the Institute for the History of Natural Sciences of Chinese Academy of Sciences, and Tsinghua University.

Su Song's clock tower has been hailed as the first astronomical clock tower in the world. Its original size is about 12 meters in height, and 7 meters in both widths. It was an assembly of the armillary sphere, the celestial globe and the time-keeping mechanism, all driven by weight of water through the Central Wheel that carried 36 scoops around its circumference. The wheel moved constantly, thus the whole system was in accordance with the celestial daily movement. The original had been maintained for 35 years before it was eventually ruined and lost in the war.

Fortunately, Su Song wrote a book titled Xin yixiang fa yao (Essentials of the method of the new instrument), which is still existent today, containing detailed descriptions and illustrations of the instrument's size, structure, and components. Since 1950s, there have been many reconstruction models. But concerning the clock's crucial "escapement mechanism", all previous reconstructions were based on J. H. Combridge's "flip-scoop" hypothesis (Nature, No. 4964, December 19, 1964) that does not fit the original description of the mechanism in Su Song's book. The exhibiting reconstruction is based on a new "fixed scoop" model for the escapement mechanism, which completely fits the original text and works well.

For more details about the reconstruction and ancient Chinese astronomy, please pay attention to the special lecture by Prof. Sun at 12:30-14:00 on Wednesday, Aug. 29th, Plenary Hall B. ■

Li Geng
National Astronomical Observatories of China, Center of Ancient Chinese Astronomy

American Astronomical Society Welcomes International Affiliate Members

The American Astronomical Society, a professional membership organization for research astronomers based in the United States, welcomes astronomers worldwide as members. In addition to the Full, Associate and Junior membership classifications, a special membership classification was formed several years ago to enable astronomers from around the world to join at a lower cost. An additional affiliate membership classification has also been established for those working in education. Most of the same benefits that full and associate members enjoy are shared by International and Educational Affiliate members; including individual subscription to the electronic versions of AAS journals for only USD 25, beginning in 2013. Full details on how to join may be found on the AAS website: aas.org.

The AAS also publishes the Job Register, an online compendium of open positions in astronomy and affiliate sciences from around the world. Anyone may access the Job Register free of charge, while employers may post their job announcements online for a nominal fee.

The AAS, like the IAU, organizes scientific conferences on a regular basis, with the largest meetings taking place in January and June each year. The AAS added a sixth Division this year in the area of Laboratory Astrophysics, with the remaining five Divisions being the Division for Planetary Sciences, High Energy Astrophysics Division, Solar Physics Division, Division on Dynamical Astronomy and the Historical Astronomy Division. Each Division has their own meetings, websites, electronic communications and networking activities.

Although based in the United States, the AAS seeks to enhance and share humanity's scientific understanding of the Universe regardless of borders and welcomes international members from around the world and looks forward to hosting the 29th General Assembly in Honolulu, Hawai'i in August 2015. ■

Kevin B. Marvel
Executive Officer of the American Astronomical Society

Chinese Classes

shuǐ xīng	jīn xīng	dì qíu	huǒ xīng	mù xīng	tǔ xīng	tiān wáng xīng	haǐ wáng xīng
水星	金星	地球	火星	木星	土星	天王星	海王星
Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune

tiān wén	tiān tǐ wù lǐ	yǔ háng yuán	héng xīng	xīng xì	gè xiàng yì xìng	chāo xīn xīng
天文	天体物理	宇航员	恒星	星系	各向异性	超新星
astronomy	astrophysics	astronaut	star	galaxy	anisotropy	supernova

Day 7: Program Summary

Plenary talk by Natalie Batalha (8:30-10:00 room 309A+B): The Kepler mission: NASA's ExoEarth Census

12:30 Film: Saving the Hubble (room 311)

IAUS 289	Milky Way to the Local Group
IAUS 293	Missions & Terrestrial planets
IAUS 294	Small-scale magnetic fields & Coronal activity
IAUS 295	Galactic evolution
SpS8	SFR measurements and calibrations based on various approaches
SpS9	Ground-based and space-based projects
SpS10	Stellar variability & Star-planet relations
SpS11	Regional development
SpS12	ISM and stars: Star formation and feedback
SpS13	Star models and binary stars & Solar CNO abundance problem
SpS 15: "Data intensive astronomy"	Past, ongoing and future surveys
SpS 16	Dust particles and nanoparticles & Post-AGB stars and PNe

JD7 Space-time reference systems for future research starts.

IAU Division Restructuring (EC Resolution B4, to be voted on Thu.): Presentation by Assistant Gen. Sec. Thierry Montmerle and a 45-min open discussion. More info can be found in Day 2 IH. Time: Tue. 28, 12:30-13:30, Room 311.

INQUIRIES OF HEAVEN (天问) is the official newspaper of the IAU General Assembly 2012. Online version: www.astronomy2012.org/ih Contacting email: heaven@nao.cas.cn. It is published by Research in Astronomy and Astrophysics in collaboration with China Features of Xinhua News Agency, Amateur Astronomer, and Chinese National Astronomy. **Advisor:** Thierry Montmerle; **Editor and Associate Editors:** Jingxiu Wang, Xiaowei Liu, Shude Mao, Shuang-Nan Zhang, Yongtian Zhu; **Editorialists and Language Editors:** Peter Anders, Thijs Kouwenhoven, James Wicker, Marcel Zemp; **Reporter:** Sarah Reed; **Art and Technical Editors:** Yangyang An, Geng Li, Jian Li; Yijie Zhang; **Managing Coordinator:** Suijian Xue; **Secretary:** Lan Wang; **Editorial Assistant:** Jingyi Huang.

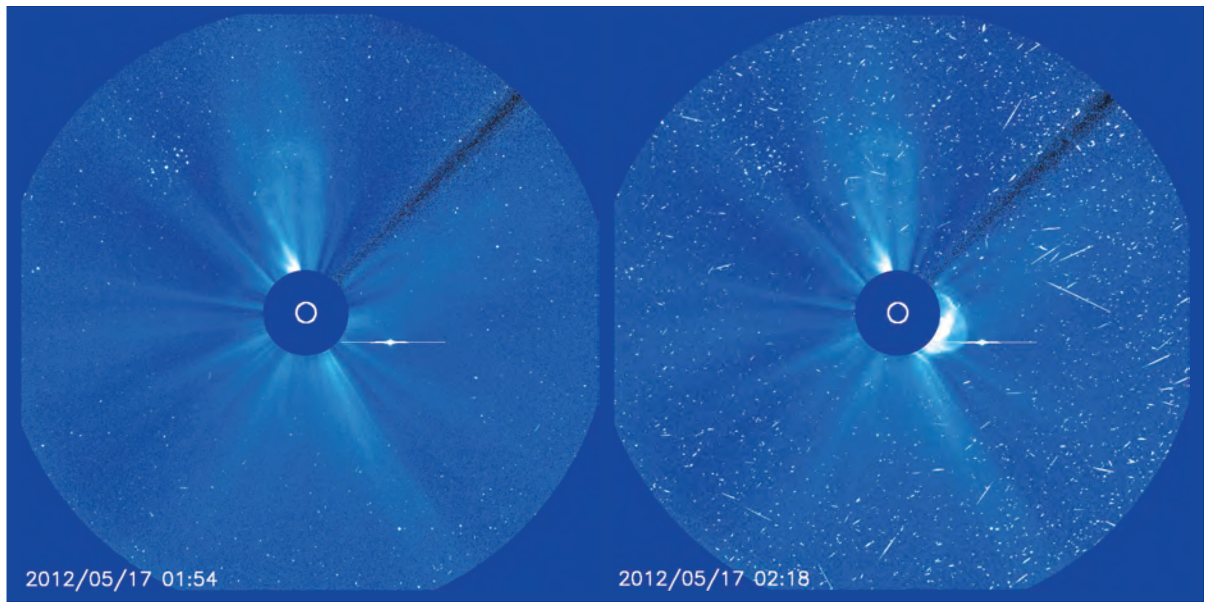
INQUIRIES OF HEAVEN

IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA, AUGUST 20 - 31, 2012 WEDNESDAY, AUGUST 29, 2012 DAY 8

A Tell-Tale Sign of a Wimpy Solar Cycle: the First GLE Event of Solar Cycle 24

Sudden spikes of energetic particle events from the Sun superposed occasionally on the cosmic ray background are known as ground level enhancement (GLE) events because these particles can be detected by neutron monitors and muon telescopes on the ground. These protons interact with air molecules and produce secondary neutrons and muons that are detected at the ground level. GLEs are the highest energy (~GeV) component of the normal solar energetic particle events accelerated by shock-driven ultra-fast (2000 km/s) coronal mass ejections (CMEs). Typically about 15 GLE events occur in a solar cycle (cycle 23 had 16 GLEs).

The current cycle 24 has produced only one GLE event so far on May 17, 2012, whereas cycle 23 had produced five of the 16 GLEs in the first 4.5 years. The Sun is already in its solar maximum phase, which means it did not produce any GLE event during its rise phase. Thus the cycle 24 seems to be extremely poor in producing GLE events so far.



The coronal mass ejection (CME) on 2012 May 17 that produced the first Ground Level Enhancement (GLE) event of solar cycle 24. The images, separated by 24 minutes, show the fast CME above the southwest limb of the Sun. The white circle in the center is the size of the Sun and provides the scale to the images. The white streaks appearing all over the image on the right along with the CME are the energetic particles reaching the telescope and creating additional signal in the detector. [Images taken by the Solar and Heliospheric Observatory (SOHO) mission. Courtesy: ESA and NASA]

The May 2012 GLE event was weaker than all the GLE-associated flares of solar cycle 23. There were eight other flares originating from the western hemisphere of the Sun in the longitude range 55-85 degrees favored for GLE origin, but none of them was associated with a GLE event. On the other hand the CME itself is very fast (2000 km/s) and formed a shock at a distance of 230 megameters above the surface based on the radio signatures. The GLE particles were released when the CME reached a height of about 930 megameters above the surface. This additional distance is needed for the shock to gain strength and accelerate protons to GeV energies. Images from the Solar Dynamics Observatory (SDO) revealed that the May 2012 CME overtook a hot plasma (> 6 MK) ejected some 40 minutes before. The preceding hot plasma implies the presence of particles that were already energized, making it easy for the shock to accelerate them to higher energies.

The lone GLE event is consistent with a weak cycle 24: the sunspot number peaked at 97 compared to 170 in cycle 23, indicating that cycle 24 is 40% weaker. The weakness of the cycle can be attributed to the weak polar magnetic field during the prolonged minimum between cycles 23 and 24. According to the Babcock-Leighton solar dynamo model, what goes in the polar region comes up as the sunspot activity. Thus a weaker input during cycle 23 must have resulted in the weaker sunspot activity in cycle 24. There have been suggestions that the solar activity might continue to decline over the next couple of cycles, approaching a global minimum in the middle of the 21st century. Such global minima were discovered by the American scientist John Eddy in 1976 who named the deepest such minimum, during the years 1645 to 1715, the Maunder minimum. ■

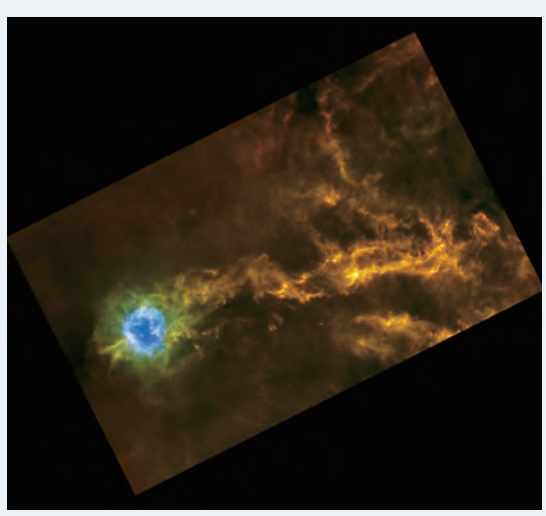
Nat Gopalswamy

Staff scientist at NASA's Goddard Space Flight Center (GSFC), and President of ICSU's Committee on Solar Terrestrial Physics (SCOSTEP) and IAU commission 49.

Today's Invited Discourse (18:00 - 19:30, Plenary Hall B)

The Herschel View of Star Formation

Star formation is one of the most fundamental, most complex, and least understood processes in astrophysics. Recent studies of the nearest star-forming clouds of the Galaxy at submillimeter wavelengths with the Herschel Space Observatory have provided us with unprecedented images of the initial conditions and early phases of the star formation process. The Herschel images reveal an intricate network of filamentary structure in every interstellar cloud. These filaments all exhibit remarkably similar widths - about one third of a light year - but only the densest ones contain prestellar cores, the seeds of future stars. The Herschel results favor a scenario in which interstellar filaments and prestellar cores represent two key steps in the star formation process: first turbulence



Herschel's Cocoon

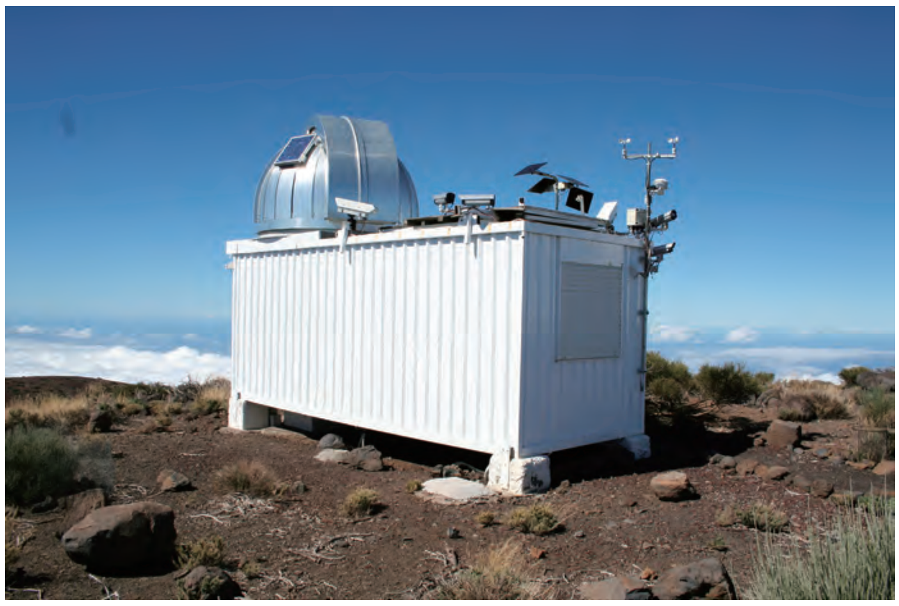
stirs up the gas, giving rise to a common web-like structure in the interstellar medium, then gravity takes over and controls the further fragmentation of filaments into prestellar cores and ultimately protostars. This scenario provides new insight into the inefficiency of star formation, the origin of stellar masses, and the global rate of star formation in galaxies. Despite an apparent complexity, global star formation may be governed by relatively simple universal laws from filament to galactic scales. ■

Philippe André

PI of the Herschel Gould Belt Survey, Senior Researcher CEA, Laboratoire AIM Paris-Saclay, CEA Saclay, France.

Vice President Xi Jinping makes Astronomy Economically Important Again

The study of astronomy started life as the secret source of information for kings and rulers who believed their future was written in the stars. Later it became the key to effective navigation and time keeping but with the invention of the Global Positioning System, it joined the ranks of normal science being driven essentially by curiosity. That is, until recently. Astronomy is the secret ingredient in the recipe for building a knowledge economy. Vice President Xi Jinping recognised this new reality in opening the 28th General Assembly by linking Chinese investment in Astronomy to the future development of China.



University of Bradford Robotic Telescope at the Instituto Astrofisicas de Canarias, Observatorio Del Teide, Tenerife.

Many countries face the challenge of transforming their economies into knowledge driven economies as their manufacturing moves to lower cost locations. The World Bank and many others see an innovative and creative workforce as the basis of a Knowledge Economy, and there is ample evidence to show that innovation and creativity are best developed through education programmes which include a hands-on science like Astronomy.

The Bradford Robotic Telescope (http://schools.telescope.org) has an extensive web site delivering practical astronomical science in over 20 areas of Astronomy for students from the age of 10 to first year University. Using a service robot telescope, it delivers on a mass scale supporting teachers in the classroom and measuring the impact of the programme on both the teachers and the students.

The learners delight in having a real telescope to take the observations for them. It is their enthusiasm that drives the teacher to develop their own subject knowledge. It is measuring the impact that enables us to optimise the programme and improve it until it is now many times better than the alternatives. We clearly need to start talking to Vice President Xi Jinping to help bring hands-on science to China.

If you want to use astronomy to help push your country towards a knowledge economy then contact John Baruch.

Contact: john@telescope.org ■

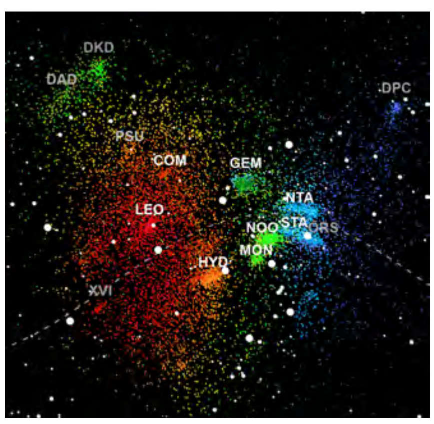
John Baruch

Head of Robotic Telescopes; University of Bradford, Bradford BD14-6AU, UK.

C22: 95 Meteor Showers and Counting

The tally of established meteor showers has increased to 95, following the Commission 22 business meeting last Friday. Since the Prague General Assembly in 2006, the Working Group on Meteor Shower Nomenclature keeps track of newly discovered showers and reports to Commission 22 a list of showers that all members can agree do really exist, and 31 showers were added to that list in Beijing.

The NASA-sponsored Cameras for Allsky Meteor Surveillance (CAMS) project is the latest effort to greatly scale up the measurement of precise meteoroid orbits. In a series of maps, such as the one above, the night-time showers among the 95 established showers are identified. The showers marked XVI, DAD, KDR, PSU, ORS, and DPC are among the 31 newly established showers. The strong December phi Cassiopeiids (DPC) shower of slow 20 km/s meteors was not present in 2007-2009.



Map of direction and speed of approaching meteoroids in the first week of December (red = fast, blue = slow), from 3,240 meteoroid orbits measured by CAMS and 4,250 orbits measured by the Japanese SonotaCo network. White dots are the constellations of stars. The dashed line is the ecliptic plane.

Each meteor shower is important. In some cases, the meteor shower is the only evidence of the existence of a potentially hazardous comet. If the parent body of a shower can be identified among the new objects discovered in the ongoing asteroid and comet surveys, then the three-dimensional shape of its dust streams can be calculated. In the future, the modeled solar system will be populated by such meteoroid streams in order to predict their impact probability on satellites.

Other such maps are posted here: http://cams.seti.org/maps.html ■

Peter Jenniskens

Chair of the Working Group on Meteor Shower Nomenclature, new President of Commission 22, PI of the CAMS project and based at the SETI Institute and NASA Ames Research Center.

SpS7: The Impact Hazard: Current Activities and Future Plans

Asteroids and comets are space rubble left over from the formation of the Solar System about 4.6 billion years ago. Most of them orbit the Sun in faraway regions; a fraction of them, however, can come relatively close, in astronomical terms, to our planet, and even impact it. Thus, astronomers worldwide regularly track the motions of these bodies, both for the purpose of cataloging their orbits (something that has led in recent years to spectacular advances in our understanding of the dynamics of the Solar System) and to identify the next possible collision of one of these bodies with the Earth as early as possible.

The conventional threshold to classify an asteroid or a comet as a "Near-Earth Object" is that its perihelion distance has to be less than or equal to 1.3 AU; in the early 1990s, the goal was set, by the US Congress, to discover 90% of Near-Earth Objects larger than 1 km in diameter. Nowadays this goal has been essentially achieved, and a new one has been proposed, to reach 90% completion down to 140 m in diameter. As a consequence of this more ambitious goal, much more capable telescopes are required, and the amount and quality of the data processing has to increase significantly, not only because of the larger number of objects to be discovered and tracked, but also because, as we go to smaller sizes, subtle non-gravitational effects come into play in the modelling of the motions.

Special Session 7 "The impact hazard: current activities and future plans" focuses on the current and future state of affairs in NEO-related activities; its topics cover the impact hazard, impact consequences, impact frequency for different sizes, the population of NEOs, the status of current surveys and plans for forthcoming ones, space exploration, mitigation measures, short-warning and long-warning strategies and methods, as well as issues about public policy, communication and international collaboration. ■

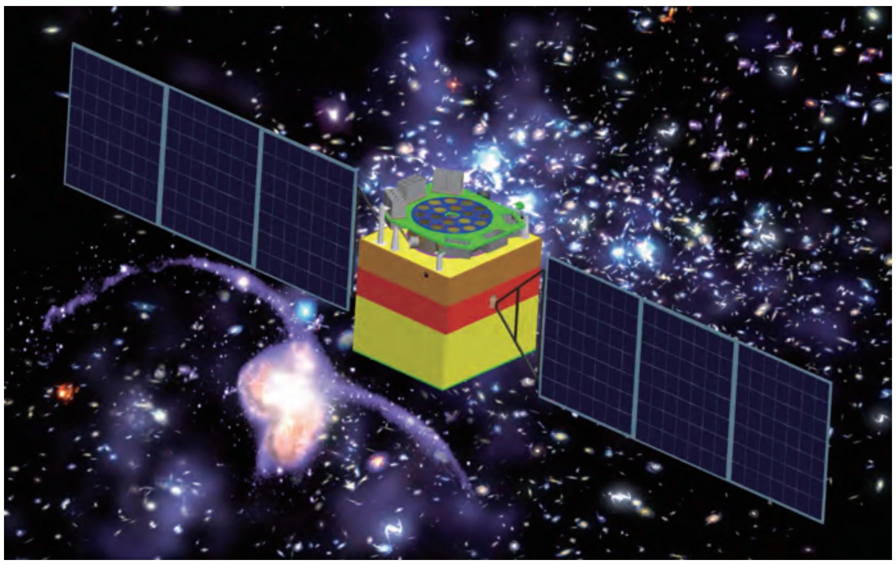
Giovanni B. Valsecchi

Senior researcher at the Istituto di Astrofisica e Planetologia Spaziali, Vice President of IAU Division III; asteroid (3725) Valsecchi is named after him.

China's First Dedicated Astronomy Satellite

The Hard X-ray Modulation Telescope (HXMT) Mission

HXMT is an X-ray astronomy satellite consisting of three slat-collimated instruments, the High Energy X-ray instrument (HE), the Medium Energy X-ray instrument (ME), and the Low Energy X-ray instrument (LE). HE is sensitive in the 20-250 keV range. It contains 18 individual cylindrical NaI(Tl)/CsI(Na) phoswich modules, each with an area of 283.5 cm^2 and a field of view (FOV) of 5.7° × 1.1° (FWHM). ME is sensitive in the 5-30 keV range. It contains three individual Si-PIN detector arrays with an FOV of 5.7° × 1.1° each, and the total collection area is 952 cm^2. LE uses the Swept Charge Device as the detector which is sensitive in the 1-15 keV range. LE also contains three individual detector arrays each with two kinds of FOVs, 5.7° × 1.1° and 5.7° × 2.2°, in order to study the cosmic X-ray background in this energy band. The total collecting area of LE is 384 cm^2. Its main objectives include probing the properties of black holes and neutron stars. It will therefore conduct large area sky surveys and pointed observations of Galactic compact objects emitting X-rays.

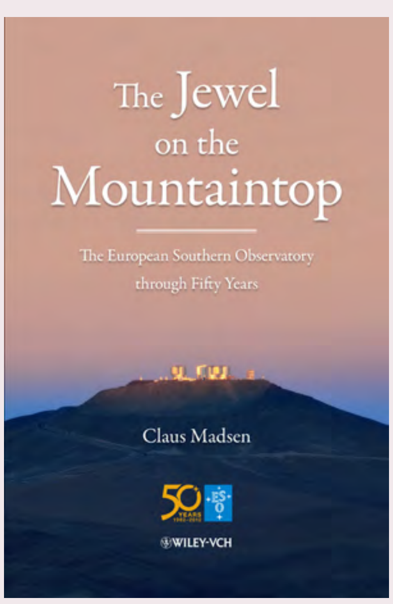


An artist's illustration of HXMT in space.

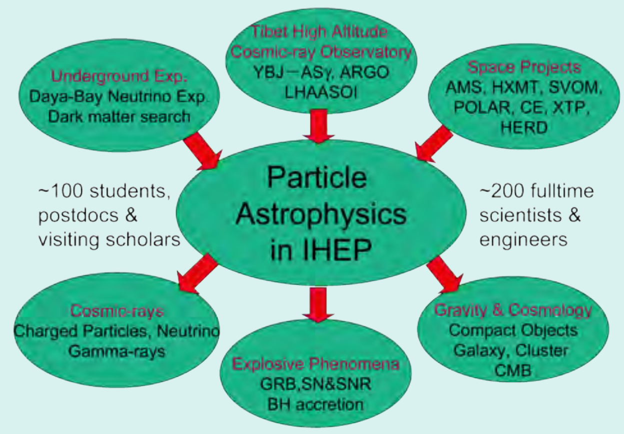
The mission is currently in Phase C and expected to be launched into a low earth orbit around 2015. It will become China's first dedicated astronomy satellite. It is jointly funded by China National Space Administration, and by Chinese Academy of Sciences (CAS) under the Space Science Pilot Special Project, which is managed by the newly established National Space Science Center (NSSC) of CAS. The mission was originally proposed and is currently led by the Institute of High Energy Physics (IHEP), CAS. IHEP is responsible for developing and building all the three main instruments on-board, namely, HE, ME and LE. Other main participating institutions include Tsinghua University, NSSC, China Academy of Space Technology (responsible for building the satellite), and Beijing Normal University. The PI and co-PI of the mission are Ti-Pei Li (litp@ihep.ac.cn) and Shuang-Nan Zhang (zhangsn@ihep.ac.cn). The leader for the payloads is Fangjun Lu (lufj@ihep.ac.cn). Please contact them for further details. ■

2012 - A Year of Celebration

This year's IAU General Assembly is a cause for celebration by Chinese astronomy. This was underscored most impressively by the Opening Address by His Excellency Xi Jinping, the Vice-President of the People's Republic of China. This year is also a year of celebration for European astronomy, as ESO marks the 50th anniversary of the signing of the Convention that led to the creation of the organisation and gave European optical astronomers a focal point and a tool for pooling their resources. The outcome has had a strong influence on world astronomy: The La Silla Observatory, the Very Large Telescope (VLT) on Paranal, the European participation in the ALMA project and the upcoming 39 meter European Extremely Large Telescope (E-ELT). ESO and European astronomers, thus, have plenty of reasons for celebration, but also to reflection, as it passes the half-century milestone. Two books will be published in the first week of September. "Jewel on the Mountaintop" authored by ESO senior advisor Claus Madsen is 560 action-packed pages of ESO history and dramatic stories about the people behind the organisation. With 150 photos and illustrations it is not only a historical book about ESO, but also about a truly remarkable European success story in research. The second book "Europe to the Stars" is a richly illustrated coffee-table book taking the reader behind the scenes of ESO. It has 300 hand-picked images from ESO's large collection of more than 100,000 images. The books are published by Wiley-VCH. ■



Center for Particle Astrophysics Institute of High Energy Physics Chinese Academy of Sciences



The Center for Particle Astrophysics (CPA) of the Institute of High Energy Physics (IHEP), which is also the Key Laboratory of Particle Astrophysics (KLPA), Chinese Academy of Sciences (CAS), has a history of about 60 years. It was founded as a research laboratory to study cosmic rays in 1951. In 1997, it was expanded to become the Open Laboratory of Cosmic Ray and High Energy Physics of CAS, and became a major research center in IHEP under the same name. In 2002, it was renamed as the Key Laboratory of Particle Astrophysics of CAS and Center for Particle Astrophysics in IHEP. Currently there are about 200 staff scientists and engineers, and more than 80 graduate students, postdoctoral fellows, and visiting scholars working in the laboratory and center. The current director of CPA and KLPA is Shuang-Nan Zhang (zhangsn@ihep.ac.cn).

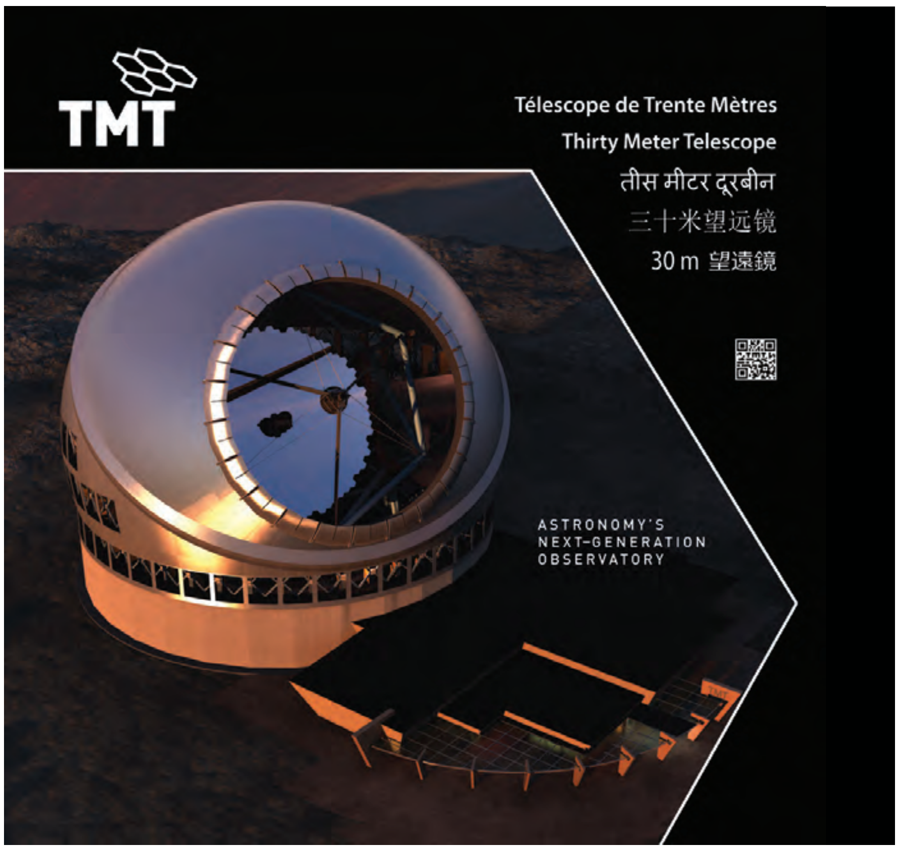
In accordance with the mission of IHEP, CPA/KLPA is a leading research center and laboratory on interdisciplinary fields between particle physics and astrophysics, including cosmic ray physics, high energy astrophysics, space astronomy and instrumentation, underground neutrino measurements, as well as China's participation to the CMS experiment at CERN. CPA/KLPA emphasizes interactions between theoretical particle astrophysics, instrumentation, and data analysis. ■

Thirty Meter Telescope – An International Collaboration

The Thirty Meter Telescope (TMT) represents the next generation of ground-based astronomical observatories. Driven by frontier science themes, TMT offers 10 times the light-gathering power of the largest existing ground-based optical/near-IR facilities and will produce images 10 times more detailed than the Hubble Space Telescope. With this tremendous increase in power, TMT will deliver as yet unforeseen, groundbreaking discoveries about the Universe. In short, TMT will herald a new generation of telescopes and will serve its partner communities as a flagship research facility.

TMT is an international partnership involving the USA, Canada, Japan, China, and India. It represents a unique combination of technical, industrial, and scientific collaboration that benefits all partners. Sited on Mauna Kea in Hawaii near existing, complementary facilities, TMT will unite the Pacific Rim astronomical community about its vantage point, and will exclusively provide extremely-large telescope access to the northern sky.

The large aperture size and field of view of TMT, combined with its powerful adaptive optics systems and versatile science instruments, will provide unique gains in imaging at the diffraction limit, precision astrometry, high-contrast imaging and spectroscopy from the ultraviolet through the mid-infrared.



Thirty Meter Telescope

The TMT design has been under development since 2003 and is now technically mature. TMT is ready to enter the construction phase in April 2014, with first light in December 2021.

History and Partners

The University of California (UC) and Caltech founded the TMT Observatory Corporation. The Association of Canadian Universities for Research in Astronomy (ACURA) joined immediately as a partner. In the following years, other partners joined: National Astronomical Observatory of Japan (NAOJ), National Astronomical Observatories, Chinese Academy of Sciences (NAOC), and the Department of Science and Technology of India (DSTI).

Together, approximately 450 million USD have been pledged, including 250 million USD from the Gordon and Betty Moore Foundation and 100 million USD from Caltech and UC. Recently, India committed more than 100 million USD to TMT, as announced by Indian Minister of External Affairs Shri S. M. Krishna and U.S. Secretary of State Hillary Clinton in June 2012.

TMT-China

China is a critical partner in TMT, providing high-technology contributions, and development of a number of vital components occurring within China. Participating in TMT will also increase Chinese technology and management experience in extremely large astronomy projects, and provide Chinese astronomers with access to the world's largest telescope and participation in cutting-edge scientific discoveries for decades to come.

Five institutes within the Chinese Academy of Sciences are playing a leading role.

1. **NAOC** (National Astronomical Observatories of China) is the leading institute of the TMT-China Consortium and the China Representative in the TMT International Collaboration including:
• Identifying TMT-China science goals and building up TMT-China science teams for Chinese astronomical communities.
• Identifying and establishing TMT-China technical research and development teams among relevant CAS institutes and universities, as well as forming the coalition with relevant industrial enterprises.
• Hosting the TMT-China project office, which manages internal and international scientific, technical and cooperative activities.

2. Responsibilities of **NIAOT** (Nanjing Institute of Astronomical Optics & Technology) include:
• Developing the processes and technologies for polishing and fabricating TMT segmented primary mirrors.
• Participating in the design development, possible fabricating and assembling of TMT "First Light" science instrument WFOS/MOBIE.

3. **CIOMP** (Changchun Institute of Optics, Fine Mechanics and Physics) will design and fabricate the Giant Steering Science Mirror (GSSM), including:
• Updating the design of the Cell and Positioner Assembly.
• Polishing and fabricating the largest flat telescope mirror – 3.5 m × 2.5 m.
• Assembling and delivering the GSSM system, which allows for rapid beam-switching from instrument to instrument.

4. **IOE** (Institute of Optics and Electronics) will design and fabricate the Laser Guide Star Facility (LGSF) including:
• Updating the design of the LGSF.
• Fabricating the Beam Transfer Optics.
• Fabricating the Laser Launch Telescope system.
• Assembling and delivering the LGSF together with TIPC lasers.

5. **TIPC** (Technical Institute of Physics and Chemistry) is responsible for:
• Engineering and testing the prototype of the solid-state high power sodium pulsed laser.
• Delivering 6-9 lasers for the TMT Adaptive Optics System.
• Potential provider of TMT's instrumentation cryogenic system.

Following the IAU meeting, the TMT international Science Advisory Committee will meet in Beijing and engage in discussions with the Chinese astronomy community. ■

Gordon K. Squires

Astronomer at the California Institute of Technology, working with TMT, NASA's Spitzer Space Telescope, the Herschel Space Observatory, the Galaxy Evolution Explorer and other telescopes with Caltech and JPL involvement.

Announcement

IAU Commission 8 (Astrometry) Science Session is on Wednesday 29 at 16:00-19:30 in Room 406 in the CNCC. Presentations will be given on space and ground-based astrometric projects.

Further details can be found at http://www.ast.cam.ac.uk/ioa/iau_comm8/iau28/ ■

What is the Real Driving Force behind the Square Kilometre Array Project?

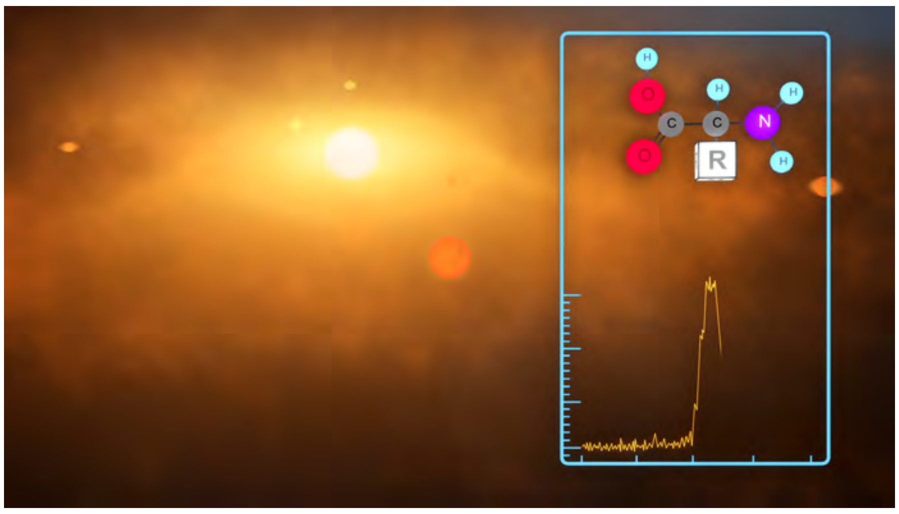
In the early 1990s international researchers first realised that to continue pushing the boundaries of physics and astronomy they would need a new instrument. They imagined a large hydrogen telescope that would reveal other galaxies like our own by capturing the faint radio signals from hydrogen gas from far back in the history of the Universe.

It was clear that such a telescope would have to be exceptionally sensitive and that building a sufficiently large dish would be impractical, not to mention expensive. The alternative, an array of multiple radio antennas, offered not only high sensitivity thanks to the large collecting area, but also long baselines (the distance between antennas) giving excellent image resolution. And so the concept of a giant array was born.

Some years on, the telescope now known as the Square Kilometre Array (SKA) in acknowledgement of its collecting area, is being developed as part of a formal project to make those early hydrogen dreams a reality. Three antenna types - dishes (with two different types of receiver), low frequency aperture array antennas and midfrequency aperture array antennas are all on the cards. While the SKA project has grown steadily over the years and is now more than a mere twinkle in the eyes of astronomers, it is still supported by the people who first conceived it. A steadfast and passionate group, they are dedicated to making the telescope a reality.

Just as building a colossal single dish would be impractical, funding such a megaproject is too much to ask of a single country. Besides, this project was born global and so far international cooperation has been one of the project's great strengths. Ten countries are now members of the SKA Organisation, and each full member has pledged funds for the preconstruction phase (2012 – 2015) with formal construction funding commitments expected in 2014.

The spirit of global partnership recently extended to hosting the telescope when the members of the SKA Organisation agreed to co-locate the array across the two candidate sites, South Africa and Australia. This takes advantage of the MeerKAT and ASKAP precursor telescope infrastructure that already exists at both locations.



Will the SKA detect the building blocks of life in proto-planetary discs? Credit: SKA Organisation/Swinburne Astronomy Productions.

Artist's impression of the SKA dishes by night. Credit: SKA Organisation/TDP/DRAO/Swinburne Astronomy Productions.

The move calls for close cooperation between the sites which, until recently, were competing for exclusive rights to host the telescope. Both sites have however declared satisfaction at the outcome of the agreement acknowledging that it is best for the project as a whole. They are already working together and with the other members of the SKA Organisation.

The responsibility of delivering the world's largest and most sensitive radio telescope falls to the SKA Organisation and it's no mean feat. Operating from the SKA HQ in Manchester, UK, the Office of the SKA Organisation coordinates the member countries and will manage the work package consortia during the engineering development work. The project presents huge challenges in data transport, data storage, supercomputing and power provision as well as mass production of the thousands of antennas required and their installation across vast swathes of inhospitable desert.

Interim Director General Michiel van Haarlem admits that "This project is exceptionally ambitious; it's a challenge, but it is achievable." He goes on: "In the Office of the SKA Organisation we play the part of project strategists, politicians and peace keepers. We drive the project forward; we overcome occasional setbacks, and, with the technical capability and experience of our partners around the world, we genuinely believe that together we can build the SKA".

Van Haarlem's words are a rallying cry to those countries poised to join the project. Indeed if the SKA is to succeed it is going to need all the support it can get both financially and in terms of engineering expertise. The project is still growing however. India has become an associate member, with the intention of upgrading to full membership soon, and other countries are interested in joining.

But what is it that is encouraging governments from around the world to invest? As a pioneering technology development project it is, by its very nature, untried and untested territory and so high risk. Is it the passion and enthusiasm of scientists carrying the governments along? It's doubtful that governments would admit to that. They prefer to quantify investment benefits. They talk about commercialising spin off technologies and big contract wins for industry; about percentage increases in GDP and improved trade links with other partner nations. They do mention human capital development, and inspiring the next generation of scientists and engineers, but then qualify their statements with the future benefits that this will bring to their economies.

Is economics the real reason that the SKA and other megascience projects are being realised? Or are these pragmatic explanations masking something deeper, an underlying human instinct to explore and discover? Indeed if this is the real driver, the SKA certainly fits the bill. The telescope will address five unresolved areas of physics and astronomy:

- **Galaxy evolution, cosmology and dark energy** - How do galaxies evolve and what is dark energy?
- **Strong-field tests of gravity using pulsars and black holes** - Was Einstein right about gravity?
- **The origin and evolution of cosmic magnetism** - What generates the giant magnetic fields in space?
- **Probing the dark ages** - How were the first black holes and stars formed?
- **The cradle of life** - Are we alone?

While this is in itself exciting stuff, it is acknowledged that there is enormous potential for the SKA to stumble upon something completely unexpected. The SKA will genuinely explore the unknown.

So could this be it? Hidden beneath all the quantifiable economic benefits used to justify involvement in the world's largest telescope project, we are actually bowing to human nature's unstoppable desire to discover the unknown and explore the Universe. ■

For more information about the SKA project contact the Office of the SKA Organisation enquiries@skatelescope.org Tel: +44(0)161 275 4239

Tsinghua Center for Astrophysics

The Tsinghua Center for Astrophysics (THCA) was founded in 2001. The main research directions at THCA are high energy astrophysics and cosmology with space and ground observations in X-rays, gamma-rays, optical wavelengths, and more recently gravitational waves, dark matter and dark energy.

A distinguishing characteristic of THCA's astrophysics program is its emphasis on space X-ray and gamma-ray instrumentation. The Hard X-ray Modulation Telescope (HXMT), jointly developed by the Chinese Academy of Sciences and THCA, should be China's first independently developed space astronomy satellite.

THCA faculty and students are heavily involved in data analysis and improving observation techniques. Using the Tsinghua University - National Observatory Telescope (TNT), we found a number of new supernovae and made other discoveries of transient celestial phenomena.

THCA is actively involved in the construction of the National Antarctic astronomical observatory. THCA contributes to the three 50 cm (effective aperture) telescopes of the Schmidt telescope array (AST3). As a member of the Antarctic Astronomy Center, THCA also participates in the common management of the telescope. The project is part of an international collaboration where US and Australian scientists – together with Chinese astronomers – successfully measured the site parameters relevant for astronomical observations.

Supernova (SN) science is now well known for its impact on cosmology. THCA has joined the SNFactory effort to better understand nearby SNIa and their environment in order to find new ideas for improving SNIa constraints on cosmological parameters.

Besides SNIa for cosmology, THCA members are also involved with weak lensing analysis of data from the Canadian France Hawaii Telescope (CFHT), and the WMAP satellite's Cosmic Microwave Background data.

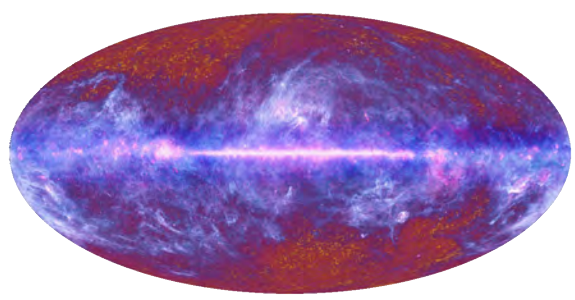
THCA pays special attention to interdisciplinary research across boundaries of astronomy, physics, cosmology, instrumentation, computational science, nuclear engineering, space and aeronautical engineering. THCA welcomes academic visitors, excellent applicants for faculty positions at all levels, and excellent students for graduate studies. ■

Planck Sheds Light on the Interstellar Medium

The Planck satellite (http://www.esa.int/Planck, Tauber et al. 2010) was launched on 14 May 2009, and has been surveying the sky stably and continuously since 13 August 2009. Planck carries a scientific payload consisting of an array of detectors arranged in nine broadband channels sensitive to a range of frequencies between ~25 and ~1000 GHz, which scan the sky simultaneously and continuously with an angular resolution varying between ~30 arcminutes at the lowest frequencies and ~5 arcminutes at the highest. The Planck satellite, its payload, and its performance as predicted at the time of launch, are described in 13 "prelaunch papers" included in Volume 520 of Astronomy & Astrophysics.

The main objective of Planck is to measure the spatial anisotropies of the temperature of the Cosmic Microwave Background (CMB) over the whole sky, with an accuracy set by fundamental astrophysical limits. Its level of performance will enable Planck to extract essentially all the information in the CMB temperature anisotropies. Planck will also measure to high accuracy the polarization of the CMB anisotropies, which encodes not only a wealth of cosmological information, but also provides a unique probe of the thermal history of the Universe during the time when the first stars and galaxies formed. The scientific objectives of Planck are described in detail in Planck Collaboration (2005).

Although Planck is by design a cosmology experiment, the presence of very significant Galactic and extragalactic emission in the band where the CMB peaks means that Planck has to determine their contribution in great detail. Therefore, its all-sky surveys also produce a wealth of information on the properties of extragalactic sources and on the dust and gas in our own Galaxy. This fact can be clearly appreciated in the Figure, which is a composite of data acquired during Planck's first complete all-sky survey. Galactic emission dominates a large part of the sky, both at low frequencies (by a mixture of synchrotron, free-free and other non-thermal radiation) and at high frequencies (mainly by thermal dust emission), and has to be measured accurately and removed to gain access to the CMB.



The microwave sky as seen by Planck. This multi-frequency all-sky image of the microwave sky has been composed using data from Planck covering the electromagnetic spectrum from 30 GHz to 857 GHz.

1. The higher frequency maps allow for the first time to measure accurately the characteristics, amount and distribution of the coldest dust present in the ISM, both in the diffuse ISM (e.g. Planck Early Results XXIV) and in dense molecular clouds (e.g. Planck Early Results XXV), not only in our own Milky Way, but also in nearby objects such as the Magellanic Clouds (Planck Early Results XVII). A spectacular early result by Planck is the detailed mapping of so-called "dark" gas, i.e. gas which is not spatially correlated with known tracers of neutral and molecular gas (Planck Early Results XIX). Planck's ability to detect very cold dust has revealed the widespread presence of dense and compact clumps of gas, certainly the sites of future star formation (Planck Early Results XXIII), and allows statistical determination of their properties and morphology.

2. The wide frequency range allows Planck to detect and study components of the interstellar medium with uncommon spectral characteristics, for example the anomalous excess emission which has been interpreted as arising from small spinning grains (Planck Early Results XX).

3. The all-sky coverage enables global studies of the ISM distribution in the Milky Way, for example to estimate the radial distribution of molecular, neutral, and ionized gas in the Milky Way (Planck Early Results XXI).

4. The combination of all-sky coverage and cm-to-submm wavelength range allows Planck to survey key parts of the spectral energy distribution of external galaxies (Planck Early Results VII), and has already revealed surprises such as the high number of spectrally flat or rising radio galaxies (Planck Early Results XIII), and the relative excess of dusty galaxies with respect to expectations, perhaps resulting from the presence of previously unaccounted for cold dust (Planck Early Results XVI).

5. The ability to measure polarization between 30 and 350 GHz is undoubtedly one of the most interesting aspects of Planck, and promises an entirely new view of the interstellar medium. The Galactic ISM is threaded by magnetic fields whose morphology is largely unknown at large and small scales; this field in turn induces polarization of both synchrotron and dust emission. Planck will uniquely be able to estimate the properties of both the ordered and turbulent components of the Galactic magnetic field by combining its measurements at low and high frequencies.

6. The extremely accurate calibration of Planck, both for diffuse emissions and for compact sources, will provide highly precise photometric standards in this frequency range. Efforts are already underway to use Planck to improve the calibration of EVLA (e.g. Planck Early Results XIV) and Herschel/SPIRE, which will be very beneficial to ISM science.

The above examples illustrate the wide range of ISM studies enabled by Planck. When the Planck data products are released to the public, starting in January 2013, they will join a wide range of surveys from other observatories, which together provide a broad view of the phenomenology of the Interstellar Medium in our own and other galaxies. ■

Jan Tauber

Planck Project Scientist, Astrophysics Division of European Space Agency.

Astronomy and Astrophysics in India

The study of astronomy ('Jyotisha') was considered an integral part of Vedic education in ancient India. Aryabhata (476 - ?), Brahmagupta (598 - ?) and Bhaskaracarya (1114 - ?) are among important astronomers whose astronomical treatises have survived the ravages of time. This ancient astronomical tradition continued till the eighteenth century when Sawai Jai Singh (1686-1734), an enlightened ruler of a state in Rajasthan, established what were probably the world's last important observatories for naked-eye astronomical observations. His observatories in Delhi and Jaipur are still major tourist attractions.

Modern observatories were first built in India during the British rule. Norman Pogson, who is primarily remembered for developing the magnitude scale, worked in the Madras Observatory during 1860 – 1891. During the total solar eclipse of 18 August 1868 visible from South India, Pogson discovered the spectral line of an unknown element which later came to be known as helium. Two other astronomers, Janssen and Lockyer who had come to India to observe this eclipse, are also credited with this discovery. A state-of-the-art solar observatory was established in Kodaikanal in 1899. John Evershed, who worked as the Director of this observatory for several years, discovered the Evershed effect in sunspots from this observatory in 1909.

As the new science of astrophysics started emerging, one Indian – M.N. Saha – made a monumental contribution to this science in 1920 by formulating the Saha ionization equation and applying it to explain stellar spectra. During the decades when general relativity was considered to be outside mainstream physics, a tradition of research in this new field developed in India. In 1943 P.C. Vaidya came up with the Vaidya metric for radiating stars, whereas in 1955 A.K. Raychaudhuri formulated the Raychaudhuri equation, which turned out to be the key tool for proving singularity theorems a few years later.

The Giant Metrewave Radio Telescope near Pune

The quarter century after Indian independence in 1947 saw the establishment of several scientific institutes in which astrophysics became a major research activity. Several Indians who were trained abroad returned to India and played leading roles in developing the new astrophysics research groups. M.K.V. Bappu established the Indian Institute of Astrophysics in Bangalore, of which the Kodaikanal Observatory is now a part. In the Tata Institute of Fundamental Research in Mumbai, groups in radio astronomy and theoretical astrophysics flourished respectively under the leaderships of G. Swarup and J.V. Narlikar. In 1969 this radio astronomy group built the Ooty Radio Telescope. V. Radhakrishnan was the other person to initiate another important astrophysics group in the Raman Research Institute in Bangalore.

At the present time, India has two major research institutes completely devoted to astrophysics – Indian Institute of Astrophysics, Bangalore, and Inter-University Centre for Astronomy and Astrophysics, Pune – apart from astrophysics research groups of varying sizes in different institutes around India. Many new astronomical observing facilities have also come up around the country. Here we can mention only the largest radio facility and the largest optical facility. The Giant Metrewave Radio Telescope near Pune (operated by the National Centre for Radio Astrophysics, Tata Insitute of Fundamental Research) has 30 dishes of 45 m diameter and is the world's largest telescope in the metre wavelengths. The Himalayan Chandra Telescope is a 2 m optical telescope (operated by Indian Institute of Astrophysics) located in Hanle in the Himalayan region at an altitude of 4300 m at one of the best observing sites in the world. India is also poised to make a major foray in space astronomy soon. Astrosat, India's first dedicated astronomy satellite for multi-wavelength observations, is expected to be launched in 2013.

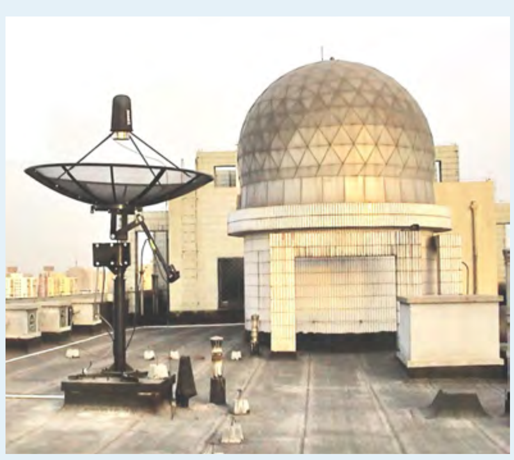
The first proper graduate school in astrophysics in India is the Joint Astronomy Programme, run by the Indian Institute of Science in Bangalore from 1982 in collaboration with several astrophysics groups. The other important graduate programme in Pune is run by the two astrophysics institutes there.

The IAU at present has 220 members from India working in different areas of astrophysics. To give an idea of the areas of astrophysics in which India has been strong, we list below those astrophysicists who are Fellows of the Indian National Science Academy, grouped under their primary research interests. Radio astronomy: G. Swarup, Gopal-Krishna, S. Ananthakrishnan; Cosmology: J.V. Narlikar, T. Padmanabhan, V. Sahni; Particle astrophysics: R. Cowsik; Solar physics: S.M. Chitre, H.M. Antia, A.R. Choudhuri; Miscellaneous topics: R. Nityananda. ■

Arnab Rai Choudhuri

Astronomy Department Beijing Normal University

Basic Information:
Founded in 1960, the Department of Astronomy at Beijing Normal University was the second astronomy department in a Chinese university. Currently, the department has 20 active teaching staff, including 10 professors (with 8 doctoral advisers), and 4 associate professors. Among the staff, 88 percent of them have a doctorate; one of them participates in the "Chang Jiang Scholars Program" and is supported by the "China National Funds for Distinguished Young Scientists". In addition, four of them are supported by the "National Program for New Century Excellent Talents". "Introduction to Astronomy" has been added to the National Quality Curriculum.
Scientific research has mainly developed around three key projects from the National Natural Science Foundation of China, which has been administered by Beijing Normal University: "Research into dark energy", "Many types of stellar pulsations" and "Research about a two-dimensional stellar model with a magnetic field and rotation." Moreover, the astronomy department participates in the "Antarctic astronomy project", "SONG project" and "HXMT Satellite ground systems project" as main contributors.



Observatory of Beijing Normal University

Doctorate majors: Astrophysics
Master majors:
Astrophysics, Celestial mechanics and Astrometry, Curriculum and teaching methodology (astronomy), OpticsDescription of Operations: There are two university laboratories, three optical astronomical telescopes, one radio telescope and data outputs for advanced detecting devices. We have built two astronomy observing bases at National Astronomical Observatory and Yunnan Observatory respectively and placed two professional astronomical telescopes at each of them.
Website: http://astrowww.bnu.edu.cn/ ■

Very Young Astronomers: IAU/UNAWE Day Camp Comes to an End

Last week, the class of "GA 2012" successfully completed a programme of astronomy-themed activities, organised by the IAU and Universe Awareness (UNAWE), in collaboration with the science communication company SterrenLab. The idea behind the IAU/UNAWE Day Camp was to combine professional childcare support for GA delegates with a rich programme of educational astronomy activities for their children.

One of the children at the Day Camp, Jade (age 5), was proud to say that both her "mummy and daddy are astronomers." Jade's parents, Wynn Ho and Karen Masters, also registered her younger brother, Gian, in the Day Camp.

"It's much easier and simpler to travel alone to attend conferences, but that means only one of us can attend the meetings," said Masters. "So, particularly for these big conferences, having other options is fantastic." In addition to the convenience of on-site childcare, Masters says her children felt like they were participating in the conference because the activities were astronomy-themed.

Masters also commented on the cultural aspects of the Day Camp "The children might already know a bit about Chinese astronomy, but not a lot, so we were doubly happy that they get the chance to learn a bit more about this part of their background."

Cristina Olivotto, Day Camp coordinator, commented "These children clearly knew a lot more about astronomy than most children of their age." Yet, the children still took a lot away from the experience. For example, Leah (age 11), visited a planetarium for the first time in one of the Day Camp excursions, as there aren't any close to where she lives.

The organisers plan to run another IAU/UNAWE Day Camp at the 29th GA in Hawaii, USA. For more information, please contact info@unawe.org ■

Sarah Reed *IAU Public Outreach Coordinator / NAOJ*

Free Visit to Beijing Planetarium

The participants of the 28th IAU GA are welcome to visit Beijing Planetarium and Beijing Ancient Observatory. You may use your name badges to get free tickets for theaters and exibitions in the ticket office of the planetarium (before this weekend, Sept. 2).

Directions to Beijing Planetarium: Take subway line 4 to Beijing Zoo Station, Exit D. Opening time: 9:00-17:00, Address: No.138, Xizhimenwai Street, Xicheng District, Beijing. Tel: 010-51583311

Directions to the Beijing Ancient Observatory: Take subway line 2 to Jianguomen Station, Exit C. Opening time 9:00-16:30, Address: No. 2. Dongbiaobei Hutong, Dongcheng District, Beijing. Tel: 010-65242202

About Beijing Planetarium

Beijing Planetarium is a national top-level natural science museum. It is a scientific institution for popularizing astronomical knowledge to the public and promoting the spirit of science, popularizing scientific ideas and science's critical methodology. It is a "Palace for Science", "to explore the mysteries of the Universe and to benefit society".

About Beijing Ancient Observatory

The Beijing Ancient Observatory was first built in 1442 in the Ming Dynasty (1368 - 1644), and was the national observatory during the Ming and Qing Dynasties. It has a history of nearly 500 years from the Ming Dynasty to 1929. There are eight ancient astronomical instruments equipped with western technology and Chinese local art design. After 1949, Beijing Ancient Observatory became a part of Beijing Planetarium. It is now in the key national relics protection program. ■

Day 8: Program Summary

Plenary talk by Bryan Gaensler (8:30-10:00):
The origin and evolution of cosmic magnetism

Lunch talk by Xiaochun Sun (12:30-14:00): Chinese Ancient Astronomy

Invited Discourse 3 by Philippe André (18:00-19:30):
The Herschel view of Star formation

Public forum at Tsinghua University (19:30-22:00): The star-planet relations

IAUS 289	Milky Way to the Local Group
IAUS 293	Planets around binary stars & Atmospheric characterization
IAUS 294	Self-organisation of plasma & Stellar and planetary dynamos
IAUS 295	Environment of galaxies & Massive galaxies today
SpS7: "The impact hazard: current activities and future plans"	Overview: population and consequences
SpS8	ISM and star formation & ISM and SFR measurements & High-z star formation
SpS10	Star-planet relations & Heliosphere and Asterospheres
SpS12	Disk-halo and ISM-IGM connection & Observations and models
SpS13	Solar-type stars and solar-type physics
SpS14 "Communicating astronomy with the public for scientists"	Public communication & School workshops & Press
SpS15	Far-future surveys & Data management & Advanced data analysis
SpS17 "Light pollution: Protecting astronomical sites and increasing global awareness through education"	Public outreach & planetarium & Effect on wildlife and health

JD7 finished.

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INQUIRIES OF HEAVEN

IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA, AUGUST 20 - 31, 2012 THURSDAY, AUGUST 30, 2012 DAY 9

TODAY'S INVITED DISCOURSE (18:00-19:30, PLENARY HALL B)

PAST, PRESENT AND FUTURE OF CHINESE ASTRONOMY

In ancient history, Chinese astronomers made tremendous achievements. Since the main purpose of ancient Chinese astronomy was to study the relation between man and the Universe, all Emperors ensured that ancient Chinese astronomy was a highly regarded science throughout history.

For a period of over 3000 years, China maintained the longest continuous records of all kinds of astronomical phenomena, including solar and lunar eclipses, sunspots, comets and meteors, guest stars (novae and supernovae), planetary events etc. Ancient Chinese astronomers made more than 100 astronomical calendars. They also constructed a large number of astronomical instruments that were used to make precise observations.

The beginning of modern astronomy research in China was in the 20th century. The Chinese Astronomical Society (CAS) was founded on October 30, 1922. Purple Mountain Observatory (PMO), the largest observatory in East Asia at that time, was built in 1934. The following year, during the fifth IAU General Assembly, China became a member of the IAU.

Just after the so-called "Great Cultural Revolution", the first Chinese delegation of astronomers visited Kitt Peak Observatory in 1976. Subsequently, the first delegation of US astronomers visited PMO in 1977. Six years later, the first international workshop on solar physics was successfully organized in Kunming. Benefiting from the fast development of the Chinese economy, the research of astronomy in China has also made remarkable progress in recent years. The CAS now has 2481 members. There are about 400 researchers and professors, two times more than ten years ago, and 1300 graduate students. The current budget for astronomy research is ten times larger than the budget ten years ago. The main astronomical organizations include PMO, National Astronomical Observatories of China (NAOC, Beijing), Yunnan Astronomical Observatory (YNAO, NAOC), Xinjiang Astronomical Observatory (XAO, NAOC), Nanjing Astronomical Instrument Research Center (NAIRC, NAOC), Shanghai Astronomical Observatory (SHAO) and the National Time Service Center (NTSC). More than 20 universities have established astronomy education and research efforts. There are astronomy departments in Nanjing University (established in 1952), Peking University (1960), Beijing Normal University (1960), University of Science and Technology of China (1978), and Xiamen University (2012).

The research covers all fields in astronomy, from Galactic to solar. Some important results have been obtained. For example, Yipeng JING et al. studied non-spherical modeling of dark matter halos, and obtained a series of fitting formulae in applying the triaxial model. By use of an Advanced Thin Ionization Calorimeter, Jin CHANG et al. found that the cosmic ray electron spectrum has an excess above 100 GeV, which is still a big mystery. A group led by Gang ZHAO in NAOC derived a series of results on stellar chemical abundances. A new direction of GRB cosmology was proposed by Zigao DAI et al., and Jinlin HAN et al. derived the spiral arm structure of the Milky Way. They also studied the magnetic fields in the Galactic disk and halo. Using VLBA and maser sources, Xingwu ZHENG and his group made the first parallax measurement and deduced the distances of some distant sources in the Milky Way with an accuracy as high as 0.05 mas. Jingxiu WANG and co-workers first recognized the large-scale source regions on the Sun for coronal mass ejections. Some global magnetic coupling has also been identified. Also in the fields of celestial mechanics and astrometry, some important results have been obtained.

A series of telescopes have been put into operation during the past three decades. Among them, the Guo Shou Jing Telescope, also called the Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST), is the largest one. Its effective aperture is 4 m, with a 5 degree field-of-view. This may accommodate as many as 4000 optical fibers. Thus, the telescope will possess the highest spectral acquisition rate in the world.

There are many ongoing and future projects using space- and ground-based facilities, including the Five Hundred Meter Aperture Spherical Radio Telescope (FAST), "Chang'e" (Lunar mission) and Mars missions, the Hard X-ray Modulation Telescope (HXMT), the DArk Matter Particle Explorer (DAMPE), the Deep Space Solar Observatory (DSO), the Chinese Antarctic Observatory (CAO), a 65 m and a 110 m radio telescope, and the Chinese Spectral Radioheliogaph (CSRH) etc. In addition, China now plans to construct a space station, on which there will be several astronomical facilities, including optical telescopes, X-ray and gamma-ray spectrometers, etc. This effort will certainly strengthen the space-based astronomical observations done by China. ■

Cheng Fang

Professor at the School of Astronomy and Space Science, Nanjing University, Academician of the Chinese Academy of Sciences and the Academy of Sciences for the Developing World.

HOT TOPIC (SPS18B: FRIDAY 31, 10:30-11:30, ROOM 303)

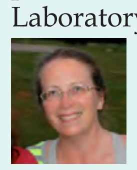
WATER ON EARTH, WATER ON MARS?

Humans and all life on Earth are aqueous beings and water has been involved in life since its first appearance on Earth. Water is a key ingredient for life, yet the origin of Earth's water is an important unsolved question, and it is getting increasingly intense scrutiny. Water is also involved in geochemical reactions that maintain surface conditions permissive of life. Today water is abundant on Earth, covering 75% of the surface. The interior of the Earth may contain an even greater amount of water. There is evidence too that early in the history of Mars, there was a period with surface water and possibly conditions suitable to life.

What was the origin of water? Water may have been delivered exogenously to the terrestrial planets, including Earth and Mars, through impacts from comets or asteroidal material, or it could have been adsorbed onto the planetesimal building blocks of the young Earth, evolving from dehydration of minerals during the accretion, or it may have formed after being dissolved in a magma ocean in equilibrium with a primordial hydrogen atmosphere. We can place constraints on when water was delivered: sometime after the formation of CAIs, but earlier than 4.38 Gy when zircons provide evidence for a veneer of water. Possible scenarios for water delivery include capture of gases adsorbed onto refractory dust grains and then incorporation into planetesimals, chemical reactions on the early Earth, and possible delivery by planetary building blocks that formed outside the snow line – including comets and asteroids. Comets have long been considered the least altered remnants of the early solar system formation process. Because of this, high priority has been placed on remote and in-situ exploration of comets.

Terrestrial planets ultimately get water that was formed initially in the ISM but we don't know the details of how this occurs, where and when.
Artwork: Karen Teramura, University of Hawaii.

This talk will present an interdisciplinary overview of the complex issues related to the origin of Earth's water as well as a look at the past, current and future Mars missions that will address questions of the early warmer Mars and habitability. In particular, some of the recent Mars Science Laboratory images will be discussed. ■



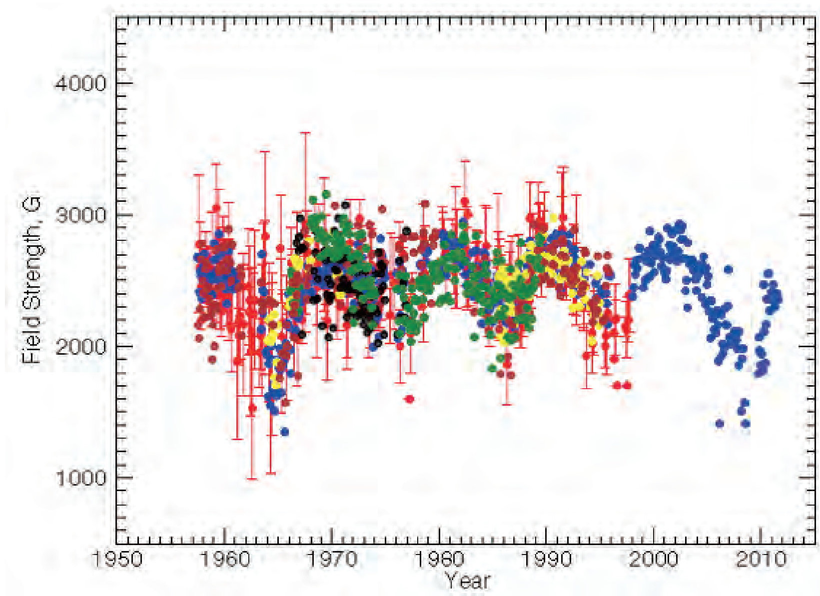
Karen Meech

Institute for Astronomy, University of Hawaii, NASA Astrobiology Institute.

Many solar cycles or why we need synoptic observations of the Sun

By the early 1900s, solar synoptic programs were established in several countries around the world. The historic records of past solar activity cycles have been used in studies of long-term variations of solar irradiance, terrestrial climate, the dynamo, and many other fields of solar and solar-terrestrial research. But in the modern era, one may wonder if we still need synoptic observations of the Sun.

The last prolonged deep minimum of solar activity raised the possibility of potentially dramatic changes in the solar cycle in the near future. According to some studies, the Sun could be on the verge of a new grand (Maunder-like) minimum. For example, the measurements of sunspot field strengths from the National Solar Observatory at Kitt Peak from 1998 to present suggest that the average field strength has gradually decreased. If the trend continues, the sunspots (as we know them) may completely disappear in the not-so-distant future. On the other hand, the combined data from seven solar observatories in the former USSR show no long-term trend, except for variations in the solar cycle (see figure). So, are sunspots destined to disappear or will they stay? It seems that the story is more complicated: the sunspots may not be disappearing, but they are changing their properties: the current Cycle 24 seems to produce a larger fraction of smaller sunspots with a weaker field as compared with previous cycles. Furthermore, the radio flux in 10.7 cm, which in the past was considered as a good proxy of solar activity, does not correlate with sunspot activity as well as before. In addition, the solar polar fields may be reversing their sign, even though Cycle 24 has not yet reached its peak. In other words, the Sun is a different star now compared to the past, but without synoptic observations, we would probably not realize the changes.



Monthly averages of strongest daily sunspot field strengths for seven observatories re-scaled to the Pulkovo Astronomical Observatory data set (red with error bars). Measurements from different observatories are marked by different colors (used by permission, Pevtsov et al. 2011, ApJ, 742, L36).

To some, the ground-based synoptic observations may not seem as "flashy" as the high resolution images and movies from space-based telescopes. But maybe 15-20 years from now, someone would wonder, why did we not continue taking the same observations (of whatever parameter) over the entire solar cycle or maybe even over several cycles? We live next to a variable star, and the only way to learn about its long-term behavior is via long-term synoptic observations. Last year, the International Astronomical Union (IAU) recognized the importance of such long-term programs and created a working group on "Coordination of Synoptic Observations of the Sun" (http://www.iau.org/science/scientific_bodies/working_groups/174/). ■

Alexei A. Pevtsov

Astronomer at the National Solar Observatory (USA), Program Scientist for the Solar Atmosphere part of NSO's Integrated Synoptic Program.

Brief Introduction of Yunnan Astronomical Observatory

General Information

Yunnan Astronomical Observatory (YNAO) is located in Kunming, in the southwest part of China. It is the only observatory in China that is near the equator and its unique location makes it an ideal place to observe both the southern and northern sky. Currently YNAO is the most productive observing site in China. It consists of three parts: the Kunming Phoenix Hill headquarters, Lijiang Observing station and Fuxian-Lake solar observing station.

Yunnan Astronomical Observatory and associated facilities

Research Fields of YNAO

Both theoretical and observational studies are carried out in YNAO. Leading experts in YNAO are performing a wide range of studies: stellar structure and evolution, binary population synthesis, stellar pulsation and helioseismology, variable and binary systems, planetary sciences, solar physics, high energy astrophysics, astrometry, and the application of new technologies and methods in astronomy.

Facilities in YNAO

YNAO currently has five major ground-based telescopes used for observations, i.e., a 2.4-m optical telescope, a 1-m solar spectral-polarimeter infra-red telescope (NVST), a 40-m radio telescope, a 1.2-m alt-az optical telescope and a 1-m optical telescope.

Major research achievements

YNAO has always been at the forefront of astronomy research. We proposed new Type-Ia supernova models and made an international impact on the relevant research communities. Another highlight is that we found a new planetary system with the planet orbiting two stars simultaneously using our ground-based telescope. Since 2000, YNAO has won eight first-class and seven second-class Science and Technology Awards from the National Government, Yunnan Province and relevant ministries. About 70 high-quality research papers (ApJ, MNRAS, A&A) are published each year. In 2007, the academician Huang Runquan was awarded the "Outstanding Contribution Prize of Science and Technology in Yunnan Province" (the highest science award in Yunnan).

International cooperation and exchange

YNAO has worldwide collaborations with famous international astronomical institutes, such as Cambridge University, Oxford University, Harvard University, Cornell University, the National Optical Astronomy Observatory in America, Max-Planck Institutes, the National Astronomical Observatory of Japan, etc. These collaborations cover a great variety of fields in astronomy and astrometry, which complement YNAO's relevant astronomical research fields. ■

RESOLUTION B1

on guidelines for the designations and specifications of optical and infrared astronomical photometric passbands.

Proposed by IAU Commission 25

The XXVIIIth General Assembly of International Astronomical Union,

noting

that considerable confusion has existed and continues to exist in the defining and naming of photometric passbands of all spectral widths in the visible and infrared regions of the electromagnetic spectrum,

considering

that minimizing such confusion has been a long-time goal of members of Commission 25 [e.g., see remarks by Wesselink and by Greaves in Transactions of the IAU, VII, pp. 267-273 (1950)],

recommends

1. that proposers of new passband systems should check the IAU Commission 25 website and links therein, especially to http://ulisse.pd.astro.it/Astro/ADPS/ (extended version of the paper by Moro and Munari 2000, A&AS 147, 361) to ascertain what passband names have already been used, before creating designations for new passbands.*
2. that names for new passbands should avoid relatively well known designations, such as UBVRIJHKLMNQ, and the designations ZJHKLMNQ should be used henceforth to refer exclusively to the terrestrial atmospheric windows in the near and intermediate infrared (see Young et al. A&AS, 105, 259-279; Milone & Young (2005), PASP, 117, 485-502). #
3. that any publication presenting the new passbands should contain the following information, to aid in transformations and standardizations:
   a) a measure of central wavelength which is not flux-dependent, such as the pivot wavelength, or mean photon wavelength, as defined, for example, in Bessell & Murphy (2012), PASP, 124, 140-157;
   b) an indication of bandwidth, such as FWHM;
   c) the spectral profile of the passband, unless it is completely symmetrical, as, for example, triangular passbands, when this shape and the domain in which this is the case (wavelength or wave number/frequency) are stipulated;
   d) a clear statement on whether the passband profile includes the spectral sensitivity curve of the detector or not, and, if so, the characteristics of the detector;
   e) the temperature at which these specifications apply;
   f) such other details (for example, roll-off, pinhole and leakage specifications) as may be needed to obtain a closely matching filter from manufacturers.
4. that a copy of this resolution should be sent to all editors of astronomical and other journals which publish papers relating to astronomical photometry. ■

** Well known and accepted nomenclature also appears in the Drilling and Landolt chapter in Cox's "Allen's Astrophysical Quantities", 4th edition, 2000, page 386, Table 15.5, and other information on basic systems appears in V. Straizys' "Multicolor Stellar Photometry" volume, 1995 (second printing), (see http://www.itpa.lt/MulticolorStellarPhotometry), among other sources.*

 # For example, "Y" and "iz" are designations that have been applied to passbands in the 1 micro-m (Z) atmospheric window.

RESOLUTION B2

on the re-definition of the astronomical unit of length.

Proposed by the IAU Division I Working Group Numerical Standards and supported by Division I

The XXVIIIth General Assembly of International Astronomical Union,

noting

1. that the International Astronomical Union (IAU) 1976 System of Astronomical Constants specifies the units for the dynamics of the solar system, including the day (D=86400 s), the mass of the Sun, M_S, and the *astronomical unit of length* or simply the *astronomical unit* whose definition[i] is based on the value of the Gaussian gravitational constant,
2. that the intention of the above definition of the astronomical unit was to provide accurate distance ratios in the solar system when distances could not be estimated with high accuracy,
3. that, to calculate the solar mass parameter, GM_S, previously known as the heliocentric gravitation constant, in Système International (SI) units[ii], the Gaussian gravitational constant k, is used, along with an astronomical unit determined observationally,
4. that the IAU 2009 System of astronomical constants (IAU 2009 Resolution B2) retains the IAU 1976 definition of the astronomical unit, by specifying k as an "auxiliary defining constant" with the numerical value given in the IAU 1976 System of Astronomical Constants,
5. that the value of the astronomical unit compatible with Barycentric Dynamical Time (TDB) in Table 1 of the IAU 2009 System (149 597 870 700 m ± 3 m), is an average (Pitjeva and Standish 2009) of recent estimates for the astronomical unit defined by k,
6. that the TDB-compatible value for GM_S listed in Table 1 of the IAU 2009 System, derived by using the astronomical unit fit to the DE421 ephemerides (Folkner et al. 2008), is consistent with the value of the astronomical unit of Table 1 to within the errors of the estimate; and

considering

1. the need for a self-consistent set of units and numerical standards for use in modern dynamical astronomy in the framework of General Relativity[iii],
2. that the accuracy of modern range measurements makes the use of distance ratios unnecessary,
3. that modern planetary ephemerides can provide GM_S directly in SI units and that this quantity may vary with time,
4. the need for a unit of length approximating the Sun-Earth distance, and
5. that various symbols are presently in use for the astronomical unit,

recommends

1. that the astronomical unit be re-defined to be a conventional unit of length equal to 149 597 870 700 m exactly, in agreement with the value adopted in IAU 2009 Resolution B2,
2. that this definition of the astronomical unit be used with all time scales such as TCB, TDB, TCG, TT, etc.,
3. that the Gaussian gravitational constant k be deleted from the system of astronomical constants,
4. that the value of the solar mass parameter, GM_S, be determined observationally in SI units, and
5. that the unique symbol "au" be used for the astronomical unit.

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Standish, E.M., 2004, The Astronomical Unit now, in Transits of Venus, New views of the Solar System and Galaxy, Proceedings of the IAU Colloquium 196, D. W. Kurtz ed., 163 ■

[i] The IAU 1976 definition is: "The astronomical unit of length is that length (A) for which the Gaussian gravitational constant (k) takes the value of 0.017 202 098 95 when the units of measurements are the astronomical unit of length, mass and time. The dimensions of k^2 are those of the constant of gravitation (G), i.e., $L^3M^{-1}T^{-2}$. The term "unit distance" is also for the length A." Although this was the first descriptive definition of the astronomical unit, the practice of using the value of k as a fixed constant which served to define the astronomical unit was in use unofficially since the 19th century and officially since 1938.

[ii] Using the equation $A^3k^2/D^2=GM_S$ where A is the astronomical unit and D the time interval of one day, and k the Gaussian gravitational constant.

[iii] Relativistically a solar system ephemeris, for which the astronomical unit is a useful unit, is a coordinate picture of solar system dynamics. SI units are induced into such a coordinate picture by using the relativistic equations for photons and massive bodies and by relating the coordinates of certain events with observables expressed in SI units.

RESOLUTION B3

on the establishment of an International NEO early warning system.

Proposed by IAU Division III Working Group Near Earth Objects

The XXVIIIth General Assembly of International Astronomical Union,

recognizing

- that there is now ample evidence that the probability of catastrophic impacts of Near-Earth Objects (NEOs) onto the Earth, potentially highly destructive to life, and for humankind in particular, is not negligible and that appropriate actions are being developed to avoid such catastrophes;
- that for the largest NEOs, thanks to the efforts of the astronomical community and of several space agencies, the cataloguing of the potentially hazardous ones, the monitoring of their impact possibilities, and the analysis of technologically feasible mitigations is reaching a satisfactory level;
- that even the impact of small- to moderate-sized objects may represent a great threat to our civilizations and to the international community;
- that our knowledge of the number, size, and orbital behaviour of smaller objects is still very limited, thus not allowing any reasonable anticipation on the likelihood of future impacts.

noting

that NEOs are a threat to all nations on Earth, and therefore that all nations should contribute to avert this threat.

recommends

that the IAU National Members work with the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) and the International Council for Science (ICSU) to coordinate and collaborate on the establishment of an International NEO early warning system, relying on the scientific and technical advice of the relevant astronomical community, whose main purpose is the reliable identification of potential NEO collisions with the Earth, and the communication of the relevant parameters to suitable decision makers of the nation(s) involved. ■

RESOLUTION B4

on the restructuring of the IAU Divisions.

Proposed by the IAU Executive Committee

The XXVIIIth General Assembly of International Astronomical Union,

noting

(a) that both the IAU and astronomy as a whole have evolved considerably since the current Divisions were introduced in 1994 and formally adopted in 1997, and that it is therefore appropriate to consider re-optimising the Divisional Structure,
(b) the report and recommendations of the Task Group established by the Executive Committee to examine the case for restructuring the Divisions, and the Executive Committee response to these recommendations,
(c) that the Commissions, Working Groups and other bodies under the Divisions may also require reform,
(d) that the implementation of the Strategic Plan through the Office of Astronomy for Development (OAD) and other associated programmes requires the Executive Committee to establish appropriate oversight and governance provisions for all Astronomy for Development activities, including the Office of Astronomy for Development, ensuring a strong link between these activities, the Divisions, and the Executive Committee,

approves

the proposal of the Executive Committee to restructure the Divisions as follows:

Division A Space and Time Reference Systems
Division B Facilities, Technologies, & Data Science
Division C Education, Outreach, & Heritage
Division D High Energies & Fundamental Physics
Division E Sun & Heliosphere
Division F Planetary Systems & Bioastronomy
Division G Stars & Stellar Physics
Division H Interstellar Matter & Local Universe
Division J Galaxies & Cosmology

and requests

the new Divisions, guided by the Executive Committee, to work together to produce initial plans for a revised structure for Commissions, Working Groups and other bodies to be approved, in accordance with the Statutes and Bye-Laws of the Union, by the Executive Committee at its meeting in May 2013. ■

DAY 9: PROGRAM SUMMARY

PLENARY TALK BY JOHN KORMENDY (8:30-10:00):
Black Holes in Galaxies
FILM (12:30 ROOM 311) "Saving the Hubble"
IAU GA SESSION II (14:00-15:30)
IAU GA CLOSING CEREMONY (16:00-18:00)
INVITED DISCOURSE 4 BY CHENG FANG (18:00-19:30):
Past, Present and Future of Chinese Astronomy

IAUS 289	Virgo cluster and beyond
IAUS 293	Habitability
IAUS 294	Interstellar and galactic dynamos
IAUS 295	SMBHs & Stellar populations
SpS7	Human and robotic exploration
SpS8	High-z star formation
SpS10	Heliosphere and Asterospheres
SpS12	ISM in nearby galaxies
SpS13	Massive and evolved stars
SpS14	New observatories & Planetary system activities & astronomy images
SpS15	Synergies with other fields
SpS17	Starlight reserves and astro-tourism & Dark skies measurements

INQUIRIES OF HEAVEN

IAU 28TH GENERAL ASSEMBLY, BEIJING, CHINA, AUGUST 20 - 31, 2012 FRIDAY, AUGUST 31, 2012 DAY 10

IAU Members in Action!

Interview with Robert Williams

Q: What are the most important changes that have been made in the IAU for promoting global development and collaborations in astronomy?

A: I think a key change for the IAU is that we are moving from an organization that historically has been largely internally focused on the professional development of astronomy to one that is more outward looking and committed to using astronomy as a tool for development in emerging nations. As part of this we are becoming a more operational organization and increasing our programs in education and outreach. Much of this has been follow up from the International Year of Astronomy 2009.

We are also about to start more serious involvement of the IAU in helping facilitate collaborations on large international projects. Large projects are expensive and it is difficult for individual governments to provide for their full funding. Therefore, for large forefront projects it is realistic to think we must encourage international collaboration. The IAU has not played a large role in this before so we have formed a working group that reports to the Executive Committee called the "Large Scale Facilities Working Group". Large project involvement clearly benefits astronomers whereas the Office of Astronomy for Development in Cape Town is directed more outside the professional astronomy community. It is healthy for the IAU to maintain emphasis on both communities, i.e., professional astronomy and society as a whole.

Q: Can you comment on some of the more outstanding and important discoveries and advances in astronomy?

A: Astronomy continues to produce many exciting discoveries. We are beginning to characterize exoplanets. We have now identified approximately 800 known planets, with the number increasing every week. Soon I am sure we will find good examples of habitable planets that are earth-like. We have methods of characterizing their atmospheres with both ground facilities and space missions that are being proposed. We have the opportunity to look for biomarkers, i.e., the spectroscopic signatures that indicate life may be present, such as ozone. This is ground breaking science.

The understanding of different aspects of dark energy and the distribution of dark matter are also advancing. We do not understand dark matter yet, but we are constraining dark matter and dark energy more and more. In terms of significant discoveries, I would include WMAP's standard cosmological model as being very important. I would also say that the continuing studies of the activity in the center of the Milky Way associated with the supermassive central black hole have been very interesting. Those examples – the Galaxy's supermassive black hole, dark matter and dark energy, the standard cosmological model, and exoplanets – are only a few examples of the significant advances in astronomy that we have heard about in the past two weeks. In terms of theory, numerical modeling has been very important in contributing to the understanding of a variety of phenomena, from the collapse of clouds that lead to star formation to accretion and jet outflows, and especially to the formation of structure from the early universe quantum fluctuations. Take your pick!

Q: What is your assessment of this IAU General Assembly?

A: From my standpoint, it has gone extremely well. The quality of the talks that I heard was quite high. We were successful in attracting Vice President XI Jinping of China to the Opening Ceremony to give an address that affirmed his solid support for science and especially astronomy. I believe the NAOC and LOC have done superb work in arranging so many details. All of the Chinese representatives have been very gracious and understanding. I have been impressed how such a complex event like this can go so smoothly. I give my heartiest congratulations to the Chinese organizers.

I must say that the Inquiries of Heaven daily newspaper has been truly professionally handled. I can also say that I have read some of the articles in the special RAA issue that was given to us and they have all been very well done. The IAU Executive Committee is very pleased with the fact that we had this special issue. It is a feature that the EC may now consider for future General Assemblies. I want to congratulate you personally, both for the Inquiries of Heaven and for all the work that was done on that special issue.

Q: You have had good communication with the Chinese astronomical community. Can I ask your ideas and expectations for Chinese colleagues?

A: The development of astronomy in China for the past 15-20 years has been remarkable. You are now competitive at the international level in ground-based facilities. In space, although the space missions are yet to be launched, China is 'on track'. China is now at the point where it can legitimately seek international collaboration on important projects and be able to offer capabilities that other countries can use. For me, internationalization is the key to success in significant scientific endeavors. My advice to Chinese astronomers would be to learn from the experience of countries with well-developed astrophysics programs and focus on the broad education of astronomy students, including offering them the opportunity to study abroad. Commit yourself to attract many of the best of them back to China to help develop your infrastructure. Educating students with international experience and participating in the most advanced international facilities, both ground- and space-based, should be a future emphasis for Chinese astronomy.

Thank you for demonstrating through this General Assembly that the sky does bind us together in a way that enriches us all. Job well done! ■

Interviewed by Jingxiu Wang, editor of IH and professor of NAOC

Interview with New President Norio Kaifu

Q: Congratulations with your position as the new IAU president. I am honored to have this opportunity to learn about your vision for astronomy and the IAU. What are the main objectives of the IAU in the coming three years?
A: The objective of the IAU is to promote astronomy in all its aspects. The priority for the IAU at this time is to broaden the activities of astronomy in research, education and public outreach all over the world.

We see more countries joining cutting-edge research, but unfortunately we still cannot share excitement of astronomy with many people in the developing world. Therefore, we started the IAU's 10-year strategic plan, "Astronomy for the Developing World", succeeding the IYA2009. The platform for the plan was settled during the past three years, thanks to the OAD and many supporters, so the coming three years will be important for implementation. The IAU is opening the doors to the entire world.
Secondly, the change of structure of the IAU organization has been approved by the General Assembly. The new Division structure gives the IAU more flexibility to cope with the rapid evolution of astronomy. We will work with new Division Presidents on Commissions and Working Groups to accomplish this change as soon as possible.
Q: You have been promoting the construction of large telescopes. What will be the impact of these, and how do you forsee the future of astronomy which requires ever larger telescopes?
A: We will have ALMA, JWST, the next generation optical/IR telescopes, SKA, etc. This is amazing! The Universe is vast and rich, and astronomers have always been confronted with unexpected discoveries. Dark energy will be studied extensively by some of those telescopes. It will require a rather long time for us, but when we understand it in some detail we may be able to have a peek into the reality of the "space" where we are living.
Exosolar planets and life are among the most interesting topics for me. I have started pondering about the conditions that may have allowed the existence of life on Earth, since I observed many organic molecules in dark clouds at the Nobeyama Radio Observatory. Recent progress in the understanding of exosolar planets is remarkable. I expect we get some evidence for life beyond the Earth within the first half of this century. I actually want to see it happening during my life.
All telescopes mentioned above are based on international consortiums. We understand that the sizes of telescopes are approaching the limitations of the world economy. The construction of huge telescopes might inevitably be slowed down, however, it will give us time to introduce a more global strategy of international cooperation for our future and to make innovative developments. During that stage the developing world will play an important role in global cooperation. We already see this happening in the SKA project.
Q: You have spent a significant part of your life on promoting cooperation in Asia. How do you foresee the future of astronomy in Asia?
A: In 1990 we started cooperation of astronomy in East Asia with many friends in this region. Regional cooperation is a keyword. It is important even, or especially, in the global era. East Asia has difficult historical matters which Japan has responsibility of its considerable part, as well as different political and economical challenges. Nevertheless, we share a long history of exchange, and we are neighbors.
We organized the East-Asian Astronomers Meeting (EAMA) as a platform of continuous mutual exchange and cooperation. Based on it we had many activities, including the East Asia Young Astronomers Meeting (EAYAM), a search for telescope sites in western China, the East Asia VLBI Network, and many others. Based on the recommendation by EAMA, the East Asian Core Observatories Association (EACOA) was established in 2005 by ASIAA, KASI, NAOC and NAOJ. Directors meet regularly to discuss exchange of young astronomers, cooperation in large international telescope projects, etc. We wish to proceed toward further cooperation of East Asian astronomy.
The South East Asian Astronomy Network (SEAAN) was also established in 2006 by eleven countries and its activity is growing. Thailand established NARIT with a 2.4-m telescope which will be used for their cooperation. These are the movements for regional cooperation in Asia. Those activities at various regional levels will provide important steps for Asian astronomy in higher level cooperations, such as the future "Asian Astronomical Observatory"; this has been my dream for many years.
Q: You have been actively participating in the scientific collaboration between Japan and China. Do you have any comments and suggestions for Chinese colleagues?
A: I have been involved in China-Japan cooperation for mm/sub-mm astronomy, telescope site survey and many exchange programs with professor Liu Cai-Pin, partly for EAMA activities. I have had a joyful time and it is a great pleasure to see advanced results based on and beyond that cooperation in this IAU General Assembly. Chinese astronomy is really growing rapidly.
Allow me to reply to a few comments about Chinese astronomy. Firstly, I see some gap between astronomy and engineering in China. Also, strong leadership of astronomers is essential for the success of a high-level project. Also, astronomers should work on engineering if necessary. Encourage astronomy graduate students to do instrumentation. In this way we can make good telescopes and instruments, and resources for next generation developments will be accumulated for the future.
The second comment is also on human resources. Chinese astronomy was damaged through the invasion by Japan, the Civil War and then by the Cultural Revolution. The lack of a number of generations to lead large projects seems still to be a subject, as China is pushing many projects ahead. I recommend encouraging (very) young astronomers to lead important projects, and to excite students to get them into astronomy. ■

Interviewed by Jingxiu Wang, editor of IH and professor of NAOC

Astronomers Are Ready to Celebrate

It's been a long two weeks of talks, plenary sessions, joint discussions, exhibits, and adventures-in-taxis at the IAU General Assembly. On Tuesday, astronomers were ready to celebrate.

Directly following the free-flowing beer at the ESO happy hour, over 200 astronomers made the short trek across the street for the TMT-China reception and dinner. From 18:30 until late in the evening, astronomers from across the world celebrated the international partnership in TMT, while looking forward to the beginning of construction in 2014 and first light in 2021.

Hosted by the National Astronomical Observatories of the Chinese Academy of Sciences (NAOC) and the TMT-China project, the reception brought astronomers from the international collaboration together, and informed new friends and colleagues about astronomy's next-generation observatory.

Nobel laureate Brian Schmidt expressed the sentiments of all astronomers present, saying that TMT, and the complimentary southern-hemisphere 30-m class telescopes GMT and E-ELT, represent "the most impressive innovation in telescopes of our generation, and perhaps of all time."

TMT is one of "the most impressive innovation in telescopes of our generation", and "where the East meets the West". Says Brian Schmidt, the 2011 Nobel Prize winner.

Joining hungry and thirsty graduate students, post-docs and senior astronomers, many dignitaries were in attendance including: Norio Kaifu (President-elect, IAU), Ian Corbett (Secretary-General, IAU), Vernon Pankonin (US National Science Foundation) and TMT Collaborative Board representatives from each partner country including Henry Yang (Chancellor, University California - Santa Barbara), Gary Sanders (TMT project manager), Greg Fahlman (General Manager, National Science Infrastructure Portfolio, National Research Council of Canada), Masanori Iye (TMT-Japan Project Director, National Astronomical Observatory of Japan), Suijian Xue (TMT-China Project Manager), and Ajit Kembhavi (Director, Inter-University Centre for Astronomy and Astrophysics, India).

Food and drinks were plentiful, with almost as many food choices as TMT mirror segments (492)! All participants joined together, toasting TMT as well as new friendships and collaborations with at least one glass (sometimes more...) of bái jiǔ.

Schmidt summed up the reception by saying: "We're ready for photons. Lots and lots of photons." ■

Gordon K. Squires

Remembering Beijing

Every General Assembly is remembered for something – in the past few years, Sydney for starting the International Year of Astronomy, Prague for Pluto, and Rio de Janeiro for the Strategic Plan. I thought that Beijing would be remembered for restructuring the Divisions and for the impressive progress we have made in implementing the Strategic Plan. But I was wrong! Above all, Beijing will be remembered for the unobtrusive but impeccable organization, the overwhelming generosity of our hosts, the smiling teams of volunteers, and the impressive CNCC.

Organising a GA starts more than six years in advance. First, the proposal has to be prepared, which involves a lot of background work. Then, once approved, the real work starts and it never stops, reaching a peak in the first few days of the actual GA. There is the National Organising Committee, the Local Organising Committee, the Professional Conference Organisers, the Convention Centre, which all have to blend together into a seamless team. This all has been done to perfection in Beijing.

In parallel, the IAU has to solicit proposals for the scientific programme, select the best, and plan the schedule, all the time maintaining very close relationships with the LOC and PCO, working together to make sure that everything is planned and all eventualities are covered. For Beijing we had a special problem: because of the high quality of the proposals we received, we decided that – quite exceptionally – we would have eight symposia while maintaining the normal programme of Special Sessions and Joint Discussions. This was not an easy decision to make, and was only possible because of the exceptional facilities of the CNCC, which offered us a wider range of rooms than most other conference centres could supply.

We also have to prepare, select and distribute the IAU grants. This year we assessed around 750 grant applications and gave out some 420 grants to a value of over 350,000 EUR. These grants are a vital part of IAU's programme: they enable people, especially young people or those from developing countries, to benefit from the "GA experience".

All this work has paid off. Everything that I have seen or heard says that the GA has been a great success, scientifically and organisationally. Our hosts astounded us all by securing the Vice-President of the People's Republic of China to make the opening speech at the Inaugural Ceremony, and we were delighted by the things he said, all highly relevant and encouraging to an astronomy General Assembly. The performances which followed at the Inaugural Ceremony were a breathtaking display of skill and artistry. Who cares if we over-ran the schedule by half an hour when something so memorable is on stage!

The science programme was outstanding. We were fortunate in having such excellent speakers for our four Invited Discourses, of course, but there were many other outstanding contributions, as the Proceedings which will appear next year will certainly show. We also managed the Young Astronomers Lunch, the Women in Astronomy day and many other special events.

All this made my task as General Secretary much easier, and I could concentrate on the business of the IAU and the plenary sessions of the GA. Much duller, but necessary!

I cannot thank everyone by name, much as I would like to do so, and so I thank everyone who had anything to do with the organisation and running of this wonderful GA. It has been a memorable experience. ■

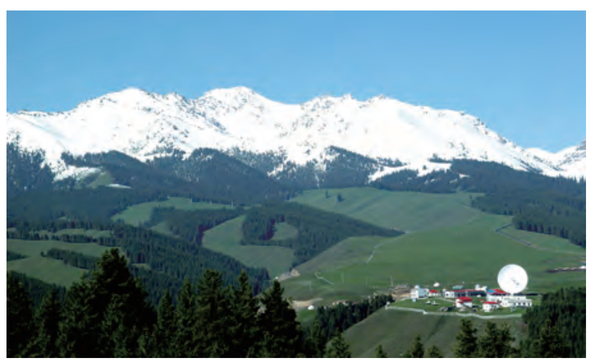
Ian Corbett

Adviser of IAU Executive Committee, past IAU General Secretary.

Xinjiang Astronomical Observatory

Founded in 1957, Xinjiang Astronomical Observatory (XAO) of the Chinese Academy of Sciences (CAS) has developed from a single satellite observatory into an important comprehensive astronomical research organization. The current research at XAO spans many fields of astronomy. It consists of radio astronomy, optical astronomy and applied astronomy, and is mainly focused in the fields of pulsars, star formation and evolution, galaxies and cosmology, high energy astrophysics, microwave reception, digital technology, space object and debris, satellite navigation, and GPS.

The 25 meter telescope in Nanshan, administered by XAO, is one of the important stations used in VLBI. In addition to being a key observatory of pulsars, centimeter wave molecular lines, and active galactic nuclei, the Nanshan station also plays an important role in China's Lunar Exploration Program.



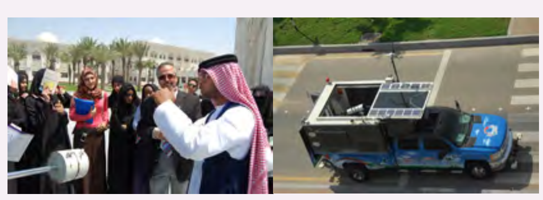
Distant view of Nanshan Observing Station

The largest fully-steerable single-dish radio telescope (diameter 110 m), which is called the Qitai Radio Telescope, or QTT for short, will be built in Qitai County in Xinjiang, China. Upon completion, the sensitivity of this 110 m antenna will be about 20 times more than the 25 m telescope. Furthermore, the QTT could meet the needs for exploring regions of deep space. The QTT project in XAO has embarked on a new research campaign and our innovative team is always looking for dedicated and creative researchers who are flexible and open to new challenges.

XAO has engaged in a wide range of interesting science communications since it was set up. International collaboration is an important channel for XAO to promote the development of astronomy, astrophysics and other related fields of science. Currently, XAO has more than 98 staff, including 77 scientific and technical personnel, 13 management personnel, and has also hired three foreign emeritus professors and experts from well-known universities and research institutions. Currently, 20 doctoral students and 107 master students are enrolled in the graduate program of XAO. ■

Emirates Mobile Observatory – Astronomy Outreach in the Arabian Penninsula

Public interest in astronomy is immense. Astronomers and amateur astronomers should work hand in hand and endeavour to spread space education with the public through audio-visual methods and create positive interest in astronomy. My intrest stretches to science in general. In the year 2002, the importance of outreach all over the United Arab Emirates and the Arabian Peninsula as well sprang into my mind to enhance science knowledge among people. In order to bring this dream into reality, I decided to execute the project of a custom-built mobile observatory. The implementation of the idea encountered some problems, but with a lot of determination and with help from my wife I managed - in September 2010 - to build the fourth version of the Mobile Observatory.



Right: Educational outreach in astronomy with observing. Left: A view of the Emirates Mobile Observatory.

The Mobile Observatory Control and Operation room is environmentlly friendly since it runs exclusively on Solar and Wind Power, using a total of 1500 W. The observatory contains over ten interchangeable telescopes ranging from a 6″ refractor to a 14″ SC telescope. The observatory can be controlled remotely, the public can watch all the observations and a documentary movie on the integrated 42′′ LED-3D television and ceiling projector. I have given many public talks and recieved great interest. ■

Nezar Hezam Sallam

Computer Engineer. for the Abu Dhabi Police, Department of Information Technology.

Message about Research in Astronomy and Astrophysics (RAA)

For the last 11 days, the gathering of the world's top astronomers during the IAU 28th General Assembly has brought Beijing to the frontier of astrophysics and beyond. As underscored by Vice-President XI Jinping in his opening speech, the international community must explore the vast Universe hand in hand, and work together toward a better future for humankind. The new journal Research in Astronomy and Astrophysics (RAA), established by converting the former Chinese Journal of Astronomy and Astrophysics (ChJAA) into a truly international journal representing the entire Asia-Pacific region, is a small step in this direction. With an editorial team of distinguished astronomers with international reputation (IAU President Norio Kaifu among them), this new journal strives to serve the global astronomical community as exemplified by the IAU. While the editorial board of RAA (listed in the box) consists of astrophysicists from the Asia-Pacific region who felt there is a need for a strong journal from this region, we invite papers from astronomers and astrophysicists all over the world.

Since its first issue in 2009, RAA has made significant progress in both its content and visibility. It has already established its position as one of the leading scientific journals in the Asia-Pacific region. RAA publishes regular papers, letters and review articles. The special issue of RAA that is entirely devoted to review articles published on the occasion of this IAU GA (a copy is included in the conference bag of all registered participants), while not representative of a typical issue, should give an impression about the nature of this journal. The policy of fast turn-around time in the review process, free page charge, open electronic access for newly published papers, and the publication arrangement with IOP, have given us much confidence that RAA will soon be publishing more and more fundamental contributions and seminal papers on cosmology, extragalactic and galactic astronomy, stellar astronomy, exoplanets, astrobiology, planetary science and solar astrophysics. Our ambition is to be on par with top journals such as Astrophysical Journal, Astronomy and Astrophysics, and Monthly Notices of the Royal Society before the end of this decade. Just like the tremendous growth in the number of young astronomers from the Asia-Pacific region as amply witnessed in this IAU General Assembly, RAA is looking forward to the opportunity of working with the broad readership and international authorship with your support. Thank you and Xie Xie (in Chinese)!

Editorial Board Members of RAA, from left to right: Arnab Choudhuri (Professor, Indian Institute of Science, Bangalore), Jingxiu Wang (Professor, National Astronomical Observatories of China, Beijing), Wing Ip (Professor, National Central University, Taipei)

RAA Editorial Borad

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2. Prof. Yipeng Jing, SHAO

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14. Prof. Jingxiu Wang, NAOC
15. Prof. Tinggui Wang, USTC
16. Prof. Sen Wang, NAOC
17. Prof. Gang Zhao, NAOC
18. Prof. Jilin Zhou, NJU ■

Supporting Editors, Authors, and Missions with IAU Recommendations

Historically, the IAU has chartered working groups to define a standard set of astronomical nomenclature, coordinates, and constants. Examples of special concern to Division III (Planetary System Science) include the names, type designations, and rotational elements of the planets, satellites, asteroids, and comets. Definitions adopted by the IAU are recognized and used by scientists, space agencies, and authorities worldwide.

The IAU WGs do not invent the names, devise the constants, or propose the recommendations. Rather, they merely confirm that the values proposed by members of the scientific community are consistent with previously agreed upon common practices. Unfortunately, it has happened sometimes that press releases and publications have introduced new names or coordinate systems that have not passed IAU review. This has especially been an issue with space missions, where mission scientists or others in the excitement of announcing new discoveries sometimes do not take account of the established conventions and standards of the community.

Of course, as our knowledge develops such systems will be corrected, improved, and made more precise. However, new data can and always have been aligned to any existing system, without any loss of accuracy in the old or new data, resulting in an improved system.

There are no "enforcement" procedures in science. We note however that data repositories such as the NASA Planetary Data System will only accept data in a coordinate system that follows IAU recommendations. And in the case of the official names of meteorites, relevant journals and meetings have agreed to not accept papers that do not follow international standards. In general, however, we rely on the good will and cooperative nature of those who would wish to fit their work into that of the larger community of scholars. In particular we would hope that authors and journal editors would follow IAU recommendations in their publications, consulting with the appropriate IAU WGs or other components as necessary. At some point there may be situations where authors, reviewers, and editors might agree that following such recommendations is not justified, but with adequate consultation, such cases are probably unlikely. ■

Karen Meech *(Outgoing Div. III President)*, **Giovanni B. Valsecchi** *(Incoming Div. III President)*, **Brent Archinal** *(Chair, WGCCRE)*, **Rita Schulz** *(Chair, WGPSN)*, *and* **Guy Consolmagno** *(WGCCRE, WGPSN)*

Future of Nobeyama Radioheliograph

A dedicated solar radio interferometric imager, called the "Nobeyama Radioheliograph (NoRH)," will be closed in two years due to budgetary reasons. There is a possibility that the instrument can be donated to a different institution or country for continued operation for the benefit of the world's scientific community. Interested parties should contact shibasaki@nro.nao.ac.jp as early as possible.

NoRH was constructed in 1991 and has been operating fort he past 20 years, observing the full Sun at 17 and 34 GHz. NoRH consists of 84 dishes with an 80 cm diameter oriented in a T-shaped baseline (EW 490 m; NS 220 m). Data have been used for various science researches, such as particle acceleration in solar flares, active regions (sunspot oscillations), measurements of the coronal/chromospheric magnetic field, prominence eruptions and polar activities. By obtaining a long, continuous, and high-quality dataset with robust calibration, solar cycle studies are also possible. Microwave emission (above 15 GHz) from the poles is unique for studies of polar activities, and this dataset is also very useful for studies of interplanetary space, especially during the current anomalous period of solar activity. The instrument is unique and is still quite healthy (99% availability). All data are open for research, education and outreach purposes for free (http://solar.nro.nao.ac.jp). ■

Kiyoto Shibasaki
Nobeyama Solar Radio Observatory

EXECUTIVE COMMITTEE (2012-2015)

PRESIDENT: Norio Kaifu (Japan)

Honorary Professor of the National Astronomical Observatory of Japan (NAOJ), and member of Science Council of Japan, Norio Kaifu is one of founders of the Nobeyama Radio Observatory, NAOJ, established in1982. He lead the construction of the 45-m mm-wave telescope and developed a large radio spectrometer

with acousto-optical technology for the first time. Pioneer of mm-wave spectral observations of interstellar molecules including discovery of many new interstellar organic molecules in dark clouds, and he studied star-forming phenomena in the era of early mm-wave astronomy. He then directed construction of the 8.2-m Subaru Telescope in Hawaii from 1991 to 2000. He was appointed Director General of the NAOJ in 2000. He formally started the ALMA-Japan which is a joint project with the NRAO and the ESO in 2004. Through these works he pushed Japanese ground-based astronomy to the current level. Published about 150 papers in international journals and wrote several textbooks for radio astronomy. His current scientific interest is planets and life in the universe.

Norio Kaifu graduated from the University of Tokyo and took Ph.D. in astronomy in 1972. Professor of the NAOJ since 1988, Director of the Subaru Telescope from 1997 to 2000, director general of the NAOJ from 2000 to 2006. He served Japanese basic science as Chair of Science and Technology Division of the Science Council of Japan from 2005 to 2008. Organized many international cooperation of astronomy including extensive UK-Japan cooperation in mm-wave and IR astronomy. He worked for cooperation of Asian astronomers for many years, and he established the EAMA (East Asian Astronomers Meeting) and the EACOA (East Asian Core Observatories Association). For the IAU he served as a Vice President (1997-2003), a member of the IYA2009 WG, President Elect (2009-2012) and as a President from 2012. He is a well known writer and lecturers of science for general public and also known as a book reviewer of wide field of sciences.

PRESIDENT-ELECT: Silvia Torres-Peimbert (Mexico)

Silvia Torres-Peimbert received her BA in physics from the Universidad Nacional Autónoma de México, UNAM, and her PhD in Astronomy from the University of California, Berkeley. She has worked at the Instituto de Astronomía UNAM. She was director of the same institution from 1998 to 2002. She has also been

editor of the *Revista Mexicana de Astronomía y Astrofísica* and of its *Serie de Conferencias*, which has published the proceedings of many astronomical meetings in Latin America, including the IAU Regional Meetings. She established the astronomy graduate program at UNAM. She is very active in public outreach, including the IYA2009, where she was SPOC for Mexico.

Her main field of study has been gaseous nebulae. One of her main interests has been the determination of the chemical composition of H II regions and planetary nebulae in our Galaxy and other galaxies, the study of the chemical evolution of galaxies and the determination of the primordial helium abundance based on very metal poor extragalactic H II regions.

She has been Vice-President of the International Astronomical Union, Councilor for the American Astronomical Society and member of the Board of Directors of the Astronomical Society of the Pacific. She received the L'Oreal-UNESCO prize for women scientists in Latin America and the Hans Bethe Prize of the American Physical Society.

GENERAL SECRETARY: Thierry Montmerle (France)

A graduate of Ecole Normale Supérieure in Paris, Thierry Montmerle did his PhD in Paris and Montreal (1975). Somewhat unusually, his thesis included theoretical work on very different fields: cosmology (origin of the gamma-ray background via matter-antimatter annihilation-, and stellar physics (diffusion processes in stellar atmospheres). He spent most of his career with the French

Atomic Energy Commission, working in the Saclay astrophysics group, near Paris, mainly dedicated to space astronomy (e.g., instrumental contributions to ESA's COS-B, XMM, INTEGRAL, ISO, Herschel, and also to NASA's Fermi, and to other satellites) and also to ground-based astronomy using derivatives of space instruments. In 2004, after heading the Theory group in Saclay for many years, he moved to Grenoble as Director of the Grenoble Astrophysics Laboratory (LAOG), then returned to Paris in 2010 to work at the Institut d'Astrophysique (IAP), which is also hosting the IAU Secretariat. He has been appointed to many national and international committees (ESA Astronomy Working Group, ESO OPC, IRAM OPC, etc.), and organized several astronomy meetings, including one of the Texas Symposium of Relativistic Astrophysics series. He has also written popularizing books in astronomy.

Thierry's main research interests are in multiwavelength observational studies of star-forming regions, focusing on stellar and diffuse high-energy processes (X-rays, gamma-rays, cosmic rays, etc.) and their connection with low-energy irradiation processes in molecular clouds (in the mm domain) and in the early solar system.

Within the IAU, as Assistant General Secretary, Thierry's main task was to chair the Executive Committee "Task Group on Division Restructuring", which helped produce the Resolution approved by the General Assembly.

ASSISTANT GENERAL SECRETARY: Piero Benvenuti (Italy)

Piero Benvenuti is currently full professor at the Department of Physics and Astronomy "G. Galilei" of the University of Padua, where he is holding the courses "High Energy Astrophysics", "Space Plasma Physics" and "History of Astronomy", the latter shared with the Department of Philosophy. He is the Director of the Interdepartmental Centre for Space Studies and Activities "CISAS – G. Colombo" of the University of Padua.

Piero Benvenuti graduated in Physics in 1970 at the University of Padua and begun his professional activity as astronomer at the Asiago Observatory in 1970.

In 1977 he joined the European Space Agency as Project Scientist and Director of the IUE (International Ultraviolet Explorer) Observatory at the Villafranca del Castillo tracking station, near Madrid, and, from 1984 to 2003, as Head of the ST-ECF (Space Telescope European Coordinating Facility) hosted at ESO, Garching bei München. In 2003 he returned to Italy where he held the position of President of the National Institute for Astrophysics (INAF) from 2003 to 2007. Between 2007 and 2011 he has been deputy President and member of the Board of Directors of the Italian Space Agency (ASI). In 2011 he has been appointed, by H.H. Benedict XVI, Consultant of the Pontifical Council for Culture of the Vatican City.

His scientific interests include the study of comets, of the diffuse interstellar medium, HII regions, supernova remnants and space instrumentation. More recently he worked in the field of astronomical digital archives, in particular in the Astrophysical Virtual Observatory Project. He is the author of more than 200 scientific papers and of several educational outreach articles. He regularly contributes to the "*Corriere della Sera*", "*Avvenire*" and "*L'Osservatore Romano*" newspapers.

VICE-PRESIDENTS (INCOMING)

Renée Kraan-Korteweg (South Africa)

Prof. Renée C. Kraan-Korteweg is Chair of Astronomy and Head of the Astronomy Department at the University of Cape Town (UCT), and co-director (and founder) of the Astrophysics, Cosmology and Gravity Centre (ACGC), an UCT-accredited Research Centre that brings observational astronomers

and theoretical cosmologists together. Before joining UCT in 2005, she worked at the University of Guanajuato in Mexico (1997-2004) where she helped build up a new Astronomy Department, the Observatoire de Paris-Meudon in France (1994-1997) as a EC postdoctoral fellow, the University of Groningen (NL; 1991-1994) on a fellowship from the Dutch Royal Academy of Sciences (KNAW), and the University of Basel (CH), her Alma Mater, where she studied and received her PhD (1985) and continued to work as a research fellow until 1991. She furthermore is a member on various national and international committees (e.g. Academy of Science of South Africa; SA Astronomy Desk; SA SALT TAC; IAU Executive Committee on Future Large Scale Facilities; SKA Pathfinder HI Surveys Coordination Committee PHISCC).

Her research interests lie in the large-scale structure of galaxies, cosmic flow fields and the continuing controversy on the scale of bulk flows, with particular emphasis on uncovering the galaxy and mass distribution hidden by Milky Way using multi-wavelengths approaches, as well as systematic HI surveys. She supervises numerous MSc and PhD students and teaches at the undergraduate and postgraduate level. She further invests in the growing the astronomical community in South Africa at a national level given the advent of SALT, MeerKAT and the SKA.

Xiaowei Liu (China Nanjing)

Xiaowei Liu is a Cheung Kong Scholar and professor of astronomy at Peking University. He received college education at Peking University in Astrophysics and received his PhD degree in 1992 from the Beijing Astronomical Observatory (now the National Astronomical Observatories), Chinese Academy of Sciences, after completing his PhD thesis at the European Southern

Observatory in Munich, Germany. He then joined the Department of Physics and Astronomy, University College London, first as a postdoctoral, then as a senior research fellow. He joined the faculty of Department of Astronomy of Peking University in 2000. He is currently serving as the Acting Director of the Kavli Institute for Astronomy and Astrophysics at Peking University.

Professor Liu's main research interest is in spectroscopic observations and theoretical analyses of emission line nebulae (planetary nebulae, H II regions), with an emphasis on the physical processes and radiative mechanisms governing photoionized low-density astrophysical plasmas. Studies of emission line nebulae yield information of stellar nucleosynthesis and the enrichment of the interstellar medium, and of the chemical evolution of galaxies. Currently, Prof. Liu is leading a large spectroscopic survey towards the Galactic anticenter with the newly built Chinese Large Sky Area Multi-object Spectroscopic Telescope (LAMOST). The survey shall yield spectra for several million Galactic stars, thus providing a unique data base to study the structure and probe the dynamical and chemical evolution of the Milky Way.

Dina Prialnik (Israel)

Dina Prialnik is full professor of astrophysics at Tel Aviv University, and incumbent of the Jose Goldenberg Chair for Planetary Physics at the Department of Geophysics, Atmospheric and Planetary Sciences. Since 2010 she serves as Vice Rector of the university, in charge of all study programs, from undergraduate to PhD. For many years she has been associate editor of *Meteoritics & Planetary Science*. Asteroid 1993 FW36 is named after her.

Dina graduated in Physics and Mathematics at the Hebrew University of Jerusalem, continued her studies in Astronomy at Tel Aviv University and received her PhD in 1980. She did her post-doc at Stanford University. In 1989 she joined the academic staff at Tel Aviv University and since then has been visiting scholar at several institutions, among them, the Hubble Space Science Institute, the Institute for Astronomy at the University of Hawaii, the Institute for Advanced Studies at Princeton, the International Space Science Institute in Bern and the American Museum of Natural History in New York City.

Her research interests lie in stellar evolution, the structure and evolution of cataclysmic variables with emphasis on nova outbursts, as well as the evolving structure and activity of comet nuclei and other small solar system bodies. She focuses on numerical modeling and evolutionary simulations, which, by comparison with observations, reveal the internal structure and composition of these objects; her publications include over 170 papers. Dina Prialnik is author of "*An Introduction to the Theory of Stellar Structure and Evolution*", published by the Cambridge University Press. She is member of IAU Commissions 15 and 35.

Vice-Presidents (second term)

Matthew Colless (Australia)

Matthew Colless is currently the Director of the Australian Astronomical Observatory, but in January 2013 will become the Director of the Research School of Astronomy & Astrophysics at the Australian National University. His research focuses on observational cosmology and galaxy evolution, particularly through the use of large galaxy surveys; he also has a strong interest in astronomical instrumentation. Matthew obtained his first degree at the University of Sydney, his PhD at Cambridge University, and has worked at NOAO, Durham, Cambridge, ANU and the AAO. He brings wide experience in astronomical research and the management of projects and institutions to his role as IAU Vice-President. See www.aao.gov.au/local/www/colless for more information.

Jan Palouš (Czech Republic)

Jan Palous is professor of astronomy and astrophysics at the Charles University in Prague and leading scientific fellow of the Astronomical Institute of the Academy of Sciences of the Czech Republic. He delivers lectures in fields of galactic and extragalactic astronomy, supervises diploma and PhD thesis. Jan Palous graduated in 1972 from the Faculty of Mathematics and Physics of Charles University, Prague, and completed his PhD in Astronomy and Astrophysics, in 1977. During 1996-2004 he was the director of the Astronomical Institute, Academy of Sciences of the Czech Republic. Since 2005 he is the member of the Council of the Academy of Sciences of the Czech Republic, where he is responsible for foreign relations.

Jan Palous is a member of the IAU, where he is affiliated to Commission 33. He was the chairperson of the National Organizing Committee of the 26th GA IAU in 2006 in Prague. Under his leadership, the Czech Republic entered in 2007 the European Southern Observatory, where he is currently active as the Council member. He is the fellow of the Royal Society of Edinburgh and honorary fellow of The Royal Astronomical Society. Jan Palous is also active as the member of the European Astronomical Society, where he was secretary and vice-president.

His scientific interests include evolution of galaxies, two component systems, interstellar matter and stars, star formation, stellar winds and mass recycling, feedback, chemical evolution, shells, supershells and filaments, gravitational instability, triggered star formation, initial mass function, galaxies in groups and clusters, tides, merger events, harassment, gas stripping, formation of super-star clusters, intracluster medium. He combines the theoretical approach with numerical simulations that are compared to observations. He is author and co-author of research articles in professional journals, public presentations in newspapers, magazines, radio and TV.

Marta Rovira (Argentina)

Marta Rovira obtained her PhD in physics at the Buenos Aires University, Argentina. She works at the Institute of Astronomy and Space Physics (IAFE), Buenos Aires. She was director of IAFE during the period 1995-2001, president of the Latin-American Association of Space Physics (ALAGE) 1998-2001, president of the Astronomy Argentine Association 1999-2002 and 2002-2005, Coordinator of the commission of physics, mathematics and astronomy from the National Agency of Science and Technology 2004-2006. During the period 2008-2012 she was the president of the National Council of Science and Technology (CONICET), Argentina.

Her main topic of research is the solar physics. In particular the modeling of solar prominences and the study in different wavelengths to find the parameters that better adjust the observations, also the study of solar flares and the relation with the terrestrial magnetic field and the ionosphere data. She wrote the book "*The Sun*" dedicated to young people interested in astronomy.

Advisers

Bob Williams
(Past IAU President, USA)

Ian Corbett
(Past IAU General Secretary, UK)

DIVISION PRESIDENTS AND VICE-PRESIDENTS (2012-2015)

Division A: Space and time reference systems

President: Sergei Klioner (Germany)

After getting his PhD in St.Petersburg, Russia and spending several years in postdoc positions in Japan and Germany, Sergei Klioner settled down to work in Lohrmann-Observatorium, Technische Universität Dresden, Germany. His research field includes gravitational physics, celestial mechanics and astrometry. Sergei Klioner is a member of the ESA Gaia Science Team and spends significant part of his working time for the preparations for this mission.

Within the IAU Sergei served as President of Commission 52 "Relativity in Fundamental Astronomy" from 2006 to 2009, and as Vice-president of Division I "Fundamental Astronomy" from 2009 to 2012. He also participated in the organization of a number of meetings including IAU Symposia and Joint Discussions.

Vice-President: Jacques Laskar (France)

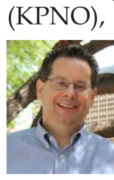
After a Master in Mathematics at Ecole Normale Supérieure de Cachan, near Paris, J. Laskar completed his PhD in Astronomy at Paris Observatory. He his now Director of Research at CNRS and Paris Observatory where he leads the group "Astronomy and Dynamical Systems". He is member of the French Academy of Sciences and Member of the "Bureau des Longitudes". For his work, he received the Silver medal from CNRS and the Brouwer Award from the Division of Dynamical Astronomy from AAS.

J. Laskar work spans various field of fundamental astronomy, his main interest being the study of motions in planetary systems. He devoted large efforts to obtain accurate solutions for the long-term motion of planets in the Solar System that are used as reference for paleoclimate studies over several million years. In pursuing this work, he demonstrated that the orbital motion of the planets of the Solar System is chaotic, with exponential divergence of the orbits of a factor of 10 every 10 million years, making it impossible to predict its motion beyond 60 million years. He showed that planetary perturbations create a large chaotic zone for the spin axis motion of all the terrestrial planets. Without the presence of the Moon, the Earth's axis would be highly unstable, and could vary from 0 to about 85 degrees. He also demonstrated that the spin axis of Mars is chaotic, and can vary between 0 and 60 degrees, inducing high climatic variations on its surface. In order to improve the long-term ephemeris for the Solar System, he initiated the development of the INPOP planetary ephemerides. He is now largely involved in the characterisation of extrasolar planets systems.

Division B: Facilities, technologies, and data science

President: David Silva (USA)

Since 2008, D. Silva has been the director of National Optical Astronomy Observatory (NOAO), the USA national observatory for nighttime ground-based astronomy. Major NOAO components include Kitt Peak National Observatory (KPNO), Cerro Tololo Inter-American Observatory (CTIO), and several major technology programs, including the LSST Telescope and Site Facilities development team. Silva received his degrees from U. of Arizona (1984) and U. of Michigan (1991). He has previously held positions at NOAO (1990 – 1996), ESO (1997 – 2005), and Thirty Meter Telescope (2006 – 2008). Silva has been involved in the development, operations and/or management of WIYN, VLT, ALMA, TMT, and LSST.



His scientific interests include extragalactic stellar populations, early-type galaxies (near and far), stars above the TRGB, and digital stellar libraries. Silva's technical experience encompasses general observatory operations and management, queue observing, astronomical data processing & quality control, and end-to-end data management systems. He has observed with a broad range of modern optical and near-IR instruments.

He has been Division Vice-President, IAU Div IX (2010 – 2012).

Vice-President: **Pietro Ubertini (Italy)**

P. Ubertini is director of the Italian Institute for Space Astrophysics and Planetology (IAPS), one of the leading European Institute in Relativistic Astrophysics and Planetary Science. IAPS supports instrument on-board major ESA and NASA space observatories, and participates with PIs and Co-Is to the ESA missions Bepicolombo, Solar Orbiter, EUCLID and JUICE. From the 70's P. Ubertini

has pioneered the ideation of novel type of X and γ-ray detectors for space experiments in astrophysics and the culmination result of his carrier has been the provision to the high energy astronomical community of the IBIS gamma-ray imager of the ESA's INTEGRAL satellite (2002-present). He has been instrumental in establishing the missing link between X and γ-ray astronomy and in developing this new space-age discipline.

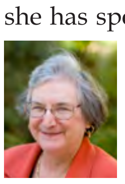
His main scientific interest is in the field of relativistic astrophysics, focussed to discover new and different classes of cosmic γ-ray sources, as well as in resolving the 30 years mystery of the diffuse Galactic plane emission in hundreds of neutron stars and black holes. Coordination activity by P. Ubertini as a Principal Investigator of the INTEGRAL observatory yielded the first *All sky soft-γ-ray catalogue*, a template for today's and future workers in the field, casting a new light on the soft γ-ray sky population and its impact on cosmology.

He is Chair of the COSPAR Scientific Commission E, Research in Astrophysics from Space, and National Delegate.

Division C: Education, outreach and heritage

President: **Mary Kay Hemenway (USA)**

Mary Kay Hemenway is a Research Fellow at the University of Texas at Austin. She received her Ph.D. at the University of Virginia in astrometry in 1971; part of her dissertation research was done at Sterrewacht de Leiden. Since 1980, she has specialized in Astronomy Education for schools and universities, with



an emphasis on Teacher Professional Development. She served as Education Officer of the American Astronomical Society for six years, Secretary to the Board of Directors of the Astronomical Society of the Pacific for over eleven years, and as a member of the IAU IYA2009 Executive Committee Working Group. She is currently a member of the IAU Office of Astronomy for Development Task Force on Astronomy for Children and Schools.

Vice-President: **Hakim Malasan (Indonesia)**

Malasan completed his doctoral degree in the field of Stellar Physics from The University of Tokyo, Japan in 1992. Part of his research on Close Binary Central Stars of Planetary Nebulae was conducted using facility at Mauna Kea Observatory. Malasan works in the field of Stellar Physics, Close Binary Systems,

Planetary Nebulae, Optical astronomy instrumentation and observation, Computational Astrophysics, Data modelling and statistics of measurements and recently, Management Information System for Observatory. He was di Director of Bosscha Observatory of ITB in Lembang, Indonesia in the period 2010-2011.

Current position: Assistant Professor at Astronomy Research Division & Bosscha Observatory, Faculty of Mathematics & Natural Sciences, Institut Teknologi Bandung.

Activities in International Astronomical Union (IAU)

1. Member of Division V, XII, Commissions 42 and 46
2. Editor, Bibliography and Program Notes of Close Binary System of Commission 42 (1990-1992)
3. Member of Program Group for World Wide Development in Astronomy (PGWWDA): Visit to Cambodia (2009), Brunei Darussalam (2011)
4. Active in Program Group Teaching of Astronomy for Development (TAD): Visit to The Philippines (2010)
5. Faculty member of IAU International School for Young Astronomer (ISYA) in 2007, Malaysia
6. Scientific Organizing Committee for Asia- Pacific IAU Regional Meeting (since 2005)
7. Coordinator for You Are Galileo! Telescope workshops in Indonesia, a collaborative activity with National Astronomical Observatory of Japan under support of IAU and UNESCO (2010) for the International Year of Astronomy and Beyond.
8. Office of Astronomy for Development (2011), member of Task Force 1

Other activities

1. General Secretary of South East Asia Astronomy Network (SEAAN) since 2011
2. Adviser for the South East Asia Young Astronomer Collaboration (SEAYAC) since 2010
3. Scientific Organizing Committee member for the Pacific Rim Conference on Stellar Astrophysics since 2008
4. Chair of National Committee for the International Olympiads in Astronomy and Earth Science (since 2010)

Division D: High energies and fundamental physics

President: **Diana Worrall (UK)**

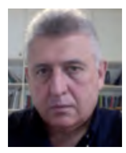
Diana Worrall is Professor of Physics at the University of Bristol, UK. Her PhD work, carried out at the University of Durham, investigated the origin of cosmic gamma rays, including assessing the contribution to the extragalactic background from the halo of our own Galaxy -- a topic of renewed interest for

the Fermi mission. She held positions with the University of Maryland, the University of California San Diego, and the Smithsonian Astrophysical Observatory before joining the University of Bristol in 1996. Her research has spanned diverse topics in high-energy astrophysics, including discovery work on the X-ray ridge, and multiwavelength campaigns to study blazars and other active galaxies. She is an expert on observations and emission processes of radio galaxies and jets, particularly directed towards their radio and X-ray radiation.

Since 2009, Diana Worrall has served on the Organizing Committee for IAU Div XI, participating actively in Division discussions, and she served on the SOC for the IAU GA Special Session on Cosmic Evolution of Groups and Clusters. She frequently serves on proposal and fellowship review panels for NASA and ESA, and is a Scientific Editor for MNRAS.

Vice-President: **Felix Aharonian (Ireland/Germany)**

After completing his PhD in Nuclear and Particle Physics at the Moscow Engineering-Physics Institute in 1979, Felix Aharonian joined the scientific staff at the Yerevan Physics Institute, Armenia. Since 2006, he has been a Professor of Astronomy and Astrophysics at the Dublin Institute for Advanced Studies



where he also serves as Director of the Center for Astroparticle Physics and Astrophysics. In addition, since 1993, he has been the Leader of the High Energy Astrophysics Theory group at the Max-Planck Institute for Nuclear Physics, Heidelberg. Professor Aharonian's research spans a wide range of topics in High Energy Astrophysics including the Gamma Ray Astronomy, Neutrino Astronomy, X-ray Astronomy, Cosmic Rays, Physics and Astrophysics of Relativistic Objects.

His work includes both the theory and phenomenology as well as the observations of high energy sources, in particular the treatment of nonthermal high energy processes in extreme astrophysical environments, based in part on the very successful H.E.S.S. project.

Division E: Sun and heliosphere

President: **Lidia van Driel (UK)**

Born in Hungary, Lidia van Driel got her PhD from the Charles University in Prague, and a DSc from the Hungarian Academy of Sciences in Budapest. She took various research and teaching positions in Hungary, the Netherlands, Japan, France, UK, and Belgium. She is currently Reader at the Mullard Space

Science Laboratory, University College London, U.K.

Her field of research is multiwavelength observational solar and heliospheric physics. The main topics she is interested in are: emergence and decay of magnetic flux, long-term evolution of active regions, flares, coronal mass ejections, magnetic helicity, coronal heating, and solar wind formation. Since 2005, she is Editor-in-Chief of "Solar Physics".

She has served as President of IAU Commission 10 (Division II).

Vice-President: **Yihua Yan (China)**

Recent Academic and Professional Positions:

2011-present: Director of Solar Physics Division, National Astronomical Observatories of China

2008-present: Assistant Director-General, National Astronomical Observatories

2008 - present: Director of CAS Key Laboratory of Solar Activity

1999 - present: Professor & Chief Scientist of Solar Radio Research, National Astronomical Observatories, Chinese Academy of Sciences

1992 - 1999: Associate Professor, Beijing Astronomical Observatory

1995 - 1996: Foreign Research Fellow, National Astronomical Observatory of Japan

1996 - 1997: Alexander von Humboldt Fellow, Astronomical Institute, Würzburg University, Germany

Dr. Yan has been engaged in studying solar magnetic fields and solar radio astrophysics over the past two decades. In particular, he is interested in coronal magnetic field reconstruction, solar radio bursts and their associations with solar flares and CMEs, data processing for aperture synthesis, astronomical methods and instrumentation. He is currently the PI of the Chinese Spectral Radioheliograph (CSRH). He also promotes the Chinese space solar physics programs. He has published more than 150 papers, co-edited Proc of IAU Symp. No.226, co-authored a book on Generalized Extension Approximations in Science and Technology, and presented tens of invited talks in the bi-lateral, international or national academic conferences.

Dr. Yan served as an OC member of Solar Eclipse Working Group of Div II in 2007-2011, co-organized the 2009 Solar Total Eclipse Expedition in Tianhuangping, Zhejiang, China. He has been an OC member of IAU Commission 10 since 2009, participating actively in Commission discussions and served as a co-chair of the SOC for the IAU GA Symposium No.294.

Division F: Planetary systems and bioastronomy

President: Giovanni Valsecchi (Italy)

Giovanni B. Valsecchi is a senior researcher at the Istituto di Astrofisica e Planetologia Spaziali, where he has been working since 1977; he got a Laurea in Physics at the University of Rome in 1975, and specializes in the dynamics of small Solar System bodies.

He has been President of IAU Commission 20 from 2003 to 2006, and is currently Vice President of IAU Division III; asteroid (3725) Valsecchi is named after him.

Vice-President: Nader Haghighipour (USA)

Education

University of Missouri-Columbia, Physics (Planetary Dynamics), PhD (1999)
University of Missouri-Columbia, Physics (Cosmology), MSc (1997)
University of Tehran, Tehran, Iran, Physics, BSc (1989)

Scientific Employment

2010 – Present: Associate Astronomer (*Institute for Astronomy, University of Hawaii*)
2004 – 2010: Assistant Astronomer (*Institute for Astronomy, University of Hawaii*)
2001 –2004: NASA Origin/NASA Astrobiology Fellow (*Department of Terrestrial Magnetism, Carnegie Institution of Washington*)
2000 – 2001: Postdoctoral Fellow (*Department of Physics and Astronomy, Dearborn Observatory, Northwestern University*)
1999 – 2000: Visiting Assistant Professor (*Department of Physics and Astronomy University of California-Irvine*)

Research Projects and Interest

Extrasolar Planets (*Theory: Formation and Dynamics*)
Extrasolar Planets (*Observation of Habitable Planets: RV, Transit, TTV/ETV*)
Solar System Dynamics and Formation (*Theory*)

Committees

2012-2018: IAU Commission 51 (Bioastronomy), member of the organizing committee
2012-2015: IAU Commission 7 (Celestial Mechanics and Dynamical Astronomy) member of the organizing committee
2010-2012 AAS Division on Dynamical Astronomy, member of the committee

Division G: Stars and stellar physics

President: Ignasi Ribas (Spain)

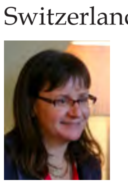
Dr. Ribas is Scientific Researcher at the Spanish Consejo Superior de Investigaciones Científicas (CSIC) and the Catalan Institut d'Estudis Espacials de Catalunya (IEEC). His main areas of expertise are stellar physics and the connection between stars and planets, in which he has authored nearly 100 refereed papers. Some of his main scientific accomplishments are: (i) Calibration of the mass-dependence of convective overshooting in high-mass stars; (ii) discovery of the important effects of magnetic activity on stellar radii and temperatures; (iii) determination of accurate distances to the Large Magellanic Cloud and M31 using eclipsing binaries; and (iv) characterization of the time-evolution of high-energy emissions of low-mass stars with direct application to planetary atmospheres. He is actively working in the emerging area exoplanets and, in particular, on the role of the host star's photometric and spectroscopic activity-induced variability on the detection and measurement of planets and their atmospheres. Dr. Ribas also carries out work in the detection of various molecules in hot Jupiter planets and the dynamical evolution of planetary systems to better understand their formation mechanisms.

Dr. Ribas is interested in astronomical instrumentation. He is co-PI of the ESA EChO mission proposal, member of the ESA EChO Science Study Team, Project Scientist of the CARMENES instrument – a visible and near-IR spectrograph for precise radial velocities of M stars –, co-I of the CoRoT space mission, and Director of the Montsec Astronomical Observatory. He has been a member of ESA's Astronomy Working Group (2009-2011), member of various time allocation committees (ESO OPC 2008, IAC 2009-2010) and is acting as an advisor for in the area of Space Research for the Spanish Ministry of Economy and Competitiveness.

Dr. Ribas is currently serving as President of Commission 42, and as Vice President of Division V.

Vice-President: Corinne Charbonnel (France)

C. Charbonnel is Directeur de Recherches CNRS (DR2) at the Institut de Recherche en Astrophysique et Planétologie, Université de Toulouse, France, and on leave as Associate Professor at Geneva Observatory, University of Geneva, Switzerland. She got a PhD in Astrophysics and Space Technology (1992) from Université Paul Sabatier, Toulouse, France.



Her research work concerns mainly stellar evolution and nucleosynthesis as well as the chemical and dynamical evolution of globular and massive star clusters. I focus in particular on the impact of transport processes of angular momentum and of chemicals in stellar interiors on the stellar structure and on the chemical yields. She studies the consequences of these aspects on surface chemical abundances, on stellar populations, on Big Bang nucleosynthesis, and on the chemical evolution of stellar clusters and galaxies. All these theoretical developments are strongly connected with observational projects on European and American facilities.

C. Charbonnel is currently serving as President of Commission 35 and on the OC of Division IV. She is also President of the National Committee for Astronomy in France and of the French astronomical society (Société Française d'Astronomie et d'Astrophysique: SF2A).

Division H: Insterstellar matter and local universe

President: Ewine van Dishoek (Netherlands)

Ewine F. van Dishoeck is professor of astronomy at Leiden University, the Netherlands. From 1984-1990, she held positions at Harvard, Princeton and Caltech before moving back to Leiden in 1990. As of 2008, she is also an external scientific member of the Max Planck Institut f"ur Extraterrestrische Physik in Garching, Germany. Her research group focusses on the astrochemical evolution from interstellar clouds to planet-forming disks and the importance of molecules as diagnostics of the star- and planet formation process, using ground- and space-based observatories. Studies of basic molecular processes form an integral part of her science.

She holds many national and international science policy functions, including scientific director of the Netherlands Research School for Astronomy (NOVA), (former) president of the IAU working group on Astrochemistry and vice-president of IAU Commission 14 on Atomic and Molecular data, co-editor of ARA&A, (former) member of the ALMA Board, co-PI of the JWST-MIRI instrument and co-I of the Herschel-HIFI instrument. She is a Member of the Netherlands Royal Academy of Sciences, Foreign Associate of the US National Academy of Sciences, and Foreign Member of the American Academy of Arts and Sciences. She enjoys giving lectures on her field to expert and non-expert audiences, including the general public.

Vice-President: Joss Bland-Hawthorn (Australia)

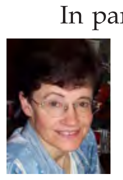
Current appointment: Professor of Physics, Australian Research Council Federation Fellow, and Associate Director of the Institute of Photonics and Optical Science (Sydney Institute for Astronomy, University of Sydney, NSW 2006, Australia.

Previous employment: Professor, School of Physics, University of Sydney (2007-), Associate Director, Institute of Photonics & Optical Science (2009-), Head of Instrument Science, Anglo-Australian Observatory (2001-2007), Senior Astronomer, Anglo-Australian Observatory (1993-2001), Professor (tenured), Rice University, USA (1988-1993), Postdoctoral Fellow, IfA, Hawaii (1985-1988). Key disciplines: Astrophysics, Astronomy, Astrophotonics, Space photonics, Instrumentation.

Division J: Galaxies and cosmology

President: Françoise Combes (France)

Françoise Combes is an astronomer at the Observatoire de Paris and member of the French Academy of Sciences. She has published many influential papers in the fields of galaxy dynamics and millimetre astronomy.



In particular, she has elaborated dynamical theories of the secular evolution of bars, formation of resonant rings, gas inflow to the nucleus to grow supermassive black holes. Through N-body and hydro simulations, she studied galaxy interactions and their consequences: formation of spheroids, shells, polar rings, etc.. She explored galaxy evolution and star formation at high redshift, discovering molecules in emission and absorption, and in all environments, including galaxy clusters and cooling flows.

Current Vice-President of Division VIII, she has also served as President of Commission 28.

Vice-President: Thanu Padmanabhan (India)

Professor Padmanabhan, Distinguished professor and Dean at IUCAA, India is well-known for his research contributions to statistical mechanics of gravitating systems, nonlinear gravitational clustering in the expanding universe and the physics of dark energy. In recent years, he has provided a clear interpretation of gravity as an emergent phenomenon and showed that this paradigm extends to a wide class of gravitational theories including, but not limited to, Einstein's theory. Such an interpretation explains why gravity is immune to the bulk cosmological constant, thereby providing a framework for linking the observed value of the cosmological constant to quantum gravitational effects. His extensive scholarship is reflected in the nine advanced level textbooks he has authored, acclaimed as magnificent achievements and used worldwide as standard references.

He has received numerous awards including the TWAS Prize in Physics (2011), Infosys Prize in Physical Sciences (2009) and the Padma Shri (2007), the fourth highest civilian honor awarded by the President of India.

He was a Sackler Distinguished Astronomer of the Institute of Astronomy, Cambridge, and is currently the Chairman of Astrophysics commission of IUPAP. In IAU, he served as the Vice-President (2006-2009) and President (2009-2012) of the Commission 47.

Interview with General Secretary Thierry Montmerle

Q: As the incoming General Secretary, what is your goal for the next three years?

A: I have two main goals: one is helping Division Presidents and Vice-Presidents to implement the new Division structure, and keep a close contact between the Executive Committee, and the other is organizing the next General Assembly in Honolulu.

For the first goal, the process will start with two steps: reassigning the existing Commissions to the new Divisions on the one hand, and organizing the affiliation of all the IAU members to one or more of these Divisions on the other hand. Then, elections of the corresponding "Division Steering Committees" will take place, and the strategy of restructuring for each new Division will be defined by them, after a wide consultation. Once this is achieved, the reviewing process for Commissions will begin. All this will be in the hands of the new Divisions, and my main responsibility will be just to coordinate the efforts, with particular emphasis on the two newly created Divisions on Facilities etc., and on Education etc.

For the second goal, i.e., the next GA - and this is also a consequence of the Division restructuring - I will pay a particular attention to the business meetings of the new Divisions and the new (or renewed, or merged, whatever) Commisions. Of course, the scientific program is very important and really is the driving force behind the organization of GAs, but the mutual interactions of IAU members within the IAU structures (Divisions, Commissions and Working Groups) is also very important. This is especially true since the whole new structure of the IAU, which I expect to be very different from now, should be in place and running for the first time in Honolulu.

Q: Can you describe the purpose of the changes in Division structure?

A: The main purpose is simply Darwinian, if I may say. That is, to propose a new organization that allows for change and adaptation to a rapidly changing world, both in astronomy and in society. It is a matter of fact that, for many reasons, the IAU Divisions and Commissions have not shown a single sign of evolution in nearly 20 years after their introduction. Yet everybody will agree that astronomy has undergone tremendous changes during that period, and the outstanding success of the International Year of Astronomy has demonstrated the formidable impact of astronomy on society in all parts of the world.

A case in point is that a scientifically important part of the evolution of astronomy has taken place outside of the IAU, either externally, like emerging fields from particle physics (very high-energy gamma-rays, neutrinos, dark matter, etc.), or internally, which is even more of a concern for the IAU. For instance, a large part of the activity in small bodies of the solar system has left the IAU to become part of new structures independent of the IAU.

The proposed changes in the Division structure, and their associated reforms (like joining Divisions first, and Commissions only when appropriate to one's research), should allow more flexibility in creating new structures (like Working Groups to start with) or in replacing existing ones that may have become irrelevant. An important feature is that I expect the Division Presidents to work together as a "horizontal" team, letting ideas flow between them, in addition to the usual "vertical" work towards the Commissions. I would say that this idea of "networking" the Commissions, either via Division Presidents, or being "inter-Division", is a good tool to evolve.

Of course, to succeed such a scheme has to be made to work by a wide range of active people, but I'm confident that, after a short period of adaptation, the IAU members will see all the benefits of the restructuring, both of Divisions and of Commissions. ■

Interviewed by Jingxiu Wang, editor of IH .

Thai National Observatory

National Astronomical Research Institute of Thailand (NARIT)

The year 2012 embraces the completion of the Thai National Observatory (TNO), a world-class astronomical observatory, in which the automated reflecting Thai National Telescope (TNT), with a diameter of 2.4 metres, has been installed. The TNT has been equipped with various detectors that are capable of collecting data on celestial objects, stars, planets and other star systems, such as binary stars, star clusters, or even galaxies in different wavelengths and spectra.

Thai National Telescope (TNT) at the Thai National Observatory (TNO).

The TNO is situated at the Doi Inthanon National Park (km 44.4), Chiang Mai Province, in the northern part of Thailand at an altitude of 2,565 metres above mean sea level. Due to its superb location at latitude 18° 34′ 21″ N, longitude 98° 29′ 7″ E, it is away from air and light pollution.

The average temperature of Doi Inthanon during wintertime is 10° C and relative humidity is less than 30% (compared to the wet season that produces nearly 100% relative humidity), making the site ideal for observations during the wintertime, on average more than 150 nights a year.

The 2.4-metre Ritchey-Chretien TNT is a compact alt-azimuth telescope, optimized for astronomical applications. The f/1.5 primary mirror provides a compact optical system. It also provides dual selectable Nasmyth foci. It is designed to create superb image quality. Furthermore, TNT is endowed with various state-of the-art detectors such as:

High Resolution CCD Camera: The high resolution 4k x 4k CCD camera is a liquid N2 cooled camera made by ARC e2v. The CCD has 4,096 x 4,096 pixels at 13.5 microns. Both shutter and filter wheel are tailor-made by ACE.

Medium Resolution Echelle Spectrograph: This has a white pupil design which spans the range of 390-800 nm and has resolution of 16,000-20,000.

Fast Readout CCD Camera (ULTRASPEC): The 1k x 1k EMCCD can be used for observations of fast stellar variability such as flares, flickering and lunar occultation.

TNO has also been designed as a very environmentally-friendly observatory, and no trees were cut down before, during, or after the construction phases. Therefore, generally speaking, the flora and fauna in TNO's vicinity have been well protected.

Upon the completion of the TNO, NARIT will thrive on delivering excellence in astronomy to the public domain. With its extensive collaborative network, both domestically and internationally, NARIT will focus on simultaneous research work under full exploitation of the TNT and its instrumentation. This will position NARIT at the forefront in the regional and international arena as an organization that emphasizes technology development and knowledge transfer for sustainable society. ■

Interview with Professor Carlos Frenk,

Director of the Institute of Computational Cosmology (ICC), Durham, UK

Q: What subjects do you think are as exciting as the dark matter studies from the 1980s?

A: The standard model is very successful in interpreting many observations. However it is based on three major assumptions, which have not yet been proven. The first assumption is inflation and the second assumption is dark energy. The third is to answer what the nature of dark matter is.

Q: What are the topics you will be most interested in during the coming five years?

A: The major challenge for me is to find out what the identity of dark matter is. To test dark matter I need to understand the connection between baryons and dark matter. To interpret dark matter through observations of galaxies I need to understand galaxy formation.

Q: What do you think an astronomer should be like in the future?

A: Astronomy is a beautiful subject. It requires a mixture of three parts: observation, theory and technology. To start a project, there are three phases: running a simulation, obtaining the data, and carrying out some fancy statistics. You can imagine all three becoming one in the future.

Q: You built up the ICC from nothing. What made that happen?

A: I would say that I was lucky to have three very important elements: resources, great subjects and intelligent people. When I arrived in Durham, Europe went through a period of great expansion of science, including astronomy. The governments realized that supporting science is very important. After the dark ages, when the conservatives were very powerful, there was a huge recovery. This period lasted about 10-15 years, and resources were plenty. That period has now ended for most places in Europe and the USA. Today it is impossible to build ICC from scratch. The only place where one could build an institute like the ICC now would be in China. Unlike the governments in the west, suffering from the financial crisis, and the overall decline both in economy and culture, in China, as we saw in the opening ceremony, the situation is exactly the opposite. The government states very clearly science is the priority in China. The vice-president committed a huge investment in Chinese science. Another important factor is that I happened to be working on a great subject that was just at its beginning in the 1980s. Cosmology as we know it today, including the key ideas of inflation and dark matter, did not really exist until the 1980s. It was a controversial subject in the following ten years. Until the 1990s, it was heavily criticized by observers who tried to prove the cold dark matter scenario was wrong. We had a great subject to work on and the resources to do it. Finally, we needed good people: finding extremely intelligent colleagues, convincing them to join the ICC and providing them with support. ■

Interviewed by Dr. Qi Guo (NAOC).

Armenian Astronomy

The history of astronomy in Armenia goes back to the distant past. Since ancient times, Armenians have accumulated astronomical knowledge and left this heritage in the form of rock art, ancient observatories, calendars and chronology, historical records of astronomical events, medieval sky maps, astronomical terms, etc.

Modern Armenia has also been engaged in astronomy. Although it is a small country in tems of territory (143rd in the world) and population (134th), it is still active in astronomy at all levels, including professional astronomy, education and public outreach. Armenia is situated in a region (the Middle East), where efforts are needed to develop and promote astronomical education and knowledge. Modern Armenian astronomy has gained international recognition as explained below:

Byurakan Astrophysical Observatory 2.6-m telescope

- The Byurakan Astrophysical Observatory (BAO) is among the most important astronomical centres in the Middle East.
- Discoveries and achievements by an outstanding scientist, former IAU and ICSU President Viktor Ambartsumian and his colleagues are well known,
- The largest telescope in the region, with diameter 2.6-m and one of the largest Schmidt telescopes in the world, with a diameter of 1-m.
- Active international collaboration with a number of countries such as France, Germany, Italy, Russia, and the USA.
- An international PhD program that has awarded scientific degrees to astronomers from several countries.
- Famous Byurakan surveys and one of the largest astronomical spectroscopic databases, which is included in the UNESCO "Memory of the World" international registry.
- Armenian Virtual Observatory (ArVO), the only such project in the Middle East and which has 19 members in the IVOA project.
- A very active Armenian Astronomical Society affiliated with the European Astronomical Society, having 95 members from 21 countries, Annual Meetings, Electronic Newsletters, and Annual Prizes. One of the major international prizes in astronomy, the Viktor Ambartsumian International Prize
- Galileo Teachers Training Program and successful participation of Armenian pupils in International Astronomical Olympiads

We have proposed to host an IAU Regional Office for Astronomy Development (ROAD) and we will encourage the creation of national nodes in neighboring countries to coordinate. ■

Areg M. Mickaelian
Leading astronomer, Byurakan Astrophysical Observatory (BAO), Co-President, Armenian Astronomical Society (ArAS)

Explanatory Supplement (3rd Edition) Available

For over 50 years, an "Explanatory Supplement" describing the technical underpinnings of the publications of the US Naval Observatory (USNO) and Her Majesty's Nautical Almanac Office (HMNAO) has been in print. This has become a standard reference book on positional astronomy. The third edition, titled "Explanatory Supplement to the Astronomical Almanac", is now available from University Science Books.

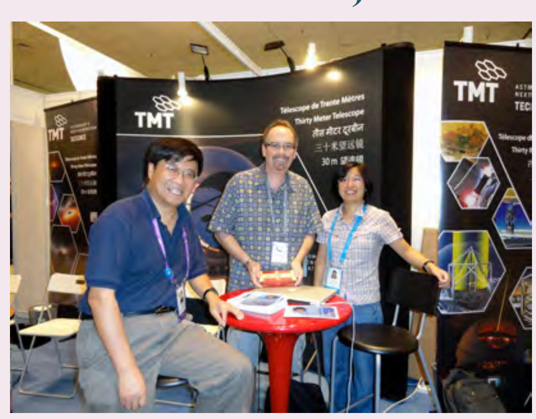
The primary goal of the book is to offer explanatory material, supplemental information, and detailed descriptions of the computational models, algorithms, and data used to produce the annual Astronomical Almanac. To fulfil this goal, it covers many aspects of modern positional astronomy.

Major changes have taken place since the second edition was published. The ICRS has replaced the FK5 system. The Hipparcos satellite dramatically altered observational astrometry. New precession and nutation theories have been adopted. A new positional paradigm, no longer tied to the ecliptic and equinox, has been accepted. These culminated in a series of IAU resolutions passed between 1997 and 2006. Because of these resolutions, we decided the time was right for another edition.

We hope the 2012 edition becomes a standard reference book for many years, but it is inevitable that it will eventually become outdated. This may begin at the GA closing ceremony, when there is a vote on the re-definition of the astronomical unit of length (au). Although hardly making this edition obsolete, it shows that another edition will be needed at some point; with some luck, not for decades. ■

Sean Urban
Chief of the Nautical Almanac Office, US Naval Observatory and member of Commissions 4 and 8.

Meeting in Beijing



The light from a cluster traveled for seven billion years to reach us. It took us two years to understand it, in Beijing and California. Ten years later, we finally meet here, because of this GA! (The full story can be found online.) ■

National Time Service Center of China

The National Time Service Center (NTSC) is a national-level base-type research institute which generates, keeps and transmits the national standard time. NTSC was formerly known as Shaanxi Astronomical Observatory and has the motto "Keep close concern with time cycling, formulate calendar of time computing". It is a vital foundational project and public welfare facility to construct, maintain and operate the time system, which has been listed as one of the national key science projects supported by special funds of Ministry of Finance. Since the 1970s, NTSC has provided high-precision time service for national economic development, defense construction and

security. In particular, it has made important contributions to space technology such as national satellites, rocket launching and defense modernization.

NTSC focuses on research and development of new methods and high precision of time frequency demanded by national defense and the rapid development of the national economy. It has been involved in fundamental works, which includes researches on time scale and new quantum frequency standard, timekeeping and navigation and positioning theory and method, measurements and controlling of time frequency, time transfer and synchronization, expansion of new time service method, distant transfer and comparison of high-precision time internationally, research and development of user time system, as well as precise orbit determination. As a result, NTSC has stimulated the advance and progress of China in this field, making it a time frequency research, service and development center with unique advantages and international influences. ■

Women in Astronomy:
An Interview with Prof. Xiangqun Cui

The organisers of the Women in Astronomy lunch at the GA, which was held on Monday 27 August, were honoured to welcome Prof. Xiangqun Cui, President of the Chinese Astronomical Society, as the keynote speaker.

After the event, Xiangqun Cui spoke to Inquiries of Heaven about the woman who inspired her from a young age and the difficulties of raising children when you have a demanding job in astronomy.

"I was fortunate that my mother had received a university education, so she wanted her children – both her sons and daughters – to be educated," says Cui. "Before she retired, my mother taught Chinese Literature at a high school in China," she adds.

Cui is also thankful that her parents bought a series of popular science books for children, called "100,000 Whys", as this is what first ignited her passion for astronomy. "With the astronomy issue, I could identify some of the stars in the night sky from beautiful Chinese stories, such as Vega and Altair. I looked up at the beautiful night sky, and fell in love with astronomy," she says.

Cui was raised in Wanzhou, in the city of Chongqing, where attitudes towards women receiving an education were more positive than in rural areas. "There are still feudal influences in China, especially in the countryside. I think the situation is much better now, but there are still a lot of families in the countryside who prefer to have a son," she says. "Previously, girls in the countryside could only get an education for maybe three or four years, and then they would have to help the mother to look after the brothers. But in past 10 years, the government has introduced a policy, which ensures that all children go to school for nine years."

Cui is aware that the problem goes beyond childhood education, and believes that sometimes strength and leadership in women is viewed in a negative way. She is also frustrated that many female undergraduates at universities that she has talked to still think it is more important to find a good husband than to have a career.

Meanwhile, for those who do pursue a career in astronomy, Cui is eager to instil the importance of achieving a good work-life balance, as she now regrets not spending enough time with her son when he was young. "When he was an infant, I was working for ESO in Germany and I could spend enough time with him during the evenings and weekends. But when he was 10 years old, I moved back to China to lead LAMOST, which was a much more time-demanding role," she says.

"My son wanted me to spend more time with him, to read bedtime stories, but I was always busy," says Cui. She says that her devotion to her work also dissuaded her son from pursuing a career in science. "The long hours that I worked made him afraid to get into this field," she says.

Sharing life lessons is one of the reasons why Cui takes the time out of her busy schedule to attend events like the Women in Astronomy lunch. "Events like these create a forum for women in astronomy from different countries and cultures to get together and exchange ideas," she says. ■

Sarah Reed *IAU Public Outreach Coordinator / NAOJ*

Accelerated Supercomputing with GPUs at NAOC & in China

Since 2009 the National Astronomical Observatories of China (NAOC) has taken part in an unusual instrument network - ten powerful supercomputers using graphical processing units (GPU) as accelerators for numerical computations have been installed in different institutes across a range of disciplines - NAOC is one of the two astronomical sites. China has been leading internationally in the field of GPU accelerated supercomputing - the Tianhe computer in Tianjin has been, for some time, the fastest computer in the world. But the competition is still ongoing. This year the US will add thousands of GPUs to their fastest supercomputer in Oak Ridge. The GPU cluster project here at NAOC is called the Silk Road Project (http://silk0.bao.ac.cn/Joomla) and the supercomputer is used by students and staff from NAOC and other Chinese and international collaborations. We are also running an international computational science center (ICCS; http://iccs.lbl.gov) together with Berkeley and Univ. of Heidelberg, Germany. Some important results obtained with the NAOC supercomputer have been for example to show that binary black holes after galaxy mergers can coalesce fast and to demonstrate that recoiling black holes after a binary black hole coalescence will generate X-ray flares from stellar tidal disruptions. The project leader of the Silk Road project, Prof. Rainer Spurzem, is now in his fourth year as a visiting professor of Chinese Academy of Sciences at NAOC.

Rainer Spurzem
Visiting Professor, National Astronomical Observatories of China, Chinese Academy of Sciences.

Space Center, Planetarium & Astro – Tourism in Tatarstan, Russia

The Kazan Federal University is one of the oldest and largest universities of higher education in the Volga regions of Russia. It was established on November 5, 1804. The Engelhardt Astronomical Observatory (EAO) was founded on September 21, 1901. Today, on the basis of EAO, an astronomical observatory of Kazan Federal University (KFU, Russia) will be created as part of the regional scientific, educational Center Space Astrometry and Observing Technologies (CSAOT) and public Astronomical Park (AstroPark) as an important part in the frame of the current strategic program (2012-2020) on transformations of the KFU to a world-leading university.

The Center has social missions: education, science, astronomy, and space-related public tourism. When built, it will be the first world's educational-academic complex, which will combine real observations of an existing Astronomical Observatory with the

Engelhardt Astronomical Observatory

operations of a modern planetarium. If all the planned facilities in the project are built, this center will be a unique world-level scientific object. We hope that the official opening of the new CSAOT and AstroPark will be fulfilled within the bounds of the World Student Games in July 2013 in Kazan, Russia. For more information, see http://www.ksu.ru/eng/departments/eao/ ■

Alexander Gusev
Vice-Director on international relations and Associated Professor of the Engelhardt Astronomical Observatory, the Kazan federal university.

Group photo of IH staff.

Thank You All!

The "Inquiries of Heaven" cordially thanks the IAU GA participants for their contributions to the IAU newspaper. Only with their help could a broad range of astronomy be fully covered: reviews about key fields in current astronomy research, introductions to the individual sessions (to stimulate participation in diverse fields), as well as presentations of various institutes and astronomical communities from different countries. We also thank ZHAI Meng, TIAN Bin, LI Kaiyuan and ZHANG Chao for providing photographs of the meeting. Also thanks Jiangpei DOU.

We hope you have enjoyed this IAU meeting with friends and were able to establish new collaborations. We hope "Inquiries of Heaven" provided useful and interesting information for our colleagues. We hope you will enjoy the remainder of your stay in China. See you in the XXIXth IAU General Assembly in Hawai'i, USA, in 2015. ■

XXIXth IAU General Assembly to Take Place in Honolulu, Hawaii, USA

In three years the world's astronomers will gather again for the XXIXth (29th) IAU General Assembly at the Hawaii Convention Center in Honolulu on the island of Oahu. From 3 to 14 August 2015, an estimated 4,000 astronomers from more than 80 countries will meet for two weeks of scientific dialog, discussion, and decision-making in the tropical island paradise of Hawaii. As with all General Assemblies, you will not want to miss this important conference — so plan now to attend. A special invitation video will be shown at the closing ceremony and will also be available on the meeting's website at astronomy2015.org. The site is available now with basic information and will be expanded in the coming months with additional details, including travel advice, tour opportunities, and program specifics.

The American Astronomical Society and the University of Hawaii's Institute for Astronomy are pleased to host the 2015 General Assembly on behalf of the National Academy of Sciences, the U.S. National Committee for the IAU. Hawaii is home to two collections of state-of-the-art astronomical observatories, one on the summit of Mauna Kea on the Big Island and the other atop Haleakala on Maui. Many of the most important telescopes at these sites were not yet built when the IAU last met in the U.S. in 1988 in Baltimore, Maryland. As a focal point of astronomy for many nations, Hawaii is a particularly fitting venue for an IAU General Assembly hosted by the United States.

Planning is already well under way for this important event, but we need your help. It is important to remember that the key to a successful scientific meeting is excellent science. The triennial IAU meetings are vibrant scientific forums because astronomers propose and organize interesting symposia, which form the core of the General Assembly program. Letters of intent to propose symposia for 2015, including the XXIXth General Assembly, is September 1, 2013. So please begin now to think about what interesting science you would like to see discussed in Honolulu.

Tours of the telescope facilities in Hawaii are planned before, during, and after the General Assembly and will not conflict with the scientific

sessions. During the conference, chances to experience Hawaiian culture and cuisine will complement recreational activities like swimming, sailing, snorkeling, and surfing. The next General Assembly will be an interesting and exciting conference, enabling collaboration and networking while enhancing our scientific understanding of the universe through shared discourse.

One sky connects us all, so plan to join your colleagues in three years in Hawaii. Aloha! ■

Kevin B. Marvel *AAS Executive Officer*
Rick Fienberg *AAS Press Officer and Education & Outreach Coordinator*

Day 10: Program Summary

IAUS 289	Virgo cluster & Cosmology
IAUS 293	Formation & Detection
IAUS 294	Turbulence and instability &
IAUS 295	Star formation & Gas transport & Modelling formation and evolution
SpS7	Future surveys & Warning strategies
SpS10	Perspectives of star-planet relations
SpS12	ISM in nearby galaxies
SpS13	Massive and evolved stars & Forecasts
SpS14	Images and social media & Astronomy evolving in different countries and astronomical heritage
SpS15	Expectations on scientific insights & Education and public outreach
SpS17	Education and site protection && Quantifying the impact
SpS18	Hot topics

The Closing Ceremony: Thank You a Thousand Times

At the closing ceremony, the stage was set for power to be handed over from the outgoing IAU President and General Secretary, Robert Williams and Ian Corbett, to their successors, Norio Kaifu and Thierry Montmerle.

In one of his final acts as IAU President, Robert Williams thanked the Local Organising Committee (LOC) in China for creating an "outstanding General Assembly". Williams also reflected on the past three years, including the International Year of Astronomy 2009 and the IAU's adoption of its Strategic Plan.

Ian Corbett picked up on the importance of the Strategic Plan in his speech, giving special thanks to George Miley the "architect" behind it. But the biggest praise went to Viviene Reuter, who is leaving the IAU Secretariat shortly after this GA. "Vivienne was a golden asset for the IAU," said Corbett.

Next, it was on to the current business at hand, with the new IAU President, Norio Kaifu, discussing the restructuring of the IAU's divisions, which was adopted in a meeting held immediately before the closing ceremony. Implementing the new divisional structure will be one of the main tasks for Montmerle, who said: "We want the Division Presidents to be the backbone of the IAU."

As with the opening ceremony, the event came to a close with various traditional Chinese dance and music performances, including the Thousand-Hand Dance. For such stunning choreography, even a bunch of astronomers were able to turn a blind eye to the serious exaggeration in numbers! ■

Sarah Reed
IAU Public Outreach Coordinator / NAOJ

Inquiries of Heaven (天 问) **is the official newspaper of the IAU General Assembly 2012. Online version**: www.astronomy2012.org/ih **Contacting email:** heaven@nao.cas.cn. It is published by Research in Astronomy and Astrophysics in collaboration with China Features of Xinhua News Agency, Amateur Astronomer, and Chinese National Astronomy. **Advisor:** Thierry Montmerle; **Editor and Associate Editors:** Jingxiu Wang, Xiaowei Liu, Shude Mao, Shuang-Nan Zhang, Yongtian Zhu; **Editorialists and Language Editors:** Peter Anders, Thijs Kouwenhoven, James Wicker, Marcel Zemp; **Reporter:** Sarah Reed; **Art and Technical Editors:** Yangyang An, Geng Li, Jian Li; Yijie Zhang; **Managing Coordinator:** Suijian Xue; **Secretary:** Lan Wang; **Editorial Assistant:** Jingyi Huang.

7 Billion Light-Years
and 10 Years Later – Meeting in Beijing

Almost ten years ago, I was a Ph.D. student at the National Astronomical Observatories, Chinese Academy of Sciences in Beijing, supervised by Prof. Suijian Xue. We did research using Chandra data on one of the highest redshift galaxy clusters known at the time, Cl J0152.7-1357 at z = 0.83.

We were interested in understanding the nature and dynamical structure of the cluster. However, without a complimentary optical image, we could not draw any solid conclusions.

I searched in the literature and found that Dr. Gordon Squires and Dr. Piero Rosati were working on a weak gravitational lensing analysis of the same cluster. I boldly contacted Gordon by email and asked whether he would be willing to provide the image of that cluster taken with Keck. I was so thrilled that he kindly offered me the original observations, and the results from their weak lensing analysis.

Although we never met in person, our collaboration resulted in a scientific publication (ApJ, 2004, 127:1263). Prior to this IAU General Assembly, I was told by Suijian that he and Gordon are both working on the TMT project, and they remembered our past collaboration. Earlier this week, we finally met in person at the TMT exhibit at the IAU-GA in Beijing. I was so pleased to present Dr. Squires with a bookmark from Peking University, as a gift to recognize and celebrate our collaboration together.

The light we analyzed from CL J0152 traveled for seven billion years to reach our telescopes. It took us two years to do our analysis and write our paper, working in China and California, respectively. Now, ten years later, we finally meet in Beijing! Thanks to the IAU-GA for bringing us a happy reunion! ■

Zhiying Huo
NAOC

What Say Us YOUNG STARS?

A study of low-mass young T Tauri-type stars and related objects as a class of objects was launched in the middle of last century with the pioneering work of American astronomer A. Joy. It soon became clear that those stars are at a very early evolutionary stage, right after their birth from the gas-dust "cocoon". The observed characteristics and physical properties of those stars are however difficult to interpret and are not well understood. The study of their unusual spectrum and structure of the circumstellar atmosphere is an important key for understanding the planet formation processes and the formation of future planetary systems similar to our Solar System.

The study of T Tauri stars and related objects at Shamakhi Astrophysical Observatory

of the National Academy of Sciences of Azerbaijan was started immediately after the formation of the scientific organization 50 years ago. Nowadays, thanks to the development of observational techniques in modern astrophysics, studies of T Tauri stars have become an all-wavelength science. Long term studies in the world have shown that it is impossible to understand the observed characteristics of those stars without carrying out a comprehensive study of such objects in different ranges of the spectrum. Therefore, at present, in the study of spectral characteristics of those stars we have analyzed the results of photometric, polarimetric, and other observations in wide spectral ranges, including investigations of the spectrum in the UV range. During this time, we showed a lot of new results on the majority of them. I plan to give reports and presentations in the symposium to be held in Beijing, at the General Assembly of the IAU.

It should be noted that in recent years China has made great developments in the field of economics, science, space instrumentation, and in all other areas. It has gained respect and admiration among the world community. So, now under the auspices of the IAU major world scientific community of astronomy which has gathered in the capital of China for their main scientific meeting, the General Assembly, I want sincerely to wish success of the work of XXVIII GA of IAU and the further prosperity of the friendly Chinese people. ■

Ismailov Nariman Zeynalabdi
Professor, Main scientific researcher of Shamakha AO of the NAS of Azerbaijan

Come to China Again!

The 13th Solar-Terrestrial Physics (STP) symposium will be held in the Fall of 2014 in Xi'an, China. It will be organized by the Scientific Committee on Solar-Terrestrial Physics (SCOSTEP – www.yorku.ca/scostep), which is an interdisciplinary body of ICSU, the International Council for Science. STP symposia are conducted every four years. The local organization will be taken care of by several institutions belonging to the Chinese Academy of Sciences. IAU and COSPAR have Bureau members in SCOSTEP, in addition to those from IUPAP, IAGA/IUGG, IAMAS, SCAR, and URSI.

Present your work and listen to others discuss how our Sun affects the Earth on timescales ranging from minutes to millennia and longer!

Once again, welcome to the City of Terracotta Warriors! ■

Nat Gopalswamy (SCOSTEP President) – NASA/GSFC
Chi Wang (LOC Chair) – State Key Laboratory of Space Weather, Beijing, China
Yihua Yan - National Astronomical Observatory of China, Beijing

Inspiring the Millions
with the Story of Astronomy

Astronomy thrives on public interest; the more the better. Citizens of tomorrow aged between ten and fourteen are now developing their views of the world, soaking up ideas, visions and knowledge, but today's media is visual: the internet, film and TV.

Chris Clayton's "Amazing Galactic Adventures" takes the story of astronomy into the visual world of comic stories designed for 12 year olds. It is the story of the trials and struggles to develop modern Astronomy from Galileo to the demotion of Pluto all in comic book format.

Twelve-year old Chris Clayton and his friend Rita meet a modern genie and start to explore our Universe of billions of Galaxies each with billions of planets. They see Tycho Brahe and the space station, the Solar System and our local Universe complete with black holes and neutron stars all in a human context. The book has been published in Chinese and is available from Amazon.com.cn. The objective of the book is to inspire young people with Space and Astronomy and to encourage them to be enthusiastic supporters of the exploration of space and the funding of telescopes and other instruments to expand our knowledge of the Universe.

Chris Clayton's "Amazing Galactic Adventures", by Baruch, Livingston and Morris. Published by China Aviation Publishing and Media Co. Ltd., Beijing, 39RMB. Available on Amazon.com.cn ■

John Baruch

John Baruch is the director of robotic telescopes at the University of Bradford. He led the team which built the first robotic telescope as a prototype in 1993. The current systems are autonomous, which is very different from normal remote telescopes. Being autonomous means that they can handle many users, and at present they have over 100,000 users. The telescope supports a group of web sites, one for schools which is in English and Chinese and one for children as individual users on space missions.

Decoration of Meteors and Stars

I took this photograph while walking back to my hotel this evening. All along Anli Road the trees were decorated with stars, moons and meteors. A very thoughtful gesture. Those meteors, especially, were a big hit with me. Nice, too, was that the lights were turned off at 10 o'clock so that watching the real thing in the sky would not be hampered by light pollution! I thank the L.O.C. of the IAU 28th General Assembly and the city of Beijing for a wonderful stay. ■

Peter Jenniskens

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Interview with the Gruber Prize winner Prof. Charles Bennett

Q: Chuck, Congratulations on winning the Gruber prize for the second time.
A: Thank you, it's very exciting.

Q: This has been your first time you have been in China? What's your impression so far?
A: It's a very interesting and eye-opening to me, of course, I have heard many things about China before coming here, but it's never the same than being at a place. I spent three days looking around, not all of China, but in Beijing, It's very interesting to see how people live, what they do and how they dress. I see this when I travel all over the world, that people are basically the same everywhere. People have the same concerns, people care about their family, they care about having enough money to do the things they want to do. People are not so different around the world in this way, that's a good thing in general to understand we are all brothers and sisters.

Q: How did you get interested in science?
A: Well, my father is actually a scientist, so probably that has something to do with interests in it. When I was a young boy, I was interested in electronics; I built circuits for myself and eventually became a ham radio operator, and I built my own electronics equipment and antennas, talked to people over the world, which was very unusual in the days before the cell phones. So I started that when I was quite a young boy. And then I think it was early in the high school, and I had a birthday, and my grandmother gave me a gift of a small telescope, so I brought

it out to the back yard, and looked up the sky. And so I had a sort of second hobby with astronomy. And then I was reading a book by Issac Asimov called the Universe, and in the book I read that these guys had discovered cosmic microwave background radiation: radio waves coming from space. And my hobby was radio waves and astronomy, and so at that point, I decided that I wanted to have a career studying radio waves from space, probably in ninth grade.

Q: How old were you in ninth grade?
A: I was probably around 14 years old, maybe 13, I don't remember exactly.

Q: What are the scientific highlights of WMAP?
A: I think there are a lot of things that come out of WMAP. In the biggest picture, we now have, really for the first time, a theory of the universe, where all different major measurements agree with each other, which was never the case before. And it's a very specific model. We can talk about the pieces of it, but we have a specific, standard model of cosmology. It’s now very difficult to come up with ideas that don’t violate some measurements. So this model has different components to the universe, including baryons, cold dark matter, neutrinos, photons and dark energy (which acts like cosmological constant), (dark matter and dark energy are) odd ingredients. And then we have very tight limits on the shape of space that, within the measurement error, is Euclidean type space, and we have a determination of how the universe has expanded. We also determined the expansion history of the universe. This gives us the time for redshift of key events throughout the history of the universe. This is all nailed down with a fair amount of precision now. One of the most amazing results is new limitations of what could have happened at the very first moments of the universe, within the first trillionth of a trillionth of a second. It's really amazing that we can say some specific theory of inflation is not what happened, so the idea that humans have the capability of measuring these things is really amazing, and I think even more amazing is what we are doing now, sorting between different precise theories of what happened in the first trillionth of a trillionth of a second of the universe. It's amazing this is possible. We have a lot of WMAP measurements that relate to inflation theory. People usually think of the Big Bang Theory as the beginning of the Universe, but it's really not. There's nothing in the theory that talks about the beginning of the Universe. It's all about the evolution, expansion and cooling of the Universe. Inflation is much closer to the idea of how the universe began, but inflation is an idea. It's not a specific model and there are lots of versions of it. But the idea is that we are now ruling out extra versions of inflation, some are out, some look good. Then we have a series of measurements that are starting to pin down inflation, and I think it is really fascinating.

Q: I guess CMB measurements are one of the most accurate in astronomy.
A: Yes, I think there is no question that the basic cosmological model is more constrained by the microwave background than by anything else, but of course it is more constrained by combining all of our measurements. Checking that all of these are consistent with each other is very important, and that used together, they can really put tight constraints on what's happened in the Universe. It's really quite different than it used to be. When I was a graduate student, people would come up with different ideas in cosmology all the time – maybe this happened, maybe that happened, and there's a fair amount of leeway in making things up. Now people have ideas and almost immediately someone will so no, that can't be because of this measurement. It's very difficult now, and that's really a sea change. It is very difficult to come up with new things that are consistent with these very tight measurements.

Q: These are really great achievements. What are you working on now?
A: WMAP answered many questions that people had for a long time, but it has not answered everything. There are still many questions that need to be answered, and I'm glad lots of people are working on the remaining questions. The one I find most fundamental and fascinating - I tend to be drawn to things that are fundamental and fascinating - is back to inflation again. We have from WMAP and some other experiments upper limits on the gravitational wave emitted during the time of inflation. We call them B-Modes. The gravitational waves affect the CMB polarization, and while we are not very good at measuring gravitational waves directly, measuring their effect on the cosmic background is doable, and we have upper limits on that. We really want to detect that because the amplitude of that polarization pattern that tells us the energy level of inflation, and that’s a very fundamental condition, and of course that will be another strong peice of evidence of for inflation in general, to detect that. So I am leading a new experiment called CLASS (The COSMOLOGY Large Angular Scale Surveyor). This is an instrument designed to detect B-modes from inflation. We've designed and we are in the building phase now. As we complete parts of the instrument, we will deploy it to the Atacama desert in Chile and begin these observations. Other groups are also pursuing this. I am glad they are because these measurements are of course difficult and having different people pursuing in different ways with different technology and different frequencies is very valuable. I strongly suspect that in the end these will all be used together to complement and act as a consistency check. I've seen this history before, and I think it is a very good thing that there are multiple approaches.

Q: This will focus on the polarization?
A: This will focus on the polarization of the cosmic background.

Q: So there will be future space experiments on this?
A: This is a ground-based experiment. There may be a future space experiment. If we start getting hints of detections on the ground, that will strengthen the call for doing this from space to measure the power spectrum more precisely from space, but I suspect that we won't be able to do a space mission like that unless we get some hint. The problem is we want to do the measurement to know what amplitude inflation happens at, but since we don't know it's hard to know what to design, and you just design the best you can. Space mission costs a lot and we would like to know there is going to a signal there to measure. We have to do something from the ground first. Working from the ground is a lot better way to develop the technology and the approach to use later for a space mission.

Q: You already hinted about how you chose your problems, like fundamental problems?
A: It's a defect that I like to work on things that very fundamental. They are the most interesting things to me – things that are very basic and fundamental in nature.

Q: You have worked at NASA for a long time, working on COBE and WMAP. What are the lessons you have learned through these missions because China is getting interested in many big projects?
A: Space missions are very difficult to do, and it takes a lot of people to do them. Everybody has to be experts and working on getting their part right. No person is perfect. Everyone makes mistakes, and there has to be a process that finds the mistakes. This is something we spent a lot of time on. It is unreasonable to expect people to not make mistakes, that's crazy, so the question is how do you know when a mistake has been made. You have to put in various levels of reviewing, double checking, or testing the hardware obviously. I think when people get into trouble in space missions is when they say they don’t have time and money to check things. I spent a lot of time with my engineers; we would sit down and say what could go wrong, and make a list. You need to imagine that things won’t work. We would ask ourselves, what if this doesn't work, or that doesn't work, so we won't have that problem. A big lesson for me is that you need to be very systematic about these things. You need to imagine that things won't work. If you imagine that everything will work, you won't have a working mission, because that is not reasonable – because of Murphy's Law. This is my rule: if something can go wrong, it will go wrong, so you have to work to stop it.

Q. That's very interesting. You have had an extremely successful career. Do you have any career advice for young astronomers, particularly for those interested in instrumentation?
A: Instrumentation is a difficult career, because a lot of times in scientific society now, people want to see lots of publications, but it's very difficult to publish while you are building something. There tends to be a period where you are working hard on your instrumentation and not getting papers out, and then when the instrument is working, all of a sudden you get a lot of papers out. It's kind of a cycle. It's more of a plea to other people to be patient with this cycle, and not to expect people to publish all the time. It isn't actually the best thing. The best thing for people is to do the cycle. I'd like to see more people involved in building instruments. My experience is that not that many people want to do it because of the difficulty, but my philosophy is that science

is inherently experimental. You can have many brilliant ideas, but the only way we know in the end which one is right is by doing the experiments. It's absolutely essential to do experiments. The job of an experimentalist is to design the experiments and figure out how to design the experiments to give believable results. I encourage people to do it, I encourage others to be patient with them. You also have to love what you are doing. I have always loved what I do. I have also been very lucky in my career, I got the opportunities; many people have been very kind to me giving me the opportunities to do things. I am very grateful to that, it does not have to be that way. I have been lucky that people gave me opportunities to build things.

Q: Scientifically China has ambitions in many areas. From your perspective, how do you see China contributing on the world scene?
A: My sense is China has a very long history, something I learned here – when you come from the US, the oldest thing in the country is just over two hundred years old, you realize just old Chinese history is. You look at it now, various historic places I went to, china has been in some times very closed or moved very slowly over time, but I have the impression now that china is moving very quickly. Things are changing very fast in China. From the days when I was a kid, you see pictures where the streets [in China] are filled with bicycles, now they are filled with cars. It's a sign of how rapidly things are changing here. You have people dress the same as in the US, things are more open, and information goes back and forth. I just sense that china is moving very quickly, in many different ways, and getting more involved in the world scientific community. I am hopeful that there is more scientific exchange: Chinese scientists going abroad and other scientists coming to china – I think this is a very healthy thing, good for everybody and I think this is good for science to have these kinds of exchanges.

Q: I guess I want to follow up the question. How do you maintain your leading position in certain area for decades in your case?
A: I don't know. I got interested in something. It's not something I planned. For example, when I was finishing my PhD at MIT, I was wondering about what to do. I really did not know what I was going to do. And I heard a talk given about the COBE mission from one of the COBE mission members. And I listened to this talk, and I thought this is the most exciting thing that I have ever heard. And I just went up to the professor, This is Ray Wise, at MIT (he was the chairman of the science working group of COBE). And I asked him: I will be graduating soon, is there any way that I can work on the COBE mission? And he said: it's funny that you should ask because we are looking for someone to work on the instrumentation of the experiment to discover the anisotropy. And I said I would love to do it. And he invited me down to the science team meeting, and talked, I ended up doing that job, and I ended up working on COBE for 10 years. Of course, during this time, I am learning the space business, and I'm working on the hardware, calibrating it, and getting it built, testing it. I was attracted to the opportunity that arose, and it arose partially because people helped, Ray Wise helped it to happen; as COBE was winding down and we had our major results out, it was obvious to everybody in the CMB field that we needed a followup mission, not just me. It was obvious to everybody. We needed a followup mission, and Dave Wilkinson talked about a followup mission, and things just happened. It was the obvious thing to do and we knew it. Dave and I got along very well. We had a lot of respect for each other. We were both experimental types of scientists. We kind of spoke the same language and had the same attitude. It happened that I went right from working on COBE to working on WMAP, and that was another 10 years or more of my career. It's not that all of this was planned ahead of time - things just happened, some of it is your choice: what things things are interesting to work on, and then making sure people know what you want to do. It's up to the other people are willing to help you out and give you an opportunity. I have been very lucky.

Q: Isn't it also a skill to pick a very successful team?
A: Yeah, one has to be careful in picking a team. So when I joined the COBE team, the team was already there. They picked me – I didn't pick them. One of the things of going to WMAP was I already knew all of these people. I don't mean the scientists – I mean the engineers and everybody. I was able to pick out people I wanted to work with. And one of my rules for the WMAP team was only to pick people that were good at working with other people. Because there are some people who are brilliant but they're really not very good with other people. And that doesn't work very well on a space mission. It's not good enough to be brilliant. If you're doing theory by yourself – it's good enough to be brilliant – but not on a team. You really have to work with people. So it was a rule of mine on WMAP that people had to be able to work with other people well. And it was also a rule that people had to be willing to work. Sometimes on teams you ask people if the wanna be part and they say: "Yes, sure". They don't really mean that they're planning to do that much. I wanted to have a very small team. And the requirement of a small team is that everybody has to work very hard. They had to be very good, very dedicated and they had to have time to work hard on the mission. And they had to be really committed to that they were going to do it.

Q: I guess one issue with China is that China has a lot of ambitions but the expertise is not yet completely there.
A: I'm a big fan and supporter of an apprentice system. You know when in the olden times someone wanted to learn how to make a horseshoe they didn't really go to school to do that. They worked with somebody who was good in making horseshoes and they learned how to do it. And of course many things were like this. You wouldn't so much learn things in school you would be working with someone who is an expert. And I think that is a very good system actually. And even for myself, when I started working for COBE I had never worked on a space mission before. And many times when things happened I would tell myself: "I wouldn't have done it that way." And then later on I would see maybe I was actually right about that. And when I had the chance on WMAP, I did things using my judgment on the best way to do things. By then I already had an apprentice on COBE. I think it is possible to succeed in other ways but you're going to make lots of failures if you don't work in an apprentice system where you're learning from people that already do good things. I don't know how useful the advice is. But the advice is that: to learn how to do something, it's good to have people work with experts that know how to do it, to learn how it works. Then they can become the masters.

Q: Another issue for any community is: how to reach consensus? What's the next big project for the US? You just had the decadal survey.
A: Yes, I participated in the decadal survey. It's a very difficult problem because there are many good things to do. One of the flaws of the decadal survey is that something really has to serve a lot of people for it to get recommended. But if you look at some of the things that have been most important – and I would count for example the Sloan Digital Sky Survey and WMAP and things like that – they were not recommended by decadal surveys. There was however a program that allowed for things like that to happen. And so these smaller, focused things that are for a smaller group of people – it's very difficult for them to get selected in a big consensus group of scientists. But the consensus group did recommend that there would be an explorer program. And that it would be competitive with proposals. I think putting into place several programs that are competitive – different sizes, different scales – is a very good thing to do. Then we have a faster turnaround. If something exciting comes up you don't need to wait for another decadal survey or something. You already have a program that can handle it in principal. I'm a very big fan of the explorer program. Both COBE and WMAP were explorer missions. COBE a big explorer – WMAP a small one. But in that program not everything has to be approved by the entire scientific community. It just has to have a proposal that beats other proposals that time around. And I think that's a good thing to do. On the other hand, we would never do the big expensive things if it wasn't for the decadal survey and they're useful too. So I think that's the way to get a balance between the big and expensive things that appeal to a lot of people and the smaller focused things that are very important by making sure that the community agrees that there should be these programs.

Q: Maybe I also ask another question: In the US, the general public, is very interested in astronomy. What kind of things have American astronomers done to generate this sort of public interest?
A: Well, I think we're lucky because astronomy is something that people are naturally interested. I don't think we have to do that much to get people interested. There's a little children's joke: there are only two things they're interested in: dinosaurs and astronomy. So I think it's a lucky field for having a natural amount of curiosity. Everybody goes out at nights and looks up at the sky and sees these stars and things in the sky and they wonder about what's out there. It's personal – people see it all the time. They don't need an astronomer to tell them that there are things in the sky that seem mysterious to them. But it is useful when

we kind of explain to people some of the exciting things out there that they can't see with their eyes. There are black holes, there's a radiation from the early universe and all of these things gets people even more excited. I think there is a natural curiosity and we can amplify that by sharing what we do. I think there used to be a feeling that science is for scientists and they couldn't be bothered to share this with other people. But it's actually a responsibility to explain what we're learning, why we're studying things. I find that people are very interested. Because of the space missions, both COBE and WMAP, I get lots of questions from people just through email – people I don't know. They see my name somewhere and they send me an email – and they're all different - I've always been fascinated by this: “Let me ask you a question”, “What about this and that”. And I would answer these emails and have some back and forth with people. Partially I wanna answer them – partially because I wanna understand what people are thinking. I would try out ways of explaining things and I would realize some ways are better than others.

To give you a specific example: the big bang theory, which is a terrible name, almost no one has the right idea what this theory is. So they ask questions. How could the universe expanding into space and the whole fundamental idea? The question is wrong. I don't blame people for this because of the silly words we use, but I find that when I can explain to people that that picture is not what any astronomer believes and here is what we actually believe.

I always find myself having to explain – almost apologize that we use the wrong words to say things. We talk about the big bang as an explosion, but actually there is no explosion in the big bang theory – we use words don’t match what we really mean. We even talk about the big bang sometimes as if it were an event, which is not we mean either. So I become much more careful when I speak in public about what words I use and how I describe things. I based this on these emails and conversations - what is misleading and which things that actually help to explain things. And I think more people should do this – just talk to people and see what it is -

when you explain something things to a non-expert did they understand what you say, and then we can develop a better way of talking. It is not easy to do this. It’s actually very challenging to develop a way of talking that engages the public with more correct public information.

Q: So actually I have more or less exhausted my questions. Do you have any other thoughts?

A: The one thing I wanted to comment on is the teams that I've worked on. I was on the COBE team and the WMAP team. And a lot of times the person that is sort of heading gets a lot of attention but everybody does a lot of work and these teams are really wonderful. The COBE team was a wonderful team. The WMAP is very special to me. It's been such a privilege to work with these people that are so smart. I wish I could describe our meetings where we discuss things and debate things. It's all 100% respectful and we try to use – you know – arguments and reasoning for is this better or is that better – should we do A or should we do B. And it's just the brilliant people with brilliant ideas – very high integrity and judgment. Nobody is trying to trick anybody. No one is playing games. We're all focused on getting the science out. These missions would not happen if it wasn't for the teams that do this. And I think the reason for why COBE was successful, the reason why WMAP was successful more than anything is having a bunch of people on a team that are really dedicated to getting it right. It was the pleasure of my life to work with the WMAP team. It was really wonderful and I learned so much from everybody. On a space mission, it is even more than the science team: there's a big team of engineers, managers and working with all of those people too where people get very dedicated to doing work. We're talking about stressful work, we're talking about late nights, through the weekends. You know, on the weekends you don't stop you keep going. You develop a very close relation to a lot of people and a lot of mutual respect goes into that. For me that's very special.

I also would like to thank special people like the Grubers who recognise the value of knowledge that benefit the mankind and ennobles human spirits, and for helping to highlight science, and get it out to the public, students and public officials. ■

Interviewed by Prof. Shude Mao (NAOC & Manchester)

Interview with the Nobel Prize Laureate Brian Schmidt

Q: Welcome to Beijing and congratulations on your Nobel Prize.

A: Thank you very much.

Q: Is this the first time you are in Beijing?

A: This is my first time in Beijing, but not my first time in China.

Q: Has the Nobel Prize changed you?

A: Well, it certainly made my life very busy. I get to do all sorts of interesting things. The fundamentals are the same, but it’s just the amount that I get to do is much larger; the first year, I decided to just do what I can. For the next year, I'll try to settle things down and make sure to have large blocks of time to do science.

Q: I want to turn to your work. In 1998, you published your main results. How surprised was the community and how well was it received?

A: In 1998, when we saw that the universe was accelerating, I have to admit being a bit scared to tell the world about it because it seemed crazy to me, and I knew it would seem crazy to everyone else. It was not a result that I liked, but it is what our data said, so ultimately as a scientist, you have to go out and say this is what our data say. You have to understand that we were competing with another team in the Supernova Cosmology Project. They apparently were getting a different answer than us, however that very clearly changed in 1998 when is was clear we were getting the same answer. It was very funny. In the end, the cosmological constant and the accelerating universe fixed a lot of problems with the cosmological model. I had not foreseen how excited the theory community would be with the results. The observers remained very sceptical and many theorists said this fixes all the problems and it's gotta be right, so it was accepted much more quickly than I had anticipated.

Q: Do you still worry about any systematics in the search?

A: We certainly worry about systematic problems. The current experiments are systematics limited, so it is very difficult. I'm not worried about the 1998 result. I think that was very clear and we had good control of systematics. I think now at a couple of per cent, it is very hard to control systematics. That is ultimately a problem for supernovae in the future, how bright something is really, absolutely, in r band compared to B band, is really really hard. It's not like other methods, like baryon acoustic oscillations, where you're just measuring distances. That's a much easier measurement. You can do it very precisely. The fundamental experiment of doing photometry is hard.

Q: This opened up the field of dark energy. What is the future of this field?

A: It's unclear. It requires very large experiments. I think we see big experiments continuing on supernovae, but also things like baryon acoustic oscillations. A very exciting, maybe somewhat unexpected thing for me was the weak lensing of the cosmic microwave background. That actually looks like it could be very nice. Then there is weak lensing in general through optical galaxies. That can have serious issues with systematic errors as well. I was asked once if I could put all my money in one place, where would I put money to solve the questions of dark energy. I'd have to put it into theory, because the evidence is that dark energy is very similar to a cosmological constant, and I suspect it will still look like a cosmological constant in the future. If that is true, then no experiment we are going to do will help us. What we need is a good idea.

Q: Now you're involved with a project called Skymapper?
A: Yes. There's a big survey of the southern sky building on the success of the Sloan Digital Sky Survey, and it was supposed to start in 2003, but my observatory burned to the ground, so we've had a slight delay, but we're up and running again. We astronomers need to know what's in the sky to do our experiments, and having a census of all the galaxies and stars in the southern sky is the toolbox for us to explore the southern sky.

Q: Regarding funding, you mentioned that many of these projects require hundreds of millions of dollars. Australia's funding of projects seems to be very good, for example, with SKA.
A: Right now Australia has invested a lot in Astronomy. If we look around, China is investing, Europe is investing. The United States is going through a rough patch right now, but the overall level of funding in the United States is still very high. I think that we need to think very hard about what we want to do well, but in Australia it is very good times right now, and I think for us, still we still have our constraints: Australia does not have a clear path in the eight-meter telescopes which I use, so we have our own issues. But on the other hand, we have the very exciting work being done in the Square Kilometer Array. We're talking about working with China in Antarctica in a more serious way in the future. We're involved in the Giant Magellan Telescope, which is a great project for 10 years from now. I think we are very lucky to have as much going on in Australia as we do now.

Q: What advice do you have for young astronomers? What are the key skills to form a successful career in Astronomy?
A: You need to be very flexible, in all sorts of things. You do not need to worry about the future so much as concentrate on what you want to do and learn how to work with other people to accomplish your scientific goals. I think it is very important to say this is what I want to achieve, this is the question I want to do, and go for it. Rather than trying to invent everything yourself, it's very collaborative. Bring the people you need along with you with your vision where you want to go. That is more or less what I did, and it works very well. Ultimately worrying about the future and being very cutthroat about your science is not going to do you any good in the long term. I think the key is to make sure to do the best you can and accept the fact that there is a random part of what allows you to be a research scientist. It's a very competitive field, and so there are two ways to deal with it. Be positive and go for it or be negative and try to take other people out. I always believe in the positive bit. Realize that it is a privilege to do astronomy and our skills are such that we can use them for anything. There are always opportunities for the young people. Revel in the opportunity you have now and the future will take care of itself one way or another. Worrying about it is not going to change things, and indeed it actually hurts you.

Q: The Chinese press talks about the Nobel Prize all the time, and China is very keen to win a Nobel Prize. What should China do? Do you have any thoughts?
A: That's interesting. This is a very common question from China. I met the Chinese ambassador to Australia, and that was the first question he asked me. What does China need to do to win Nobel Prizes? The answer is I think China is doing the right thing right now. They are spending money on people to do the science. The amount of investment China is putting in science right now is very large. It's gone up a huge amount and it's growing rapidly. That's the first key. If you really want to empower Nobel Prizes, the best thing you can do is to ensure the best young scientists, I mean 30 year olds, are able to do their own research projects. Big hierarchies with one person in charge and a bunch of people who have less and less power the younger you get, that's OK in particle physics, but that's not a way that really innovative stuff is done. I think it's important to invest in your best young people and give them the opportunity to do their own thing, and not wait till they're 50 to allow them to do that. If there's any weakness I see in systems around the world including China is that young researchers are not given the opportunity to do their own thing early enough. Look at me – my Nobel Prize happened from a project I started when I was 27. Australia gave me the opportunity to do my own research at 27. That was the thing that made me able to win a Nobel Prize. That's the thing we need to ensure happens in all countries. Not necessarily everyone, but you need to choose people who are doing the best independent research at a young age.

Q: Astronomy is becoming increasingly international. How do you see China's role in the international scene?
A: I'm familiar with China working in at least three areas in a very serious way. One is LAMOST. This big Galactic archaeology project is challenging technically; it was a bold project. Taking leadership in a project like that is good. I think it will be a challenging project because China has grown up around the site, but it was the right project to do, and that was good. I see China taking a leading role in the Thirty Meter Telescope. That is a piece of infrastructure in the future, and that is an international collaboration. I see China taking a very strong role in the SKA, and China is literally leading the way in optical astronomy in Antarctica. Boldly going with a vision where you lead by bringing others with you, I think this is what happens in all these things. Australia is involved with China in Antarctica and that's great! Maybe other countries can be involved as well. LAMOST has scientific input from lots of people. TMT is a massively international project. I see China having huge amounts of people developing technical expertise with amazing ability to do all sorts of manufacturing required in these new telescopes. In 10 or 15 years, you're going to have more astronomers than any other country in the world and I see China being a real leader in astronomy.

Q: You already mentioned some projects. I wonder how Australian astronomers actually reach consensus for the next major project. This is quite difficult to do in some countries, including China.
A: That's true. It's always hard. We get together. We're a very close-knit community. We all know each other. I pretty much know every postdoc in the country. There are only 400 of us. We all get together and we talk. And it is all about compromise. And in our case the optical astronomers made a decision to sit back, but we promoted the SKA. But then the SKA people, the radio people, have promoted the need of optical astronomers. And it's about trust. That's what it comes down to. Knowing that those people who have other priorities ultimately trust you to come up with something where everyone is a winner. Because as soon as you make it that there are winners and losers, in the end everyone is a loser, because the government says, "well, you guys don't know what you are doing. We're gonna give the money to someone else." For example, the physicists in Australia were unable to come up with, in my opinion, a clear set of priorities. Well, that means they haven't won anything. But there has to be that trust: "We're going to do something that benefits everyone in the long term." And that trust is what's needed. How do you gain that trust? Getting the right people together, and just understand each other. I know it's hard. But we're very lucky that we have it in Australia.

Q: How do you maintain the balance between life and work? You must work incredibly hard.
A: I work hard; I would say I lost the balance while working on the accelerating universe. I worked too hard. But I recognized that, I went back, and so it's not just time. It's about being able to have thoughts and balance. So I try not to work on weekends anymore. But I work very hard during the week and I have to work on weekends for disasters. But I only work outside of working hours (my main block) for disasters. So when I come home at 9 o'clock at night, I am there to be with my family. Saturday and Sunday I am there to be with my family. Now the reality is that I lose half of my Saturdays and Sundays anyway, so it is doubly important that when I don't have anything I absolutely have to do (in the weekend), I don't do it.

You have more work than you can possibly do；that happened about year 2000. When I was working on the accelerating universe, I could fit it all in, but I had to work more and more hours. And then something happened and I could no longer fit it in. It was just more than 24 hours per day. And when this happened I realized that this was crazy. I realized I had to go back a little bit to give myself and my family time. So with this balance, you need to be able to work really hard sometimes but you need to be still a person, you have a long-term view of life. And once you realize that, day in and day out I have to work that hard, that doesn't make a difference to your career. But what matters is to be able to do things when they matter. The best way to deal with this is to do really really good things you absolutely need to do them. But you have to have a balance in life to have reserves when big times come. I think many people (like me) become addicted to their work, addicted to email, addicted to the computer. That doesn't necessarily make you become a better scientist. I think I do better science now. I think more. I want to spend some time at home.

Q: Have you figured out the secret of making better wine?
A: That's a good way for me to clear my mind. When it's clear, I can rethink through problems. Making wine, for me, it is sort of an outlet, like music. It's a cleansing process when there are too many things going on, and being able to make the wine gives me a chance to get rid of that tension, worries and to rethink through things from scratch. It's very important.

Q: Do you have any other thoughts that you want to say, for example, to Chinese Astronomers?
A: I think it is an incredibly exciting time for Chinese astronomy on many fronts. There's a revolution of new possibilities. Having China have it's own vision, but to work with the rest of the world, in their own vision, for me, would be most successful. I would encourage them to do it. I think that is more or less what they are doing. I expect great things over the next several decades.

Thank you Brian. ■

Interview with Simon D. M. White

Director of the Max Planck Institute for Astrophysics

QG: A major issue in galaxy formation is the nature of the dark matter, which seems to dominate the matter content of our Universe today. Most people believe that it must be some new kind of elementary particle, yet to be detected on Earth. Why is this and what kinds of particles are possible?
SW: Well, we can now see from the pattern of fluctuations in the cosmic microwave background that dark matter was already present when the Universe first became neutral, 400,000 years after the Big Bang. The data require that even at that time, when the Universe was very nearly uniform, the dark matter interacted only gravitationally with the photons and baryons. The only known particles with such weak interactions are neutrinos, but already 30 years ago it was clear that a Universe in which the dark matter was made of neutrinos would not resemble our own. The problem is that neutrinos with the masses required to explain the total observed amount of dark matter would move so quickly at early times that their thermal motions would smear out all structure on scales smaller than present-day superclusters of galaxies. Galaxies would have to form by fragmentation of larger systems and that is inconsistent with the pattern of structure we see. Once such Hot Dark Matter was excluded, people began to think up new kinds of particles for which these early thermal motions would be weaker (Warm Dark Matter) or effectively absent (Cold Dark Matter).

QG: Do you think Cold or Warm Dark matter is more plausible? Does it make a difference for anything we can observe?
SW: Possible candidate particles for both Warm and Cold Dark matter were already proposed in the early 1980s, but until recently most people focussed on Cold Dark Matter because it is simpler to model and because the principal suggested candidates, axions or a neutralino, the lightest supersymmetric partner of known particles, seemed more plausible to the majority of particle physicists. Warm and Cold Dark Matter behave almost identically on scales that collapse to make galaxies like our own. But on substantially smaller scales there are differences. Cold Dark Matter predicts that much of the dark matter mass should be in collapsed objects (“halos”) which are too small to contain any observable galaxy. These might be detectable through their effects on the images of gravitationally lensed quasars. Such very small structures are absent for Warm Dark Matter, leading in addition to different predictions for the innermost structure of dwarf galaxies which actually seem in better agreement with some recent data than those for Cold Dark Matter.

QG: Do you think the problems with the dwarf galaxy abundance and structure constitute a crisis for the Cold Dark Matter theory?
SW: I have seen many “crises” of the Cold Dark Matter theory over the years, but it still seems to be with us, and it seems to be stronger than ever. The inner regions of galaxies are the places where the effects of baryonic physics are largest, and dwarf galaxies are the least strongly bound and most gravitationally fragile of all galaxies. Thus it is difficult to be sure that the apparent discrepancies with the Cold Dark Matter model are not just a result of the effects of the formation of the observed galaxies. Indeed, recent simulations of the formation of dwarf irregular galaxies seem to show baryonic effects altering the inner dark matter structure in just the way needed to solve the apparent discrepancy.

QG: What do you think are the chances that we will detect dark matter through non-gravitational effects in the coming years?
SW: Well, of course, this depends on what it is made of! If the dark matter is a neutralino, then its cross-section for interaction with baryons is small but non-zero. The simplest supersymmetric models suggest that collision rates could be measurable in a laboratory, provided one can build a detector with low enough background noise, and many experiments in deep underground tunnels around the world are currently searching for a signal. Indeed, at least three seem to have detected a signal, but unfortunately their results appear mutually contradictory and in disagreement with upper limits established by other experiments, at least for the simplest particle models. Axions can be detected by looking for a resonant interaction with photons in a microwave cavity tuned precisely to a frequency corresponding to their mass. The difficulty here is to cover the full allowed range of masses. Neutralinos could also be detected indirectly because in most models particle pairs can annihilate to produce among other things, gamma-rays which could be detected, for example, by the Fermi satellite. Unfortunately, although all these direct and indirect detection experiments are now working in a regime where theory suggests a detection is plausible, if nothing is seen, the theory also allows parameters which would make the effect immeasurably small.

QG: How do you see astrophysics developing over the coming years and what role do you think China can play?
SW: Astrophysics has always been an opportunistic and technology-driven science, in the sense that as new technical capabilities become available, new (and often unexpected) areas suddenly become the centre of major activity. Think, for example, of the sudden growth in studies of galaxy evolution as CCDs and larger telescope apertures made studies of galaxies in the early Universe feasible, or the explosion of studies of extra-solar planets once the precision of stellar radial velocity and photometry measurements enabled the detection of planet-induced motions and transits, or the impact of CMB studies once microwave detectors reached the sensitivity levels needed to detect the primordial fluctuations. This push towards ever more powerful technology has resulted ever fewer and more expensive facilities. In many areas only a single global telescope is now feasible, just as the world now only has one supercollider, the LHC. This requires cooperation between all scientifically advanced nations, and China, with its major and increasingly technically oriented share of the world's economy, clearly has a pivotal role to play in future developments, both through technical contributions from its industrial base and through intellectual contributions from its very large pool of highly educated scientists and engineers. ■

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