Issue 1 | August 2, 2022

Mirinae

미리내 The Milky Way

IAU | IAUGA Astronomy for All Busan 2022 | THE KOREAN ASTRONOMICAL SOCIETY 한국천문학회 | KASI Korea Astronomy and Space Science Institute

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XXXIst General Assembly Opening Address

Debra Elmegreen, IAU President

Greetings to our honored guests and to our IAU community here and around the world! I'm Debra Elmegreen, President of the IAU. It is such a delight finally to be able to hold the XXXIst General Assembly of the IAU. We have witnessed too many global tragedies since the XXXth General Assembly in Vienna, and our thoughts are with all of those who have been affected. For the next two weeks, it will be a welcome change to focus on astronomical discoveries and endeavors, to honor achievements, and to share the many efforts in which astronomy is used in development, education, and outreach.

A transition of IAU Officers takes place after General Assemblies, held every three years according to our Bye-laws. We held the XXXIst General Assembly Business Sessions virtually in August 2021, and celebrated the terms of then-outgoing President Ewine van Dishoeck and General Secretary Teresa Lago. Because of the pandemic delay of the Scientific Sessions until now, It is appropriate for me and the current General Secretary, Jose Miguel Rodriguez Espinosa, to share the Opening Ceremony with them.

This is the first General Assembly to be held in the Republic of Korea in the 103-year history of the IAU. The Republic of Korea has been a National Member of the IAU since 1973. It has a vibrant astronomical community, with over 200 Individual Members. It hosted the 7th Asia-Pacific IAU Regional Meeting (APRIM) in 1996, the 12th APRIM in 2014, and IAU Symposium 197 on Astrochemistry in 1999. I thank the National Organizing Committee and its chair, Professor Hyesung Kang (who is Korea's first IAU Vice President) for their many years of preparation for this gathering, including their additional efforts to make it the first hybrid General Assembly.

We have nearly 1700 registered participants for the meeting. I'm also happy to welcome over 500 new Individual Members and Junior Members to the IAU. We have an exciting schedule planned, with lectures from international prize laureates plus talks and posters including many by early career astronomers. The plenary talks, invited discourses, Symposia, Focus Meetings, including one with our new Center for the Protection of Dark and Quiet Skies from Satellite Constellation Interference, Meetings of the Offices, Executive Committee Working Groups, Division Days, and Women in Astronomy and Young Astronomer Lunches encompass all aspects of IAU activities.

These events reflect the goals as laid out in our 2020-2030 Strategic Plan presented at the General Assembly in Vienna, which are well underway; namely: to coordinate research efforts and communicate astronomical knowledge among professional astronomers, to promote the inclusive advancement of astronomy in every country, to promote the use of astronomy as a tool for development in every country, to engage the public in astronomy through access to and communication of astronomical information, and to stimulate the use of astronomy for teaching and education.

The General Assembly of the International Astronomical Union is a meeting place

Jose Miguel Espinosa, IAU General Secretary

The General Assembly 2022 is here now. It has been hard work due to the Pandemia. But it has been a great success which our Korean colleagues must be happy about. But most of all Prof. Hyesung Kang whose leadership and guidance brought us from one year to the next. Thanks to all the members in her team. You have been hard workers, you have been enthusiastically diligent. The General Assembly has been a well deserved success, after all the work you have invested in it. But it is not only the General Assembly what is at stake. The great city of Busan with its people, its technology, its Universities, its beaches, its mountains has welcomed us all. Thanks for this very warm welcome. The General Assembly will no doubt offer many surprises, both the GAIA and JWST are offering its first data, so we will hear many new results from the Galaxy and beyond and many new opportunities for discussions. The GA is also a great place for meeting people, for discussing with colleagues and for chatting with renowned professors. The General Assembly has a special place within the astronomical community. It is a place to meet every three years and a place where many discussions take place with people from remote places on Earth. The General Assembly is special due to its overarching coverage of topics and the many students with grants that makes the GA a young place. The General Assembly is a meeting place for Astronomy.

Welcome by KAS President

Myeong-Gu Park, KAS President

Even after many decades of my scientific life, I still have great respect especially for astronomers, who hold such a passion for something that does not make any good money. Korean people also have had the greatest respect for scholars rich in knowledge and poor in money.

Korea has a long history of observing and recording astronomical events. Dolmens in the bronze age, murals in ancient royal tombs, and the official chronicles of the Korean dynasties spanning more than two millennia still tell us how our human ancestors had been watching the sky and listening to the celestial messages. Hence, I personally believe Korea is the perfect festive place for astronomers, who observe the universe in the past to understand the present and future of the universe.

Many astronomers including myself have not participated in overseas meetings for far too long. All the wonderful achievements in modern astronomy would not have been possible without international communication, cooperation, and collaboration. Now we are together again. I heartily welcome you to Busan, one of the most beautiful and vibrant Korean cities.

Let's do some astronomy, and be happy again.

Welcome by KASI President

Young-Deuk Park, KASI President

As the president of Korea Astronomy and Space Science Institute(KASI), the co-host of the 31st IAU General Assembly, I extend to all the IAU members my warm fraternal greetings and compliments. It is my great pleasure to be able to welcome you to Busan, one of the most beautiful maritime cities in South Korea. The COVID-19 pandemic has challenged our daily activities and we could not even guarantee if indeed we can gather in one place face-to-face. And now, we are almost there for this global astronomy festival again.

South Korea has a relatively short modern history of astronomy and space science compared to other countries apart from its traditional inheritance. However, the academic advancement, despite the disadvantages of latecomer, has been constant and drastic enough to take shape for prominent observational infrastructures such as GMT, KMTNet, K-DRIFT, OWL-Net and SNIPE. Furthermore, the international collaboration especially in space science is on a steep rise in line with the worldwide attention to space exploration and Korea-US agreements for space development recently, which led KASI to go hand in hand with NASA for SPHEREx, KPLO and CLPS.

As it happens, KASI gets to celebrate the 50th anniversary in 2024, and organizes two main international meetings, IAU GA in 2022 and COSPAR SA in 2024, just before the special celebration. I am proud that a series of these host events indicates the leading status of KASI and Korean astronomy and space science in the world.

I, the president of KASI and a member of KAS at the same time, cannot weigh how challenging a turning point the Korean astronomy community is facing now. KASI, as we always have done, will take the lead and do our best to hold the GA professionally and successfully along with KAS in order to make the gathering as a new forum for scientific ideas and cultural exchange.

I do hope each of you have a memorable time exchanging your research ideas with peers and enjoy the blue water of the bay at Busan as well. I wish the 31st IAU GA will become yet another great event which makes you experience overwhelming moments off the computer screen. “Astronomy for All” is just waiting for you.

Welcome by Mayor of Busan

Heong-joon Park, Mayor of Busan

On behalf of Busan citizens, I wish to extend my warmest welcome to all members of the International Astronomical Union (IAU) who are participating in IAU GA 2022 via on and off-line channels.

The IAU, as the largest international institution within the field of astronomy in the world, has official authority to designate the names of celestial bodies, and has accomplished numerous astronomical discoveries that it has shared with all of humanity since its establishment in the early 20th century.
As for the Republic of Korea, the Korean Astronomical Society joined the IAU at the 1973 IAUGA, while the 1996 APRIM was successfully held in Busan.

During the Chosun Dynasty era of the 15th century, King Sejong developed astronomy to the world's highest standards of the day. To honor such achievements, National Treasure No.250, a Celestial Globe, is engraved on the 10,000 won bill to commemorate its great value up to this day. In the past, our ancestors expressed astronomical tools that benefited all of humanity using the symbol of a plate. They creatively invented tools in various shapes and uses, such as the Celestial Globe and Hemispherical Sundial, to predict changes in time and season by measuring altitude and bearing, as well as the exact length of day and night. Based on such predictions, people who mostly survived by farming could forecast proper planting and harvest times.

Today, Busan is home to the 'Jang Yeong-sil Science Garden' to commemorate the great scientist of the King Sejong era, 'Jang Yeong-sil', and exhibit the astronomical tools he invented in order to help raise public interest in astronomy by experiencing the tools he used to study space.
Busan, as the second largest city of Korea and global maritime city on the southernmost tip of the Korean Peninsula, came together to secure peace and offer security to war time refugees during the Korean War, while later serving as the foundation for economic growth in Korea.

In addition, as the best convergence city in Korea, Busan is putting its every effort into winning the bid to host the 2030 World Expo, driven by its excellent city branding power and successful cultural mix as a city of international conferences and film.

부산 먼저 미래로
그린스마트 도시 부산

Mayor of Busan, Park Heong-joon, represented Busan's Suyeong-gu District as a National Assembly member from 2004 to 2008, appointed as a special advisor on social issues to the President in 2011, served as the Secretary-General of the National Assembly from 2014 to 2016 and is now dedicated to his role as the Mayor of Busan from April 7th to present.

This year's IAUGA 2022 in Busan will provide a golden opportunity for around 2,000 astronomers from across the world to share their new research and discuss future developments in the field that will broaden global cooperation via various events such as, a congress, seminars, academic sessions and exhibitions. Meanwhile, I cordially ask for your kind interest and great support for Busan to win the bid to host the 2030 World Expo.

Lastly, I wish to express my sincere gratitude to all relevant officials from the IAU, the Korean Astronomical Society, and the Korea Astronomy and Space Science Institute for their hard work thus far to prepare for the successful hosting of IAUGA 2022.
I hope this conference will be a fruitful and successful occasion.

Welcome by Minister of Science and ICT

Jong-Ho Lee, Minister of Science and ICT

I extend my heartfelt congratulations on the successful hosting of the 31st General Assembly of the International Astronomical Union (IAU). I would like to convey my utmost respect and gratitude to the IAUGA 2022 National Organizing Committee and members of the Korean Astronomical Society and the Korean Astronomy and Space Science Institute for organizing the IAU General Assembly. I also take this opportunity to warmly welcome the members of the IAU and astronomers from across the world.

In the age of space, astronomy is an essential field of basic science that involves state-of-the-art technologies. I commend the hard work and dedication of astronomers and am always grateful for their passion and efforts. I am more than delighted to convey my support and appreciation, albeit through this newsletter.

Year after year, astronomers have used their collective wisdom to contribute to enhancing our understanding on the origins of our universe and unveiling the wonders of the universe. Yet, it's even more special this year. For one thing, in May, the Event Horizon Telescope (EHT) project led by a team of multinational astronomers succeeded in observing Sagittarius A, the supermassive black hole at the center of our Galaxy. We are also one step closer to looking for exoplanets with the potential for life as the James Webb Space Telescope (JWST), the world's largest and most powerful space telescope ever built in human history, began its mission. Both the EHT project and JWST are products of the collaborative efforts of numerous astronomers around the world over a long period of time. As these major achievements indicate, international cooperation is crucial for the development of big science, such as astronomy. I hope that this year's IAUGA will be a venue to expand exchanges and advance discussions on cutting-edge research in each country, further contributing to the development and well-being of mankind.

I also have high expectations for the General Assembly hosted in Busan this year. It is a meaningful event where the Korean people and the world can witness the astonishing progress in astronomy, which is a remarkable achievement made possible through efforts from across the world. Furthermore, the successful launch of the Korea Space Launch Vehicle-II (KSLV-II), aka Nuri, in June this year has significantly piqued the Korean people's and the government's interest in space. In May last year, the Ministry of Science and ICT (MSIT) of Korea signed the Artemis Accords, a U.S.-led lunar exploration alliance. As part of the Artemis program, Korea's domestically-developed Korea Pathfinder Lunar Orbiter (KPLO), aka Danuri, will be launched in August this year.

More than anything, the Korean government will continue to make bold investments in astronomy and space development with a long-term vision and a strong drive.

When Neil Armstrong stepped out onto the Moon's surface and became the first person to walk on the moon, he proclaimed, "That's one small step for a man, one giant leap for mankind." Just like an astronaut's very first steps on the moon, Though making progress may feel like a small step for each astronomer attending this IAUGA, I am confident that in the end, your efforts and hard work will shape the foundation for a giant leap forward that will uncover the answers to mankind's questions about the universe.

Once again, congratulations on the successful opening of the IAU General Assembly, and I hope that all participants will engage in meaningful and productive conversations in Busan. Thank you.

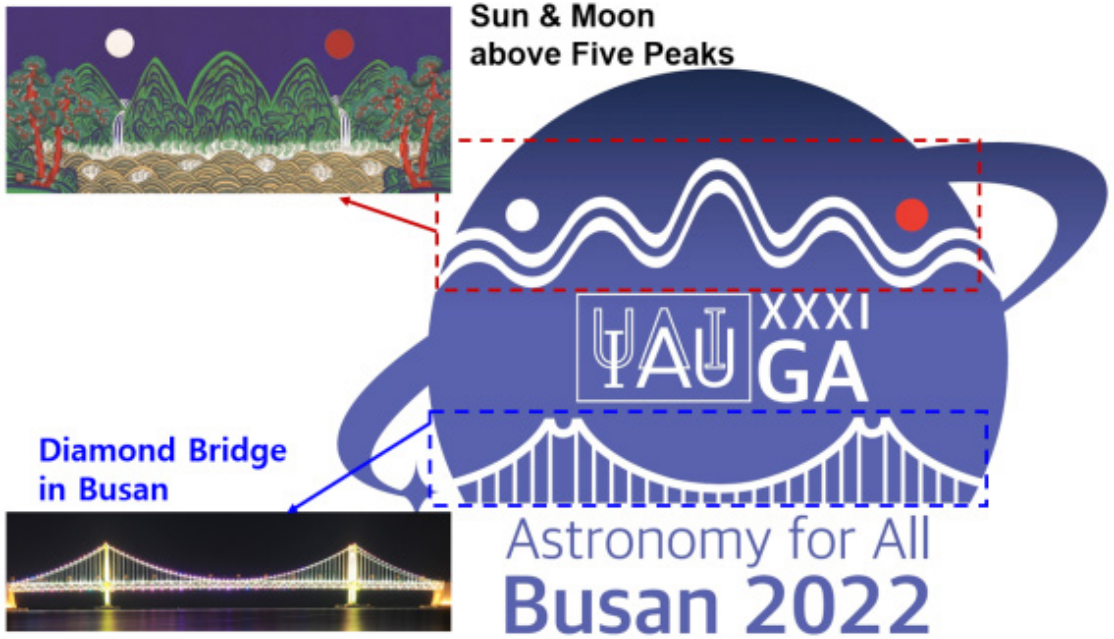
Opening Ceremony

WHERE **Auditorium**

WHEN **August 2, 17:00 – 18:30**

Part I. Program

1. Opening Performance: Korean Traditional Dance
2. Opening Announcement by Aeree Chung
3. Opening Video
4. Opening Address: Debra Elmegreen
5. Introduction of Guests
6. Welcoming Address: Tae-seog Oh, vice Minister of Science ICT
7. Welcoming Video: Heong-joon Park, Mayor of Busan
8. Welcoming Address: Myeong-Gu Park, KAS President
9. Brief Reflections on Past Triennium: Ewine van Dishoeck
10. Brief Reflections on Past Triennium: Teresa Lago



Part II. Program

1. Gruber Foundation Prize Awards:
   Ewine van Dishoeck, Sarah Hreha, Teresa Lago
2. IAU ODE Prize Awards: Ewine van Dishoeck
3. IAU PhD Prize Award: Jose Miguel Rodriguez Espinosa
4. Close of ceremony: Debra Elmegreen

Welcome Reception

WHERE **Auditorium Lobby**

WHEN **August 2, 18:30 – 20:00**

Focus Meeting 4

UV Insights to Massive Stars and Young Stellar Clusters

By DANIELLE BERG & CLAUS LEITHERER

Massive stars and young stellar clusters are cosmic drivers of galaxy evolution and are key to understanding the formation and ionization of the early universe. While the light from massive stars influences all observable facets of star-forming galaxies, the interplay between stars and gas is not well understood. Gas is accreted onto galaxies from the cosmic web, settles into their gravitational wells, and is converted into young stellar clusters. The massive stars in these clusters ionize the surrounding gas, produce nebular emission, and drive outflows. Such feedback drives chemical evolution and can modulate or limit accretion processes, thereby regulating the subsequent growth of galaxies. The effects of massive stars are broad reaching. Therefore, answers to the critical questions surrounding galaxy formation and the early universe, as well as cosmic galaxy evolution, requires understanding the astrophysical properties and lifecycles of massive stars and stellar clusters.

Focus Meeting 4: UV Insights to Massive Stars and Young Stellar Clusters	
START DATE	Tuesday, 2 August
END DATE	Wednesday, 3 August
ORAL SESSIONS	Room 202, Convention Hall, 2nd Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program or the FM 4 website

The rest-frame far-ultraviolet (FUV) offers the best observational window to study the properties of massive stars and the resulting physical conditions on the gas. In particular, FUV spectra contain features that characterize the ionizing stellar population, the imprint of their injected energy on the outflowing gas, and the physical conditions of the nebular gas within the same galaxies. This unparalleled diagnostic power is posed for rapid growth in utility, as it will be vital to the interpretation of the intermediate- and high-redshift galaxies that will be observed with future space- (JWST) and ground-based (ELTs) facilities in the next decades.

Currently, we are unprepared to interpret the UV spectra produced by massive stars and stellar clusters, especially at low-metallicities, and are facing the impending loss of access to the observed-frame FUV. Many important unknowns remain that thwart our understanding of massive stars, and, as a result, high-redshift galaxies and galaxy evolution. Fortunately, several observing campaigns have been designed to specifically tackle these challenges, such as the Hubble UV Legacy Library of Young Stars as Essential Standards (ULLYSES) initiative, The COS Legacy Archive Spectroscopic SurveY (CLASSY): A UV Treasury of Star-Forming Galaxies, and others. How we will use the existing FUV astronomical database and these coming programs to answer these key questions will be addressed in Focus Meeting 4. Within the session topics, we will conduct high-level discussions of the details of massive stars and clusters, including less understood phenomena such as the rotation and mass-loss rates, enhanced alpha/Fe ratios, stripped stars and other remnants of binary star evolution, W-R stars, and more.

Danielle Berg is an Assistant Professor at The University of Texas, Austin (USA). Her research focuses on bridging our understanding of galaxies, which comes from connecting the local galaxies in our backyard with the first seeds of galaxies in the very distant universe.

Claus Leitherer is an Astronomer at Space Telescope Science Institute, Baltimore (USA). He combines research on individual massive stars and on the integrated star-formation properties of galaxies using the population synthesis code Starburst99.

Focus Meeting 5

Broader look at the planet habitability

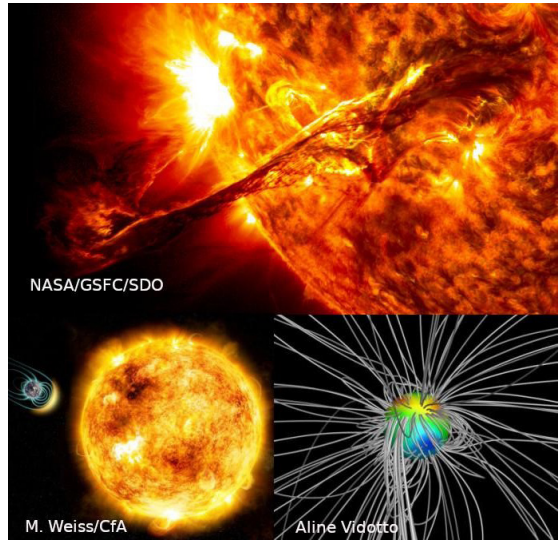
By Heidi Korhonen

Focus Meeting 5: Beyond the Goldilocks Zone - The Effect of Stellar Magnetic Activity on Exoplanet Habitability	
START DATE	Tuesday, 2 August
END DATE	Wednesday, 3 August
ORAL SESSIONS	Room 103, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

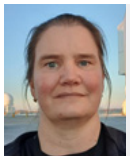
For details on presenters, topics, and times see the online program on the GA website

Our Sun harbours magnetic fields which cause a myriad of phenomena, among them flares and coronal mass ejections that are crucial ingredients in the changing environmental conditions of near-Earth space. Similarly, the magnetic activity of other stars modulate their immediate environments, and in the case of strong magnetic activity also potentially affect the habitability of the orbiting planets. Focus Meeting 5 "Beyond the Goldilocks zone: the effect of stellar magnetic activity on exoplanet habitability" takes advantage of the recent progress in studies of the Sun and the heliosphere to explore stellar activity and its impact on habitability of exoplanets.

The magnetic activity of cool stars in the form of flares, winds, and coronal mass ejections has a direct impact on planets. This activity varies with the mass, age, and rotation rate of the star and can be damaging for life, even in the case of a fairly inactive star like the Sun. During periods of intense solar activity, the solar wind is enhanced and geomagnetic storms produce auroras, disrupt radio transmissions, affect power grids, damage orbiting satellites, and can be hazardous to astronauts. By analogy, the magnetic activity of young cool stars, which exhibit much higher activity levels than the Sun, may be hazardous for the creation and development of life. Therefore, knowledge of magnetic activity of the host star is of crucial importance when determining the habitability of a planet. In close-in worlds, like in the habitable zone of an M dwarf, stellar magnetic activity could have a catastrophic impact on the actual habitability of the planet. Even the planets further away from the star are significantly affected, as is seen in the solar wind stripping of Mars' atmosphere, and in the enhanced ion escape from the Martian atmosphere in connection to coronal mass ejection events.



Focus Meeting 5 will take place on August 1 & 2 and during it we will discuss different aspects of solar and stellar magnetic activity and their effects on (exo)planets. The talks include observational and theoretical aspects of magnetic activity from solar and stellar flares and coronal mass ejections to dynamo theory and planetary magnetic fields. One important focus in the meeting is on the effect the magnetic activity has on the orbiting planets, both in our Solar System and also around other stars.



Heidi Korhonen is an Operations Staff Astronomer at European Southern Observatory in Chile. She is the president of Commission E4 and her scientific interests focus on stellar activity and its effects of exoplanets and their detection.

We hope to see many people participating in this interdisciplinary Focus Meeting that concerns many exciting aspects of stellar astrophysics and (exo)planetary research.

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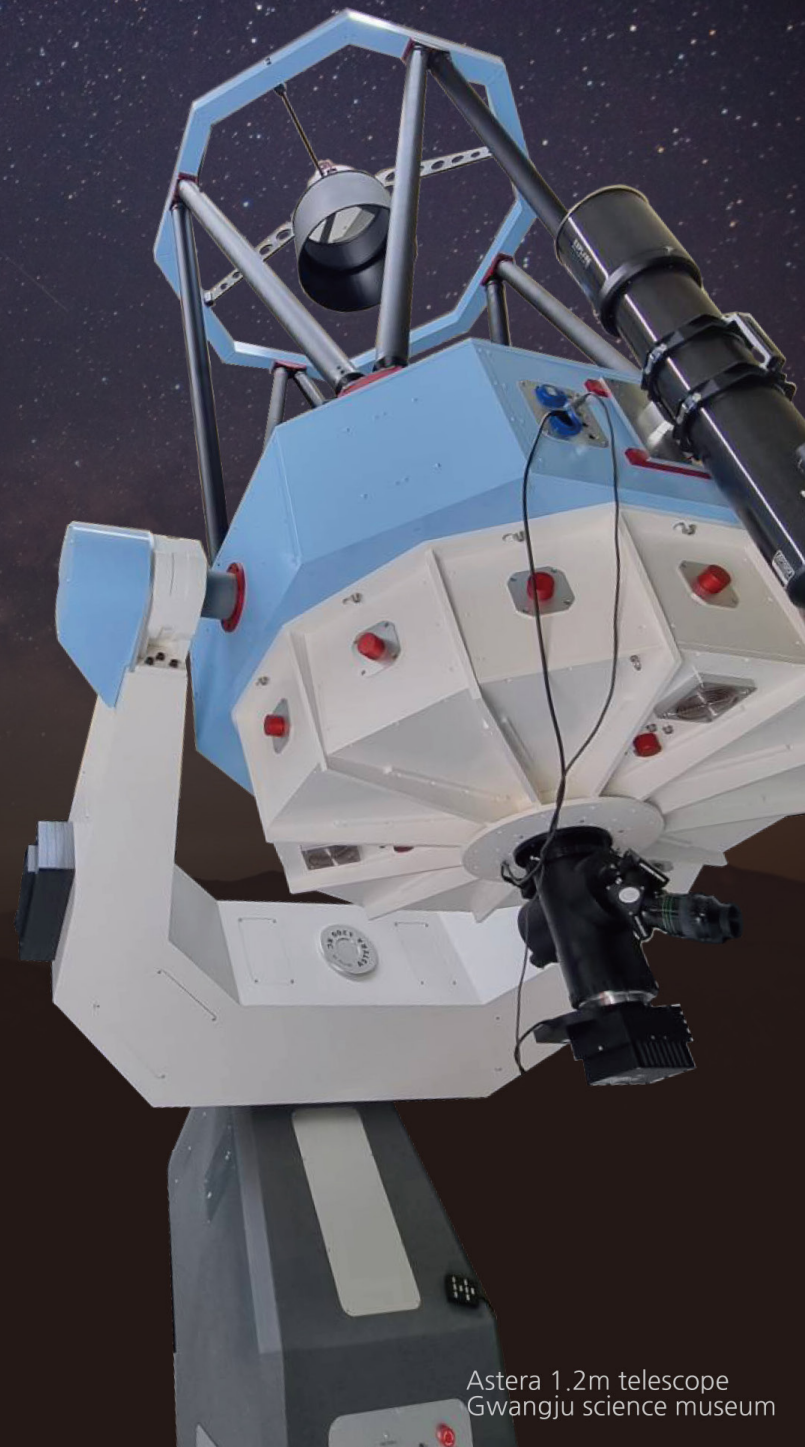

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Breaking the limits of telescopes: the GRAVITY revolution

Frank Eisenhauer, Gruber Prize Winner

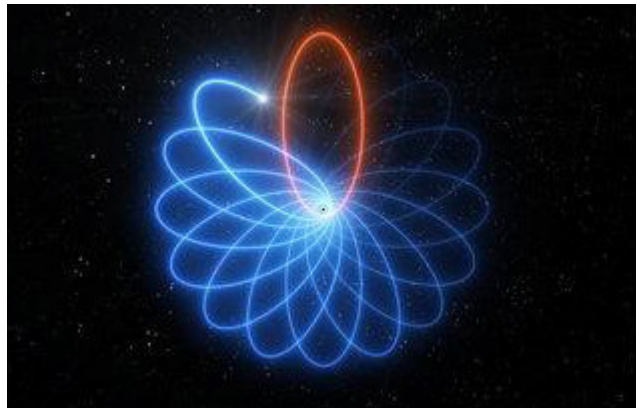
The 2022 Gruber Cosmology Prize recognizes Frank Eisenhauer of the Max Planck Institute for Extraterrestrial Physics for the revolutionary design of instruments that collected seemingly irrefutable evidence for the existence of a black hole at the center of our Galaxy. The citation honors the "unprecedented and exquisite" precision of his instrumentation.

In 2018, the GRAVITY experiment traced the behavior of various phenomena near Sagittarius A*, or Sgr A*, a supermassive and therefore gravitationally voracious, invisible object near the center of our Galaxy. Thanks to Eisenhauer's technical innovations, the GRAVITY team found that the orbit of stars and gas near the Galactic center matches theoretical predictions consistent with the existence of a black hole. Eisenhauer's mentor and longtime collaborator Reinhard Genzel shared the 2020 Nobel Prize in Physics with Andrea Ghez and Roger Penrose for his contributions to work on Sagittarius A* (Sgr A*).

GRAVITY had its basis in an earlier experiment on which Eisenhauer developed breakthrough technology in imaging spectroscopy—the measurements of how matter affects the absorption and emission of light. The instrument is part of the Spectrograph for INtegral Field Observations in the Near Infrared (SINFONI) at the European Southern Observatory's Very Large Telescope on Mount Paranal in Chile. It includes an adaptive optics system to correct the image blur from the Earth's turbulent atmosphere developed under the lead of Henri Bonnet. In 2003, SINFONI began observing stars operating under the great gravitational influence of Sgr A* as they execute their exceedingly rapid, highly eccentric orbits.

Two years later the group of German and French researchers around Eisenhauer and Genzel, Stefan Gillessen, Pierre Lena, Guy Perrin, and Thibaut Paumard began discussing an opportunity to observe an upcoming event involving one of those stars, S2. Having measured a precise orbit of S2 after the first peri-passage in 2002, they could now calculate that in 2018 the star would reach the part of its orbit where it would again pass closest to Sgr A*, a distance of only 17 light-hours. Combining the observing power of all four 8-meter telescopes at Paranal (through a process called interferometry) meant that the experiment could achieve the necessary thousandfold improvement in sensitivity over earlier interferometers necessary to resolve the resulting relativistic effects.

Frank Eisenhauer at the Paranal Observatory in Chile in 2018 when the gravitational redshift in the Galactic Center black hole was discovered. Credit: ESO



Observations have revealed for the first time that a star orbiting the supermassive black hole at the centre of the Milky Way moves just as predicted by Einstein's theory of general relativity. Its orbit is shaped like a rosette and not like an ellipse as predicted by Newton's theory of gravity. This effect, known as Schwarzschild precession, had never before been measured for a star around a supermassive black hole. This artist's impression illustrates the precession of the star's orbit, with the effect exaggerated for easier visualisation. Credit: ESO/L. Calçada

View of the GRAVITY instrument during construction. To the left of the image, the connections for the beam lines from the four VLT telescopes are visible. © MPE

Orbital motion of gas around the black hole This visualization uses data from simulations of orbital motions of gas swirling around at about 30% of the speed of light on a circular orbit around the supermassive black hole Sagittarius A*. Credit: ESO/Gravity Consortium/L. Calçada

"This project was seen by some as technically impossible," wrote one nominator for this year's Gruber Cosmology Prize. Advocates for the project, however, argued that even if the experiment didn't reach its goals, any technological advances would have broader benefits. In particular, Tim de Zeeuw and Andreas Kaufer at the European Southern Observatory supported the bold project and the team around Julien Woillez to upgrade the interferometer. Eisenhauer's designs did indeed wind up revolutionizing several kinds of instrumentation, including imaging detectors, laser metrology, and dual-beam operations.

The GRAVITY collaboration consisting of the Max Planck Institute for Extraterrestrial Physics, LESIA at the Paris Observatory, IPAG at the University Grenoble, the Max Planck Institute for Astronomy, the University of Cologne, the Center for Astrophysics and Gravitation in Portugal, and the European Southern Observatory completed the instrument with barely a year to spare, and the initial results, as one nominator wrote, "can only be described as astounding and ground-breaking for many fields of astrophysics."

Those results include: precise measurements of Sgr A*'s general relativistic influence on S2; as well as observations of gas orbiting close to the "last stable orbit"—the point before which it succumbs to the gravitational tug of Sgr A* and disappears from sight forever. Together this data provides enough evidence to satisfy the astronomical community that Sgr A* is indeed a black hole.

Among GRAVITY's other significant contributions to astronomy: A determination of the distance between the Sun and the Galactic center at a level of precision ten times greater than previous measurements (a calibration that other astronomers will use as a reliable first step in tracing the evolution of the universe on the largest scales). A test of Einstein's general relativity using supermassive black holes at the highest level of precision to date.

As GRAVITY's advocates hoped, Eisenhauer's innovations in technology—the ones for which he is receiving the 2022 Gruber Prize in Cosmology—have changed astronomy beyond just the study of Sgr A*. Other astrophysicists have already begun using SINFONI and GRAVITY instrumentation to study distant star-forming galaxies, black holes at the centers of nearby galaxies, and planets orbiting stars within our own Galaxy.

Eisenhauer will receive the $500,000 award as well as a gold laureate pin at a ceremony that will take place on August 2 at the XXXIst General Assembly of the International Astronomical Union in Busan, Korea. Previous honors for Eisenhauer include the Tycho Brahe Medal of the European Astronomical Society for his leadership of the SINFONI and GRAVITY instruments, the Stern-Gerlach Medal of the German Physical Society for his pioneering work in high-resolution infrared astronomy, and the Jackson-Gwilt Medal of the Royal Astronomical Society for the development of astronomical instrumentation. He was elected to the French Academy of Sciences.

The G RAVITY interferometer was installed at the VLTI in 2015, and has been in operation since 2016. © ESO/MPE

Astronomy in Cyberspace

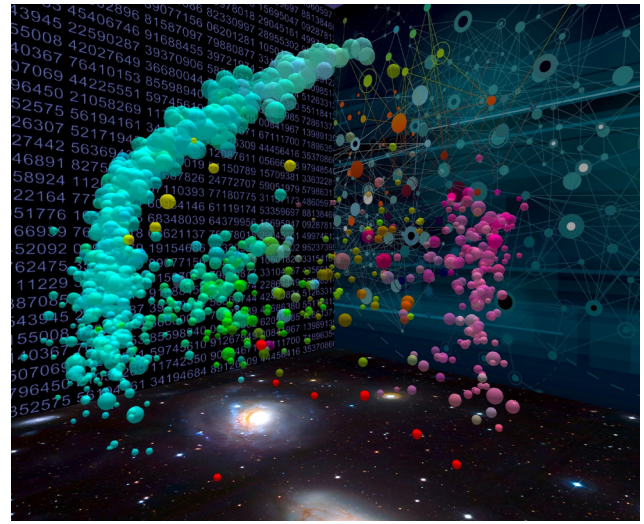
S. G. Djorgovski, S368 plenary speaker

My professional interests started in extragalactic astronomy and cosmology. They included studies of the most distant galaxies known at the time, the first glimpses of galaxy evolution, gravitational lenses and binary quasars, fundamental properties of elliptical galaxies (e.g., the Fundamental Plane correlations and their implications), etc. I also worked on the structure, dynamics, and stellar populations in globular clusters, including the discovery of collapsed cores. Later on, I worked on the studies of gamma-ray burst afterglows and their host galaxies, including the first spectroscopic demonstration of their cosmological nature, properties of the dark energy, and the approach to the reionization era, etc. More recently, I have been working on the exploration of the Time Domain using large synoptic sky surveys, and studies of AGN variability in particular, including the changing look quasars, possible supermassive black hole binaries, and other interesting phenomena. In all of that, I was fortunate to work with many excellent collaborators, too numerous to list in this short contribution, but they deserve most of the credit for these discoveries and results. It was a lot of fun.

Starting in the early 1990s, my attention turned to the advent of 'big data' astronomy, prompted by the first large digital sky surveys. That led to the establishment of Virtual Observatory framework, but also introduced us to the applications of Machine Learning tools for the exploration and analysis of these exponentially growing data sets and data streams. That naturally led to the development of Astroinformatics as a major component of the scientific methodology for the era of growing data abundance.

In my presentation, I will provide a brief overview of the use of Machine Learning tools in astronomy, starting from the early applications for star-galaxy separation in sky surveys and photometric redshifts, to a remarkable and growing spectrum of other applications and use cases today, with the number of publications growing exponentially. Machine Learning and other aspects of AI are now necessary tools for data-rich astronomy, as well as in any other scientific discipline. I will also review some of the currently promising and/or fashionable methods, mostly based on Deep Learning. Finally, I will address the rise of the AI tools and methods that are leading us to a genuine human-computer collaborative discovery and offer some speculations about the future.

My key scientific interests are now in understanding how computing and information technologies are changing science, scholarship, and education. These technologies have profoundly changed the world and just about any human endeavor. This poses some interesting sociological challenges for academia as well since our institutions and traditional ways of doing research and teaching are developing much more slowly than these enabling technologies. Our present is interesting and challenging, and the future will be even more so.



A schematic illustration of the intersection of astronomy, big data, and machine learning. Credit: S. G. Djorgovski, Caltech.

A roller coaster into the IAU's second century:

reflections by the IAU Past-President

Ewine F. van Dishoeck, Former IAU President

On August 26 2021, I stepped down as your IAU President at what was the first-ever virtual GA Business session. Now, nearly a year later, we are finally here together at the actual GA in beautiful Busan and have the pleasure of seeing and hearing each other in person again. Annyeonghaseyo, mannaseo bangabseubnida! I have been asked to briefly reflect on the 2018-2021 period. What a rollercoaster triennium it was, plunging from the peak of the IAU 100 years celebrations in 2019 down to the onset of the global pandemic in early 2020, and finding a new equilibrium and way of working together ever since.

The overarching guide for the IAU's activities is the Strategic Plan 2020-2030, written together with now President Debra Elmegreen and approved at the GA 2018 in Vienna. Significant progress has been made on its implementation, thanks also to the hard and capable work by past general secretaries Teresa Lago and Piero Benvenuti. Most notably, the IAU now has four well-functioning Offices, those for young astronomers (OYA), development (OAD), outreach (OAO), and education (OAE), with each of them having their Regional Offices and national contacts. This family of Offices is proving to be an increasingly strong and global network. Other achievements include the revival of the global coordination of ground and space astronomy working group, the establishment of the junior member category, and the strengthening of actions to make our field more diverse and inclusive.

To deliver on its mission and the ambitions set out in the Strategic Plan, the IAU needs to reach new audiences who can support it beyond what the annual resources from its member states enable it to do. Fundraising has therefore become a growing activity with a number of significant successes in this triennium. Most notably, new funding has enabled the annual Shaw-IAU education workshops, the new IAU Hands-On workshops to train young astronomers in the use of large and complex data sets, an annual multidisciplinary Kavli-IAU symposium, support for the CAP conference, and coordination of the annual Women and Girls in Astronomy week.

Undoubtedly, the 2019 IAU 100th anniversary celebrations were the highlight of the triennium. As President, it was my privilege to help develop and experience them. A goal of IAU100 was to show not just to our fellow scientists, but also to policy makers, teachers, educators and the general public what a century of astronomical discoveries has brought to society. It also allowed to reflect on its future. The IAU100 theme "Under One Sky" emphasized the global nature and the role that the IAU plays in bringing people together. It was a very busy year: IAU100 hosted over 5000 activities that engaged over 100 million people in 143 countries. High points included the Flagship meeting in Brussels on "Astronomy with and for society", the "Above and Beyond" exhibition in 75 countries, the "NameExoWorld" contest across the world, and two books describing the IAU's history. I highly recommend browsing through the beautifully conceived IAU100 Final Report to get an impression. IAU100 ended with the 30 year celebration of the iconic "Pale Blue Dot" picture, driving home the message to society, especially children, that

Opening of the IAU100 exhibition "Above and Beyond" at the GA 2018 in Vienna (credit IAU/M. Zamani).

Alternative: Group photo from the 100 years Under One Sky Celebration Flagship Ceremony in Brussels April 11-12 2019 (credit IAU/Babak Tafreshi).

IAU meetings in Covid times: IAU symposium 367 took place fully online in December 2020 (Credit: IAU/B. Garcia).

our planet is small and fragile in space and that we should take well care of it.

Just weeks later, the pandemic hit, turning everyone's life upside down and causing hardships across the globe. Office and scientific meetings moved online, with the advantage that researchers from around the world could join and present their work at almost no cost. Indeed, some IAU Commissions held very successful virtual meetings: they have the right size (few hundred people) and focus to do so. My strong recommendation is that Commissions continue such virtual meetings regularly, especially to give young scientists a platform. However, most IAU-sponsored symposia chose to postpone until they can be in-person, offering the benefits of people getting to know each other and triggering new ideas and collaborations through unstructured discussions. Hybrid meetings now seem the new norm, also for environmental reasons, but how well they will work for large intercontinental meetings like the GA with thousands of participants is yet to be explored.

As with any organization, new challenges emerge at any time. The IAU's mission includes protection of the dark and radio-quiet skies. During 2019, it became clear that our skies are now being threatened not just by huge increases in urban lighting and radio interference due to telecommunication, but notably by the launch of swarms of small satellites. The IAU and its partners organized major online workshops in 2020 and 2021 resulting in a detailed report that describes the impact of human activities and makes recommendations for mitigating actions. This includes pushing the issue at the UN Committee on the Peaceful Uses of Outer Space (COPUOS). The IAU subsequently issued a call to establish a new "Centre for the Protection of the Dark Sky from Satellite Constellation Interference" to coordinate actions internationally; the selection of the Centre was announced in early 2022.

I ended my online speech last year with bubbles. Thanks to Covid, everyone is familiar with the concept of bubbles: small groups of people that only interact with each other but not with rest of the world. Alas, they are becoming more common in science and society, whether at the national, regional and/or scientific topic level. The importance of the IAU, and especially its General Assembly, is that it takes you outside your bubble, giving you the full perspective of the field and letting you make worldwide connections. With an increasing number of conflicts around the world, such international relations are more important than ever to build respect, trust and support for each other.

Hence, let's uncork some bubbles to the IAU as it embarks on its next century, and let me quote the African-American abolitionist and activist Harriet Tubman (1822-1913): "Every great dream begins with a dreamer. Always remember, you have within you the strength, the patience and the passion to reach for the stars to change the world." Unlocking this strength in everyone through "Astronomy for All" (the GA 2022 motto!) is exactly what the IAU aims to do.

A million thanks to my fellow Officers, Office, Vice and Division Presidents, IAU100 team, and IAU family of Offices for a great triennium!

The IAU, a vibrant organisation

Teresa Lago, Former IAU General Secretary

My tenure as General Secretary (September 2018-2021) was very exciting. It covered the implementation of the IAU's first global Strategic Plan 2020-2030 and included notable events in the life of the Union such as: - Centennial celebrations through more than 5,000 activities involving several million people in 140 countries; - The creation of the new IAU Office of Astronomy for Education (OAE) - the enthusiastic response to the international call for partnership (October 2018) led to the agreement with the Max Planck Society for the Advancement of Science signed within one year, and to the start of the OAE activities in January 2020. This three-year period was also marked by the consolidation of the IAU's international collaboration through its other offices, namely - The revision of the agreement with the Norwegian Academy of Science and Letters (2019) which resulted in a substantial update of the Office of Young Astronomers (OYA); - The revision of the agreement with the National Astronomical Observatory of Japan, leading to a profound restructuring and improvement of the Office of Astronomy Outreach (OAO); - The review of the agreement with the National Research Foundation of South Africa for the Office of Astronomy for Development (OAD).Regardless of whether they pursue ambitious programmes tailored to their specific missions, the four IAU Offices now have a similar structure and coordinate an incredible worldwide network of regional nodes and hundreds of national teams in over 100 countries. Another major achievement in the triennium was the creation of Catalyst (2019), a new concept for the IAU Bulletin revived after a long hiatus. Catalyst is intended to be a tool for direct communication between the various structures and members of the IAU, and with other international scientific organisations. The period 2018-2021 was also an intense period for key management initiatives essential in an international organisation. Relevant missing policy documents were prepared, and others completely revised: - The Rules and Guidelines for Scientific Meetings, a concise document that replaces an earlier set of rules with many gaps and duplications; - Rules and Procedures for IAU missions; - The IAU Code of Conduct, including hectics and anti-harassment; - The IAU Communication Policy guidelines. Other successes include: - The exhaustive review of the IAU Website (structure and contents) valuing the institutional brand; - An agreement with the CNRS-INSU resulted in the free hosting of the IAU Office by the Institut d'Astrophysique de Paris; - Changing the application process for individual members that have become annual since 2019. The triennium was also very successful in the relationship with sponsoring organisations: the Kavli Foundation, the Gruber Foundation and the Shaw Prize Foundation, which since 2019 has financed the annual Shaw-IAU Workshop on "Astronomy for Education" organised by the OAE. Of course, this triennium was also unique due to the pandemic and its impact on our lives and practices. For the IAU, which is all about cooperation, networking, knowledge-sharing and public engagement, it was a huge challenge: the Paris Office was closed for some time, most scientific meetings and other activities planned for 2020 were postponed, or cancelled, including the XXXI General Assembly, with the exception of the business sessions held in virtual format (August 2021). Even so, the IAU did not stop and reacted to the circumstances in order to fulfil its mission. We know that the IAU was created in difficult times. We also know now that it is capable of continuing and even making great strides in very difficult and unusual circumstances. The IAU is indeed an impressive and vibrant organisation!

Cover of 1st Catalyst (The IAU Catalyst — a Revival of the IAU Bulletin)

A group photo of signing the agreement for hosting the IAU OAE by the Max Planck Institute for Astronomy, during the 1st IAU-Shaw Workshop in Paris, December 2019 (see IAU Office of Astronomy for Education Agreement Signed during the 1st IAU–Shaw Workshop)

Focus Meeting 8

Planetary Astronomy via Telescopic and Microscopic Approaches

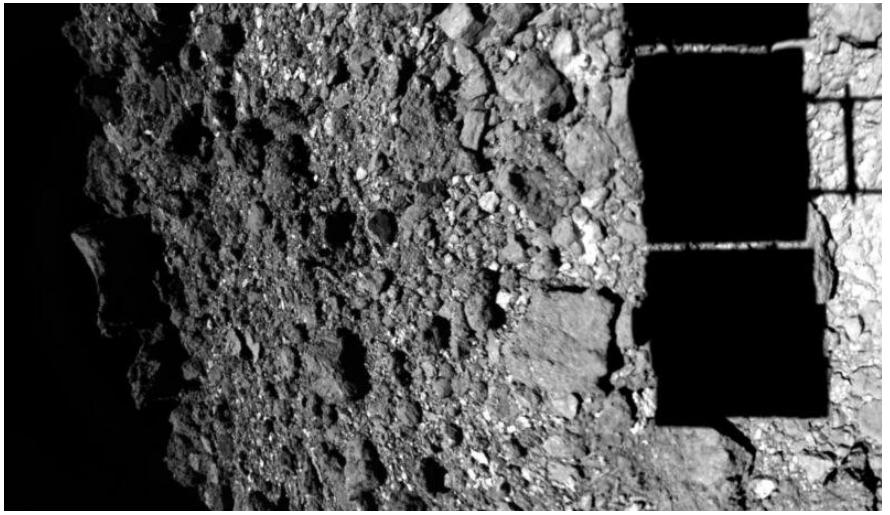
Focus Meeting 8: Planetary Astronomy via Telescopic and Microscopic Approaches	
START DATE	Tuesday, 2 August
END DATE	Wednesday, 3 August
ORAL SESSIONS	Room 106, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

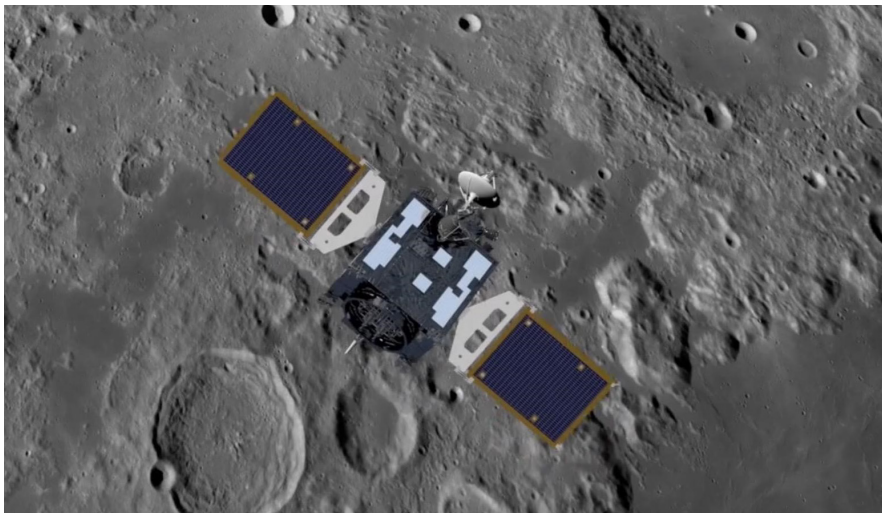
The Solar System research is on course to a new frontier with cutting-edge technologies lifting its sophistication to unprecedented levels. Advanced telescopes and microscopes have presented a closer-than-ever look at distant celestial bodies that are still shrouded in mystery. And we are now seeing a layer of the mystery peel off when materials brought by sample-return missions are analyzed.

The Focus Meeting 8 (FM8), set to take place as part of the IAU GA 2022 in the Republic of Korea, will review recent achievements and findings in this field and discuss issues that need to be explored in the coming decades. It will put together planetary astronomers around the world who study their targets with a wide range of sizescales using various techniques. They will share their latest findings and ideas for future missions, setting the stage for young researchers in related fields and students to think about the uniqueness of our planetary system and the origin of life as we know it.

Broadening the lens and studying other solar systems are critical to construct 'comprehensive references for distant worlds.' And doing so is getting easier and technically guided thanks to increasingly sophisticated instruments. In other words, we are making progress and growing sophisticated in Solar System research with telescopes and microscopes, and we are about to establish a new frontier in research linking the Solar System, exoplanets, planet-forming regions, and astrobiology. It was



The surface of Ryugu as Hayabusa2 made its approach (ISAS)



An artist's impression of the Korean Pathfinder Lunar Orbiter at the Moon (KARI)

something unthinkable five decades ago when the first human landed on the Moon. But it's no longer the case. The planetary science community has grown tremendously, surveying small Solar System bodies by telescope, sending spacecraft to all major planets, and sending spacecraft to some smaller Solar System bodies. These celestial bodies, once considered unreachable, are now visited and investigated by spacecrafts and their onboard instruments. The research targets in planetary science have downsized significantly from kilometer to submicron, or even smaller. Theoretical approaches such as light scattering models for understanding the observational data have similarly improved in sophistication.

In addition, a series of sample return projects will enable us to build a link between telescopic and microscopic approaches. Starting with the Stardust and Hayabusa missions, planetary scientists are now analyzing extraterrestrial materials in the laboratory, under the microscope and at nanoscale. While Hayabusa2 brought collected samples to the Earth in 2022, OSIRIS-Rex will return with carbonaceous materials from their target asteroids in 2023. They will provide the first opportunity to analyze pristine minerals and organic materials in the laboratory.

The sessions of the Focus Meeting will focus on the following:

- Planetary science with ground-based and spaceborne surveys, Hayabusa2 and OSIRIS-REx
- Remote sensing observations, Rosetta, Dawn, and other missions
- Celestial bodies under the microscope, sample analyses for space missions, laboratory studies with microscopes, and organic matter in small bodies
- Interdisciplinary science, extrasolar planetary systems, and future projects

HONG-KYU MOON, is a planetary astronomer at Korea Astronomy and Space Science Institute, South Korea and the Chair of IAU Focus Meeting 8.

MASATERU ISHIGURO, is a professor at Seoul National University, South Korea and the Co-Chair of IAU Focus Meeting 8.

ANTONELLA BARUCCI, President of Division F Planetary Systems and Astrobiology, is an astronomer at Paris Observatory involved in many space mission and at present PI of the MIRS instrument of the JAXA MMX mission.

RICARDO GIL-HUTTON, is a professor at San Juan National University, Argentina, and Vice-president of IAU Commission F4.

Focus Meeting 9

Stellar Synthetic Spectra to Study Stellar Populations in the Era of Gaia

The goal is to assemble the community that has made significant advances in the last ten years in the field of model atmospheres, in the modeling of stellar spectra and the use of synthetic spectra to interpret the observations of stars in the Galaxy and in the Local Group galaxies. Our focus meeting is particularly timely since our community will be involved in the analysis of a plethora of upcoming ground and space-based observations obtained using sophisticated instruments such as the next generation ESO instruments 4MOST and MOONS or NIRSpec on board of the James Webb Space Telescope.

Focus Meeting 9: Stellar Synthetic Spectra to Study Stellar Populations in the Gaia Era	
START DATE	Tuesday, 2 August
END DATE	Wednesday, 3 August
ORAL SESSIONS	Room 109, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

The meeting is in memory of Fiorella Castelli who greatly contributed to the field.

Among the questions that we wish to tackle are: What developments do we need for non-LTE modeling? What developments do we need for 3D model atmospheres? What are the best ways to scale up these methods and compute large grids of model atmospheres and synthetic spectra, to meet the needs of modern stellar surveys ? What are the best ways to validate the realism of synthetic spectra and colors? What is the role of relatively small samples of stars with extremely high quality observations, in the era of large surveys? What are the best ways to extract astrophysical information from extremely large collections of data?

One of the peculiarities of this focus meeting is that there are no invited talks. We decided to experiment this format since we felt that too often younger scientists are not given enough space in international meetings, given the small fraction of time often reserved to contributed talks. We consider our experiment has been a success, we have 25 talks, two e-talks and seven e-posters. Of the 25 talks 10 will be delivered by PhD candidates. We do not have the data “years after PhD” to make a proper statistics, but from personal acquaintance we can say that the younger scientists are well represented, quite likely more than they would have been if we had decided to invite speakers, several of which would have been “not-so-young”.

The topics covered are very diverse and stimulating ranging from the recent efforts in 3D simulations of stellar atmospheres and related spectrum synthesis to kinetic equilibrium computations (non-local thermodynamical equilibrium) to the use of stellar spectra in a cosmological context to the results of large spectroscopic surveys. The talks provide a good sample of theory and practice and we hope they will provoke interesting discussions and spin off new collaborations. We hope to see many people drop by and follow the talks of FM 09!

Piercarlo Bonifacio is Research Director of CNRS at GEPI department of Observatoire de Paris (PSL University) and French PI of the WEAVE multi-object instrument on the WHT.

Swetlana Hubrig is an emeritus researcher at the Leibniz-Institut für Astrophysik Potsdam (AIP) and the former head of its Stellar Physics and Stellar Activity section.

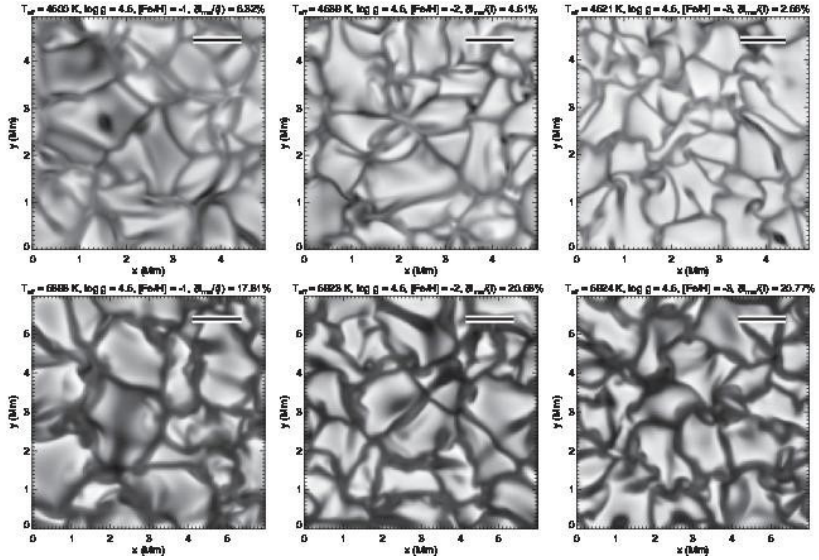


Figure 1
Tremblay et al. 2013, A&A 557, A7. Emergent bolometric intensity for dwarfs at different metallicities. In the first row, Teff = 4500 K, log g = 4.5, and [Fe/H] = – 1, – 2 and – 3 (from left to right). In the second row, Teff = 5900 K, log g = 4.5, and [Fe/H] varies again from – 1 to – 3. © Astronomy & Astrophysics

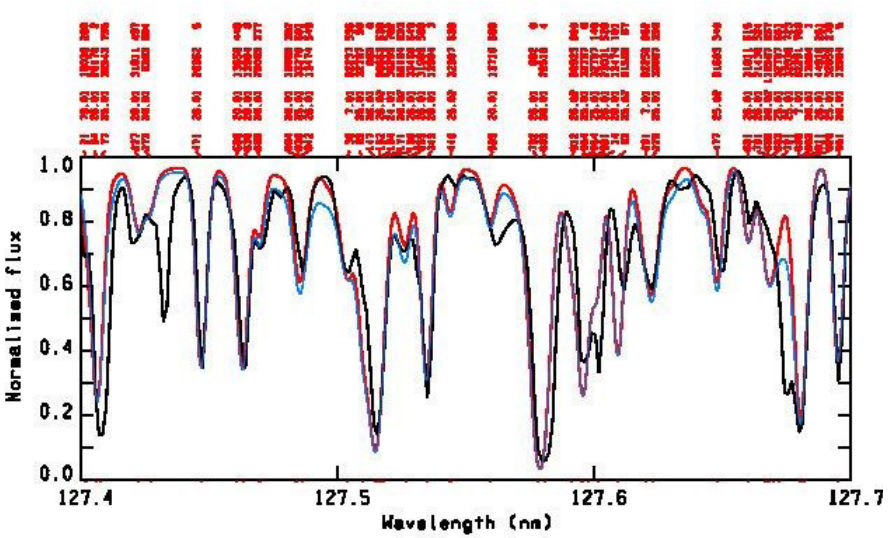


Figure 2
Castelli et al. 2017, A&A 601, A119. A portion of the STIS-HST spectrum of the Bp star HR6000, N I lines of UV mult. 4 at λλ 1492.625, 1492.820, and 1494.675 Å (black), compared to a spectrum synthesis (red). © Astronomy & Astrophysics

Symposium 368

Machine Learning - Possibilities and Pitfalls

Symposium 368 of the IAU GA in Busan from Aug 2 to 4 2022 revolves around machine learning in astronomy, in particular the potential it has created to solve many problems in astronomy, but also the possible problems that can be encountered when applying these often black-boxy techniques without proper care.

We received overwhelming support with close to 450 astronomers wanting to attend the symposium in person, and about 100 submitting abstracts for presentations. We have tried to select representative presentations from across the spectrum, and the talks cover theory, simulations, applications, interpretations and are on datasets from the Solar System to Galactic to extragalactic astronomy to cosmology.

There were many more deserving abstracts that had to be converted to e-talks and e-posters. The e-talks will be available throughout, and the e-poster presenters will have short windows during the main conference to advertise their posters. We have ensured that we have kept ample time for discussion through various panels on topics like GW/MMA, broader ML, and fusion of large datasets in which all attendees will be able to participate.

The invited talks cover several related topics going into more details of aspects like existing datasets for machine learning in astronomy (Renee Hlozek), physics informed ML for exoplanet surveys (Eric Ford), tools for outreach and education (Ivy Wong), as well as overviews like ML in astronomy (Michelle Lochner), and more generic tutorials on ML for the broader community (Sara Webb), and classic ML techniques (Guillermo Cabrera-Vivas).

The plenary talks will address the trends and challenges in deep learning (Ofer Lahav), and the path to collaborative Human-AI learning (George Djorgovski).

The challenges that ML is facing include the lack of interpretability and explainability. On another level not many techniques allow for proper uncertainty quantification. While we do not expect the symposium to solve these big problems, even if a larger set of users and practitioners become aware of the issues, we will see better ML practices in the future and more applications.

The broad hope and expectation is that attendees get the breadth of available datasets and techniques, and the expertise on display during the symposium allows them to step out of their comfort zone to take on bigger problems in a safe manner. In particular, we hope to see more population studies incorporating more publicly available datasets (including transfer learning across datasets) rather than specialized studies involving smaller private and proprietary datasets, and we believe the symposium will help us move in that direction.

The SOC of the symposium includes: Ashish Mahabal (Co-Chair, Co-Editor), Christopher Fluke (Co-Chair, Co-Editor), Tara Murphy (Co-Chair), Jessica McIver (Co-Editor), G C Anupama, Dalya Baron, Nadia Blagorodnova, Andrew Connolly, Gwendolyn Eadie, Francisco Forster, Vanessa McBride, David Parkinson, Kai Polsterer, Pavlos Protopapas, Arman Shafieloo.

IAU Symposium 368: Machine Learning in Astronomy - Possibilities and Pitfalls	
START DATE	Tuesday, 2 August
END DATE	Thursday, 4 August
ORAL SESSIONS	Room 205, Convention Hall, 2nd Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

Ashish Mahabal is an astronomer and lead computational scientist at Caltech's Center for Data Driven Discovery. He is interested in discovering and interpreting unusual objects in large astronomical datasets.

IAU Office for Astronomy Outreach: building bridges through access, communication and international cooperation

The IAU Office for Astronomy Outreach (OAO) is a joint project of the International Astronomical Union (IAU) and the National Astronomical Observatory of Japan (NAOJ), based in Tokyo, Japan. Our work builds bridges between the IAU and the global astronomy community of amateur astronomers, outreach practitioners, educators, communicators, and the general public. Through this and our international collaborations, we aim to make the science of astronomy accessible to all.

Office Meeting: IAU Office for Astronomy Outreach	
START DATE	Tuesday, 2 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 108 (8/2), 101 (8/8), Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

The goal of the OAO is to engage the public in astronomy through access to astronomical information and communication of the science of astronomy. We accomplish this through our network of IAU National Outreach Coordinators (NOCs) and the IAU's engagement initiatives with the public.

During the XXXI IAU General Assembly in Busan, our team is looking forward to meeting the IAU members and other participating astronomy professionals. During these two weeks, we hope to engage with you as much as possible. We, therefore, issue an open invitation for all to drop by our booth in person, if you are joining us face-to-face, or online, if you are attending virtually. We have prepared an exciting and engaging programme that will hopefully foster future collaborations between you and our IAU Outreach programmes, and inspire you to share the wonders of the universe with your communities.

Meet the IAU Astronomers!
Bring IAU members into astronomy clubs, classrooms, museums, or out-of-school-time initiatives.

100 Hours of Astronomy
An event of 100 hours of continuous astronomy outreach events in October.

Women and Girls in Astronomy
A project to honour the contribution of women and girls to astronomy. Most events run throughout February and March centred around the International Day of Women and Girls in Science (11 February) and International Women's Day (8 March).

Dark and Quiet Skies Awareness
A project to raise awareness of the need for dark and quiet skies centred around the month of May and the International Day of Light (16 May).

NameExoWorlds
A programme that offers the public the opportunity to give a name to one exoplanet and its host star.

Inclusive Outreach Astronomy
A programme that aggregates best practices in diversity, equity, and inclusion, collected from practitioners from around the world. These resources help create astronomy outreach events or programming that are accessible to audiences of all abilities.

Communicating Astronomy with the Public
A collection of programmes to support the professional development of astronomy communicators, including CAP Conferences, CAPjournal and CAP Public Engagement Training.

In addition to welcoming you to our OAO booth, we are looking forward to seeing you in our workshop on August 9th, and at OAO sessions throughout the General Assembly.

You can access our programme here:
https://www.iau.org/public/oao/gabusan2022/

Overall, our programmes help build relations between professional astronomers, amateurs, and the public, creating fairer societies that are able to think critically and make informed decisions using science.

The OAO team wishes you a fruitful and inspiring General Assembly. We are looking forward to engaging with you!

Lina Canas, on behalf of the OAO Team

LINA CANAS is the Director of the IAU Office for Astronomy Outreach. The OAO is a joint venture between the International Astronomical Union (IAU) and the National Astronomical Observatory of Japan (NAOJ) with the goal of making astronomy accessible to all.

The Office of Astronomy for Development

OFFICE OF ASTRONOMY FOR DEVELOPMENT

The International Astronomical Union's Office of Astronomy for Development (OAD) was established in 2011 and aims to use the skills, methods and techniques of astronomy to impact socio-economic development. The Office is based in Cape Town, South Africa, and is a joint venture between the International Astronomical Union and South Africa's National Research Foundation, with strong support from South Africa's Department of Science and Innovation.

The OAD advances development through an annual call for proposals that is open to anyone, anywhere in the world, and provides seed funding for innovative "astronomy for development" projects. The OAD also had three flagship projects along the themes of "Astronomy for stimulating economies", "Astronomy in science diplomacy" and "Knowledge & skills from astronomy". Central to the OAD's effectiveness is its family of eleven regional and language centres, along with a broad network of volunteers and fellows.

The OAD institutional meeting will take place at GA2022 in 5 sessions on the 3rd and 8th of August. The key discussion topics are:

- OAD Flagship Projects
- Global structure in astronomy-for-development – OAD's Regional Offices
- OAD Projects – evaluation and future directions; impact of COVID-19 and related projects
- Interdisciplinary imperatives: synergies between natural and social sciences for the UN Sustainable Development Goals
- Reviewing the OAD: Past, present and future of Astronomy-for-Development
- Synergies between IAU structures (OAD, OAO, OYA, OAE, IAU Divisions, etc)

Office Meeting: IAU Office for Astronomy Development	
START DATE	Wednesday, 3 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 108 (8/3), 205 (8/8), Convention Hall, 1st and 2nd Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

The mission of the OAD is driven, in large part, by the global astronomy community. In his talk at the virtual business sessions of the IAU organised in 2021, OAD Director Kevin Govender appealed to the IAU membership, communicators, educators, and the larger astronomy community to join hands with the OAD, contributing their skills and time to create a better world for all. He said, "The global pandemic has highlighted the great challenges of our time and the inequalities that persist. The OAD is a place for people to come together and tackle these challenges by applying the sophistication and grandeur of astronomy." Chat to us online (info@astro4dev.org), at the OAD institutional session at GA2022, or at the IAU exhibition booth at BEXCO about how we can collaborate to use astronomy towards a better world!

www.astro4dev.org

Astronomy for Development at the IAU General Assembly 2022: https://www.astro4dev.org/iauga2022/



This article is written by Kevin Govender, Vanessa McBride and Ramasamy Venugopal for the Office of Astronomy for Development.

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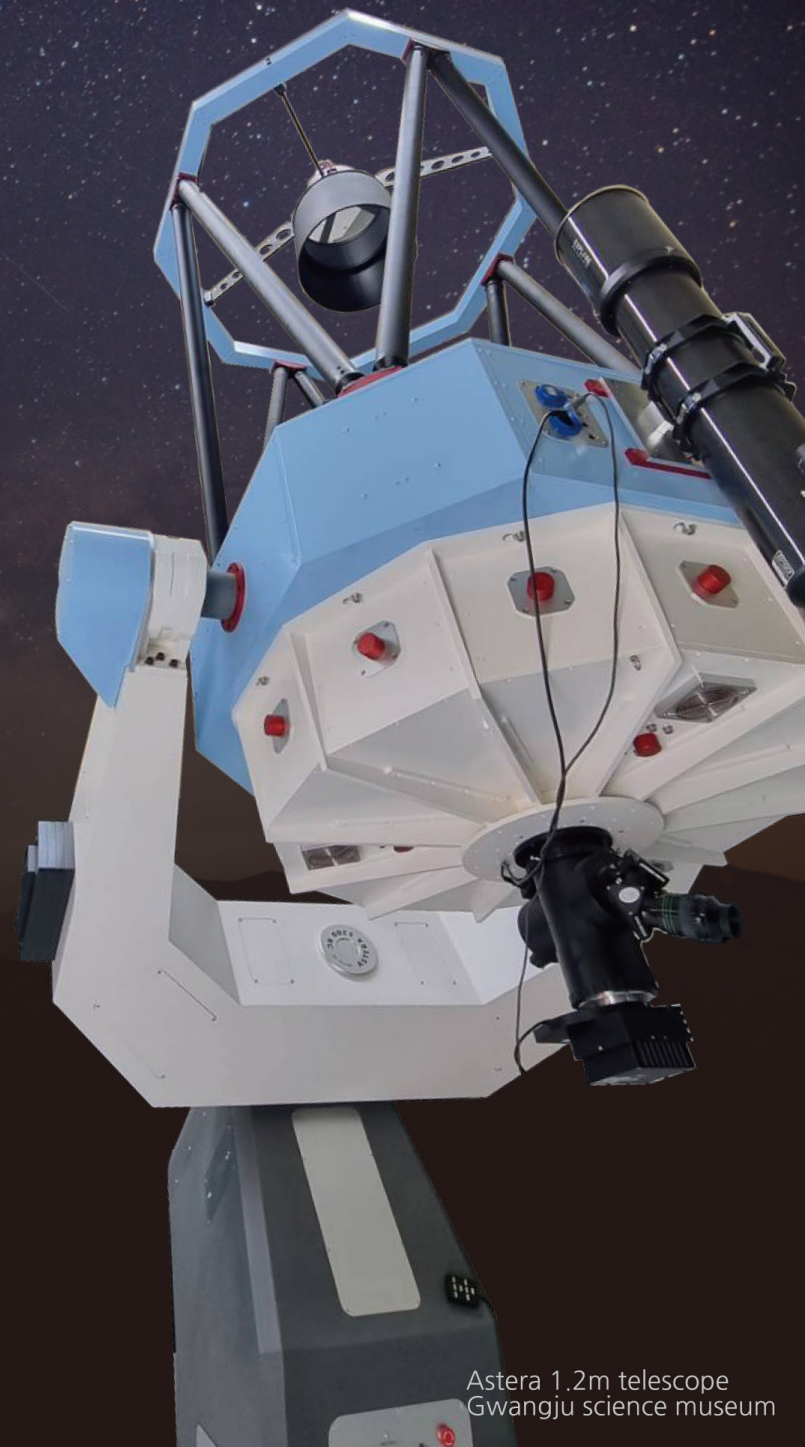

Astera 1.2m telescope
Gwangju science museum

REALIZATION OF THE FUTURE ASTRONOMY

- Telescope on Earth
- Telescope in Space
- Astronomical Research
- Astronomical Education

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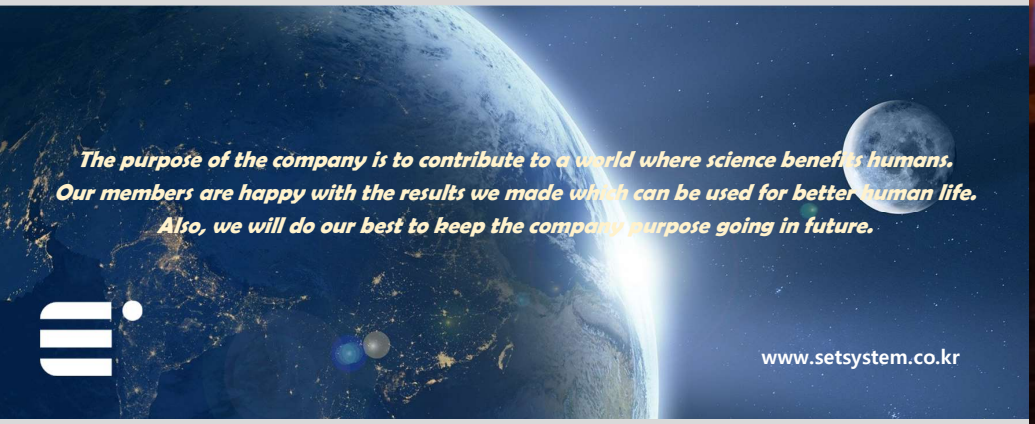
SETsystem Inc. is a research based small business firm established in 2006. Most of the members have their academic background in Astronomy and Space science. As you can guess from the company name, we deal with scientific projects related to space and earth. More specifically, we are specialized in the field of Space Situational Awareness (SSA) including space weather and radar based space surveillance and tracking (SST).

For the Korean Space Weather Center, a government agency responsible for space weather research and operation of the Republic of Korea since 2011, we have developed algorithms for 1) solar absolute radio flux calculation, 2) automatic classification of solar radio burst type II and III, 3) digital beamforming routine for low frequency InterPlanetary Scintillation (IPS) array, 4) algorithm for Geomagnetic Induced Current (GIC) calculation, 5) analysis and visualization of various space weather data etc. In the field of instrumentation, we have developed several space weather oriented equipment including 1) Solar 2.8 GHz absolute flux receiver, 2) Multi frequency solar radio flux receiver, 3) IPS array radio telescope for solar wind imaging, 4) GIC monitoring system.

Based on experience from space weather projects, we expanded our business area which develop both software and hardware of remote sensing instrument for scientific and civil usage. The first remote sensing instrument was High Frequency Surface wave Radar. HF ocean radars are efficient to monitor wide areas of ocean at low cost, and are used to measure ocean currents and waves in many countries. You can find specification/features and performance verification of developed HF ocean radar, called "SEODAE" on the company website, www.setsystem.co.kr. The same technique was applied to X-band patch array radar we have been developing recently, the X-band FMCW radar together with digital beam forming process allows various applications in real day like 1) basic testbed for the Space Surveillance Radar 2) detecting low RCS (radar cross section) targets, Drones, micro-UAVs.



Opening Ceremony at the IAUGA 2022

Opening Ceremony at the IAUGA 2022

Opening Ceremony at the IAUGA 2022

Issue 3 | August 4, 2022

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미리내 The Milky Way

IAU | IAUGA Astronomy for the Future Busan 2022 | THE KOREAN ASTRONOMICAL SOCIETY 한국천문학회 | KASI Korea Astronomy and Space Science Institute

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#IAUGA2022 is an official hashtag of the IAUGA2022

Looking into the Sun and stars

Conny Aerts and Jørgen Christensen-Dalsgaard, Kavli Prize Winners

After completing his MSc at Aarhus University, Denmark, Jørgen started his PhD studies in Cambridge, UK, working on solar modelling and oscillations. During his studies, observations by Franz Deubner confirmed the modal identification of the five-minute oscillations made by Roger Ulrich. At the same time, data on the solar diameter by Henry Hill hinted at global solar oscillations (the data were later found to be spurious). This changed the direction of Jørgen's work towards testing the possibilities of using such data for probing the properties of the solar interior.

The first truly global solar oscillations were identified by George Isaac and his group in Birmingham in 1979, observing the Sun as a star. This restricted the modes detected to those of the largest scale on the solar surface, which are also the modes that penetrate to the solar core. Detailed observations of these modes were obtained shortly after from the South Pole by Gerard Grec and Eric Fossat from Nice, together with Martin Pomerantz, providing the first observational constraints on the solar core. Such data were used a few years later by Yvonne Elsworth and her Birmingham collaborators to confirm models of the solar core at a level that demonstrated that the observed low level of neutrinos from the Sun were unlikely to be caused by errors in the solar model. This has later been confirmed by the definite detection of changes in the nature of neutrinos en route from the sun to the detectors.

In parallel, the first observations were obtained of the resolved oscillations on the solar surface, providing a much richer set of data for modes sampling different parts of the Sun. On this basis Jørgen and his collaborators could make a first inference the sound speed in the solar interior in substantial detail, and with his student Jesper Schou he obtained an early determination of the variation of rotation inside the sun, from a dependence on latitude in the outer layers to nearly uniform rotation in the deeper interior.

Since these early investigations, space-based observations and ground-based networks have provided a huge amount of very detailed information on the solar interior. As an example, Fig. 1 shows inferred differences between the solar squared sound speed and that of a solar model. Superficially, the agreement is excellent, at a level below one per cent; however, compared with the very small statistical uncertainty in the results there are highly significant differences between the sun and the model, later aggravated by revisions in determinations of the solar composition. A determination of solar internal rotation is illustrated in Fig. 2, clearly showing the relatively sharp transition between rotation in the convection zone and the radiative interior. The origin of this behaviour is still not fully understood.

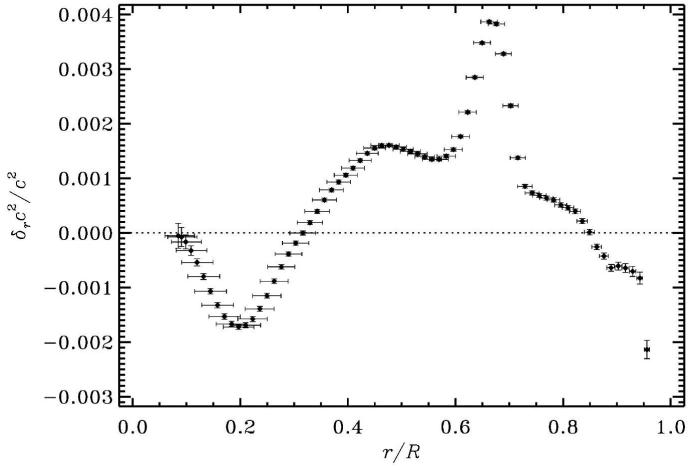


Figure 1: Relative difference between the squared sound speed in the Sun and the corresponding results for a solar model, as a function of the distance to the solar centre in units of the solar surface radius. The (barely visible) vertical bars show the statistical uncertainty in the results, while the horizontal bars indicate the resolution of the analysis. Courtesy Maria Pia Di Mauro.

From the realization that solar oscillations are excited by the turbulence in the outer convection zone followed that similar oscillations were expected in all cool stars with outer convection zones, including low-mass main-sequence stars. However, the very small oscillation amplitudes greatly complicated actual detection. The first definite success, in observations in 1995 made by Jørgen's group, concerned the subgiant η Bootis. This was followed by a few additional detections over the following years, notably for α Centaurus A, a solar twin, announced by Swiss astronomers at the Leuven pulsation conference in 2001. However, a major breakthrough came with the launch in 2009 of the NASA Kepler mission, with the primary goal of detecting extra-solar planetary systems using the transit technique. The exquisite photometric precision allowed the detection of solar-like oscillations in a large number of stars, including tens of thousands of red giants. Analyses of data on main-sequence stars hosting exoplanets have identified planetary systems twice as old as the solar system, while observations of red giants have distinguished between stars without and with helium fusion in their helium cores, and have determined the rotation rates of the cores, in tension with current models of stellar evolution.

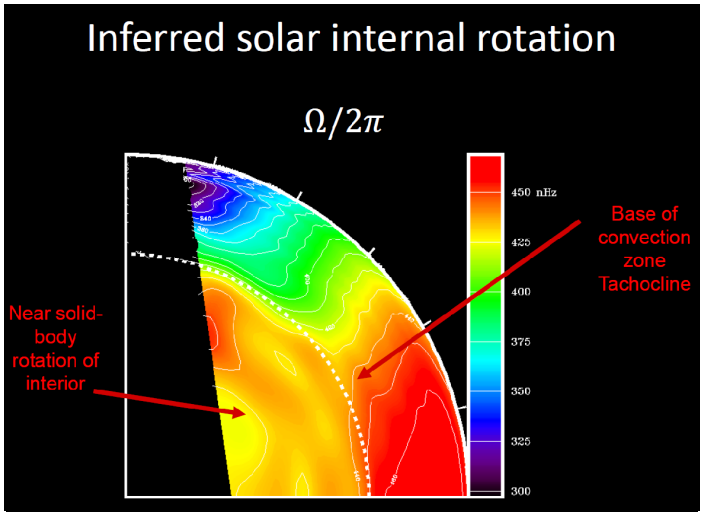


Figure 2: Rotation rate in the quarter of a cross-section of the Sun. The dashed line marks the bottom of the convection zone, which also marks the transition between the differential rotation in the convection zone and the nearly uniform rotation in the deeper interior. Courtesy Rachel Howe.

Kepler ended its mission in 2018, but similar observations are now carried out by the NASA TESS mission, and further extensive data of very high quality are expected from the ESA PLATO mission planned to provide its first data as of 2027. Both Jørgen and Conny are heavily involved in TESS and PLATO. While Jørgen is one of the founding fathers of helio- and asteroseismology, Conny is a representative of the second of meanwhile four generations of asteroseismologists. After completing her MSc studies in mathematics in 1988 at Antwerp University, she took up PhD studies in astrophysics in Leuven, both in Belgium. For her PhD, she developed methodology to identify nonradial oscillation modes from high-resolution time-series spectroscopy. This was at a time when such type of measurements constituted a technological novelty, only accessible with high signal-to-noise within short integration times of less than half an hour for bright stars. In her PhD thesis she presented mode identifications for several bright stars based on such high-precision spectroscopic data.

Meanwhile, Conny's asteroseismic studies cover stars with a broad range of masses, evolutionary stages, and rotation rates. She is mostly recognised for her work on massive pulsators, including those that will explode as supernova at the end of their evolution. In 2003 she offered the first asteroseismic measurement of the internal rotation rate at the convective core of such a "pre-supernova" pulsator from long-term multicolour photometric monitoring by many Leuven group members (during 21 years!). As a postdoctoral researcher, Conny undertook numerous asteroseismic studies of stars covering the broad mass range between 1.3 and 9 solar masses. Such stars reveal nonradial gravity modes with long periods of roughly half to three days. Such slow modes are among the toughest to study because their rotation and oscillation periods are similar, both on the order of the daily rhythm of our planet's rotation period. This not only offers a challenge observationally – essentially making ground-based asteroseismology of such stars impossible - it also implies a challenge for their modelling, as one cannot treat the rotation as a small perturbation as in the case of the fast oscillations of sun-like stars and red giants.

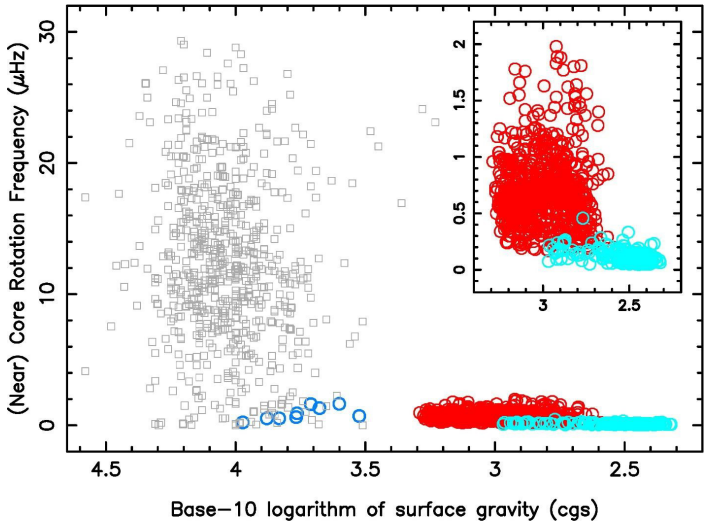


Figure 3: The core or near-core rotation frequency of more than 1000 stars in our Milky Way covering the mass range between 0.7 and 8 times the mass of the sun as deduced from asteroseismology is plotted against their surface gravity. The different symbols stand for core-hydrogen-burning dwarfs with a mass between 1.3 and 8 solar masses (grey squares), low-mass subgiants (blue circles), stars in the shell-hydrogen-burning stage climbing up the red giant branch (red circles), and core-helium-burning giants (cyan circles). Figure reproduced from Aerts, C., 2021, Reviews of Modern Physics, Vol.93, 015001.

The gravity modes of intermediate- and high-mass stars are strongly affected by their rotation. Kepler data revealed that stars born with a convective core have a diversity of internal rotation periods, with some stars revolving only once during several hundred days while others do it in less than a day. The Coriolis force implies a serious mathematical complication in the description of the internal structure and nonradial oscillations of rapid rotators, but at the same time it offers a wonderful diagnostic tool to unravel the rotation rate near their convective core. Fig. 3 is a reproduction of Conny's summary plot of internal rotation rates for more than 1000 stars, assembled by three generations of asteroseismologists. Two decades ago, this diagram was empty! The first measurements occurred between 2003 and 2011 for less than a handful of massive stars. Evolved low-mass stars started populating this figure as of 2012. Since rotation has a major impact on the way chemical species get mixed inside stars, asteroseismology brings a powerful tool to evaluate how gradients of the internal rotation contribute to the chemical evolution of stars, which will ultimately offer a new understanding of the yields expelled throughout stellar life via stellar winds and supernova explosions.

In conclusion, asteroseismology of thousands of low-mass stars offers precise age-dating for galactic archaeology and of exoplanet hosts, while its applications to hundreds of massive stars allows us to calibrate the chemical evolution models of our Milky Way. In the next era, TESS and PLATO will offer the use of this wonderful tool to more than a million metal-poor and metal-rich stars in the Milky Way. Along with Gaia measurements, the duet of space asteroseismology and astrometry will make it possible to look back upon our galaxy's history and to guide the way to compute its future chemical enrichment and fate.

Autobiographies are available at
https://www.kavliprize.org/conny-aerts-autobiography
https://www.kavliprize.org/jorgen-christensen-dalsgaard-autobiography

Helioseismology - My role in the beginnings

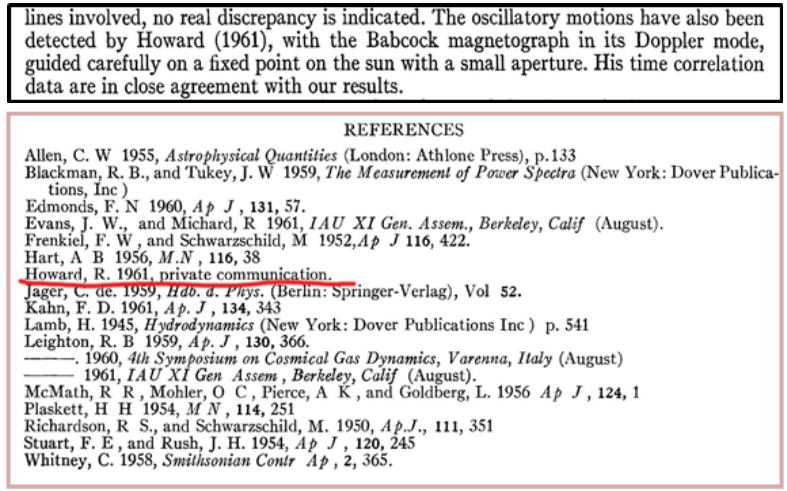
Roger Ulrich, Kavli Prize Winner

Helioseismology began with the 1962 report by Leighton, Noyes and Simon announcing the discovery of the 5-minute oscillations. As a side note, the Babcock magnetograph included a cam with an attached meter stick on the Doppler compensator which tracks the displacement of the spectral line being used to measure Zeeman splitting. Bob Howard later commented to the Mt. Wilson staff that he had seen oscillations in the cam position but never reported the motions to the astronomical community. The attached photograph shows the meter stick and Howard. Leighton and students adapted a technique invented by Fritz Zwicky to image the velocity by subtracting spectrally resolved photographic images from the red and blue wings of the line. The Leighton, Noyes and Simon paper references Howard for a private communication about the oscillations in 1961.

The discovery above all happened before I was a professional astronomer. As a graduate student at UC Berkeley I worked in Louis Henyey's group studying stellar structure and evolution. My thesis was on convection where I tried to improve the mixing length theory. As I was nearing completion of the thesis, John Bahcall visited and suggested we should compute a solar model. I computed a solar model, sent it to John and was greeted by return mail with a list of things that had to be fixed. These got done and a paper published with help from fellow graduate students. I got an invitation from John to come to Cal Tech and work on computing solar models. I accepted John's invitation and started a collaboration studying solar neutrino fluxes that lasted years.

My interest in the solar 5-minute oscillations began with observations by fellow graduate student Ed Frazier which showed that the oscillatory motion was disrupted by convection cells rather than being generated. Based on that clue, I carried out a modal analysis of a numerical representation of a convective envelope. My calculations showed that the oscillatory power should be restricted to frequencies that depend on the horizontal wavelength.

Confirmation of my prediction required using measurements from new instruments developed at Sacramento Peak Observatory and at Kitt Peak Observatory. These instruments obtained 2-dimensional grids of the velocity at regular time intervals for a duration of hours. Eventually



lines involved, no real discrepancy is indicated. The oscillatory motions have also been detected by Howard (1961), with the Babcock magnetograph in its Doppler mode, guided carefully on a fixed point on the sun with a small aperture. His time correlation data are in close agreement with our results.

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Edward Rhodes, Jr., myself and Franz Deubner made the required observations and confirmed the predicted pattern.

Ed and I subsequently spent years persuading NASA to put an instrument on a spacecraft where the solar oscillations could be observed continually. In parallel a network of instruments was built by the Global Oscillation Network Group (GONG) to make the necessary observations from multiple ground instruments. These projects led to the development of helioseismology as a major technique for the study of solar interior structure and dynamics.

I enjoyed an important opportunity supported by the American Astronomical Society who decided to hold their 2017 Fall meeting in Portland Oregon so that an excursion to the August 17 eclipse could be arranged. I invited family members to take advantage of this and twelve relatives came and enjoyed the totality.

An extended version of my story is at:
https://www.kavliprize.org/roger-k-ulrich-autobiography

The oral history project at Cal Tech includes a description of the 5-minute oscillation discovery which can be found at:
https://resolver.caltech.edu/CaltechOH:OH_Leighton_R SESSION 4: January 13, 1987

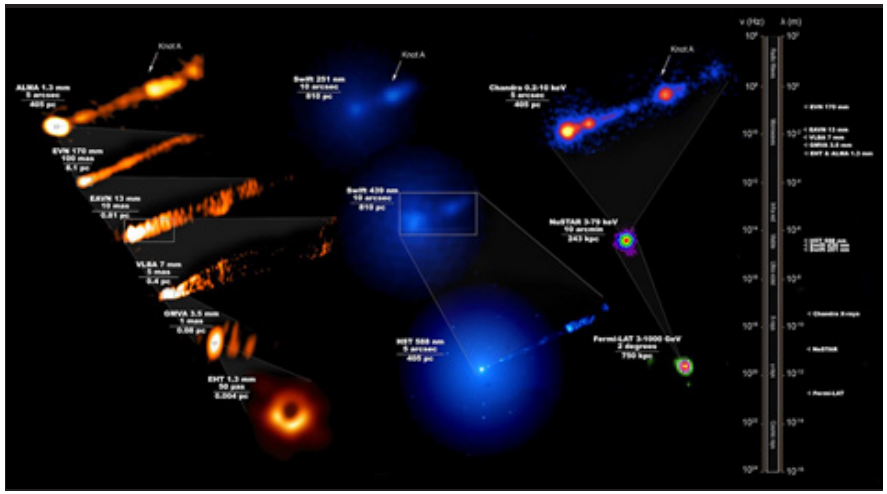
Focus Meeting 1

Physics of relativistic jets on all scales

Relativistic jets are among the most powerful manifestations of the energy released by compact objects on galactic and extragalactic scales. Non-thermal processes operating in jets are responsible for multi-messenger emissions, such as broadband electromagnetic radiation, from radio band to gamma rays, and high-energy neutrinos. Active Galactic Nuclei with powerful relativistic jets represent the dominant fraction of the extragalactic population observed at the highest energies. Their gamma-ray emission is often characterized by huge flares that may also be detected at longer wavelengths. The location (close to or at pc-scale from the central engine) and the physical mechanisms responsible for the gamma-ray emission is still largely debated, with shocks, turbulence, and magnetic reconnection, among others, being plausible particle acceleration mechanisms. Direct comparison between theoretical models and multiband observations provided by current and forthcoming facilities will be crucial for understanding the dissipation processes. Moving to larger scales, numerical simulations have been playing a key role in our understanding of jet structure and evolution as jets propagate in the environment. The presence of outflows of gas in active galaxies pinpoints the impact of relativistic jets on the host galaxy and the ambient medium, providing crucial information on the AGN-galaxy feedback. The importance of jet interaction with the surrounding medium, either within or beyond the host galaxy, needs to be considered in light of improved high-resolution multiband observations in continuum and spectroscopy. AGN are not the only engine able to produce a relativistic jet. Moving to galactic scales, jets are involved in many transient phenomena like long and short gamma-ray bursts, the latter being associated with the coalescence of binary neutron stars, giving gravitational waves.

Focus Meeting 1: Physics of Relativistic Jets on All Scales	
START DATE	Thursday, 4 August
END DATE	Tuesday, 9 August
ORAL SESSIONS	Room 109, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website



Event Horizon Telescope Multi-wavelength results of M87

The goal of this Focus Meeting is to bring together experts in observational, theoretical and computational astrophysics with the aim of promoting our understanding of the physics of relativistic jets. Relativistic jets are unique laboratories for studying the physics of matter and magnetic field in extreme conditions. This new era of multi-messenger astronomy will offer us the unprecedented opportunity to combine more than one messengers to solve some long-standing puzzles of jet physics. Critical to future understanding of jet physics will be joint observations and multi-wavelength electromagnetic coverage combined with the information from the different messengers. The Event Horizon telescope has already proved new imaging capabilities of horizon scales, something that was never achieved before. New and forthcoming facilities and new surveys that are collecting information on a large part

of the sky at different wavelengths, are bringing new capabilities and coverage. At high energies, the Cherenkov Telescope Array with its greatly improved sensitivity in the TeV energy range and the almost full sky cover, will open a new window to the high-energy sky, allowing for the first time statistical studies of jets at the highest energies.

The sessions planned in this Focus Meeting reflect these topics, which are key for understanding the physics and role of jets. Contributions will cover a broad range of communities working on jets providing the latest research findings and fostering interdisciplinary research and new ideas. Please join us!

Monica Orienti, Co-Chair of Focus Meeting 1, is a Researcher of National Institute for Astrophysics, Italy.

Bong Won Sohn, Co-Chair of Focus Meeting 1, is a Principal Researcher of Korea Astronomy and Space Science Institute, South Korea.

IAU Symposium 369

The Dawn of Cosmology and Multi-messenger Studies with Fast Radio Bursts

Fast radio bursts (FRBs) are brilliant bursts of radio emission that typically only last for milliseconds from sources located in distant galaxies. Their short durations and large distances necessitate extremely energetic and compact sources like neutron stars. Despite the discovery of thousands of FRBs since 2007, their true nature and energy production mechanism remains unclear. What makes them most intriguing is that they are cosmic messengers from halfway across the Universe. The radio signal is influenced by the material along their journey to the telescope on Earth and consequently are a gold mine of information as they bear the imprint of the intervening ionised gas. This provides us with a novel way to investigate the structure, matter and magnetic fields between stars and galaxies outside our Milky Way. With the ongoing development of new instrumentation and software, we have now reached a point where radical changes in the field occur on timescales of a few months. As a result, the quest to answer the fundamental questions of their enigmatic nature, progenitors, environments, spatial distribution, and their potential for use as cosmological probes is gaining enormous momentum. The aim of this symposium is to facilitate the essential convergence of data and theory at a time when many of the latest experiments will have been running for sufficient time to make significant progress in answering these questions.

IAU Symposium 369: The Dawn of Cosmology & Multi-Messenger Studies with Fast Radio Bursts	
START DATE	Tuesday, 2 August
END DATE	Thursday, 4 August
ORAL SESSIONS	Room 101, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

The last few years have revolutionized FRB astronomy, and as a community we are on the brink of answering some of the open questions regarding the nature and uses of FRBs. The entire electromagnetic spectrum along with gravitational waves and neutrinos are now open for FRB detections. With the potential of multi-wavelength detections and their uses as effective cosmological probes, it appears that FRBs have formed a bridge across all astronomy. The field has now reached a stage where progress in the field requires, and will benefit from, collaborations and exchange of knowledge and ideas with researchers from across the photonic and non-photonic windows as well. The Scientific Programme of the IAU Symposium 369 is built to aid and facilitate in the confluence of astronomers with expertise in other areas like cosmology, galaxy properties and dynamics, high-energy phenomena and stellar physics, which will be very useful for strategizing and planning the next decade of FRB astronomy. This look forward to the future is essential as the continuous improvement of current facilities and building of superb new facilities promise decades of exciting (astro)physics to follow.

Manisha Caleb, Co-Chair of IAU Symposium 369, is a Discovery Early Career Researcher Fellow and Lecturer at the University of Sydney. She is actively involved in the MeerTRAP project at the MeerKAT telescope to discover and study fast radio bursts.

Benjamin Stappers, Co-Chair of IAU Symposium 369, is a Professor at the University of Manchester. He is the PI of the MeerTRAP project at MeerKAT and his primary research interests are radio pulsars, neutron stars and rapid radio transients.

IAU Symposium 372

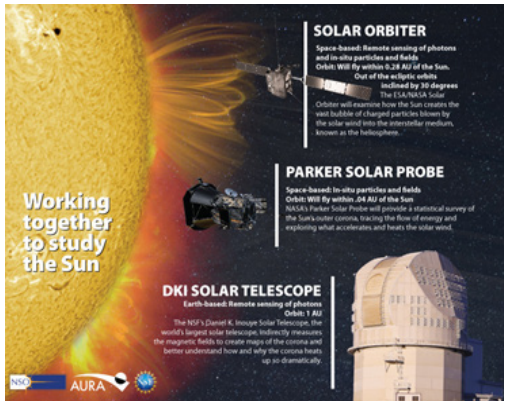
The Era of Multi Messenger Solar Physics

Multi-messenger science has a long history in solar astronomy. For decades, direct measures of particles emanating from the Sun, like the solar wind, have been used together with electromagnetic field diagnostics as the couriers of information. This approach has shaped our understanding of how solar activity forms and relentlessly influences its environment, and the planetary system existing within it.

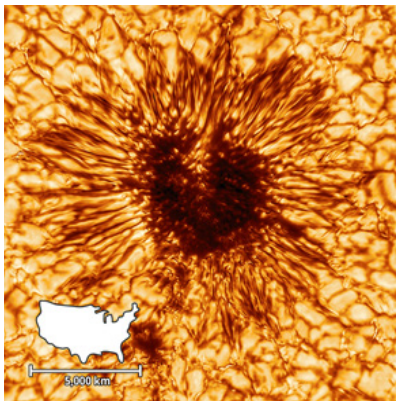
IAU Symposium 372: The Era of Multi Messenger Solar Physics	
START DATE	Tuesday, 2 August
END DATE	Friday, 5 August
ORAL SESSIONS	Room 104, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

A number of new facilities are now heralding an exciting era of scientific opportunities within multi-messenger solar physics. The NSF's 4-m Daniel K. Inouye Solar Telescope (DKIST), the largest high-resolution solar optical/IR ground-based telescope ever built, commenced its Operations Commissioning Phase in early 2022. Early science observations are already revealing details of the solar photosphere and chromosphere at scales of 20 km at the solar surface. The daring encounter missions Parker Solar Probe (PSP, NASA) and Solar Orbiter (SO, ESA/NASA), launched in 2018 and 2020 respectively, are both getting closer to the Sun during each orbit, providing unprecedented measurements of the outer solar atmosphere and solar wind. At the end of its nominal mission in 2025, Parker Solar Probe will approach our star at closer than 10 solar radii, well below the interface between the solar atmosphere and the freely flowing solar wind. Over the next several years, Solar Orbiter will instead gradually leave the ecliptic and reach an inclined orbit of up to 33 degrees, allowing the first clear view of the solar poles with remote sensing instrumentation. The upcoming multi-instrument Aditya mission from India, slated to operate at the first Lagrangian point, will add to this powerful suite of space facilities. Recent access to astronomical radio observatories like ALMA and LOFAR has added novel wavelength ranges to the already accessible spectrum, allowing us to better study the outer atmospheric layers of the Sun, as well as the creation and evolution of transients in the heliosphere, such as Coronal Mass Ejections and related disturbances. Dedicated solar imaging spectroscopy and polarimetry at microwave frequencies from EOVSA and MUSER are rapidly changing our understanding of the active solar corona and flares.



How to work together



DKIST first sunspot with scale

Each facility will provide fantastic new results. Still, the most profound advances in our physical understanding of the Sun and its environment are expected from combined, coordinated observations using many of them at once. Being able to observe the same target, at the same time, using many different diagnostics, allows us to clearly identify physical processes from their solar source to their effects at Earth, a unique capability that should be thoroughly exploited. Scientific synergies, as well as coordinated efforts among the different observatories (space or ground-based) are thus needed. Given the many different stakeholders, priorities, operational models and scheduling constraints,

all embedded in a quickly changing scientific landscape, this is a quite challenging task that we are just starting to address.

During IAUS372 we will discuss these new facilities, their coordination, and the exciting science they are enabling. The main scientific sessions will be held on August 2-4, 2022, and the plenary talk in the morning of August 5th.

Gianna Cauzzi is a scientist at the National Solar Observatory (USA). Her main scientific interests are related to the dynamics of small scale structures in the solar lower atmosphere. She is currently in charge of community activities related to DKIST science.

Alexandra Tritschler is a senior scientist at the National Solar Observatory and the DKIST Program Scientist for Operations. Her main scientific interests focus on the study of solar active regions.

Astronomy for Education 101

Office Meeting: IAU Office of Astronomy for Education	
START DATE	Thursday, 4 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 108 (8/4), 103 (8/8), Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

Education is both one of the UN Sustainable Goals for Development and also one the five Goals of the IAU Strategic Plan 2020 - 2030. In the context of the IAU, the focus on education is being led by the IAU Office of Astronomy for Education (OAE), which was officially launched in December 2019 at the IAU Headquarters in Paris. The OAE is based at Haus der Astronomie (literally "House of Astronomy") in Heidelberg, Germany, but has quickly built up a large network of collaborators, including several branch offices (which are called OAE Centers or OAE Nodes).

The IAU OAE has established five overarching objectives: professionalizing astronomy education; providing access to effective resources for teaching astronomy; promoting astronomy in curricula; creating, maintaining and growing a network of associates in support of the OAE mission; and spreading the news.

The IAU OAE focuses on education in primary, middle and secondary school, and has developed its objectives in such a way as to enable and support teachers, and educators from around the world to take advantage of the potential offered by astronomy in engaging students. Given the nature of astronomy, it is vital that any effort towards fostering and supporting astronomy for education include the global astronomy and education communities. As such the OAE continues to establish a worldwide network of National Astronomy Education Coordinators (NAECs). The aim for the NAEC network (https://www.astro4edu.org/naec-network) is to support the promotion of astronomy in national curricula, supporting teachers with evidence-based education research and helping the community with its professional development. The OAE is also intended to facilitate discussion and knowledge sharing within the community, particularly between astronomers, astronomy education researchers and practitioners.

Drawing on the IAU OAE objectives, the OAE sessions at the IAU GA 2022 bring together individuals active in astronomy education, and members of the OAE network to focus on four overarching themes:

- The role of national bodies in astronomy education
- Astronomy education projects placed in extracurricular activities
- Astronomy education: Tools and resources
- The OAE's network of Centers and Nodes

These sessions will be an opportunity for the IAU community to learn about the field of astronomy education, how to engage with the astronomy education community, the role of OAE in the education ecosystem, and more importantly the theme of 'Astronomy for all'. To view the program please visit: https://www.astro4edu.org/GA2022/

At the IAU OAE there are always various opportunities for scientists to volunteer their time, this could include, but not limited to: reviewing definitions for the astronomy glossary (https://astro4edu.org/resources/glossary/search/); providing input into scientific aspects of teaching resources; helping with events hosted by the OAE and much more. Please feel free to contact us: oae@astro4edu.org. In addition, Scientists could also engage with their local NAEC team and to find out how they can best support them in their efforts of developing and enhancing astronomy education in their respective regions.

To learn more about the IAU OAE and collaboration opportunities, please visit: https://astro4edu.org

The IAU OAE which was officially launched in December 2019 at the IAU Headquarters in Paris. The OAE is based at Haus der Astronomie (literally "House of Astronomy") in Heidelberg, Germany.

A Time to Reflect on How to Impact Young Astronomers Education

The Office for Young Astronomers (OYA) has as its main program the International Schools for Young Astronomers (ISYA), started in 1967 by the IAU, and nowadays also co-sponsored by the Norwegian Academy of Science and Letters. It organizes three-week intensive graduate schools in parts of the world where students have less opportunity to be directly exposed to the full extent of up-to-date astrophysics. The program targets mainly, but not exclusively, students from astronomically developing countries. ISYA offers students coherent lectures that cover the basic concepts of selected fields of astronomy and astrophysics, the opportunity to carry out and analyze multi-wavelength data, engage in group projects, workshops on career development and a network of fellow students to grow with into the next generation of leaders in their countries.

Office Meeting: IAU Office for Young Astronomers	
START DATE	Thursday, 4 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 202 (8/4), 104 (8/8), Convention Hall, 1st and 2nd Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

Over its 55 years of existence, there have been 42 ISYA organized in 27 countries. Schools usually have 30-50 students from the host country and from countries in the same IAU region. They are aided by a team of 10-15 lecturers which are world-wide experts on their topics. Over time, ISYAs have hosted over 1400 students and 400 lecturers. Many prominent IAU members were students of the program, and time has come when alumni are enthusiastic promoters and lecturers of new ISYAs.

OYA is hosting an open Office Meeting during the General Assembly (4th and 8th of August). We invite participation from all IAU members to brainstorm on the most effective ways to impact young astronomers' careers in the developing world. We will have an in-depth analysis of the successes and challenges experienced by ISYA alumni in the past and in recent years. Testimonials from four historical alumni and five recent alumni coming from different IAU regions will be a highlight of the program. We will also have an expert on career perspectives and challenges from Nature. The leaders of several specialized graduate schools will participate in a round table to discuss how to enhance the chances of students from the developing world to participate in those, and how ISYA and specialized graduate schools can interact. Finally, we will review the prospects for the new generation of astronomers in parts of the world where Astronomy is starting to get developed.

INVITED AND KEYNOTE SPEAKERS

Itziar Aretxaga (INAOE, Mexico; ISYA Director) & David Mota (Univ. Oslo, Norway; ISYA Deputy Director) "The 5-decade long ISYA program under observation"

Michele Gerbaldi (IAP, France) & Jose Miguel Rodríguez Espinosa (IAC, Spain; IAU General Secretary): "Challenges perceived from within the IAU"

Chris Woolston (Careers Nature, USA, 30 min) The Challenges and Possibilities of a Science Career: "Lessons from Nature"

Historical alumni testimonials: Mónica Rubio (Univ. Chile), Xiaohui Fan (Univ. Arizona, USA), Kingsley Opkala (Univ. Nigeria), Somaya Saad (NIARG, Egypt)

Recent alumni testimonials: Hira Fatima (Univ. Karachi, Pakistan), Etseganet Getachew (ESSTI, Ethiopia), Daudi Mazengo & Privatus Prius (Univ. Dodoma, Tanzania), Luis Salazar-Manzano (Univ. Texas at Rio Grande Valley, USA).

Interaction with other graduate school programs: Mariano Méndez (Univ. Groningen, The Netherlands; I-HOW/COSPAR), Basilio Ruiz (IAC, Spain; IAC Winter Schools).

Itziar Aretxaga is research professor at INAOE, Mexico, specialized on galaxy formation and evolution.

David F. Mota is a professor at University of Oslo, Norway, specialized in Gravity and Cosmology. They are the current directors of the ISYA Program.

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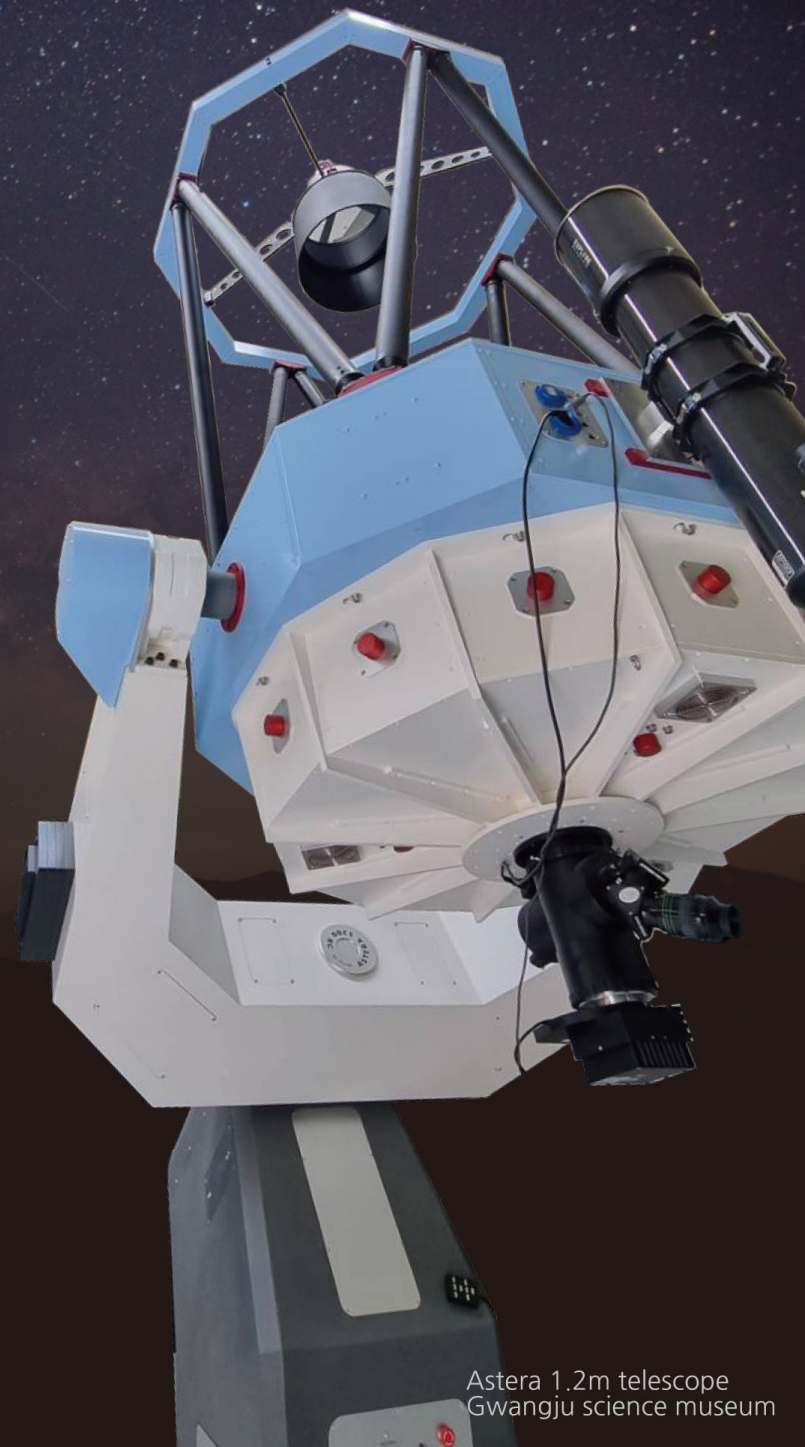

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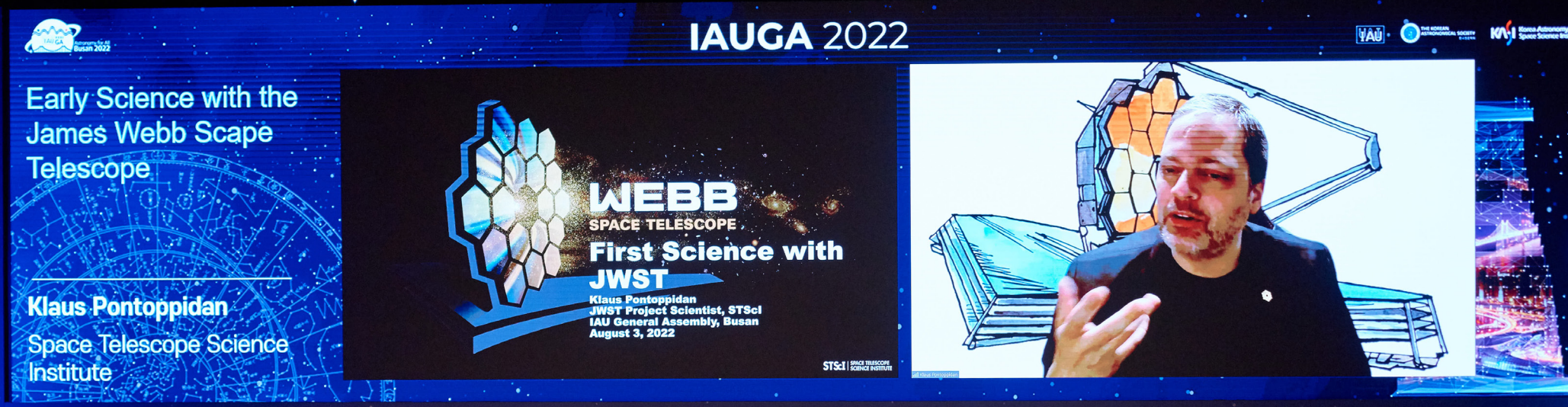

Invited Discourse 1_Klaus Pontoppidan

Issue 4 | August 5, 2022

Mirinae

미리내 The Milky Way

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#IAUGA2022 is an official hashtag of the IAUGA2022

SOLAR PHYSICS IN THE 2020s: HOW WE GOT HERE

Valentin Martinez Pillet, S372 plenary speaker

In the late 80s, various European countries built a series of solar telescopes in the Canary Islands. The Swedish Tower at La Palma (50cm, now 1m) focused on obtaining the highest quality images of the solar surface. The German telescopes (45-70 cm) on Tenerife in high resolution spectroscopy. The French-Italian THEMIS (90cm), also on Tenerife, specialized in polarimetry. The solar group at the Instituto de Astrofisica de Canarias, where I began my career, contributed instrumentation for these telescopes by providing polarimetric capabilities to those that didn't have it from the start. In this intellectually vibrant environment, I forged my career path that also benefited from a postdoctoral stay in the US, where I participated in the commissioning of a polarimeter for a solar telescope (76cm) operated by the National Solar Observatory (NSO) in New Mexico. Diffraction limited imaging and spectropolarimetry are crucial to understand solar magnetic fields at their fundamental scales. The photon mean-free path and the scale height in the solar photosphere are about 100km. With typical convective velocities of several km/s, the evolutionary times scales are of a few tens of seconds. Solar magnetic concentrations polarize only one out of several thousands of photons in a typical spectral line. Detecting them is crucial to understand how the Sun creates its magnetic environment. Using standard formulas, it is not too difficult to see that this detection needs telescopes of several meters of aperture. However, the use of vacuum systems prevented at that time building capable telescopes above 1m. One solution adopted by solar astronomers was to fly in space or in stratospheric balloons telescopes as large as realistically possible. The SUNRISE telescope (1m, led by Germany) flew for the first time in 2009 and, at that time, it was the largest solar telescope equipped with a spectropolarimeter, that I built, and that obtained data that is still unsurpassed. SUNRISE obtained the most detailed animations of the weakest known manifestation of tangled, mixed polarity, magnetic fields. Our best hope today to make critical progress in our understanding of solar magnetism is the recently built Daniel K Inouye Solar Telescope (DKIST, Maui, Hawai'i) operated by the NSO since late 2021. Having eliminated the need for vacuum systems, the National Science Foundation (NSF) DKIST has a 4m aperture and will provide the required on-disk resolution and sensitivity. Additionally, NSF´s DKIST will observe the solar corona thanks to its unique off-axis design and occulters that block the direct light from the Sun's disk. This ability to observe the off-limb corona comes at a time when NASA and ESA operate two encounter missions, Parker Solar Probe (PSP) and Solar Orbiter, that approach the Sun and measure in-situ the pristine consequences of the magnetic interactions that create various forms of the expanding Sun. By combining in-situ measurements of the near-sun plasma and detailed remote observations of multiple layers of the Sun, DKIST, PSP, and Solar Orbiter form an unprecedented multi-messenger constellation to study the magnetic connectivity inside the Sun's astrosphere.

Imaging Black Holes: Building the Event Horizon Telescope

Sheperd Doeleman, Public Lecturer

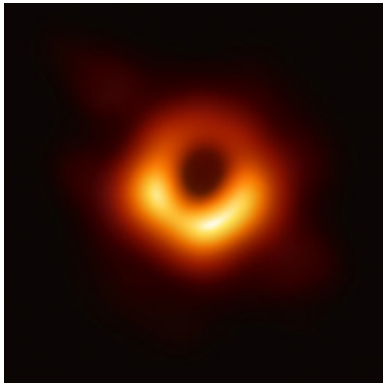


Image of M87

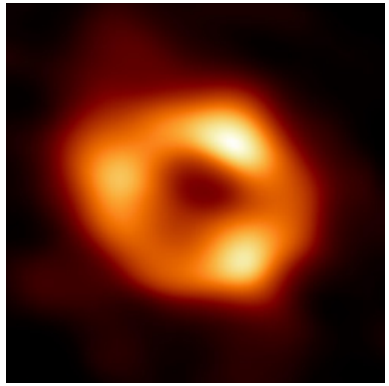


Image of Sgr A*

Earlier this year the Event Horizon Telescope (EHT) Collaboration announced the first image of SgrA*, the supermassive black hole at the center of the Milky Way. An unmistakable ring shape revealed the black hole 'shadow': a feature long-predicted by Einstein's gravity. By confining over 4 million solar masses to lie within the photon orbit, this result presents us with the best and clearest evidence for the existence of supermassive black holes and their cosmic role at the centers of galaxies. Together with the image of M87 (6.5 billion solar masses), announced in 2019, EHT black hole images now confirm strong-field GR predictions over more than three orders of magnitude in mass. The EHT has done this by creating an Earth-sized virtual telescope that links radio dishes around the world, synchronized by GPS and stabilized with a network of atomic clocks.

And this is just the beginning. The EHT has already mapped the magnetic field structure surrounding M87 through polarimetric imaging, and data from following epochs will soon enable us to precisely study black hole accretion and jet launching on horizon scales. More than this, the next-generation EHT project (ngEHT) will extend the observing frequency range, quadruple the bandwidth, and double the number of telescopes in the global array for unprecedented new movie-making capability. These advances set the stage for true black hole 'cinema' – high-fidelity time resolved video of the horizon – by the end of this decade.

I suppose my preparation for this type of work began in Antarctica, where I spent a year after my undergraduate degree running several atmospheric and physics experiments in challenging circumstances. In graduate school, I was extremely fortunate to work with Alan Rogers at MIT who introduced me to the magic of mm-wavelength interferometry. The next decade was spent developing and deploying ultra-wideband instrumentation to increase the sensitivity of planet-sized arrays, which led to the 2008 discovery of horizon-scale structure in SgrA* and the launch of the EHT. It has been a joy and privilege to work with the EHT community, now grown to over 300 members.

Apart from the scientific impact of these discoveries and new directions, a human dimension to these projects resonates with the curious public. This work has produced visual evidence of the most mysterious objects in the Universe – making real and distinct the limits of our understanding of fundamental physics. But it has also relied on coordinating resources and expertise from around the world: a hopeful example of how we can tackle seemingly impossible global challenges when a coherent vision binds everyone on the planet together.

Sheperd Doeleman, Founding Director of the Event Horizon Telescope

Activities of Division B Commissions and Working Groups

Figure 1. Starlink satellites and star trails in the Milky Way direction

Division Meeting B: Facilities, Technologies and Data Science	
START DATE	Friday, 5 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 101, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

IAU Division B, Facilities, Technologies and Data Science, has at present 4256 active members and 355 junior members. It has 8 participating Commissions with a total of 12 working groups (Division, Commission, and Inter-Commission). The Division Steering Committee prepared a program to present several relevant activities in its Commissions and working groups at the Division Days at the IAU GA.

Division B days will open with a Plenary Session (Friday August 5th at 10:30), where PhD winners of our Division in the last 4 years will present and discuss their scientific results. All topics are very timely and relevant in the present astrophysical landscape: Spectropolarimetric and imaging properties of Fabry-Pérot etalons; Laboratory studies of interstellar methane ice in the era of JWST; Exact wide-field interferometric imaging via distributed sparse image reconstruction; and The astrochemical factory: Producing the first biomolecule building blocks.

In the afternoon, activities will be split into two parallel sessions: **New Facilities and Growing Archives and History of Radio astronomy in Eastern Asia.**

In the **New Facilities and Growing Archives** sessions will focus on important developments in the field of Computational Astrophysics (Commission B1) and first results and properties of new relevant telescopes: the Iranian National Observatory 3.4m optical telescope, the FAST radio telescope in China, and the Imaging X-ray Polarimeter Explorer (IXPE). Furthermore, problems related to the SKA data reduction and important results from the SKA precursor ASKAP will be presented. Virtual Observatory (VO) science will be introduced and problems/solutions related to the rapidly increasing satellite pollution in radio and optical bands will be discussed (Figure 1).

In the **History of Radio Astronomy in Eastern Asia** sessions, coordinated by the WGHRA, the radio astronomy developments in the Republic of Korea, Japan, Taiwan and China will be presented. We like to draw attention to a talk on the history of space VLBI in Japan.

On Monday August 8th Commission B5 (**Laboratory Astrophysics**) will present and discuss its activity in Korea, South America, Japan, the US and Europe in the morning session with contributions from local people. A presentation on the relevance of Quantum Sensing for Astronomy will be given. At the same time in a parallel session, the working group **The Global VLBI Alliance** will present talks on main VLBI arrays: EVN, VLA/ngVLA, LBA, EAVLBI (Figure 2) and invite astronomers to join the GVA Science Forum.

In the afternoon session, the International **Virtual Observatory Activity** will be discussed and main principles will be presented. At the same time, the **UV working** group will discuss UV photometry, approved standards and their implementation.

Figure 2. Concept map of the EAVN including the three correlator sites in China, Japan, and Korea. FAST 500 m telescope, which is to be used for EAVN observations at lower frequencies (< 1.6 GHz), and the Thai National Radio Telescope (TNRT), which is under construction, are also included in the map. Photograph of each radio telescope and correlator site are overlaid on 'the Blue Marble' image. Credit of the ground image: NASA's Earth Observatory.

Gabriele Giovannini was appointed in 2001 Full Professor in Astrophysics at the Bologna University. In the years 2010 – 2012 he was the Director of the PhD School in Mathematics, Physics, and Astrophysics of the Bologna University. In 2011 was named INAF representative in the RadioAstron International Science Council (RISC). He retired in 2020, and because of his activity, he was named Professor of the ALMA Mater (PAM), University of Bologna. He was the Past President of Commission B4 Radio Astronomy (2015-2018) and Past Vice-President of Division B Facilities, Technologies and Data Science (2018-2021) and now he is President of Division B.

Towards inclusion in astronomy education, outreach, history and heritage

The pandemic has had a profound effect on the way we, as science communicators or astronomers engaged in science communication, approach educational projects. Almost all in-person educational and outreach activities abruptly halted in March and April 2020.

The projects which suffered the most were those delivered in-person, some having to completely stop all activities. Many projects were either able to shift their activities online or change their activities sufficiently so they could be performed remotely, even if they had to pause their activities. Not all projects were successful and many also had to stop while cases of Covid-19 were high, those in the developing world were particularly badly affected.

Division Meeting C: Education, Outreach and Heritage	
START DATE	Friday, 5 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 104, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

In addition to the pandemic, social and cultural movements have also had a large impact on astronomy. It is important that we as astronomers, are fully aware and sympathetic towards indiginous concerns and these social movements. We need to be inclusive in the way we preserve the history of astronomy and tell the stories of different cultures.

The objective of this session is to open astronomical science to broader perspectives including gender, the role of native societies in preserving celestial heritage, and indeed how astronomy can play a decisive role as an open discipline in the development of science in all continents. Education and outreach should indeed play a role in that. We all live under one sky.

For the Division Days for Division C (Education, Outreach and Heritage) we wanted to shine some attention on some of these as well as providing practical lessons from the experiences of education and outreach practitioners had during the pandemic.

Edward Gomez is the education director for Las Cumbres Observatory and director of the Global Sky Partners programme. He is the vice-president of IAU Division C, an astronomer, coder, science communicator, story-teller and dad of twins.

Across the Mass Spectrum of Neutron Stars and Black Holes

Workshop for Division D : High-Energy Phenomena & Fundamental Physics

Black holes and neutron stars have served as showcases for relativity and quantum physics for more than half a century. They are now being observed in more ways than ever before, across all wavelengths from radio to gamma rays, and as gravitational-wave sources in binary inspirals. This multi-messenger toolkit provides insights into the intrinsic properties of these compact, strongly gravitating objects. Knowing their mass is essential to interpreting the various facets of their physical structure and radiative activity. Their mass distribution also reflects the history of their formation in a single collapse or in a merger event, as well as their cumulative accretion history before and after formation. Recent observations have dramatically expanded our views on the mass range of neutron stars and black holes, so Division D has organized a workshop to review these findings, spanning both Galactic and extragalactic settings. The workshop summarizes the observational status quo, explores potential pathways to explain extant data, and briefly highlights future prospects for new observations to propel our understanding forward.

Division Meeting D: High Energy Phenomena and Fundamental Physics	
START DATE	Friday, 5 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 201, Convention Hall, 2nd Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

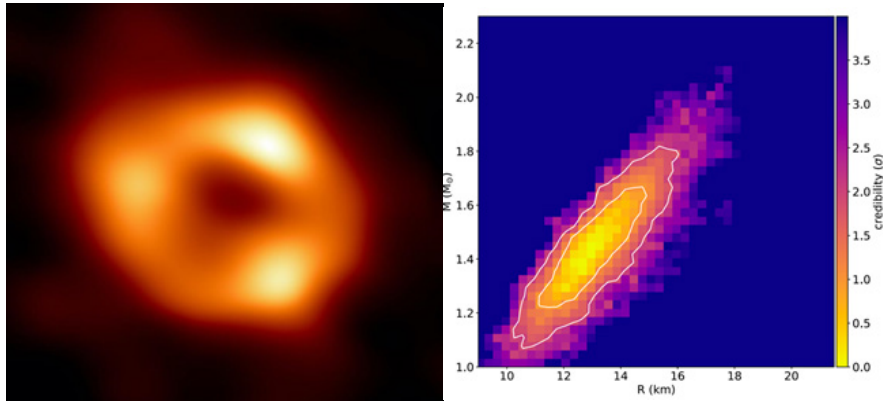


Fig. 1: Left: Event Horizon Telescope mm-band image of the environs of the Sagittarius A* supermassive black hole (around 4 million solar masses) at the center of the Milky Way. [From EHT web page]. Right: mass-radius constraint diagram from NICER X-ray light curve data for the millisecond pulsar J0030+0451 [Miller et al., ApJ Letters 887, L24, 2019)]

For neutron stars, the presentations will compare mass and radius measurements from the modulated thermal emission from hot spots on the stellar surface, dynamical mass measurements in binary systems, which exploit the arrival time of radio pulses or Doppler shifts of emission lines from the companion star, and mass estimates from the gravitational-wave data. The program will also address constraints from eclipses in binary systems. A seminal theme of interest concerns what the mass-radius relation of neutron stars is, which places important constraints on the equation of state of cold neutron or more exotic matter at nuclear densities.
Furthermore, of key importance are why typical masses congregate around the Chandrasekhar mass and why the maximum observed mass of neutron stars appears to be below some theoretical expectations? This sets the scene for the so-called "mass gap" between Galactic neutron stars and black holes.

For black holes, the program will review the surprisingly large masses found by gravitational-wave events in the stellar graveyard, explore how stellar evolution and environmental dynamics can produce them. It will explore what the implications are of the relatively poor census of black holes in the intermediate 102-105 solar-mass domain, contextualized per a range of theoretical predictions. The different means to measure the mass of supermassive objects (e.g. from gas or stellar motions, reverberation mapping, tidal disruption events,

accretion luminosities, etc.) will be reviewed, including the topical data of Sgr A* and M87 from the Event Horizon Telescope data. The workshop will examine how black-hole masses scale with the velocity dispersion or stellar mass in the surrounding bulge as the black holes and their host galaxies co-evolve, thereby connecting to the topical AGN feedback problem. Also discussed are how black holes heavier than a billion solar masses can form rapidly, within a few hundred million years after the Big Bang, and from what seeds they can grow.

Prof. Isabelle A. Grenier, President of IAU Division D. CEA-Saclay and Université de Paris, France. Has worked extensively over many years on the observational study of the ISM, molecular complexes, supernova remnants, cosmic rays and signatures of particle acceleration.

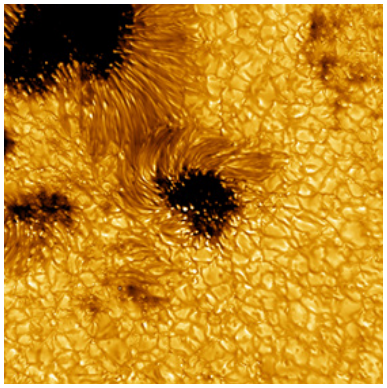
Prof. Matthew G. Baring, Vice-President of IAU Division D. Rice University, USA. Has worked extensively over many years on the theoretical study of neutron stars and black holes, gamma-ray bursts and blazars, radiation processes, cosmic rays and particle acceleration at shocks.

Division E Days: Heliophysics in the 21st Century

The research covered by Division E includes the study of the Sun, its variability, activity, and dynamics, as well as its impact on the Earth and other bodies within the heliosphere. The proximity of the Sun enables detailed investigation of its structure, the dynamo operating in its interior, and the radiation and solar wind that propagate outward, in the heliosphere. Dynamical phenomena include flares, coronal mass ejections, shock fronts and their propagation, as well as the acceleration of particles into the interplanetary medium.

Division Meeting E: Sun and Heliosphere	
START DATE	Friday, 5 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 108, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website



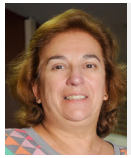
A new high-resolution image of sunspots captured by the Daniel K. Inouye Solar Telescope on 11 May 2021. The data leading to this image were acquired with the Visible Broadband Imager blue channel at a wavelength of 450 nanometers (spatial resolution around 20 km at the Sun). Credit: NSO/AURA/NSF.

The Workshop "Heliophysics in the 21st Century" is organized in five sessions. Three of these sessions are devoted to the main scientific pillars of Division E: Solar Radiation and Structure, Solar Active Phenomena, and Solar Impact throughout the Heliosphere. Two invited lectures per session will highlight recent progress in these three broad fields, encompassing advances in solar dynamo theory and solar cycle prediction, the dynamics of small-scale atmospheric structures, filament disruptions and their implications, modeling and simulations of solar magnetic phenomena, large-scale structures in the heliosphere and their space weather impact, as well as the dynamics of the global solar wind and the heliospheric magnetic field over small and very long temporal scales. A relevant number of contributions will accompany these invited reviews.

We will have the pleasure to dedicate a session to the talks of seven young solar physicists, winners of IAU PhD and IAU "at-large" PhD Prizes between 2018 and 2021, who will present their thesis results.

Another session will be devoted to the status and science of recent and future instrumentation both ground-based and space-borne. Highlights include the related collaborative features between the recently launched Solar Orbiter and the new National Solar Observatory facility, the 4-meter, Daniel K. Inouye Solar Telescope (DKIST). The next-generation Global Oscillation Network Group (ngGONG) instrumentation, which incorporates space weather requirements, will also be presented. Parker Solar Probe and ground-breaking discoveries, such as solar wind switchbacks, will be reviewed. Among future missions, the status and science objectives of the Polarimeter to Unify the Corona and Heliosphere (PUNCH) and Aditya-L1 will be discussed. PUNCH is a NASA Small Explorer (SMEX) mission that aims to better understand how the mass and energy of the Sun's corona become the solar wind. It consists of four suitcase-sized satellites that will work together to produce images of the entire inner solar system around the clock and determine the cross-scale physical processes that unify the corona with the rest of the heliosphere. Aditya-L1 is a future coronagraphy spacecraft to study solar atmosphere, in particular the corona, currently being designed and developed by the Indian Space Research Organization (ISRO) and various other Indian research institutes, which will be inserted in a halo orbit around the L1 point between the Earth and Sun.

Join us in this trip from inside the Sun to the heliosphere!



Cristina H. Mandrini, chair of the Division E Days and President of IAU Division E, is a Senior Researcher at the Institute of Astronomy and Space Physics (Instituto de Astronomía y Física del Espacio), Buenos Aires, Argentina, and retired Professor at the University of Buenos Aires, Department of Physics.

PhD Prize Winners in 2018-2021

PhD Prize Year	Division	Name and Country	Title of PhD Thesis
2018-2019	B	Niels Ligterink, Netherlands	“The Astrochemical Factory: A solid base for interstellar reactions”
2018-2019	D	Laura Becerra, Colombia	“Accretion in Compact Stars: Hypercritical Accretion in the Induced Gravitational Collapse and the Post-Merger Evolution of White Dwarfs Mergers”
2018-2019	E	Jenna Samra, USA	“An Airborne Infrared Spectrometer for Coronal Observations: Development, Characterization, and First Science Results from the 2017 Solar Eclipse”
2018-2019	F	Tim Lichtenberg, Switzerland	“Thermal Evolution of Forming Planets: Isotope Enrichment, Differentiation & Volatile Retention”
2018-2019	G	Adam Jermyn, UK	“Turbulence and Transport in Stars and Planets”
2018-2019	H	Meriem El Yajouri, Morocco	“Diffuse Interstellar absorption Bands: a new look at an old problem”
2018-2019	J	Jorryt Matthee, Netherlands	“Identifying the origin of galaxy formation”
2018-2019	PhD at-large Prize	Gopal Hazra, India	“Understanding the behaviour of the Sun’s large scale magnetic field and its relation with the meridional flow”
2019-2020	A	Joseph O’Leary, Australia	"General relativistic and post-Newtonian dynamics for near-Earth objects and solar system bodies"
2019-2020	B	Luke Pratley, UK	"Radio Astronomy in the Big Data Era"
2019-2020	C	Maria Giulia Andretta,Italy	"The conquest of the Moon. The history, the legacies and the cultural influence of the Moon landing. Analysis of the Italian media phenomenon as an example of pop science"
2019-2020	D	Guang Yang, USA	"What drives the growth of black holes?"
2019-2020	E	Munehito Shoda, Japan	"Fast solar wind driven by parametric decay instability and Alfvén wave turbulence"
2019-2020	F	Przemyslaw Mroz, Poland	"Astrophysical applications of gravitational microlensing in the Milky Way"
2019-2020	G	Simon Blouin, Canada	"Modeling of high-density effects at the photospheres of cool white dwarfs"
2019-2020	H	Jennifer Bergner, USA	"Tracing organic complexity during star and planet formation"
2019-2020	J	Anna-Christina Eilers, Germany	"Unravelling 13 Billion Years of Cosmic History with Spectroscopic Studies: From the Milky Way to the Epoch of Reionization"
2019-2020	PhD at-large Prize	Prantika Bhowmik, India	"Data Constrained Models for Solar Activity Predictions"

2020-2021	A	Etienne Savalle, France	“Testing general relativity with clocks in space, and dark matter research with cold atom interferometry on Earth”
2020-2021	B	Danna Qasim, the Netherlands	“Dark Ice Chemistry in Interstellar Clouds”
2020-2021	C	Magdalena Kersting, Norway	“General Relativity in Secondary School: Research-Based development of Learning Resources and Analyses of Students”
2020-2021	D	Ziggy Pleunis, Canada	“Fast radio burst detection and morphology with the CHIME telescope”
2020-2021	E	Camilla Scolini, Belgium	“Modeling analyses of the evolution of magnetic fields in coronal mass ejections, from Sun to Earth”
2020-2021	F	Jane Huang, USA	“Rings and Spirals in Protoplanetary Disks: The ALMA View of Planet Formation”
2020-2021	G	Lisa Bugnet	“Characterization of solar-type stars and study of their internal magnetic fields along the evolution”
2020-2021	H	Cecilia Bacchini, Italy	“Star formation laws and gas turbulence in nearby galaxies”
2020-2021	J	Solène Chabanier, France	“Neutrino and dark matter cosmology with the Lyman-α forest, the interplay between large-scale evolution and small-scale baryonic physics”
2020-2021	PhD at-large Prize	Raissa de Lourdes Freitas Estrela, Brazil	“Exoplanet Atmospheres and Habitability”
2021-2022	A	Chris Hamilton, UK	"Secular Dynamics of Binaries in Stellar Clusters"
2021-2022	B	Francisco Javier Bailen Martinez, Spain	"Spectropolarimetric and Imaging Properties of Fabry-Pérot Etalons. Applications to Solar Instrumentation."
2021-2022	C	David Barrado Navascués, Spain	"Cosmography: the science of the two Orbs"
2021-2022	D	Riccardo Arcodia, Germany	"Accretion onto Black Holes Across the Mass Scale”
2021-2022	E	Souvik Bose, Norway	"On the Dynamics of Spicules and Mass-Flows in the Solar Atmosphere"
2021-2022	F	Megane Mansfield, USA	"Revealing the Atmospheres of Highly Irradiated Exoplanets: From Ultra-Hot Jupiters to Venus Analogues"
2021-2022	G	Kareem El-Badry, USA	"Binary Stars Across the Milky Way: Probes of Star Formation and Evolution"
2021-2022	H	Anirudh Chiti, USA	"Mapping the Ancient Milky Way & its Relic Dwarf Galaxies”
2021-2022	J	Zhijie Qu, USA	"The Warm-Hot Circumgalactic Medium and its Co-Evolution with the Galaxy Disk"
2021-2022	PhD at-large Prize	Reetika Joshi, India	"Study of Solar Jets and Related Flares"

PhD Prize Honorable Mentions in 2021

Division	Name and Country	Details
B	Divita Gupta, France	"Rate Coefficients and Branching Ratio Measurements for Reactions of Astrochemical Relevance Involving CN Radicals"
C	Saeed Salimpour, Australia	"Visualising the Cosmos: Teaching Cosmology in High School in the era of Big Data"
D	Benjamin Crinquand, France	"Particle Acceleration in Kerr Black-Hole Magnetospheres"
D	Kishalay De, USA	"The Whisper and the Bang: Cosmic Fireworks in the Lives of Compact Binaries"
E	Wenzhi Ruan, Belgium	"Solar Flares and Kelvin-Helmholtz Instabilities: Particle Acceleration and High Energy Radiation"
F	Chloe Fisher, Switzerland	"Characterising Exoplanet Atmospheres using Traditional Methods and Supervised Machine Learning"
F	Rafael Luque Ramirez, Spain	"Planetary Systems Around Red Dwarfs and Activity of their Host Stars"
H	Rebecca Levy, USA	"Investigating Star Formation Feedback through Gas Kinematics in Nearby Galaxies"
J	Martyna Chruslinska, Germany	"Galaxies, Binaries and Gravitational Waves"

Young Astronomers Lunch (YAL)

Young Astronomers Lunch (YAL) meeting will take place at Hall 5A, Exhibition Center II, BEXCO on the 5th of August at 12:00-13:30. The aim of the Young Astronomers Lunch is to stimulate networking opportunities between senior astronomers and young astronomers at the start of their careers. The main objectives of the YAL are:

- to give young astronomers (i.e. early career astronomers) the opportunity to discuss predefined topics of their choice, related to careers and research organization in astronomy, with more experienced astronomers,
- to raise the awareness of the YAs of their importance to the IAU,
- to enhance networking among YAs of different countries.

You can sign up for this event when you register for the GA.

We kindly acknowledge a generous donation by US National Academy of Sciences (US NAS) and the Norwegian Academy of Science and Letters (NASL) that have made the organization of this event possible.

※ To participate in this event please bring the ticket issued with your name badge.

Korean history and astronomy

Astronomy, along with mathematics and medical science, is one of the oldest fields in the history of humanity's pursuit of knowledge. Aside from China, Korea is the country with the longest history of astronomy in the world. Korea honors a long-standing legacy of astronomy, treasured for thousands of years.

Ancient Astronomy

The origin of Korean ancient astronomy dates back to the prehistoric era. Astronomical signs in the prehistoric age are star-like cup-marks carved on cover stones of dolmens. It is evident that ancient Korean kingdoms established their own bureaus of astronomy, built observatories, and employed administrators designated to observe astronomical phenomena. Initial observations of astronomical phenomena started from the 1st century BCE and over 20,000 extensive historical records and relics have passed down from generation to generation. In particular, Cheomseongdae Observatory, built in 633 CE is one of the oldest observatories in the world.

King Sejong the Great (1418-1450) and Joseon Dynasty

In general, Korean kings and nobilities were in favor of supporting astronomy. The reign of King Sejong the Great, between 1418 and 1450 is known as the unprecedented Golden Age of Korean science and culture, with particular attention to astronomical instruments and technologies. King Sejong the Great commissioned a substantial revision of Western, Islamic and East Asian traditional sciences and placed Korea as one of the frontrunners leading the calendrical science, astronomical observation, and invention of related instruments in the region.

One of the outstanding astronomical heritages during the Joseon Dynasty is a star chart carved on a stone plate in 1395. The stone star chart contains 1,467 stars with various sizes. According to modern calculations, it is known that the location of the star was found to be located in the 1st century and the 14th century.

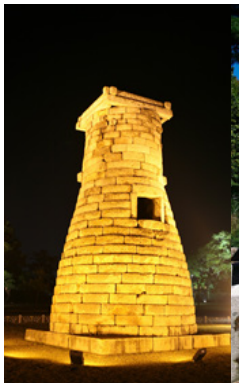
The astronomical instruments and calendars during the Joseon Dynasty are well examined by Needham et al. 's book entitled "The Hall of Heavenly Record: Korean Astronomical Instruments 1380-1780," published by Cambridge University Press in 1986. Needham et al. label Korean astronomy as "a true national variant of the East-Asian astronomical tradition" and note, "The instruments and written records are a valuable legacy to the history of science everywhere."

Modern Astronomy

Due to the tragic collapse of the Joseon Dynasty in 1910 and followed Japanese colonial rule and Korean War, Korean modern astronomy in the early 20th century struggled for existence. Nonetheless, Koreans in the midst of hardship strived to continue and honor the legacy of astronomy research. Since the first modern lecture on astronomy taught at the Yonsei University in 1915 and the launch of the first independent department of astronomy at the Seoul National University in 1958, Korean astronomy underwent steady expansion.

Now with eight universities offering up to Ph.D programs in astronomy and astrophysics, Korean astronomy enjoys a rapid growth in numbers of well educated human resources, cutting edge research outputs, and astronomical instruments. Together with Korean astronomers' dedicated commitment to astronomy and substantial government support, Korea is engaged in various activities including the launch of space telescopes, Korea VLBI network (KVN), the network of three wide-field telescopes in the Southern Hemisphere (KMTNet) monitoring the sky 24 hours a day. Active international collaborations are also sought, by partaking in the Giant Magellan Telescope (GMT) consortium. After a long pause, Korea once again steers the way into the great endeavor to stand on the frontline of astronomy and space science for mankind and a better tomorrow.

Korea's Ancient Observatory



Cheomseongdae in Kyeonju of Korea, built in AD633 in thee Silla Kingdom

Astronomical Observatory in Gaeseong of North Korea, built in ~13th Century in the Goryeo Dynasty (National Research Institute of Cultural Heritage, 2018)

The Three Kingdoms period of Korea (57BC-AD935)

The Three Kingdoms period is defined as when Silla, Baekje and Goguryeo dominated the Korean peninsula and the neighboring areas. In Gyeongju, the capital of Silla, stands a 9.1-m high bottle-shaped observatory, Cheomseongdae. The observatory, built in 633, is the oldest astronomical observatory in the world that is still preserved. This observatory, taking the shape of circle and square, symbolizes the ancient cosmology of the East, and there is a window in the middle of the south side of the body. According to records, the observer went through a window and climbed to the top, observing the sky.

Cheomseongdae's appearance and shape allude to various astronomical symbolism. Layers of stones symbolize the 24 solar terms (seasonal division) and the 28 oriental constellations (lunar mansions), and the number of stones in Cheomseongdae has been theorized to reference the number of days of a year.

It is known that Goguryeo and Baekje were as active in astronomical observations as in Silla, but there remains no observatory. Meanwhile, records from the 18th century show that Goguryeo royal observatory was located to the south of the royal palace. Baekje had a high level of astronomical studies, so much so that it shaot of relevant knowledge with Japan, but no records are remaining about astronomical observatories in Baekje.

Goryeo Dynasty (AD918-1392)

In Gaeseong (開城), the capital of the Goryeo Dynasty in northern Korea, stands a stone structure known to be the remnant of an observatory. The observatory was built around the 13th century, the current remains of which consist of a stone platform about 3m2 supported by five 3-m high upright stones. Goryeosa, the official history book of the Goryeo Dynasty, includes a record that an astronomical observatory and an astronomical instrument were made to observe astronomy in 1281, implicating that a simple observation instrument was installed on the observatory at that time. Goryeosa contains about five thousand astronomical records.

Joseon Dynasty (AD1392-1910)

The Joseon dynasty built its main palace in Hanyang (now Seoul) and installed an astronomical observatory with several observation instruments in 1432. The astronomical observatory at that time was much larger than that of Silla or Goryeo, enabling far more professional observation. Unfortunately, all the royal observatory and observation instruments at that time disappeared, and only two simple observatories have remained to date. More than 20,000 records of astronomical observations in the Joseon dynasty have been kept.

Hong-Jin Yang, Center for Historical Astronomy, Korea Astronomy & Space Science Institute

Busan Tour Attractions

Busan is a stunning confluence of scenery, culture and cuisine in repose between mountains and sea. It's long been domestically lauded as the country's best beach getaway, but South Korea's second largest city packs an eclectic offering of activities to suit all travelers: hike hills to Buddhist temples, settle into sizzling hot springs and feast on seafood still a-wriggle at Jagalchi, the country's largest fish market.

IAUGA 2022 provides several Busan tour programs including free tour, half-day tour, and one-day tour. Further information about all tours can be found at https://www.iauga2022.org/tour/. Through this tour, you can get an up-close-and personal look at some of the must-visit locations on Busan including Songdo Cloud Walkway, Busan X the SKY, Haeundae Blue Line Park, Haedong Yonggungsa Temp, The Bay 101 Yacht Tour, Gamcheon Culture Village, and Hongbeopsa Temple (Tour Overview).

You can also explore some of the main tourist attractions near IAUGA venue. Tour the Haeundae with a self-guided walk and visit four most popular attractions in Haeundae.

Haeundae Beach

• **Haeundae Beach**

Haeundae Beach is one of Korea's hottest summer destinations, attracting over 10 million visitors every season. Its 1.5 km white sandy beach is lined with many entertaining facilities. Haeundae Beach has become the most popular spot for foreign tourists and vacationers from all over the country who enjoy swimming and sunbathing on a sunny beach.

Dongbaek Coastal Trail

• **Dongbaek Coastal Trail**

Walk along the Haeundae Beach deep in thought while looking out at the open sea to reach the cozy Dongbaekseom Island located at the end. Formerly an island, the coastal trail is now connected to the land through years of sedimentation. The people of Busan, however, still refer to the place as Dongbaekseom Island. Dongbaek Park, built with the natural elements of the area still intact, is a beautiful place with a dense habitation of black pine. The coastal trail connects to a white lighthouse and a wide observatory, where you can look out into the ocean to see the Nurimaru APEC House and Gwangandaegyo Bridge. Turn your gaze a bit to the left to see the Oryukdo Islets. This is a great spot to view the sea of Busan all at once.

• Dalmajigil Road

Dalmajigil Road, which one should definitely not miss when visiting Haeundae. Dalmajigil, a hilly road from Mipo at the end of Haeundae to Songjeong Beach, is a place for healing in nature away from the hustle and bustle of the city by absorbing oneself in meditation and relaxation. The Dalmajigil Road requires climbing up the Dalmaji Hill, but the slope up is not troublesome at all. Thanks to the rising level, Haeundae Beach, Dongbaekseom Island, and Gwangandaegyo Bridge come into view simultaneously. The beautiful cafés and romantic restaurants located along the stone wall path make visitors' hearts flutter with anticipation.

Dalmajigil Road

• Busan X the SKY

Busan X the SKY is located in the second highest building in Korea, Haeundae LCT the Sharp (411.6 m). In this highest, biggest-scale observatory, you can view the wide-spread ocean of Haeundae and the beautiful city of Busan. On top of the world-famous landmarks of Busan such as the Gwangandaegyo (Diamond Bridge) and Marine City, you can view the day and night of Busan while you enjoy the premium services of the interior media facade, lounge cafe, and casual cafe. Experience the whole world below your feet at BUSAN X the SKY.

Busan X the SKY

Korea Tour Attractions

1) Hahoe Village in Andong

Hahoe Village in Andong is Korea's most representative folk village with a long history. The village is full of wooden and thatched-roof houses and sits between a river and mountains. It shows Confucian culture from the 14th-15th century and was registered as a UNESCO World Heritage in 2010. The village has a beautiful river and lake scenery, perfect for walking around, and a splendid night view as well. Find more information at http://www.hahoe.or.kr/.

2) Gyeongju

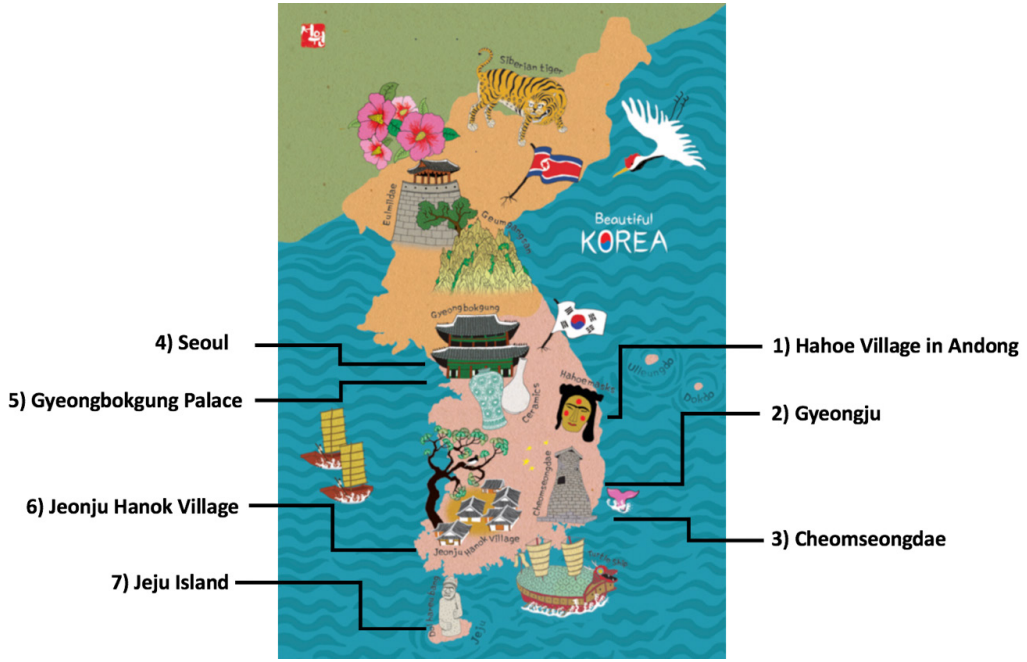
Gyeongju was the capital city of the ancient kingdom of Silla. The city is often referred to as a "museum without walls" because of the many cultural relics scattered throughout the city. Almost everything in this city, from the streets to the mountains, is rich in history. Gyeongju has roughly 300 sites that have been designated as a cultural heritage, with some of them being UNESCO-recognized World Heritage Sites. Find more information at https://www.gyeongju.go.kr/.

3) Cheomseongdae

This scientific stone building is the "oldest astronomical observatory in Asia" and was built by Queen Seondeok. It is filled with ancient scientific secrets. The 365 stones from which Cheomseongdae was built represents the number of days in a year, and the total of 29 levels and 30 levels of stone steps (depending on which level to count from) represents the number of days in a lunar month. The top 12 columns and the bottom 12 columns of the window symbolize the 24 seasonal divisions of the year according to the lunar calendar. Experts believe astronomers would have stepped inside the structure as they observed the starts. Find more information at https://www.gyeongju.go.kr/.

4) Seoul

Seoul is the capital of Korea and is the heart of Korea's culture and education as well as politics and economy. Seoul is home to many historic sites and places of traditional culture. The shopping and entertainment districts also draw a large number of tourists every year. The Hangang River, which runs through the center of the city, is a distinctive landscape of Seoul



that offers a myriad of resting areas for citizens. Find more information at https://english.visitseoul.net/.

5) Gyeongbokgung Palace

Built in 1395, Gyeongbokgung Palace is commonly referred to as the Northern Palace because its location is furthest north when compared to the neighboring palaces of Changdeokgung (Eastern Palace) and Gyeonghuigung (Western Palace). Gyeongbokgung Palace is arguably the most beautiful, and remains the largest of all five palaces. The premises were once destroyed by fire during the Imjin War (1592-1598). However, all of the palace buildings were later restored under the leadership of Heungseondaewongun during the reign of King Gojong (1852-1919). Find more information at http://www.royalpalace.go.kr.

6) Jeonju Hanok Village

Jeonju Hanok Village is the largest traditional hanok village in Korea, with more than 700 hanoks in the Pungnam-dong area of Jeonju.It is the only hanok district that is located in the center of a city. It is an important space in the development process of Korea's modern housing culture, which started in 1910, and is the home of about 20 cultural facilities including Gyeonggijeon, Omokdae, and Hyanggyo. It is a representative travel destination of Korea and is integrated with the style of Korea such as hanok, hanji, hansori, hanbok, Korean food, and oriental medicine. Find more information at http://hanok.jeonju.go.kr.

7) Jeju island

Jeju Island, designated as Jeju Special Autonomous Province, lies southwest of the Korean Peninsula and is the largest tourist destination in Korea. The whole island was designated as a special tourist zone, and wherever tourists go, they can look upon beautiful scenery. Jeju Island earned the UNESCO triple crown, being designated as a World Natural Heritage, Global Geopark, and Biosphere Reserve as well as one of the Seven Wonders of Nature. Traveling the 182-kilometer circuit road along the coastline by car, motor scooter or bike is recommended. There is a trail for walking called “Jeju Olle-gil” for those who choose to make a round trip on foot. Find more information at https://www.visitjeju.net/en/.

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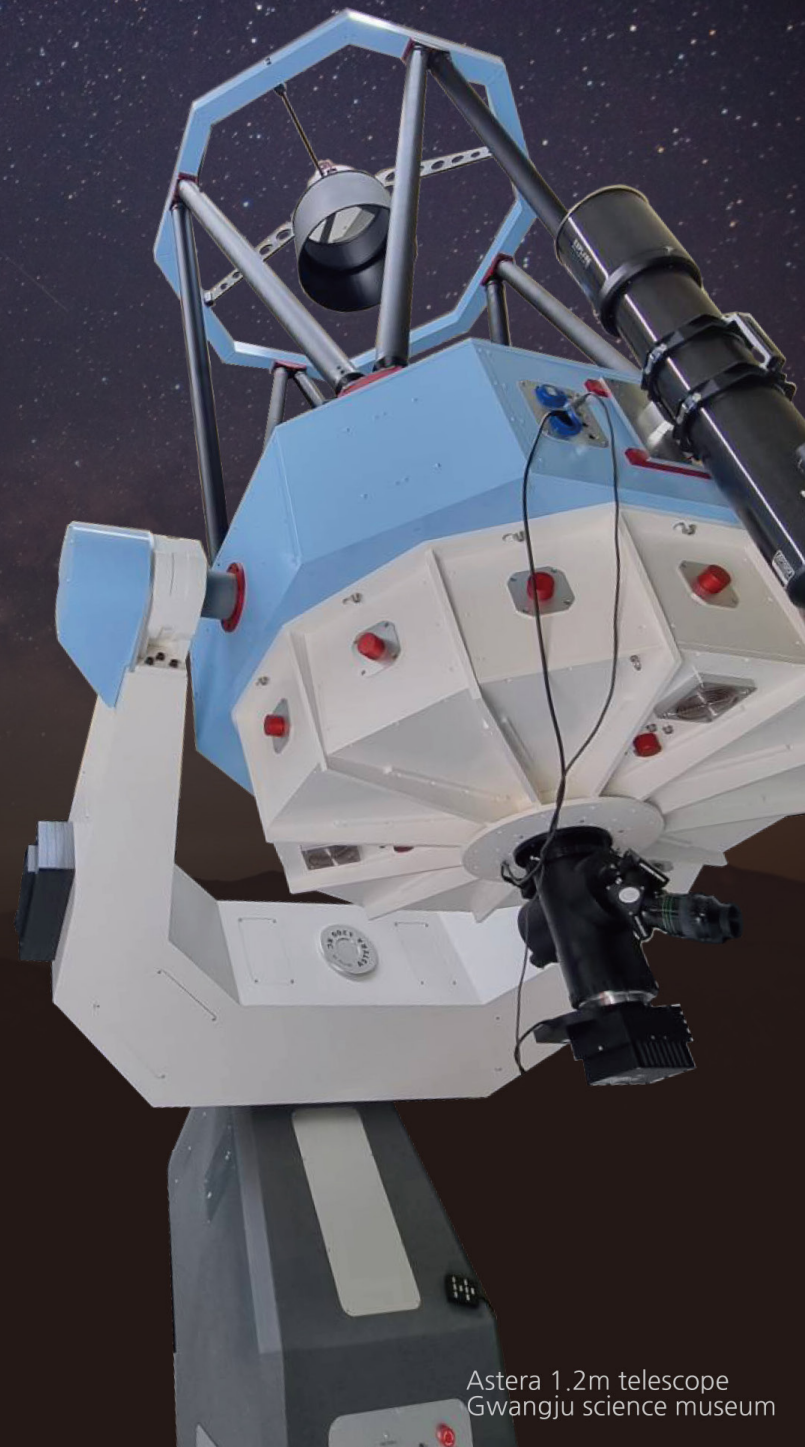

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2022 Kavli Prize in Astrophysics Winner

Invited Discourse 2_Sherry Suyu

Welcome Message on the Diamond Bridge from the Busan Metropolitan City
(Photo by Jeon, Yeong-Beom (KASI))

Issue 5 | August 8, 2022

Mirinae

미리내 The Milky Way

TABLE OF CONTENTS

#IAUGA2022 is an official hashtag of the IAUGA2022

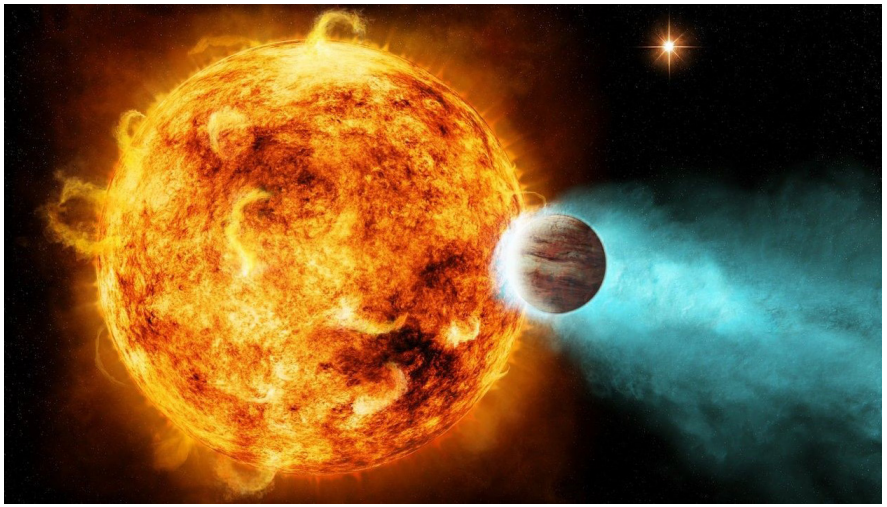
Winds and magnetospheres from stars and planets: similarities and differences

Stan Owocki, S370 plenary speaker

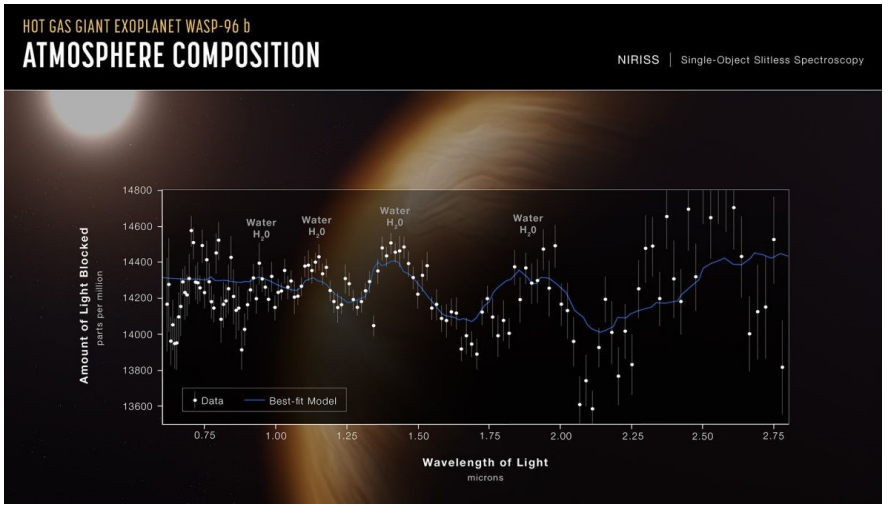
As a young boy in the 1960's, Stan Owocki became fascinated with the night sky, wondering about the swarms of stars, where they come from, what they're made of. When, for his 11th birthday, he got his first telescope, a 3-inch Newtonian reflector, he discovered that among the best targets were the bright planets: Venus with its crescent shape; reddish Mars with hints of a bright polar ice cap; Jupiter with its four shuffling moons; Saturn with its magnificent, glorious rings.

As a young man Stan went on to get a doctorate in astronomy, and since 1987 as a professor at the University of Delaware in the US he has made a career of studying stars, with a particular focus on their somewhat peculiar tendency to shed some of their mass through outflowing "stellar winds". Though following with great personal interest the many spacecraft tours that revealed in wonderous detail all the planets and moons of our solar system (including Pluto), their technical study seemed quite distinct and far afield from his work on stars.

Then in the mid-90's came the discovery of the first extra-solar planets, many of them "hot Jupiters" that orbit so close to their host star that the stellar radiation heats up their outer atmosphere to such a high temperature that some of the gas expands outward in a "planetary wind". The attached figure shows an artist's depiction of such a hot Jupiter orbiting close



An artist's depiction of a "hot Jupiter" exoplanet orbiting close to its star. (Image credit: NASA/Ames/ JPL-Caltech)



Webb's (reversed) transmission spectrum, with the "peaks" showing where water molecules have absorbed starlight. (Image credit: NASA/ESA/CSA and STScI)

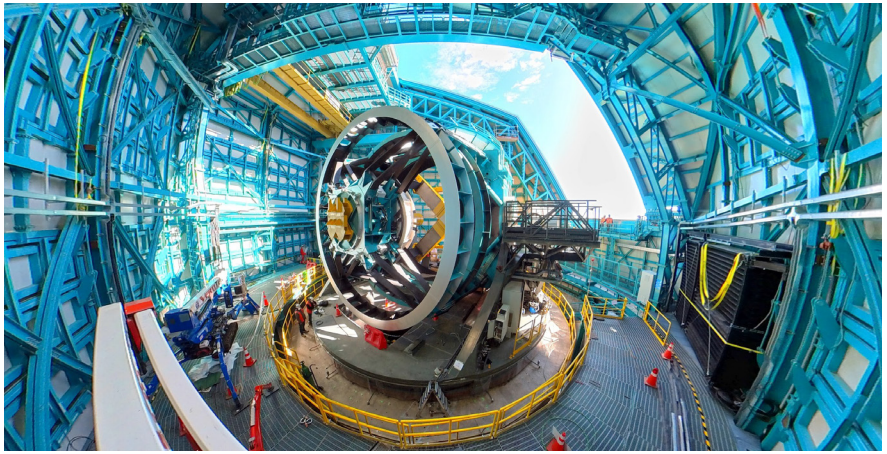
to its star. Among the 5000 exo-planets detected since then are also "super-Earths", with a rocky core and a dense atmosphere, orbiting at various distances from their star. When any planet with an atmosphere passes in front of its host star, the absorption features it imparts in the star's spectrum allows one to infer information on the atmosphere's density and composition, and even if it is extended into an outflowing wind. The recent spectrum from the Webb telescope of water absorption by the exo-planet Wasp 96b is a prime example.

Thus a central issue in the study of exo-planets, and particularly whether they can have the mild temperature and dense atmosphere for the extensive liquid water that is key to life on earth, is how well they retain their atmosphere against loss to a wind, or to ablation from the star's wind.

The organizers of the IAU Symposium 370 on "Winds from Stars and Planets" thus aim for the meeting to bring together researchers on stars and exo-planets, with emphasis on exploring the overlap and distinctions in the physics underlying their wind outflows. Stan's opening plenary talk will introduce these concepts, with added emphasis on how magnetic fields of both stars and planets can influence these outflows, and their key observational signatures ranging from X-ray to radio wavelengths.

Stan Owocki (University of Delaware) during a visit to the Galapagos Islands.

Science Program for Division G: Stars and Stellar Systems



The Vera C. Rubin Observatory is located on the Cerro Pachón ridge in north-central Chile; it hosts an 8.4-m telescope that will conduct a 10-year Legacy Survey of Space and Time (LSST). The survey will focus on probing dark matter and dark energy, complete the census of the Solar system, explore the transient sky and map the Milky Way galaxy. Image courtesy of Rubin Obs/NSF/AURA.

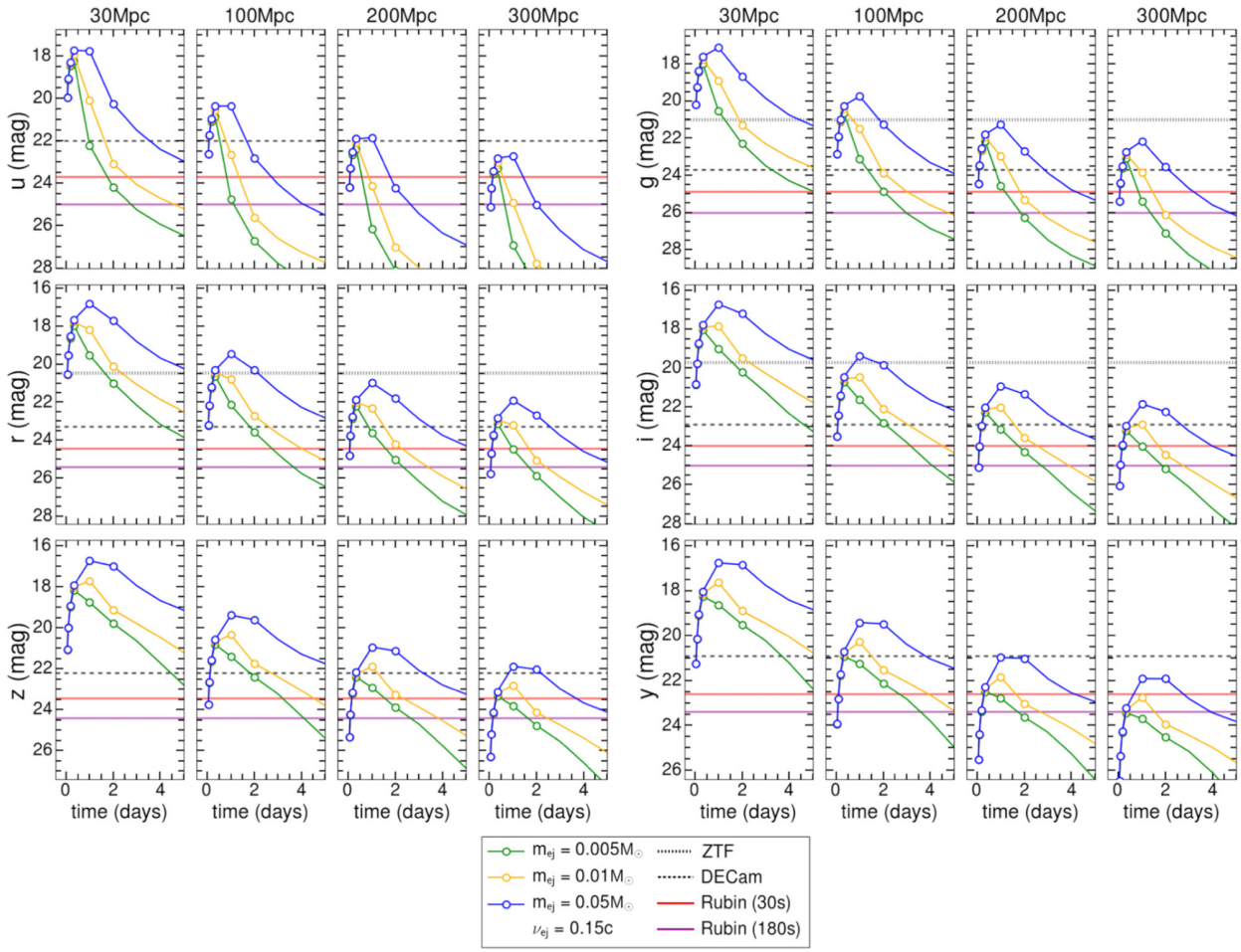
Division Meeting G: Stars and Stellar Physics	
START DATE	Friday, 5 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 106, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

Division G fosters research, sharing expertise, disseminating knowledge and public outreach related to all areas of stellar astrophysics. The topics include stars, their populations and evolution, binary and multiple systems, stellar variability and observables across the entire light spectrum.

Stellar astrophysics has seen major advancements in the last triennium, mostly thanks to the large surveys that observe large swaths of the sky and deliver aggregate petabytes of data. With the delivery of heterogeneous, high-precision data and advances in data science and computing power, we have been witnessing a substantial increase in model fidelity across stellar astrophysics: from stellar formation and evolution across the H-R diagram, to binary and multiple star physics and asteroseismology, all the way to galactic structure and evolution. Division G days provide us with an opportunity to reflect on what we have learned over the last triennium and ponder on the most pressing current challenges in the field of stellar astrophysics.

Division Days at the General Assembly take place on Friday (Aug 5) and Monday (Aug 8), where we welcome everyone interested in the latest advancements in stellar astrophysics. We will focus specifically on radiative transfer, radioactive decay and magnetic pressure in stellar atmosphere models; the roles of magnetic fields, convection, gravity waves, shear and turbulence in stellar interiors; symbiotic stars, cataclysmic variables and contact binaries; compact objects and tidal disruptions; evolved stars; and the search for transients across the sky. The scientific program comprises 5 invited talks, 16 contributed talks, and 18 e-talks and e-posters. Invited speakers include PhD prize winners Drs. Lisa Bugnet, Simon Blouin and Steven Goldman, Division vice-president Dr. Merieme Chadid, and the LSST/TVS pulsating stars chair Dr. Kelly Hambleton. The program also includes a 30-min discourse on Division G's role, scientific and collaborative impact, and worldwide support for stellar astrophysics.



Simulated kilonova light-curves in the six Rubin LSST filters for different properties of the ejecta (mass and velocity) at four representative distances (30, 100, 200, and 300 Mpc). Dotted and dash-dotted lines mark typical 5-sigma detection thresholds of ZTF and DECam, respectively, assuming 30-s exposure times. Red and purple solid lines: Rubin LSST 5 sigma detection thresholds for exposure times of 30-s and 180-s under ideal observing conditions. The superior sensitivity of the Rubin Observatory is essential to detect the multi-color emission from kilonovae. Adopted from Andreoni et al. (2022).

Dr. Andrej Prša is a Professor of Astrophysics at Villanova University in Pennsylvania, USA. He serves as president of IAU's Division G for the 2021-2024 triennium. His scientific interests straddle computational astrophysics of binary and multiple stellar systems, stellar populations and bulk analysis of large survey data.

Division Galaxies and Cosmology meets in Busan: 100 years of Extragalactic Astrophysics

The members of Division J of the International Astronomical Union will meet in Busan in August 2022 during two sessions, on August 5th and on August 8th. Division J is the Division Galaxies and Cosmology, and it focuses on the Physics of the Universe and galaxies beyond the Milky Way. All approaches, theory, simulations and panchromatic observations are considered by our Division. It is important to notice that Division J connects across many of the other Divisions and has strong overlap with Div. B, Div. D, Div. G and Div. H.

Division Meeting J: Galaxies and Cosmology	
START DATE	Friday, 5 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 205, Convention Hall, 2nd Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

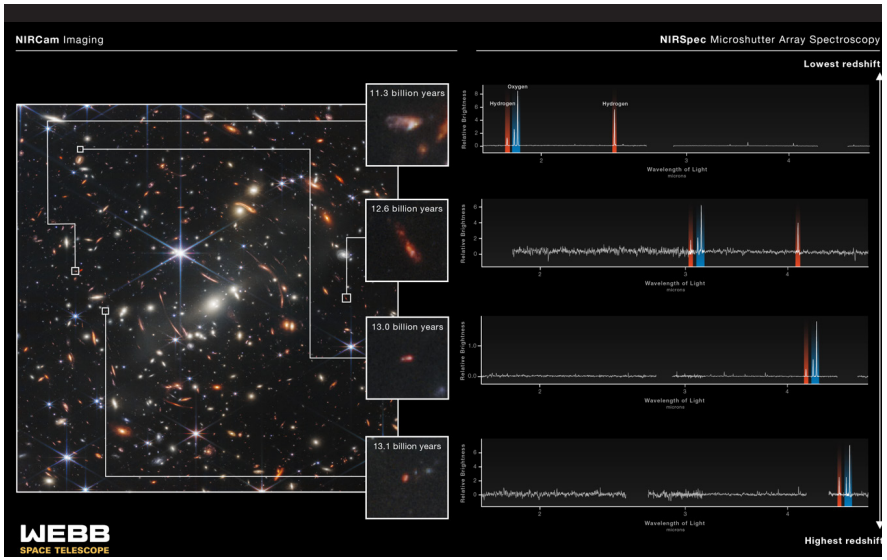
We cannot detail in this paper the rich programme of our two division days that will cover the fields studied by our division members. This is why we decided to present in this paper only the PhD prizes granted over the 4 yours since the last general assembly. The recipients of these prizes represent the youngest generation that started their career in Astrophysics and in Cosmology.

- Anna-Christina Eilers: The Growth of Supermassive Black Holes in the Early Universe, Prize 2019
- Jorryt Matthee: (Re)solving Reionization with Lyman-alpha emission, Prize 2018
- Solène Chabanier: Neutrino and dark matter cosmology with the Lyman-alpha forest, Prize 2020

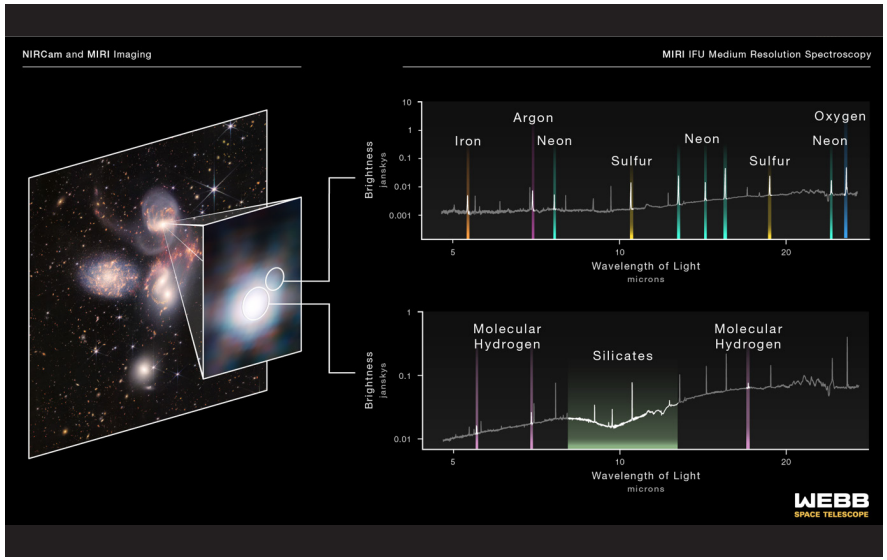
An important information about our division, that might actually be relevant to the entire Earth population, is that our understanding of the Universe is quite recent. It was in April 1920 that the Great Debate was held at the Smithsonian Museum of Natural History, between Shapley and Curtis, on the nature of spiral nebulae and the size of the Universe. From the presentations, two papers have been published by Shapley and by Curtis in the May 1921 issue of the Bulletin of the National Research Council (Shapley & Curtis 1921). Shapley supported the idea that distant nebulae were relatively small and lay within the outskirts of what is now called the Milky Way, while Curtis was convinced that these nebulae were actually other, independent objects such as our galaxy, the Milky Way. Curtis' view implies that galaxies are very large objects, at very large distances from Earth. Only in 1924, Hubble's detection of Cepheids and other variable stars in some of these nebulae (e.g., NGC 6822, M331, M32 and M31), finally allowed to estimate the distance to these nebulae and to show that they are indeed extragalactic objects. This closed the Great Debate.

The end of this debate is therefore the spiritual birthdate of the Division Galaxies and Cosmology.

The Covid-19 sanitary crisis prevented us from actually celebrating this event and even to plan for a celebration in Busan. We suggest to start planning for a celebration during the next IAU General Assembly in 2024, to mark the closing of the Great Debate.



Webb spectra identify galaxies in the very early Universe: Of the thousands of distant galaxies behind galaxy cluster SMACS 0723, NIRSpec observed 48 individually. A quick analysis made it immediately clear that several of these galaxies were observed in the early universe. These observations mark the first time these particular emission lines have been seen at such immense distances. However, there may be even more distant galaxies in this image. With Webb's data, we will now be able to measure the galaxy's distance, temperature, gas density, and chemical composition. NIRSpec was built for the European Space Agency (ESA) by a consortium of European companies led by Airbus Defence and Space (ADS) with NASA's Goddard Space Flight Center providing its detector and micro-shutter subsystems.



Composition_of_gas_around_active_black_hole_MIRI_spectra: Stephan's Quintet is a visual grouping of five galaxies located in the constellation Pegasus. Together, they are also known as the Hickson Compact Group 92 (HCG 92). Although called a "quintet," only four of the galaxies are truly close together and caught up in a cosmic dance. The fifth and leftmost galaxy, called NGC 7320, is well in the foreground compared with the other four. The topmost galaxy in the group – NGC 7319 – harbors an active galactic nucleus, a supermassive black hole 24 million times the mass of the Sun. The NASA/ESA/CSA James Webb Space Telescope studied the active galactic nucleus in great detail with the Near-Infrared Spectrograph (NIRSpec). The instrument's integral field units (IFUs) provided the Webb team with a "data cube," of the galactic core's spectral features. NIRSpec was built for the European Space Agency (ESA) by a consortium of European companies led by Airbus Defence and Space (ADS) with NASA's Goddard Space Flight Center providing its detector and micro-shutter subsystems. MIRI was contributed by ESA and NASA, with the instrument designed and built by a consortium of nationally funded European Institutes (The MIRI European Consortium) in partnership with JPL and the University of Arizona.

Denis Burgarella was the President of Division J from 2018 to 2021. He is now President of the Commission Galaxies at the Epoch of Reionization. He also coordinates a French – Japanese international network called NECO. He makes use of multi-wavelength data to study the formation and the early evolution of galaxies. Denis Burgarella developed the CIGALE code with Médéric Boquien.

Cristina Popescu is the current Vice-President of Division J. She was the President of Commission J1 - Galaxies Spectral Energy Distributions - between 2018-2021. She pioneered and developed radiative transfer methods to account for the spectral energy distribution of galaxies.

Kim-Vy Tran is currently on the faculty at the University of New South Wales and has been a professional astronomer for more than 20 years. Before becoming Division J President in 2021, she served as the Division J Vice-President in 2018-2021. Her astronomy research program advances our knowledge of how galaxies assemble over cosmic time by capitalizing on the high resolution, extreme sensitivity, and broad wavelength coverage of ground and space-based telescopes. This comprehensive approach enables us to study galaxies from the local neighborhood to the edge of the observable Universe.

IAUS 370: Winds of stars and exoplanets

Division Meeting C: Education, Outreach and Heritage	
START DATE	Monday, 8 August
END DATE	Thursday, 11 August
ORAL SESSIONS	Room 101, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

Winds form an integral part of astronomy - from regulating rotation of stars through enriching galaxies with fresh materials, outflowing winds persist during the entire lives of stars and play a key role in shaping the observed exoplanet demographics. In the case of massive stars, their winds are a vital ingredient of their evolution, from the main sequence to the pre-supernova stage, determining black hole masses as measured from gravitational waves. In the case of low-mass stars, their winds dictate rotational evolution, which affect angular momentum distribution within the stellar interior and thus affect generation of magnetic fields. Finally, in the case of planets, winds take the form of atmospheric escape, which can strongly affect their atmospheric evolution. Strong escape of highly irradiated exoplanets have now been observed in several close-in exoplanets during transits and are indirectly detected in the observed exoplanet radius distribution.

Although the only astrophysical wind that we are able to directly probe is that of the Sun, the past decades have seen great progress in observing winds of other astrophysical objects. In particular, in recent years, several observing programmes and space missions have focused on studying winds from our Sun, other stars and exoplanets.

On the solar side, two new space missions, Parker Solar Probe and Solar Orbiter, are dedicated to studying the physics of the solar wind. By traveling much closer to the Sun than any other spacecraft has ever been, these new missions allow direct measurements of the solar wind at an unprecedented close distance. Data from these missions might provide interesting implications for the variability of the plasma environment at the orbits of close-in exoplanets.

On the stellar side, winds of low-mass stars are magnetically driven, and magnetism has been either directly (through Zeeman effects) or indirectly (through activity proxies) observed in these stars. Recently, many new magnetospheres were detected around massive stars as well. In spite of similarities, there is a major difference between winds of low- and high-mass stars: their mass-loss rates are orders of magnitude different, due to different physical processes driving their winds. Even with substantially lower mass loss rates, winds of low mass-stars play a fundamental role in removing angular momentum, and thus, shaping the rotational evolution of these stars.

On the planetary side, missions like Kepler, TESS and Plato (will) provide the statistics for planet population studies and hence infer the indirect presence of outflowing planetary winds in shaping the distribution of sizes of close-in exoplanets. HST has been fundamental in detecting strong atmospheric escape of close-in giant planets through ultraviolet transmission spectroscopy. Recent observations have also opened the possibility to detect escaping planetary winds from the ground.

In order to gain insight in the physics and the modeling tools used by different communities, we wish to bring together researchers working on winds of close-in exoplanets (atmospheric escape), winds of low- and high-mass stars and the solar wind in a symposium dedicated to “winds”. Our hope is that this will foster communication between these different communities and drive advances in these fields.

Aline Vidotto (Chair) is an Associate Professor at Leiden Observatory. Her research is focused on star-exoplanet relationship — by using theory and numerical simulations, her group research the interaction of exoplanets with their host star's wind.

Luca Fossati (co-chair) is a group leader at the Space Research Institute of the Austrian Academy of Sciences, His research focuses on the observational and theoretical characterisation of exoplanetary upper atmospheres and escape, as well as of star-planet interactions, particularly at ultraviolet wavelengths.

Jorick Vink (co-chair) is a Research Astronomer at Armagh Observatory and Planetarium. His research focuses on the winds and evolution of the most massive stars. He is interested in both theory and observations, such as the UV data obtained with the HST ULLYSES project and complementary ESO-VLT X-Shooter data for massive stars at low metallicity.

IAU Executive Committee Working Group meeting: global coordination of ground and space

International collaboration has always been an important part of research in astronomy. Over the past two decades, the increasing complexity and cost of new facilities, the constrained amount of funding available from individual sources, and the rapidly increasing volume of data have made international collaboration and coordination essential to our ambitions for ever more capable facilities and more augmenting progress in moving the field forward. This Working Group Meeting will provide a forum to discuss how to improve coordination of global planning and build towards future projects. Working towards a new paradigm of global Open Data and Open Science will be a major theme of the meeting. These topics are particularly timely given the recently published planning documents by ESA (Horizon 2050) and the US National Academy Decadal report (Pathways to Discovery in Astronomy and Astrophysics for the 2020s)

IAU Executive Committee Working Group Meeting: Global Coordination of Ground and Space Astrophysics	
START DATE	Monday, 8 August
END DATE	Wednesday, 10 August
ORAL SESSIONS	Room 108, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

The first session introduces a new approach to surveying In the opening session, speakers will provide a survey of the landscape of future large facilities. We have organized tThree plenary talks on Large Space Missions, Large Ground based projects, and coordination between ground and space. In each case these will cover projects that will be coming online in the next decade giving an update on the status of planning. The speakers will address key questions, such as what are the most difficult challenges for the agencies around coordination, and how they are working towards the goal of Open Data. These three overviews will be followed by will be followed by an open discussion.

on the ground and in space that will be coming online in the next decade, and give an update on the status of planning. The speakers will address key questions, such as what are the most difficult challenges for the agencies around coordination, and how they are working towards the goal of Open Data. Three plenary talks on Large Space Missions, Large Ground projects, and coordination between ground and space will be followed by an open discussion.

The second session will be devoted to a discussion of the key questions in specific science areas and how we might improve what kind of coordination amongst and between ground and space based facilities to make faster progress. is required by different science areas. This session will feature talks on exoplanets, stellar populations, black holes, galaxies, and cosmology, followed by an open discussion. We will attempt to identify types of coordination that can benefit multiple science areas.

The third session will focus on one of the most challenging but potentially impactful areas for coordination, which is the exciting and rapidly exploding field of multi-messenger astronomy. We will hear a summary report from the Kavli-IAU Cape Ttown 2020 meeting on this topic, followed by presentations on ground and space based gravitational wave facilities, and neutrino, gamma ray and cosmic ray telescopes. This session will conclude with a panel discussion with representatives from all of the major types of facilities.

The final session will address the future role of current telescopes, and the critical topic of data archiving. This session will open with a panel discussion among representatives of current facilities. The panelists will address questions such as: how will the use of their facilities evolve over the next decade as new telescopes come online? How can we coordinate the use of the full international portfolio of new and older facilities to optimize the science? In the archive session, representatives from different archiving centers facilities will summarize how efforts are currently being undertaken to coordinate archiving of data from different facilities, agencies, and wavelengths.

All IAU members have a stake in the strategic decisions made by nations, agencies, and scientific consortia. We invite all members to attend the working group meeting and contribute towards this important effort.

Full program: https://www.iauga2022.org/program/program_06_6.asp?sMenu=abo6

Roger Davies is the Wetton Chair in Astrophysics and a student of Christ Church. He is the current president of the European Astronomical Society and the founding Director of the Oxford Hintze Centre for Astrophysical Surveys.

Rachel Somerville is a Group Leader at the Center for Computational Astrophysics at the Flatiron Institute in New York City.

Highlights of Young Astronomers Lunch (August 5)

How to get people outside their boundaries and make people aware of their work was one of the hot topics at Young Astronomers Lunch (YAL).

"I always tweet about my student's paper on Twitter," answered Xiaohui Fan from the University of Arizona, the USA, to a Ph.D. student's question, "Do you think using social media is important to get information about many things in astronomy such as conferences or new papers, and help to promote myself?"

The Young Astronomers Lunch event, first introduced at the 2006 IAU meeting, was held on Thursday, 5 August, from 12:00 to 13:30 this year. The meeting aims to provide networking opportunities between senior astronomers and young astronomers in an open and friendly atmosphere. More than 300 conference attendees participated in the event, and two mentors were matched with 3-4 mentees per table. After a 15-minute lunchtime in silence as part of coronavirus prevention measures, mentor-mentee pairs began to have a full-fledged conversation. Various topics were discussed at each table, and one of the key discussion topics was the issue of finding a job. Mentees asked their mentors for advice on promoting their research, whether using social media would be beneficial, and how to enhance their visibility in their own research field.

"I was delighted to have this precious opportunity at the conference I attended for the first time, and I got a lot of advice on the path to becoming an astronomer," said an undergraduate student at Kyung Hee University in Korea.

Women in Astronomy Lunch

Women in Astronomy Lunch meeting will take place at Hall 5A, Exhibition Center II, BEXCO on the 8th of August at 12:00-13:30.

The gender and diversity dimension of science and technology has become one of the most important and debated issues worldwide, impacting society at every level. The International Astronomical Union, through its Executive Committee Working Group on Women in Astronomy, has been a strong advocate for discussing these themes openly and for supporting initiatives that can improve a more balanced representation of diversity in our community. In this context, the Organizing Committee of the IAU EC WG on Women in Astronomy together with the NOC of the IAU-GA in Busan are proud to announce the Women in Astronomy Lunch Meeting (WL) for networking and discussions of important issues.

You can sign up for this event when you register for the GA.

We kindly acknowledge a generous donation by US National Academy of Sciences (US NAS) and the Norwegian Academy of Science and Letters (NASL) that have made the organization of this event possible.

※ To participate in this event please bring the ticket issued with your name badge

Korean Food (Busan Food) and Busan Culture

Here are top 3 Busan foods chosen by local and foreign travelers as their favorites.

Pork and Rice Soup

Wheat Noodles (Milmyeon)

Sliced Raw fish

Pork and Rice Soup

Which dish first comes to mind when you think about Busan? The list is too long, but many Koreans would pick Busan's specialty, rice and pork soup. Hot broth with pork bones, fresh chive kimchi, salted shrimp, and noodles are prepared in a set. Roll the thin noodles as the appetizers by adding a spoonful of seasoned chives and salted shrimp into the soup with an incredible amount of meat and soup for a more pleasantly surprising flavor.

Wheat Noodles (Milmyeon)

The second-best food for travelers in Busan will be wheat noodles (milmyeon).

Here is the tip recommended for you to taste mulmimyeon (soup wheat noodles). Firstly, take a sip of the broth, then add vinegar and mustard sauce to satisfy your taste! If you like to enjoy the unexpected perfect blend of spicy, sweet, and sour sauce at the tip of your tongue, you might finish a bowl of bibimyeon (spicy wheat noodles) within a minute.

Sliced Raw fish

Any trip to Busan wouldn't be complete without some sliced raw fish. Old restaurants with several layers of history are the best way to meet the people of Busan, while window seats in restaurants offer a beautiful view of the city to be enjoyed with good food. But no matter where you go, you'll surely enjoy sliced raw fish in Busan.

If you want to experience the energy of Busan, we recommend Gwanglli Beach and Nampo-dong.

Gwangalli Beach

Nampo-dong

Gwangalli Beach

Gwangalli Beach is a famous beach and one of Busan's representative hot spots together with Gwangandaegyo Bridge. It is the closest beach to the city center and also a trendy meeting place for Busan's youth.

Along with its white sandy beach, Gwangalli is filled with diverse attractions such as restaurants serving delicious foods, coffee shops with an open view of the sea and exotic stores hidden in alleyways. Gwangalli is also known for its numerous coffee shops and restaurants with a great view of the sea. If you want to enjoy the night view of the sea a bit more, the Waterside Park is the best place to go.

Nampo-dong

A major urban district, the neighborhood has a park, a department store, a traditional market, and major tourist attractions, making it a hot place for locals, tourists, and foreigners alike. As the area is large, you may have to spend an entire day or even longer to enjoy every part of Nampo-dong. Enjoying local food is the best part of a trip. Nampo-dong Food Alley, where each building is full of clothing stores and restaurants, and the center of the narrow alley is lined up with various accessories and food carts selling street food. Its street food is also popular among tourists. Cheap and delicious street food you can only taste in Busan.

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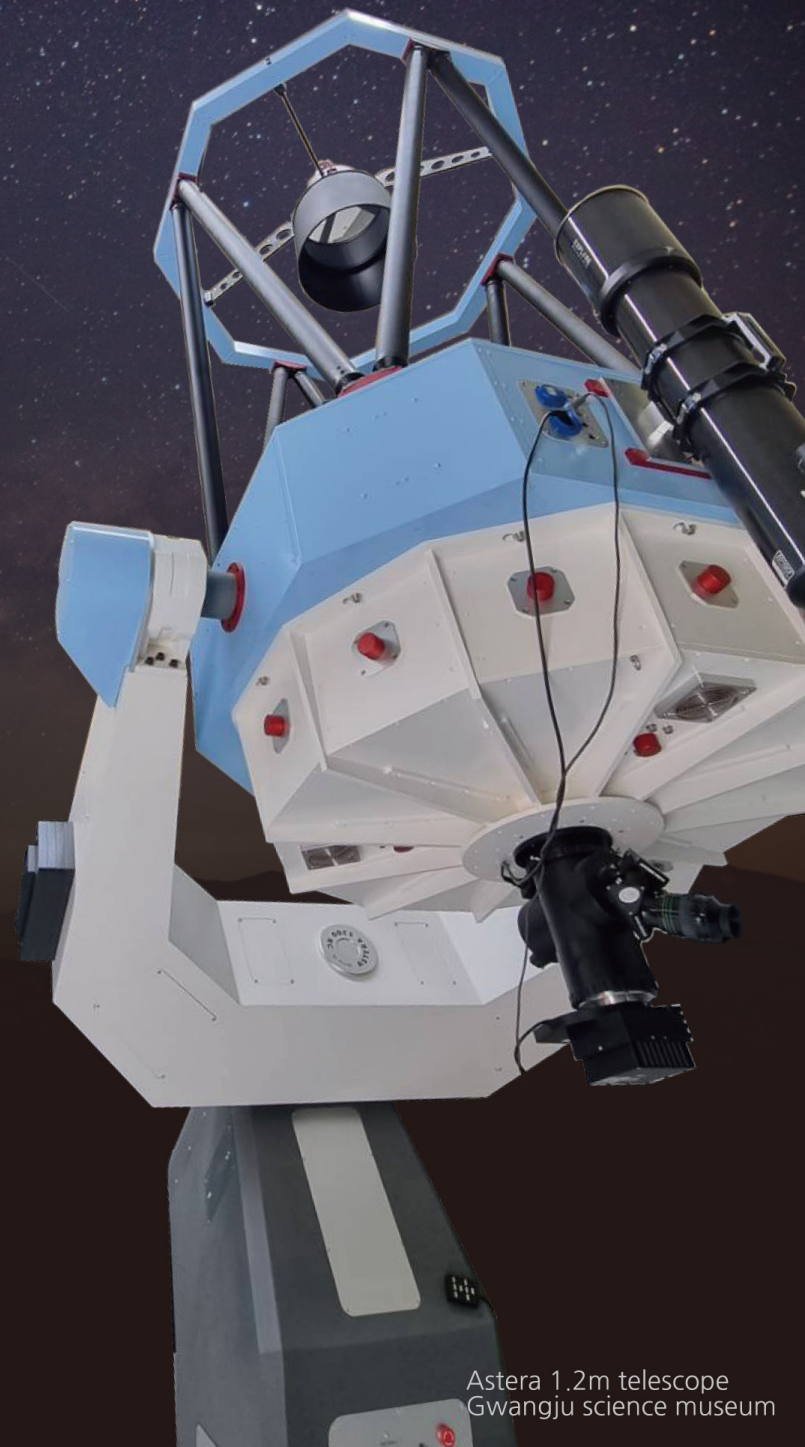

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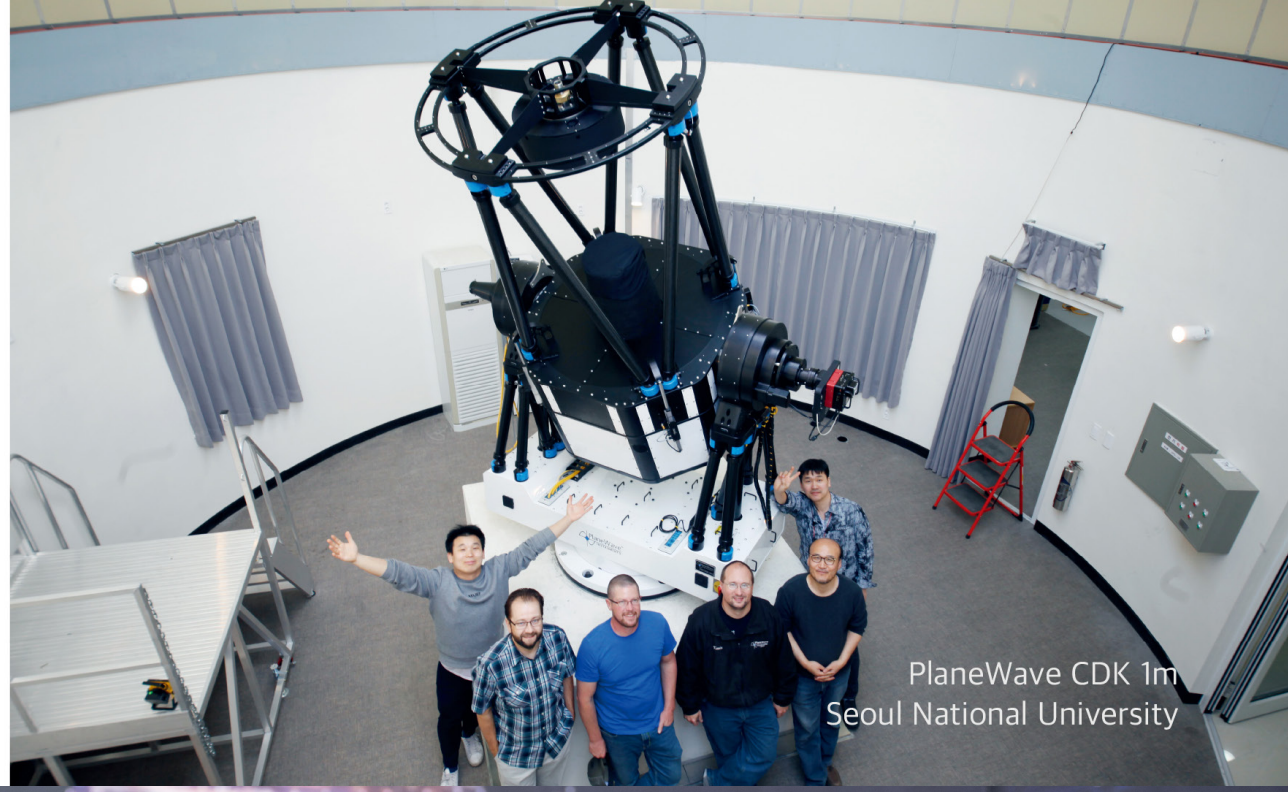

PlaneWave CDK 1m
Seoul National University

Young Astronomers Lunch

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Mirinae

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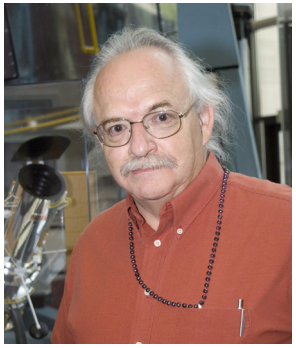


In the late 1970s I worked for the American Institute of Physics in an oral history program sponsored by the NSF to create a collective portrait of 20th century astronomers by interviewing them to record and preserve their impressions of how astronomy changed during their careers. Using citation studies and lists of prize winners, as well as the advice of a senior advisory panel, and some thematic questions, like how physics became central to astronomical practice, we came up with an extensive list. Charlotte Emma Moore Sitterly of the National Bureau of Standards was of very high priority, for no less a reason that over her lifetime she was a central figure in the classification and analysis of solar and stellar spectra. In Donald Menzel's words, she "turned chaos into order" which was just a "little short of miraculous." I was honored to be able to interview her, travelling to Washington DC and visiting her home on Brandywine Street on July 15, 1978.

After graduating from Swarthmore with some exposure to general astronomy, Moore spent much of her professional life, starting in the 1920s, working for Henry Norris Russell at Princeton, the leading American astrophysical theorist of the first half of the Century. Menzel's comment above applied as well to how she organized and helped execute Russell's own research enthusiasms. She was a meticulous and steadfast worker, taking Russell's ideas and directives, applying them to the rapidly growing stores of spectroscopic data to turn them into new insights about the physical processes producing them. She soon met observational astronomers and physicists from many observatories and institutions, acting as a clearing house for their data. She also worked at the Mount Wilson Observatory for several years on leave from Princeton in the 1920s to be closer to the source of the data and returned there to complete her thesis at Berkeley on "Atomic Lines in the Solar Spectrum" in 1931. With Russell and others, she had already participated in a revision of Rowland's tables of the lines in the solar spectrum, and in 1931 returned to Princeton to work for Russell until his retirement in 1945. Her many close contacts since the 1920s included William Meggers of the National Bureau of Standards, who eagerly hired her to continue refinements of solar and stellar spectra, constantly improving the NBS "Multiplet Tables of Astrophysical Interest," a central resource for astrophysics.

She was an ardent member of the new IAU Commission 14 (then called "Fundamental Spectroscopic Data") eventually becoming its president in 1961, and helped it grow over the years because, in her words, astronomers had a "never ending demand for tables and data analysis." Here we provide a brief overview of Charlotte Moore Sitterly's life and how she came to be at the center of change. We will recount highlights of her early life, aspirations, training, and contributions during her years at Princeton, Berkeley, Mount Wilson, and the National Bureau of Standards.

(Left) Charlotte Moore circa 1919. (Right) Charlotte Moore working at her desk at the National Bureau of Standards in Washington, D. C. Courtesy of Michael Duncan via the M. D. Moore Family. From: https:/www.smithsonianmag.com/science-nature/how-charlotte-moore-sitterly-wrote-encyclodpedia-starlight-180973152/

IAU Symposium 371

Honoring Charlotte Moore Sitterly: Astronomical spectroscopy in the 21st century

Spectroscopy lies at the heart of our physical understanding of the universe and its constituents. And at the heart of spectroscopy is laboratory astrophysics. Although the lab work may not always be as conspicuous as other aspects of astronomy, progress would be impossible without it, especially as we extend our observations into new domains.

IAU Symposium 371: Honoring Charlotte Moore Sitterly - Astronomical Spectroscopy in the 21st Century	
START DATE	Tuesday, 9 August
END DATE	Thursday, 11 August
ORAL SESSIONS	Room 202, Convention Hall, 2nd Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

Charlotte Moore Sitterly

Our knowledge of the grand cosmos depends primarily on the nanoscale quantum transitions within atoms and molecules. Our knowledge of those transitions, in turn, depends on laboratory-scale efforts, with a very special contribution from Charlotte Moore's multiplet table. Dr. Moore's work in the first half of the 20th century has been central to the successes of astronomical spectroscopy ever since. She started as a "computer" for Henry Norris Russell, discovered technetium in the Sun, and went on to the U.S. National Bureau of Standards, where she compiled the multiplet table and many other essential references. This IAU General Assembly symposium is in her honor. Moreover, the centennial of the IAU meshes perfectly with this subject, both because of the significance of her work over that time, but also because she worked directly with Henry Norris Russell, one of the IAU's founders.

The need for precise and accurate laboratory data has never been greater. Every time better spectrographs are built or new wavelength domains explored, we find critical information missing that is needed for analyses. As an example, the advent of ALMA forced a need for millimeter-wave laboratory data of a quality to match what was coming from the facility. And improved knowledge of physics leads to challenges in interpreting models of stars and planets. How much UV opacity are we still missing? How can we improve the interpretation of exoplanet observations, both from direct imaging and from transit spectroscopy? Do we truly know the absolute abundances in the Sun of such key elements as carbon, nitrogen, and oxygen? How can we extract the best information from the necessarily low-resolution of celestial objects to compare to high-resolution lab data? All of these areas are in flux.

This symposium addresses two main goals. First, we want to provide the broad astronomical audience of the IAU General Assembly with a view of the state of atomic and molecular studies that help move astrophysics forward. A key factor is bringing together the laboratory people with modelers and observers to learn more from each other. The second main goal is to provide a forum for the new work being done today by early-career researchers from all over the world.

This symposium encompasses nearly all the science themes that the IAU covers, from near to far in the universe, and at all wavelengths. We will particularly focus on emerging areas, which include near-infrared, mid-infrared (both about to be boosted by JWST) and sub-mm and millimeter. These regions provide the opportunity to greatly expand our understanding of molecules in planets, the ISM, and cool stars. Future x-ray studies promise much higher spectrum resolution and throughput, allowing significantly more detail to be derived from spectra.

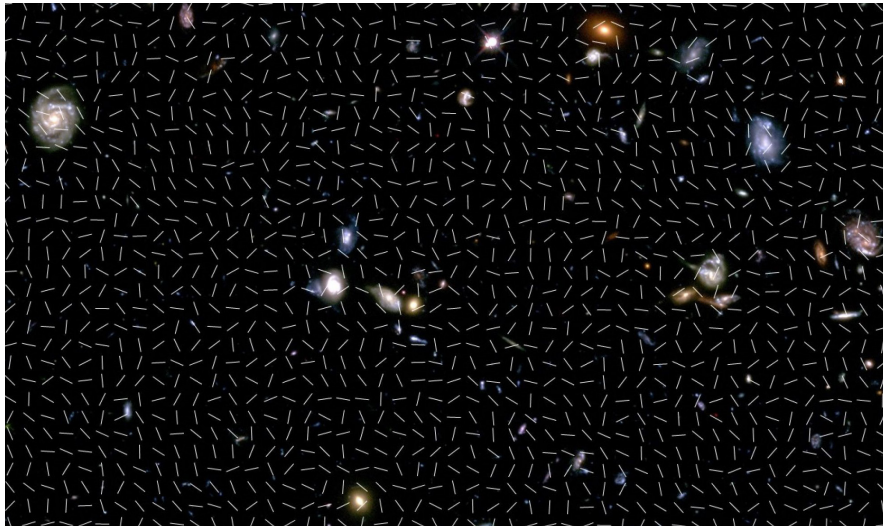
Our focal point for IAU Symposium 371 is Charlotte Moore Sitterly, a remarkable scientist who well deserves commemoration. I know her from her compilation "A Multiplet Table of Astrophysical Interest," which was my go-to resource for learning how to read stellar spectra when I was a graduate student. She did much more than that as a long-term scientist at the National Bureau of Standards (now the National Institute for Standards and Technology). The IAUS 371 SOC has selected two outstanding speakers to introduce members to Charlotte Moore Sitterly and her life, and also the significance of her work as astrophysics advances in the 21st century.

David Soderblom is the SOC Chair of the IAU Symposium 371.

Consensus Cosmic Shear in the 2020s

Focus Meeting 3: Consensus Cosmic Shear in the 2020s	
START DATE	Wednesday, 10 August
END DATE	Thursday, 11 August
ORAL SESSIONS	Room 103, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website



Sketch of the shear field (white ticks) in the Hubble Ultra Deep Field (credits: image based on NASA/HST data, modified by N. Martinet). Cosmic shear exploits the gravitational shear field produced by the large scale structure to probe cosmology.

Recent measurements of the Hubble constant and (to a lesser extent) of the density and clustering strength of matter, hint at the possibility that cosmological parameters estimated at high- and low-redshift are inconsistent. Such a finding could be a sign that the highly successful Lambda CDM standard model of cosmology does not fully describe the true nature of our Universe, or could simply be a reflection of unrecognised systematics within one or more of these analyses. As a result, recent studies of low redshift probes utilising, in particular, the gravitational lensing of large scale structures (i.e. cosmic shear) have been particularly focused on the exploration and mitigation of systematic effects. At the sensitivity of current surveys, the community's understanding of cosmic shear systematics is largely acceptable. However with the immense statistical power of next generation cosmic shear surveys, it will soon become paramount for the community to understand these systematics with unprecedented accuracy, particularly before proposing extensions to the standard LCDM paradigm: i.e. via dark energy, modified gravity, massive neutrinos, etc. Moreover, with the start of Rubin's science operation and the launch of Euclid both in 2023, the IAU General Assembly 2022 is an extremely timely opportunity to address these questions. The aim of this focus meeting is therefore to bring together experts from the ongoing and future lensing surveys, thereby fostering collaboration between traditionally competitive teams, in order to build a consensus regarding cosmic shear methodologies, and identify the key systematics and cosmological models that will need to be tested in the 2020's.

Angus Wright (left) is a Research Fellow at the Ruhr-University Bochum, Germany. Nicolas Martinet (right) is Assistant Astronomer at Laboratoire d'Astrophysique de Marseille, France. They are both working on developing cosmic shear as a powerful cosmological probe for current and future large surveys.

Highlights of Women in Astronomy Lunch (August 8)

The Women in Astronomy Lunch at the IAUGA, which was held on Monday, 8 August, was opened with two speeches by Debra Meloy Elmegreen, IAU President to the Women in Astronomy, and professor Jinah Park at the KAIST and also Vice President of KWSE (Korean Woman Scientists and Engineers).

In the opening remarks at the event, Debra Meloy Elmegreen said, "The purpose of this lunch is to bring together young and senior women astronomers for networking and discuss topics of interesting concerns, regarding careers, family, ethics, and many, many issues. I am looking forward to hearing all discussions."

More than 180 female and male astronomers participated in the event, and two mentors were matched with 3-4 mentees per table. After having a short 20-minute lunch break during the speeches, a discussion between mentors and mentees began for about 90 minutes. A wide range of questions was raised at each table. "Why don't we have enough female astronomers at the science management level? What kind of leadership is required for a woman at the manager level? What can be done at the institutional level to enhance female astronomers' job security?" and "How to solve a 2-body problem while staying in academia?" Young female astronomers seriously listened to what seniors were saying.

As the Vice President of KWSE said in her opening remarks, it does not matter if you are a girl or a boy. We all wonder and look up at the sky with curiosity and imagination as a citizen of the earth, like the lyrics of the song we all sang when we were kids. "Twinkle, twinkle, little star, how I wonder what you are!"

Highlights of Public Lectures

Imaging a Supermassive Black Hole

Sheperd S. Doeleman (Harvard & Smithsonian Center for Astrophysics, USA)

During the 31st IAU General Assembly, which is being held under the theme of "astronomy for all", two open lectures were organized in an effort to deliver cutting-edge science to the public. On August 5th, the first public lecture was given by Professor Sheperd Doeleman (Harvard & Smithsonian Center for Astrophysics, USA) on the topic of "Imaging a Supermassive Black Hole". The lecture was held at the BEXCO Auditorium from 7:00 PM to 8:30 PM, and was broadcast live through the IAU and KAOS Science Foundation YouTube channels. In addition to a total of ~300 on-site public attendees, a number of IAU committee members and many conference volunteer students/postdocs attended the lecture. More than 500 people participated in the lecture through the two online channels. Live Q&A and comments were active during the lecture online. Starting with some basics of black holes and implications of the black hole image caught by the Event Horizon Telescope (EHT), Prof. Doeleman introduced the technical challenges and journeys leading to the success of the EHT project. He particularly emphasized the challenge of young researchers and the team spirit as the elements which led the EHT project to success. After the lecture, a long line formed as soon as participants were encouraged to ask questions. The direction of the questions varied broadly from the motivation for studying black holes, the nature of the supermassive black hole, and the technology of the radio interferometer to the difficulties in the research. Prof. Doeleman answered every single question with great enthusiasm, but among all, his comment on the value of astrophysics was quite moving: "If you only work on things that have applicable use you will really limit your understanding of the universe. The idea of doing basic research and astrophysics is that you cast a broad net intellectually." The lecture ended with Prof. Doeleman's thanks to the audience, including middle and high school students who left a deep impression on the lecturer with their enthusiasm and curiosity.

The State of the Universe

Brian P. Schmidt (Australian National University)

On August 6th, a hot sunny Saturday, we had the 2nd public lecture that was delivered by Professor Brian P Schmidt (Australian National University). The lecture title is "The State of the Universe." We have more than 350 audience on-site including IAUGA participants and a few hundreds participated in the lecture online. Prof. Schmidt started his lecture with a brief introduction about the IAUGA2022 itself. He then began his discussion with Hubble's law and Einstein's theory of general relativity and moved onto observational efforts such as CMB and supernovae surveys in the context of cosmology. Prof. Schmidt then expanded his discussion by asking astro-particle-cosmology questions "what is dark matter?", "what is dark energy?" and also commented on big questions in astronomy showing many recent and latest progresses made in the past years. SKA, JWST, TESS, LIGO, EHT and their implications were touched on. At the end of his lecture, Prof. Schmidt emphasized how understanding the universe can be useful. He concluded his lecture by commenting on the fate of the universe that is dominated by dark energy. Among the audience, many young children and students at all ages (from elementary school to graduate school) could be easily seen. All were very excited to meet Prof. Schmidt and took part in the Nobel Laureate's lecture on the universe. There was also a long queue for questions and we had questions from young children, secondary school students, university undergraduates, and a high school science teacher. After the Q&A session, a group photo with the speaker was suggested.

Overall, IAUGA2022 public lectures went smoothly and almost on schedule. Audience showed great enthusiasm and curiosity toward the contents of lectures. The audience was not just from the Busan area. Many students in the audience visited Busan from other parts of Korea in order to attend the public lecture(s). From the group photos you can see both speakers and audience seem happy with big smiles. We are very grateful to have Prof. Doeleman and Prof. Schmidt as public lecturers here in Busan, Bexco. Within a couple of days, we already have close to 10,000 views for the public lectures online. The online recording can be found in the IAU YouTube channel (https://www.youtube.com/channel/UCc3I9q-N0NA05vIYeNMmtTw).

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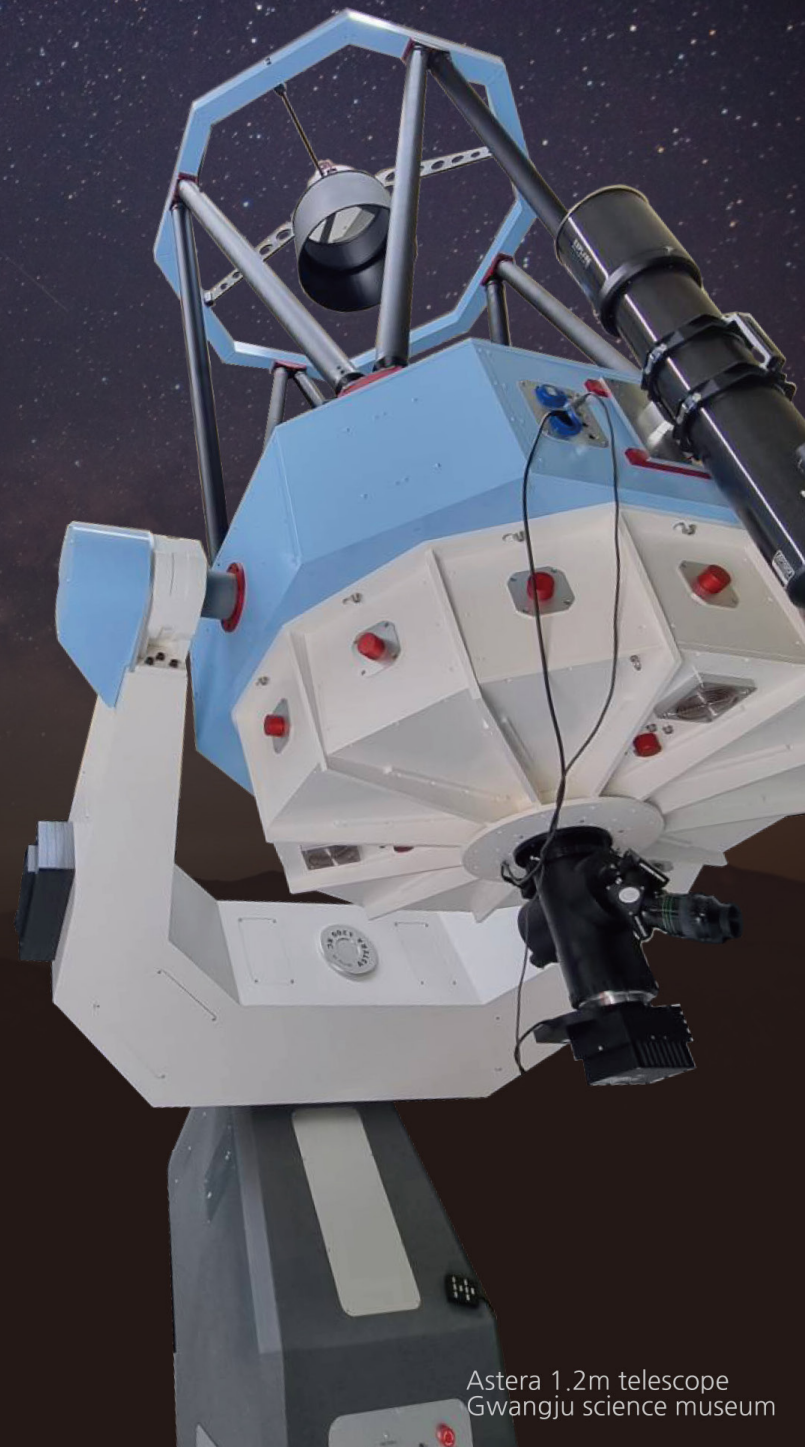

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For the Korean Space Weather Center, a government agency responsible for space weather research and operation of the Republic of Korea since 2011, we have developed algorithms for 1) solar absolute radio flux calculation, 2) automatic classification of solar radio burst type II and III, 3) digital beamforming routine for low frequency InterPlanetary Scintillation (IPS) array, 4) algorithm for Geomagnetic Induced Current (GIC) calculation, 5) analysis and visualization of various space weather data etc. In the field of instrumentation, we have developed several space weather oriented equipment including 1) Solar 2.8 GHz absolute flux receiver, 2) Multi frequency solar radio flux receiver, 3) IPS array radio telescope for solar wind imaging, 4) GIC monitoring system.

Based on experience from space weather projects, we expanded our business area which develop both software and hardware of remote sensing instrument for scientific and civil usage. The first remote sensing instrument was High Frequency Surface wave Radar. HF ocean radars are efficient to monitor wide areas of ocean at low cost, and are used to measure ocean currents and waves in many countries. You can find specification/features and performance verification of developed HF ocean radar, called "SEODAE" on the company website, www.setsystem.co.kr. The same technique was applied to X-band patch array radar we have been developing recently, the X-band FMCW radar together with digital beam forming process allows various applications in real day like 1) basic testbed for the Space Surveillance Radar 2) detecting low RCS (radar cross section) targets, Drones, micro-UAVs.

Women in Astronomy Lunch

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Mirinae

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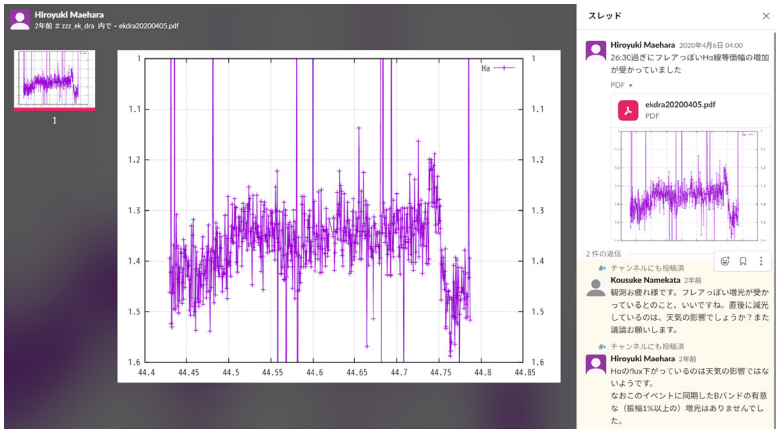
My superflare research in Kyoto and Okayama

Hiroyuki Maehara, Invited Discourse speaker



The H-alpha light curve of the superflare and post-flare dimming on EK Dra, which I posted to the Slack channel for our observing campaign.

Solar flares are the rapid releases of magnetic energy stored near the sunspots through magnetic reconnection and are sometimes accompanied by coronal mass ejections (CMEs). They sometimes impact various social systems such as power grids, satellites, and radio communications. Similar flares also occur on other stars. In addition, some active stars exhibit more energetic flares called "superflares." The occurrence rate of solar flares depends on flare energy; more energetic flares occur less frequently, according to solar observations. Can superflares occur on our Sun? How often would superflares occur on the Sun? These are big questions but difficult to answer only from modern solar observations. One possible way to answer these questions is the long-term, continuous, and precise observations of many "Sun-like" stars.

In 2010 when I was a postdoc at the Kwasan Observatory, Kyoto University, I started to search for flare candidates on solar-type stars from the Kepler light curves with Prof. Kazunari Shibata and his 1st-grade undergraduate students. In December 2010, one of the undergraduate students, Takuya Shibayama, discovered some solar-type stars showing flare candidates. After developing the flare search code, we detected thousands of flare candidates on solar-type stars. At first, I thought that they were not real superflares on solar-type stars, but contaminations of flares on M dwarfs in the photometric aperture. However, the detailed analysis found that the contaminated flare scenario cannot explain some of these flare candidates on solar-type stars. Finally, we concluded that superflares could occur on solar-type stars (e.g., Maehara et al., Nature 485, 478, 2012; Shibayama et al., ApJS 209, 5, 2013; Shibata et al., PASJ 65, 49, 2013).

Can superflares produce “super-CMEs”? To answer this question, we need spectroscopic observations of superflares. The 3.8-m “Seimei” telescope was constructed by Kyoto University in 2018 at Okayama and started its scientific operations in February 2019. Our team has performed the intensive time-resolved spectroscopy of solar-type stars showing superflares by using the Seimei telescope simultaneously with the TESS observations since 2020. Despite the COVID-19 pandemic, we successfully observed superflares on some active solar-type stars. On 5 April 2020, we found mysterious phenomena in the H-alpha light curve of EK Dra. The H-alpha intensity decreased just after the flare and became fainter than the pre-flare level. Dr. Kousuke Namekata solved this mystery. The comparison with the Sun-as-a-star H-alpha spectra during solar flares suggests that the massive filament eruption associated with the superflare occurred on EK Dra and caused the post-flare dimming in the H-alpha light curve (Namekata et al., Nature Astronomy 6, 241, 2022). However, it is still unclear whether superflares and subsequent massive filament eruptions can lead to super-CMEs. Further simultaneous multi-wavelength observations are necessary to unveil the connection between superflares and super-CMEs.

Dr. Hiroyuki Maehara is an assistant professor at National Astronomical Observatory of Japan (NAOJ).

A Career in Space Astrometry

Michael Perryman, Shaw Prize Winner

I started out on my scientific career with a mother passionate about education, and an inspiring school teacher excited by the beauty of mathematics. I studied mathematics and theoretical physics at Cambridge University between 1973-1976, and received my doctorate from the Cavendish Laboratory, Cambridge University, in 1979, on the subject of the cosmological evolution of extragalactic radio sources.

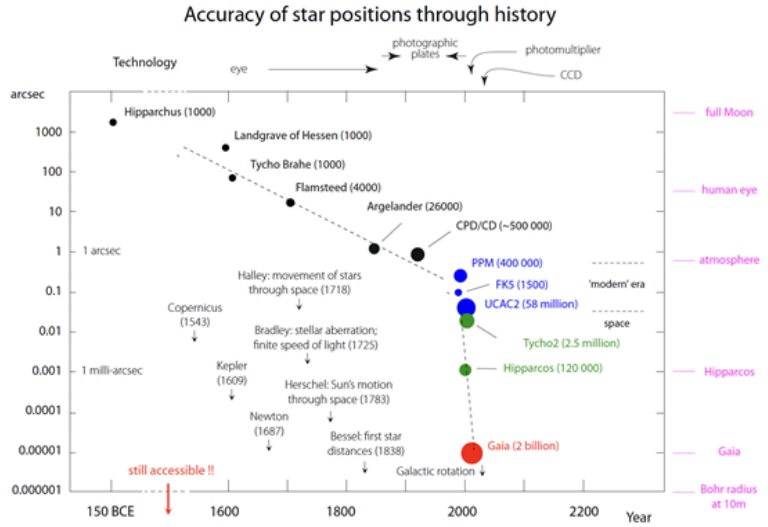
I joined the European Space Agency (ESA), in The Netherlands, as a research fellow in 1980. A year later, at the age of just 26, I was appointed as Project Scientist for the recently-adopted Hipparcos space astrometry mission, which I subsequently headed as lead scientist between 1981-1997.

Astrometry was a new field for ESA. My work involved overall coordination of the scientific aspects of the satellite design, manufacture and testing, assisting with the parallel preparation of the input catalogue and overall data analysis (major tasks led by my long-term colleagues Erik Høg, Jean Kovalevsky, Lennart Lindegren, and Catherine Turon), and chairing the Hipparcos Science Team. Like all space missions, Hipparcos presented a continuous series of difficult challenges, tackled in collaboration with a highly motivated team of scientific colleagues across Europe, project managers in ESA, and talented engineers in European industry. After its launch in 1989, the satellite failed to reach its target geostationary orbit, and I also took over the overall mission management with the numerous associated recovery operations. It was a tense, difficult and protracted period, but the project eventually delivered all and more of its original scientific objectives, and validated the principles underpinning space astrometry.

In 1993, together with Lennart Lindegren, and building on earlier ideas by Erik Høg and Lennart Lindegren, I jointly proposed a more ambitious mission to take advantage of technological advances such as CCDs, large lightweight ceramic mirrors and structures, and micro-Newton gas thrusters. The mission was approved by ESA's Science Programme Committee in 2000. I was the scientific leader of the Gaia project from its inception until shortly before the Critical Design Review in 2008, establishing the payload concept, its technical feasibility, the data analysis principles, its organisation structure, and its scientific case. Its launch in 2013 was just one year after that targeted at its adoption in 2000.

Now eight years into its operational lifetime, Gaia is generating progressively improved catalogues of more than two billion stars, leading to a detailed portrait of our Galaxy and its formation, and impacting on all branches of astronomy. What is of enormous satisfaction to me today is reading the scientific papers based on the Gaia results, and admiring their ingenuity, their breadth, and the huge scientific advances that they represent. I host some regular essays and interviews at my own site www.michaelperryman.co.uk.

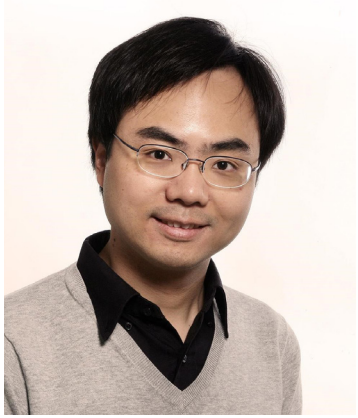
I am very grateful to the Shaw Prize Foundation for their recognition of my contributions to space astrometry, which I am delighted to share with my colleague Lennart Lindegren. And let me also stress the self-evident: that the major scientific advances gained by Hipparcos and Gaia could only have come about through the dedicated and outstanding contributions of many others - scientists, managers, and engineers - over very many years.



The accuracy of star positions through history, showing some of the barriers, the adopted technologies, and a selection of achievements as accuracies improved

From galaxies to haloes – "reverse engineering" of the evolving galaxy population

Yingjie Peng, S373 plenary speaker



Yingjie Peng is an astronomer and phenomenologist at the Kavli Institute for Astronomy and Astrophysics (KIAA) and the School of Physics at Peking University. He received his PhD from ETH Zurich in 2012 with the award of the ETH Medal, and then he became a research associate at Cavendish Laboratory and a postdoctoral fellow at Kavli Institute for Cosmology, University of Cambridge. He was also a fellow of the Homerton College, University of Cambridge. In 2015, he returned to China and joined KIAA as a tenure-track Assistant Professor through the Chinese National Youth Thousand Talents Program. He was awarded the MERAC Prize in Observational Astrophysics by the European Astronomical Society (EAS) in 2016, and the National Science Fund for Distinguished Young Scholars in 2021. He is now Full Professor at KIAA and School of Physics.

The main focus of Yingjie Peng's research is studying galaxy formation and evolution through cosmic time. New technologies and more powerful telescopes have enabled routinely large multi-wavelength sky surveys from nearby to the distant Universe, delivering an unprecedented wealth of high-quality data. This enables the statistical study of detailed galaxy properties and their evolution over a broad range of cosmic time with great precision. However, there are still many unsolved fundamental questions in this field, as galaxy formation and evolution are complicated non-linear processes with many different physics involved at different epochs. The main philosophy and approach of his research are using the large multi-wavelength surveys in the nearby and distant universe to "reverse engineer" the observed galaxy population at different epochs, identify the key features of the galaxy populations, and derive the analytical forms for the dominant evolutionary processes that control galaxy evolution, by using continuity approach and building phenomenological models. The goal is to build a simple, self-consistent and powerful analytical framework to describe the formation and evolution of different galaxy populations, from dark matter haloes to gas and to the stellar population, to explore the key issues in the galaxy ecosystem, such as the physical mechanism of star-formation quenching; the cosmic star-formation history and stellar mass assembly history of galaxies, and their connections to the dark matter haloes; the self-regulation of star formation and gas cycle; the role of the AGN feedback.

Yingjie Peng has been actively involved in several ongoing or forthcoming observation projects and facilities, such as MOONS, MSE, FAST, SKA, and the Chinese Space Station Telescope (CSST). High-quality data obtained by large multiple-wavelength surveys from X-ray to radio, and their synergies are the foundation of this reverse engineering and phenomenological approach.

Farewell by IAU President Elect

Willy Benz, IAU President Elect

A farewell always brings a touch of sadness because it marks the end of something and the time to say goodbye. Yes, the GA 2022 is drawing to a close, but what a pleasure it was to meet and speak with people in person. After over two years of meeting people on computer screens, it was a delight to come to Busan. For all the exciting invited presentations, the different symposia, and all the meetings and activities that together make up a General Assembly. Placed under the motto of "Astronomy for all", the event displayed the broad spectrum of IAU sponsored activities from science and education to outreach and development. Not to forget global coordination between ground and space astrophysics and the protection of our astronomical sky.

But there is a lot more to it than the sessions. There are the people we meet, the one-on-one discussions during coffee breaks, poster sessions, around exhibits, spontaneous exchanges in the hallways, networking during receptions and dinners, etc. All these little things that are as essential to us as morning coffee.

The first thing I realised while coming to the Republic of Korea for the first time, was how wonderfully organised this country is. From the rather complex entry procedures at the arrival airport, the high-speed trains, to the organisation of the largest astronomical gathering, everything works perfectly. The tremendous growth of the Korean astronomical community is not only evidenced by the successful organisation of GA2022 but also, and mainly, through its involvement in major astronomical projects (e.g. Gemini, ALMA, GMT, and even a successful launch of a satellite aimed at studying the Moon). And finally, there is the hospitality with which our hosts have treated us the whole week which will make this GA unforgettable beyond science.

A farewell is also an opportunity to look ahead. The next General Assembly in Cape Town in South Africa is only two years away and it will be the first of its kind on the African continent; a historic event. Reaching professional astronomers all over the world has always been at the heart of the IAU mission. The use of astronomy to also reach the people to foster development and education is a more recent element of the IAU strategy. Cape Town being the home of the IAU Office of Astronomy for Development, there is no better place!

It's time to say thank you, goodbye, and have a safe trip home to everybody. I am sure you will return home with many new ideas, friends, memories, and stories to share. I look forward to seeing you all in Cape Town in a couple of years.

Welcome reception. What a great pleasure to be able to meet people again around good food and a drink.

The KASI booth in the Exhibit Hall. Showcasing the amazing activities carried out by the Korean astronomical community

A Message from the Assistant General Secretary

Diana Worrall, IAU Assistant General Secretary

It is a great pleasure to be here in Busan, in person, for the GA. Under normal circumstances this GA would have been over before I took on my Assistant General Secretary responsibilities. As it is, I've had the pleasure of helping in a small way and seeing at first hand the dedication of colleagues in making this GA a reality. As may be true for others of you, this is my first trip to a scientific conference outside my home country (in my case the UK) since the start of the covid pandemic.

My first post-pandemic-onset foreign trip was actually to the IAU Executive Committee meeting in Paris this April, at which the Busan GA was an important discussion topic. The second was again to Paris, a couple of weeks later, to assist the General Secretary in the allocation of grants for this meeting. With that we were greatly helped by Piero Benvenuti in using the software tools that as General Secretary he had developed for the previous GA which now seems rather a long time ago --- 2018 in Vienna!

My science has been informed by, and I've drawn inspiration from, the meetings I've attended. Each GA has provided me with a special memory of the people I've met and the places I've visited. Never in the past did I expect to be one of those expected to be on stage at a Closing Ceremony!

As this GA begins to draw to a close we have only two years to wait before the next, in Cape Town in 2024. Meanwhile, a rich array of IAU Scientific meetings on a broad range of topics awaits our participation. Not least, the IAU is sponsoring nine newly-selected symposia in 2023, and four selected earlier are also still to be held (see https://www.iau.org/science/meetings/future/symposia/).

The Assistant General Secretary, Diana Worrall, outside the Paris Observatory in late April 2022. The Executive Committee meeting was held at the Institut d'Astrophysique de Paris, next door.

Sparked by this GA, I'm sure you will have 2024 in your sights. The deadline for letters of intent (LoI) for six symposia and twelve focus meetings for the 2024 GA are due soon, on September 15th, together with LoI for three non-GA symposia. If you miss the LoI deadline, you can still submit a full proposal by December 1st, but you are strongly encouraged to consult in advance with the IAU Division you choose as your Coordinating Division to receive their constructive feedback on your plans. Rules and Guidelines for hosting IAU Symposia can be found at https://www.iau.org/science/meetings/rules/. The IAU looks forward to hearing from you.

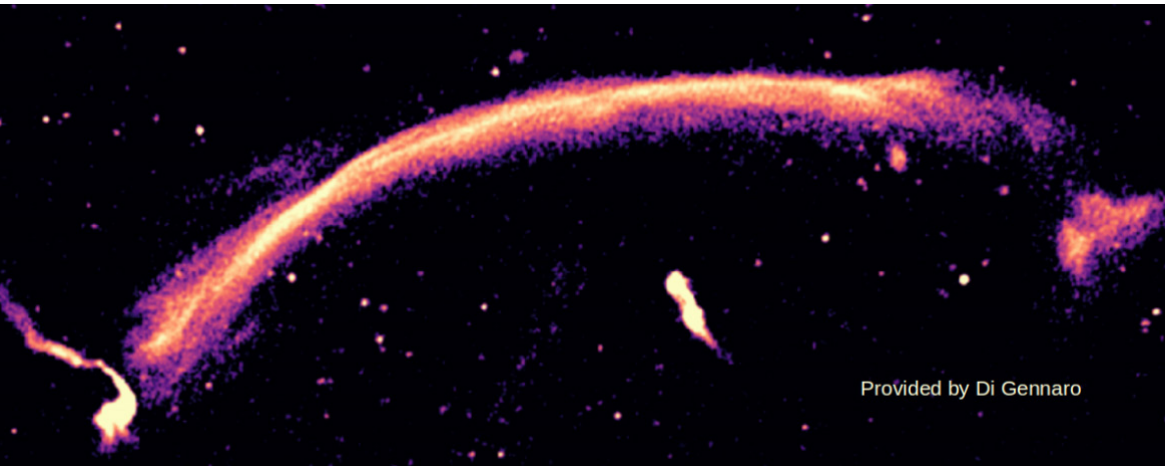
Focus Meeting 6

Dynamics of the ICM: Radio and X-ray Observations and Theory

Focus Meeting 6: Dynamics of the ICM - Radio and X-ray Observations and Theory	
START DATE	Wednesday, 10 August
END DATE	Thursday, 11 August
ORAL SESSIONS	Room 106, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

Most of the baryonic matter of galaxy clusters is in the form of hot gas in the intracluster medium (ICM). The ICM has been recognized as a vital element in the formation and evolution of the large-scale structure of the universe and individual galaxies, as well as an essential diagnostic tool when studying galaxy clusters. It is highly dynamic and also contains nonthermal components such as magnetic fields and cosmic-ray protons and electrons. In the Focus Meeting 6 (FM6) of IAUGA 2022, among cross-communities of radio, X-ray, and SZ observations and theory, we will initiate discussions that define the roles of turbulence, shocks and cold/sloshing fronts in the ICM, as well as establish reliable, discriminating observational signatures of their properties and inter-relationships. In particular, we will address critical observational and theoretical challenges in the coming decades, specifically how emerging and planned observational efforts, such as LOFAR, uGMRT, MeerKAT, ASKAP, SKA, ngVLA (radio), eROSITA, XRISM, ATHENA (X-ray), and ACT, SPT, Planck, MUSTANG2 on the 100-meter GBT, NIKA2 on the IRAM 30-meter, ALMA + ACA, CCAT-prime, TolTEC on the 50-m LMT/GTM, Simons Observatory, APEX/CONCERTO, CMB-S4, AtLAST, LST, and potential new space-based CMB probes (SZ), can be combined with theoretical understandings to enable a comprehensive picture of the ICM. The need for such a gathering is motivated by revelations of the importance of the dynamics of the ICM through recent observations, especially in radio, X-ray, and SZ, but also in other bands, as well as developments in simulation and theory hinting at possible interpretations. The current understanding is still very incomplete. However, observations with coming facilities, together with signals from multi-messenger astronomy, and rapid progress in simulation and theory have the potential to resolve fundamental blocks to the understanding of the nature of the ICM.



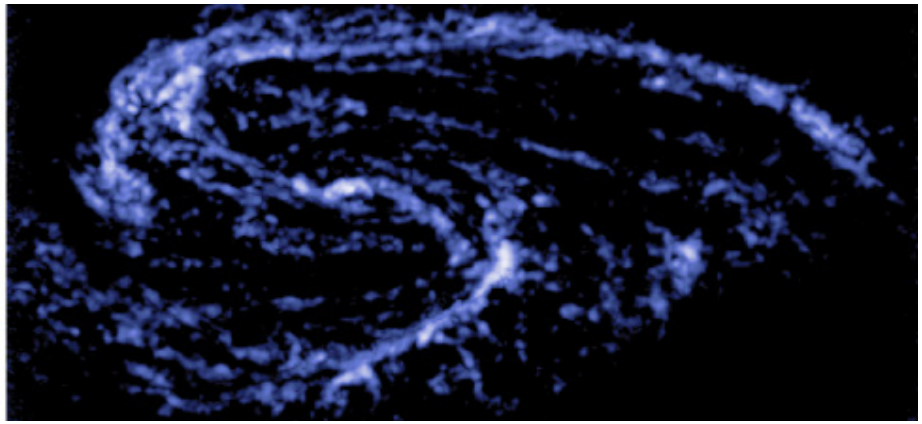
The topics of IAUGA2022 FM6 includes

1) Measuring and interpreting the dynamical states of the ICM,
2) ICM shocks, cold fronts, sloshing fronts, turbulence; their natures and their consequences
3) Nature and origins of radio halos and radio relics in galaxy clusters
4) What the new generation of radio, X-ray, and SZ (Sunyaev-Zeldovich effect) observatories will reveal and what new challenges and opportunities can we expect?

Dongsu Ryu, the SOC chair of IAUGA2022 FM6, is a professor at Ulsan National Institute of Science and Technology (UNIST). Currently, he is the director of the Center for High-Energy Astrophysics in UNIST.

IAU Symposium 373

Resolving the Rise and Fall of Star Formation in Galaxies



The past decade has seen rapid growth in our ability to examine star formation in significant samples of galaxies, thanks to ever larger observational surveys (including those based on integral field spectroscopy) and groundbreaking new facilities such as ALMA. At the same time, our understanding of the Milky Way is being revolutionized by the fossil record of past star formation revealed by projects such as Gaia and APOGEE. The general picture of galaxy evolution is one of steady, inside-out growth and maturation of galaxy disks accompanied by rapid aging of the highest mass galaxies due to internal and/or external processes that inhibit star formation. Yet the roles of various factors in the aging process - e.g., galaxy mergers, gas consumption, environmental refueling (or lack thereof), and nuclear activity - remain poorly understood. Integrated over the galaxy population, the effect of galactic aging can be seen as a dramatic decline in the cosmic star formation rate since the epoch of "cosmic noon" at a redshift z~2.

For galaxies that are still forming stars today, the star formation rate is strongly correlated with the stellar mass and the supply of molecular gas. However, the exact form of these star formation (scaling) relations, their universality, and the role of additional physical parameters (including galaxy conditions and environment) remain important topics of discussion. Moreover, these relations have provided limited insight into the cessation of star formation, commonly termed "quenching".

Until fairly recently, the communities that studied star formation in galaxies were divided into those who studied small scale processes at high resolution in very nearby galaxies (including our own), and those who treated star formation as a galaxy-scale process,

IAU Symposium 373: Resolving the Rise and Fall of Star Formation in Galaxies	
START DATE	Tuesday, 9 August
END DATE	Thursday, 11 August
ORAL SESSIONS	Room 205, Convention Hall, 2nd Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

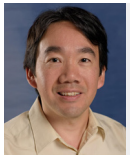
studied out to high redshifts. In the last decade, the study of star formation has been undergoing a revolution that has connected these communities – thanks to a combination of new interferometric facilities in the radio and sub-mm (e.g., ALMA, NOEMA) and IFUs in the optical (VLT MUSE and surveys such as CALIFA, MaNGA, and SAMI). The key advance has been the ability to spatially resolve the sub-kiloparsec scales on which star formation relations are established, bridging the gap between resolved studies in the local neighborhood and large scale galaxy surveys. As we finally meet for a General Assembly in 2022, JWST observations are underway, and we will soon witness a flood of data from surveys including the Legacy Survey of Space and Time at the Vera Rubin Observatory. Helping to interpret these new data will require a new generation of cosmological simulations and new techniques for confronting them with observations.

IAU Symposium 373, running from 9-11 August at the XXXI General Assembly meeting in Busan, provides an opportunity to share the latest findings in the field of star formation on sub-galactic scales. It is divided into the following topical sessions:

- Scales of Star Formation: From Molecular Cores to Galaxies
- Sustaining Star Formation: Gas Conditions & Environment
- The Decline of Star Formation: Feedback, Fuel Shortage or Inefficiency?
- The Rise and Fall of Star Formation Across Cosmic Time
- Regulation of Star Formation and the Evolution of Galaxies

A key objective for the meeting is to synthesize our knowledge of how star formation is regulated within individual galaxies and leverage it to understand the rise and fall of the star formation rate on cosmological timescales. To this end, the organizers have solicited talks from experts in different methodologies, addressing star formation at both low and high redshift. The resulting program of talks highlights the youth and diversity of the field, and will hopefully inspire many new collaborations, despite the ongoing challenges to conference participation imposed by the pandemic and economic and political factors. This symposium is particularly well-suited for a GA because many astronomers attending the GA will be interested in aspects of star formation (e.g., in relation to galaxy evolution) but may not consider themselves star formation specialists.

Given the limited time available for a GA symposium, we have had to be quite selective in terms of topics covered, and participants may notice less emphasis on interstellar processes and on the formation of individual stars and clusters than would be typical for a star formation conference. Many of these topics will be explored in other GA sessions (e.g., Division H and J meetings) which we strongly encourage interested parties to attend.



TONY WONG is a professor of astronomy at the University of Illinois, with research interests in molecular clouds and star formation.

EVA SCHINNERER leads the research group “Extragalactic Star Formation” at the Max Planck Institute for Astronomy (Heidelberg, Germany) where she is also a staff member.

What May be the Biggest Heliophysics Discovery at the General Assembly that you Missed

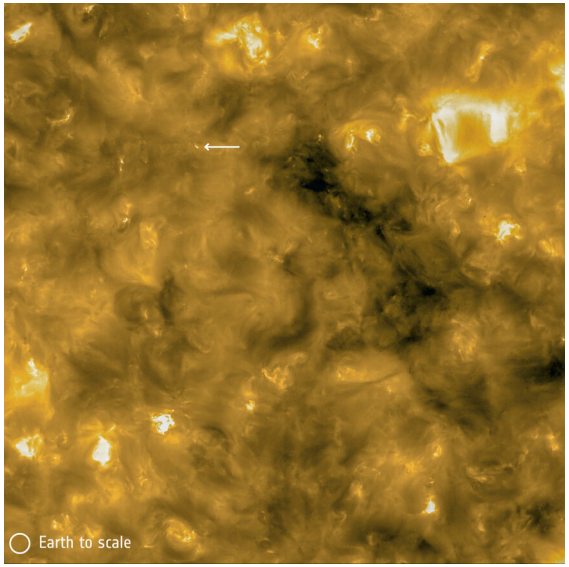


Image of a small area on the solar surface in the extreme ultraviolet range, with a campfire indicated by the white arrow. The image was obtained by the extreme ultraviolet imager (EUI) instrument onboard the Solar Orbiter (credit ESA).

As many have noted, the world has certainly changed since the last IAU General Assembly. But besides the most obvious social changes, a great deal has been happening in solar physics. Indeed, the virus is not the only corona that scientists have been paying attention to.

For decades solar physicists have been puzzling over a major mystery: why the Sun's corona is so hot. The surface of the Sun is around 5,800K, but the corona is a factor of 300 hotter, at 2,000,000K. This high corona is of course an important factor in space weather and has profound implications for Earth and ourselves, but we don't yet fully understand why its temperature is so extreme.

Eugene Parker was among the first to tackle the problem. In the 1970s and 1980s he developed a theory of so-called 'nanoflares' – much smaller versions of solar flares – as a potential heating mechanism. The idea was that individual flares were too small to be seen with the technology of the time, but that they existed on the Sun in great numbers, so could collectively convey a huge amount of heat energy.

This General Assembly in Busan has been the first opportunity in a long time for solar physicists to meet in person and discuss the coronal heating problem within the IAU framework. And it turns out to have been an extremely important one.

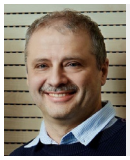
It's the first time we have met since the ESA Solar Orbiter spacecraft approached the Sun at just 77 million km in 2020, capturing images from closer to our star than ever before. The images appeared to contain the unmistakable signatures of nanoflares visible as 'campfires' in the extreme ultraviolet range – which had only been theoretical up until that point – as detailed in an ESA press release in July 2020.

From Solar Orbiter's data, we have discovered that these structures exist, and that they are a few hundred km in size, hinting that they could indeed be the cause of the corona's extreme temperature. But those images were only the beginning. That's why this face-to-face meeting in Busan has been so invaluable – it has really showcased all the progress being made on coronal heating by solar physicists who are analysing the data and developing the theory.

At this IAU GA, seven presentations were made on this topic as part of symposia 370, 372 and division E. Fore example, Jack Reid et al's talk explained simulations of how campfires could distribute heat, while Divya Oberoi et al's talk explored weak radio emissions that could be coming from the campfires.

Although more work has to be done to know for sure, the field of heliophysics is slowly converging on the connection between the campfires and the coronal heating. Only now, when we could all meet and exchange our views and research in person here in Busan, has the importance of this discovery dawned on us.

Many thanks to the local organisers for enabling this in-person exchange of views. Let's see what we can discover within the next triennium.



Professor Ilya Usoskin from the University of Oulu, Finland is an expert in cosmic-ray, solar and heliospheric physics.

Laura Hiscott is IAU Deputy Press Officer.

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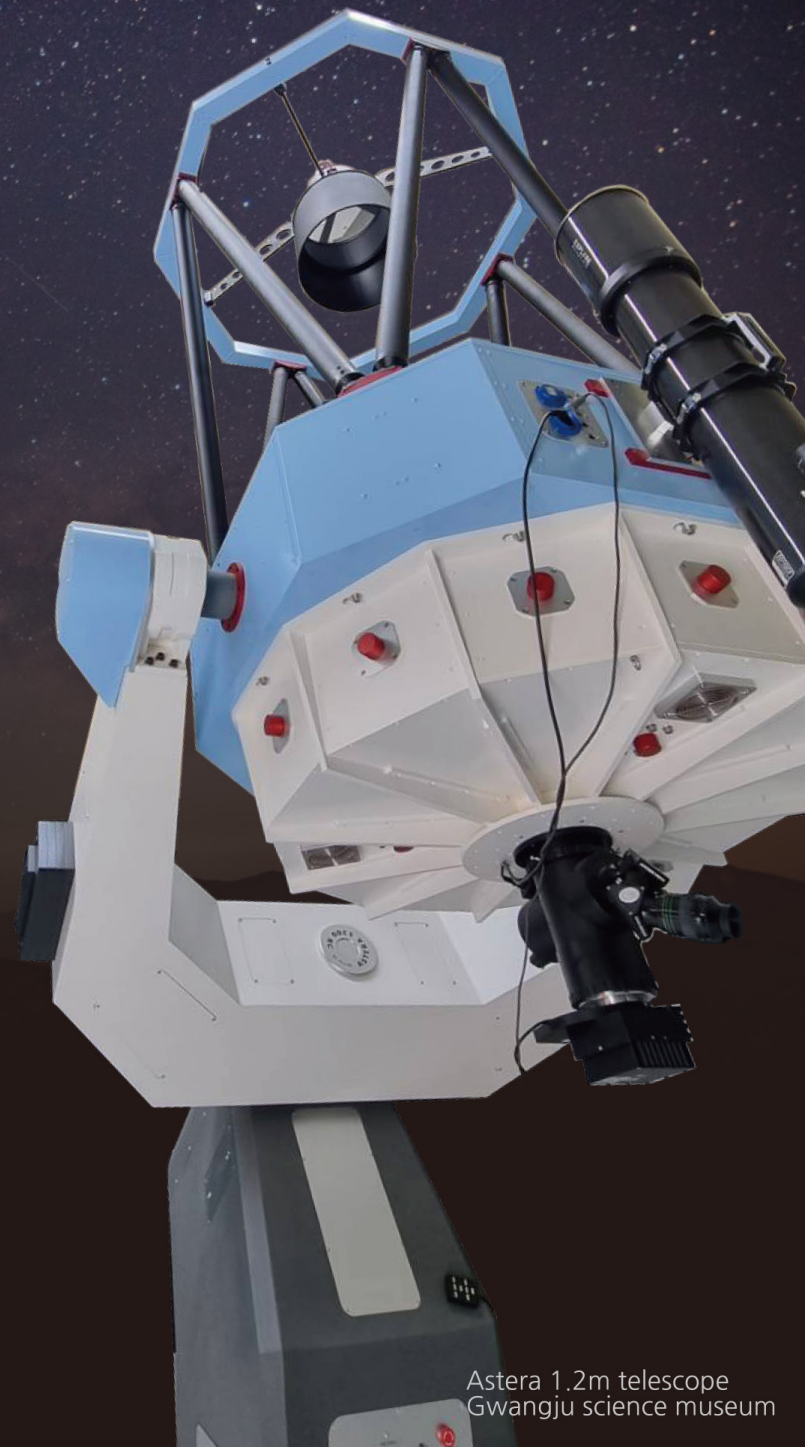

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Mirinae

미리내 The Milky Way

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Hosting a hybrid General Assembly in the midst of COVID-19 pandemic

Hyesung Kang, Chair of the National Organizing Committee

Winning the Bid for the 31st GA

It was January 2014 when I first agreed to lead the team to host the 31st General Assembly on behalf of the Korean Astronomical Society (KAS). When our team won the bid at the GA2015 in Hawaii, I did not fully comprehend the fact that I would spend the next seven years of my life preparing and organizing the GA2021. Early 2020 the COVID-19 pandemic hit the globe unexpectedly, so the National Organizing Committee (NOC) confronted many uncertainties since then. Until the end of 2020, the IAU officers and the NOC explored several options to implement various virtual elements to the upcoming GA. To my great relief, in April 2020, the Korea Astronomy and Space Science (KASI) joined the effort as a co-host institution.

Postponement due to COVID-19 Pandemic

Early December 2020, we finally decided to postpone the GA for one year and began to plan for the GA2022 as a hybrid meeting, which would allow both in-person and remote participation. For the first time in the IAU history, new virtual elements, such as virtual registration, remote talks, e-posters, e-talks and online chatting programs were introduced, which injected unprecedented complexities and confusions into the GA logistics. Consequently, the GA secretariat has received thousands of email inquiries regarding the registration and abstract submission. Furthermore, as of June 2022, we are busy assisting the issuance of visas, and providing guidance on the COVID-19 health regulations, which are being updated continuously as the pandemic situation is evolving.

"Astronomy for All" in a Hybrid GA

Initially, the NOC proposed "Astronomy for all" as the main theme, in a hope to make the Busan GA as inclusive as possible. The KAS grant was designed to support the participation of young students and early career astronomers. All along, the NOC was determined to host the GA as an offline meeting, at least partially. After more than two years of online meetings, we believe astronomers are eager to meet our colleagues face-to-face. The NOC is thrilled that it will finally happen this August, although it is somewhat uncertain how many participants will actually attend the GA in person despite high costs and risks of international travels. We remain hopeful as the pandemic situation is improving and travel restrictions are being lifted.

Many Thanks to Dedicated Colleagues

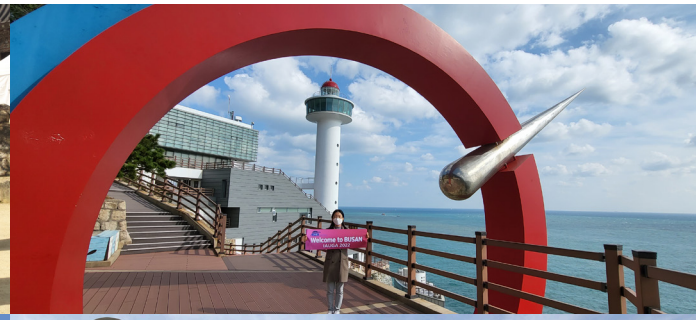
Along the treacherous paths up to this point, many colleagues from various sectors contributed to the preparation of the GA2022: the NOC members, local sponsors, the past and present officers of the IAU, and the professional team of our PCO, Meci International. Without their perseverance and devotion, we would not have made it this far. As the Chair of NOC, I would like to express my deepest gratitude for their service and sacrifice.

What a beautiful venue, Busan, we have been in last two weeks

Members of the GA2022 NOC (BEXCO, November 2021)


山本大刹禪
金井金魚梵
門溪曹
Welcome to BUSAN
IAUGA 2022


Welcome to BUSAN
IAUGA 2022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IAUGA 2022


2021
송도해상케이블카
BUSAN AIR CRUISE
Welcome to BUSAN
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송도용궁구름다리
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동백꽃(Camellia)
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It's Time for Africa!
An Invitation by the National Organising Committee IAU GA 2024

Vanessa McBride, Chair of the National Organizing Committee of IAUGA 2024 (South Africa)

XXXII IAU GENERAL ASSEMBLY

CAPE TOWN, SOUTH AFRICA, 2024

As the IAU GA 2022 draws to a close, and we are left with fond memories of Korean culture and beautiful Busan, Africa prepares to take centre stage as host for the next IAU General Assembly in 2024. Affectionately known to locals as the 'Mother City', Cape Town, in the Republic of South Africa, will welcome global astronomers from the 5th to the 16th of August 2024. Known for its natural beauty, vibrant and friendly culture, and numerous international tourism accolades, the city is well-prepared to welcome guests from around the world. The city and surroundings also play host to a variety of world-class astronomy facilities and organisations, including the South African Astronomical Observatory, the South African Radio Astronomy Observatory, the Inter-university Institute for Data Intensive Astronomy, the African Astronomical Society, the IAU Office of Astronomy for Development and the Iziko Planetarium, as well as multiple universities with strong astronomy programmes. The GA 2024 will be hosted by South Africa's National Research Foundation, and is receiving strong support from the South African Department of Science and Innovation, which is championing the development and growth of the multiwavelength astronomy community both in South Africa and across Africa.

As the first IAU General Assembly to take place on the African continent, the community's excitement is palpable! GA 2024 is more than just a meeting - it encompasses the aspirations of the African astronomy community, and is an opportunity to change the way the world sees Africa. These audacious ambitions have been captured in our Vision2024, available to explore on our conference website: www.astronomy2024.org.

For many, this will be a first opportunity to visit Africa. Whether you're coming for the astronomy and staying for the splendour, or whether you're coming for the experience and staying for the science, our side programmes in development, education and sightseeing will leave an impression on visitors and locals alike. Our organising committee is already planning initiatives that are sustainable, inclusive and have a lasting impact. We look forward to the legacy that the General Assembly in 2024 will leave in its wake.

So, on behalf of the National Organising Committee of the XXXII General Assembly of the International Astronomical Union, and on behalf of the astronomy community in Africa, we invite you to make history with us on our African shores in 2024 and share in the African spirit of Ubuntu: We are all One!

Ke nako!! It's time for Africa!

Sally Macfarlane & Vanessa McBride, on behalf of the GA2024 Local Organising Committee
Please visit our website, astronomy2024.org to find out more, follow us on Facebook (@Astronomy2024CapeTown), or Twitter (@astronomy2024).

Sally Macfarlane is a post-doctoral fellow at the South African Astronomical Observatory and is a member of the GA2024 Communications, Education and Outreach committee.

Vanessa McBride is deputy director of the Office of Astronomy for Development and co-chair of the GA2024 National Organising Committee.

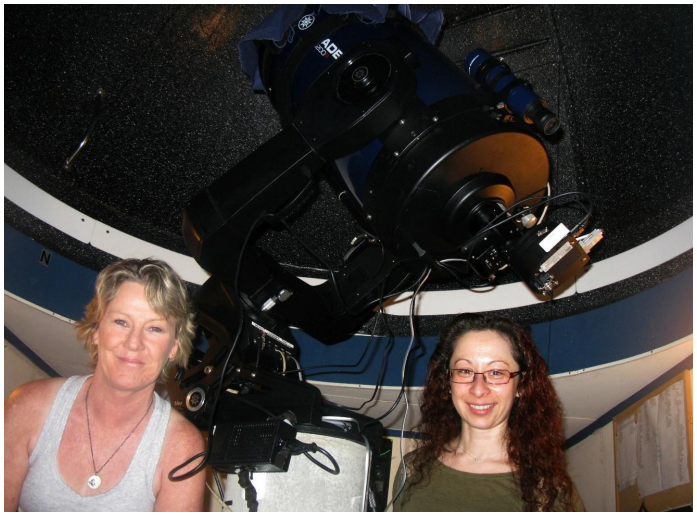
EC Working group for Professional-Amateur Relations in Astronomy

The IAU working group for professional-amateur relations in astronomy (for short, the pro-am WG) was formed in April 2021 as a WG under the Executive Committee. The IAU Strategic Plan 2020-30 stated that connecting professional and amateur astronomers was one of its goals for the decade. This is also an integral mission of the IAU Office for Astronomy Outreach, with which the WG works closely.

For the first century of its existence, the IAU has had very few formal contacts with the much larger body of amateurs around the world. This changed in 2019 with a successful one-day workshop for amateurs in Brussels, followed by the formation of the new Working Group in April 2021 for professional-amateur relations in astronomy.

IAU Executive Committee Working Group Meeting: Professional-Amateur Relations in Astronomy	
START DATE	Thursday, 11 August
END DATE	Thursday, 11 August
ORAL SESSIONS	Room 108, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website



Jennie McCormick (left) is one of New Zealand's leading amateur astronomers. She has contributed many observations of galactic microlensing events to detect and characterise extrasolar planets, as well as CCD photometry of variable stars. In 2009, she discovered a 19th mag asteroid, now officially named New Zealand. She is seen here with former AAVSO director, Stella Kafka (right) who was also a member of the Pro-am WG Organizing Committee and with Jennie McCormick's Meade 14-in telescope at her private Farm Cove Observatory in Auckland, New Zealand.

At the present time, no-one has a clear idea of how many amateurs there are in the world, but it is likely to be of the order of a million individuals, some two orders of magnitude greater than the number of active professionals in the IAU. The new pro-am WG wants to reach out to the amateur community, with the aim of promoting research collaborations with some of the most active amateurs. Further workshops are also envisaged, following on from Brussels 2019, and the OAO program 'Meet the IAU Astronomers!', in which professionals give talks to amateur societies, will be further promoted.

The relatively new WG has great hopes of making a fundamental change in how the IAU interacts with the amateur community and success should greatly benefit and enrich both communities.

As a first step, the pro-am WG conducted a survey of amateur astronomers to find out what they want from the IAU and whether this includes closer research collaborations and workshops. The survey was carried out between December 2021 and February 2022. The survey had several thousand responses and the results showed an overwhelmingly strong support for promoting pro-am research collaborations and for having a biennial hybrid pro-am workshop. The survey results will be reported by Tim Spuck (USA) at the Pro-am WG session of the GA on August 11.

The survey also allowed a database of hundreds of the principal amateur societies and associations to be compiled, which will be used for future contacts with amateur astronomers world-wide.

One result of the survey was also to establish a WG membership at large from IAU members who wish to join the WG and stay informed of our activities. Those interested to join should contact the Pro-Am WG secretary, Yuko Kakazu (USA/Japan) or co-chair Aniket Sule (India) at respectively kakazu naoj org and aniket sule gmail com.

An initial Organizing Committee (OC) for the WG was established as follows: John Hearnshaw (New Zealand, co-chair), Lina Canas (Japan and Portugal), Beatriz Garcia (Argentina), Stella Kafka (USA), Yuko Kakazu (USA and Japan, secretary), Moein Mosleh (Iran), Mirjana Povic (Ethiopia), Kazuhiro Sekiguchi (Japan), Boonrucksar Soonthornthum (Thailand), Aniket Sule (India, co-chair), Timothy Spuck (USA), Ilya Usoskin (Finland, EC liaison), Antonia Varela (Spain). At the end of 2021, Povic and Kafka both resigned from the WG. They were replaced by Mayra Lebron (Puerto Rico) and Clementina Sasso (Italy). The very wide geographical distribution of the OC members and good gender balance are noted.

We have high hopes of making waves in the amazing community of amateur astronomers around the world, and are proud of our progress so far. Please come to the Pro-am WG session at 15:15 on Friday August 11 if you wish to join us in our work.

John Hearnshaw is Emeritus Professor of Astronomy at the University of Canterbury, Christchurch, New Zealand. He was Division C president 2015-18 and IAU vice-president 2018-21. He helped found the Pro-am Working Group while serving on the IAU Executive Committee.

Institutional Meeting of the Office of Astronomy for Development: Flagships and Interdisciplinary Imperatives

The IAU Office of Astronomy for Development (OAD) is driven by the concept of "astronomy for a better world" and understands the value that science has in the development of the people and the communities we live in. Everything is interconnected and that makes it only natural that the various disciplines, in the natural and social sciences, share their knowledge and expertise and collaborate their efforts towards sustainable development. It is this concept of interconnectedness that makes the interdisciplinary approach that much more important, foregrounding the need for us to strive for more meaningful collaborations with all actors in society.

The OAD held a session on Wednesday 3 August, with the theme "OAD Flagship Projects and Interdisciplinary imperatives: Synergies between natural and social sciences for the UN Sustainable Development Goals". Presentations in the session were based on three flagship themes which are being implemented globally. They are "Astronomy to stimulate economies", "Astronomy for Diplomacy" and "Knowledge and skills from astronomy". The flagships allow the OAD to scale the impact of astronomy for development over a substantial part of the world. The projects within the flagship themes include: Astrostays – a community led astro-tourism project that uses astronomy as a tool to create sustainable livelihoods and community development, under the "Astronomy to stimulate economies" flagship theme. The DARA Big Data Hackathons project was presented, based on the flagship theme of "Knowledge and Skills from astronomy" and focuses on the use of data science and machine learning skills that are broadly used in astronomy, but are applied in this context to tackle developmental challenges. Lastly, the Astronomy for Mental Health project, which sparked a lot of interest from the delegates, was presented under the flagship theme "Astronomy for Diplomacy".

These flagship projects and themes are central to issues of development, directly address the United Nations' Sustainable Development Goals and also highlight the many ways that astronomy can be used as a tool for impactful and sustainable development. The OAD fosters opportunities for collaborations, especially in cases where there are overlaps and this, in turn, strengthens the projects and increases their impact.

The session was very informative, engaging, quite inspiring and certainly motivated people and organisations to be more innovative in their efforts and contributions towards sustainable development.

Duduzile Kubheka is the BRICS Astronomy Project Coordinator based at the South African Astronomical Observatory(SAAO) and is running the BRICS Astronomy Flagship Project called the BRICS Intelligent Telescope and Data Network. She also works with the Office of Astronomy for Development (OAD) as well as the African Astronomical Society (AfAS). She is passionate about people empowerment, education, outreach, social justice and development and is striving to use her position and impact to inspire positive, meaningful and sustainable change in society.

New Insights into Satellite Constellation Effects on Astronomy

This image shows the double star Albireo in Cygnus and was taken on 26 December 2019. Two out of ten 2.5-minute exposures recorded Starlink satellites moving across the field. Credit: Rafael Schmall

On Monday evening we raised a glass to toast the new Center for the Protection of the Dark and Quiet Sky from Satellite Constellation Interference (CPS). We started operating in April, and we have wasted no time in pursuing our mission. A new website has just been launched for CPS.

While light and radio pollution has long been an issue, the new satellite constellations are a whole new level of threat to astronomy. With 3388 already in the sky, we are facing potential future numbers of more than 400,000 in orbit, planned by 13 operators so far (as of today 9 August 2022). These numbers of planned satellites are monitored by Jonathan McDowell (Harvard-Smithsonian Center for Astrophysics) and displayed on the frontpage of the new website.

Our first goals as a center are to develop software that predicts when and where the satellites will pass overhead, and to build a data repository for images. We have had people observing for us for two years, but this operation has really started to get much more organised in the last few months.

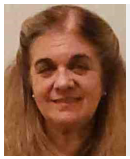
We are also looking at creating masking software, to remove the effects of satellites from the images as much as possible. While such software would be a valuable tool, it would have limitations; there is no replacement for a pristine sky. So it is still key to work on mitigating the effects of satellites at the source.

To this end, we already have more than 150 people signed up to work with us, including professional and amateur astronomers, space lawyers and institutions. Crucially, the space industry is also actively engaging with us. SpaceX removed the reflective visors from the satellites they launched in December, and they are now developing a new coating, to reduce the amount of light getting directed towards Earth. Just last month they published a new report on brightness mitigation best practices.

Of course, these mitigation efforts require validation and feedback from astronomers, as highlighted by Jeremy Tregloan-Reed in Focus Meeting 2 here at the General Assembly. Other results presented here for the first time included the increasingly sophisticated simulations to predict what the satellite beams would look like passing over a radio observatory; and new observations, mostly of OneWeb, showing that the effects seem to depend on wavelength.

Also new to astronomers at this meeting was the IAU CPS work to include the impact on astronomy as one of the modules of the new Space Sustainability Rating. The Space Sustainability Rating is a new project to provide a rating system for the sustainability of space missions, seeking to encourage space actors to cooperate on the long-term sustainability of the space environment. This project has been developed by EPFL, MIT and ESA, the World Economic Forum and a joint team led by Space Enabled at MIT, with collaboration from BryceTech and the University of Texas at Austin.

If you are interested in our work at the CPS and would like to contribute, please check out our website at https://cps.iau.org/ and consider becoming a member. We are always looking out for people who share our goal of protecting dark and quiet skies.



Connie Walker is Co-director of IAU CPS at NSF's NOIRLab, IAU Inter-Division B-C Commission Protection of Existing and Potential Observatory Sites and Chair of Executive Committee WG Dark and Quiet Sky Protection.

Laura Hiscott is IAU Deputy Press Officer.

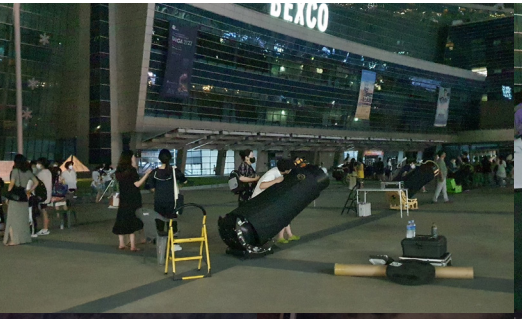
Highlights of Public Star Party (August 9th)

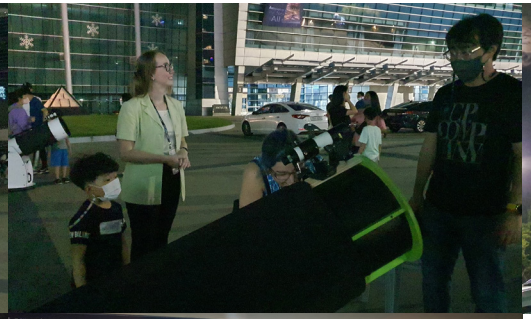
The Public Star party at the IAUGA was held in the BEXCO square on Tuesday, 9, August. The Star Party was organized as one of the hands-on programs for IAUGA2022, in keeping with the IAUGA's motto, "Astronomy for all", to give a fantastic opportunity to promote IAUGA to the public and to demonstrate the solar system celestial bodies through telescopes, such as the Sun, the Moon, and Saturn.

To event drew over 400 astronomers and members of the general public. Despite the fact that the day was cloudy, a number of telescopes began operating at 3:00 p.m. to observe the Sun. As volunteers, amateur astronomers from Busan area brought their own telescopes to this event. People were able to observe the Sun with various types of solar filters whenever light shines through solar cloud cover.

In addition to observation, a variety of booths provided science kit creation and experimentation. Making science kits, such as Kepler Telescopes, assisted children in understanding the science behind the telescopes. Childrens could also learn about the principles of stars and planets by playing games like becoming planets themselves.

As the star party took place at night in the cool air and among walkers, each telescope was crowded with people. The opportunity to see the moon through clouds and marvel at its majesty while also seeing Saturn's rings and satellites makes a fantastic public Star Party event.





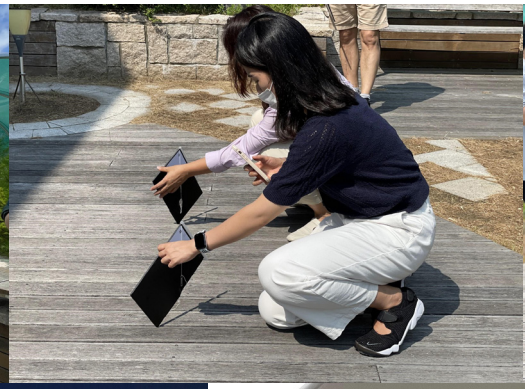


Sung-Ju Kang has a Ph.D. in Astrophysics and he is currently a Research Officer in Gwacheon National Science Museum. He is also a science communicator and runs a YouTube channel 'Unrealscience', attempting to make scientists' accomplishments understandable to the public.

Training Courses for School Teachers

Training courses for school teachers ran for 4 days from 5th August to 8th August 2022 with the Network for Astronomy School Education (NASE) in part of Commission C1 Astronomy Education and Development of IAU. It was held in the Korea Science Academy of KAIST and BEXCO. A total of 10 teachers from elementary schools and high schools attended.



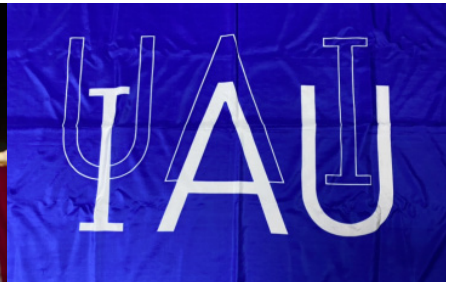




A Group Photo of IAUGA 2022

Welcome to the Closing Ceremony and Flag Handover Ceremony

Dae-Chwi-Ta



The official IAU flag

Dance of Cranes under Spring Moon

Program

1. Memories of GA2022: video
2. Closing Remarks & announcement of GA2027 host : Debra Elmegreen, President
3. Closing Remarks: Jose Miguel Rodriguez Espinosa, General Secretary
4. Closing Remarks: Willy Benz, President Elect
5. Closing Remarks: Diana Worrall, Assistant General Secretary
6. Closing Remarks: Park, Young-deuk, President of KASI
7. Closing Remarks & Thanks: Kang, Hyesung. GA2022 NOC chair
8. Flag Handover from Busan to Cape Town
9. Welcome Remark: Takalani Nemaungani, Department of Science & Innovation
10. Welcome Invitation: Vanessa McBride, GA2024 NOC chair
11. Closing Performance: Korean Traditional Dance
12. Group photo

A team for the IAUGA e-Newspaper

Sang-Sung Lee, Editor in Chief

Iam very much pleased to introduce an amazing team for the IAUGA e-Newspaper consisting of a 6-member Editorial Board, an advisory group, and a designing person. The e-Newspaper Editorial Board was firstly formed with four members: Woojin Kwon, Ji-hoon Kim, Dohyeong Kim, and me. Later the Board was completed by inviting Sascha Trippe and Myoungwon Jeon.

Woojin Kwon is a professor in the Department of Earth Science Education of Seoul National University, who has extensively communicated with all plenary speakers, prize winners, and public lecturers for inviting valuable stories of the speakers. **Ji-hoon Kim** is a professor in the Department of Physics and Astronomy of Seoul National University, who has sedulously contacted with all SOC chairs of IAU Symposia, Focus Meetings, WGs, Divisions, and IAU Offices, for hosting shiny highlights of all meetings in the e-Newspaper. **Dohyeong Kim** is a professor in the Department of Earth Science Education of Pusan National University, who had to ask for welcoming messages from important guests and has played an important role in determining the header picture of the e-Newspaper. **Sascha Trippe** is a professor in the Astronomy Program of the Department of Physics and Astronomy of Seoul National University, who has jointly advised the Board. **Myoungwon Jeon** is a professor in the School of Space Research of Kyung Hee University, who contributed to writing articles about the highlights of two lunch meetings. I am a principal researcher in the Korea Astronomy and Space Science Institute, playing the role of Editor-in-Chief. I would like to note that the team for the IAUGA 2022 e-Newspaper is mostly from the Korean Astronomical Society.

The team for the IAUGA e-Newspaper (sitting, left to right): Byeong-Gon Park, Hyesung Kang, Sang-Sung Lee, and Myeong-Gu Park; (standing, left to right): Juneui Lee, Woojin Kwon, and Dohyeong Kim.

I would like to note that the e-Newspaper would not be completed without excellent proof-readings by an advisory group of the Chair and vice-Chair of the National Organizing Committee: **Hyesung Kang** and **Byeong-Gon Park**, and wonderful designing works by Juneui Lee from our partner company, MECI. Finally, my last thanks should go to **Myeong-Gu Park**, President of the Korean Astronomical Society, who had successfully led the initial discussion for the e-Newspaper of IAUGA 2022.

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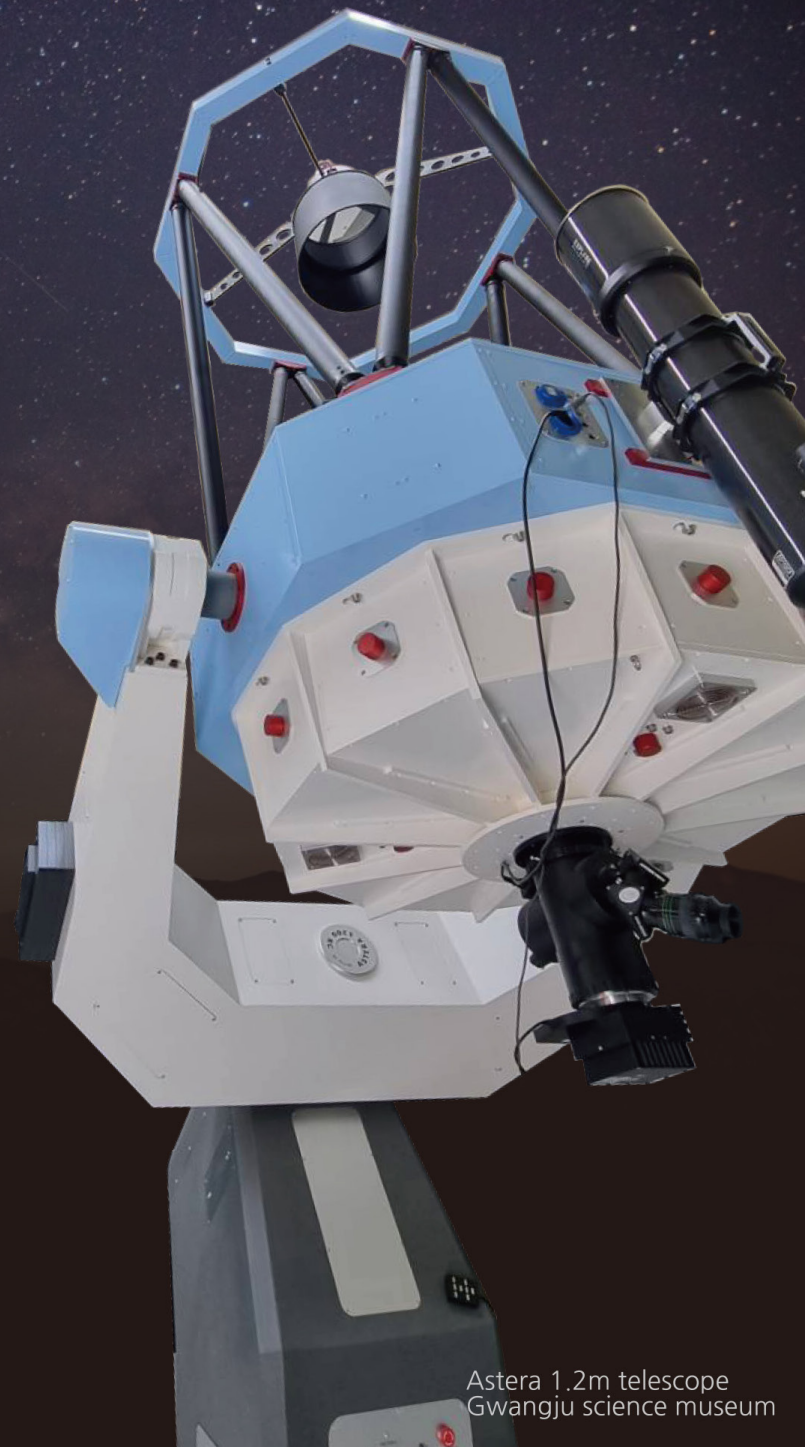

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2022 Shaw Prize in Astronomy Winner

Invited Discourse 3_Hiroyuki Maehara