

DIVISION B

FACILITIES, TECHNOLOGIES, DATA SCIENCE

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DIVISION B PARTICIPATING COMMISSIONS

Commission B1

Computational Astrophysics

Commission B2

Data and Documentation

Commission B3

Astroinformatics and Astrostatistics

Commission B4

Radio Astronomy

Commission B5

Laboratory Astrophysics

Commission B6

Astronomical Photometry and Polarimetry

Commission B7

Protection of Existing and Potential Observatory Sites

[Inter-Division with Div. C]

DIVISION B PARTICIPATING WORKING GROUPS

Working Group for Information Professionals

Working Group for Time Domain Astronomy

Working Group for UV Astronomy

INTER-DIVISION WORKING GROUP

Div. B–E WG for Coordination of Synoptic Observations of the Sun

TRIENNIAL REPORT 2018–2021

1. Activities of IAU Division B1 during 2018-2021

The Division steering committee worked with the IAU Executive to produce a booklet entitled “From Medicine to Wi-Fi – Technical Applications of Astronomy to Society” as part of the IAU’s centenary celebrations. This can be obtained from the IAU website via the URL <https://www.iau.org/news/announcements/detail/ann19022/>.

The Division successfully argued for Division B members to be able to join 4 IAU Commissions, so long as one of the 4 Commissions is from Division B. The argument here is that Division B is an enabling Division, in a similar similar to Division C (for Education, Outreach & Heritage), with the majority of our members also actively (and often primarily) engaged in the pure science of the other Divisions. Hence Division B (and C) members can now also include membership of a fourth Commission if it is in one of these two Divisions.

A short article about the Division appeared in the IAU's Catalyst publication of June 2020. As of March 2021 there are 4,016 members of the Division, with an additional 237 junior members.

2. IAU Symposia

The Division was the Coordinating Division for 4 IAU Symposia scheduled during the trimester. Unfortunately, due to the Covid situation, only one of these has so far been able to be held in person. The Symposia are as follows:

- IAUS 350 : Laboratory Astrophysics – from Observations to Interpretation, held Cambridge, UK, April 2019.
- IAUS 360: Astronomical Polarimetry – New Era of Multi-Wavelength Polarimetry, held virtually from Japan, March 2021.
- IAUS 362: Predictive Power of Computational Astrophysics as a Discovery Tool, now planned to be held in-person in Chamonix, France in November 2021.
- IAUS 368: Machine Learning in Astronomy: Possibilities and Pitfalls, planned as part of the IAU GA in Busan, Korea in August 2022.

3. PhD Prize

The following people were awarded the Division B PhD Prize over the trimester, which is awarded annually:

- 2019: Niels Ligterink, “The Astrochemical Factory: A solid base for interstellar reactions”, Leiden, Netherlands.
- 2020: Luke Prately, “Radio Astronomy in the Big Data Era”, University College London, UK.
- 2021: *Will add details when confirmed.*

The recipients are invited to present their thesis work at the next IAU General Assembly, XXXI in Busan, Korea (now postponed to 2022).

4. Commission Reports

4.1. *Commission B1: Computational Astrophysics*

The main goal of the Commission B1 in the past triennium was to strengthen the computational astrophysics community and, by the end of this term, to mitigate the pandemic consequences. We have advertised our activities at various workshops, promoted the ways to become a commission member, sent numerous personal invitations in order to encourage interested people to join the commission. These efforts have led to a significant growth of the Commission membership (from less than 250 in 2018 to well over 300 by the spring of 2021). In the beginning of the triennium we have initiated publishing the Commission newsletter, which is used to inform the computational astrophysics community about important news, forthcoming conferences and other events. A Commission B1 web site had been opened in September 2018 and is now available at https://iau.org/science/scientific_bodies/commissions/B1/info/.

A significant part of our housekeeping activity in the past triennium was related to conferences, both in terms of organizing them and of providing support to other meetings connected to computational astrophysics. A capacity building workshop “Challenges and Innovations in Computational Astrophysics” (ChaICA) has been organized by the Commission B1 organizing committee in September, 2019, in St. Petersburg, Russia. About 50 talks have been given by the conference participants. Our next plan was to organize a IAU Symposium on computational astrophysics to be held in Chamonix, France, in June 2020. Unfortunately, the COVID-19 situation has forced us to suspend all these activities and to shift the IAU Symposium 362 dates to November, 2021. We still hope that these efforts will no be in vain, and the same venue and SOC/LOC configuration will help to restart the IAUS 362 successfully. Meanwhile, in November, 2020, we held a virtual workshop nicknamed ChaICA-II. Speakers from 16 countries have presented 41 talks with topics ranging from celestial mechanics to theoretical cosmology. We plan to continue this series of virtual meetings, and the next online meeting (ChaICA-III) is tentatively planned for mid-summer, 2021.

4.2. *Commission B2: Data and Documentation*

Commission B2 is host of four essential Working Groups.

WG IAU Data Driven Astronomy Education and Public Outreach (DAEPO; chair Chenzhou Cui) has been very active by being involved in seven meetings /conferences and several contests.

WG Designations (chair Marion Schmitz) has continued its work to clarify existing astronomical nomenclature and to oversee the IAU REGISTRY FOR ACRONYMS (for newly discovered astronomical sources of radiation). The Clearing House screens the submissions for accuracy and conformity to the IAU Recommendations for Nomenclature. From its beginning in 1997 through March 2021, there have been 355 submissions and 325 acceptances.

WG Preservation and Digitization of Photographic Plates (chair Elizabeth Griffin) has recently revised its membership and includes now a number of astronomical librarians and archivists who understand the potential of historical data collections and their correct management. The WG will work steadily through the desiderata (history, preservation, handling, cleaning, documenting, storing and finally digitising) in the coming years. The effort, time and resources required to follow through this programme fully will clearly take more than the three years allocated to a regular WG, and the WG is preparing an application to become a Functional WG.

The WG Data Representation (chair Jessica Mink) was expanded from the WG FITS (custodian and advocate for the Flexible Image Transport System format since it was formally endorsed by the IAU in 1982) in 2015 to encompass other data formats from upcoming facilities, organised in the Structured Data Expert Group. However, the WG Data Representation have recently decided to return to a FITS Working Group (also applying to become a Functional WG).

4.3. *Commission B3: Astroinformatics and Astrostatistics*

Commission B3 continued to build bridges with other similar groups like the American Astronomical Society (AAS), the American Statistical Association (ASA), the International Astrostatistics Association (IAA), International Astroinformatics Association (IAIA), the International Virtual Observatory Alliance (IVOA) and many other national organisations. The commission continues engaging with major survey collaborations like ZTF, Gaia, SKA, LSST/Rubin on various relevant topics. The symposium ‘Machine Learning in Astronomy: Possibilities and Pitfalls’ will be held along with the GA in Aug 2022. The commission will be sponsoring a seminar series, joint with IAA. Members contributed to many online events during the pandemic.

4.4. *Commission B4: Radio Astronomy*

Commission B4 has supported an exciting triennium period, with the maturation of a number of significant radio astronomy facilities in recent years. National and international endeavours have seen the realisation of major new telescopes, upgraded observatories and new/enlarged research groups. Communicating news of these developments and exploring synergies with other branches of physics and engineering, is fundamental to the activity of CB4.

Major new radio telescopes include the East Asia VLBI Network (EAVN), the Karoo Array Telescope (MeerKAT), the Australian SKA Pathfinder (ASKAP) telescope and the Five-hundred-meter Aperture Spherical Telescope (FAST). A number of massive, highly sensitive

and legacy surveys are in progress on these, and other upgraded facilities, contributing to the explosion of powerful multi-messenger astronomy. The sudden loss of Arecibo 305-m telescope in late 2020 was a sad moment for the CB4 community. Long baseline initiatives like the Event Horizon Telescope have continued to produce stunning scientific results. Large new facilities (SKA, ngVLA, DSA2000) will begin construction in coming years, and promise new scientific frontiers late this decade.

4.5. *Commission B5: Laboratory Astrophysics*

The last three years have seen the IAU Commission B5 go from strength to strength in supporting Laboratory Astrophysics activities. Most importantly the commission, led by former President Dr Farid Salama organised the IAU Symposium S350 “Laboratory Astrophysics: From Observations to Interpretation”, with over 160 attendees from countries as diverse as Russia, Australia, Thailand Egypt tunisia and Vietnam attending, alongside more “traditional” laboratory astrophysics groups from the US, Japan and Europe. Over 40 travel grants were given to support attendees, supported by national agencies as well as the IAU and Europlanet. In late 2020 the proceedings were made available electronically and in printed format for the benefit of attendees and the wide variety of sponsors who supported the event. The symposium was used to produce a video of ~ 100 females stating “We are laboratory astrophysicists” for inclusion in the IAU diversity video made for the IAU Centenary celebrations. In keeping with the IAU mission of astronomy for diversity, development and diplomacy, public events were an integral part of the meeting, including two public lectures that were also broadcast via Youtube and available worldwide to IAU audiences to watch at the time and afterwards, as well as a public outreach afternoon where the conference lecture theatre and environs was converted into a haven for schools and families with children “craft building” lab astrophysics experiments, learning about interstellar and cometary ices, walking through ice molecular structures, using spectroscopy, and experiencing planetary science by testing geological surfaces and formations. In all the IAU S350 public programmes reached $> 4,000$ individuals worldwide.

Beyond Symposia, two working groups have continued their work within the Commission, one in High-Accuracy Stellar Spectroscopy and one in Spectroscopic and Radiative Data for Molecules. As is always the nature of laboratory astrophysics, there is much work to be done in not only highlighting where good data is produced and can be found to reference when using it to interpret astrophysical observations or add to models, but also the ever-ongoing importance of appropriately referencing that data and ensuring those scientists underpinning the data needs of the scientific community are appropriately acknowledged. This together with the impact in the second part of this triennial of Covid on laboratory communities world-wide makes the longevity and role of this Commission even more important. Laboratory sciences have been particularly hard hit by lockdowns, social distancing and curfew rules of various kinds worldwide, and a very un-level playing field has resulted, especially for younger members of the community. Whilst membership of Comm B5 has grown in the last triennial, we would strongly like to see the IAU working with professional bodies beyond astronomy to encourage membership of those working in interdisciplinary ways to become involved in IAU activities, particularly the younger and early career members of our community. Their lives and careers have been strongly affected by Covid, and as established members have necessarily been diverted from research to challenges such as remote teaching and home schooling, we hope the Commission and the IAU can look to how to support laboratory astrophysicists further on equal footings in a post-pandemic world.

4.6. *Commission B6: Astronomical Photometry and Polarimetry*

4.6.1. *Photometry*

The ESA satellite, Gaia, has been in routine operations since July 2014 performing a continuous all-sky scan and observing all point-like sources down to G 20.7 mag. Major achievements were the release of Gaia-DR2/EDR3 in April 2018 and December 2020. These include positions and magnitudes of 1.8 billion sources and in spite of limitations of in crowded regions the Gaia photometry is the most accurate and homogeneous all-sky survey to date. Many surveys will use Gaia information to improve their photometric calibration through the technique of the stellar locus regression. SkyMapper uses this catalog to improve their accuracy. Further, new grids of pure hydrogen white dwarf NLTE model atmospheres have also been developed to improve the absolute flux calibration from the far UV to the mid-infrared.

The Dark Energy Survey collaborators are continuing an effort to characterize DA white

dwarfs to use as survey absolute flux calibrators. This effort will result in several faint spectrophotometric stars in the southern hemisphere useful as standards and survey calibrators. These stars lie in the DES footprint so we anticipate they will be useful for LSST as well.

Steady improvements in absolute flux calibration in the infrared continue, though there has been little intrinsic improvement of ground-based IR photometry since the design of a new infrared passband system stemming from recommendations made at the Baltimore IAU GA in 1988. That passband system (the IRWG) minimized the effect of atmospheric water vapor on infrared photometry. Infrared standards development continues and these are integral to the success of current IR surveys.

4.6.2. *Polarimetry*

Polarimetry continues to be a very active field, be it in terms of research papers, meetings, instruments and research programs. This was particularly true from March 2018 through March 2021, period to which our full report refers to. The area of optical high angular resolution continues to progress very rapidly, while the sub-mm band is also growing fast. GAIA data has also started to be used as support to building models, especially of the Interstellar Medium, using polarimetric data. The simultaneous use of various bands to approach a problem has become commonplace, just as in the last (2015-2018) Triennial report. The full report begins by highlighting some areas where research in polarimetry has been very active. We do this by summarizing meetings that took place in the period of the full report. They provide a representative snapshot of the field and the overarching breadth of Polarimetry today. The main meeting of the field in the period was the IAU Symposium 360, ASTROPOL 2020, that took place virtually in 2021 due to the pandemic and organized by Japan (Hiroshima U., Kagoshima U., Kagawa U. and NAOJ). After providing links to a representative set of instruments spanning the ELM spectrum, we review some of the progress and activities in Polarimetry in which members of the Commission B6 Organizing Committee (OC) were directly involved. We finally describe activities of OC members in Scientific Organizing Committees and other IAU activities, which included the preparation of an IAU booklet and a Newsletter for Comm B6.

4.7. *Commission B7: Protection of Existing and Potential Observatory Sites*

The term began with the very successful two-day, off-campus focus meeting held during the 2018 IAU GA that brought together CIE and B7 to discuss next steps. The fruition of that was their involvement in the Dark and Quiet Skies for Science and Society working groups which did extensive research in establishing recommendations for optical observatories, radio observatories, dark skies oases, bio-environments and the impact of satellite constellations. This was a meeting requested by the UN. (As an outcome, an MOU between CIE and IAU is presently being composed.) The final reports included attendee feedback from the workshop and has been published as a full workshop report (<https://www.iau.org/static/publications/dqskies-book-29-12-20.pdf>) and a Conference Report Paper (<https://www.iau.org/static/publications/uncopuos-stsc-crp-8jan2021.pdf>) to be presented at the UNOOSA COPUOS Science and Technology Subcommittee in April 2021. This was preceded by the SATCON1 workshop. The B7 President was co-chair for both workshops, and many B7 members including the VP, OC and members of the EC WG on Dark and Quiet Sky Protection were also engaged in the workshop Science Organizing Committees and working groups (WG), which were also responsible for the research before each workshop. Strategically as well, B7 members involved in these workshops have had meetings on satellite constellations with EAS, RAS, CIE, SpaceX and COSPAR, as well as organised special sessions every year on light pollution and satellite constellations with the AAS.

The progress on stopping encroachment of artificial sky glow and radio-frequency interference on major astronomical research facilities has been on an individual member level, as with Richard Green (U. Arizona), John Barentine (IDA), and with Connie Walker (NOIRLab) winning the battle for the Outdoor Lighting Code and the Sign Code in the Tucson, Arizona, USA area. Zouhair Benkhaldoun, David Galad-Enriquez, Martin Aub, Josefina F. Ling, Ramotholo Sefako, Diane Turnshek and Harvey Liszt, have also contributed on local and national efforts, as is described in the separate Report of the Commission C.B7 OC and Technical and Site Protection Working Groups.

We have also made world-encompassing educational/outreach events for the public through the IAU100 Dark Skies for All Global Project in 2019. Many of our B7 members have led local,

national and international events and programs, like Globe at Night, the successful, longest-running citizen science campaign measuring light pollution worldwide. C.B7 WG chairs and members contributed to IAUS367 with a 2-hour event dedicated to light pollution issues, highlighting the efforts of our commission.

Michael Burton
President of the Division