

## Annual Report Division B: Facilities, Technologies and Data Science

The Division B Steering Committee, Commissions and Working Groups for the IAU Trimester for 2018-2021 are as follows:

### Steering Committee

Michael Burton	President
Gabriele Giovannini	Vice-President
Pietro Ubertini	Advisor
Dmitri Bisikalo	Commission B1 President
Anja Schroeder	Commission B2 President
Prajval Shastri	Commission B3 President
Tony Beasley	Commission B4 President
Helen Fraser	Commission B5 President
Antonio Mario Magalhaes	Commission B6 President
Connie Walker	Commission B7 President
Ana Gomez de Castro	Member
Wenwu Tian	Member
Jan Mathjis van der Hulst	Member
Yongtian Zhu	Member

### 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 Working Groups

Information Professionals	Chair: Donna Thompson
Time Domain Astronomy	Chair: Rob Seaman
UV Astronomy:	Chair: Ann Gomez de Castro

There is one Inter-Division Working Group:

Coordination of Synoptic Observations of the Sun, Divs. B–E  
Co-chairs: Alexei A. Pevtsov & Frédéric Clette

Further information is available at [https://iau.org/science/scientific\\_bodies/divisions/B/](https://iau.org/science/scientific_bodies/divisions/B/)

The Division steering committee worked with the IAU Executive to produce a booklet in 2019 entitled “From Medicine to Wi-Fi – Technical Applications of Astronomy to Society” as part of the IAU’s centenary celebrations. For further information and to download please visit <https://www.iau.org/news/announcements/detail/ann19022/>.

## Reports from the Commissions

### B1 Computational Astrophysics

Since XXX GA IAU (August 2018) our main efforts have been aimed at the Commission build-up. For that purpose, we have advertised our activities at various workshops and explained how to become a commission member in order to encourage interested people to join the commission. In September, 2019, we have organized a capacity building workshop “Challenges and Innovations in Computational Astrophysics” (St. Petersburg, Russia, <http://agora.guru.ru/display.php?conf=comp-astrophys-2019>). The conference was attended by 102 researchers from 14 countries, including Austria, Canada, China, France, Germany, India, Japan, Netherlands, Poland, Russia, South Africa, Sweden, Taiwan, and USA. Also, we provided informational support to other workshops related to our activity. These efforts led to a significant growth (from 248 to 300) of the Commission membership and to establishing tighter connections between the CB1 members.

The Commission B1 web site has been opened in September 2018. Its content includes a list of relevant meetings, back numbers of the newsletter, a list of commonly used public astrophysical simulation codes, and FAQs.

We have initiated publishing the Commission newsletter, which is used to inform the computational astrophysics community about important news, forthcoming conferences and other events, and also to disseminate abstracts of works related to computational astrophysics. So far, five issues of the newsletter have been published.

The Commission was successful in securing support for a symposium proposal, which has resulted in the approved IAU Symposium 362: <http://iaus362.astro.unistra.fr/IAUS362.html>. The Symposium was due to be held in Chamonix, France, in June 2020. The Symposium was widely advertised at the national and international level through newsletters (e.g., national astronomy societies, ESO), social media (Astronomy-devoted Facebook groups and Twitter) to boost regular postings at websites with high visibility. The aim was to attract half or more of the Commission membership to gather momentum in this field of research. The list of registered participants had peaked at 160 before the COVID-19 situation has forced us to stop all the fore-going activities and instead to shift the Symposium dates to 2021. We do hope the same venue and SOC/LOC configuration will help to restart the process successfully.

## B2 Data and Documentation

Over the reporting period, Commission B2 included four working groups.

The WG Preservation and Digitization of Photographic Plates (chair Elizabeth Griffin) is involved with an IAU Symposium proposal for 2021 (Time Domain Astrophysics from Digitized Astronomical Imaging Plates) and is planning a major update of the membership and tasks to be conducted during the symposium. The WG Data Representation with its two expert groups FITS Special Expert Group (FITS SEG) and Structured Data Expert Group (SDEG) has a new chair, Jessica Mink.

The WG Designations (chair Marion Schmitz) has been accepted as a functional WG in May 2019. The WG clarifies existing astronomical nomenclature and helps astronomers avoid potential problems when designating their sources. The most important function of WG Designations is overseeing the IAU REGISTRY FOR ACRONYMS (for newly discovered astronomical sources of radiation: see the website <http://cdsweb.u-strasbg.fr/cgi-bin/DicForm> which is sponsored by the WG and operated by the Centre de Données astronomiques de Strasbourg (CDS). The Clearing House screens the submissions for accuracy and conformity to the IAU Recommendations for Nomenclature (<http://cdsweb.u-strasbg.fr/iau-spec.html>). From its beginning in 1997 through March 2020, there have been 348 submissions and 318 acceptances. The WG is saddened to report the passing of two long-standing members of the WG – Paul Hodge passed away in Nov 2019, and Dick Hunstead passed away in Feb 2020.

The WG Data Driven Astronomy Education and Public Outreach (DAEPO) is now a B2 WG (formerly it was an inter-commission B2-C1-C2 WG). In 2019, the WG kept acting as a forum for members to discuss the value of astronomical data in EPO and provided guidelines, curriculum, data resources, tools for data driven EPO activities. WG members keep pushing the boundary of astronomy education and public outreach. Highlights of the reporting period are several meetings supported by the WG: the International Virtual Observatory Alliance (IVOA) Interoperability meeting being held in Paris, France, the Astronomy for Development Forum being held in Xinchang, China, and the IAU Symposium Astronomy for Equity, Diversity and Inclusion (IAUS358) that was held in Tokyo.

The Working Group on Astronomical Data Representation is mostly working through its FITS Expert Group which has been discussing the wisdom of extending the FITS standard to allow longer keywords. Several solutions have been proposed and trials implemented, but the group has not reached a decision. There with been discussions among members of a potential Data Structures Expert Group, as most large telescope projects are looking at ways to structure their data beyond FITS. The annual Data Formats workshop at the 2019 Astronomical Data Analysis Systems and Software meeting was devoted to discussions of new standards and what changes could make FITS more useful within new data structures, but it has been difficult to agree on shared standards between projects, so formation of a formal group has been slow. We are now looking for ways to publish the current FITS standard (4.0) in a way that makes citation possible when the standard itself may not be appropriate for journal publication.

## B4 Radio Astronomy

Milestones in the year 2019 included:

### A) Major conferences focusing on Radio Astronomy:

- Planets2020: Ground and Space Observatories: A Joint Venture to Planetary Science – sponsored by the ALMA Observatory. <URL: <https://conference.almaobservatory.org/planets2020/>>;
- SKA History Conference in Jodrell Bank during April 2019; the “Science At Low Frequency” meetings have established themselves as a major conference for those working at <300 MHz, with a number of new and enhanced instruments collecting data (MWA, LOFA, LWA, HERA...). The 2019 meeting at Arizona State University in December 2019 was the 6<sup>th</sup> of the series.
- The first CTA symposium on May 6th, 2019 in Bologna, “1st International Cherenkov Telescope Array Symposium – Exploring the High-Energy Universe with CTA” discussed the novel investigations CTA will bring to the field and its synergies with other wavebands and messengers. It also covered instrument characteristics, analysis tools and opportunities for guest investigators and how coordinated observations with CTA will have a significant impact on the exciting new era of multi-wavelength and multi-messenger astrophysics.
- A conference to commemorate 60 years since the first release of the Third Cambridge Catalogue (3C) was organized in Torino on September 16<sup>th</sup>: “The 3C Extragalactic Radio Sky: Legacy of the Third Cambridge Catalogue”.
- The East Asia VLBI Network is now in its real operation with 10 stations (KaVA, Tianma, Nanshan and Nobeyama). The EAVW-2019 was the first meeting after this milestone, presenting an increasing number of exciting results: “12<sup>th</sup> East Asian VLBI Workshop”.

### B) Radio surveys continued to provide important data that drives research.

Interferometers employing focal-plane arrays (Apertif & ASKAP) began L band surveys, and the MeerKat instrument produced impressive first results. The LOFAR two metre sky survey (LoTSS) released its first data release of 300,000 sources at 120-168 MHz, 0.07 mJy beam<sup>-1</sup> sensitivity and 6” resolution, along with a special A&A publication of the first 26 LoTSS science papers. LoTSS will eventually cover the whole northern sky, and imaging across the entire EU baseline demonstrates that resolutions of 0.2” at 155 MHz can be achieved.

New and in-progress surveys:

- LOFAR: Two metre sky survey (LoTSS)
- WSRT: APERTIF
- JVLA: VLASS
- MeerKAT
- MWA: Gleam
- FAST: will soon begin the Commensal Radio Astronomy FaST Survey (CRAFTS)



Working Group on Historical Radio Astronomy

The Working Group on Historical Radio Astronomy is a joint Working Group of the IAU and URSI, and within the IAU a joint WG of Commission B4 as well as C3 on the History of Astronomy. During the past year, the WG has been compiling a list of historical radio astronomy publications going back decades, with particular attention to non-English language publications. The full list will soon be posted on the WG's website <https://rahist.nrao.edu/>. The WG is also in the process of compiling past triennial reports from the radio astronomy commissions in IAU and URSI which, once copyright issues have been resolved, will also be posted on the WG website, <https://rahist.nrao.edu/HRAWG-meeting-reports.shtml>, and continues to prepare short Biographical Memoirs for deceased radio astronomers which appear on the WG website <https://rahist.nrao.edu/HRAWG-bio-memoirs.shtml>.

The WG has organized a session on The Impact of Radio Astronomy on Technology and Society at the URSI GA in Rome(2021), which will comprise invited talks and contributed posters that focus on developments and inventions in the history of radio astronomy that have directly or indirectly impacted society. Topics include: The Story of Wi-Fi; VLBI, Navigation, and Geodesy; Cold-War Diplomacy at the Jodrell Bank Observatory; Radio Interferometry and Medical Imaging; Deep Space Navigation; and Parkes and Apollo 11. For more details see: <https://rahist.nrao.edu/>.

## B6 Astronomical Photometry and Polarimetry

### *Photometry*

The Dark Energy Survey collaborators are continuing an effort to characterize DA white dwarfs to use as absolute flux calibrators (lead by Douglas Tucker, William Wester, and Sahar Allam at Fermilab). This effort will result in several (~30) “faint” ( $r \sim 16-17$  mags.) spectrophotometric stars in the southern hemisphere useful as standards and survey calibrators. These results are in preparation for publication. These stars lie in the DES footprint so we anticipate they will be useful for LSST as well.

Abhijit Saha and collaborators are continuing their semi-parallel effort to develop faint DA standards using HST, also for large survey calibration. The initial results of this effort are reported in Narayan et al. (arXiv:astro-ph/1811.12534).

Results from GAIA are revolutionizing our understanding of the local universe (for example, arXiv:2001.07737). These data will play an important role in the next few decades. The Space Telescope Workshop, “Accurate Flux Calibration for 21<sup>st</sup> Century Astrophysics” (scheduled for 17–19 March, 2020) has been postponed due to the Coronavirus pandemic.

Results for establishing a network of spectrophotometric standards at equatorial and northern declination using DA white dwarfs were published (Narayan et al. 2019, ApJS, 241, 20). Work on a southern set is in progress, which when completed will provide ~35 spectrophotometric standards at  $V \sim 18$  mag spread across the entire sky.

### *Polarimetry*

Polarimetry continues to be a very active field, be it in terms of research papers, meetings, instruments and research programs. The area of optical high angular resolution continues to progress very rapidly, while the sub-mm band is also growing fast. Use of sub-mm ALMA bands to study disks around young stars with high angular resolution is one example. Simultaneous use of various wavelength bands to approach the interpretation of astrophysical situations has become commonplace. GAIA data has also started to play a major role to support the use of polarimetric data. One promising application is to modeling of the Galactic magnetic field structure using starlight optical/NIR polarimetric data.

In 2019, Commission B6 members who work on Polarimetry, together with colleagues from around the globe, were busy helping organize the ASTROPOL 2020, that would have taken place at Hiroshima on March 23-27, 2020. Because of the current pandemic, the meeting has been postponed and will take place at a safe and convenient time, probably in 2021. As originally planned, essentially all areas, from Solar/Extrasolar Systems to Cosmology, will be contemplated.

## B7 Protection of Existing and Potential Observatory Sites

The Organizing Committee and Working Groups have been active in representing the interests of IAU in several major areas:

- In organizing and executing its third successful Focus Meeting during the last three IAU General Assemblies. With the 2018 GA taking place in Vienna, C.B7 took the opportunity to strengthen the relationship with CIE.
- In organizing and executing a successful special session on light pollution, radio interference and satellite constellations for each of the last three years at the January American Astronomical Meeting (AAS). The January 2020 AAS meeting had a VP from SpaceX as a guest speaker.
- In developing a new set of webpages for B7 which is almost complete.
- In writing and publishing two IAU announcements and an IAU theme in the last 9 months to spread awareness on the impact of satellite constellations on the field of astronomy and what IAU B7 was doing to address it.
- In requesting half dozen astronomers from Europe, Chile and the USA to discuss modeling the impact of satellite constellations and share results. A few papers have resulted. One is from B7's secretary, David Galadi-Enrique (Observatorio de Calar Alto). Another is from Olivier Hainaut (ESO).
- In requesting (with other institutions) groups (Las Cumbres Observatory, CTIO, and the Universidad de Antofagasta) to observe Starlink's DarkSat; a paper by the last group will be published soon.
- (B7 President and VP:) in holding 10 calls with SpaceX through the AAS in as many months to understand each others' culture and work toward solutions on the impact of satellite constellations on astronomy.
- (B7 President:) in working with educational organizations to spread awareness of and solutions toward light pollution, radio interference and satellite constellations:
  - 1) co-chairing the IAU100 Dark Skies for All Global Project and helping to make the IAU100 Dark Skies Ambassadors into the IAU Dark Skies Ambassadors to continue their great work;
  - 2) heading the International Dark Sky Association (IDA) Outreach Committee and partnering with the IDA on International Dark Sky Week;
  - 3) partnering with Citizen Science Association, Astronomers Without Borders, and SciStarter on the Globe at Night light pollution measuring campaigns;
  - 4) partnering with Laser Classroom to manufacture the IAU IYL Quality Lighting Teaching Kit as the Turn on the Night kit (at no profit); and
  - 5) organizing and holding a couple of international education events (e.g., including the first e-Light pollution exhibition during the IAU GA 2018 and a world-wide children's art campaign on light pollution) through the effort of Margarita Metaxa, co-chair of the B7 WG on Achieving Sustainable Development within a Quality Lighting Framework.
- (B7 President:) in compiling a technical paper on modeling sky glow as part of IES's Sky Glow Calculation Technical Committee.
- (B7 President, Advisor and Members): in co-organizing a conference (most likely virtual) with IAU, COPUOS and IAC on "Dark and Quiet Skies: Science and Society" to be held October 6-9, 2020. A slack workspace has been organized to enable organizing among the SOC members. Working groups are being defined to tackle key issues in advance, including satellite constellations. The event will result in a



document that describes what measures Governments and private enterprises can adopt to mitigate the negative impact of technological implementations on astronomy without diminishing the effectiveness of the services they offer to citizens. The final document will be presented to COPUOS for endorsement, to become a reference for regular future analysis of the situation.

- (B7 President, VP and Advisor): in co-organizing a workshop (now virtual) with NOIRLab and AAS on satellite constellations impact and solutions to be held June 9-11, 2020. A slack workspace has been created to enable organizing among the SOC members. Working groups are being defined to tackle key issues in advance of the workshop. The workshop goal is to assemble solutions the satellite constellation companies and various observatories can implement to lessen the brightness of the satellites.

## Reports from Working Groups

### UV Astronomy

The charter of the UV astronomy working group (UVA WG) for the period 2018-2020 is to set the grounds for the definition of a UV photometric system suitable to be implemented in small missions and that grows on the scientific challenges addressed by using UV astronomical observations.

During 2020, the UVA WG has been drafting a document to persuade the community to adopt standards that will allow easy data fusion from different missions. The document includes a review of UV missions and the photometric and a proposal for a 7 band photometric system covering the spectral range from 90nm to 350 nm. Current planning includes the submission of the document to the Steering Committee of Division B by June 2020 aiming at a final approval at the GA.

### Inter-Division Working Group on Coordination of Synoptic Observations of the Sun

<https://gonewithsolarwind.com/index.php/iau-wg/>

In 2018, this WG spearheaded the development of the IAU Resolution B3: “on preservation, digitization and scientific exploration of historical astronomical data”, which was accepted by the General Assembly XXX. As a follow up of this work, we initiated the IAU-wide Survey of historical astronomy data, which received information about 115 endangered historical datasets across all fields of astronomy. We plan to summarize these submissions and make them available to the international astronomy community by mid-2020.

The WG continued raising the awareness about the importance of historical astronomy datasets and an urgent need for their preservation. Thus, the members of the WG co-authored two White Papers submitted to the ASTRO2020 Decadal Survey aimed at identifying the key priorities in astronomy and astrophysics and developing a comprehensive strategy for US Agencies investments in the upcoming decade. On one of these White Papers was in collaboration with the Working Group on the Preservation of Astronomical Heritage (WGPAH) of the American Astronomical Society (AAS).

- Lattis, J., Osborn, W., Bartlett, J. L., Griffin, E., Hockey, T., McCluskey, S., Oswald, T., Pevtsov, A.A., Schechner, S., Trimble, V.: 2019, “Astronomy’s Archival Materials”, State of the Profession White Paper submitted to ASTRO2020 Decadal Survey, ArXiv: 1907.10686
- Pevtsov, A., Griffin, E., Grindlay, J., Kafka, S., Bartlett, J. L., Usoskin, I., Mursula, K., Gibson, S., Pillet, V. M., Burkepile, J., Webb, D., Clette, F., Hesser, J., Stetson, P., Munoz-Jaramillo, A., Hill, F., Bogart, R., Osborn, W., Longcope, D.: 2019, “Historical astronomical data: urgent need for preservation, digitization enabling scientific exploration”, White Paper submitted to ASTRO2020 Decadal Survey, ArXiv: 1903.04839

We worked with the IAU General Secretary and two IAU Division Presidents to arrange for a letter of endorsement for the World Data Center for Sunspot Index and Long-term Solar Observations (WDC- SILSO) to continue and expand their activity on the production, preservation and dissemination of the international sunspot number. We also arranged for

a support letter for a researcher to promote the access and the digitization of Lindener's manuscripts for astronomical observations from the University Archive of Wrocław, Poland.

The WG also provided the endorsement letter for IAU Symposium "The Sun and Solar Twins: Variability, Planetary Systems, Composition" proposed by Drs. N. Krivova and A. Shapiro for the next IAU General Assembly in Busan, South Korea.

The members of the WG continued activities aimed at developing a "community consensus" time series of sunspot and group numbers. The discussions continued in the framework of the international team on "Recalibration of the Sunspot Number Series" supported by the International Space Science Institute (ISSI, Bern Switzerland). In addition, several members of the WG had participated in discussion of the "Solar variability and sunspot indices" started by SCOSTEP's Variability of the Sun and Its Terrestrial Impact (VarSITI) program. The purpose of this discussion was to assess the needs and approaches for developing a single "community consensus" time series of sunspot and group numbers.

We also continued informing the WG members about the relevant activities by other groups. One of these was a call issued by the Digital Preservation Coalition (DPC) to submit nominations for its 2019 edition of the 'BitList' (which digital materials the digital community thinks are most at risk).

One of the at-risk datasets is the Debrecen Photoheliographic Data (DPD) sunspot catalogue, which since 1972 served as a continuation of Greenwich Photoheliographic Results (GPR).

Many historical astronomy dataset continue to be at risk, including several solar (heliophysics) datasets. Lack of dedicated funding is the main issue for delaying the rescue of such important datasets. Nevertheless, the digitization activity continues mostly via the dedicated (often, volunteer) efforts of our astronomy colleagues. Thus, for example, in 2019, the datasets of (1917-2016) magnetic field measurements in sunspots and the full disk observations in Ca II K line from the Mount Wilson Observatory have been digitized and made public. H-alpha observations from the Solar Optical Observing Network (SOON) are put in a public domain by Dr. Alan Kiplinger (University of Colorado). The long-lost sunspot-number archives of the Zurich Observatory (1945-1980) were recovered thanks to a collaboration between the World Data Center SILSO in Brussels and the Specola Solare Observatory in Locarno. Those source data tables are now progressively digitized by the library of the ETH Zürich, in the framework of the e-manuscript, a Swiss federal program. There is a continuing effort by the German astronomy community to digitize their extensive collection of the photographic plates including the photographic solar images (Archives of Photographic Plates for Astronomical USE, APLAUSE), and several others. We also note a recent effort to digitize the solar observers' logs from the Tashkent Astronomical Observatory (now Ulugh Beg Astronomical Institute of the Uzbekistan Academy of Sciences). We plan collecting the links to the digitized archives on a new Historical Solar Data (<https://historicalsolardata.org>) server.