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CHAPTER V

THIRTY-FIRST GENERAL ASSEMBLY

RESOLUTIONS OF THE XXXIst GENERAL ASSEMBLY

1. Resolutions Committee (2018–2021)

The members of the Resolutions Committee for the 2018–2021 triennium were:

Claus Leitherer (USA; Chair)
Laura Ferrarese (Canada)
Tushar P. Prabhu (India)
Nicolay N. Samus (Russia)
Adriana Valio (Brasil)

2. Approved Resolutions

RESOLUTION B1

In support of the protection of geodetic radio astronomy against radio frequency interference

Proposed by the IAU Commission A2 (Rotation of the Earth) and the IAU Commission A1 (Astrometry)

The XXXI General Assembly of the International Astronomical Union,

recognising

1. that the International Astronomical Union (IAU) is a Sector Member of the Radiocommunication Sector of the International Telecommunication Union (ITU-R),
2. that in Article 5 of the Radio Regulations of the ITU (RR) [1] a number of frequency bands are allocated to the radio astronomy service (RAS) on a primary and secondary basis,
3. that footnote RR No. **5.149** [1] lists several additional frequency bands not allocated to the RAS in the Table of Frequency Allocations in Article 5, and specifies *"administrations are urged to take all practicable steps to protect the radio astronomy service from harmful interference"* within bands covered by this footnote,
4. that footnote RR No. **5.340** [1] lists a number of frequency bands where no emissions are allowed,

5. that provision No. **29.9** of Article **29** of the RR [1] states that *"In providing protection from interference to the radio astronomy service on a permanent or temporary basis, administrations shall use appropriate means such as geographical separation, site shielding, antenna directivity and the use of time-sharing and the minimum practicable transmitter power"*,
6. that Recommendation ITU-R RA.769-2 [2] and Report ITU-R RA.2131-0 [3] specify the protection criteria used for radio astronomy measurements, including VLBI systems;

noting

7. that within the radio window of the Earth atmosphere, only a few narrow bands are allocated to the RAS in the frequency range 2–14 GHz on a primary or secondary basis; Considering
8. that IAU Resolution B4 2015 [4] states that "radio astronomy observations consist of the reception of extremely weak signals from cosmic sources, that radio astronomy receivers have exceptionally high sensitivity, which results in high susceptibility to interference caused by man-made radio signals", and "that radio frequencies are a limited resource that must be shared",
9. that the Earth Orientation Parameters (EOP), a product that depends on geodetic radio astronomy using the Very Long Baseline Interferometry (VLBI) observation method, are indispensable for many critical applications (IAU Resolution No B7, 1997) [5], such as precise orbit determination, operation of global navigation satellite systems Executive Committee Report 15 (GNSS), spacecraft launch and operations, time keeping, and precise navigation on land, sea, in air and space,
10. that geodetic radio astronomy provides the International Celestial Reference Frame (ICRF) (IAU Resolution B2 2018) [6], to which all other reference frames, such as the Planetary and Lunar Ephemerides, Gaia Celestial Reference Frame, reference frames at other wavelengths are referred to and that is essential for the most precise determina- tion of the EOP,
11. that geodetic radio astronomy contributes also to the International Terrestrial Reference Frame (ITRF) (IAU Resolution B1 2018) [7], which is fundamental for positioning, surveying and geo-referencing the phenomena of geodynamics and global change, and its method, VLBI, is the only technique that provides the direct tie between the ICRF and ITRF by means of the EOP,
12. that the IAU has mandated the International Earth Rotation and Reference Systems Service (IERS) [8] to produce and disseminate the products that fall under considering 9–11 (IAU Resolution No. B 2 1985) [9] and hence is dependent on high quality data from geodetic radio astronomy,
13. that the International VLBI Service for Geodesy and Astrometry (IVS) [10] is the IAU Service Organisation (IAU Resolution No. B1.1 2000) [11] providing geodetic radio astronomy data and products to the IERS, space agencies, space and other industries, satellite operators, public administrations, and scientific institutions, on a regular basis,
14. that geodetic radio astronomy observations have been carried out since the early 1980s using frequencies in the frequency ranges 2.2–2.35 GHz and 8.1–8.9 GHz outside of the narrow allocated RAS bands, but the increasing number of applications, such as wireless local area networks (WLAN), mobile networks, synthetic aperture

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radar (SAR), satellite constellations, and other active services constrain the VLBI community to consider new frequency bands for its indispensable observations,

15. that the IVS implements a modern geodetic radio astronomy observing system, namely the VLBI Global Observing System (VGOS) [12], that requires observation band- width in the frequency range of 2–14 GHz in order to address the accuracy goals complying with the United Nations (UN) societal goals on sustainable development [7, 13, 14] as well as for the related scientific questions [15, 16],
16. that the frequency range of 2–14 GHz is allocated mostly to other active radio services, whose signals have a potential to interfere with geodetic radio astronomy ob- servations and will have an essential impact on the radio astronomy equipment and the quality of acquired data,
17. that the increasing number of active services in the frequency range of 2–14 GHz limits the use of that range for radio astronomy in general and for geodetic radio astronomy in particular (IAU Resolution No. A 2 1988) [17],
18. that emissions from spaceborne or airborne platforms can be particularly severe sources of interference to the RAS (IAU Resolutions Nos. 3 1979, B 3 1985, and A 3 1991) [18, 19, 20] and that these cannot be avoided by choice of site for an observatory or by local means of protection, such as site shielding;

recommends

19. to support the exploration of new observation bands for geodetic radio astronomy in the frequency range of 2–14 GHz outside of the existing RAS bands,
20. to promote cooperation with the national spectrum authorities for the protection of the observing sites of the global geodetic radio astronomy network to maintain the mission of geodetic radio astronomy for satisfying the societal and scientific needs,
21. to support a "Proposal for a draft new Question regarding the VLBI Global Observing System (VGOS)" to ITU-R [21],
22. administrations to consider a new Agenda Item at the World Radiocommunication Conference 2027 (WRC-27) [22] or as soon as possible, addressing the spectrum needs of geodetic radio astronomy in the frequency range of 2–14 GHz and the local protection of the few globally distributed geodetic radio astronomy observatories that form the Global Geodetic VLBI Network.

resolves

23. to express the view that the most effective protection of geodetic radio astronomy sites would be through radio quiet or coordination zones,
24. to encourage studies by the VLBI community possibly together with national spectrum authorities on the impact of the increasing radio frequency interference to geodetic radio astronomy observations, to support *site testing and maintenance to avoid generating interference or importing interfering devices*, and to support *monitoring the ambient spectrum and tracking the occurrence of interference*,
25. to encourage astronomers, geodesists and scientists of related disciplines, to work proactively in protecting radio astronomy service observations in the frequency range 2–14 GHz and to join the efforts of the European Committee on Radio Astronomy Frequencies (CRAF) and elsewhere,

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26. to send a copy of this Resolution to administrations that operate or host geodetic radio astronomy network stations which use the frequency range 2–14 GHz for observations, and where active radio services are operating or are planned to operate in the same frequency range,
27. to bring this Resolution to the attention of the Director of the United Nations Statistical Commission (UNSC) [24], to the Director of United Nations Office for Outer Space Affairs (UNOOSA) [25] and to the Secretary General of the International Telecommunication Union (ITU) [26].

References

[1] ITU Radio Regulations 2020, http://handle.itu.int/11.1002/pub/814b0c44-en

[2] ITU *RA769-2: Protection criteria used for radio astronomical measurements* 2003, https://www.itu.int/rec/R-REC-RA.769/en

[3] ITU "Supplementary information on the detrimental threshold levels of interference to radio astronomy observations in Recommendation ITU-R RA.769" 2008, https://www.itu.int/pub/R-REPRA.2131

[4] IAU Resolution B4 "Protection of Radio Astronomy Observations in the Frequency Range 76 - 81 GHz from Interference Caused by Automobile Radars." 2015, https://www.iau.org/static/resolutions/IAU2015_English.pdf

[5] IAU Resolution No B7 1997, https://www.iau.org/static/resolutions/IAU1997_French.pdf

[6] IAU Resolution B2 *on The Third Realisation of the International Celestial Reference Frame* 2018, https://www.iau.org/static/resolutions/IAU2018_ResolB2_English.pdf

[7] IAU Resolution B1 "on Geocentric and International Terrestrial Reference Systems and Frames" 2018, https://www.iau.org/static/resolutions/IAU2018_ResolB1_English

[8] International Earth Rotation and Reference Systems Service (IERS), https://www.iers.org/

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[17] IAU Resolution No. A 2 1988, https://www.iau.org/static/resolutions/IAU1988_French.pdf

[18] IAU Resolution No. 3 1979, https://www.iau.org/static/resolutions/IAU1979_French.pdf

[19] IAU Resolution No. B 3 1985, https://www.iau.org/static/resolutions/IAU1985_French.pdf

[20] IAU Resolution No. A 3 1991, https://www.iau.org/static/resolutions/IAU1991_French.pdf

[21] ITU-R 2020 "Proposal for a draft new Question regarding the VLBI Global Observing System (VGOS)": https://www.itu.int/md/R19-SG07-C-0018/en

[22] World Radio-communication Conference (WRC): https://www.itu.int/en/ITUR/conferences/wrc/

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[24] United Nations Statistical Commission (UNSC), https://unstats.un.org/unsd/statcom

[25] United Nations Office for Outer Space Affairs (UNOOSA), https://www.unoosa.org/

[26] International Telecommunication Union (ITU) Office of the Secretary-General, https://www.itu.int/en/general-secretariat/Pages/osg.aspx

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RESOLUTION B2

Improvement of the Earth's Rotation Theories and Models

Proposed by the IAU Commission A2 'Rotation of the Earth'

The XXXI General Assembly of the International Astronomical Union,

noting

1. that the consistent definition and determination with increased accuracy of the rotation between the International Terrestrial and Celestial Reference Systems and Frames, adopted by Resolutions B1 and B2 of the XXX IAU General Assembly in 2018, is necessary for the accurate realisation of those two frames, advancing astrometry and furthering our insight into the realisations of celestial reference frames at different wavelengths, investigating the global change of the Earth, and determining global geodetic variables, among numerous scientific and technical topics related to precise positioning on Earth and space navigation;
2. that the IAU adopted the nutation theory IAU2000A and the precession theory IAU2006, by Resolutions B1.6 and B1 of its XXIV and XXVI General Assemblies, which were endorsed by Resolutions 4 and 1 of the XXIII and XXIV General Assemblies of the International Union of Geodesy and Geophysics (IUGG), respectively;
3. that the current Earth rotation theories, even including supplemental models provided by the International Earth Rotation and Reference Systems Service (IERS), are unable to model and predict the Earth orientation parameters (EOP) with an accuracy close to the current stringent requirements, for instance those set by the Global Geodetic Observing System of the International Association of Geodesy (GGOS/IAG), in spite of the improved accuracy and precision of the individual and combined solutions derived from single or multiple techniques;
4. that the precession-nutation theories IAU2000 and IAU2006 suffer from internal inconsistencies and systematics whose correction is partially available, but also from inconsistencies due to incorporating outdated models instead of the state-of-art models used in EOP determination,
5. that the theoretical precession-nutation models and the observations of the different EOPs are not always referred to the current IAU and IUGG/IAG standards, in particular regarding terrestrial reference frames;

recognising

6. the outcomes of the IAU Commission A2 Joint Working Group on Theory of Earth Rotation and Validation (JWG TERV), joint with the IAG Commission 3, summarised in its report published in the IAG Travaux 2015–2019 (Vol. 41, pp 292–301);
7. that the IAG Council at the XVII IUGG General Assembly in Montreal 2019 adopted the IAG Resolution 5 on Improvement of the Earth's Rotation Theories and Models, accepting the conclusions of the IAU/IAG JWG TERV, published in Ferrándiz J.M., Gross R.S., Escapa A., Getino J., Brzeziński A., Heinkelmann R. (2020) Report of the IAU/IAG Joint Working Group on Theory of Earth Rotation

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and Validation. In: International Association of Geodesy Symposia, Springer, https://doi.org/10.1007/1345_2020_103;

8. the need of taking advantage of the advances accomplished or yet in progress on different aspects of the theoretical and empirical modelling and prediction of the Earth's rotation to get closer to the accuracy currently required and foreseen in the near future; and
9. the need of better consistency between the IAU, IAG, and IUGG standards and products,

resolves

10. to encourage a prompt improvement of the Earth rotation theory regarding its accuracy, consistency, and ability to model and predict the essential EOP;
11. that the definition of all the EOP, and related theories, equations, and ancillary models governing their time evolution, must be consistent with the reference frames and the resolutions, conventional models, products, and standards adopted by the IAU, IUGG/ IAG and its components;
12. that the new models should be closer to the dynamically time-varying, actual Earth, and adaptable as much as possible to future updating of the reference frames and standards; and
13. that the IAU acts in close cooperation with IUGG/IAG and other concerned organizations.

RESOLUTION B3

On the Gaia Celestial Reference Frame

Proposed by the IAU Division A WG 'Multi-waveband Realizations of the International Celestial Reference System'

The XXXI General Assembly of the International Astronomical Union,

noting

1. that Resolution B2 of the XXIIIrd General Assembly (1997) resolved "that, as from 1 January 1998, the IAU celestial reference system shall be the International Celestial Reference System(ICRS)";
2. that Resolution B2 of the XXIIIrd General Assembly (1997) resolved 'that the Hipparcos Catalogue shall be the primary realization of the ICRS at optical wavelengths';
3. that Resolution B2 of the XXXth General Assembly (2018) resolved "that, as from 1 January 2019, the fundamental realization of the International Celestial Reference System (ICRS) shall be the Third Realization of the International Celestial Reference Frame (ICRF3), as constructed by the IAU Working Group on the Third Realization of the International Celestial Reference Frame";

recognizing

4. that since the establishment of the ICRF3, the ESA space telescope Gaia has conducted relevant optical observations of extragalactic sources and made available a high quality astrometric catalogue for these sources;
5. that the observational principles of Gaia regarding the extragalactic sources meet the ICRS requirements;
6. that the Gaia reference frame in the visible (Gaia-CRF3) and the radio ICRF3 are aligned to each other thanks to a set of common sources in the optical and radio bands;
7. that the Gaia-CRF3 and the stellar Gaia catalogue have largely superseded the Hipparcos Catalogue;
8. that the Gaia-CRF3 is de facto the optical realization of the Celestial Reference Frame in use within the astronomical community;
9. that the Gaia-CRF3 data has been released in December 2020 within the Gaia EDR3 and is accessible in the Gaia archive;

resolves

10. that as from 1 January 2022, the fundamental realization of the International Celestial Reference System (ICRS) shall comprise the Third Realization of the International Celestial Reference Frame (ICRF3) for the radio domain and the Gaia-CRF3 for the optical domain.

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Reference

Gaia Collaboration, Gaia Early Data Release 3. Summary of the contents and survey properties, A&A, 649, A1 (2021), https://doi.org/10.1051/0004-6361/202039657

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RESOLUTION B4

On the use of a standard photometric system in ultraviolet (UV) astronomy

Proposed by the IAU Division B WG 'Ultraviolet Astronomy'

The XXXI General Assembly of the International Astronomical Union,

noting

1. that access to UV data is fundamental in many areas of astrophysical research,
2. that the rapid evolution and standardization of space technologies together with the scarcity of large UV observatories is creating a new generation of UV astronomers developing small, project oriented satellites,
3. that there is no standard photometric system established at ultraviolet wavelengths (90-350nm),
4. that the lack of UV standards of reference would hamper the reproducibility of the observations and, therefore, does not satisfy the requirements of the scientific method,
5. that the exchange of information between researchers becomes very difficult and a significant fraction of the UV data may get misused or lost for the astronomical community, at large,

recognizing

6. that it is necessary to define common grounds to facilitate comparing and contrasting data from different UV missions,

recommends

7. that the following photometric bands passes (see the precise definition in [1]) are used as a reference for data exchange in UV photometry:
   a. UV1 from 91 nm to 110 nm.
   b. UV2 from 125 nm to 140 nm (alike [CsI photocathode + F125LP(CaF_2)]- [CsI photocathode + F125LP(BaF_2)].
   c. UV3 from 140 nm to 180 nm (similar to the FUV band implemented in the UV mission Galaxy Evolution Explorer – GALEX-).
   d. UV4 from 180 nm to 210 nm.
   e. UV5 from 210 nm to 230 nm.
   f. UV6 from 230 nm to 280 nm (similar to F250W filter implemented in the Advanced Camera System on board the Hubble Space Telescope).
   g. UV7 from 280 nm to 350 nm (similar to F330W filter implemented in the Advanced Camera System on board the Hubble Space Telescope).
8. that the UV spectrophotometric standards defined in the Vega system by the HST are used for the photometric calibration
9. that spectrophotometric UV data or photometric UV data obtained in other bands are post processed to provide synthetic photometry in the abovementioned bands.

Reference

[1] https://www.iau.org/static/science/scientific_bodies/working_groups/267/report-uva-wg-20200730.pdf

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