IAU Letter of Intent for a new Commission for Radio Astronomy

Deadlines: Full proposal by 31 Jan 2015

Proposed Commission

Name of the Commission: Radio Astronomy

Commission Category: Regular Commission

Parent Division: Division B: Facilities, Technologies and Data Science

Proposer details:

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Second co-proposer: Xiaoyu Hong, Shanghai Astronomical Observatory, Shanghai, China

Third co-proposer: Nicholas Seymour, Curtin University, Perth, Australia

Rationale

History : Based on an existing Commission.

Existing Commission: Commission 40 for Radio Astronomy

Justification

Background

The proposed new IAU Commission: ***Radio Astronomy***, will provide a natural extension and growth of the present IAU Commission 40 (hereafter C40) for Radio Astronomy. C40 was first established in 1948 and has been extremely successful at supporting the Radio Astronomy community. C40 currently has approximately 1,100 members from 50 countries and so represents about 10 per cent of the total IAU membership. From 1997 to 2012 C40 was the sole Commission in Division X. In 2012 Division X ceased and C40 became a part of Division B.

The C40 website is available at www.atnf.csiro.au/iau-comm40/index.html where the present Letter of Intent (LoI) and a discussion site are available.

Scientific Domain

Radio Astronomy observations provide the most sensitive, highest angular resolution, and broadest fractional wavelength coverage observations in modern astronomy.

The new Commission "Radio Astronomy" will bring together scientists and engineers who carry out observational and theoretical research in radio astronomy and who develop and operate the ground and space-based radio astronomy facilities and instrumentation that are used to explore the Universe at radio wavelengths.

Radio Astronomy is an important window to study the Universe as it provides insights into fundamental physics that are otherwise unobtainable. Radio observations provide unique information about the two fundamental long-range forces, electromagnetism and gravity, allowing us to improve our knowledge on fundamental properties of matter and on the origin and evolution of the Universe. Many of the now familiar astronomical phenomena such as quasars, pulsars, the Cosmic Microwave Background, masers, the solar wind, gravitational lens, giant molecular clouds, non thermal radiation, and cosmic evolution were first discovered at radio wavelengths. It was radio observations that opened up the high redshift universe through the discovery of radio galaxies, then quasars, and more recently CO emission.

Cosmic radio emission is the result of thermal radiation from stars, planets, and HII regions and non--thermal emission due to synchrotron radiation. Radio observations allow studies of the 21 cm Hydrogen-line and many molecular lines which provide essential information on the Epoch of the Reionization, on the Cosmological Microwave Background, and on stellar objects such as pulsars and magnetars. In the radio band we can also study the intensity, properties and origin of the poorly understood large scale magnetic fields in the Universe.

Radio Astronomy defines the fundamental celestial reference frames used by all astronomy and global timekeeping (ICRF-2, ICRF-3).

Across the radio spectrum, many powerful instruments are available today (such as the Very Large Array, the Very Long Baseline Array, the Australia Telescope Compact Array, the European VLBI Network, the Submillimeter Array, etc.) and they continue to develop their capabilities. Very Long Baseline Interferometry (VLBI) techniques provide radio images at the highest angular resolution possible in astronomy (microarcsec scale with Space VLBI and mm-VLBI).

In recent years, radio observations have expanded the observing frequency range. At very high frequencies new facilities such as ALMA are opening a new window on the millimetre universe, allowing studies of the high redshift Universe and the chemistry of gas and star formation. At low frequencies existing and new instruments such as the Low Frequency Array (LOFAR) and the SKA precursor Murchison Widefield Array (MWA), will provide wide-field, sensitive observations of the Universe at arcsecond resolution. These arrays will be used to study key questions including the Epoch of Reionization, Ultra High Energy Cosmic Rays, and Cosmic Magnetism.

Looking ahead, the Square Kilometre Array (SKA) and its pathfinders and precursors are expected to have a very large impact on all of astronomy. The SKA will operate over a wide range of frequencies and will be up to 50 times more sensitive than any present radio instrument. It will be able to survey the radio sky more than ten thousand times faster than any previous instrument. This revolutionary observational improvement implies a dramatic change in imaging technology and a huge increase in data rates. Learning how to analyse and to manage the statistics from such large amounts of data will be essential for the next generation of radio astronomers.

Need for a Commission

The primary purpose of this Commission will be to coordinate the unique role of Radio Astronomy as part of our global multi-wavelength capability in astronomy, taking in consideration the long-term development in this field at the international level.

Radio Astronomy from its beginning has had a multi-wavelength approach. The necessary identification of the objects emitting radio wavelengths implied a strong connection between radio and optical images. The importance of results obtained in the radio-band (e.g. magnetic fields) and this multi-wavelength approach implies that Radio Astronomy need to be adequately represented in global multi-wavelength astronomy.

The scientific goals of Radio Astronomy are ambitious and cover a large range of topics. These include studies of the most distant parts of the Universe at its earliest epochs, General Relativity, the evolution of stars and galaxies from just after the Big Bang to present, the nature of dark energy, and the search of life in the Universe.

Moreover, managing the data from the new generation of radio telescopes, producing science-ready data products, and providing facilities that allow astronomers to access the data archives and combine radio astronomy results with those from other areas (infrared, x-ray etc), will be great challenges.

In this context the proposed Commission will provide a focus to discuss new scientific and technical advances which will be shared with the broader IAU community. A connection with a new Commission equivalent to the current Commission 5 (Documentation & Astronomical data) may be useful.

In addition, this new Commission will continue the important role of the current C40 in providing support to external bodies that protect radio environment, including URSI, COSPAR, the International Telecommunications Union (ITU), and the Scientific Committee on Frequency Allocations for Radio Astronomy and Space Science (IUCAF).

In particular, we propose that the current arrangements for allocation members from to IUCAF should continue under the new Commission for Radio Astronomy.

Perimeter of the Commission Community

As demonstrated by the current C40, the potentially interested community is very large. It includes scientists and engineers who carry out observational and theoretical research in radio astronomy and who develop and operate the ground and space-based radio astronomy facilities and instrumentation that are used to explore the universe at radio wavelengths.

We are now living a golden age for radio astronomy with a phenomenal investment in the development of international radio astronomy facilities at a scale that significantly impacts all the international community. This includes both major enhancements such as the transition from the VLA to the JVLA, the GMRT, and the development of new facilities such as LOFAR, ALMA, FAST, and SKA precursor telescopes in Australia (ASKAP, MWA) and South Africa (MeerKat, KAT7). ALMA is the first 'global' mm observatory moreover we see the proliferation of other facilities in space (Herschel, Planck) and on the ground (e.g. JCMT, APEX, CARMA, IRAM) and more are in progress (LMT, CCAT).

These developments are driven by advances in radio-frequency, digital and information technologies that tremendously enhance the capabilities in radio astronomy, and our evolving understanding of the science. These new developments foreshadow major scientific advances driven by radio observations in the near future.

Commission Working Groups

Commission 40 currently has three working groups (for details see links from C40 Home Page). These are:

a) *Astrophysically Important Spectral Lines* (Chair: Masatoshi Ohishi). This group compiles and reviews list of "Astrophysically Important Spectral Lines".

b) *Historic Radio Astronomy* (Chair: Ken Kellermann). This group assembles a master list of surviving historically-significant radio telescopes and associated instrumentation found worldwide, and documents the technical specifications and scientific achievements of these instruments.

c) *The radio astronomy definition of continuum flux density in Broad-band SED observations* (Chair: Ron Ekers). This group has been set up to clarify the radio astronomy definition of continuum flux density in the case of wide-band radio telescope systems and to develop a future IAU resolution.

The new Commission will support all these Working Groups. Of these, (a) and (b) are both well-established with long term goals. These are expected to continue into the 2015 – 2018 triennium and beyond. Working Group (c) is focussed on a specific issue and is likely to complete this activity during 2015.

Following the establishment of a new Commission, the Organizing Committee will consult with the full membership to consider new Working Groups that meet the membership needs. These may include, for example, working groups working on radio astronomy data archives, and emerging facilities for radio astronomy.

Key goals

For the first six to nine years, key goals for the new Commission will be to:

1) **Stimulate and support IAU symposia and other international meetings** especially on cross-disciplinary themes where Radio Astronomy can play an important role and that cover more than one facility, e.g. major surveys, science data processing, imaging and calibration standards. Promote connection and interchanges among present and future large scale facilities.

2) **Connect Radio Astronomy to informatics and statistics**, provide information on available radio astronomy archives and promote a multi-wavelength approach to the sharing of astronomy data and the scientific importance of combining results from across the electro-magnetic spectrum.

3) **Foster discussions and share information on topics of current interest to radio-astronomers around the world** and provide up to date information on radio science, data, facilities and techniques. Special attention will be devoted to the new Radio Astronomy windows at ultra-high frequency (mm band) with ALMA and mm-VLBI, and low frequencies with e.g. LOFAR, ASKAP, MeerKat, MWA and the SKA.

4) Act as an interface between the large number of individuals and groups working in this field and other Commissions, Divisions and the IAU in general.

5) **Encourage membership, broaden participation, and support the development of younger astronomers working or interested in radio astronomy.** This will be done through a forum and/or through support for dedicated meetings similar to the *Young European Radio Astronomy Conference* (YERAC). The importance of gender and countries diversity will be properly considered.

6) **Provide support to IUCAF and the ITU**, primarily through the appointment of members to IUCAF and by providing web information on these activities on the Commission website.

7) Develop connections and partnerships with the commissions of the IAU working in the areas of outreach and education. Astronomy in general, and Radio Astronomy in particular, are exciting topics for students and the general public.

End of form