Radio Science in Canada

by **David Michelson**

Next year, in 2019, the International Union of Radio Science (abbreviated URSI, after its French name, Union Radio-Scientifique Internationale) will celebrate its centennial. The past one hundred years have borne witness to the tremendous impact that the application of electromagnetic fields and waves have had on society, industry and the economy. From wireless communications to microwave ovens to fibre optics to radar to remote sensing to radio astronomy, it is difficult to imagine today's world without the benefits of electromagnetic technology.

URSI has a long history of cooperating with IEEE to advance international cooperation in the study of electromagnetic fields and waves. One of the best known examples is, of course, the IEEE AP-S Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting that is organized each summer by the IEEE Antennas and Propagation Society and the U.S. National Committee for URSI. With the launch of this regular feature in IEEE Canadian Review, IEEE Canada members will have an opportunity to learn more about URSI, its organization and activities, and how they can both contribute to and benefit from URSI's mission.

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A BRIEF INTRODUCTION TO URSI

URSI was formed in 1919 during the Constitutive Assembly of the International Research Council, the predecessor to the International Council for Science (ICSU). One of the four founding members of the ICSU, URSI is currently one of 30 international scientific unions affiliated to it. Other ICSU unions include the International Astronomical Union, the International Mathematics Union, the International Union of Pure and Applied Chemistry, and the International Union of Pure and Applied Physics.

URSI's mission is to stimulate and co-ordinate, on an international basis, studies, research, applications, scientific exchange, and communication on all aspects of electromagnetic fields and waves. In particular, URSI seeks:

- to encourage and promote international activity in radio science and its applications, for the benefit of humanity;
- to encourage the adoption of common methods of measurement, and the comparison and standardisation of the measuring instruments used in scientific work;
- to stimulate and coordinate studies of:
  - the scientific aspects of telecommunications using electromagnetic waves, guided and unguided;
  - the generation, emission, radiation, propagation, reception, and detection of fields and waves, and the processing of the signals embedded in them.
- to represent radio science to the general public, and to public and private organisations.

The URSI Secretariat is based in Brussels, Belgium. The 44 member countries of URSI are each represented by a National Committee. Members of the National Committees are drawn from the ranks of leading researchers in each country and are responsible for both representing the interests of researchers in their country to the URSI Secretariat and the ICSU, and informing researchers of URSI activities and opportunities relevant to their interests. In many cases, national committee members are called upon to serve pro bono as "advisers to the nation" on research and policy matters related to electromagnetic fields and waves.

The technical activities of URSI are conducted through ten scientific commissions that represent the various specializations involving electromagnetic fields and waves. They include:

- Commission A: Electromagnetic Metrology
- Commission B: Fields and Waves
- Commission C: Radiocommunication Systems and Signal Processing
- Commission D: Electronics and Photonics
- Commission E: Electromagnetic Environment and Interference
- Commission F: Wave Propagation and Remote Sensing
- Commission G: Ionospheric Radio and Propagation
- Commission H: Waves in Plasmas
- Commission J: Radio Astronomy
- Commission K: Electromagnetics in Biology and Medicine

FOCUS ON

URSI Commission J – Radio Astronomy

Dr. Lewis Knee
Canadian representative to Commission J and Member, Canadian National Committee

URSI Commission J – Radio Astronomy is concerned with observation and interpretation of all radio emissions and reflections from celestial objects. Commission J places emphasis on the technical means for making radio-astronomical observations and data analysis as well as the support for activities to protect radio-astronomical observations from harmful interference.

Atacama Large Millimeter Array in Chile

Like other international scientific unions, URSI pursues its mission by sponsoring publications, hosting conferences, and organizing working groups.

The Radio Science Bulletin (published quarterly in March, June, September and December) contains scientific articles covering the fields of interest of the ten scientific commissions of URSI. Emphasis is placed on non-specialized contributions that are oriented towards the entire radio science community.

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The journal Radio Science, sponsored by URSI and published by the American Geophysical Union, contains original research articles on all aspects of electromagnetic phenomena including propagation through, and the interaction of electromagnetic waves with, geophysical media, biological media, plasmas, and man-made structures.

URSI has held a general assembly every three years since 1922. The 32nd URSI General Assembly and Scientific Symposium (URSI GASS) was held in Montreal from 19-26 August 2017. The next URSI GASS will be held in Rome in 2020.

In recent years, URSI has begun to organize two other conferences that take place between General Assemblies. The 2018 URSI Atlantic Radio Science Meeting, AT-RASC, will be held in Gran Canaria, Spain from 28 May – 1 June 2018. The 2019 URSI Asia-Pacific Radio Science Conference will be

The largest-ever radio telescope built by Canadian universities, CHIME (Canadian Hydrogen Intensity Mapping Experiment

Photo: Andre Renard/Dunlap Institute for Astronomy and Astrophysics

There is a very high level of activity in Canada within the remit of Commission J. The largest-ever radio telescope built by Canadian universities, CHIME (Canadian Hydrogen Intensity Mapping Experiment), has been completed and has begun initial science operations on the high-frequency side of band, attempting to detect the signature of atomic hydrogen at cosmological distances around a redshift of z ~ 0.4.

CHIME uses innovative FPGA and GPU-based back end systems to handle the multi-terabits per second data rates. At (sub)millimetre wavelengths, the Atacama Large Millimeter Array (ALMA) in Chile is currently in its fifth full year of science operations, with Canadian participation in science user support, science operations, and in the technical maintenance of its W-band receiver suite. ALMA is arguably the astronomy facility having the most scientific impact at the present time. A Canadian astronomer, Sean Dougherty, has just become the international ALMA Director. Canada is also a partner in the Square Kilometre Array (SKA) development program, with NRC leading the mid-frequency Central Signal Processor project and contributing to front end development for both the SKA and its precursor MeerKAT array in South Africa.

The Dunlap Institute has been awarded a major grant to develop a radio astronomy data centre to serve both the Very Large Array (VLA) Sky Survey under way in the United States and the future needs of Canadian SKA users. Canada is also a major partner in the definition phase of the proposed next-generation VLA array proposed to be built in the American southwest: Canadian astronomers are playing prominent roles in the definition of the science case for the array and NRC is working on high-frequency front ends as well as developing a proposed antenna design based on its unique composite materials antenna technology.

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Photo: ESO/C. Malin

held in New Delhi, India from 9-15 March 2019. The URSI Young Scientist Program provides travel grants to new members of the radio science community to attend these meetings as part of a cohort of other young scientists.

URSI IN CANADA

Canada joined URSI in 1952, somewhat later than its sister Commonwealth countries Australia (1922) and New Zealand (1931). During the Second World War, radio research in Canada had grown rapidly under the direction of the National Research Council (NRC) of Canada's Associate Committee on Radio Research. By 1950, with many of NRC's radio researchers no longer involved in defence work, an Associate Committee on Radio Science was formed. In 1951, this became the Canadian Committee for URSI under the chairmanship of D. W. R. McKinley, then Associate Director of the Radio and Electrical Engineering Division of NRC. Canada became a member of URSI the following year.

The Canadian National Committee (CNC) originally consisted of six senior scientists and engineers from government laboratories and departments concerned with radio science and its applications, and five radio physicists, an electrical engineer and a radio astronomer from the universities. By 1968, the size of the committee had grown to 23 members from government, universities and industry. In 1971, the committee assumed its present form, and currently consists of the Committee Chair, a Past Chair, a Secretary and a Chair for each of the URSI Scientific Commissions.

The Canadian National Committee for URSI was very active in 2017. We hosted the 32nd URSI General Assembly and Scientific Symposium in Montreal (19-26 August 2017) which attracted over 2,000 presentations from over 50 countries; Canadian participation in URSI-GASS was second only to the U.S. In addition, Canada ran its first CNC-sponsored summer school (19 August 2017) which attracted some 60 students. Many international attendees commented that this was by far the best attended meeting since the 2003 meeting in Maastrich, Netherlands.

The National Research Council of Canada is the adhering member for Canada in international scientific and technical organizations and was instrumental in the establishment of the Canadian National Committee for URSI. The Canadian National Committee is supported jointly by NRC Government and International Relations and NRC Herzberg Astronomy and Astrophysics Research Centre.

For more information about URSI International, *please visit http://www.ursi.org/ .*

To learn about URSI Canada, *please visit http://www.ursi.ca/.* ■

URSI COMMISSION J – RADIO ASTRONOMY

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MeerKAT array in South Africa

Photo: SKA South Africa

Photo: NRAO/AUI/NSF

Through all these disparate activities, Commission J serves to facilitate communication and collaboration through its involvement in scientific and technical meetings. Commission J played a prominent part in the 2017 URSI General Assembly in Montreal, and promoted the participation as exhibitors of the international radio astronomy facilities in which Canada has an interest. In the Commission J scientific sessions there were three invited lectures, fifteen contributed papers, and three poster presentations, all of which had Canadians in the author list. The upcoming ANTEM2018 meeting will be held in Waterloo in August 2018 with Canadian radio astronomy community participation, Commission J also plans a presence at the upcoming meeting of the Canadian Astronomical Society in Victoria. ■

Dr. Lewis Knee is a Senior Research Officer and Team Leader of the Millimetre Instrumentation Group, Astronomy Technology, at the NRC Herzberg Astronomy and Astrophysics Research Centre. His scientific interests include radio and (sub)millimetre observational studies of star formation, young stellar objects, and the structure and evolution of the atomic and molecular components of molecular clouds and the general interstellar medium of the Galaxy. He is experienced in radio telescope operations and the commissioning of single dish and interferometric radio astronomy systems. His technical interests cover centimetre-wave and millimetre-wave radio astronomy instrumentation and systems.

Very Large Array (VLA)

Photo: NRAO/AUI/NSF

About the Author

Prof. David Michelson is Chair of the Canadian National Committee of the International Union of Radio Science (2018-2020). He has led the Radio Science Lab at the University of British Columbia, Dept. of Electrical and Computer Engineering since 2003. His current research focuses on short-range/low-power wireless networks for smart utility, smart transportation and natural resource applications, millimeter-wave channels and systems, and satellite networks for communications and remote sensing. Prof. Michelson serves as a member of the Board of Governors of the IEEE Communications Society (2017-2019) and the IEEE Vehicular Technology Society, as a member of the Steering Committee of the NIST-sponsored 5G mm-Wave Channel Model Alliance., and as co-director of the AURORA Connected Vehicle Technology Testbed at UBC.