

Commission J 2002-2005 Triennium Report

1. Scientific Activities

The Wilkinson Microwave Anisotropy Probe (WMAP) has made the detailed full-sky map of the oldest light in the universe. WMAP detected anisotropies at a level of roughly 10^{-5} on scales of tens of arcminutes to several degrees in the microwave background radiation of the Universe, and the age of the Universe is shown to be 13.7 billion years with an accuracy of 1%. Furthermore, many cosmological parameters such as the geometry and contents of the Universe were derived in detail (http://map.gsfc.nasa.gov/m_mm.html). Follow-up and more deep observations have been done. The nature of Gamma Ray Burst (GRB) has been investigated by coordinated observations from gamma-ray to radio resumes. GRB has been understood that in some kind of a massive star explosion, the energy is concentrated into the narrow beam to be seen as GRB. Studies of binary system have been made: a double pulsar system was found to allow high precision tests of general relativity, and binary black hole system is searched to investigate evolution of massive black hole in AGNs.

2. Engineering/Technical Developments

The Atacama Large Millimeter Array (ALMA) project is an international astronomy facility and an equal partnership between Europe and North America, in cooperation with the Republic of Chile. ALMA is funded in North America by the U.S. National Science Foundation (NSF) in cooperation with the National Research Council of Canada (NRC), and in Europe by the European Southern Observatory (ESO) and Spain (<http://www.alma.info/>). The National Astronomical Observatory of Japan (NAOJ) and the radio astronomy research community in Japan joined to form the Extended ALMA with the Atacama Compact Array (ACA), receiver production, the ACA correlator etc.

LOFAR (LOw Frequency ARray) started its construction in the Netherlands. LOFAR is an array of simple omni-directional antennas instead of mechanical signal processing with a dish antenna. The electronic signals from the antennas are digitised, transported to a central digital processor, and combined in software to emulate a conventional antenna, operational at frequencies below 250 MHz (<http://www.lofar.org/>).

The Square Kilometre Array (SKA) project has made substantial progress in many areas, from science to technical to organizational. The science case was published as 49 refereed papers in a special issue of *New Astronomy Reviews* Vol. 48 in December 2004. Proposals for siting the SKA are in preparation in four countries, and RFI monitoring is being carried out. A series of papers on the technology to be employed in the SKA have been published in a special issue of *Experimental Astronomy*, Vol. 17. Funding has been obtained for a major SKA design study in Europe, and for SKA Pathfinder telescopes in Australia and South Africa. The International SKA Project Office has been established to coordinate the international efforts (<http://www.skatelescope.org>).

The rapid advance of both data-transmission technology and signal-processing technology over the past few years is responsible for dramatic increases in the power and sophistication of signal transport and analysis. This technology allows more data to be transmitted further, faster, and with more power, stability and reliability than was ever before possible. The encapsulation of much of this power into field-programmable gate arrays (FPGAs) has also led to unprecedented flexibility as well, helping to greatly reduce design and testing times, and allows hardware to be re-used for diverse sets of needs and applications.

Thanks to these developments, extensions to wideband systems have been made in several telescope systems. These are the Expanded Very Large Array Project (EVLA: <http://www.aoc.nrao.edu/evla/>) and e-MERLIN (<http://www.jb.man.ac.uk/research/rflabs/eMERLIN.html>), which are up-grade of the existing interferometer array systems.

3. Report on Resolutions

- U1 - International Radio Quiet Reserves

Objectives:

To investigate the desirability and the issues involved in establishing International Radio Quiet Reserves for future radio astronomy.

Background:

Radio telescopes are sensitive to man-made radio frequency interference and it is desirable to minimize the effects of RFI by establishing mitigation strategies and processes. Radio quiet zones have come out as the most powerful and natural approach to optimize the observational conditions.

What was done and by whom since GA 2002:

Most recently a taskforce on regulatory issues on the Square Kilometre Array has been established and has drafted a memorandum on these issues. IUCAF through its participation in ITR-R study group 7 has established a question to study the properties and characterization of Radio Quiet reserves. The OECD Global Science Forum through the Taskforce on Radio astronomy and the Radio Spectrum has published a Report in February 2004 resulting in 4 recommendations including the establishment of a small number of "...zones on the ground where future radio observatories could be located and within which satellite emissions could be controlled."

The outcome:

The series of international workshops on Radio Frequency Interference Mitigation Strategies was continued at a two day workshop in Penticton, Canada in July 2004. Preparation for the JA-session "Radio Frequency Interference; Problems and Solutions" to be held in at the next, 2005, URSI-GA in Delhi, is in progress.

- U2 - Establishment of a working group on the possible redefinition of UTC

Objective:

To survey URSI membership and determine what affect a redefinition of UTC would have on their systems

Background:

The ITU is considering a redefinition of UTC so as to eliminate leap seconds, which cause confusion. As part of its deliberations, it had asked several international bodies, including URSI, to let them know what objections or other considerations they may have.

What was done and by whom:

A Commission J Working group surveyed URSI and the general public, and presented a report at the 2002 General Assembly. An URSI-wide resolution was passed then, and a new Working Group was formed which again surveyed the general membership and prepared a resolution.

The outcome:

The resolution, submitted for consideration at the 2005 GA, notes that no substantive response was received from URSI members and calls for the ITU to be informed that URSI has no objection to a change in UTC, but also does not endorse such a change.

4. National Report on Highlights and Topics

- Report from Australia by Ray P. Norris
 1. The Australia Telescope Compact Array has been upgraded to operate at 3 and 12 mm, and has produced a number of exciting results at both wavelength bands. These include the detection of CO in the most distant known radio galaxy, at a redshift of 5.2. See <http://www.atnf.csiro.au/research/highlights/2004/klamer/klamer.html> for more details.
 2. The Australian contribution to the SKA has been focused into the development of a New Technology Demonstrator to be developed at a radio-quiet site in Western Australia. See <http://www.atnf.csiro.au/projects/ska/> for more details.
 - Report from France by Gerard Beaudin and Thibaut Le Bertre
- Summary of activities:

- scientific activities: exploitation of ground-based instruments (IRAM, RD + cosmic ray air shower experiment, RH, RT), and space-borne instruments (radar on CASSINI, ODIN)
- protection of radio frequencies from 20 MHz to 300 GHz (1.5 man year in organisms such as C6, ANF, CRAF, IUT),
- preparation to the international projects (SKA, FASR, LOFAR) : developments of ASICs (front end) and EMBRACE demonstrator for SKA ; RFI mitigation (real time algorithms that are tested on the Nançay instruments),
- preparation for mm and sub-mm instruments (ALMA, Herschel, Planck): algorithms, detectors, spectrometers, correlators, etc.
- members of com. J are also involved in teaching radio techniques and applications in various universities.

- Report from Germany by Ernst Fuerst

Most important for Commission J in Germany was the beginning of astronomical operation of the APEX telescope. Also money was granted to change the current sub-reflector of the 100-m-RT by a new one with an active surface, to compensate for the remaining distortion of the main dish (not perfect homology). Currently we are planning to establish LOFAR stations at various places in Germany, among them the 100-m RT site and AIP Potsdam. Along with this, mainly argued by e-VLBI, it is planned to connect the 100-m-RT with the main institute in Bonn by a 10 Gbit/s fiber link.

- Progress in China by Yihua Yan

For Chinese Lunar Exploration Mission and future Chinese VLBI network, a 50m antenna in Miyun Radio Astronomical Station of NAOC, Beijing and a 40m antenna in Yunnan Observatory of NAOC are under construction in 2005. For the future FAST (Five-hundred-metre Aperture Spherical Telescope), being as the demonstrator of the Chinese SKA (Square Kilometre Array) concept, its scaled model of 30m is being built at Miyun station. For future generation telescopes, the site survey looking for best potential sites is being conducted by NAOC. An array (21CMA) of ~100 elements with each of 127 logarithmic periodic dipole antennas in 70-200MHz range is being built (30 of such elements have been constructed in 2005) in Xinjiang, aiming at observing the highest redshift of the 21 cm HI line. A Chinese Spectral Radioheliograph in dm-cm wave range (CSRH) with ~100 antennas of 2-3 m in diameter is proposed with a potential radio quiet site in Inner Mongolia and a 2-element prototype interferometer has been developed and tested. The development of different techniques in wide wavelengths in radio astronomy, such as VLBI broadband digital correlators, superconducting mixers at sub-mm wavelengths and development of a compact 500 GHz SIS receiver have been conducted.

- Report from Hungary by Istvan Fejes

The most distant radio-loud quasar known at present ($z=5.8$) the sub-mJy radio source SDSS J0836+0054, has been imaged with the European Very Long Baseline Interferometry Network at 1.6 and 5 GHz. The quasar at this early cosmological epoch appeared surprisingly "normal", its radio emission is confined within the central 40 pc.

- Report from Japan by INOUE Makoto

Several new observing systems have been operational, particularly in Universities. We formally participated in the ALMA project and began construction. A space mission is waiting for the launch to the Moon, and the second Space VLBI project has been proposed. The organization system of National Universities and Institutes was largely changed to agencies, and the effects are not yet understood.

The National Committee of URSI publishes and distributes the National Report at every URSI GAs, and the Report of National Commission J is included in it. The report is also seen in the National Commission J web site at <http://vsop.mtk.nao.ac.jp/URSI/CommJJ.html>, which is in the 'Link to National Committees' of the URSI Commission J web site (<http://vsop.mtk.nao.ac.jp/URSI/>).

- Report from Norway by Per B. Lilje

Most of the work in Norway within radio astronomy has concerned space borne CMB experiments, notably development of new data analysis methods for Gaussianity testing, component separation and power spectrum estimation. These methods have been applied to the data from the COBE-DMR experiment and the Wilkinson Microwave Anisotropy Probe (WMAP), and will in the future be applied to the Planck data. Norwegian astronomers have been co-discoverers of anisotropies and

non-gaussianities in the WMAP data that have caused wide interest. Norwegian astronomers have also taken part in the development of the LFI instrument of the Planck satellite. Norwegian chemists have taken part in radio astronomical discoveries of the new interstellar aldehyds propenal and propanal and have studied gas-phase formation of methyl formate in an astrophysical setting. Norwegian physicists have also studied properties of radar echoes from meteor trails.

- Report from Peru by Walter R. Guevara Day

1. Instrumentation and site searching .

Work has started to search for an Astronomical Site for visible, IR and radio bands in the south Peruvian mountains (over 4500 m).

2. Educational.

We (CONIDA and UNMSM) have started lectures about topics in astronomy and radioastronomy at pre-graduate level around our country. We need some help the international institutes for development of radioastronomy in our country with Visiting lecturer program for post-graduate level astronomy and instrumentation.

- Report from UK by Jim Cohen

Double Pulsar:

An international team of scientists from the Jodrell Bank Observatory in the UK and from Australia, Italy, India and the USA have discovered the first double pulsar system (Lyne et al., Science 8 January 2004). Orbiting the 23-millisecond pulsar PSR J0737-3039A is a companion pulsar PSR J0737-3039B, rotating once every 2.8 seconds and orbiting PSR J0737-3039A in only 2.4 hours. The orbit is shrinking by 7mm per day, and the pair will merge in about 85 million years. The double pulsar will allow new high precision tests of general relativity.

e-MERLIN:

Work is well underway on upgrading the MERLIN interferometer network. The telescopes are now connected by dedicated optical fibres which carry a maximum bandwidth of 2 GHz in each of two polarizations from each of the 5 remote telescopes to Jodrell Bank Observatory. The wideband correlator to process the data is being built at Penticton by the National Research Council of Canada and will be delivered in 2006/7.

Professor INOUE Makoto, with contributions from Session Conveners, National Chairs and WG Chairs.