

COMMISSION 50: PROTECTION OF EXISTING AND POTENTIAL OBSERVATORY SITES¹

(PROTECTION DES SITES D'OBSERVATOIRES EXISTANTS ET POTENTIELS)

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1. Introduction

The proceedings of IAU Symposium 196 "Preserving the Astronomical Sky" (Cohen & Sullivan 2001) give a good overview of the scope and the work of Commission 50. Our efforts are directed towards:

- monitoring the conditions at astronomical observing sites;
- controlling unwanted emissions (light pollution, radio pollution, etc.);
- political action to set appropriate technical standards and regulations;
- education and outreach.

This report covers the activities of Commission 50 in the triennium 1st July 1999 to 30th June 2002.

On light pollution matters the Commission works closely with international organizations of lighting engineers such as the CIE (Commission International d'Eclairage), and with organizations of astronomers such as the IDA (International Dark-Sky Association). As recommended by Symposium 196, a new Commission 50 Working Group on Controlling Light Pollution was established in February 2000 under the chairmanship of Malcolm Smith. It has its own website (http://www.ctio.noao.edu/light_pollution/iau50/) and makes its first report elsewhere in these transactions.

In matters concerning radio frequency interference the Commission works closely with IUCAF, the Scientific Committee on Frequency Allocations for Radio Astronomy and Space Science. IUCAF coordinates the radio astronomy input to the International Telecommunication Union (ITU), in particular input to the World Radio Conferences (WRCs) held by ITU, and input to Working Party 7D of ITU-R, which deals with technical studies related to protection of radio astronomy. Commission 50 is also in close contact with the new Division X (Commission 40) Working Group on Radio Interference Mitigation, with the OECD Global Science Forum Task Force on Radio Astronomy and the Radio Spectrum, and with the deliberations of the UN Committee on the Peaceful Uses of Outer Space (UN-COPUOS) on the protection of the space environment.

2. Symposium 196 and UNISPACE III

IAU Symposium 196, 'Preserving the astronomical sky', was a milestone, being the first full IAU Symposium on environmental issues. The meeting was held on 12-16th July 1999 at the Vienna International Centre, as an integral part of UNISPACE III, the third United

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Nations conference on the exploration and peaceful uses of outer space. This conjunction gave the astronomy community its first opportunity to address the United Nations and representatives of the space industry directly on the issue of adverse environmental impacts on astronomy. During Symposium 196 proposals were developed which then went forward to UNISPACE III where they were presented by General Secretary Johannes Andersen.

The Symposium had 70 participants from 25 countries, plus 3 press officers to ensure that the issues were widely publicized. The three main issues considered were light pollution, space debris, and radio pollution. The specific proposals we developed during the Symposium included five recommendations, summarized as follows:

- (a) better protection of quiet frequency bands for radio astronomy, through the International Telecommunication Union (ITU), including protection from transmitters on satellites;
- (b) exploration of new mechanisms to protect selected regions of Earth and space from radio emissions (radio-quiet zones);
- (c) cooperation to ensure that future space activities are subject to an international environmental impact assessment before approval;
- (d) control and reduction of space debris, and
- (e) control of light pollution.

Our proposals were accepted virtually word for word and are included in the Final Report of UNISPACE III (available at <http://www.un.or.at/OOSA/>) as item II of Annex III. This forms a springboard for further work, through the UN-COPUOS, to improve international protection of the astronomical sky and the near-Earth space environment as the cultural heritage of all humankind.

The proceedings of the Symposium were published by the Astronomical Society of the Pacific (Cohen & Sullivan 2001). A meeting report and the table of contents of the proceedings are available on the Commission 50 website.

2.1. Follow-Up Actions in UN-COPUOS

Following the recommendations made at UNISPACE III, the UNO Office of Outer Space Affairs has set up action groups on a number of topics, including the following, for which the IAU has appointed contact persons as listed:

- Mitigation of space debris (Walter Flury);
- International coordination on NEOs (Hans Rickman);
- Minimizing radio interference (Harvey Butcher);
- Enhance capacity building in developing countries (Syuzo Isobe);
- Education opportunities in space science and technology (Peter Willmore).

IAU representatives have made invited presentations to the Scientific and Technical Subcommittee of COPUOS, the UN Committee on the Peaceful Uses of Outer Space, on subjects including interference to radio astronomy from satellites (Klaus Ruf and Jim Cohen), collision hazards from near Earth Objects (Hans Rickman), and obtrusive space advertising (Johannes Andersen).

3. Other Meetings

3.1. Astronomical Site Evaluation in the Visible and Radio Range

An IAU technical workshop was held, in conjunction with URSI, on 13-17th November 2000 in the Cadi Ayyad University of Marrakech, Morocco. The goal of the meeting was to assess the state of the art with regard to astronomical site testing in the visible, IR and radio ranges. There were 120 participants representing 26 nations. A round-table discussion was held to promote the construction of the first Moroccan national astronomical observatory. This meeting led to the creation of an International Scientific Committee. The proceedings

of the colloquium are published as Volume 266 in the *Astronomical Society of the Pacific Conference Series* (Vernin et al. 2002).

3.2. La Serena Conference on Light Pollution

The international conference on light pollution held in La Serena, Chile, on 5-7th March 2002 was a great success, with 132 participants from 12 countries. In addition to light pollution the meeting addressed radio frequency interference and radio-quiet zones (with special reference to the ALMA site), space advertising and aircraft contrail pollution, in both English and Spanish (with full translations). There was strong local interest in the meeting, with extensive coverage in the national media. During the opening ceremony, awards were presented to lighting engineers and local politicians responsible for advances in light pollution control in Chile. Highlights of the meeting included the presentation by Falchi of the *World Atlas of Light Pollution* (Cinzano et al. 2001), plus predictions for the growth of sky brightness over Chile. The meeting concluded that a second edition of the Atlas is essential, despite funding uncertainties.

A full report on the conference, with links to a photo gallery and the presentations, is available at the OPCC website (<http://www.opcc.cl/>), or by clicking on the relevant news item on the Commission 50 website. The proceedings will be published by Kluwer, edited by Hugo Schwarz.

3.3. Summer School: Spectrum Management and Radio Astronomy

One of the challenges facing the radio astronomy community today is a shortage of skilled spectrum managers for radio astronomy, who can function effectively in the ITU circles. In order to address this shortage, a summer school on "Spectrum Management and Radio Astronomy" was held on June 9-14th 2002 at the National Radio Astronomy Observatory in Green Bank, West Virginia, home of the Robert C. Byrd Greenbank Telescope. The school, the first of its kind, was organized by IUCAF. By any criterion, the school was a great success. There were 45 participants from 12 countries: 23 from the USA and 22 from elsewhere. Some 35 formal lectures were presented during the week, and there were also hardware demonstrations by Green Bank staff and a tour of the new telescope and facilities. Details of the Summer School, including most of the Power Point presentations, are available on the IUCAF website (<http://www.iucaf.org/sschool>). The lectures will be compiled into a book, to be printed by NRAO. The intention is to repeat the Summer School on a 3-year cycle and so train the new generation of spectrum managers for radio astronomy.

4. Developments in the International Telecommunication Union

4.1. World Radio Conference WRC-2000

Radio astronomers fielded their largest delegation ever for the month-long World Radio Conference WRC-2000, held in Istanbul in May/June 2000: 16 of the 2,500 delegates were astronomers, about as many as a medium-sized national delegation. Radio astronomy made great gains in the protection of the mm-wave spectrum. As a result, radio astronomy now has primary allocations in most of the spectrum in the three atmospheric windows between 71 and 275 GHz. Currently the ITU does not allocate frequencies above 275 GHz. Radio astronomy usage up to 1 THz is now recognized through a new Footnote 5.565 to the Radio Regulations, while frequency allocations above 275 GHz have been placed on the preliminary agenda for WRC-2006.

WRC-2000 also placed the first limits on unwanted emissions from satellites, which will apply to all new systems from 1 January 2003 and to all systems from 1 January 2012. This is an important first step in providing protection from satellites operating at frequencies close to radio astronomy bands. Studies are continuing within ITU-R Task Group 1/7 on the question of whether tighter limits can be set for specific frequency bands.

4.2. Progress in ITU-R Working Party 7D (Radio Astronomy)

Working Party 7D carries out technical studies which form the basis of input to WRCs. Preparations for WRC-2003 have occupied most time in the current triennium, since radio astronomy could be affected by 8 of the 39 agenda items. In addition WP7D has introduced two new recommendations which deserve note in this report.

Recommendation ITU-R RA.1417, "A radio-quiet zone in the vicinity of the L_2 Sun-Earth Lagrange point," explains the unique scientific advantages of the L_2 point, which is already used for space radio astronomy, and recommends that a coordination zone be established to maintain the naturally radio-quiet environment in the vicinity of the L_2 point.

An important new Recommendation ITU-R RA.1513, "Levels of data loss to radio astronomy observations and percentage of time criteria resulting from degradation by interference for frequency bands allocated to the radio astronomy service on a primary basis", sets out for the first time acceptable levels of data loss for radio astronomy. This information is essential in considering interference from satellites, which may, on rare occasions, pass directly through the main beam of a powerful radio telescope. Unwanted emissions from satellites can block the quiet frequency bands allocated for radio astronomy, compromising their usefulness for front-line research.

A disturbing development in the past three years is the trend for large-scale attendance at WP7D meetings by representatives of industry (satellite operators, aircraft corporations, etc.). For example, at the February 2002 meeting of WP7D there were 50 delegates, only 12 of whom had ever used a radio telescope. It is difficult to believe that the outcome of such a meeting can truly reflect the views of the radio astronomy community. This trend poses a threat to the ITU itself, which is in danger of being overwhelmed by multinational companies arguing for the introduction of new radio systems without due regard for existing users of the radio spectrum. In this climate it is vital that the radio astronomy community takes up the challenge and increases the resources it devotes to frequency protection matters and spectrum management.

4.3. Regulation of the Optical/IR Spectrum?

Within the ITU there are moves to claim jurisdiction over the entire electromagnetic spectrum, as far as telecommunications go. Specifically, a US-led group of countries has proposed to delete the upper frequency limit for the ITU terms of reference. The reason for this is the development of optical and infrared laser communications systems for intersatellite and satellite-to-ground links. Some of these links are already operational, and some astronomers already plan to use the technology to bring back large amounts of data from future space missions (Bland-Hawthorn et al. 2002). The preferred sites for ground stations (to down-link to) are on high, dry mountains, preferably with mains services and vehicular access (which astronomers may well have provided).

This threat is not something which can be ignored! There is no doubt that the lasers will be used, so it is best that their use be regulated. If this is done through the ITU then there is the possibility to protect particular frequency bands and to provide protection to given power flux densities at designated optical and IR observatories, as has been done for radio astronomy. It will be necessary for IAU to provide the necessary technical experts to partake in relevant ITU studies. A meeting has been convened for the 25th General Assembly to address this matter.

5. OECD Task Force on Radio Astronomy and the Radio Spectrum

The new generation of mega-instruments for radio astronomy, such as the Atacama Large Millimetre Array (ALMA) and the Square Kilometer Array (SKA), will bring major increases in sensitivity and will of necessity operate in some frequency bands not officially allocated for radio astronomy. In order to ensure that these new instruments achieve their

full potential, we need to find new ways to minimize the impact of growing levels of man-made radio interference. The problem needs to be tackled on several levels.

As discussed at Symposium 196, a new internet site was created specifically to discuss the technical challenges of making radio astronomical measurements in the presence of other radio signals (<http://www.atnf.csiro.au/SKA/intmit>).

Recognizing the particular threat posed by radio transmitters on satellites, the Organization for Economic Cooperation and Development (OECD) established a high-level Task Force "to map out a strategy for ensuring the future of radio astronomy while allowing for the continued vigorous growth of commercial space-based telecommunications." The terms of reference of the Task Force include the following items:

A. Technological solutions: Radio astronomers and industry representatives could identify and jointly implement interference mitigation schemes.

B. Regulation: If new, innovative ways of sharing the radio spectrum are to be found, the appropriate discussions must begin soon within national agencies and the ITU, as the implementation of new regulations usually requires a considerable amount of effort over several years.

C. Radio-quiet zones: Remote areas on the Earth's surface could be designated where future radio observatories could be located, and where radio emissions, especially from spaceborne and airborne sources, would be restricted in frequency and time. The technical, regulatory, and legal dimensions of this concept would have to be carefully examined.

The report of the Task Force, which should be published late in 2002, is expected to recommend the early identification of a small number of sites for international radio-quiet zones.

6. Future Work

Since the first gas lights went on in nineteenth century London, astronomers have been in retreat from advancing technology, building their telescopes in ever more remote places. At the start of the twenty first century we are running out of places to hide. We have found superlative observing sites in Northern Chile and elsewhere, but we now need to devote significant resources to protecting them for the future. It is remarkable what has already been achieved, considering the small number of people involved. The Norma Luminica (Chilean Lighting Guideline) established by President Frei on 1st October 1999 is an important step in environmental legislation. Likewise the site protection that is being put in place at the ALMA site on Chajnantor. But activity and awareness among astronomers themselves must also increase. An urgent priority for myself and my successor is to raise the profile of the work of our Commission and in particular to raise its membership. As a guideline, 2% of the IAU membership coopted into Commission 50, and 2% of observatory budgets devoted to site protection, would handsomely improve on the current situation and would give astronomy a better future.

R. J. Cohen

President of the Commission

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