EUROPEAN SCIENCE FOUNDATION

28 CRAF News

The newsletter of the ESF Expert Committee on Radio Astronomy Frequencies

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Editorial

In April this year I attended the Fourth Spectrum Management School in Santiago, Chile. It was the first time that I had attended the school and, although I have been active in the field of spectrum management for a couple of years now, I learned several interesting things. There was considerable interest from Chilean participants, and at the end of the School I was invited by some of them to visit the Astronomy Department of the University of Chile in Santiago, where they have a small laboratory for developing instruments for radio astronomy. They were very proud to show that they were introducing techniques into Chile for the development of their instruments, which were not available in their country as yet. They saw it as their duty to make these techniques available in Chile for the benefit of the whole country by training students and engineers. Of course, they want to do science with the instruments they develop. Once again, this shows that radio astronomy is of value for many countries and provides a strong motivation to continue to protect the radio astronomy bands.

Sensitivity is one of the key parameters for radio astronomy. According to the sensitivity equation the threshold power of detectable sources is proportional to the system temperature, inversely proportional to the receiving device's signal collecting area and inversely proportional to the square root of the integration time and measurement bandwidth. Current technology has approached the lower limits of system temperatures, which are dictated by the laws of physics. The SKA will have a huge signal collecting area to achieve a high sensitivity, but for existing telescopes this is fixed. So, to improve the sensitivity of current telescopes, only the integration time and the measurement bandwidth can be increased, although for those radio sources whose flux densities vary over very short timescales, it is not possible to increase the integration time, so the only option is to increase the bandwidth. Consequently, radio astronomers are trying to use larger and larger bandwidths, even outside the frequency bands allocated to radio astronomy. The risk of interference increases considerably with this, which makes the receiver designs more challenging, and, because of the pressure on the spectrum from all kinds of services, it is very unlikely that radio astronomy will be allocated more spectrum to accommodate these larger bandwidth observations.

Cover
ALMA telescopes during a maintenance period.
Credit: Rob Millenaar

Currently being discussed and investigated is the future allocation of spectrum to devices that can sense their environment and select their transmit frequencies, based upon their location and environment. Radio astronomy, as a passive service, is especially vulnerable to such devices and care has to be taken that these devices are regulated properly.

CRAF is very pleased to announce that in the middle of March this year, a new Frequency Manager, Talayeh Hezareh, was appointed. She started to work for CRAF at a very busy time and has already attended a large number of meetings covering several issues during the first three months of her appointment. I am very happy that Talayeh was prepared to be our frequency manager and I wish her a lot of success working with our CRAF members in protecting the radio astronomy bands.

Hans van der Marel, *CRAF Chairman*

The new Frequency Manager

CRAF welcomes Dr Talayeh Hezareh from the Max-Planck-Institut-für-Radioastronomie (MPIfR) in Bonn, Germany. Talayeh started her undergraduate studies in 1997 in physics at the Sharif University of Technology in Iran. As a student, she became head of the university's amateur astronomy group and organised public star gazing nights, astronomy lectures, and various activities such as astrophotography of the night sky. The group observed the total solar eclipse of 1999 and also meteor showers, providing a detailed report of the Perseid meteor shower observations of 1998-99 to the international meteor organization (IMO). Talayeh submitted her bachelor's (B.Sc) thesis based on the data analysis of the observations that she carried out in 2002.

She moved to Canada in 2003 to study for higher degrees, completing a master's degree in experimental solid state physics in 2005 at Brock University. For her thesis, she worked on piezoelectric materials and their application in pressure sensors.

She then switched to what she considered to be her "dream field" – astronomy – and began working on the role of magnetic fields in star forming regions as part of her studies for a PhD at the University of Western Ontario in Canada. This involved both observational and instrumentation projects in addition to the data processing and analysis, and astronomical interpretation of her results, which are a part of most if not all astronomy PhD theses nowadays. Her thesis was nominated for the Plaskett medal, a prize for the most outstanding doctoral thesis in astronomy or astrophysics in Canada in the preceding two calendar years. After graduation in 2010, she moved to Germany to start a postdoctoral position as an Alexander von Humboldt research fellow at MPIfR, continuing her research into star-forming regions and their associated magnetic fields until early 2014, when she became CRAF's new frequency manager. She is still based at MPIfR and, although trying to maintain interest in some research projects with former colleagues from time to time, her main focus is very much the protection of the frequency bands used for radio astronomy observations from harmful interference.

ERATec Bonn 2013

Radio Interference with Large Bandwidth Observations

Communication, training and scientific interaction between engineers and scientists involved in the development and operation of radio astronomical instruments represent a key issue in keeping these facilities at a world class technical level. The Technical Workshop, held in Bonn, Germany, in the week from 8 to 12 April 2013, which was sponsored by RadioNet3 (see below), brought together developing engineers, technical operators and observing astronomers. There were two days of general talks on Radio Frequency Interference (RFI) related issues, which are of fundamental interest for the entire community, followed by three days of more specific meetings for individual groups. The workshop was attended by 74 participants from 19 countries. The RFI presentations from the meeting can be found at: http://www.radionet-eu.org/radionet3wiki/doku.php?id=na:eratec:eratec_joint_workshop_2

The workshop treated several topics across the broad spectrum of problems of RFI in high-sensitive, radio-astronomy observations. After welcome addresses by the RadioNet3 project scientist, Franco Mantovani, and the European Radio Astronomy Technical Forum (ERATec) Chairman, Reinhard Keller, a set of talks provided an overview of spectrum management for radio astronomy and RFI monitoring measurements, as well as mitigation strategies. The rest of the day was dominated by talks on RFI measurements and related instrumentation. The second day was mainly dedicated to RFI mitigation

and bookkeeping of measured data in related databases. The latter dominated the vivid forum discussion at the end of the workshop, during which the privacy problem of measured data arose. In this context we have to distinguish between a database to keep the protected bands clean and a database of local spectral occupancy at the different observatories. It was especially during this discussion that the interdisciplinary approach of the Technical Workshops became obvious. Being a platform for engineers, technical operators and observing astronomers, the various views of the different groups could be presented and immediate clarifying responses were possible. At the end, a wish for a RFI database workgroup was expressed. This workgroup would be composed of representatives of the three involved groups, which should again provide an enormous increase of efficiency through the maximum exploitation of complementary capabilities among the groups and their observatories of origin. This may be an excellent example of how the pooling of resources can lead to common solutions for common problems. Another example of best practices was identified and shared, notably the creation of a RFI archive for the European radio observatories.

RadioNet3 (http://www.radionet-eu.org/) is a project supported by the European Commission under the 7th Framework Programme (FP7), which builds on the success of two preceding RadioNet projects, but also takes a leap forward towards the facilities of the future (such as ALMA and the SKA). The meeting described above was supported by ERATec, which is one of the networking activities within RadioNet3. The main activity of ERATec is to organise and support meetings and workshops of European radio astronomy staff directly involved in the technical development of the observing facilities and their application. The next TWS (this time on Antenna Metrology) will take place in Gothenburg 1-2 September (http://www.ira.inaf.it/eratec/gothenburg/). There will be a TWS during 2015 but there are no plans for that yet.

Michael Lindqvist

IUCAF Spectrum Management School, Santiago de Chile

7-11 April 2014

The Joint ALMA Office in Santiago hosted the 4th IUCAF School on Spectrum Management from 7 to 11 April 2014. This school, organised by a scientific committee led by IUCAF chairman, Masatoshi Ohishi, and a local organising committee led by Tom Gergely, was sponsored by the NSF, IUCAF, CORF, CRAF, Radionet and RAFCAP. The adjacent weekend offered the possibility of a visit to the ALMA observatory in the Northern part of Chile.

The School was attended by 36 participants from 13 countries in five continents. The strategy to hold such a school in a fairly remote place such as Chile was rewarded with 11 participants from South-America. In the introduction to the school the IUCAF chairman remarked that "our success in spectrum management is invisible", meaning that considerable effort is necessary in order not to suffer from the "visible" interference in our observational data.

The organisers see an efficient spectrum management as critical for the future of radio astronomy. Hence, the purpose of the school was to provide the next generation of scientists, engineers and administrators with the skills required for scientific motivation and diplomacy, and give them appropriate technical background and legal knowledge, which is normally not taught as part of a science curriculum. Only with a dedicated application of skills to spectrum management will new discoveries via observations using the radio spectrum be enabled. The IUCAF Spectrum Management School 2014 was conducted by 21 experts in this field, having a very considerable level of experience. In recognition of the facilities based in the hosting nation, special emphasis was given to millimeter-wave technologies and its related spectrum issues.

The School presentations during the first two days covered the technical aspects and during the second two days the administrative aspects of spectrum management with the following topics:

- Radio Astronomy Techniques and Observations
- Units and working with numbers
- Earth Remote Sensing & Space Radio Astronomy Observations
- Spectrum: Frequency Allocation, Bands and Uses
- The International Telecommunication Union (ITU) and other Regulatory Agencies
- Recommendations, Reports and Notification

Figure 1. Lecturers and participants of the IUCAF Spectrum Management School 2014 in front of the Joint ALMA office.

- Radio Science & Technology
- Antennas, Propagation, Receivers, Backends
- Interference to Radio Astronomy
- Interference and mitigation techniques
- International, National and Regional Regulatory Structures
- Coordination with other Radio Services
- RFI from New Technologies and Unlicensed Devices
- New Frontiers in Spectrum Management
- The submm/TeraHertz regime, Radio Quiet Zones and SKA

The School finished with a workshop / discussion on spectrum sharing. This is an issue of great concern to radio astronomers, instigated in the US by a 2013 presidential memorandum, in which economic growth is seen as equivalent to the increase of communication capabilities (i.e. requiring more electromagnetic spectrum availability). Unfortunately this policy is also being adopted in some other (emerging) countries. Our US colleagues are being forced not only to defend their usage of the spectrum for science against commercial interests, they even have to provide a concept of a coexistence of radio astronomy sites with upcoming services. So far no rules or regulations relating to sharing of frequencies have been established. New technologies have to be devel-

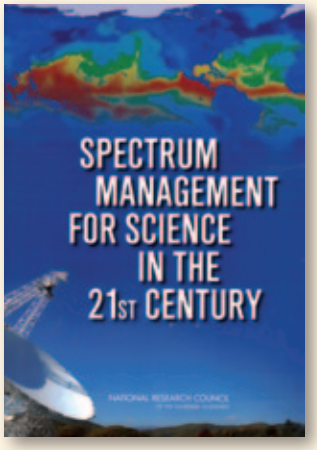
oped. Fortunately, in many other developed countries radio astronomy frequencies are being respected by the national authorities and are not being discussed for sharing. It is hoped, that most countries will not follow the US example. The future will show whether "sharing means giving up" – or not. At the moment there is a very urgent task for the defence of radio astronomy interests to find a clear position globally.

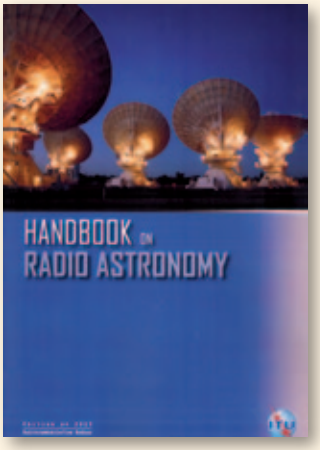
The IUCAF School in 2014 was important and useful not only for those new to radio astronomy, but also for the senior experts. A number of very well prepared presentations[1] were given. Such a school is an ideal place for anybody who wants to learn about spectrum management for radio astronomy and Earth sciences.

Two handbooks have been made available to the participants of the IUCAF-School 2014. Both are an essential resource for further insights into why spectrum management is important, and how it is done.

1. ITU-R: Handbook on Radio Astronomy
2. Spectrum Management for Science in the 21st Century

Hayo Hase





Cognitive Radio and White Space Devices – Part 1

Spectrum – a valuable commodity

During the last few years it has been recognised by many governments and commercial organisations that spectrum is a very valuable financial commodity. In endeavouring to follow the US, the UK Government Department for Culture, Media and Sport, which is responsible for communications, has recently issued a document entitled "The UK Spectrum Strategy, Delivering the Best Value from Spectrum for the UK". From the title alone, one can quickly see that the main thrust of the document is making money out of spectrum, and it rapidly becomes clear that what is of real importance is 'How much money can the sale and licensing of spectrum contribute to the UK Treasury?'. There is a forward to the document by the Minister for Culture, Communications and Creative Industries, who is responsible for the Department, in which he points out that spectrum is already worth over 50 billion pounds per year to the UK economy. He goes on to say that the UK policy for spectrum use is aimed at doubling its annual contribution to the UK economy (i.e. to a value of over 100 billion pounds per year) by 2025! This may not be so easy since the amount of spectrum available is finite and most of it is already in use or at least allocated. In fact, as is known only too well from the current major threats to the radio astronomy bands, as seen from the Agenda Items for the next World Radio Conference in 2015 (especially AI 1.1), commercial companies are almost falling over themselves to gain access to as much spectrum as possible. So, people like the UK Minister are starting to say that if everybody shares spectrum and releases it for use by others at any time that they are not using it (i.e. stop transmitting so that the band appears to be unoccupied), then this represents a greater efficiency of its use and, of course, more money from more users. At the end of his first introductory paragraph, the UK Minister refers to new techniques which will enable spectrum to be shared, and I quote "so that we can squeeze more value from it". Later in the document – section 5.8 – it says "The concept of owning a particular piece of spectrum in a given region for your exclusive use will thus no longer be the main way of operating". Not surprisingly, this has generated very many emails from radio astronomers from around the world expressing considerable alarm. They are very much aware that there is no possibility of sharing the passive bands or for further sharing those which are already shared with commercial companies with fixed licences on a co-ordination basis. Clearly, in the vicinity of radio telescope observatories, the bands allocated for use by radio astronomers and the Earth Exploration Satellite Service (EESS) on a purely passive basis should always be empty or unoccupied.

1. http://www.atnf.csiro.au/people/Tasso.Tzioumis/sms2014/presentations/

Cognitive Radio – what is it?

So what has this to do with Cognitive Radio. Well, a lot. According to one definition, Cognitive Radio (CR) is a form of wireless communication in which a transceiver (i.e. a device capable of transmitting and receiving, such as a mobile phone) can intelligently detect which communication channels are in use and which are not, and instantly move into vacant channels, thus avoiding occupied ones. In other words a Cognitive Radio is an intelligent radio with software-controlled hardware that can enable the system to be configured dynamically to use any part of the communications spectrum in which it doesn't find anybody else transmitting at any given time – obviously an apparently efficient means of sharing the spectrum, but on a first come basis, and what about the passive bands, the bands that should be free of all transmissions? One could say that dynamic spectrum access optimises the use of the available radio-frequency spectrum, whilst perhaps minimising interference to other users, but that is far from certain. One feels that whoever manages to gain access to a part of this spectrum will just continue to transmit forever (perhaps just rubbish) so that they always have access to the spectrum channels whenever they want them!!

The passive and other bands used for radio astronomy as defined in Footnotes 5.340 and 5.149 to the radio regulations should be always unoccupied in the case of 5.340 bands and every effort made by administrations to keep them unoccupied in the vicinity of radio observatories in the case of 5.149 bands.

Some form of administration will need to be put in place to ensure that they remain unoccupied, but is this always possible even assuming that Cognitive Radio systems are only officially allowed to operate at frequencies away from those defined in the above footnotes. Could the software in a cognitive radio system be hacked so that it checks for transmissions in unauthorised bands, such as the radio astronomy bands, which it would then find to be quiet and would then start transmitting? We hear almost every week of new computer software viruses and systems being 'hacked' just for the fun of it. The annual costs of this can run into billions of pounds / dollars.

We are all aware of equipment failures that can result in spurious transmissions into bands occupied by other users. One might say that this can already occur at the present time, but the added problem with a Cognitive Radio system is that one minute there can be interference within somebody's band, and the next it has disappeared because the Cognitive Radio system has changed its operating frequency – the source of interference could be very difficult to find. The UK Spectrum strategy document view, that at some time in the future, all spectrum will probably have to be shared also seems to be a very dangerous philosophy. On 5 March 1969 Prinair Flight 277 (a De Havilland Heron), on approach to San Juan airport in Puerto Rico, crashed into a mountain some 14 nautical miles from the airport, killing all 19 persons on board (17 passengers and 2 crew members). Although, according to the subsequent enquiry, the main cause of the crash was because of an air-traffic control error, this error probably resulted from (as it says in the report) "a stress producing and very irritating element" in that pilots of many other aircraft in the vicinity were complaining almost constantly to the air-traffic controller about interfering transmissions by somebody else transmitting in the same frequency band as the controller. It is beginning to sound like a major administrative task and not so easy to allow people to simply start transmitting in any band allocated for communications that they find vacant, and certainly the first 'commercial' systems currently being tested have not really solved the administrative problem as originally envisaged.

Peter Thomasson & Howard Del Monte

The European Science Foundation hosts six Expert Boards and Committees:

- The European Space Sciences Committee (ESSC)
- The Nuclear Physics European Collaboration Committee (NuPECC)
- The European Marine Board (EMB)
- The European Polar Board (EPB)
- The Committee on Radio Astronomy Frequencies (CRAF)
- The Materials Science and Engineering Expert Committee (MatSEEC)

In the statutory review of the Expert Boards and Committees conducted in 2011, the Review Panel concluded unanimously that all Boards and Committees provide multidisciplinary scientific services in the European and in some cases global framework that are indispensable for Europe's scientific landscape, and therefore confirmed the need for their continuation.

The largely autonomous Expert Boards and Committees are vitally important to provide in-depth and focused scientific expertise, targeted scientific and policy advice, and to initiate strategic developments in areas of research, infrastructure, environment and society in Europe.

Committee on Radio Astronomy Frequencies (CRAF)

CRAF is an Expert Committee of the European Science Foundation. Established in 1988, it represents all the major radio astronomical observatories in Europe. Its mission is to coordinate activities to keep the frequency bands used by radio astronomers in Europe free from interference.

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