

Radio Astronomy in the European Regulatory Environment

R. J. Cohen

*University of Manchester, Jodrell Bank Observatory, Macclesfield,
Cheshire SK11 9DL, UK*

Abstract. European radio astronomy has major world-class facilities which operate successfully in a hostile electromagnetic and economic environment. In 1988 the Committee on Radio Astronomy Frequencies (CRAF) was established under the auspices of the European Science Foundation, 'to keep the frequency bands used for radio astronomical observations free from interference'. Coordination of the European efforts through CRAF adds value through the sharing of expertise and information. Having one recognized voice for European radio astronomy also gives us strength. For example, the agreement concluded with Iridium LLC offered radio astronomy significant concessions compared with agreements reached elsewhere in the world. As Europe moves towards harmonized use of the radio spectrum, CRAF members participate in the discussions alongside representatives of governments and industry, to ensure that radio astronomy will have a secure future in Europe. This paper gives an overview of the European regulatory environment and the ways in which CRAF is working to protect radio astronomy.

1. Introduction

This paper describes some of the interference issues for radio astronomy in Europe and the work of the Committee on Radio Astronomy Frequencies (CRAF), of which I am Chairman. In Europe we have a very diverse collection of radio telescopes. Altogether there are 40 radio observatories in 17 countries. Figure 1 shows the locations of most of them.

All types of antenna and array configuration are here, and all radio astronomy frequency bands are covered, from 10 MHz up to 275 GHz, beyond which there are no international frequency allocations, either to radio astronomy or to any other radio service.

The European facilities are characterized by large collecting area and high sensitivity at all radio wavelengths. There are decametric and decimetric arrays at Nançay, Medicina and Cambridge, large reflectors for centimetre wavelengths at Effelsberg, Jodrell Bank, and Nançay, the large millimetre wave dish at Pico Valeta, the MERLIN and Westerbork arrays for aperture synthesis imaging at centimetre waves, the Plateau de Bure interferometer for millimetre-wave aperture synthesis, and the European Very Long Baseline Interferometer Network (EVN). The Joint Institute for VLBI in Europe (JIVE) operates the world's fastest VLBI correlator, designed for data rates of up to one gigabit per second.



Figure 1. Locations of radio observatories in Europe.

Radio telescopes and people are crowded together in Europe as nowhere else on Earth. This presents us with particular regional problems and challenges. A good example is the use of television channel 38, at 606-614 MHz. Some European countries such as the UK use the frequency band for radio astronomy. For example, at Jodrell Bank Observatory the band is used continuously for pulsar timing, and periodically for VLBI. Other countries use the band for television broadcasting, most recently digital TV. Sharing studies show that 600-km separation is needed between a typical TV transmitter and a radio telescope if interference to radio astronomy is to be at an acceptable level. In European terms this is a big coordination zone. For example, a 600-km radius around Vienna includes 10 countries outside of Austria (namely Hungary, Italy, Czechia, Slovakia, Ukraine, Romania, Yugoslavia, Switzerland, Poland, and Liechtenstein), each with its own laws and uses of the radio spectrum. How can radio astronomers deal with this and keep channel 38 clear for astronomical use?

CRAF was founded in 1987 because radio astronomers saw the need for a body to defend radio astronomy in regional interference issues such as that of TV channel 38. The first chairman was Hans Kahlmann of the Netherlands Foundation for Research in Astronomy (NFRA). The CRAF Secretariat and 'clearing house' were also established at NFRA. From these beginnings CRAF has developed to become the voice of radio astronomy within the European radio regulatory arena.

2. The European Environment

The countries of Europe are small and politically diverse. In order to coexist and to make efficient use of the radio spectrum they are having to harmonize their use of radio frequencies and set tight standards for electromagnetic compatibility. The European Common Market policy means that there should be free circulation of equipment and mutual recognition of standards and licences. There is rapid technical and political change. There are many pan-European bodies, each with different powers.

The European Commission (EC) sets policy based mainly on political and commercial considerations. Directives and decisions of the European Union are binding on member states. Radio astronomy is not a big player in this market-driven forum. The recent EC Green Paper on Radio Spectrum Policy sets out broad strategy for commercially exploiting the radio spectrum. The radio spectrum has become a scarce resource, and pressures are growing to manage it in a way which reflects its market value. As part of the consultation process, CRAF has drawn the attention of the EC to the value of non-commercial use of radio and has asked for a policy on defective space systems.

The Conférence Européen des Postes et des Télécommunications (CEPT) is the body of 43 member countries which has to work through the technical issues flowing from policy decisions. This is the forum where radio astronomers can make an impact. The CEPT has a complex hierarchy, with a permanent secretariat, the European Radiocommunications Office (ERO), and three permanent committees of which the European Radiocommunications Committee (ERC) is the most important for radio astronomy. In particular, the ERC prepares common European positions for the World Radio Conferences (WRCs). The ITU rule of "one member one vote" gives the CEPT considerable leverage at WRCs. European Common Proposals to a WRC coming from a block of 43 countries carry great weight.

Working groups and project teams within the ERC carry out detailed technical studies and produce reports which lead to ERC decisions. Radio astronomers are active in Working Groups SE (spectrum engineering) and FM (frequency management). Project team SE21, for example, deals with spurious emissions and prepares European contributions to the work of the ITU task group TG1/5. Project team SE28 deals with mobile satellite issues, such as the introduction of Iridium and Globalstar into Europe. Project Team FM33 has been looking at new allocations for passive services at frequencies above 71 GHz, in preparation for WRC-2000. Radio astronomy is represented in these project teams by CRAF members who work alongside representatives of government, industry, broadcasting, and science. ERC decisions and recommendations, however, are not mandatory for the CEPT countries.

The European Telecommunications Standards Institute (ETSI) sets European standards for new equipment. ETSI is an open-forum organization with about 700 members from 50 countries, representing administrations, network operators, manufacturers, service providers, and users. CRAF needs to be aware of developments within ETSI, and may comment on the impact for radio astronomy through national administrations. Coordinated action through CRAF stands a much bigger chance of influencing standards than actions taken by individual astronomers in isolation.

3. CRAF Activities

CRAF was established as the regional body to deal with European interference issues, and to coordinate the efforts of individuals at European observatories. The first meeting of CRAF was held in Paris in 1987. This was an open meeting of radio astronomers who were concerned at growing levels of interference to their observations, and who wanted to do something about the situation. Interference problems can be local (such as a nearby radio link), regional (such as television broadcasting in channel 38), or global (such as global satellite systems). Each problem needs to be tackled at the appropriate level.

In 1988 CRAF became an associated committee of the European Science Foundation (ESF). CRAF's mandate is 'to keep the frequency bands used for radio astronomical observations free from interference'. Under the ESF umbrella CRAF has published a Handbook for Radio Astronomy, already in its second edition (1997). The ESF has ensured wide publicity and a wide circulation for the CRAF Handbook (which is available free on request).

Since 1997 CRAF has had a full-time Frequency Manager for European Radio Astronomy, Dr. Titus Spoelstra of NFRA, who has also served as Secretary since CRAF began. The position is funded by CRAF member countries and observatories. The availability of a full-time professional has greatly strengthened our efforts, and has allowed CRAF's voice to be heard in many new fora.

Today, CRAF has 24 members from 17 countries. We meet two or three times per year, and also have teleconferences. Most of our work is carried out between meetings, communicating by email and correspondence. There is a CRAF web-site (<http://www.astron.nl/craf>), with an electronic newsletter. The CRAF Newsletter is read by people from government and industry, as well as by radio astronomers. Via the Newsletter CRAF is able to publicize issues such as that of the TEX Satellite, which was for many years an unknown source of interference to radio astronomy at 328 MHz, a frequency not even allocated to satellites (CRAF Newsletters 1996/3 and 1998/2, on the CRAF web site).

CRAF's remit has broadened beyond radio astronomy to include aeronomy, geodesy and the European Incoherent Scatter Scientific Association EISCAT, which can all face similar interference problems in reception. The CRAF network allows us to share information and coordinate our efforts. Having a single voice for radio astronomy in Europe gives us a strong bargaining position, which is recognized within the CEPT and its working groups.

CRAF also maintains close working relations with the other regional body, the Committee on Radio Frequencies (CORF) in North America, and with the global "action group" IUCAF. Like IUCAF, CRAF now participates in ITU activities as a sector member, entitled to submit papers and speak at conferences, but not to vote. CRAF has taken the lead on several key issues within ITU, such as the protection requirements for millimetre-wave astronomy. This work included a collaboration with industry (European Space Agency and Oerlikon-Contraves) on techniques for fabricating millimetre-wave filters (Natale et al. 1998). CRAF has also held workshops to discuss the issue of defining an acceptable percentage of time lost to radio astronomy through interference, and has produced input documents to the ITU on this matter. Finally, and most importantly, CRAF takes a strong lead on presenting the radio astronomy position for WRCs to the European administrations.

4. CRAF and Iridium

A topical illustration of CRAF's work is the negotiations recently concluded with Iridium LLC (Abbott 1998, 1999). Iridium is the first of a new generation of mobile satellite communication systems. Unfortunately the frequency band chosen for the Iridium downlink to subscriber terminals is very close to the frequency of the hydroxyl (OH) spectral line at 1612 MHz. This poses the threat of interference to radio astronomy from the unwanted emissions of the Iridium satellites, so-called radio smog (Schenker 1999). The potential danger was recognized as early as 1991, when Iridium and Motorola personnel visited Jodrell Bank. They were referred to CRAF and the CEPT, as this was clearly not a local UK problem.

Technical studies on the impact of Iridium in Europe were conducted within the ERC project teams SE17 and SE28, which looked at many sharing issues: sharing with military radars in Sweden, with tactical point-to-point communications links used by NATO in Germany, with the Russian Global Navigation Satellite System GLONASS, with the INMARSAT satellite communications via geostationary satellite, and of course with radio astronomy. The technical studies reached deadlock over the issue of protecting radio astronomy. Iridium could not guarantee to keep the unwanted emission levels of its satellites below the interference thresholds for radio astronomy given in the ITU-R Recommendation RA.769-1. Furthermore, they claimed that radio astronomy did not really need this protection level. They proposed a series of mitigation factors and techniques, all of which were rejected by CRAF. Iridium clearly felt in a strong position at this time, having reached a time-sharing deal with US astronomers. However, the 4 hours per night agreed in the USA was totally inadequate to the needs of European radio astronomy, where some facilities spend up to half their observing time at 1.6 GHz.

In 1997 direct negotiations began between CRAF and Iridium, under the auspices of the Milestone Review Committee of the ERC, to try to reach a compromise deal. The discussions were difficult and often hostile. The tactics of big business were brought to bear, along with corporate lawyers, and CRAF was glad to be able to call on the services of the ESF legal advisor. Under great pressure agreement was reached to give radio astronomy full protection for part of the time. Until 2006 there would be full protection to ITU levels for 7 hours per day and 2 whole weekend days per month, plus protection to an intermediate level for all other weekend days. Furthermore from 2006 there would be no need for operational restrictions on either side. In the interim period there was a work plan to study the use of mitigation factors at the radio astronomy observatories, as well as suppression or prevention of unwanted emissions at the satellite transmitters. The complete text of the agreement is published on the CRAF web pages.

The Iridium case shows the need for radio astronomers to fight together. Iridium tried many ways and many times to destroy our unity, making approaches to individual observatories and administrations in order to circumvent CRAF. Our persistence was rewarded in that achieved a deal which was less damaging to radio astronomy than the deals struck elsewhere in the world. It is also legally binding in Europe. My hope now is that the mitigation factors don't come back to haunt us in the future.

5. Summary

At the turn of the millenium CRAF has unique opportunities to influence events to secure a good future for radio astronomy in Europe. As Europe works towards harmonized frequency use and standards we are making a place for radio astronomy. We are registering the radio observatories and their frequency requirements in the European database of spectrum usage. We are explaining, which usually means defending, our protection requirements and interference thresholds, and we are carrying out technical studies and interference assessments within the CEPT working groups and project teams and elsewhere, based on the ITU protection criteria. Now is the time to state our requirements clearly, or active services will simply dictate to us what we are getting. Our experiences with Iridium have amply demonstrated the advantages of having a single voice for European radio astronomy.

It is very important that CRAF participates directly in the European preparations for WRCs. We can thereby influence the CEPT position, which counts for 43 votes at the conference. Incidentally, WRC-2000 will be the first WRC at which European radio astronomers can register as CRAF delegates. We have already had CRAF delegates to ITU Working Party 7D (radio astronomy) and Task Group 1/5 (unwanted emissions).

Finally, through our umbrella organization the ESF, we have new links to explore outside the telecommunications community. It is in the wider arena that our arguments need to be carried, not just within the confines of the specialist working groups and committees, but with the entire scientific community, as well as with the educated public.

References

- Abbott, A. 1998, *Nature*, 394, 607
Abbott, A. 1999, *Nature*, 399, 513
CRAF Handbook for Radio Astronomy, 2nd edition 1997, European Science Foundation: Strasbourg
CRAF web pages <http://www.astron.nl/craf>
Natale, V., Tofani, G., Tomassetti, G., Dainelli, V. & van't Klooster, C. G. M., 1998, in Proceedings of the 12th International Wroclaw Symposium on Electromagnetic Compatability, J. Janiszewski, W. Moron & W. Sega, pp.621-624
Schenker, J. L. 1999, in *TIME Magazine International*, vol. 154, No. 2, p.112