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Radio Spectrum Management Review,
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Response to the Independent Spectrum Review of Radio Spectrum Management on behalf of the UK radio astronomy community.

1. Background

Radio astronomy began in earnest at the end of the Second World War. The UK has played a leading role in the subject since those early days. The Cambridge radio astronomy group pioneered interferometry and pulsar research, resulting in Nobel prizes for Sir Martin Ryle and Tony Hewish. Today the Ryle Telescope continues to do front-line research in conjunction with the Very Small Array (VSA), a compact interferometer specially designed for high sensitivity studies of the cosmic microwave background radiation. The VSA operates in Teide Observatory, Tenerife, as a UK-Spanish collaborative project.

The 250-ft Lovell Telescope, completed at Jodrell Bank in 1957, was for many years the largest fully-steerable radio telescope in the world, and even today there are only two bigger. The Lovell Telescope is currently undergoing a major upgrade, including new surface panels to give the dish better performance at higher frequencies. The MERLIN interferometer network based at Jodrell Bank Observatory is a unique array for subarcsecond imaging, producing radio images sharper than those produced by the Hubble Space Telescope. The MERLIN telescopes regularly participate in Very-Long Baseline Interferometry (VLBI) experiments, as part of global networks which achieve the sharpest images of any branch of science, at angular resolutions down to tens of microarcseconds (approximately the angle subtended by a golf ball on the Moon). Funds are currently being sought to upgrade MERLIN to E-MERLIN, in which a tenfold increase in sensitivity will be achieved by linking the telescopes using optical fibres.

Today the Particle Physics and Astronomy Research Council spends approximately 8M pounds on ground-based radio astronomy, including the UK facilities mentioned above, plus the James Clerk Maxwell Telescope on Hawaii, which is the world's largest submm-wave telescope. The facilities based in the UK take 70% of this budget. The UK has recently joined the ALMA project, a largescale new facility for mm-wave interferometry which is being constructed in Chile.

Radio astronomy has no obvious commercial product, but contributes in many ways to society. The scientific results are published in the literature and freely available to all. The research produces a steady stream of highly skilled young people with problem-solving skills, who go on

to diverse careers in science, industry, the public sector and the financial sector. Jodrell Bank Observatory also runs a Science Centre which attracts over 100,000 visitors each year, including 40,000 school children. This testifies to the strong and continuing interest that the general public has in our research and the fundamental questions addressed by astronomy.

2. Frequency Bands Needed for Radio Astronomy

The cosmic radio emissions studied by astronomers are extremely faint and often have the character of random noise. Radio astronomy therefore needs quiet frequency bands in which to operate successfully. We have no control over the power of the cosmic emissions or their frequency. The International Telecommunication Union has allocated about 2% of the spectrum below 50GHz to radio astronomy. The frequency bands are set in by the laws of nature. One third of the allocations are purely for passive use, shared with passive remote sensing and earth observation. It is in the UK's interest to maintain these passive bands unpolluted, so that reliable data can continue to be obtained about UK weather, resources, land use, etc. The remaining two thirds of the frequency bands are shared with active services which transmit, usually fixed and mobile services. We are greatly concerned at proposals to charge for scientific use of these shared bands at some notional "commercial rate".

3 Spectrum Pricing for Radio Astronomy

Radio provides a quick and cheap way to connect people, but the actual radio frequencies used for communication are not critical. They are usually selected entirely for convenience, for example whatever happens to be cheapest at the time. Fixed and mobile services have allocations right throughout the spectrum, some shared with radio astronomy and some not. Equipment may be used for ten or fifteen years and then instead of replacing the equipment a new frequency band may be chosen. The fixed and mobile service applications come and go in different bands, whereas the radio astronomy need for the band is a continuous one. The economic value of a particular piece of spectrum changes completely over the years according to economics and national politics.

As an example from the 1980s, in the political drive for competition in telecommunications an astronomically important frequency band at 22GHz was downgraded in the UK from a primary allocation internationally to a secondary allocation nationally, thus promoting the fixed service. The frequency band is used to connect mobile phone base stations. Base stations within 50km of a radio telescope have to coordinate - in some cases they can operate close to a telescope, if there is terrain shielding for example, while in other cases an alternative frequency band is used. The mobile phone companies all have complete networks in this situation. Sharing with radio astronomy has not cost them greatly. No part of the LJK has been denied coverage. If radio astronomy ceased to exist in the UK then the mobile phone companies' income would not suddenly increase. It does not seem reasonable to charge radio astronomy a large amount for this piece of spectrum. In fact any calculation of economic value would

be very difficult to justify. The recent auctions may have given a misleading impression of the true situation. There is not enough money in the UK to buy the whole radio spectrum at that level of pricing! Nor are there enough customers!

We believe that it is more appropriate to charge scientific use of the spectrum at a discounted rate, for many reasons. Ours is a public service. Within the research community a new charge exceeding our current operating budget would have negative effects. Suddenly UK-based radio astronomy would appear expensive on the books, even if funds were transferred to PPARC to compensate. And PPARC itself would suddenly appear more expensive too. This would simply look like more money for PPARC science at a time of deep financial constraints, and when PPARC is trying hard to get additional funds for actual science (not an accounting exercise). In short, introducing large factors into the equation could have far-reaching and unintentional effects, to the detriment of UK research in astronomy and particle physics.

4 Responses to specific issues for discussion

iii How far can spectrum pricing be applied in practice?

Radio astronomy is a small user of the spectrum. Eliminating us entirely will not release much spectrum but Britain will lose its window on the radio universe and its scientific prestige as a world leader in this discipline. You could always make money by building on national parks, but as a country we have decided we don't want that.

Some radio services need to be protected from the economic muscle of big multinational corporations. Charging everyone for spectrum at the same rate will threaten that protection.

xiii Transparency of spectrum use

The Australian radio astronomers have made good use of the publicly available database of spectrum use, as a tool in tracking down sources of interference and in selecting sites for new instruments. We support moves towards a similarly open system in the UK.

xviii Sharing with defence users

UK radio astronomy successfully shares some bands with the Ministry of Defence, with astronomy very much the minor partner. The arrangement works well when the defence use is sporadic (but intense). It fails when the defence use is continual (as in base station communications).

xxx Have the present economic incentives helped?

There has been no change in UK radio astronomy use of the spectrum as a result of the current pricing scheme. We identified one band that was attributed to us for pricing when in fact the only UK use was in remote sensing. The satellite operating in that frequency

band was not a UK satellite but it supplied data to the UK Met Office. Where did the accountants send the bill?

xxxii Choice of frequencies for auction?

We are concerned that auctions of frequency bands shared with radio astronomy should carry safeguards to protect our operations (such as prescribed sharing arrangements).

xxxix Licence-exempt spectrum use

We have had unhappy experiences with licence-exempt devices, for example the video senders at 1393 MHz. There is no way to protect a radio observatory from such devices once they are freely available for anyone over the counter. The fact that the Radiocommunications Agency calls them low power devices, and their use indoors, has not stopped them interfering with radio astronomy.

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