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# Radio spectrum issues in radio astronomy

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Cosmic radio emissions were first detected more than 90 years ago while searching for the origin of the weak static that was causing interference to communications. This opened a new discovery window into our universe and since then radio astronomy has revolutionized our view of the Universe through the discovery of quasars, pulsars, the Cosmic Microwave Background, surveys of our Galaxy in the 21-cm hydrogen line, molecular lines, and many other phenomena.

The radio signals received from cosmic sources are mostly exceedingly faint, and radio astronomy receivers are many orders of magnitude more sensitive than earth communications systems. Hence, radio astronomy systems are potentially very susceptible to radio frequency interference (RFI) and need to be protected.

Radio communications systems are regulated worldwide via the International Telecommunications Union (ITU), a United Nations agency which maintains the Radio Regulations as an international treaty. Radio astronomy is included as a radiocommunications service and ITU-R Working Party 7D is tasked to define the technical and regulatory requirements to enable the continued operation of radio astronomy. Through the ITU processes radio astronomy has been allocated some protected radio bands especially for special molecular emission lines.

Cosmic radio emissions cover the entirety of the radio spectrum and cannot be controlled. Moreover, the expansion of the universe shifts even the fixed-frequency molecular lines to other parts of the spectrum. Hence, radio astronomy studies need access to whole radio spectrum! At the same time there is an explosion of new radio applications such as mobile, wi-fi and new satellite constellations of thousands of satellites leading to a very congested radio environment.

So, radio astronomy faces the fundamental challenge of operating extremely sensitive receivers over the whole radio spectrum in the presence of an ever-increasing RFI environment!! A very challenging but also very exciting research and development environment.

Solutions to such challenges are necessarily multi-faceted and need to adopt many and varied techniques and approaches. These include:

- Avoidance of RFI e.g. remote siting; Radio Quiet Zones
- Minimisation of RFI by regulatory mechanisms
- Increased tolerance to RFI by developing robust radio astronomy systems via technological solutions
- Advanced RFI mitigation techniques e.g RFI excision; RFI nulling
- Taking advantage of new communications technologies, especially in the digital domain.

New technologies often lead to increased RFI problems but can also provide technological solutions and new horizons for radio astronomy. Solutions developed in radio astronomy can also feed back into advanced commercial applications.

A brief historical overview of the evolution of radio astronomy spectrum management and protection will be given. It will be followed by discussion of current issues and solutions and mechanisms developed to address them. Finally, new emerging issues and potential impact and solutions will be addressed.