

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of)
)
Unlicensed White Space Device Operations in the) ET Docket No. 20-36
Television Bands)

**COMMENTS OF THE
NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES**

The National Academy of Sciences, through its Committee on Radio Frequencies (hereinafter, CORF¹), hereby submits its Comments in response to the Commission's March 2, 2020, Notice of Proposed Rulemaking (NPRM) in the above-captioned docket. In these Comments, CORF discusses the nature of observations by the Radio Astronomy Service (RAS) in the 608-614 MHz band (*i.e.*, TV Channel 37) and supports the Commission's proposals to protect RAS observation on Channel 37 by limiting proposed power and antenna height increases to transmissions below TV Channel 36.

I. Introduction: The Role of Radio Astronomy, the Special Vulnerability of Passive Services to Interference, and the Importance of Observations on TV Channel 37.

As the Commission has long recognized, radio astronomy is a vitally important tool used by scientists to study our universe. It was through the use of radio astronomy that scientists discovered the first planets outside the solar system, circling a distant pulsar. The Nobel Prize-winning discovery of pulsars by radio astronomers has led to

¹ See the Appendix for the membership of the Committee on Radio Frequencies.

the recognition of a widespread population of rapidly spinning neutron stars with gravitational fields at their surface up to 100 billion times stronger than on Earth's surface. Subsequent radio observations of pulsars have revolutionized understanding of the physics of neutron stars and have resulted in the first experimental evidence for gravitational radiation, which was recognized with the awarding of another Nobel Prize. Recently, fast radio bursts (FRBs) have been discovered. These are short, dispersed pulses from seemingly random locations on the sky with only a small number noted to be repeating. The origin of these FRBs is so far unknown and is the subject of ongoing observations, particularly at sub-gigahertz frequencies. Radio astronomy also has enabled the discovery of organic matter and prebiotic molecules outside our solar system, leading to new insights into the potential existence of life elsewhere in the Milky Way galaxy. Radio spectroscopy and broadband continuum observations have identified and characterized the birth sites of stars in the Milky Way, the processes by which stars slowly die, and the complex distribution and evolution of galaxies in the universe. The enormous energies contained in the enigmatic quasars and radio galaxies discovered by radio astronomers have led to the recognition that most galaxies, including our own Milky Way, contain supermassive black holes at their centers, a phenomenon that appears to be crucial to the creation and evolution of galaxies. Synchronized observations using widely spaced radio telescopes around the world give extraordinarily high angular resolution, far superior to that which can be obtained using the largest optical telescopes on the ground or in space.

The critical scientific research undertaken by RAS observers, however, cannot be performed without access to interference-free bands. Notably, the emissions that

radio astronomers receive are extremely weak—a radio telescope receives less than 1 percent of one-billionth of one-billionth of a watt (10^{-20} W) from a typical cosmic object. Because radio astronomy receivers are designed to pick up such remarkably weak signals, radio observatories are particularly vulnerable to interference from in-band emissions, spurious and out-of-band emissions from licensed and unlicensed users of neighboring bands, and emissions that produce harmonic signals in the RAS bands, even if those human-made emissions are weak and distant. It is particularly difficult for ultra-sensitive RAS facilities to track and limit interference from unlicensed devices such as TV white-space devices (WSDs).

Of particular concern in this proceeding is protection of RAS observations at 608-614 MHz (TV Channel 37). This band was originally allocated to RAS to provide appropriate spectral sampling of the spectral energy distribution of astronomical sources.² For example, continuum (broadband) observations in this TV Band are used to study the interstellar medium, pulsars, and the Sun. In addition, observations in this band are a critical resource for the following three important areas of astrophysics: (1) observations of neutral hydrogen (with a rest frequency of 1420 MHz) shifted in frequency by the Doppler effect (red shift) into this band are a critical probe of the state of the universe at a time 2.8 billion years after the Big Bang, when the universe was only 20 percent of its current age; (2) pulsar timing measurements can be made with extraordinary precision in this band and are expected to yield detections of black hole

² In 1963, the Commission adopted a Report and Order that reserved TV Channel 37 exclusively for the RAS, Report and Order, Docket No. 15022, 39 FCC 884 (1963). This protection in the broadcast service was enhanced through a number of actions taken from 1975 to 1986. See, Order, 53 FCC 2d 627 (1975); Second Report and Order, Gen. Docket No. 80-739, 49 Fed Reg. 2357 (January 19, 1984) (amending Footnote US 246 to U.S. Table of Allotments to reflect allocation to RAS); Order, Mimeo 4385 (released May 12, 1986) (amending Section 73.606 (c) to reflect the allocation).

mergers, which cause ripples in the space-time fabric of space; and (3) spectrally dispersed FRB detections are predominantly made in the 400-810 MHz range, with more than a 1,000 detections made to date. Such observations are used to investigate interstellar matter, the evolution of galaxies, and to reveal the origin and nature of FRBs. In regard to the interstellar medium, Channel 37 is used to investigate the thermal and non-thermal diffuse radiation in the Milky Way. Such observations give information on the high-energy cosmic-ray particles in our galaxy and their distribution, and also on the hot, ionized plasma in the disk of our galaxy.

Important observations at Channel 37 are also made of radio-frequency outbursts from the Sun that precede bursts of high-energy particles that interact with Earth's atmosphere. These bursts can cause severe interruptions in radio communications and power systems and have dangerous effects on aircraft flying at altitudes above 15,000 m. Study of these solar bursts at radio frequencies can enable prediction of failures in radio communications and forecasts of possible disruption of other critical infrastructure. In addition, knowledge regarding high-energy solar bursts is essential for safe and successful space exploration, both manned and unmanned.

II. The NPRM Properly Protects RAS from Interference by Limiting Power and Antenna Height Increases to Below Channel 36.

CORF acknowledges the Commission's commitment, stated numerous times in the NPRM, to protecting RAS observations on Channel 37. Specifically, in proposals for higher power limits for fixed WSDs, the NPRM states that "we continue to protect ... Radio Astronomy Service operations by maintaining the current power and HAAT

[height above average terrain] limits on Channel 36.”³ In proposals for increasing the current limits for antenna height of fixed WSDs, the NPRM states that “[t]o protect ... radio astronomy operations on Channel 37, we do not propose to revise our rules to permit operation with a higher HAAT in Channel 36 or higher.”⁴ Lastly, regarding higher-power mobile operations within “geo-fenced” areas, the NPRM specifically proposes to limit such changes to TV Channels 2-35.⁵

The Commission’s commitment to protect RAS observations on Channel 37 is consistent with its prior actions in this proceeding.⁶ CORF recognizes the importance of maximizing spectrum efficiency through thoughtful sharing of spectrum bands, where practical. However, the public interest supports protecting RAS observations on Channel 37, now and in the future.⁷

While the NPRM properly proposes to protect RAS by limiting increases in WSD power and antenna height to operations below Channel 36, the proposed power and height increases are targeted only to “less congested” areas,⁸ defined as “those areas

³ NPRM at para. 9. See also, paras. 12-14 and footnote 25.

⁴ NPRM at para. 17. At paragraphs 19-22, the Commission seeks comments on coordination of WSDs with other users of the spectrum. It should be remembered that WSD operation on any channel is prohibited within 2.4 km of specified radio astronomy observatories. See, Section 15.712(h)(1) of the Commission’s rules. In addition, any WSD operations on Channel 37 are prohibited in the National Radio Quiet Zone, as defined in § 1.924(a)(1) of the Commission’s rules, and on the islands of Puerto Rico, Desecheo, Mona, Vieques or Culebra. See, Section 15.712(h)(3). Furthermore, operation of any new or modified station at a permanent fixed location in the NRQZ requires notification to the National Radio Astronomy Observatory, per Section 1.924(a)(1). Operation of a new station at a permanent fixed location in Puerto Rico on a service (such as WSDs) that does not involve individual station licenses must nevertheless provide notification to the Arecibo Observatory, per Section 1.924(d).

⁵ NPRM at para. 39.

⁶ See, e.g., Amendment of Part 74 of the Commission’s Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and the 600 MHz Duplex Gap, Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions, ET Docket No. 14-165 and GN Docket No. 12-268, 30 FCC Rcd 9551 (2015) (*2015 White Spaces Order*) at paras. 225-232.

⁷ The amount of RAS observation at any particular frequency is driven by the then-current state of the science. Thus, observation at a particular frequency may increase and decrease over time, but bands allocated to RAS must still be protected, as a new scientific discovery can occur at any time, driving increased need to observe at that frequency.

⁸ See, e.g., NPRM at paras. 12 and 18.

where at least half the television channels in the band of operation (i.e., low VHF, high VHF, or UHF) are not in use”⁹ Of course, such areas have less TV service because they are primarily rural areas.¹⁰ The radio astronomy community is well aware that there is typically much less use of the spectrum (by TV and other services) in rural areas, and it is for that very reason that most RAS observatories are located in rural areas. RAS observatories will need protection from WSD operations in rural areas. Of course, limiting proposed power and antenna height increases to below Channel 36 should have no impact on use of WSDs because the spectrum in such areas is less congested with TV stations, which means that there are typically numerous other TV channels for WSD use in such areas.

III. Conclusion

CORF appreciates the Commission’s continued commitment to protecting RAS observations in Channel 37 by limiting proposed power and antenna height increases to transmissions below TV Channel 36. Such protections promote the public interest in protecting important science, with a minimal impact on wireless communications. While CORF generally supports the sharing of frequency allocations where practical, in light of the difficulty for ultra-sensitive RAS facilities to track and limit interference from unlicensed devices such as WSDs, the proposed protections for the RAS are necessary and proper.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'

⁹ *Id.* at para 10.

¹⁰ *Id.* at para 35.

COMMITTEE ON RADIO FREQUENCIES

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