Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of

Allocation and Designation of Spectrum for Fixed-Satellite Services in the 37.5-38.5 GHz, 40.5-41.5 GHz and 48.2-50.2 GHz Frequency Bands; Allocation of Spectrum to Upgrade Fixed and Mobile Allocations in the 40.5-42.5 GHz Frequency Band; Allocation of Spectrum in the 46.9-47.0 GHz Frequency Band for Wireless Services; and Allocation of Spectrum in the 37.0-38.0 GHz and 40.0-40.5 GHz Frequency Band for Government Operations.	IB Docket No. 97-95

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

The National Academy of Sciences, through the National Research Council's Committee on Radio Frequencies (hereinafter, CORF[1]), hereby submits these Reply Comments in response to the Commission's Notice of Proposed Rulemaking (NPRM; FCC 10-186) in the above-captioned docket. Herein, CORF notes the importance of protecting Radio Astronomy Service (RAS) users in the 42.5-43.5 GHz band from out-of-band interference and addresses relevant filed comments.

I. Introduction: The Role of Radio Astronomy and the Importance of Observations in the 42.5-43.5 GHz Band.

CORF has a substantial interest in the spectrum issues raised in this proceeding, because it represents the interests of the passive scientific users of the radio spectrum,

[1] A roster of the committee members is attached.

including users of the RAS bands.[2] RAS observers perform extremely important yet vulnerable research and provide data of national importance.

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. It has also enabled the discovery of organic matter and pre-biotic molecules outside our solar system, leading to new insights into the potential existence of life elsewhere in the galaxy. Measurements of radio spectral line emission have identified and characterized the birth sites of stars in the Milky Way galaxy, the processes by which stars slowly die, and the complex distribution and evolution of galaxies in the universe. Radio astronomy measurements have discovered fluctuations in the cosmic microwave background, generated in the early universe, which later formed the stars and galaxies we know today. RAS observations have established the existence of a black hole in the galactic center of the Milky Way, a phenomenon that may be crucial to galaxy formation. Observations of supernovas have allowed us to witness the creation and distribution of heavy elements essential to the formation of planets like Earth, and of life itself.

However, the critical science undertaken by RAS observers cannot be performed without access to interference-free spectrum. Notably, the emissions that radio astronomers receive are extremely weak—using its full allocated band, a radio telescope receives only about one-billionth of one-billionth of a watt (10^{-18} W) from a

[2] CORF also represents the interests of remote sensing scientists, including users of the Earth Exploration Satellite Service, which has an allocation at 40.0-40.5 GHz.

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 weak, distant in-band man-made emissions have precluded RAS use of these bands on numerous occasions.

Of particular importance in this proceeding are observations at 42.5-43.5 GHz. Radio astronomers make spectral line observations of silicon monoxide (SiO) in this band because it contains several of the lowest rotational transitions (J = 1-0) of various vibrational states of the SiO molecule, a key tracer of the physical conditions in the envelopes of some aged stars and young stellar objects. Because of its masing capabilities, the transition can be used to obtain unique information on the temperature, density, stellar wind velocity, and envelope geometry for these objects. More importantly, observing the angular movement of the SiO masers in these objects can lead to a direct estimate of the distance to the objects in question. Traditionally, determining an accurate distance to an astronomical object outside the solar system is the most difficult task in astronomy, so that any tool that can be employed to this end is priceless. In addition to observing the SiO masers, RAS use of this band includes determining the high-frequency portion of continuum spectra for galaxies and quasars. This requires interference-free access to the full 1 GHz band.

The SiO spectral lines with rest frequencies of 42.519, 42.821, 43.122, and 43.424 GHz are included in Table 1 of Recommendation ITU-R RA. 314-10, which lists the radio frequency lines of greatest importance to the RAS. Studies of multiple SiO transition lines are desirable because, when coupled with radiative transfer models of the molecular emission environment, they offer the best technique for obtaining the volume density of the region in question.

II. CORF Supports Deletion of the BSS Allocation at 42.0-42.5 GHz.

As noted in paragraph 12 of the NPRM, the National Telecommunications and Information Administration (NTIA) seeks deletion of the Broadcasting Satellite Service (BSS) allocation at 42.0-42.5 GHz, because it would be "difficult or impossible to reduce out-of-band emissions into the 42.5-43.5 GHz band, where sensitive RAS operations are located, if BSS operations were to be implemented in the 42.0-42.5 GHz band." Similarly, in the Comments of the National Radio Astronomy Observatory (NRAO) at paragraph 4, it is noted that "the ubiquitous nature of the desired coverage of [BSS] and the presence of a signal originating on the sky in direct line of sight appears to make compatibility between BSS and RAS problematic." CORF concurs with NTIA and NRAO on the degree of the out-of-band emission problem that such BSS operations would cause for RAS observers, and agrees that the best solution in this case would be deletion of that BSS allocation.

III. If the Commission Adds an Allocation for FSS at 42.0-42.5 GHz, the Commission Should Also Mandate the Protection Levels in Footnotes 5.551H and 5.551I for the Neighboring RAS Band.

CORF takes no position on the proposal in the NPRM to add an allocation for FSS (Fixed Satellite Service) at 42.0-42.5 GHz. However, if such an allocation is added, then the Commission should, as suggested at paragraph 20 of the NPRM, enact additional measures to protect RAS observations/users in the 42.5-43.5 GHz band.

CORF concurs with NRAO (Comments at paragraph 6) that the Footnotes 5.551H and 5.551I provide the appropriate levels of protection for RAS use in this band. The protection levels for non-GSO (non-geostationary orbit) systems stipulated in Footnote 5.551H are particularly important given the inability of RAS operations to avoid the near-ubiquitous presence of non-GSO systems at a given time or position in the sky.

Although the Satellite Industry Association (SIA) states that the limits provided in these two Footnotes are acceptable to the industry, SIA does recommend (Comments at page 7) that the Commission apply the "per 500 KHz components" of the power limitations in those Footnotes only in the 42.7-43.5 GHz portion of the RAS band. CORF opposes this suggestion, since as noted above in Section 1 of this document, RAS use of this band to determine the high-frequency portion of continuum spectra for galaxies and quasars requires interference-free access to the full 1 GHz band. In addition, SIA's suggestion is inconsistent with the international requirements. SIA stated (Comments at page 17) in a different context that "[t]he inherently international nature of satellite service makes it particularly important to maintain consistency with the international regulations for satellite services as much as is possible." That same need for consistency applies as well to requirements affecting the RAS.

IV. CORF Supports Exclusion of the Aeronautical Mobile Service from 40.5-42.5 GHz.

In paragraph 25 of the NPRM, comments are sought as to whether the Commission should change the allocation for the Mobile Service in the 40.5-42.5 GHz band to exclude the Aeronautical Mobile Service (AMS), noting that AMS use of that band could cause in-band interference to FSS gateway Earth stations as well as increase the chance for harmful out-of-band interference to RAS observations. CORF supports the exclusion of the AMS from this band. The risk to RAS observations is suggested by Footnote US211, which urges protection of RAS observations in this band from interference from airborne operations. CORF recognizes that while NRAO states at paragraph 12 of its Comments that elimination of the AMS allocation would be beneficial to the RAS, it also notes that some AMS use might be compatible with RAS use, where there is sufficient geographic separation and attention is paid to individual cases. However, CORF believes that more generally, the risks of interference from such use outweigh the potential benefits.

V. Conclusion.

Recognizing the important scientific data obtained by RAS users in the 42.5-43.5 GHz band, and the unique vulnerability of RAS observations to interference, CORF urges the Commission to delete the BSS allocation at 42.0-42.5 GHz, and if the Commission enacts an allocation to FSS, to mandate the protection levels in Footnotes 5.551H and 5.551I. The Commission should also exclude the AMS from the 40.5-42.5 GHz band.

Respectfully submitted,

NATIONAL ACADEMY OF SCIENCES'
COMMITTEE ON RADIO FREQUENCIES

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Attachment

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