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| **Document Title:** Working Document Towards a Preliminary Draft New Report: The Applicability of Current Practices to Protect RAS operations in Antarctica to Future Operations Around the Shielded Zone of the Moon.[SZM-DARK\_SECTOR] |
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| **Purpose/Objective:** To provide information about the coordination practices in place within and around the Antarctic Dark Sector and how these practices may be relevant to future operations around the Shielded Zone of the Moon (SZM). |
| **Abstract:** Following the adoption of the ITU-R Question 260/7 “Radio astronomy in the shielded zone of the Moon”, this new Report will summarize current practices for spectrum management in Antarctica, especially in the Antarctic Dark Sector, as applicable to radio astronomy operations on the Moon. This new Report will address lessons learned from operations in practice to protect RAS in Antarctica to better inform the future development of lunar operations around the SZM. |

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| Working document towards a preliminary draft new Report ITU-R RA.[SZM-DARK\_SECTOR] |
| **The Applicability of Current Practices to Protect RAS operations in Antarctica to Future Operations Around the Shielded Zone of the Moon****Introduction**This contribution is a new Report to summarize current practices for spectrum coordination in Antarctica, especially in the Antarctic Dark Sector, as applicable to radio astronomy operations on the Moon. This new Report will address lessons learned from operations in practice to protect RAS in Antarctica to better inform the future development of lunar operations around the SZM.**Attachment:** 1 |

ATTACHMENT

Working Document towards a Preliminary
Draft New Report ITU-R RA.[SZM-DARK\_SECTOR]

**The Applicability of Current Practices to Protect RAS operations in Antarctica to Future Operations Around the Shielded Zone of the Moon**

(Question ITU-R 260/7)

{Editor’s note: the concern has been raised as to whether this Question is relevant. This requires further consideration and may be changed.}

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# **1 Introduction**

Radio astronomy is a powerful branch of astronomy that studies celestial objects and phenomena by detecting and analysing the radio waves they emit. Radio astronomy has been instrumental in key discoveries, including the cosmic microwave background radiation, the confirmation of gravitational waves, and the mapping of galaxy distribution in the universe. However, access to the radio spectrum for these highly sensitive observations is severely limited from the Earth due to atmospheric effects as well as terrestrial emissions for radiocommunications. For this reason, astronomers have sited their telescopes in remote locations free from terrestrial emissions and in high altitude, dry climates where atmospheric effects are minimal.

One such location is the South Pole, Antarctica. Astronomy in the Dark Sector of Antarctica leverages the unique advantages of one of Earth’s most remote regions. Located at the Amundsen-Scott South Pole Station, The Dark Sector is a designated zone for astronomy, in which strict restrictions on radio emissions are in effect to ensure a pristine observational environment. Its geographic location offers a continuous view of the southern celestial hemisphere, and a stable environment with minimal atmospheric turbulence during austral winter when the Sun sets for six months. The dry, stable atmosphere minimizes water vapor interference, allowing telescopes to probe the universe with remarkable precision. These factors make the Dark Sector a unique site for cutting-edge astronomical research across a range of wavelengths. Researchers take advantage of these conditions to study the cosmic microwave background (CMB) radiation, a relic of the Big Bang, providing crucial insights into the universe’s origins, structure and evolution. Such studies have been pivotal in refining cosmological models, including constraints on dark matter, dark energy and inflationary theories.

The Dark Sector hosts a number of experiments including the South Pole Telescope (SPT), the BICEP/Keck Array, and the IceCube Neutrino Observatory. These observatories have enjoyed protection afforded by the Dark Sector frequency emission regulations, enabling them to conduct their observations in a radio quiet environment.

The Dark Sector of Antarctica has maintained a radio quiet environment in part due to its remote location at the geographic South Pole, but an important contributing aspect to the success of spectrum coordination and management is the naturally limited access to this extremely remote area. This limited access is not the result of any regulation or restriction, but is the result of the extreme environment and weather conditions, especially during the austral winter. Any new local transmitters or sources of interference can be traced to a small number of stakeholders and visitors. During the austral winter, travel to and from the South Pole, as well as all air traffic in Antarctica, completely stops. During this period of time, with a limited population at the South Pole station, the radio environment is quiet as well as stable.

Another location offering a pristine environment for radio astronomy is the Shielded Zone of the Moon (SZM). The shielded zone of the Moon, an area somewhat less than half of the lunar surface, is a zone in which passive observations remain unhindered by interference as this part of the Moon’s surface is always facing away from Earth and is therefore shielded from Earth-based and Earth-orbital radio signals. A number of facilities and mission concepts have been proposed including the Radiowave Observations at the Lunar Surface of the photoElectron Sheath (ROLSES), which already landed and collected data in 2024, among other projects already in development. Lunar-based radio astronomy holds immense potential to address fundamental questions about the universe.

While the Radio Regulations (RR) Article 22 provides protection for the radio astronomy service on the SZM, practical mechanisms for implementing spectrum management in the lunar environment will need to be established. Both Antarctica and the Moon are locations without national sovereignty. Therefore, spectrum coordination practices and lessons learned in Antarctica’s Dark Sector could inform future coordination on and around the SZM. This Report serves to highlight how international coordination is undertaken in the Antarctic Dark Sector as may be relevant to inform future practices on the Moon.

# **2 The Regulatory Landscape of Antarctica and the Moon**

{Editor’s note: Content to be developed further. The following bullet points are included as placeholders for further elaboration.}

• The Antarctic Treaty

• Dark Sector regulations and enforcement practices

• The role of national programs (e.g. US South Pole station & NSF)

• The Outer Space Treaty (as applicable to the Moon)

• RR Article 22 (leaves enforcement up to multilateral discussions)

• Recommendation ITU-R RA.479

• Compare/contrast Antarctica with the SZM (controlled/limited access, terrestrial vs. space operations, land size, existing regulations & mechanisms, international cooperation, exploitation of natural resources)

# **3 Scientific Investigations Enabled by the Antarctic Dark Sector Environment**

*{Editor’s note: Content to be developed further. The frequency coordination practices in place for each telescope/observatory to be addressed here.}*

## **3.1 The South Pole Telescope (SPT)**

## **3.2 BICEP/Keck Array**

## **3.3 The IceCube Neutrino Observatory**

## **3.4 The Askaryan Radio Array (ARA)**

# **4 Processes for Coordination and Notification**

*{Editor’s note: Content to be developed. A procedure is needed for informing frequency usage on the Moon. National experiences with coordinating in Antarctica to be discussed here, including intergovernmental agreements, with a focus on technical lessons learned. Noting that the intent is not to suggest reproducing practices in Antarctica directly to the Moon as some lessons learned could inform what ought not be reproduced.}*

# **5 Summary**

*{Editor’s note: Summary to be written upon completion of the Report }*

TBD

# **6 Related ITU-R Recommendations/Reports**

Recommendation ITU-R RA.314 – *Preferred frequency bands for radio astronomical measurements*

Recommendation ITU-R RA.479 – *Protection of frequencies for radioastronomical measurements in the shielded zone of the Moon*

Report ITU-R RA.[SZM]

# **7 Abbreviations/Glossary**

SPT South Pole Telescope

RFI Radio Frequency Interference

RR Radio Regulations

SZM Shielded Zone of the Moon