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Science case for Ultra-Long-Wavelength Astronomy from the Moon's surface and vicinity

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The Ultra-Long-Wavelength (ULW) range of the electromagnetic spectrum (wavelengths longer than ~15 m, frequencies below ~20 MHz) is the last unexplored window into the electromagnetic Universe. At this wavelength regime, the Earth's ionosphere does not allow the cosmic electromagnetic emission to reach the Earth's surface. Thus, observations of celestial sources in this spectrum domain are possible only from space-borne radio telescopes.

The ULW range is offering unique opportunities for pioneering research in many fields of astrophysics and cosmology, from Solar-terrestrial studies, to Galactic and extragalactic radio astronomy (Jester and Falcke 2009 and references therein). Particularly attractive are applications of ULW observations for studies of Fast Radio Bursts (FRB), pulsars, and imprints of the cosmological evolution of the Universe in the distribution of highly redshifted emission of the atomic hydrogen (HI). Studies of cosmic radio emission in the ULW regime are also very informative for diagnostics of the interplanetary plasma and properties of the planetary bodies in the Solar system.

From the technological perspective, the ULW instrumentation is relatively simple and affordable. It can be based on the widely available instrumentation, developed for the Earth-based radio astronomy of shorter wavelengths (meters and shorter). An issue of special concern for ULW astronomy is protection from and mitigation of human-made radio frequency interference (RFI) that can affect operations of a radio telescope anywhere in the Earth's vicinity up to distances of tens of the Earth diameters and even farther away. The Moon represents a natural and efficient shield from the Earth-originated RFI.

An ULW astronomical facility can be placed on a free-flying platform on a selenocentric orbit, e.g. as described by Boonstra et al. 2016, or on the Moon far side (Mimoun et al. 2014). The latter case is especially attractive with the ULW radio telescope permanently shielded from the Earth-originated RFI. Economically attractive might be an option of placing an ULW radio telescope near the southern pole of the Moon with the crater rim offering sufficiently efficient protection from the Erath-originated RFI.

An ULW facility of the first generation does not require for its operations significant power and extensive maintenance, its mass is measured in kilograms, not tons. It is perfectly suitable for the role of a cost-efficient "piggy-back" payload for the early wave of Moon exploration missions.

References

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