TOWARD MOON-BASED VERY LONG-WAVELENGTH RADIO ASTRONOMY FACILITY: SCIENCE DRIVES AND TECHNOLOGICAL CHALLENGES.

L.I. Gurvits[1] and H. Falcke[2,3]

[1]Joint Institute for VLBI in Europe, P.O. Box 2, 7990 AA Dwingeloo, The Netherlands, lgurvits@jive.nl
[2] Radboud University, P.O. Box 9010, 6500 GL Nijmegen, The Netherlands, h.falcke@astro.ru.nl
[3]ASTRON, P.O. Box 2, 7990 AA Dwingeloo, The Netherlands

Scientific laboratories at manned and un-manned Moon bases are top priorities for the next wave of exploratory missions. Environmental conditions on the Moon are beneficial for various types of experimental research. Very Long Wavelength Astronomy (VLWA) is among the most attractive scientific disciplines for the suit of Moon-based laboratories.

Space-based facilities has revolutionised astronomy by opening up several hitherto inaccessible windows in the spectrum. The opening of each new spectral window has resulted in unexpected discoveries and made it possible to obtain a comprehensive picture of physical processes in celestial sources. One of the last remaining unexplored regions of the spectrum is at the lowest radio frequencies. Radio emission below 10 MHz (wavelengths longer than 30 m) is inaccessible from the Earth surface due to absorption and scattering in the ionosphere.

Unique new science areas for VLWA studies include: (i)Investigation of radio sky at so far inaccessible regime of electromagnetic radiation; (ii) Cosmological “experiments” with “fossil” relativistic electrons; (iii) Investigation of ultra-high-energy cosmic rays via VLWA emission from particle interactions with the Moon; (iv) Solar system “weather”, including coronal mass ejections, (v) Searches for Jupiter-like exoplanets.

In addition to the astrophysical tasks mentioned above, the VLWA facility on the Moon can be implemented as a Wide Area Network, as pioneered by the Earth-based Low Frequency Array (LOFAR). Inclusion of non-astronomy sensors, such as seismic detectors to conduct selenological studies, can greatly enhance scientific and “exploratory” return of the mission. The LOFAR is being constructed in The Netherlands. It will operate in the frequency range 20 - 220 MHz. Several other projects will aim at addressing cosmological problems by studying the Universe at the range of frequencies below 100 MHz. These and other new radio astronomy facilities will lay the scientific and technological ground for VLWA on the Moon.

We will present a multi-step approach toward creating a permanent VLWA observatory on the Moon. Its first phase would include a demonstrator to be deployed as a small-scale scientific payload onboard one of the lunar missions of the next decade. A concept of an affordable full-scale observatory will be presented in the context of a long-term Moon exploration programme.