ULTRA-LONG WAVELENGTH RADIO ASTRONOMY – SCIENCE CASES AND TECHNICAL CHALLENGES

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Space based ultra-long wavelength radio astronomy has recently gained interest. The need for large effective apertures spread over long ranges implies that advanced technologies are required, which is in reach at this moment. This together with the unexplored frequency band below 30 MHz makes these initiatives very interesting. Due to a combination of ionospheric scintillation below ~30MHz, its opaqueness below ~10MHz, and man-made radio frequency interference (RFI), earth-bound radio astronomy observations are either severely limited in sensitivity and spatial resolution or entirely impossible.

A space or Lunar based low-frequency radio array would suffer significantly less from these limitations and hence would open up the last, virtually unexplored frequency domain in the electromagnetic spectrum. This is a region of the electromagnetic spectrum, which is essentially unexplored by astronomy. The only space-based observations at low frequency are done by the Radio-Astronomy-Explorer-2 satellite in the seventies, but are very limited in resolution and sensitivity since it was a single antenna instrument. Opening this last region of the electromagnetic spectrum of at least three orders of magnitude, the likelihood of discovering new processes and objects is great.

Several science cases are in reach by observing at low frequencies. One of the science cases is the search for exoplanets by looking at direct radio signals of exoplanets. If direct radio observation of the exoplanet's signal was possible, new scientific information will help us in the search for Earth like planets. At this moment, more than 3500 exoplanets have been discovered in about 2650 planetary systems. The majority of the discoveries of exoplanets is measured by indirect means (radial velocity method, transit method, astrometry and microlensing), while a small number have been discovered through direct imaging. Magnetised exoplanets are expected to emit strongly at radio wavelengths, in the same way as magnetised planets in our own solar system. Direct radio observations of exoplanets, therefore, will give important additional information to science. It would confirm that the planet has a magnetic field and it will also put a limit on the magnetic field strength near the surface of the planet. The determination of circular polarization would indicate the source of the magnetic hemisphere and would give limits on the plasma density in the magnetosphere. However, not a single exoplanet radio detection has been measured until now. The most recent attempt was done by Murphy at all using the Murchison Widefield Array (MWA) in Australia. The team targeted 17 known exoplanets observing at a frequency of 151 MHz. No emissions were observed from any of the exoplanets.

The mission design philosophy is that the science drives the mission and that it defines the requirements of the satellite swarm. In this paper an overview of the possible science cases will be given which will drive the list of requirements for a space based ultra-long wavelength instrument. The four main challenges will be addressed in more detail: the propulsion and attitude control system, the science antenna system, the communication aspects and the in-space interferometry. In the paper also an overview of our approach to realize a space based observatory will be presented – OLFAR, the Orbiting Low Frequency Antennas for Radio Astronomy.