4th URSI AT-RASC, Gran Canaria, 19-24 May 2024

A new era in HI cosmology: from SKA to the Moon

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In this presentation I will review the current and upcoming radio telescopes attempting the elusive detection and study of the 21-cm line from atomic Hydrogen. 21-cm cosmology promises to unlock the mysteries of the early Universe, such as the initial conditions for first structure formation during the Dark Ages, the birth of the first population of stars and galaxies during the Cosmic Dawn, or the re-shaping of the Universe due to the radiation of this first generation of celestial objects during the Epoch-Of-Reionization.

Experiments range from relatively small single antenna experiments such as EDGES [1], with a reported a potential first detection of the sky-averaged 21-cm signal in 2018, to super observatories like the upcoming SKA1-LOW radio interferometer [2], aiming at tomographic studies of the 21-cm emission from the Cosmic Dawn and the Epoch-Of-Re-ionization with its unprecedented sensitivity and survey speed. The challenges are however not small. Foreground contamination 5 orders of magnitude stronger than the target cosmological signal, strong instrumental and environmental effects, Radio Frequency Interference from Earth sources or Ionospheric disturbances, are amongst the many difficulties faced by radio astronomers.

Now, different countries are preparing for the next step in radio cosmology, “radio cosmology from the Moon”. Trying to bypass some of the issues faced by Earth ground-based instruments, moon-based radio cosmology, both on the ground and in orbit, promises to produce better observations, a higher chance of detection and access to higher redshifts, owing to the Dark Ages ($z \sim 300 - 30$).

During the talk, I will review the state of the art of current observations, and I will discuss their limitations and the planned experiments and observational approaches for the future. I will primary focus on the experimental and observational aspects of HI radio cosmology with the goal of painting a cohesive picture of the state of the field as of 2024.

1. Bowman, J., Rogers, A., Monsalve, R. et al. An absorption profile centred at 78 megahertz in the sky-averaged spectrum. Nature 555, 67–70 (2018). https://doi.org/10.1038/nature25792

2. The SKA observatory, https://www.skao.int/en