Observing Cosmic Dawn with a closely-spaced radio array

Research Field
Radio Astronomy/Engineering

Project Suitability
PhD
Honours

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The redshifted 21-cm signal from neutral hydrogen is the most promising opportunity to directly observe the Universe's first billion years of evolution. The faint signal should be detectable at low radio frequencies (50 - 300 MHZ), however, it is obscured by bright foregrounds sources and requires extreme precision in instrumental calibration. The EDGES experiment (Bowman et. al., 2018) has made the first claimed detection of the signal, and many experiments are attempting to verify their unexpected results. Most of these 'global signal' experiments make use of single dipole or monopole antennas, which can be prone to systematic effects that could cause a false detection.

In general, radio interferometers measure angular fluctuations in the sky brightness and are largely insensitive to the global average. However, interferometers with very short baselines (less than a wavelength) do have a significant global-signal response. While interferometers are not immune to effects that may corrupt measurements of the redshifted 21-cm signal, the systematics involved are quite different from single-dipole experiments and they therefore offer an independent means to verify the EDGES signal.

The Engineering Development Array - 2 (EDA-2) is a prototype instrument located at the future site of the Square Kilometre Array - Low (SKA-Low), which consists of 256 Murchison Widefield Array dipoles arranged in the proposed SKA-Low station layout. These antennas are packed tightly together in a roughly circular area with a diameter of just 35 m. This short spacing between antennas makes the EDA-2 an ideal test-bed instrument for observing a global redshifted 21-cm signal. In this project you will have the opportunity to analyse data from the EDA-2 and develop new calibration and observing strategies. You will also run simulations to test and verify methods for extracting the faint 21-cm signal from behind the veil of bright foreground emission from our own Galaxy. This is a great opportunity to join a growing team working on a common goal with far reaching implications for observational cosmology.