Managing the Complexity of Low-Frequency Radio Telescope Station Array Model and Reality

The Low-Frequency Square Kilometre Array (SKA-Low) operating from 50 MHz to 350 MHz is envisaged to comprise 512 stations each of which consists of 256 pseudo-randomly located antennas. Accurate knowledge of the station beam and its receiver noise property is essential to successful astronomical imaging and observation. The more sensitive the observation, the higher the demand placed on the knowledge of instrumental effects. For brevity, we henceforth refer to the station beam and its receiver noise property as the station model.

Research Field
Radio Astronomy/Engineering

Project Suitability
PhD
Honours (as appropriate)

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Although the knowledge and tools exist to model the properties of the SKA-low station, they are only an approximation of reality. It is impracticable to expect that every detail of the deployed station be recorded and computed for each station as the simulation time becomes prohibitively long. The objective of this project is to devise a method to manage the tension among the required model accuracy, simulation time, deployment impairment and component tolerances. Dish-based radio astronomy appears to have a widely-accepted handle on this problem through smoothness tolerance and verification method both in the laboratory and in the field. Such a consensus seems to be missing in low-frequency radio astronomy.

The aim of this project is to fill this gap by developing a clear, actionable and measurable guideline for low-frequency station realization. Initially, we will study high-precision dish-based radio telescopes such as ALMA and glean key similarities and differences to low-frequency telescope. Based on this, we will divide the low-frequency problem into modules each with a well-defined interface which takes into account understanding of modelling and measurement constraints. The end result is an SKA-low station beam model and verification guideline with clear connection and distinction to high-performance and well-accepted radio telescopes.