NASSP 2019 Honours and MSc Project Proposal

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- <u>Title of Research Project:</u> HIRAX: Analysis, foregrounds and cosmological cross-correlations

- <u>Level of Research Project:</u> Honours and MSc

- <u>Description of the Research Project:</u>

A central goal of current and future cosmological surveys is to uncover the nature of dark energy. The University of KwaZulu-Natal is leading the Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX) project, which will comprise a compact array of around 1,000 small (~6m) dishes operating between 400 and 800 MHz. The primary aim of HIRAX is to map baryon acoustic oscillations (BAOs) in the cosmological 21cm intensity distribution over a significant fraction of the sky between redshifts 0.8 and 2.5, and thereby place strong constraints on the dark energy equation of state. The HIRAX project offers students the opportunity to train on cutting edge science, engineering, analysis and big data techniques in a South African-led project. The relatively short time-scale for the full HIRAX survey makes it ideal for Hons and MSc projects. The project will also include student involvement in the analysis of data from the HIRAX 8-element and 128-element prototypes that will operate on the 1-3 year timescale.

A major challenge in uncovering the cosmological 21cm signal is the presence of galactic foregrounds that are several orders of magnitude above the signal but fortunately smooth in frequency in contrast to the 21cm signal. This project will focus on the design of optimal estimators to extract the various 21cm cosmological signals, such as BAOs and lensing, in the presence of foregrounds and noise. The foreground challenge can be mitigated through cross-correlations with other large-scale structure tracers, which will be available from other cosmological surveys e.g. LSST, that have independent noise and systematics. The key part of the MSc project will involve applying these techniques to the HIRAX data to test their suitability and allow the student to build more robust and effective techniques, taking into account real effects that are seen in the data.