

NASSP Honours Project 2026

1. Level of the project:

Honours

2. Name of primary supervisor:

Prof. Kavilan Moodley

3. Institution of supervisor:

University of KwaZulu-Natal

4. Name of co-supervisor:

Dr. Liantsoa Finaritra Randrianjanahary

5. Institution of co-supervisor:

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7. Project title:

Interacting Dark Energy with 3×2-Point Statistics: Synergy Between HIRAX and LSST

8. Description of project:

Interacting dark energy models allow a non-gravitational exchange of energy or momentum between dark matter and dark energy, modifying both the cosmic expansion history and the growth of matter perturbations. These effects leave characteristic imprints on the clustering of matter and on weak gravitational lensing observables. This project investigates the characteristics of interacting dark energy (IDE) using large-scale structure probes, including neutral hydrogen and weak lensing (shear). To probe these signatures, we will combine HI clustering, cosmic shear, and HI–shear two-point correlations. The analysis is based on 3×2-point statistics and the synergy between the Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX) radio survey and the Vera C. Rubin Observatory Legacy Survey of Space and Time (LSST) shear survey.

Objective: In this project, the student will constrain the interaction parameter between dark matter and dark energy. We will use measurements of weak lensing, which are sensitive to the matter distribution projected along the line of sight, combined with HI measurements, which also trace the dark matter.

Methodology: To constrain our key parameters, we will perform a Fisher-matrix forecast based on projected spectra within an interacting dark energy paradigm. This combined HIRAX-LSST analysis provides a powerful framework for testing deviations from the standard Λ CDM model

and exploring the physics of dark energy through complementary large-scale structure observations.

Expected Outcome:

The student will become familiar with summary statistics like 2-point correlation functions and power spectra, and can theoretically and numerically compute these spectra using the Limber approximation and Boltzmann solvers like CAMB or CLASS. The student will understand the properties of interacting dark energy. The student will write the code for the HIRAX-LSST spectra analysis and demonstrate how to constrain parameters using the Fisher forecast approach.

Requirements:

Programming skills in Python. Basic knowledge of cosmology.
