NASSP Honours Project 2026

1. Level of the project:
Honours

2. Name of primary supervisor:
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3. Institution of supervisor:
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4. Name of co-supervisor:
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5. Institution of co-supervisor:
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7. Project title:
Understanding of Systematics in Stage-IV Galaxy Weak Lensing Surveys

8. Description of project:
In modern cosmology, huge “Stage-IV” galaxy surveys map millions of galaxies across the sky to measure how our Universe has grown over time. These surveys aim to answer big questions about dark energy, dark matter, and the overall geometry of the Universe. However, small measurement errors, known as “systematics”, can easily mimic or hide real cosmological signals if they are not properly understood and corrected.

Weak gravitational lensing surveys use small distortions in galaxy shapes to map the matter distribution in the Universe and to test models of dark energy. In Stage-IV surveys, the statistical errors are very small, so controlling systematic effects becomes crucial. In this project, we will focus on the two major systematics, e.g., intrinsic alignment (IA) and photometric redshift (photo-z) errors in Stage-IV-like weak lensing surveys. Intrinsic alignments arise when galaxies are physically aligned with the surrounding large-scale structure, which can either mimic or dilute the true lensing signal. Photometric redshift errors occur because galaxy redshifts are estimated from multi-band imaging rather than spectroscopy, leading to biases and scatter in the redshift distribution of the source galaxies.

Using simple toy models and publicly available mock weak lensing catalogues, We will study how IA and photo-z errors change key observables such as the shear two-point correlation functions or tomographic power spectra. We will then explore basic mitigation strategies, for example adding simple IA templates to the signal model, varying the assumed redshift distributions, or marginalizing over nuisance parameters that describe IA and photo-z bias. As a future direction, if sufficient progress is made, this Hons project can naturally evolve into a Master's project focused on using HI spectroscopic surveys to characterise and mitigate these systematics via cross-correlations analyses.

9. Student's role: The student will gain expertise in cosmological and mathematical modelling of weak lensing signals and systematics. The student will also write and test code to compute and analyse auto- and cross-power spectra, including the contributions from intrinsic alignments and photometric redshift errors, using simulated or mock survey data.