Observational cosmology with Euclid, LSST, and the SKA

Supervisors: *Dr Chris Clarkson, Dr Will Sutherland*

We are now entering a golden age of observational cosmology, with multiple gigantic large-scale structure surveys coming online throughout the 2020s. These will map out the cosmic matter distribution over larger volumes, and further back in time, than ever before, and promise to reveal the physical nature of elusive forces and fields such as dark matter, dark energy, and possible modifications to General Relativity. Several large survey telescopes will begin operation in the next few years, including the optical ground-based LSST (at the Vera Rubin Observatory), optical/near-infrared space-based Euclid mission, and the SKA and its precursors in the radio. Thanks to the sheer size of these surveys, and the possibility of combining them together in multi-wavelength, multi-tracer analyses, we may soon be able to detect subtle relativistic effects and hints of new fields and forces for the very first time.

During this project, the PhD student will develop data analysis techniques and/or theoretical models required to extract and interpret observational cosmology data from the Euclid, LSST/VRO, and SKA surveys, and beyond. This project could include:

- Constructing and characterising novel observables designed to uncover subtle relativistic effects, e.g. via multipoles of the multi-tracer bispectrum.
- Simulating maps and images of galaxies in the radio and optical, in order to develop and test ways of extracting novel gravitational signatures from large-scale structure surveys.
- Incorporating new theoretical models into the data analysis machinery of big surveys like LSST, in order to distinguish between different theories of dark energy.
- Studying astrophysical “gravitational laboratories” (e.g. wide binaries) to test GR.

Note: This project description can be used for the “Research Proposal” part of your application.