Relativistic cosmology and perturbation theory

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On the scale of the entire observable Universe it is no longer appropriate to use Newtonian theory to describe gravitational interactions. Instead, we need to use Einstein's relativity in order to gain a proper understanding of the large-scale expansion of space, and to make detailed predictions of the relativistic effects that can only be observed on the very largest of scales. This project will use Einstein's theory of spacetime to investigate inhomogeneity in cosmological modelling, and to make predictions that can be tested using upcoming observational missions. This is the ideal time to be performing this work, with astronomical surveys being performed over the coming decade that will map out the Universe to unprecedented depth and accuracy.

During this project, the PhD student will investigate relativistic effects in cosmology. This project could include:

- Investigating how cosmological expansion emerges in inhomogeneous spacetimes, and the consequences of this for cosmological observables.
- Applying higher-order perturbation theory to the study of gravitational fields in the Universe, in order to calculate subtle relativistic effects.
- Simulating relativistic effects in the formation of large-scale structure, by developing novel techniques that allow for their inclusion.
- Calculating and predicting the observational properties of the distribution of galaxies in the Universe, and how they can be used to investigate relativistic gravity.

$$R_{\mu\nu} - \frac{1}{2} R\, g_{\mu\nu} + \Lambda\, g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

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