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Gravitational-wave lensing as a probe of dark matter halos & Decoherence of Cosmological Perturbations from Boundary Terms and the Non-Classicality of Gravity

Tuesday, 18 October 2022 14:00 (1h 20m)

Gravitational waves can probe cosmic structures via gravitational lensing in ways that are highly complementary to electromagnetic signals: 1) their low frequency and phase coherence makes them sensitive to wave-optics diffraction and frequency-dependent effects, 2) weak interactions with matter allow them to probe dense regions, such as the cores of galactic halos and 3) accurate waveform models provide an additional handle to pinpoint lensing effects.

In this talk I will describe how these features can be used to probe features of matter halos, such as the radial slope of the density and the existence of a central core. These unique signatures will enable novel probes of fundamental physics and astrophysics in galactic centres.

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The quantum-to-classical transition of inflationary cosmological perturbation is necessary to explain today's classical observations originating from primordial vacuum fluctuation. In the literature, such a transition is the decoherence obtained by tracing out the unobserved modes from a state having couplings between long and short modes by bulk interactions. We note that the decoherence of inflationary curvature perturbation is dominated by a boundary term of the gravity action. Although this boundary term cannot affect normal cosmological correlators, it induces much faster decoherence than the previous calculations based on bulk interactions. We also point out that the gravitational origin of inflationary decoherence may shed light on the quantum nature of gravity. By comparing with a Schrödinger-Newton semi-classical gravity, we show that gravity theories of classical or quantum origins can be distinguished by comparing their different decoherence rates of cosmological perturbation. Our result also suggests that density fluctuation better preserves quantum information than curvature perturbation for the purpose of constructing cosmological Bell-like experiments.

The talk is based on arXiv:2207.04435.

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