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The effect of quantum decoherence on inflationary gravitational waves

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The theory of inflation provides a mechanism to explain the structures we observe today in the Universe, starting from quantum-mechanically generated fluctuations. However, this leaves the question of: how did the quantum-to-classical transition, occur? During inflation, tensor perturbations interact (at least gravitationally) with other fields, meaning that we need to view these perturbations as an open system that interacts with an environment, which leads to quantum decoherence. In this talk I will show how this interaction can lead to a change in the gravitational wave power spectrum. By using current upper bounds on the gravitational wave power spectrum from inflation, obtained from CMB and the LIGO-Virgo-KAGRA constraints, we find an upper bound on the interaction strength between the system and the environment. We also show how using sensitivity forecasts for future gravitational-wave detectors, such as LISA and ET, could further constrain the decoherence parameter space. Furthermore, we indicate the minimal interaction strength needed for a specific scale to have successfully decohered by the end of inflation. This allows us to indicate a lower bound on the interaction strength, assuming CMB modes have completely decoherence. Additionally, this allows us to look at which scales might not have fully decohered and could still show some relic quantum signatures.

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