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Cosmological stimulated emission

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We study the analogy between graviton emission and absorption in a thermal radiation environment and the laser mechanism, in which photons of the same momentum and polarization are amplified. Using interaction-picture perturbation theory, we analyze the time evolution of the graviton number operator and its expectation value in a squeezed vacuum state, which characterizes the inflationary graviton state. First, we examine this effect in a thermal bath in a Minkowski background and find that emission or absorption occurs depending on the initial squeezing parameters. As a thought experiment, we consider LIGO/Virgo-like detectors immersed in a radiation environment at temperatures of O(0.1) GeV. In this scenario, graviton numbers at frequencies of O(100) Hz could be enhanced, suggesting a possible mechanism for amplifying gravitational wave signals. While this setup is beyond current experimental capabilities, it highlights potential advancements in gravitational wave detection. The significant effect observed in a flat background implies a backreaction of the thermal bath on spacetime. Thus, understanding this effect in an expanding universe is essential. During the radiation-dominated era of the early universe, gravitons within the horizon at reheating undergo stimulated absorption. We find a secular logarithmic growth for the superhorizon mode, leading to the breakdown of perturbative analysis, which requires further investigation in future.

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