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Resonant instability of axion cloud

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Abstract

The presence of sufficiently light particles in the fundamental Lagrangian could trigger instability in rotating black holes, the so-called superradiance instability. In particular, axion and axion-like-particles (ALPs) are good candidates to prompt such an instability. As a result, a high-density axion cloud forms around the black hole. The system of black holes and the axion cloud surrounding it is called a gravitational atom. Examining the evolution of this gravitational atom could lead to the discovery of an axion or introduce new constraints on their parametric space. The axion cloud becomes unstable under certain conditions when axion-photon interactions and axion self-interactions are considered. The nature of these instabilities is the parametric resonance. In this paper, we obtain an upper bound for the rate of this instability. The results show that for the simplest axion models, this instability occurs at a very low rate because, before the resonance becomes effective, self-interactions cause the axion cloud to collapse. But for some exotic models, the resonance rate could be large enough to introduce observable effects. In addition, we will show that the parametric resonance caused by self-interactions never happens at a significant level.

Keywords: superradiance, instabilities, Kerr blackhole, parametric resonance, axion

For full article, refer to the Persian section