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Dynamic instability analysis for bumblebee black holes: the odd parity

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Spherical black-hole (BH) solutions have been found in the bumblebee gravity where a vector field nonminimally couples to the Ricci tensor. We study dynamic (in)stability associated with the gravitational and vector perturbations of odd parity against these bumblebee BHs. Under the plane-wave approximation, we find that bumblebee BHs do not suffer ghost instability, but gradient instability and tachyonic instability exist when the bumblebee charge exceeds certain values. The existence of the instabilities also depends on the nonminimal coupling constant ξ that, there is a minimal value $\xi \sim 4\pi G$ with G the gravitational constant for the instabilities to happen.
The theoretical consideration for bumblebee BH stability turns out to place stronger constraints on the parameter space than those from the recent observations of supermassive BH shadows by the Event Horizon Telescope Collaboration. It is also reminiscent of Penrose's cosmic censorship conjecture since the charge of bumblebee BHs cannot be too large due to the dynamic instabilities. Specifically, for $\xi(\xi - 16\pi G) > 0$, we find that the charge of a bumblebee BH cannot be larger than its mass.

Paper info

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