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Quasi-normal mode of dyonic hairy black hole and its interplay with phase transitions

We explore the dynamics of the massless scalar field in the context of hairy black holes within the Einstein–Maxwell-scalar gravity system. Utilizing both the series solution and shooting methods, we numerically compute the corresponding quasinormal modes (QNMs) across various black hole parameters. Notably, the values obtained from these two methods exhibit robust agreement. The consistently negative imaginary part of the QNM underscores the stability of the massless scalar field in the backdrop of the black hole. Our investigation reveals that both the decay and oscillatory modes of the scalar field perturbation exhibit a linear increase with the horizon radius, particularly notable for large black holes. We conduct a comprehensive analysis of QNMs across diverse black hole parameters, encompassing the electric charge, magnetic charge, horizon radius, and the hairy parameter. Moreover, we extend our scrutiny to the QNM behavior near the small/large black hole phase transition. Intriguingly, we discern distinct characteristics in the nature of QNMs between the large and small black hole phases, indicating the potential of QNMs as a probing tool for black hole phase transitions.

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