Future Research Plans

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Research purpose

With the ultimate goal to investigate the mystery of dark matter and dark energy through multi-messenger astronomy, as well as testing the general relativity and the superstring theory, my purpose is to analytically and numerically understand the massive bosonic fields on the black hole spacetimes, and to understand the dynamics by comparing the obtained results with analyrical and numerical calculations. For that purpose, the main tasks are to derive master equations for massive bosonic fields on black hole spacetimes, to construct global solutions, and to analyze the stability conditions and quasinormal modes.

Research tasks

For the static black hole spacetimes, the master equations have already been obtained by [1, 2], so it is necessary to solve these equations. On the other hand, for the rotating black hole spacetime, the master equation for the massive vector fields have already been obtained in the paper [3], but it is not clear whether the derived master equation describes all the dynamical degrees of freedom in arbitrary dimensions, so it is necessary to investigate this in detail. In addition, since for the massive tensor fields on rotating black hole spacetimes, even the separation of variables is nontrivial, so the establishment of this analytical method is also a problem to be dealt with. Therefore, the main research tasks are as follows:

I. As a preparation for rotating black hole spacetimes, we first construct a global solution of the master equation obtained in [1,2] for static black hole spacetimes, and perform the stability analysis and quasinormal mode analysis. Then, we also perform the same analysis numerically and compare the obtained results.

II. We step up to more complicated and difficult rotating black hole spacetimes and we derive the master equations for each massive bosonic field, and perform the stability and quasinormal mode analysis on rotating black hole spacetimes.

Research plans

We first focus on the analysis of static black hole spacetime in the above task I. Among the black hole spacetimes, there are interesting spacetimes such as the asymptotic AdS black hole spacetime, which is expected to be applied to the AdS/CFT correspondence, and the asymptotic dS black hole spacetime, which is closely related to the expanding universe. Therefore, we analyze the dynamics of massive vector and tensor fields on the asymptotic AdS and dS black hole spacetimes from both analytical and numerical approaches. On the massless topological black hole spacetime, we have already construct the global solution, and performed stability analysis and quasinormal mode analysis of the master equations. Therefore, we attempt to extend the same analysis to asymptotic AdS black hole spacetime by using some appropriate approximation methods such as matched asymptotic expansion and Born approximation.

[1] K. Ueda and A. Ishibashi, Phys. Rev. D **97**, 124050 (2018).

[2] V, Cardoso, T. Igata, A. Ishibashi, and K. Ueda, Phys. Rev. D **100**, 044013 (2019).

[3] V.P. Frolov, P. Krtous, D. Kubiznak, J.E. Santos, Phys. Rev. Lett. 120, 231103 (2018).