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QUASINORMAL MODES AND STABILITY OF A FIVE-DIMENSIONAL DILATONIC BLACK HOLE

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We exactly calculate the quasinormal frequencies of the electromagnetic and Klein–Gordon perturbations propagating in a five-dimensional dilatonic black hole. Furthermore, we exactly find the quasinormal frequencies of the massive Dirac field. Using these results we study the linear stability of this black hole. We compare our results for the quasinormal frequencies and for the linear stability of the five-dimensional black hole with those already published.

Keywords: Quasinormal modes; black hole; linear stability.

1. Introduction

In general relativity and related areas, the quasinormal modes (QNMs) of a black hole are physical quantities whose computation is useful because they depend on the physical parameters that characterize the space–time and the classical field. Thus, if we know the properties of the field, by measuring its quasinormal frequencies (QNFs) we infer the values corresponding to several physical quantities of the black hole (see Refs. 1 and 2 for comprehensive reviews of QNMs).

The QNMs of the gravitational perturbations propagating in several four-dimensional black holes were calculated because we expect that these modes will be significant in gravitational wave astronomy.[1–3] Also, the QNMs are useful for studying the linear stability of the black holes, because if we find modes satisfying the boundary conditions of the QNMs and with amplitudes increasing in time, then the black hole is linearly unstable.[4–7] Also, recently the QNMs have been helpful in other research lines, such as the AdS/CFT correspondence of string theory[8,9] and Hod's conjecture in quantum gravity.[10,11]

We know several three-dimensional and two-dimensional space–times whose QNFs were calculated exactly, such as the three-dimensional BTZ black hole,[9,12,13] the three-dimensional black hole of the Einstein–Maxwell dilaton with cosmological