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ON THE TIME TIMES TEMPERATURE BOUND

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Recently Hod proposed a lower bound on the relaxation time of a perturbed thermodynamic system. For gravitational systems this bound transforms into a condition on the fundamental quasinormal frequency. We test the bound in some space–times whose quasinormal frequencies are calculated exactly, as the three-dimensional BTZ black hole, the D-dimensional de Sitter space–time, and the D-dimensional Nariai space–time. We find that for some of these space–times their fundamental quasinormal frequencies do not satisfy the bound proposed by Hod.

Keywords: TTT bound; BTZ black hole; de Sitter space–time; Nariai space–time.

1. Introduction

The quasinormal modes (QNM) characterize the response of a black hole to external perturbations.[1,2] Their complex frequencies, the so-called quasinormal frequencies (QNF), determine the oscillation frequency and the decay time of the field that moves in the black hole. Furthermore the QNF depend on the physical parameters of the black hole, thus the QNM provide us with a useful tool to measure its physical properties. Some time ago, the applications in astrophysics motivated the study of the QNM.[1,2] Recently the QNM have found applications in other lines of research (see Refs. 3–6 for examples).

For a space–time, its fundamental mode, that is the least damped QNM, determines the decay time of the perturbation field when it propagates in the background. Furthermore in a space–time the decay time of the perturbation is equal to

$$\tau = \frac{1}{\omega_I}, \tag{1}$$

where ω_I stands for the absolute value of the imaginary part of the fundamental QNF ω.[1,2,7]