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Anti-de Sitter Spacetime: Stability and Instability

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Anti-de Sitter (AdS) spacetime is the maximally symmetric exact solution to the vacuum Einstein field equations with negative cosmological constant. The negative cosmological constant acts like an attractive potential, preventing timelike geodesics from reaching spatial infinity. On the other hand, null geodesics can reach spatial infinity in finite time, and one has to provide boundary conditions at infinity in order to have a well-determined Cauchy problem. Natural boundary conditions to impose are that null geodesics are reflected at infinity, conserving the energy of the spacetime. This makes pure AdS a confined spacetime, providing one with a natural spacetime to study the dynamics of fields in a cavity. In this context, it is important to understand whether AdS is stable against small perturbations, that is, whether small perturbations created in its interior remain small at later times. For AdS, it is found that when perturbed, the corresponding modes oscillate normally, having real frequencies. For asymptotically AdS spacetimes containing a black hole, as it is the case of AdS-Schwarzchild spacetimes, the modes are quasinormal, with frequencies containing both real and imaginary parts, the latter due to the decay of the modes into the black hole. These have been studied for scalar, massless vectorial and massless tensorial perturbations. The quasinormal modes are specially interesting in the context of the AdS/CFT conjecture, where a perturbation in the black hole is dual to a perturbation in the thermal state of the conformal field theory (CFT). In this work, we intend to review the most recent studies on linear stability and non-linear instability of AdS. Then, we want to compute the normal modes of AdS and the quasinormal modes of AdS-Schwarzchild for different scalar, vectorial and tensorial perturbations in dimensions greater or equal than four, interpreting the results within the scope of the AdS stability problem and the AdS/CFT conjecture.

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