NSYSU physics 書報討論

Weekly Seminar

Black Holes: Quasinormal Modes, Photon Rings and Chaos. All with a Penrose limit

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Abstract

In the high-frequency limit, the eikonal quasinormal modes of a black hole are related to the exponential divergence of the unstable circular photon orbits. We discuss an alternative method to realize this connection geometrically. We explain and derive the Penrose limit of the black holes, which describes the physics near the photon ring. We demonstrate that the obtained plane wave geometry is directly linked to the frequency matrix of the massless wave equation of an inverted harmonic oscillator form, as well as the instabilities and Lyapunov exponents of the null geodesics. As a result, the Lyapunov exponents and frequencies of the photon geodesics, along with the quasinormal modes, can be all extracted from a single Hamiltonian in the Penrose limităplane wave metric. Furthermore, we present applications of our findings on a holographic duality for astrophysical black holes, by realizing the photon ring as an effective holographic horizon.

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