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Contributory: Homothetic Killing Horizons in Vaidya and Kerr–Vaidya Black Holes

Thursday, 19 November 2026 14:15 (15 minutes)

I would like to give a presentation in which I will discuss the existence and physical implications of homothetic Killing vectors (HKVs) in a broad class of dynamical Vaidya spacetimes, including generalized spherically symmetric Husain-type solutions and rotating Kerr–Vaidya geometries. By solving the conformal Killing equations, it can be demonstrated that these spacetimes admit a unique class of HKVs only when the dynamical parameters, namely the mass, charge, and rotation parameter, evolve linearly with the advanced null coordinate. For Kerr–Vaidya spacetimes, the existence of an HKV requires both the mass and angular momentum to be dynamical and satisfy a definite relation between their rates of evolution. The null hypersurface where the HKV becomes null defines a homothetic Killing horizon (HKH), providing a natural generalization of the Killing horizon for nonstationary black holes. The presence of an HKV allows the original dynamical spacetime to be conformally mapped to a stationary spacetime, thereby enabling the application of standard geometric methods associated with Killing horizons. Using this framework, we analyse the geometric and thermodynamic properties of HKHs by evaluating different notions of surface gravity and identifying the conformally invariant surface gravity relevant for dynamical black-hole thermodynamics. Finally, a maximal analytic extension of a self-similar charged Vaidya spacetime is constructed the HKH framework provides a suitable setting for investigating the particle creation by Hawking radiation in dynamical backgrounds. These results establish homothetic symmetry as a powerful organizing principle for understanding horizon geometry, thermodynamics, and quantum phenomena in a wide class of nonstationary black-hole spacetimes.

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