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Understanding Gravitational Entropy of Black Holes: A New Proposal via Curvature Invariants

Wednesday, 6 July 2022 09:00 (45 minutes)

Pioneered with the Christodoulou-Ruffini irreducible mass and subsequently reformulated with the Hawking-Bekenstein entropy, it can be shown that the area of the horizon of a black hole cannot decrease. Partly motivated by the arrow of time problem in cosmology and the Weyl curvature hypothesis, previous works in the literature have proposed - among other possibilities - the square of the Weyl curvature, as being the underlying entropy density function of black hole entropy, but the proposal suffers from a few drawbacks. In this work, we propose a new entropy density function also based solely on the Weyl curvature, but adopting some other combinations of curvature invariants. As an improvement we find that our method works for all static black hole solutions in four and five dimensional general relativity regardless of whether they are empty space solutions or not. It should also be possible to generalize our method to higher dimensions. This allows us to discuss the physical interpretation of black hole entropy, which remains somewhat mysterious. Extending to modified theories of gravity, our work also suggests that gravitational entropy in some theories is a manifestation of different physical effects since we need to choose different combinations of curvature quantities. My talk will be based on Phys. Rev. D 105, 104017 (2022).

Presenter: GREGORIS, Daniele (danielegregoris@libero.it)

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