Contributed Talk

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Title: Black hole thermodynamics in the presence of nonlinear electromagnetic fields

Abstract: As the interaction between the black holes and highly energetic infalling charged matter receives quantum, nonlinear corrections, the basic laws of black hole mechanics have to be carefully rederived. Nonlinear electrodynamics (NLE) has its roots back in the 1930s, within the problem of infinite self-energy of the point charges, proliferating into a vast web of modern NLE theories. In this talk we shall discuss recent generalizations [1,2] of the basic laws of black hole thermodynamics in the presence of NLE fields, defined by Lagrangians depending on both quadratic electromagnetic invariants, $F_{ab} F^{ab}$ and $F_{ab} {*F}^{ab}$. Resting upon several complementing proofs of the zeroth law of black hole electrodynamics, "equilibrium state" and "physical process" versions of the first law have been derived [1] using the covariant phase space formalism. Smarr formula, originally generalized via Bardeen-Carter-Hawking mass formula [2], has been deduced from the first law with "scaling argument", giving us yet another consistency check. Finally, we shall discuss under which conditions the generalized Smarr formula attains linear form. [1] A. Bokulić, T. Jurić and I. Smolić: "Black hole thermodynamics in the presence of nonlinear electromagnetic fields", Phys. Rev. D 103 (2021) 124059 [arXiv:2102.06213]. [2] L. Gulin and I. Smolić: "Generalizations of the Smarr formula for black holes with nonlinear electromagnetic fields", Class. Quantum Grav. 35 (2018) 025015 [arXiv:1710.04660]