Dynamical and observational properties of weakly Proca-charged black holes

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Abstract

The most straightforward approach to account a mass into the vector potential of electromagnetism involves modification of the Einstein-Maxwell action into the Einstein-Proca form. By employing perturbation theory, where both the Proca mass and the black hole's charge serve as small parameters, it becomes possible to find an exact analytical solution. In this solution, the metric tensor remains unchanged, but the vector potential deviates from the Coulomb potential. Notably, even when the Proca mass lies within the range below the current experimental upper limit for photon mass, it contributes significantly to the dynamical equations. Further, we examine the motion of neutral and charged particles in the vicinity of a weakly charged Proca black hole. We also discuss the observational implications of the solution on the gravitational bending, black hole shadow, and fitting of the Galactic Center flare orbits.

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