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Black hole superradiance as a source of high-energy cosmic rays

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Ultralight charged bosons can extract energy, angular momentum, and charge from a Kerr–Newman black hole (BH) due to superradiant instability, resulting in the formation of a BH–condensate system. In this work, we focus on a scalar field with a minicharge and numerically investigate in detail the evolution of this system. We find that even a tiny initial mass asymmetry between the positively and negatively charged components of the condensate can induce continuous charge accumulation in an initially neutral BH. BHs can accumulate charges large enough to induce the Schwinger effect, which leads to a copious production of electron–positron pairs. The particles carrying the charge opposite to that of the BH are emitted with electrical potential energies up to $\sim 10^{21}$ eV, suggesting that BH superradiance may serve as a source of high-energy cosmic rays.

Primary author(s) : ZHANG, Hong (Shandong University -Qingdao); Mr XU, Qi-Xuan (Instituto Superior Tecnic, Universidade de Lisb); BAO, Shou-shan (Shandong University); Mr GUO, Yinda (Shandong University)

Presenter(s) : Mr GUO, Yinda (Shandong University)

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