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General features of energy extraction from black holes through charged particle production

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There has been a surge of interest into collisional Penrose process after Bañados, Silk and West described an idealised edge case, in which particles coming from rest at infinity can collide with arbitrarily high centre-of-mass collision energy close to the horizon of a black hole. However, it turned out that in the vacuum case, there is an unconditional upper bound on the efficiency of extraction of energy from the black hole through such processes even under the most idealised conditions. On the other hand, in the less studied charged case, no such bound has been found. Indeed, in our previous work [PhysRevD.100.064041, PhysRevD.105.024014], we have shown that the bound is absent whenever both the black hole and the escaping particle are charged, even if the black-hole charge is arbitrarily small. Nevertheless, this conclusion was derived under the approximation of the black hole being extremal and the collision happening at an infinitesimal coordinate distance from the horizon. Such approximations are not the most fitting for elementary particles, which have enormous charge-to-mass ratios. In the present talk, we examine a simple model process with such realistic particles and show that it has generic features, which are similar for both extremal and subextremal black holes, but which are not captured by the near-horizon approximation in the extremal case.

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