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# Penrose process in Reissner-Nordström-AdS black hole spacetimes: Black hole energy houses and black hole bombs

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## Abstract

The Penrose process provides a mechanism of extracting energy from black holes related to particle decays. It was originally applied for rotating black holes, which have ergoregions, i.e., regions with negative energy states. In crossing the ergoregion, a parent particle can decay into two particles, in such a way that one of the particles falls into the black hole and the other escapes to infinity. The falling particle can have negative energy, and due to energy conservation, the escaping particle must then have an energy larger than the parent particle. The Penrose process can also occur with electrically charged particles in electrically charged Reissner-Nordström black hole spacetimes. Recently, it has been considered a confined Penrose process in a Reissner-Nordström black hole spacetime. It has been shown that in the presence of a reflective mirror, placed at a certain radius to reflect back the outgoing energetic particles and providing thus a confining box, one can build a black hole bomb using the Penrose process recursively, analogously to the black hole bomb built on superradiant scattering. Now, asymptotically anti-de Sitter (AdS) spacetimes, spacetimes with negative cosmological constant, confine particles and provide a natural box in which particles emitted to infinity are scattered back. It is thus of interest to know if there is the possibility of building a black hole bomb in a pure Reissner-Nordström-AdS background through a recursive Penrose process. With a reflective mirror placed at some radius, there are instances where one can store a finite amount of energy in a given region leading to a black hole energy house, and there are other instances where the energy stored tends to infinity leading to a black hole bomb. Taking the mirror to infinity, i.e., in a pure Reissner-Nordström-AdS spacetime, one can show that there is no black hole bomb. This is because without the mirror the volume in which the particles remain confined, increases to infinity along the chain of decays, leading to an effective zero value of the energy extracted per unit volume. Thus, the effect of taking the mirror to infinity is of demining the bomb.

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