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Entropy created when colliding particles fall into a black hole

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If two particles collide in the vicinity of a black hole horizon, their center of mass energy is practically unlimited, so another black hole with a large mass and thus entropy can be created. The resulting black hole can then merge with the original one. If the black hole is created very close to the horizon, its energy will be highly redshifted for ansymptotic observer. However, its entropy is not redshifted. We demonstrated that the newly created entropy can be higher than the Bekenstein-Hawking entropy of the final black hole, though we neglect that a certain amount of energy can escape to infinity, carrying away part of the entropy produced in the process. This is a counterexample to the statement that the black hole thermal entropy counts all the states inside the black hole. Unlike similar examples, this colliding process does not involve exotic matter, alternative theories of gravity, nor artificial ad hoc gluing of two different spacetimes.

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