Modelling Energy Extraction via the Penrose Process in Analog Black Holes

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Black holes exhibit extraordinary behavior unparalleled in the known universe, providing the opportunity for experimental insight into determinism, extra dimensions, and the intersection of general relativity and quantum mechanics. All the more, black holes present the exciting possibility to one day act as an energy source through the Penrose process. The Penrose process is also a candidate to explain high energy, relativistic jets observed to be emitted from rotating black holes. Direct experimental study of the Penrose process is difficult, considering the many light-years distance separating Earth from the nearest black hole. The role of analog black holes, in this case composed of a carefully engineered fluid, is to allow for experiments to be performed in a laboratory on Earth. In this project, the Penrose Process is modelled in the fluid analog to generate data to be compared against results of the corresponding experiment, and thus provide further insight into the nature of black holes and their energy applications. This is done by solving for the trajectory of an object undergoing the Penrose process numerically using MATLAB and mapping it into the fluid analog. A velocity and density function of the fluid is obtained, altogether allowing a comprehensive analysis of the expected results of an analog Penrose process experiment.

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