Understanding the physics of black holes in extended space-time

Black holes are massive objects in the Universe whose gravitation is strong enough to capture even light, and which consist of a singular point in its center surrounded by the event horizon determining the limit beyond which no information can espace the black hole.

The main obstacle with black holes is that its center has such a high mass density which makes it necessary to apply the laws of General Relativity, but then also is singular which requires a quantum physical description. Unfortunately, a fundamental theory of quantum gravity does not exist and thus it is not possible to describe the complete physics of black holes.

However, in a recent paper [C. Köhn, 2020. A Solution to the Cosmological Constant Problem in Two Time Dimensions. J. High Ener. Phys. Grav. Cosm., vol. 6, pp. 640-655] it was shown that the existence of a second time dimension could avoid the singularity at the Big Bang which poses the question whether a second time dimension could also mitigate the problem of a singularity in black holes.

The project will consist of extending four dimensional metrics, which describes the physics of black holes, to five dimensions with two time dimensions and of solving the corresponding Einstein equations. The main goal would be to understand whether this extension would improve our understanding of the physics of black holes. Special care needs to be taken to ensure that in the limit of one time dimension only results are compatible with the solutions for the four dimensional metrics. After the analytic treatment of the five dimensional metric, numerical simulations could be performed to understand the proximity of black hole centers.

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