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The nature of trapping horizons in collapses forming black holes

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In the context of gravitational collapse to form a black hole, one sees the appearance of inner and outer trapping horizons (foliated by marginally trapped surfaces), as was already noted in numerical calculations in the 1960s. This phenomenology has acquired new interest in connection with discussions of the Hayward unified first law of black hole dynamics. We have investigated the nature of the inner and outer horizons (ie whether they are spacelike, timelike or null), making contact with the Misner-Sharp formalism used in calculations for collapse of spherically symmetric fluid configurations to form black holes. By means of numerical simulations, we have followed the R=2M condition dynamically during the gravitational collapse, and have found that the nature of these trapping horizons is given by a very simple expression depending on the equation of state, related also to the velocity of the horizon with respect the collapsing fluid. Whether these horizons are spacelike or timelike plays an important role in in classical depletion and quantum evaporation of black holes because only timelike or null horizons allow particles to pass through. We have observed different behaviours for the cases of stellar collapse and primordial black hole formation within an expanding Universe, resulting from the different nature of the matter involved. In this talk we will present results from our investigations.

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