NUS National University of Singapore | Department of Mathematics
Faculty of Science

Research Highlight: Emergence of Apparent Horizon in Gravitational Collapse

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In general relativity, to study the evolution of the Universe and to understand the details of black hole formation, we need to solve the Einstein's equations, which are a system of super-critical quasilinear hyperbolic system, composed of 10 separate equations.

In this work, we solve Einstein vacuum equations in a spacetime region up to the "center" of gravitational collapse. Within this region, we construct a sequence of marginally outer trapped surfaces (MOTS) with areas going to zero. These MOTS could be considered as the analogue of minimal surfaces in spacetime and they form a marginally outer trapped tube (apparent horizon). It emerges from a point and is smooth (except at that point). In the proof we employ a scale critical trapped surface formation criterion established by An and Luk and a new type of quasilinear elliptic equation is studied. One of the main conclusions in this work proves a conjecture of Ashtekar on black hole thermodynamics. And the spacetimes constructed here could also be viewed as (non-spherically symmetric) generalizations of the well-known Vaidya spacetime.

References:

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