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Theory: Geometry of the black-to-white hole transition

Thursday, September 7, 2023 2:45 PM (15 minutes)

The Oppenheimer-Snyder model is the prototypical example of black hole formation by gravitational collapse. It predicts that a black hole horizon is formed once a star collapses to within its own Schwarzschild radius. After that, the collapsing matter reaches Planckian densities in a short proper time. What happens next is outside the reach of general relativity, as it involves the quantum behavior of the gravitational field in the strong field regime.
By considering quantum corrections coming from loop quantum gravity I will show how the quantum-corrected Oppenheimer-Snyder model predicts a non-singular black hole interior and a bounce of the collapsing star. However, this model does not take into account the quantum corrections to the physics of the outer horizon. For this reason, starting from the spacetime of the quantum-corrected Oppenheimer-Snyder model, in which the interior trapped region undergoes a transition to an anti-trapped region (passing through an intermediate non-trapped region), I will then construct a spacetime where the outer horizon undergoes a quantum transition from trapping to anti-trapping as well. In this scenario the black hole evolves into a white hole "remnant" living in the future of the parent black hole, in its same asymptotic region and location.
I will derive the metric describing the spacetime in a single coordinate patch and discuss the resulting geometry of the black-to-white hole transition.

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