Seventeenth Marcel Grossmann Meeting



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Revisiting compaction functions for primordial black hole formation

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Shibata and Sasaki [Phys. Rev. D 60, 084002 (1999)] introduced the so-called compaction function. Since then, it has been empirically established that the maximum value of this function (or its volume-averaged counterpart) in the long-wavelength solutions gives a very robust threshold of primordial black hole formation. In this paper, we show that in spite of initial intention, the Shibata-Sasaki compaction function cannot be interpreted as the ratio of the mass excess to the areal radius in the constant-mean-curvature slice of their choice but coincides with that in the comoving slice up to a constant factor depending on the equation of state. We also discuss the gauge (in)dependence of the legitimate compaction function, i.e., the ratio of the mass excess to the areal radius.

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