

On the definition of mass and center of mass of isolated systems in Newtonian gravity and general relativity

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ABSTRACT

Isolated gravitating systems such as stars, black holes or galaxies play an important role both in Newton's theory of gravity(NG) and in general relativity (GR). While the definition of mass and center of mass via the mass density is straightforward in NG, GR knows several promising approaches. The most important definitions of center of mass in GR go back to Beig and O Murchadha/Arnowitt, Deser and Misner (BM/ADM) as well as to Huisken and Yau (HY). Under certain assumptions on the asymptotic decay, the BM/ADM and the HY centers coincide (Huang, Metzger-Eichmair, Nerz). However, both notions subtly depend on the chosen asymptotic coordinates; in particular, we will present an explicit example in which both centers diverge and a corresponding example in NG (C-Nerz). Moreover, we will relate the Newtonian and the relativistic centers with the help of the Newtonian limit (in the case of static systems).