Numerical General Relativistic Simulations: Core Collapse Supernovae and Neutron Stars Astrophysics

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Abstract

The formation and behaviour of compact objects are highly complex and relativistic phenomena that require numerical simulation to model accurately. Most of the existing studies on core-collapse supernovae and oscillating neutron stars are based on Newtonian gravity or effective potentials. However, the compactness of a (proto-)neutron star, defined as the ratio of the Schwarzschild radius to its radius, is far larger than massive stars. For these systems, Newtonian gravity will no longer be valid and ignoring relativistic strong-field effects could return inaccurate results. In particular, few studies have considered relativistic strong-fields effects for the post-bounce evolution of proto-neutron stars and the oscillation of hypermassive/cold neutron stars. We use a new multidimensional general-relativistic hydrodynamics code to investigate the proto-neutron star formation in core-collapse supernovae and the corresponding g-mode oscillation, and the properties of the oscillating (hypermassive/cold) neutron stars. In particular, we present the influence of general relativity on neutron-star evolution, the f/r-mode instabilities and gravitational-wave asteroseismology.

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