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A research of proto-neutron star evolution and the structure near the surface

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A proto-neutron star (PNS) is born after a core-collapse supernova. The size of the young neutron star exceeds that of a typical neutron star and consists of dense, hot nuclear matter. In discussions of PNS evolution, neutrinos play a crucial role. It is generally understood that the emission of neutrinos leads to the cooling of the PNS. With upcoming neutrino detectors such as upgraded water-Cherenkov observatories and the liquid scintillator detector JUNO in China, the observable duration is expected to extend to several tens of seconds during a Galactic supernova event.

To investigate the long-term evolution of the PNS, we employed a quasi-static evolution code that solves neutrino transport using a multi-group flux-limited diffusion scheme under spherical symmetry with general relativity. We computed the evolution up to 50 seconds for two different nuclear equations of state (EOS). Additionally, we discuss the thermal structure near the surface where the crust is expected to form.

Since convective motions within the PNS are expected to significantly affect its evolution, we implemented a diffusion-based treatment of convection in our code. Partial evolution results incorporating this convective module are also included for comparison with earlier models.

Collaboration you are representing

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