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Multi-dimensional core-collapse supernova simulations with the Boltzmann-radiation-hydrodynamics code

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In this talk, I would like to report the recent results of the multi-dimensional core-collapse simulations with the Boltzmann-radiation-hydrodynamics code, which solves the Boltzmann equations for neutrino transport directly. The neutrino transport is an important ingredient of the core-collapse supernova (CCSN) simulations since the neutrino heating plays a crucial role in the explosion mechanism. Indeed, the fact that the CCSN does not explode under the spherical symmetry is concluded by the Boltzmann-radiation-hydrodynamics simulations. Among recent multi-dimensional CCSN simulations, only our Boltzmann-radiation-hydrodynamics code solves the neutrino transport in a direct manner.

We simulate the collapse of non-rotating and rotating cores of the progenitor with $11.2\,M_\odot$ with Furusawa-Shen and Lattimer-Swesty equations of state under the axisymmetry. We pay particular attention to the neutrino distribution in phase space, which is accessible only by the Boltzmann solver. Especially, we compare the Eddington tensors calculated both from the raw data and from the M1-closure approximation. We find that the difference in the Eddington factors reaches $\sim 20\%$ in our simulation. This is due to the different dependence of the Eddington and flux factors on the angular profile of the neutrino distribution function, and hence modification to the closure relation is needed.

Keywords

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