

The MHD-CCSN code comparison project

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The gravitational collapse of massive stars can lead to extreme stellar explosions when both fast rotation and strong magnetic fields are present during the onset of the supernova. A detailed understanding of how magnetic fields extract angular momentum from the central proto-neutron star is paramount to produce quantitative predictions with respect to not only the explosion dynamics, but also the associated multi-messenger emission of gravitational waves and neutrinos. Numerical simulations are one of the most important tools at disposal to characterize the properties of magneto-rotational supernovae. Their ever-increasing accuracy and complexity allows one to tackle the non-linear dynamics at work during the onset of such explosive events, but there are still many uncertainties related to the specific numerical algorithms and physical approximations adopted.

I will present recent results obtained by an on-going comparison project that involves 5 state-of-the-art codes for the modeling of extreme core-collapse supernovae. Starting from the same initial conditions (i.e. a massive star with a fast rotating and highly magnetized inner core) all codes produce prompt magneto-rotational explosions. All models lead to proto-neutron stars with similar masses and rotation, but we observe some variations in quantities such as the shock expansion and the explosion energy which are connected to the technical properties of the individual codes. I will discuss the impact that aspects such as neutrino transport, grid geometry, and gravity treatment can have on both the explosion and the associated multi-messenger emission.

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