Contribution ID: **70** Type: **Poster**

3D numerical study of gravitational-wave signatures from magnetorotational effects in extreme core-collapse supernovae.

Monday 21 July 2025 16:34 (2 minutes)

Core-collapse supernovae are among the most energetic explosions in the universe. Their evolution is shaped by hydrodynamics, neutrino transport, and magnetic fields at work in the first seconds after collapse. We investigate these processes through 3D simulations of an extremely compact 39 Msun progenitor using the FLASH M1 magnetohydrodynamics code. Our study explores three models –a non-magnetized non-rotating baseline model, a non-magnetized rotating model, and a magnetized rotating model –to highlight the roles of rotation and magnetic fields in shaping the explosion mechanisms and associated gravitational-wave (GW) and neutrino signatures.

We evolve each model from core collapse through bounce into the early post-bounce phase. We employ a three-species, energy-dependent M1 moment scheme for neutrino transport, incorporating a state-of-the-art nuclear equation of state and advanced treatments of deleptonization and neutrino heating/cooling. All models undergo similar gravitational collapse and bounce. However, during post-bounce, rotation and magnetic fields significantly impact the shock dynamics, explosion morphology, protoneutron star evolution, and variations in neutrino emission.

We specifically analyze GW signals derived from quadrupole moment calculations and neutrino emission asymmetries, emphasizing how rotation and magnetization distinctly shape these signals. We highlight key features in the GW emission patterns, such as frequencies, amplitudes, and time evolution, that could aid observational identification of magnetorotational effects. Our results underscore the potential of GW astronomy to differentiate magnetorotationally influenced explosions from more spherical scenarios. Future work will extend our gravitational wave analysis by refining neutrino microphysics, incorporating full general-relativistic treatments, and exploring a broader range of progenitor conditions.

Presenter: KOVALENKO, Liubov (Stockholm University)

Session Classification: Poster Sparkler