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Simulation of Core Collapse Supernovae[1]

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One of the most interesting open problems in modern astrophysics is the origin of the chemical elements of which we and the planet we live are made. We know now that most of the heavy elements (i.e., heavier than Iron) are produced in core collapse supernova explosions (CCSN). These explosions mark the end of the lives of stars with masses in the range of ten to a few dozens solar masses and they still carry mysteries very hard to unravel. Chief of them is the mechanism by which the explosion itself occurs. Simulating CCSN is one of the hardest challenges in numerical astrophysics and despite of decades of work and great progress, the physical processes that fuel the explosion are not yet fully understood. To complicate matters, the astronomical observations of CCSN are mostly confined to electromagnetic signatures that provide information on processes occurring at the explosions outer boundaries since the core is deeply shrouded in opaque material. Fortunately, CCSN are among the sources that will produce gravitational waves (GW) detectable by GW observatories around the globe. In particular, a Galactic supernova event will likely produce a signal well within the Advanced version of the ground-based GW observatories across a broad range of frequencies. Comparisons of GW signals with numerical models could settle many questions about the origin and evolution of CCSN. This talk will cover some of the latest simulations of CCSN with particular emphasis in the generation of long term GW (i.e., covering about the first second of the explosions) and the numerical challenges they face currently and in the road ahead.

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