Universität Basel

Research Project

FaInt Supernovae and Hypernovae: Mechanism and Nucleosynthesis

Third-party funded project

Project title FaInt Supernovae and Hypernovae: Mechanism and Nucleosynthesis
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<!– @page { margin: 2cm } P { margin-bottom: 0.21cm } –> Massive stars in the range of 8-140M undergo core-collapse at the end of their evolution, leading to a central neutron star or possibly a black hole. Stars in the mass range of 140-260M have been expected to experience thermonuclear explosions, known in the literature as pair instability supernovae (PISNe). More massive objects will form black holes during their final collapse. If these events lead to ejecta, they will have experienced explosive burning, possibly under the strong influence of interactions with neutrinos. **The impact of the most massive objects will enter at the earliest stages of the evolution of galaxies, influencing the abundance pattern visible in the spectra of extremely low metallicity stars, both topics of extremely active research**. Apparently one does not observe the abundance yields expected from PISNe, indicating that probably all very massive stars underwent strong mass loss during their evolution and undergo final core collapse. It is still an open issue, whether and how this collapse leads to neutron star formation or black holes (possibly also occurring subsequently), forming as a function of progenitor mass **supernova events (SNe)**, **faint supernovae** with fallback from the innermost ejected zones (**faint SNe)**, or **hypernovae/collapsars/gamma-ray bursts (GRBs)** in conjunction with rotation, magnetic fields and highly energetic explosions. **The focus of the present proposal is this transition region in stellar progenitor mass and its nucleosynthesis contributions to galactic evolution, linking diverse research fields like nuclear physics far from stability, the equation of state of dense objects, 3D magnetohydrodynamics with neutrino transport and computational methods**. The outcome is of **extreme importance** in understanding the **nucleosynthesis impact of the first stars**, the **chemical evolution of galaxies** and the **origin of all elements**, including those **processes with still highly uncertain origins/sites** like the **r-process**, the ν**p-process** - where the upper limit of atomic masses affected has still to be determined, and the **p-process** where the traditional explanation fails for the abundances of lighter p-nuclei, and the **Fe-group composition**.

Keywords faint supernovae, hypernovae, gamma-ray bursts
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