Role of neutrinos for the nucleosynthesis of heavy elements beyond iron in explosions of massive stars

Tobias Fischer[1], Gabriel Martínez-Pinedo[2,3], Lutz Huther[2] and Andreas Lohs[2]

[1] *University of Wroc law, Pl. M. Borna 9, 50-204 Wroc law, Poland*
[2] *University of Darmstadt, Schlossgartenstrasse 2, 64289 Darmstadt, Germany*
[3] *GSI, Helmholtzzentrum für Schwerionenforschung GmbH, 64291 Darmstadt, Germany*

Motivated from recent observations of metal-poor stars (metalicity as stellar age tracer)core-collapse supernovae are being reviewed as nucleosynthesis site for the production of heavy elements beyond iron. In addition, modeling core-collapse supernovae requires the inclusion of a broad spectrum of physical phenomena. In particular, the high densities and temperatures reached during such events, as well as the large neutron-to-proton asymmetry of high density matter, could in principle be addressed by heavy-ion collisions. These together with observational, masses and radii of neutron stars, and theoretical constrains provide powerful constrains on the nuclear equation of state that is one of the largest uncertainties in modeling core-collapse supernova. Relevant for the synthesis of elements is the material ejected in the actual supernova explosion, and in particular the neutrino-driven wind. It is a low-mass out ow which develops independent from details of the explosion due to continuous neutrino heating at the surface of the newly formed protoneutron star. After the explosion has been launched the protoneutron star settles into a quasi-static state, which can be modeled within the framework of spherically symmetric general relativistic radiation hydrodynamics. Here, I will discuss the role of neutrinos as key players in determining the nucleosynthesis relevant conditions for the production of heavy elements beyond iron. In general, neutrinos of all avors diuse from high towards low densities at the protoneutron star surface where they nally decouple from matter, over a timescale of 10{30 seconds. Of particular importance is thereby the accurate treatment of neutrino transport including neutrino opacities consistent with the underlying equation of state. This determines the spectral dierences between electron neutrino and antineutrino, which in turn sets the proton-to-neutron ratio of the ejected material and hence the number of unbound neutrons available for potential r-process nucleosynthesis. Up to now this important quantity cannot be uniquely determined taking into account current uncertainties. Nevertheless, recent advances point to the robust production of intermediate-mass nuclei with 32< Z <50 known as light neutron-capture elements.

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