NUSTAR / Theory Seminar

Andre Sieverding

University of Minnesota, USA

Wednesday, May 08, 2019 at 15:15 p.m.

Seminar Room Theory SB3 3.170a

Planckstraße 1, 64291 Darmstadt

“The ν-process with fully time-dependent supernova neutrino emission spectra”

The ν process contributes to the production of a few rare isotopes (in particular ^{11}B, ^{138}La and ^{180}Ta) in supernova explosions via neutrino induced nuclear reactions. This process has been studied in various publications and one of the key ingredients for the calculations is the modeling of the neutrino emission that has previously been approached in a purely parametric way, restricted to the characteristics of the proto-neutron star cooling phase.

We improve on this approach by using, for the first time, data from a detailed supernova simulation about the neutrino emission to carry out a supernova nucleosynthesis study. Compared to parametric approaches, the neutrino emission predicted by a simulation involves time-dependent neutrino spectra, i.e., time- dependent average neutrino energies and also a time-dependent spectral shape, deviating from a non-degenerate Fermi-Dirac distribution. Important for the ν process is in particular the fact that the neutrino spectra during the early emission phases, i.e., the deleptonization burst and the accretion phase, are more energetic than the proto-neutron star cooling phase. Comparing the nucleosynthesis results based on the simulation data to different approaches of parameterizing the neutrino emission we find that the early phases of neutrino emission have a significant impact on the nucleosynthesis results. We identify subtle differences in the nucleosynthesis that arise purely from the timing of the neutrino emission relative to the propagation of the supernova shock and including for the first time the spectral shape (pinching), we find, that it does not have a large effect on the results. Due to the sensitivity of the ν-process yields to the duration of accretion phase we find that prompt as well as very late explosions lead to tensions with the observed solar system abundances.

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