Contribution ID: **17** Type: **not specified**

Origin of the LEPP nuclei in supernovae

Thursday, 15 July 2010 15:00 (30 minutes)

Observations indicate that r-process elements have at least two components. The heavy r-process nuclei (A>130) are synthesized by rapid neutron capture in a yet unknown site. The second component corresponds to the lighter element primary process (LEPP) or weak r-process. Our nucleosynthesis studies are based on hydrodynamical simulations for core-collapse supernovae and their subsequent neutrino-driven winds. We show that heavy r-process elements cannot be synthesized in these neutrino-driven winds. However, LEPP elements can be formed for a broad range of conditions. We have studied the impact of the electron fraction on the LEPP. This provides constraints on the electron fraction evolution based on the pattern observed in the atmosphere of UMP stars. We have found that the elemental abundances can be reproduced under proton-rich conditions explaining the origin of the LEPP elements found in UMP stars. However, isotopic abundances show that only p-nuclei are produced, discarding proton-rich winds as the origin of LEPP nuclei in the solar system, where also neutron-rich isotopes are expected. Our results show that, in neutron-rich winds, LEPP elements (including all isotopes) are also synthesized, but with the old overproduction problem around A=90. Future observations of isotopic abundances in UMP stars can discriminate between proton- and neutron-rich winds. These will give rise to new insights that can constrain the evolution of the electron fraction and thus of neutrino properties in supernovae.

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Session Classification: Session 1: r-process: Observations vs. models