Precise nuclear binding energies for the r process and core collapse

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The r-process abundances depend sensitively on nuclear masses, i.e. binding energies [1]. We have recently measured masses of several rare-earth nuclei with the JYFLTRAP Penning trap in Jyväskylä and studied their impact on the r-process calculations. The rare-earth abundance peak at $A \approx 165$ forms during the later stages of the r process and reflects both the astrophysical conditions as well as properties of nuclei in the region [2]. The observed weaker neutron pairing toward the midshell at $N = 104$ results in a smoother abundance pattern and in a better agreement with the observed solar r-process abundances [3]. In addition to the main r process, we have determined masses of several nuclei close to ^{78}Ni relevant for the core collapse phase of supernovae. Prior to collapse the nuclei are in nuclear statistical equilibrium (NSE), and the abundances are governed mainly by nuclear binding energies. On the other hand, electron captures on nuclei play a key role in the collapse [4]. They drive matter toward more neutron-rich nuclei, cool the core via neutrino emission and reduce the amount of electrons thus affecting the electron degeneracy pressure resisting the gravitational collapse. In this contribution, I will give an overview of these recent mass measurements at JYFLTRAP and discuss their astrophysical motivation and impact.

References

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