Mass measurements at the extremes: an input for astrophysical calculations

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Nuclear masses play an important role in many calculations in nuclear astrophysics.

There exist numerous mass measurement techniques that offer various possibilities; from high precision mass measurements of nuclei close to the line of stability to the mass measurements of very exotic species. The latter ones struggle with very short half-lives and difficulties associated with production of the ions. The most exotic nuclei are accessed by time-of-flight techniques at radioactive beam facilities. In general, a TOF mass measurement can be provided with a rate of 0.01 particle/s. On the contrary, the Penning trap measurements with the best precision require at least 100 particle/s.

The NSCL facility offers ideal opportunities for TOF mass measurements of very exotic ions. We have recently implemented a TOF-Bρ technique at the NSCL and performed a mass measurement of neutron-rich nuclides in the Fe region. Mass values of neutron rich nuclei are important for r-process calculations, and for calculations of processes occurring in the crust of accreting neutron stars.

At the NSCL, a primary beam ^{86}Kr was accelerated in the K500 and K1200 coupled superconducting cyclotrons to the energy of 100MeV/u. A fast radioactive beam was then produced by fragmentation reactions in the 47 mg/cm^2 and 94 mg/cm^2 Be targets and separated in the A1900 fragment separator. For this experiment a 58 m long time-of-flight path was used starting at the extended focal plane of the A1900 and ending at the focal plane of the S800 spectrograph. Fast scintillation detectors provided a timing resolution of about σ=30 ps, the relative magnetic rigidity Bρ was measured at the momentum dispersive plane of the S800 by position sensitive micro-channel plate (MCP) detectors.

Details of the experimental technique will be discussed and preliminary results will be presented.