Contribution ID: **266** Type: **Invited Presentation**

Precision Mass Measurements of Neutron-rich In Isotopes Relevant to r-process Calculations

Tuesday, 30 May 2017 17:35 (15 minutes)

Mass measurements of nuclei far from stability provide an important input to nuclear structure studies and simulations of the rapid-neutron capture process (r-process), the proposed mechanism by which many of the elements heavier than iron are created. Since the exact astrophysical site of this process is still under debate, the route by which the chain of neutron captures, photodissociations and beta decays proceeds through the nuclear chart is uncertain, and sensitive to the model inputs. Precise neutron separation energies, derived from mass measurements, are particularly important for the calculation of elemental abundances predicted by various r-process scenarios.

The TITAN experiment at TRIUMF has recently measured the masses of the ground and isomeric states of the neutron-rich indium isotopes A=125-130 using the time-of-flight ion cyclotron resonance technique in a precision Penning trap. Isotopes near neutron shell closures, such as $^{125-130}$In, are particularly important for r-process calculations. At these points, the rate of neutron capture slows, resulting in experimentally observed abundance peaks. The indium isotopes presented here lead up to the N=82 shell closure at ^{131}In, and their mass uncertainties are critical for predictions of the A=130 abundance peak. They also present a significant improvement in precision over previous measurements, from which only ^{129}In/^{129m}In were well known. This increase in precision will feedback into r-process calculations and mass models, leading to improved future predictions. The significance of these new high-precision mass measurements for elemental abundance predictions will be discussed, as well as the implications for nuclear structure, based on comparisons to theory.

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Session Classification: Breakout 1