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Precision mass spectrometry of short-lived nuclei with minute production rates

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As matter becomes very neutron-rich, the proton-neutron imbalance changes the structure of nuclei with respect to the level ordering observed in stable nuclei. Since models used for predicting the structure of exotic nuclei are fitted to describe the shell gaps in stable nuclei, the question arises whether these models produce a correct description of the shell closures far from stability where nuclei typically have very short half-lives. The position and strength of these closures are critical for the successful modelling of astrophysical processes, where masses are needed as important input.
The mass spectrometer ISOLTRAP consists of four traps, a radio-frequency Paul trap for beam cooling and bunching, two Penning traps –the first for purifying the beam, the second for the actual mass measurement – and an electrostatic mirror trap acting as a multi-reflection time-of-flight mass separator (MR-TOF-MS). This device is especially suited for mass measurements on nuclides with ms half-life and production rates of only a few ions per second and still provides uncertainties sufficient to answer nuclear-structure and astrophysical questions.
The recent measurements on neutron-rich calcium and potassium isotopes up to 54Ca and 53K as well as a comparison to recent ab-initio calculations using three-nucleon forces will be presented.

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