Precision mass measurements of refractory radioactive isotopes

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The atomic mass of a nucleus carries fundamental information on the masses of its constituents and the binding energy. Thus precise mass measurements may reveal information on the macroscopic and microscopic structure of the nucleus. The binding energies are also important ingredients for reliable calculations in nuclear astrophysics. They affect the rates of the relevant reactions and they influence the time-scale and energy production of nucleosynthesis. In summary, the binding energies adjust the balance, which defines the process paths.

A combination of the ISOL-method and Penning trap technology has opened up the possibility to extend direct precision measurements to radioactive isotopes. At JYFL we have combined Penning trap technology with the IGISOL-technique, thus precision studies of atomic masses can be expanded to short-lived exotic isotopes without target-ion source chemistry related restrictions [2]. A Penning trap is well suited for mass spectroscopy, since radial eigenmotions in the trap sum up to a cyclotron motion, the frequency which in the given magnetic field is mass dependent. By measuring periodically the cyclotron frequency of the unknown isotope and a well known reference ion, it is possible to deduce the mass of the unknown isotope with an accuracy in the range of a few keV.

In this presentation we will review the mass measurements of neutron-rich nuclei in the transitional region from Ge (Z=32) to Pd (Z=46) nuclei [1,2], where more than a hundred atomic masses have been recently measured at JYFL. This region offers an interesting playground to look for nuclear structure signatures in the mass surface, which appear as anomalies in relative binding observables, like two neutron separation energies (S_{2n}), pairing (Δ_n, Δ_p) and shell gap energies. The results are discussed in comparison to other spectroscopic information and theoretical studies. In addition, we will compare our results to the recent Atomic Mass Evaluation [3]. The observed local deviations of tabulated values from precision measurements will be discussed.

We have also initiated a project to measure the binding energies of nuclei located in the expected region of the rp-process path. These measurements include $^{80-83}$Y, $^{83-86,88}$Zr and $^{85-88}$Nb isotopes [4], of which ^{84}Zr has been measured for the first time. The obtained data has improved considerably S_p and Q_{EC} values for astrophysically important nuclides. These results will also be reviewed in this contribution.

This work has been supported by the EU-FP6 I3-EURONS activity TRAPSPEC and by the Academy of Finland under the Finnish Centre of Excellence Programme.

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