Final Results of Schottky Mass Measurements with New *TCAP*-System at the ESR ◇

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Schottky Mass Spectrometry, an excellent tool for systematic nuclear mass measurements, has been improved by the development of the new Time Capture System *TCAP* [2] which yields several advantages for the data analysis. The *TCAP*-System leads to a new quality of raw data compared to former measurements [4], [5], [6] by storing the digitized frequency signal with 16 bits of resolution and a sampling rate of 640 kHz.

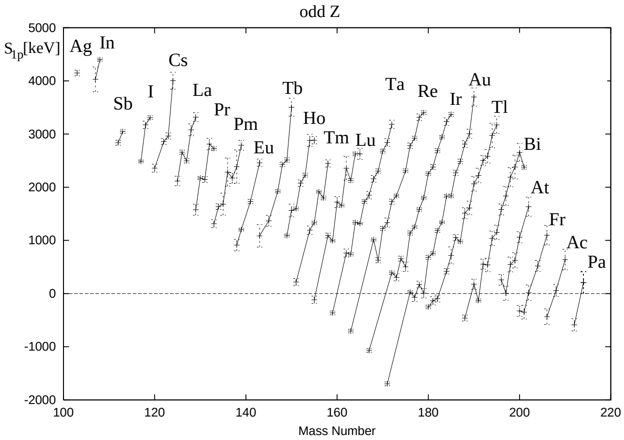
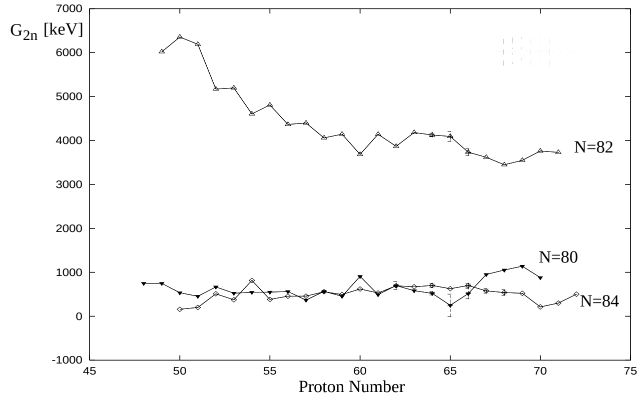


Fig. 1: 1-Proton separation energy versus mass number of measured nuclei for odd proton nuclei.

The systematic determination of the mass surface for neutron deficient Bi-fragments has been done using Schottky Mass Spectrometry with the *TCAP*-System [3] at the ESR at GSI. In the experiment masses of 346 nuclei between Rh and Po with half-lives down to 10 s were measured containing 152 nuclei with previously unknown mass values. Using known Q_α-values for mass determination along α-chains linked to the region of measured masses, another 88 previously unknown masses with half-lives down to milliseconds habe been derived. From the experimental mass values 1-proton separation energies S_{1p} were calculated with errors of (35-200) keV. As shown in Fig. 1 values for S_{1p} for odd-Z nuclei between Lutetium and Protactinium get negative, fixing the proton-drip line in this region.

Differences $G_{2n} = S_{2n}(Z,N) - S_{2n}(Z,N+2)$ and $G_{2p} = S_{2p}(Z,N) - S_{2p}(Z+2,N)$ of 2-neutron and 2-proton separation energies calculated from the measured mass values increase near doubly magic nuclei indicating 'mutual support' of magicity. This is shown for the isotones $N = 80, 82, 84$ near the doubly magic nucleus $^{132}_{50}Sn_{82}$ (upper part of Fig. 2), for the isotopes $Z = 80, 82, 84$ near the doubly magic nucleus $^{208}_{82}Pb_{126}$ (not shown) and for the Gd isotopes (lower part of Fig. 2). A subshell closure at $Z = 64$ is derived with the G_{2p}-values from the measured masses of Gd and Dy isotopes.



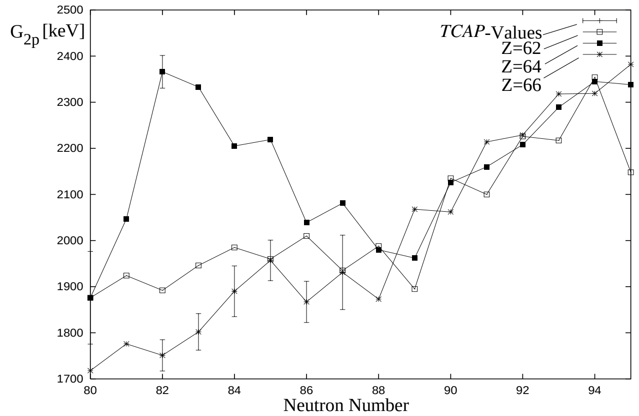


Fig. 2: Differences of 2-neutron (upper part) and 2-proton separation energies calculated from experimental mass values (with error bars) and from literature values (without error bars).

With the new *TCAP*-system a mass resolution of $\Delta m/m = 1.8 * 10^{-6}$ has been achieved which is an improvement by a factor of 2 compared to former measurements. This corresponds to errors of $\Delta m = (15 - 250)$ keV/c^2 and allows the resolution of isomeric states. The systematic error has been reduced by a factor of 5 to $\sigma_{\text{syst.}} = 16.2$ keV. More details are given in the thesis of M. Falch [3], that will be put into the internet of the Atomic Mass Data Center.

References

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