Summary

of dissertation of Markus Falch,
(Supervisor: Prof. Dr. K.E.G. Löbner)

Sektion Physik, Ludwig-Maximilians-Universität München, Germany

Schottky Mass Spectrometry at the experimental storage ring ESR of the Gesellschaft für Schwerionenforschung GSI is an effektive tool for systematic mass measurements of exotic nuclei [Beh95, Ker96, Sch97, Rad98, Rad00]. The technique of Schottky Mass Spectrometry is based on the detection of the revolution frequencies of highly-charged ions which are stored and cooled in the storage ring ESR. The revolution frequencies are measured by frequency analysing the Schottky-signal of the ions circulating with a relative momentum spread of $\delta p/p \approx 10^{-6}$ due to electron-cooling.

A new data aquisition system was developed, which stores the complete digitized raw data. This yields several advantages for the off-line data analysis. During a beamtime of two weeks in November 1997 the new data aquisition system was used for the first time for systematic mass measurements of exotic nuclei at the ESR of the GSI. The measured nuclei were produced by fragmentation of ^{209}Bi ions at energies of about 900 MeV/u in a thick beryllium target. During the experiment raw data with an amount of about 1 terabyte were stored, leading to the determination of the masses of 346 neutron-deficient nuclei in the region of Rh to Po with half-lives $\geq$ 5s containing 152 nuclei with previously unknown mass values or with large mass errors.

Since several α-decay chains with known Q_α-values and in one case with a known proton-decay energy are connected to nuclei measured in this experiment, the masses of 88 nuclei have been determined additionaly. With the new *TCAP*-system a mass resolution of $\Delta m/m = 1.8 * 10^{-6}$ has been achieved. This corresponds to errors of $\Delta m = (15 - 250)$ keV/c^2 and allows the resolution of isomeric states. The experimental results contain very proton-rich nuclei reaching the proton-dripline from Lu to Pa.

Storing the digitized Schottky signal instead of calculating online-Fourier transformation yields several advantages for the data analysis. Because of an increased bandwidth of the frequency spectra of 10 kHz in former measurements to 320 kHz in this experiment in combination with an increase of the frequency resolution by a factor of 2, a precise determination of the momentum-compaction factor with the measured data is possible. With the new *TCAP*-system the measurement time can be reduced by two ordes of magnitude. Another new feature is the possibility of offline-drift-correction of the measured frequency spectra and the investigation of the intensity of frequency peaks as a function of time giving rough information about the half-lives of the measured ions. The new possibilities of the data analysis are used to solve problems of the method of Schottky Mass Spectrometry and represents a fundamental advancement of the method.

The achieved systematic error of the measured atomic masses is $\sigma_{\rm syst} = 16.2$ keV. It has been reduced by a factor of 5.7 compared to former measurements at the ESR of the GSI [Rad00] ($\sigma_{\rm syst} = 93$ keV).
The great number of measured masses allows the investigation of nuclear structure effects as shell closures or changes in deformation of the nuclei. The investigation of separation energies near magic nuclei give evidence for the proton subshell at $Z = 64$ and the breakup of this subshell at $N = 90$ and $N < 82$. As masses of nuclei have been measured at the onset of deformation at $N = 90$, the change to deformed nuclei as a function of the proton number is shown. This can be explained by the reduction of spatial overlapp of the valence- neutrons and -protons for $Z > 66$. Furthermore the onset of deformation at $N = 90$ is seen at $Z = 70$.
The comparison of measured masses of previously unknown nuclei with different mass models show relative large differences in the region of shell closures. The macroscopic-microscopic model of Möller and Nix [Moe88] doesn't follow this trend and shows the most accurate consideration of the nuclear shell structure. The lowest root mean square deviation for previously unknown masses of $\sigma_{\rm rms} = 119$ keV has been found by comparing the experimental data to the empirical mass predictions of Audi and Wapstra [Aud95].

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