Schottky Mass Spectrometry of Cooled ^{209}Bi Fragments in the ESR ◇

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In January 1995 a Schottky mass spectrometry beamtime was performed at the experimental storage ring ESR of the GSI. The primary ^{209}Bi-beam was accelerated in the UNILAC and SIS to 920 A*MeV, and passed through a 8 g/cm^2 ^{9}Be-target. The projectile fragments were separated by the FRS, injected into the ESR and cooled with the electron cooler. For a description of the setup at ESR see [7] and the references therein. By systematically changing the m/q-settings of ESR and FRS a "mass surface" of the nuclear chart was scanned over a large range and with high precision and efficiency.

The masses were determined by measuring 10 kHz wide Schottky spectra and using the relation between the m/q-values and the measured frequencies:

$$\ln \frac{f}{f_0} = -\alpha_p \ln \frac{m/q}{m_0/q_0},$$

where α_p is the momentum compaction factor. If there are at least two isotopes with known masses, we can determine the momentum compaction factor and the reference by linear regression.

During the ten days ^{209}Bi-beam time, the masses of 341 neutron deficient isotopes in the range from Nd to U were measured, either directly or using known Q-values of α-decay chains, see fig. 1. The masses of 60 isotopes were not measured before. For another 138 isotope masses the precision could be improved. We achieved mass values with errors of $\sigma_M = (50 - 150)$ keV/c^2.

Since many of the nuclides were measured independently in different charge states, an error reduction could be performd by averaging over those different measurements. Measuring masses of nuclides, which are connected by known Q_α-values, gives another possibility for error reduction and consistency checking.

Finally, we used the determined masses for testing the accuracy of different mass models and the extrapolated values of Audi/Wapstra. The root mean square deviations of the predictions from our experimental values are shown in the following table:

Audi/Wapstra[1]	115 keV
Jänecke/Masson[2]	445 keV
Duflo[3]	347 keV
Spanier/Johansson[4]	1180 keV
FRDM[5]	394 keV
ETFSI[6]	756 keV

References

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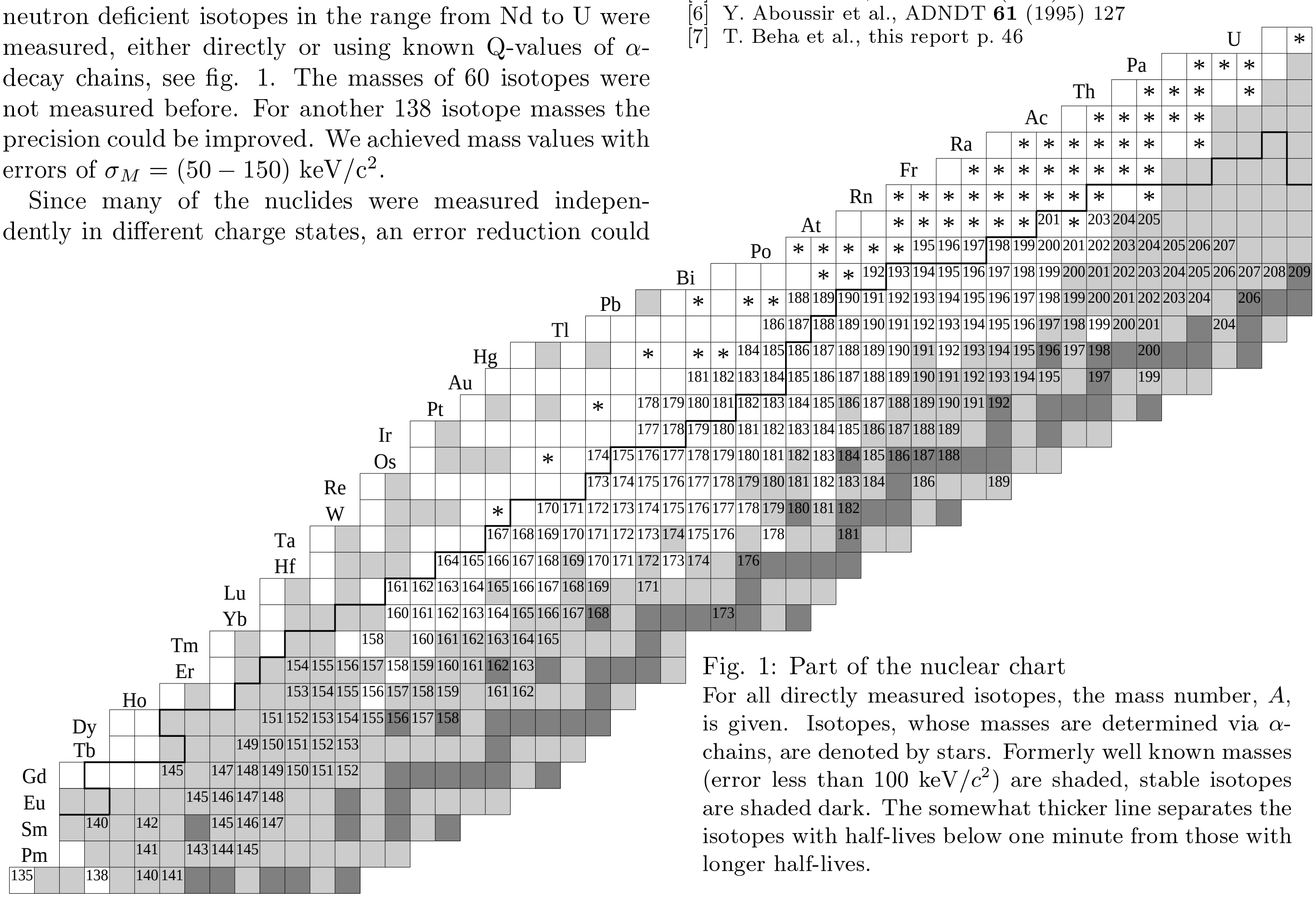

Fig. 1: Part of the nuclear chart
For all directly measured isotopes, the mass number, A, is given. Isotopes, whose masses are determined via α-chains, are denoted by stars. Formerly well known masses (error less than 100 keV/c^2) are shaded, stable isotopes are shaded dark. The somewhat thicker line separates the isotopes with half-lives below one minute from those with longer half-lives.

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