Effects of the pairing energy on nuclear radii

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Abstract. The mass region around the $Z = 82$ shell closure is characterized by strong nuclear structure effects, like *e.g.* shape coexistence. In this contribution results from mass spectrometry and laser spectroscopy are examined for a possible correlation between mass values and radii.

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This work was initiated at the ENAM 2001 conference based on the high-precision mass measurements of neutron-deficient Hg isotopes [1]. The appearance of shape coexistence as observed in the large odd-even staggering of Hg radii near the $N = 104$ mid-shell region was explained by the size of the neutron pairing energy. As this quantity has an absolute value of only about 1 MeV, mass data available at that time were of insufficient precision for any analysis. The high relative mass uncertainty of $\delta m/m = 10^{-8}$ and a resolving power of up to 10^7 obtained with the ISOLTRAP Penning trap mass spectrometer is a necessary requirement to resolve isomeric states in the recent measurements on neutron-deficient Tl, Pb, and Bi isotopes [2]. New results of laser spectroscopy studies are available for neutron-deficient Pb isotopes [3] which will be compared with the Pb masses, in an upcoming work. The systematic comparison of the neutron pairing gap energies

$$\Delta^3(N) = \frac{(-1)^N}{2} [B(N-1) + B(N+1) - 2B(N)], \quad (1)$$

$$\Delta^4(N) = \frac{1}{2} [\Delta^3(N) + \Delta^3(N-1)] \quad (2)$$

to the behaviour of the nuclear mean square charge radii $\delta \langle r^2 \rangle$ (data from [4,5]) is used to search for a possible correlation. Fig. 1 shows the two examples of mercury- and thallium-isotopes. In $\Delta^3(N)$ and $\Delta^4(N)$ the shell closure at $N = 126$ is visible. In addition, distinct minima are observed around the mid-neutron shell. The systematic study of these fine correlations has become possible due to the high precision of the ISOLTRAP data.

References

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Fig. 1. Comparison of neutron pairing gap energies $\Delta^3(N)$, $\Delta^4(N)$ to nuclear mean square charge radii $\delta \langle r^2 \rangle$. Note that in thallium the radii of the isomer exhibit the staggering behaviour.

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