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In-source laser photoionization spectroscopy of heavy (N > 126) Bi isotopes

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Nuclei in the "lead region" of the nuclide chart (Z close to 82) are of particular importance for nuclear physics. Nuclides in the vicinity of neutron mid-shell N = 104 exhibits striking effects such as shape coexistence, shape staggering etc. The heavier isotopes (N > 126) are also of great interest. One of the reasons is so-called "shell effect" in charge radii [1]. This effect consists in the presence of the characteristic kink in the charge radii at the N = 126 neutron shell closure.

Studies of the heavier isotopes $^{214-218}$Bi (including isomers) were performed at the ISOLDE facility (CERN) using the in-source photoionization laser spectroscopy. The changes of the mean square charge radii and electromagnetic moments were measured.

The observed deviation of the behavior of the magnetic moments from the trend for the lighter isotopes and other isotopic chains may indicate structural changes in the heavy Bi isotopes.

The isomer ^{215}Bi^m (I = 25/2…29/2) is of particular interest. Measurement of the isomer shift $\delta\langle r^2\rangle_{215,215m}$ enables checking the hypothesis of the determinative role of the $\nu 1i_{11/2}$ occupancy in the formation of the kink in charge radii when crossing N = 126, since the main peculiarity of this isomer is the presence of the unpaired neutron on the $i_{11/2}$ shell.

It's commonly accepted that the kink in charge radii appears only when the neutron $1i_{11/2}$ shell is substantially occupied in nuclei with N > 126 [2]. In particular, this kink is quite successfully reproduced in Covariant Density Functional Theories (CDFT) with the variety of covariant energy density functionals [3]. HBF calculations with an additional density-dependent term to the spin-orbit interaction (proposed by Nakada and Inakura [4]) also reproduced more rapid rise of the radii in the heavier isotopes (N > 126). Nevertheless, the first rude estimations based on the sign and amplitude of the $\delta\langle r^2\rangle_{215,215m}$ are in favor of the CDFT approach.

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Section

Nuclear structure: theory and experiment

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