Contribution ID: **18** Type: **Oral**

Ground state and beta-decay properties of heavy isotopes near N=126

The precision laser spectroscopy data for exotic neutron-rich nuclei obtained at the RIB facilities call for unified description of the charge radii, magnetic moments and β decay half-lives. Our calculations in the long chains of spherical isotopes near the magic neutron shell Nmag =126 use the self-consistent Finite Fermi System Theory (FFST) and new version of Fayans energy density functional DF3-a with modified volume isovector part [1].
The isotopic behavior of the charge radii and magnetic moments is sensitive to the spin-parity of the orbital occupied by the valence neutron. A delicate competition of the Gamov-Teller (GT) and high energy first-forbidden (FF) decays at N>Nmag, increases sensitivity of the total rate to the ordering of neutron orbitals.
The Fayans-type functionals complies with the experimental single-particle neutron spectra above N =126 (for the reference 208Pb nucleus Δε (n2g9/2 - n1i11/2) = - 780 keV). The present calculations, as the ones by [2, 3] show that reproducing the normal ordering of the quasi-particle neutron spectra at N >Nmag is crucial for simultaneous self-consistent description of the charge radii, magnetic moments and β decay half-lives. For comparison, relativistic Hartree-Bogoliubov (RHB) model with covariant functionals [4] which gives an inversed order of these neutron states reproduces the kink in the charge radii at N=126. At the same time, global RQRPA calculation [5] typically overshoot available experimental β decay rates of the isotopes near N =126.
Simultaneous description of the experimental data on nuclear geometric properties and spin-isospin response is indispensable for fine calibration of the energy density functionals and reliable prediction of the β decay rates for the waiting-point nuclei important for the astrophysical r-process nucleosynthesis.

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Session Classification: 1. Experimental and theoretical studies of nuclei

Track Classification: Section 1. Experimental and theoretical studies of nuclei.