Contribution ID: **16** Type: **Presentation**

Collective motion, rotation alignment, and K-isomeric states in very heavy nuclei: A theoretical study

Saturday, 5 April 2008 10:20 (20 minutes)

Recent experimental advances have made it possible to study spectroscopy in very heavy nuclei. It has been suggested [1] that by studying the transfermium isotopes, in particular their excited structure, one can gain useful information on relevant single-particle states, which is the key to locating the anticipated 'island of stability'.

The study of rotation alignment of quasiparticles in superheavy elements sensitively probes the single particle states of the high-j intruder orbits. These orbits are caused by the spin-orbit interaction, which is ultimately linked to the question of energy gaps in the single particle spectrum. We extend the applicability of the Projected Shell Model (PSM) [2] to the transfermium region. We study rotation alignment and the corresponding band-crossing phenomenon in Cf, Fm, and No isotopic chains, and propose observables to test the picture.

Isomeric states in very heavy nuclei are particularly interesting because of their relatively long lifetimes. Xu {\it et al.} suggested [3] that the occurrence of isomeric states can enhance the stability of superheavy nuclei because the multi-quasiparticle excitations decrease the probability for both fission and α-decay. Based on the successful PSM description for the ^{254}No isomers [1], we give a systematical prediction for K-isomeric states in very heavy nuclei.

Knowledge on vibrational states is useful for this less known mass region because of the interpretation of observed low-lying spectroscopy. We further show that in very heavy nuclei collective vibrations systematically appear as low-energy excitation modes [4]. We make a detailed prediction on γ-vibrational states and their E2 transition probabilities to the ground state band in the isotopes where active structure research is going on. Octupole effects on single particle and collective motions will also be discussed.

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Primary author: Prof. SUN, Yang (Shanghai Jiao Tong University)

Presenter: Prof. SUN, Yang (Shanghai Jiao Tong University)

Session Classification: Stability of Very Heavy Nuclei

Track Classification: Shell structure and stability of very heavy nuclei