Studies of quadrupole and octupole deformations in the $f_{7/2}$ shell nuclei via Coulomb excitation

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Odd mass nuclei in the lower part of the $f_{7/2}$ shell provide striking examples of non-closure effects of the N = Z = 20 shells, which result in the occurrence of many low-lying positive parity "intruder" states, e.g. in ^{43}Sc, ^{45}Sc, ^{47}Sc, ^{45}Ti, and ^{49}V. The structure of odd-mass Sc isotopes is particularly interesting because of the coexistence of positive-parity and negative-parity bands near the ground state. Moreover, shape coexistence has been suggested for several odd-mass nuclei in this mass region, and experimental measurement of deformation parameters is of great importance for the possible prolate-oblate competition/shape coexistence.

For example, in ^{45}Sc the $7/2^-$ ground state is almost degenerate because the $3/2^+$ intruder state with half-life $T_{1/2}$ = 318 ms is only 12.4 keV higher. This long-lived positive parity isomer can be seen as a manifestation of the inversion of the spherical *sd* and deformed proton *fp* orbitals. Further, its positive quadrupole moment was deduced from laser spectroscopy measurements, and this isomeric state constitutes a band-head of a rotational band developed at higher spins. However, the shell model approach, despite the adopted quite a simple excitation mechanism of the $d_{3/2}$ proton, has serious problems with obtaining such low excitation energy. Therefore, to face its nature, dedicated Coulomb excitation experiments were conducted at the University of Warsaw HIL and IUAC in New Delhi, aimed at determining the matrix elements of state transitions in the vicinity of this isomer.

In this talk, the electromagnetic properties of ^{45}Sc will be discussed in the framework of mean-field theory and shell-model calculations, with a particular focus on the collective properties of the observed states.