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Nature of the excited bands in odd-mass triaxial nuclei within the quasiparticle-plus-triaxial rotor model

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Nuclei are quantum mechanical systems with discrete states with quite complicated nature. The understanding of these states has been gradually reaching new depths while at the same time it has been expanding toward different frontiers, for instance toward high spins, toward heavy nuclei, toward nuclei near the proton-drip lines and for neutron-rich nuclei, as well as toward non-yrast structures. Revealing the nature of yrare nuclear states is in general quite challenging. While the yrast states are usually well understood and described by the presently available nuclear models, the yrare states are often more complex and difficult.

In general the rotational bands in deformed odd-mass nuclei with triaxial shape can be described with the quasiparticle-plus-triaxial rotor (QTR) model. The model couples the three-dimensional rotation of the triaxial core (that looks like a precession similar to the precession a rotating top) with the single-particle degree of freedom of the odd nucleon. The calculated rotational bands represent combinations of these two mechanism, and look like tilted precession, TiP bands, [1]. The collective rotation comprises a dominant rotational component around the axis with largest moment of inertia (called here favoured rotation) and a rotational component orthogonal to this axis (unfavoured rotation). In the case where the single-particle configuration is frozen and where the unfavoured rotational angular momentum is small, the tilted precession can be approximated with wobbling, that is it can be described as a coupling of favoured rotation with excitations of wobbling phonons [2]. Therefore the calculated excited rotational bands are associated with 1-, 2-, etc. wobbling phonons. However the harmonic frozen approximation (HFA) [2] is typically valid for one-quasiparticle bands in odd-mass nuclei only for longitudinal coupling of the angular momenta of the valence nucleon and the core and only at high spins. Therefore the nature of the proposed low-spin wobbling bands in a number of nuclei [3-9] seems open to question and needs further investigations. Serious questions on the nature of the excited bands in two of these nuclei, (^{135}Pr and ^{187}Au), were also raised by very recent experimental data [10,11], where the measurements are in conflict with the previously proposed wobbling.

In this presentation the nature of the excited bands in odd-mass triaxial nuclei are studied with the QTR model. In particular the HFA condition and the difference between TiP and wobbling phonon bands will be discussed. In addition a study of the nature of the QTR model solutions for the $\pi h_{11/2}$ bands in ^{135}Pr will be presented. The calculations highlight the important impact of the single-particle degree of freedom on the nature of the bands. They show that for these bands the angular momentum of the valence nucleon rapidly aligns from the short toward the intermediate axis as the spin increases, which is in contrast with the fixed alignment along the short axis imposed within the HFA.

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