

DECOUPLED AND STRONGLY COUPLED BANDS FOR THE HIGH-SPIN STATES

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Since the experimental discovery of a systematic appearance of "decoupled" and "strongly coupled" unique-parity bands in transitional and spherical nuclei¹, considerable interest has been shown in the theoretical discussion of these bands. These bands have been interpreted as evidence for coupling a quasiparticle (particle) to a rigid rotor of triaxial shapes².

It is somewhat surprising that the simple fact that "decoupled" and "strongly coupled" band patterns are generated in the spherical representation already in leading order terms was not connected with the experimental discovery of these bands. This was explicitly shown in ref. 3 for the simplest version of coupling a unique-parity single-particle state to an anharmonic phonon. In fact, the type of the pattern depends on the sign and magnitude of $Q(j) \cdot Q_{VIB}$. Strongly coupled and decoupled bands are developed for the product of quadrupole moments $Q(j) \cdot Q_{VIB} < 0$ and $Q(j) \cdot Q_{VIB} > 0$, respectively. Here, $Q(j)$ and Q_{VIB} are the ground-state and the phonon quadrupole moments, respectively.

On the other hand, the anharmonic-vibrator — particle coupling model is an approximation of the cluster-vibration model, or of the shell model for the case when the wave function of the unique-parity state can be factored out of the correlated wave function.

Thus, the "decoupled" and strongly coupled" band pattern for unique-parity states is a feature rather insensitive to the choice of the quantum-mechanical basis for its description. Both the rotation aligned coupling and triaxial shapes in the deformed representation as well as the shell-model, cluster-vibration coupling, or the particle (quasiparticle) — anharmonic-vibrator coupling in the spherical representation also lead to this pattern. An important and additional critical test of the model are predictions for the properties of normal-parity states. Here the cluster-vibration coupling is successful in specific cases⁴⁻⁹, providing a description in agreement with experiment. In particular, the coupling of three proton holes to quadrupole vibrations results simultaneously in both a weak-coupling pattern for normal-parity states and a "decoupled" band pattern for unique-parity states.

In the case of even-parity yrast bands, regularities as well as irregularities of the yrast bands appear as consequences of the interplay of clusters and vibrational degrees of freedom^{6,10-12}.

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