LONG QUASIROTATIONAL BANDS AS AN EXAMPLE OF LARGE AMPLITUDE QUADRUPOLE COLLECTIVE MOTION

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In spite of the accumulation of experimental information and immense theoretical efforts, we still lack full understanding of soft (transitional) nuclei. The difficulties of microscopic theory are due to the fact that the system under study is a finite self-sustaining drop of superfluid Fermi-liquid in the vicinity of the phase transition to static deformation. Low frequencies and, whence, large vibrational amplitudes and strong collective transition probabilities are the typical features of spectra in soft nuclei which imply nonperturbative anharmonic interactions between the collective quanta. In such a situation, the standard "mean field + random phase approximation" description is not sufficient. On the other hand, just because of that one can expect here more or less universal behavior which, similar to Landau theory of macroscopic phase transitions, can be phenomenologically parameterized.

Recent progress in phenomenological nuclear spectroscopy of soft nuclei turned out to be related mainly to the IBM which predicts, in particular, various phase transitions and coexistence regions. However, as a consequence of identifying the interacting bosons with valence fermion pairs, the IBM is invalid for the description of many long high spin bands which go well beyond the IBM cut-off without changing their properties.

We show that many high spin bands, typically outside the domain of validity of the IBM, manifest the regularities predicted by a simple model of quadrupole vibrations with strong quartic anharmonicity. The examples include bands built on the ground state and on intrinsic excitations decoupled from the quadrupole mode as in isotopes of Rn and Ra. Certain superdeformed bands reveal very similar trends raising the question whether the deformation in these cases is static or dynamic due to the large amplitude collective vibrations.

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