EXOTIC MODES OF COLLECTIVE QUANTAL EXCITATIONS:
Nuclear Tidal Waves and the Phenomenon of Multiple Chiral Bands

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The collective quadrupole excitations of nuclei are often classified as "rotational" and "vibrational" with a rigid rotor and a harmonic vibrator being the limiting ideal cases. Rotational bands that extend over ten and more states are ubiquitous. Vibrational excitations of spherical nuclei are much less distinct. While the two-phonon triplet is often observed, identification of all members of the three-phonon multiplet is already problematic. This is because the time scale of collective vibrations is not much larger than that of the intrinsic quasiparticle excitations. The adiabatic separation of the time scales, which is a pre-requisite for the appearance of collective quantum states, rapidly deteriorates with the number of excited quanta (phonons). With increasing number of phonons, the collective states are embedded into a progressively dense background of quasiparticle excitations. This coupling (to the quasiparticle background) fragments the vibrational levels and thus terminates their existence as individual quantum states. Since the density of quasiparticle excitations is lowest near the yrast line, only yrast members of the vibrational multiplets are expected to keep their identity as collective quantum states the longest. This behavior, which is semi-classically described as quadrupole running waves on the nuclear surface (tidal waves), is expected in the transitional region between spherical and well deformed shapes. In the first part of my talk, I will discuss our recent lifetime measurements that lead to the first experimental identification of a seven-phonon yrast state in ^{102}Pd. The structural composition of these states is interpreted as a rotating condensate of d-bosons. The second part of my talk will be based on the new concept of multiple chiral doublets (MχD): the existence of more than one pair of chiral doublet bands in a single nucleus, a phenomenon previously predicted in the framework of the relativistic mean field (RMF) theory. Two distinct pairs of bands have been identified in ^{133}Ce and are suggested as chiral partner bands. The chiral nature of these bands will be discussed in the context of the established fingerprints of nuclear chirality along with theoretical calculations that support this claim.