A mechanism for shape coexistence

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Abstract

The selection rules of the quadrupole-quadrupole $(qq)$ interaction indicate, that this type of long-range, attractive interaction binds together the orbitals with the same total number of oscillator quanta $n$, i.e. orbitals between the 3D, harmonic, isotropic oscillator magic numbers. In spherical nuclei the common $n$ orbitals are divided into two sets, due to the large single-particle energy gaps at the major magic numbers 28, 50, 82, 126. Thus in this case the two sets are isolated from each other and the $qq$ interaction cannot be applied in the whole harmonic oscillator shell. But in deformed nuclei there are no major magic numbers [1]. As a consequence the $qq$ interaction automatically unifies the valence nuclear shells 6-14, 14-28, 28-50, 50-82, 82-126 with the harmonic oscillator shells 2-8, 8-20, 20-40, 40-70, 70-112 respectively [2]. The unified shell reproduces an excited $0^+_2$ band, which is the excited $0^+_2$ band of nuclei with shape coexistence. The mechanism is proposed in the context of the Proxy SU(3) Symmetry [3–5]. The islands of shape coexistence and of inversion of states on the nuclear map are reproduced without any parameters [2]. Specifically the inversion of states appears as a side effect of shape coexistence.

References