Pairing versus quadrupole collectivity of low-lying 0^+ states in deformed nuclei

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Recent high resolution (p,t) experiments have established the existence of a large number of low-lying excited 0^+ states in deformed nuclei of the rare earth and actinide regions [1-3].
We have adopted the microscopic quasiparticle-phonon model (QPM) to carry out a systematic and detailed study of these states in most of the nuclei explored experimentally [4,5].
The QPM calculation shows that, in order to account for all observed 0^+ levels, it is necessary to go beyond the mean field approximation (RPA) and to include the two-phonon space, consistently with previous projected shell model calculations, performed in a space spanned by two plus four quasiparticle states [6].
The quadrupole collectivity is reported to be weak in all 0^+ states of ^{158}Gd, in agreement with the shell model findings [6], and lacking in ^{168}Er. It is appreciable, but still modest, in the actinides. All one-phonon states are found to be dominated by pairing. This, however, acts coherently in one excited 0^+ state only. In fact, consistently with experiments, only one 0^+ state gets strongly populated through (p,t) reactions in ^{158}Gd and the actinides. In ^{168}Er, the RPA (p,t) strength is still concentrated in one state. In QPM, however, the strength gets fragmented among different 0^+states, as a result of the coupling among different phonon states, in agreement with experiments.
The octupole phonons, whose importance was stressed in IBM studies [7], enter with large amplitudes in several states of ^{158}Gd, but play a marginal role in ^{168}Er. In the actinides, they result to be far less important than expected on the ground of previous IBM predictions [2] and in spite of the occurrence of very low-lying RPA octupole collective phonons. The suppression of the octupole coherence is shown to be due to the repulsive effect of the Pauli principle which redistribute the strength of the collective octupole phonons among several, closely lying, 0^+ levels.

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