Algebraic Realization of the Pairing-plus-Quadrupole Model

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Correspondence between the $SO(8)$ pairing basis containing both isoscalar ($T = 0, S = 1$) and isovector ($T = 1, S = 0$) pairing states and the Elliott's $SU(3)$ basis that describes collective rotation of nuclear systems with quadrupole deformation is established by the use of their complementarity to the same shell model number conserving chain $U(4\Omega) \supset U_L(\Omega) \otimes U_{ST}(4)$ of Lie algebras. The classification of states for a given number of nucleons is obtained in both cases and is applied to study the interplay between the pairing and quadrupole interactions in a Hamiltonian containing each of them as limits in a single or two harmonic oscillator valence shells. In the latter case single-particle interactions and pair-scattering between the two shells are also considered. Reasonable choices of values for the interaction parameter strengths are established on the basis of comparing the theoretically obtained behavior of the energy spectrum as a function of the Hamiltonian parameters with the experimental values for the energies of nuclear systems with different mass. Successes as well as limitations of this approach will be discussed in details. Some possible future extensions will be outlined.