COLLECTIVE STRUCTURES WITHIN THE CARTAN-WEYL BASED GEOMETRICAL MODEL*

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The geometrical Bohr-Mottelson model is a macroscopic nuclear structure model in the sense that it considers the atomic nucleus as a charged liquid drop with a definite surface, rather than a many-body system of constituent particles. The quantum mechanical treatment of the surface excitations leads towards the Bohr Hamiltonian, which describes the dynamics of the nuclear surface up to spheroidal deformations [1]. Depending on the choice of the potential, this Hamiltonian is able to explain the low-energy structure of medium and heavy atomic nuclei (away from the shell closures) in terms of rotations, vibrations and a coupling between them [2]. For this purpose, many different techniques to handle general collective potentials have been proposed and profoundly discussed in the literature [3]. These techniques are based on combinations of analytical and algebraic methods, making use either of special function theory or the underlying $SU(1,1) \times O(5)$ Lie group structure of the Bohr Hamiltonian.

This contribution will discuss a technique [4] which is completely algebraic in the sense that no explicit representations have to be constructed. By means of a rotation to the Cartan-Weyl scheme and an intermediate state method, all necessary ingredients for the matrix representation can be derived within this basis.

Test-results for this formalism find their application in the field of nuclear quantum shape phase transitions [5]. It will be discussed how the fingerprints of quadrupole collective motion change from vibrational, γ-independent and axial deformed rotational, over triaxiality to shape coexistence with respect to the parameter space of the general collective potential.

References

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