UNITARY GROUP APPROACH FOR EFFECTIVE POTENTIALS IN 3D SYSTEMS

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An algebraic approach based on the unitary $U(4)$ algebra is proposed to describe 3D systems for effective potentials. Our approach is based on the 3D vibron model where the addition of a scalar boson is introduced into the space of a 3D harmonic oscillator keeping constant the total number of bosons N. However instead of dealing directly with the dynamical symmetries we proceed to identify the coordinates and momenta in the algebraic space. Our approach is based on the mapping between the $U(4) \supset U(3) \supset O(3)$ dynamical symmetry and the harmonic oscillator states. A minimization procedure is used in order to determine the coefficients involved in the algebraic expansion of the coordinates and momenta. This allows the kets associated with the different subgroup chains to be linked to energy, coordinate and momentum representations. This identification provides useful tools to obtain the matrix representation of 3D Hamiltonians in a simple form through the use of the transformation brackets connecting the different bases. The exact energy and wave functions are obtained in the N large limit. As an application of this approach the eigensystem of the 3D-Morse potential is analyzed, whose wave functions are contrasted with the approximate analytical solutions for null angular momentum. The analyses of inertia moments as well as the dipole moment strengths are also included. This approach provides results which contrasts to the 3D-vibron model where the Morse functions are identified with a dynamical symmetry.