BOHR HAMILTONIAN WITH EXACTLY SOLVABLE ENERGY DEPENDENT POTENTIALS

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A new breed of exactly solvable collective solutions is proposed by considering an energy dependence in the potential of the Bohr Hamiltonian. For simplicity, the potential is chosen as gamma independent with two forms: harmonic oscillator and Coulomb. The energy dependence is the simplest one, i.e. linear, and is induced to their corresponding coupling constants. The modification of the shape phase space triggered by the non-local nature of the potential leads to a series of conditions for the slope parameter which assure that the resulted system is physically coherent. An interesting situation arises in the asymptotic limit of the slope parameter, where both models become parameter free due to scaling. Moreover, both asymptotic solutions exhibit some distinctive features of U(5) dynamical symmetry. Indeed, in case of the harmonic oscillator potential, the distribution of states on quantum numbers is the same as in the U(5) case but with an expanded energy spectrum. In contradistinction, the model based on the Coulomb potential preserves the U(5) energy levels, however with a different degeneracy. From phenomenological point of view, the first is associated to a stiffening spherical vibrator, while the later to a softening vibrator. Possible experimental realisation of the two parameter-free models is found in few vibrational-like medium nuclei.