SCHRÖDINGER EQUATION FOR THE CHIRAL GEOMETRY IN ATOMIC NUCLEI

Radu BUDACA[1]

Abstract. The dynamical and spectral features of the chiral geometry in atomic nuclei are described by means of a triaxial rigid rotor Hamiltonian cranked by quasiparticle alignments. The problem is treated alternatively in the space of angular momentum states and using a Schrödinger equation for a continuous variable associated with an angular momentum projection. The later is constructed using a semiclassical approach. Numerical applications performed for various deformation and alignment conditions with both methods are compared in terms of energy levels and wave functions.

Keywords: Chiral geometry, Triaxiality, Semiclassical description

DOI 10.56082/annalsarsciphyschem.2024.1.7

1. Introduction

The concept of chirality or handedness is related to the asymmetry properties of a system. Basically, a chiral system is distinct from its mirror image. This property is systematically encountered in nature and subsequently is important in most domains of science. One of the most immediate examples of chirality are the human hands. Shells of snails, spirals and coils of plant veins, or flower formations are other macroscopic biological ensembles with a chiral geometry. From mathematical point of view, a system is chiral if its mirror image cannot be obtained by a combination of only translation and rotation transformations. In science, the chirality is more often invoked in molecular and biological chemistry, where chiral partners of compound molecules often exhibit drastically different properties such as smell, taste, or colour. A notable example of a chiral biological molecule, is the DNA double helix. The chirality in physics is mostly associated with spin dynamics and the polarization of the electromagnetic waves.

In nuclear physics, chirality is related to the trihedral geometry of three mutually perpendicular angular momentum vectors corresponding to the core rotation and two distinct spins coming from out of core nucleons. The three vectors can therefore be arranged into a right-handed or left-handed order. Given the fact that vectors are involved instead of coordinate loci, the nuclear chirality is of the dynamical type. The two chiral configurations in this case can be obtained from each other through a rotation and a time reversal transformation instead of a space inversion employed for

[1] rbudaca@theory.nipne.ro, budacaradu@gmail.com "Horia Hulubei" National Institute for R&D in Physics and Nuclear Engineering, Str. Reactorului 30, RO-077125, POB-MG6 Bucharest-Măgurele, Romania; Academy of Romanian Scientists, Splaiul Independentei 54, 050044, Bucharest, Romania