An application of algebraic geometry to a nuclear-structure problem

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Field: nuclear physics (theory)

Prerequisites: quantum mechanics, mathematical methods in physics, nuclear physics

Description

In this project the ground-state solution of a correlated system consisting of two neutrons and two protons is studied. General neutron-neutron and proton-proton interactions are considered while the neutron-proton interaction is assumed to be dominated by a single component, recently shown to be a reasonable approximation. With this assumption the ground state can be obtained from the eigenvalue problem associated with the sum of a diagonal matrix and a separable matrix, which can be solved with methods taken from algebraic geometry.

Outline of the project

- Getting familiar with the shell-model problem of neutrons and protons in a valence space.
- Derivation of the secular equation in the case of two neutrons in a single orbital j_n and two protons in a single orbital j_p.
- Derivation of the solution of the eigenvalue problem associated with the sum of a diagonal and a separable matrix as a function of an angle θ, introduced through algebraic geometry.
- Study of the dependence of θ on the strength of the interaction between like nucleons versus the strength of the neutron-proton interaction.
- Study of the spherical-deformed character of the ground-state solution as a function of the angle θ.