Internship in theoretical nuclear physics

Gamow shell model for non-Hermitian interactions

Loosely bound nuclei are currently at the centre of interest in low-energy nuclear physics. The deeper understanding of their properties provided by the shell model for open quantum systems changes the comprehension of many phenomena and offers new horizons for spectroscopic studies from the driplines to the well-bounded nuclei for states in the vicinity and above the first particle emission threshold [1].
The configuration-interaction approach based on Gamow states, the so-called Gamow shell model (GSM) [1,2], is a complex-energy generalization of the standard shell model in which the harmonic oscillator basis is replaced by the Berggren basis that includes bound states, resonant states, and complex-energy scattering states. The shell model in this formulation respects unitarity in all regimes of the binding energy and provides a comprehensive description of both the configuration interaction and the shell structure, while removing inconsistencies and limitations present in the standard shell model. To describe nuclear reactions, one has to express GSM in the coupled-channel representation [1]. In this representation, the GSM unifies nuclear structure and nuclear reactions because the same Hamiltonian and the same many-body approach describes both the discrete part of the energy spectrum and the reaction cross-sections at low excitation energies. The application of GSM for nuclear reactions faces a problem of an insufficient completeness of the reaction channel basis in realistic applications which might be circumvented by introducing complex correction factors in the channel-channel coupling potentials.
In this internship, it is proposed to investigate Berggren completeness relation and properties of the GSM spectra with the non-Hermitian interaction.

[1] N. Michel, M. Płoszajczak, "*Gamow Shell Model - The Unified Theory of Nuclear Structure and Reactions*", Lecture Notes in Physics 983 (Springer, Cham, 2021).
[2] N. Michel, W. Nazarewicz, M. Płoszajczak, and T. Vertse, J. Phys. G. Nucl. Part. Phys. 36, 013101 (2009).

Expected skills
Good knowledge of quantum mechanics, excellent skills in numerical methods and applications

This work can be pursued by a PhD-thesis

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