Contribution ID: **335** Type: **Poster**

Hypernuclei in Gamow Shell Model

One of goals of hypernuclear physics is to obtain information on baryon-baryon interaction in a unified way. Especially, it becomes an important issue to obtain information on hyperon(Y)-nucleon(N) interaction. For this purpose, hyperon-nucleon scattering experiments are planned at JLab and J-PARC facilities [1].

The physics of strangeness $S = -1$ hypernuclei bears a fundamental difference from nucleonic systems: the number of protons, neutrons, Λ, and $\Sigma^{-,0,+}$ particles is not conserved, as only total charge, strangeness, and baryon number are good quantum numbers [2]. Concerning the YN interactions, one can have the direct $\Lambda N - \Lambda N$ part and the $\Lambda N - \Sigma N$ conversion couplings. The conversion couplings are expected to play an important role in the structure of heavier neutron-rich Λ-hypernuclei [3]. In fact, $\Lambda N - \Sigma N$ conversions are necessary to understand the binding energies of known hypernuclei [4,5], and is also important for understanding the equation of state that governs the size and mass of neutron stars [6].

Description of an hyperon in the nuclear medium is a many-body problem, and therefore, hypernuclei have to be treated using microscopic nuclear theory models. An extension of the Gamow shell model (GSM) formalism [7,8] has been done to the study of hypernuclei (GSM-H), extending the nucleon space to a more general baryon space, with applications for the structure of single-strangeness hypernuclei. The GSM makes use of Slater determinants defined in the Berggren [9] ensemble of single-particle (s.p.) states, which includes bound states, resonances, and (complex-energy) scattering states, to define the many-body basis in which the GSM Hamiltonian is diagonalized. In this way, one obtains the theory which preserves unitarity in all regimes of binding energy, since bound, resonance, and scattering states are treated on equal footing [7,8].

Motivated by the proposed and approved experiment at JLab to investigate the isospin dependence of medium-heavy hypernuclei ${}^{40,48}_{\Lambda}\mathrm{K}$ (${}^{39,47}\mathrm{K} + \Lambda$), we have applied the GSM-H to determine the binding energies of the Λ hyperon and excited spectra of ${}^{40,48}_{\Lambda}\mathrm{Ca}$ (${}^{39,47}\mathrm{Ca} + \Lambda$) and ${}^{40,48}_{\Lambda}\mathrm{K}$ isotopes. Moreover, a careful analysis of the $\Lambda N - \Sigma N$ coupling and its effects on spectra and binding energy has been done. Finally, we determined the nucleon number dependence of the YN effective interaction and the differences between neutron-Λ and proton-Λ interactions when increasing the number of valence neutrons.

References:

[1] S. N. Nakamura, EPJ Web of Conferences 271, 11003 (2022).
[2] B. F. Gibson, *et. al.*, Progress of Theoretical Physics Supplement 117, 339 (1994).
[3] E. Hiyama, *et. al.*, Physical Review C 89, 061302 (2014).
[4] Y. Akaishi, *et. al.*, Physical Review Letters 84, 3539 (2000).
[5] A. Umeya and T. Harada, Physical Review C 83, 034310 (2011).
[6] E. Hiyama and K. Nakazawa, Annual Review of Nuclear and Particle Science 68, 131 (2018).
[7] N. Michel, *et. al.*, Journal of Physics G: Nuclear and Particle Physics 36, 013101 (2008).
[8] N. Michel and M. Ploszajczak, *Gamow Shell Model: The Unified Theory of Nuclear Structure and Reactions*, Lecture Notes in Physics, Vol. 983 (Springer International Publishing, Cham, 2021).
[9] T. Berggren, Nuclear Physics A 109, 265 (1968).

Authors: DASSIE, Alan Cruz (Grand Accélérateur National d'Ions Lourds (GANIL), CEA/DSM - CNRS/IN2P3, BP 55027, F-14000 Caen, France); HIYAMA, Emiko (RIKEN); PLOSZAJCZAK, Marek (GANIL); MICHEL, Nicolas (AS Key Laboratory of High Precision Nuclear Spectroscopy, Institute of Modern Physics, Chinese Academy of Sciences, Lanzhou 730000, China)

Presenter: DASSIE, Alan Cruz (Grand Accélérateur National d'Ions Lourds (GANIL), CEA/DSM - CNRS/IN2P3, BP 55027, F-14000 Caen, France)

Session Classification: Poster session

Track Classification: Nuclear Astrophysics