Int. Workshop “Shapes and Dynamics of Atomic Nuclei: Contemporary Aspects”
ed. Nikolay Minkov, Heron Press, Sofia 2023

Nuclear Level Density Studied in Projected Shell Model Approach

Saumi Dutta[1] **Jiaqi Wang**[1] **Yang Sun**[1] **Long-Jun Wang**[2]

[1]School of Physics and Astronomy, Shanghai Jiao Tong University, Shanghai 200240, China
[2]School of Physical Science and Technology, Southwest University, Chongqing 400715, China

Abstract

Nuclear level density (NLD) is one of the basic properties of atomic nuclei and is a crucial ingredient in nuclear reaction theories. We have studied NLD in deformed even-even ^{164}Dy nucleus using Projected Shell Model [1] to address several interesting and important structure-related phenomena. We have used a deformed single-particle basis, a multi-quasiparticle (qp) configuration space, and a two-body Hamiltonian with residual interactions which allows us to treat the dynamics of nuclear ground state as well as many high excited states in an effective and systematic way that takes into account the collective rotation and vibration, breaking of nucleon pairs, and the gradual building up of the multi-qp configurations with the broken nucleon pairs in compliance with the Pauli principle [2–4]. By a quantitative comparison with discrete levels from spectroscopic measurements, we have found that while the pronounced step-wise structure in the low-energy NLD curve can be understood as the collective excitation and nucleon-pair breaking, the exponential growth of levels in the higher-energy NLD can be described by the combination of the broken-pair states. Moreover, our finding for ^{164}Dy suggests a step structure beyond 2.0 MeV of excitation which is presently missing in the NLD data extracted in the Oslo method [5]. Since our calculation is purely spectroscopic in nature, our further investigation of spin and parity distribution of NLD as well as the effect of nuclear deformation has revealed sensitive and interesting structure-dependent characteristics.

References

[1] K. Hara and Y. Sun, Int. J. Mod. Phys. E **4**, 637 (1995).
[2] L.-J. Wang, F.-Q. Chen, T. Mizusaki, M. Oi, and Y. Sun, Phys. Rev. C **90**, 011303(R) (2014).
[3] L.-J. Wang, Y. Sun, T. Mizusaki, M. Oi, S. K. Ghorui, Phys. Rev. C **93**, 034322, (2016).
[4] L.-J. Wang, J.-M. Dong, F.-Q. Chen, and Y. Sun, J. Phys. G: Nucl. Part. Phys. **46**, 105102 (2019).
[5] T. Renstrøm, H. Utsunomiya, H. T. Nyhus, A. C. Larsen, M. Guttormsen, G. M. Tveten *et al.*, Phys. Rev. C **98**, 054310 (2018).