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Séminaire de Physique Nucléaire Théorique

Non-empirical description of nuclear collective motion with optimized basis for multi-reference density functional theory

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The generator coordinate method (GCM) has been a well-known method to describe nuclear collective motions. In GCM, one a priori specifies collective degrees of freedom (collective coordinates), such as nuclear deformations, and superposes many Slater determinants (SDs) within the selected collective subspace. However, there always exists arbitrariness in this approach in the choice of collective coordinates, for which one has to rely on empirical and phenomenological theory. With such choice, it is not trivial whether the collective motion of interest can be optimally described (See e.g., [1]). Therefore, a description of the collective motion without pre-set collective coordinates is desirable in order not to miss important degrees of freedom. In this seminar, we present a new extension of GCM in which both the basis SDs and the weight functions are optimized according to the variational principle [3]. With such simultaneous optimization of the basis states, one does not have to specify beforehand the relevant collective degrees of freedom covered by the set of basis SDs. In this talk, we will show results for sd-shell nuclei with the Skyrme energy functional. We will show that some collective coordinates often assumed in conventional GCM calculations, such as quadrupole moment, may not provide optimum basis to describe the ground state. This would be an important step towards consistent description of nuclear collective motions. [1] N. Hizawa, K. Hagino and K. Yoshida, Phys. Rev. C 103, 034313 (2021). [2] N. Hizawa, K. Hagino and K. Yoshida, Phys. Rev. C 105, 064302 (2022). [3] N. Shimizu et al., Prog. Theor. Exp. Phys. 2012, 01A205 (2012).

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