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Electromagnetic moments from angular momentum projected nuclear DFT

The spontaneous symmetry breaking is one of the core elements in the nuclear density functional theory (DFT). It allows effectively to include various correlations on the wave-function, while still preserving the simplicity of the mean-field based description. Unfortunately, with broken symmetries, the obtained wave-function is no longer an eigenstate of corresponding symmetry group. For example, a deformed mean-field wave-function has no definite value for angular momentum. Therefore, it is not meaningful compute certain observables, like the nuclear electromagnetic moments. To remedy this issue, broken symmetry needs to be restored with projection techniques.

This presentation describes the new angular momentum projection (AMP) implementation on the HFBTEMP computer code. The HFBTEMP code [1] solves the Hartree-Fock-Bogoliubov (HFB) equations in axial basis, without assuming time-reversal symmetry. This allows a proper treatment of various polarization effects in odd-A nuclei. After solving the HFB state, AMP is carried out to obtain various electromagnetic moments, among other observables. Implemented hybrid OpenMP+MPI parallelization allows efficient use of supercomputing facilities. As a case study to benchmark the new implementation, calculated spectroscopic nuclear magnetic moments and magnetization distributions in potassium isotopic chain are discussed. These are connected to recent measurement of the differential hyperfine anomaly between 47K and 39K at ISOLDE, CERN [2]. In order to investigate this anomaly, various radial moments of M1 operator and spin-asymmetry operator have been calculated. The calculated radial moments of magnetization have much larger variation among potassium isotopes as compared to the magnetic dipole moments. This indicates that estimation of the Bohr-Weisskopf effect via simple uniformly magnetized sphere may not be sufficiently accurate.

[1] M. Kortelainen, to be published (2024).
[2] M. L. Bissell, et al., in preparation (2024).

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