

Anapole Moment Calculated within Nuclear DFT

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A parity-violating weak interaction between nucleons gives rise to the parity-odd anapole moment of the nucleus [1]. The extended Siegert's theorem [2] allows us to decompose the anapole moment operator into two terms: the first is constrained by current conservation, while the second is not. Both terms are proportional to the total current of the nucleus. In the nuclear DFT approach, the total current operator is assumed to consist of two parts: the convective (orbital) and magnetic (spin) currents.

Similar to the Schiff moments, the laboratory anapole moment is calculated using perturbation theory. Perturbation theory indicates that the dominant contributions to the laboratory anapole moments arise from the expectation values of the anapole operator and the parity-nonconserving (PNC) potential, evaluated between the ground and partner states of the octupole deformed nucleus, owing to the small energy difference between these states. For example, in the octupole deformed Ac-227 nucleus, this energy difference can be as small as 27.369 keV. The Desplanques, Donoghue, and Holstein (DDH) potential [3] is commonly used as the PNC perturbing potential that induces parity violation. In the nuclear DFT approach, the deformed ground and partner states are determined from Hartree-Fock-Bogolyubov calculations with broken symmetries, in particular time-reversal symmetry and parity.

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[3] B. Desplanques, J. Donoghue, and B. R. Holstein, Ann. Phys. 124, 449 (1980)