The Schiff moment and the isoscalar giant dipole resonance

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The theoretical determination of Schiff moments is necessary in order to relate the measured upper limits of dipole moments in atoms to the upper limits of time reversal violations. At present several experiments are planned and being performed to measure dipole moments in the radium isotopes. The Schiff operator is identical to the excitation operator associated with the isoscalar giant dipole resonance (ISGDR). It is therefore important to study the strength distribution of ISGDR and to find nuclei in which this strength is shifted to low-energies. Such low-energy strength in the even-even nucleus could couple to the single-particle states of opposite parity in the odd-even nucleus and enhance the effects of T, P-violation.

One could look for such low-energy ISGDR strength by calculating the inverse energy weighted sum rule (IEWSR):

$$IEWSR = \sum_n \left| \langle n | \hat{S} | 0 \rangle \right|^2 (E_n - E_0)^{-1} \ .$$

This sum rule can be obtained from the response function of the ISGDR, evaluated in fully self-consistent Hartree-Fock (HF)-based random phase approximation (RPA). Even better and more efficient is to perform a constrained Hartree-Fock (CHF) computation with the $\lambda\hat{S}$ operator being the constraining term. One can then obtain the IEWSR by evaluating the second derivative of the HF energy with respect to λ. A large IEWSR signals a phase transition, which in this case could mean a change in the nuclear shape. Studying nuclei away from the stability line will conceivably lead to some regions in which the enhancements of the Schiff moment due to low-lying ISGDR strength will be large. We will carry out calculations for the ISGDR for neutron-rich light and heavy nuclei.