# NUCLEAR STRUCTURE AND RELATED TOPICS

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## CONTRIBUTIONS

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# RELATIVISTIC CORRECTIONS TO THE NUCLEAR SCHIFF MOMENT

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The mechanism of generation of $P-$ and $T-$violating electric dipole moment (EDM) is the following: $P,T$-odd nuclear forces produce $P,T$-odd nuclear moments; in turn, these moments can induce electric dipole moments in atoms through the mixing of electron wave functions of opposite parity. The EDM of a point-like nucleus according to the Schiff theorem is completely screened by atomic electrons. However, due to finite nuclear size, some dipole component of the electrostatic potential still exists. It is generated by the Schiff moment, the higher moment in the dipole density distribution.

The electrostatic potential produced by the Schiff moment is usually presented in the form

$$\phi(\mathbf{R}) = 4\pi\mathbf{S}\cdot\boldsymbol{\nabla}\delta(\mathbf{R}), \tag{1}$$

where $\mathbf{S}$ is the Schiff moment. The presence of the gradient of $\delta(\mathbf{R})$ means that the matrix element of the potential given by Eq. (1) between $s$- and $p$-atomic states is proportional to $(\nabla\psi_p^\dagger\psi_s)_{R=0}$. However, at high $Z$ the relativistic wave functions of atomic electrons vary significantly ($\sim Z^2\alpha^2$; for $^{199}$Hg $Z^2\alpha^2 = 0.34$) inside the nucleus. This produces a correction from higher moments of the dipole density distribution leading to a *local dipole moment*

$$\mathbf{L} = e\sum_{k=1}^{\infty}\frac{b_k}{b_1}\frac{1}{(k+1)(k+4)}\left[\langle\mathbf{r}r^{k+1}\rangle - \frac{k+4}{3}\langle\mathbf{r}\rangle\langle r^{k+1}\rangle\right] = L\mathbf{I}/I. \tag{2}$$

The summation is carried over odd powers of $k$, $k = 1, 3, 5, \ldots$ The first term ($k = 1$) in Eq.(2) is just the Schiff moment and the first nonzero correction ($k = 3$) to it comes from $b_3/b_1$. The ratios $b_3/b_1$, being of the order of $Z^2\alpha^2$, differ for $p_{1/2}$ and $p_{3/2}$ atomic states.

We calculate the local dipole moments for $^{199}$Hg and $^{205}$Tl where the most accurate atomic and molecular EDM measurements have been performed.