Testing Time Reversal Symmetry Using YbF

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We are conducting an experiment to measure d_e, the permanent electric dipole moment of the electron, using the heavy polar diatomic molecule YbF. YbF is expected to be nearly three orders of magnitude more sensitive to this time reversal (T) violating effect than the most sensitive atomic system, which is Tl. [1] This enhancement can be parametrized by an internal electric field in the YbF molecule, $E_{eff} = 26$GV/cm, which is produced by polarizing the molecule in a modest external field. The experiment is designed to measure the interation energy $\vec{d_e} \cdot \vec{E_{eff}}$, where $\vec{d_e} = |d_e|\vec{\sigma}$ and $\vec{\sigma}$ is the spin of the electron. The basic scheme of the T violation experiment has been described in [2].

Our molecular beam apparatus is easiest to understand as an interferometer for electron spin. The ground electronic, vibrational and rotational state of YbF consists of four hyperfine levels, an F=0 singlet and an F=1 triplet. A beam of YbF is first prepared in F=0. This population is then split into a coherent superposition of the hyperfine states $|F = 1, m_F = \pm 1\rangle$ by an rf transition. After the two halves of this tensor polarized state have evolved in a strong electric field E and a weak magnetic field B they are recombined by a second transition, going back to F=0. Population in F=0 is probed with fluorescence detection. For a time of flight T the signal intensity is proportional to $\cos^2(\mu_B BT/\hbar + d_e ET/\hbar)$. For our apparatus the magnetic fringe spacing is on the order of $100\mu G$. The T violation experiment searches for a fringe shift when the relative directions of E and B are reversed. Such a shift would indicate a non-zero value of d_e. We will report our progress towards the first measurement of d_e in a molecular system at this conference.

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