Search for Asymmetric Interactions between Chiral Molecules and Spin-Polarized Electrons

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EXPERIMENT

In this experiment, spin-polarized electrons with alternating forward and backward longitudinal spins collide with a chirally-pure molecular vapor target. The experimental apparatus is shown in Fig. 1. The transmission current asymmetry is defined as

\[ A = \left( \frac{I_+ - I_-}{I_+ + I_-} \right)_R \left( \frac{I_+ - I_-}{I_+ + I_-} \right)_L, \]

where \( I_+ \) (\( I_- \)) is the transmitted current measured for forward (backward) electron spins, and "L" ("R") correspond to the left- (right-) handed chirality of the target molecules.

RESULTS

At present, we have made measurements of \( A \) for the transmission of longitudinally spin-polarized electrons through a vapor of chirally-pure bromocamphor (C_{10}H_{15}BrO) at 1.5 eV and 3.5 eV electron scattering energy. The magnetically-collimated electron beam is attenuated by bromocamphor to 30% of its initial value for our measurements. Our preliminary results with Chauvenet’s criteria applied give \( A_{1.5 \text{ eV}} = 0.41(7) \times 10^{-4} \) and \( A_{3.5 \text{ eV}} = 0.58(7) \times 10^{-4} \) (see Fig. 3). This should be compared with the measurements of Mayer et al. [1], where they report asymmetries (by our definition and scaled for electron polarization and beam attenuation) of \( A_{1.5 \text{ eV}} = 1.2(2) \times 10^{-4} \) and \( A_{3.5 \text{ eV}} = 0.4(1) \times 10^{-4} \).

Fig. 1. Experimental apparatus: (1) laser beam for GaAs source; (2) electron beam; (3) guiding magnets; (4) GaAs photocathode; (5) cesiators; (6) gate valve; (7) chiral target cell; (8) optical polarimeter target cell; (9) lens; (10) to optical polarimeter.

Fig. 2. Example of data collected to measure the transmission asymmetry of spin-polarized electrons through the two different enantiomers of bromocamphor.

Fig. 3. Results for spin-polarized electron transmission asymmetry through bromocamphor at 1.5 eV (top) and 3.5 eV (bottom) incident electron energy.


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