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

$$A = \left(\frac{I_\uparrow - I_\downarrow}{I_\uparrow + I_\downarrow}\right)_R - \left(\frac{I_\uparrow - I_\downarrow}{I_\uparrow + I_\downarrow}\right)_L ,$$

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

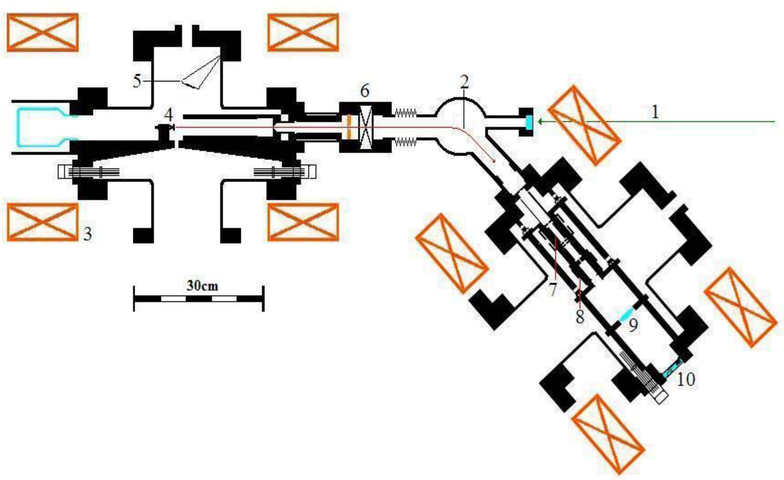

Fig. 1. Experimental apparatus: (1) laser beam for GaAs source; (2) electron beam; (3) guiding magnets; (4) GaAs photocathode; (5) cesiators; (6) gate valve; (7) chiral target cell; (8) optical polarimeter target cell; (9) lens; (10) to optical polarimeter.

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 $A_{1.5\,eV}$ = 0.41(7)*10^{-4} and $A_{3.5\,eV}$ = 0.58(7)*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 $A_{1.5\,eV}$ = 1.2(2)*10^{-4} and $A_{3.5\,eV}$ = 0.4(1)*10^{-4}.

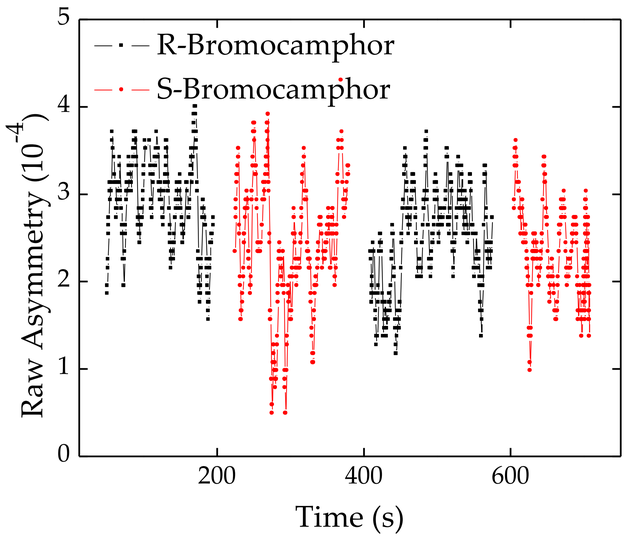

Fig. 2. Example of data collected to measure the transmission asymmetry of spin-polarized electrons through the two different enantiomers of bromocamphor.

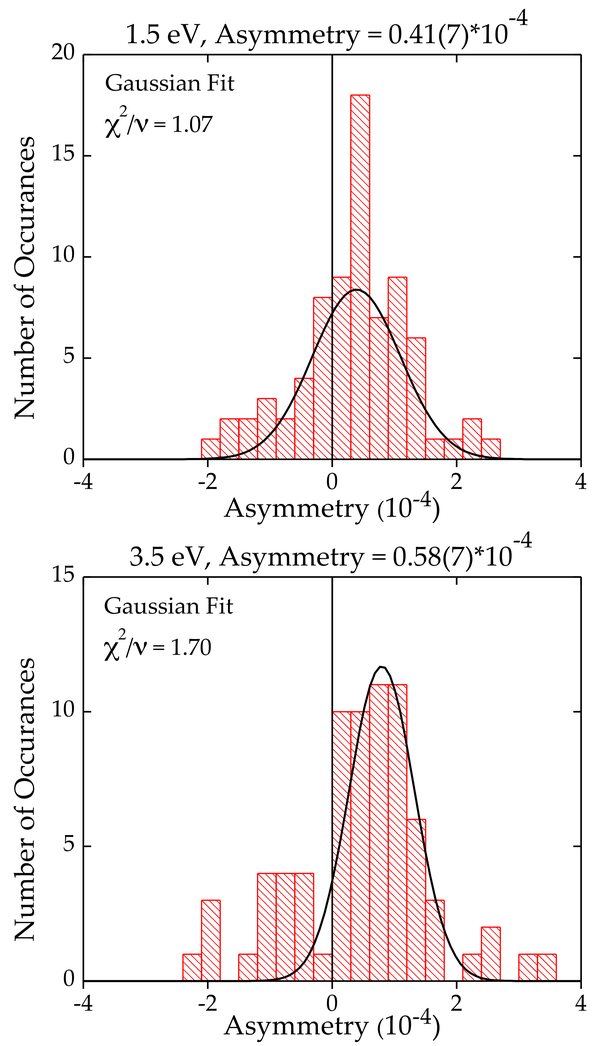

Fig. 3. Results for spin-polarized electron transmission asymmetry through bromocamphor at 1.5 eV (top) and 3.5 eV (bottom) incident electron energy.

[1] S. Mayer, C. Nolting, and J. Kessler, J. Phys. B **29**, 3497 (1996).

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