Abstract Submitted
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Surface-sensitive molecular interferometry: beyond ^{3}He spin echo experiments[1] JOSHUA T CANTIN, ROMAN V KREMS, Univ of British Columbia, ODED GODSI, TSOFAR MANIV, GIL ALEXANDROWICZ, Technion - Israel Institute of Technology — ^{3}He atoms can be used as surface-sensitive atomic interferometers in ^{3}He spin echo experiments to measure surface morphology, molecular and atomic surface diffusion dynamics, and surface vibrations. However, using the hyperfine states of molecules gives experiments the potential to be less expensive, be more sensitive, and include angle-dependent interactions. The manifold of hyperfine states of molecules is large in comparison to the two nuclear spin states used in ^{3}He spin echo experiments and allows for increased precision, while simultaneously complicating experimental interpretation. Here, we present the theoretical formulation required to interpret these experiments. In particular, we show how to determine the effect of magnetic lensing on the molecular hyperfine states and use a modified form of the transfer matrix method to quantum mechanically describe molecular propagation throughout the experiment. We also discuss how to determine the scattering matrix from the experimental observables via machine learning techniques. As an example, we perform numerical calculations using nine hyperfine states of *ortho*-hydrogen and compare the results to experiment.

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