Quantum Reflection, Evaporation, and Transport Currents in ^{4}He

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We study transport currents induced by excited states in surfaces and bulk ^{4}He. This requires the calculation of particle currents $\langle n|\hat{\mathbf{j}}|n\rangle$ to second order in the excitation amplitudes. For that purpose, we take a well-tested microscopic theory of inhomogeneous quantum liquids and extend it to find the mass currents created when a quasiparticle propagates through the liquid, when atoms scatter off a surface or when excitations evaporate atoms. Specifically, we look at the phonon lifetime, quantum reflection, and quantum evaporation. We show that quantum reflection is sensitively affected by both details of the liquid surface profile and by many-body effects. This is the first theoretical study of transport phenomena in a quantum liquid based on a quantitative microscopic theory.