Hydrodynamics of Superfluid Flow through a Nanohole: Towards the 1D Regime

G. Gervais

Department of Physics, McGill University, Montreal, Canada, H3A 2T8

Quantum fluids, whether constituted of atoms, electrons or nucleons, are ubiquitous in nature. In three dimensions, their quantum statistics are restricted to the Bose and Fermi statistics, each of which can be found to be at the heart of the superfluidity and Fermi liquid behavior for ^{4}He and ^{3}He. In two dimensions more exotic quantum statistics can occur (the so-called anyons), and it has long been known theoretically that in one dimension, fermionic systems should bosonize, and in some ways their quantum statistics be quenched. Such one-dimensional quantum fluid, known as a Luttinger liquid, might be observable in liquid helium when constrained radially by a lengthscale nearing the nanometric scale [1]. In this talk, we discuss our results and progress of an experiment where the superfluid helium flow across a tailor-made single nanohole with a $\sim$45 nm diameter is measured via mass spectrometry [2]. The measured mass flow is modeled by a two-fluid model which accounts for the end effects of the short-pipe, and the extracted superfluid velocities are compared with existing data from the literature. Finally, we discuss how one might be able to reach the one-dimensional regime, and study the behavior of a helium Luttinger liquid.
(1) A. Del Maestro, M. Boninsegni, and I. Affleck, Phys. Rev. Lett. **106**, 105303 (2011).
(2) M. Savard, C. Tremblay-Darveau, and G. Gervais, Phys. Rev. Lett. **103**, 104502 (2009); *ibid* to be published.