Local Superfluidity at the Nanoscale

A. Del Maestro[a], G. Gervais[b], and B. Kulchytskyy[b]

[a]Department of Physics, University of Vermont, Burlington, VT 05405, USA
[b]Department of Physics, McGill University, Montreal, H3A 2T8, Canada

To understand how the enhancement of both thermal and quantum fluctuations affects superfluidity in low dimensional nanoscale constrictions, we have performed quantum Monte Carlo simulations measuring the superfluid response of helium-4 to the linear and rotational motion of the walls of a confining nanopore. Within the pores, the portion of the normal liquid dragged along with the boundaries is dependent on the type of motion and the resulting anisotropic superfluid density exhibits plateaus at low temperature. The origin of this saturation, which is not observed in bulk quantum fluids, is uncovered by computing the spatial distribution of superfluidity, with only the core of the nanopore exhibiting any evidence of phase coherence. We find that the superfluid core displays scaling behavior consistent with Luttinger liquid theory, thereby providing an experimental test for the emergence of a one dimensional quantum fluid.

Section: LD - Low dimensional and confined systems

Keywords: superfluidity, quantum Monte Carlo, Luttinger liquid