Drag Force on a High Porosity Aerogel in Liquid ^{3}He

H. Takeuchi, S. Higashitani, and K. Nagai

Graduate School of Integrated Arts and Sciences, Hiroshima University, Kagamiyama 1-7-1, Higashi-Hiroshima 739-8521, Japan

When a body is immersed in liquid ^{3}He and there is a velocity difference between them, a drag force acts on the surface of the body. The drag force can be characterized by the linear size of the body, a, and the quasiparticle mean free path, $l_{\rm in}$, originating from inelastic mutual collisions. In the Knudsen limit $l_{\rm in} \gg a$, the drag force depends on the geometry of the body through the cross-sectional area, as can be found from analysis of the Landau transport equation with an appropriate boundary condition at the surface. In the opposite limit $l_{\rm in} \ll a$ (the hydrodynamic limit), it is well known that the drag force is proportional to the linear size a; e.g., for a spherical body of radius a, the hydrodynamic drag force obeys the Stokes law $6\pi\eta a\mathbf{v}$ with η the viscosity of liquid and $\mathbf{v}$ the flow velocity relative to the body. We discuss the crossover from the Knudsen limit to the hydrodynamic limit in a high porosity silica aerogel filled with liquid ^{3}He. In this system, a corresponds to the size of the silica particles ($\sim$ 3 nm). Then it is expected that the crossover occurs at $\sim$ 100 mK as a result of the decrease of the quasiparticle mean free path $l_{\rm in}$ with increasing temperature. Such a crossover seems to be observed by the ultrasound attenuation measurements reported by Choi *et al.*[1], as rapid increase of the attenuation at around 100 mK.

[1]H.C. Choi *et al.*, J. Low Temp. Phys. **148**, 609 (2007).