First-sound Measurements of Liquid ^{4}He near T_λ in Microfluidic Devices

X. Rojas, Y. Yang, A. Duh, and J. P. Davis

Department of Physics, University of Alberta, Edmonton AB, Canada

We present the first measurements of a new type of apparatus to probe the properties of quantum fluids in restricted geometries. We have confined liquid ^{4}He within microfluidic devices formed from borosilicate glass, in which one dimension is restricted to nanometer or micron scales. Nanofabrication techniques allow us to obtain fine control over the size and roughness of the surfaces of the resulting cavity [1]. Using an acoustic Fabry-Pérot technique we measure the first-sound of liquid ^{4}He confined within these cavities, which is a sensitive probe of the superfluid state. Piezoelectric drive and receiver transducers are bound onto each side of the device in order to measure the acoustic signal transmitted through the resonant cavity with a high-frequency lock in amplifier. We show preliminary measurements probing finite size effects near T_λ in confined liquid ^{4}He using this technique. This experiment could also be extended to liquid ^{3}He, in order to obtain a direct measurement of transverse sound in the normal state, or to verify the theoretical prediction of a new superfluid phase that breaks the translational symmetry [2].

[1] Microfluidic and Nanofluidic Cavities for Quantum Fluids Experiments, A. Duh, A. Suhel, B.D. Hauer, R. Saeedi, P.H. Kim, T.S. Biswas and J.P. Davis, J. Low Temp. Phys. **168**, 31 (2012).

[2] Crystalline Order in Superfluid ^{3}He Films, A. B. Vorontsov and J. A. Sauls, PRL **98**, 045301 (2007).

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