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Ultrasonic measurements of normal and superfluid He-3 in high porosity aerogel[1]

YOONSEOK LEE, Department of Physics, University of Florida

Ultrasound spectroscopy and nuclear magnetic resonance have been proven to be the most valuable spectroscopic tools in the study of superfluid ^{3}He. These experimental methods provide complementary information on the orbital and spin structure of the Cooper pairs. In particular, the rich spectrum of the order parameter collective modes, a direct consequence of the exotic broken symmetry in the superfluid phases, have been mapped out by ultrasonic spectroscopic techniques. Aerogel possesses a unique structure, whose topology is at the antipode of conventional porous media such as Vycor glass and metallic sinters. High porosity aerogel presents additional scattering channel that substantially changes the ultrasonic behavior in both normal and superfluid phase of ^{3}He. For example, in the normal fluid the classic first to zero sound crossover is effectively prohibited due to the residual elastic scattering from aerogel. However, the hydrodynamic-Knudsen crossover arises owing to the unique structure and the widely varying inelastic mean free path in ^{3}He. In superfluid, no signatures of the order parameter collective modes were observed but the gapless superfluidity has been clearly verified through ultrasound measurements. In this paper, we will present the experimental results obtained in the past decade using ultrasonic techniques.

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