Ultrasound Attenuation and a P-B-T Phase Diagram of Superfluid ^{3}He in 98% Aerogel

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The effect of disorder on a many particle system is one of the most important and ubiquitous problems in condensed matter physics. We study the effect of controlled disorder in otherwise the purest condensed matter system, liquid ^{3}He by utilizing nanometer scale porous medium, silica aerogel.

Especially in the low milikelvin range, we can study the influence of disorder on unconventional (*p-wave*) superfluid ^{3}He. Using high frequency ultrasound, we found drastically different behavior in the transition between two superfluid phases (the A- and the B-phase) in response to applied magnetic field from the pure superfluid. Using this technique we constructed a phase diagram in pressure-field-temperature space.

The key features of the phase diagram can be understood on the basis of two fundamental points: firstly, the strong coupling effect is significantly reduced in this system by impurity scattering, and secondly, the anisotropic disorder presented in the form of aerogel strands plays an important role that emulates the effect of a magnetic field.

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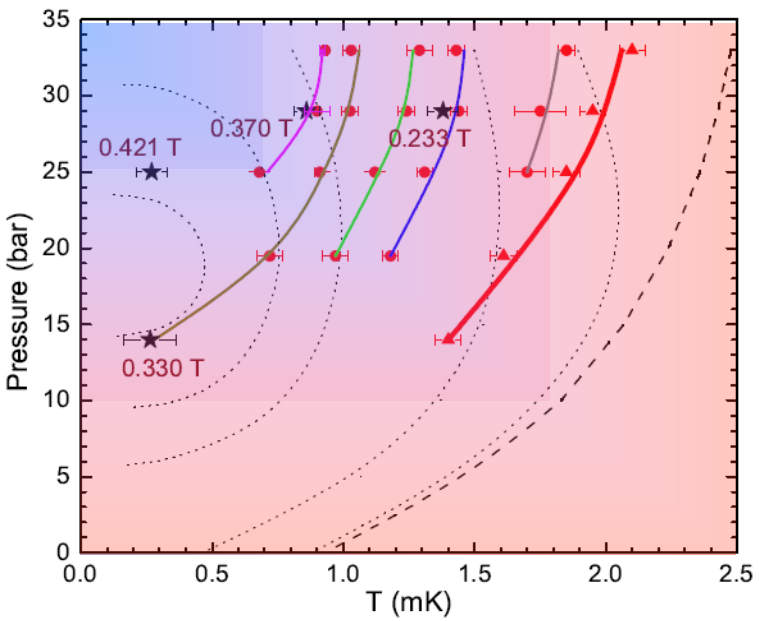

Phase diagram of superfluid ^{3}He in 98% aerogel. The solid triangles represent the aerogel superfluid transition. The A-B transitions in aerogel obtained by two different methods are represented by solid circles and stars. For comparison, the constant field A-B phase boundaries for the bulk liquid are shown by the dotted lines for 0.1, 0.3, 0.5, 0.55, and 0.58 T, respectively. The numbers next to the star symbols indicate the mid-field strength.