Suppression of the B-like Phase of Superfluid ^{3}He by a Magnetic Field in 98% Aerogel

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Introduction

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. We have investigated the phase diagram of this system in high magnetic fields up to 15 T [1], and measured the sound attenuation in the B-like phase of superfluid ^{3}He in 98% aerogel in zero magnetic field [2]. In this work, we have extended measurements to the A-like phase stabilized by a magnetic field up to 4.44 kG and constructed the low field part of the phase diagram focusing on the field dependence of the A-like to B-like transition.

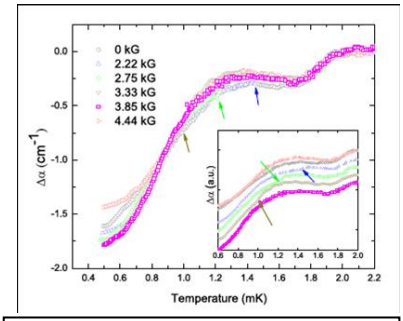

Fig. 1 Sound attenuation for B < 4.44 kG
Inset: magnified view around the B to A transition

Experimental

Two longitudinal $LiNbO_3$ transducers, with fundamental resonances of 1.1 MHz, were used as a transmitter and a receiver separated and supported by a 3 mm Macor spacer. 98% porous aerogel was grown in the acoustic cavity which is oriented to have a $\boldsymbol{q} \perp \boldsymbol{H}$ configuration. A MATEC broadband pulsed spectrometer was used to transmit and detect 3 μs pulses of 6.22 MHz, the 5th harmonic of the transducers.

Results and Discussion

We measured sound attenuation down to 0.3 mK in the presence of magnetic fields from 0 to 4.4 kG at 19.5 and 29 bar as shown Fig. 1. For 0 < H < 4.44 kG, the attenuation follows the B-like phase curve at lower temperature and makes a smooth crossover to the A-like phase curve at the B to A transition. The identification of this transition becomes difficult near the temperature range where the attenuation in both phases is practically identical. The A-B transition points identified in this way are displayed in Fig. 2 along with the bulk A-B transition lines at the comparable magnetic fields. The pressure dependence of the aerogel A-B transition at a given field is drastically different from that of the bulk. In bulk, the A-B transition line possesses an inflection point near the polycritical point where the sign of the slope changes. In aerogel the A-like to B-like phase transition line seems to show only a positive slope.

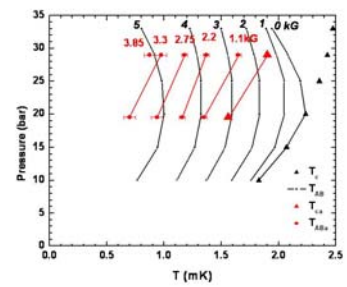

Fig. 2 A-B transition at various magnetic fields for 19.5 and 29 bar

Conclusions

We have investigated the low field phase diagram tracing down the suppression of the B-like phase in aerogel by magnetic field. The field dependent A-B transition exhibits the opposite sign of slope to that of the bulk in the same pressure range.

Acknowledgements

This work is supported by NSF through DMR-0239483 and 0803516 (YL) and DMR-0701400 (MWM). This work was carried at the High B/T Facility of the National High Magnetic Field Laboratory supported by the National Science Foundation Cooperative Agreement No. DMR 0654118 and by the State of Florida.

References

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[2] Choi, H.C., *et al.*, Phys. Rev. Lett. **98**, 225301 (2007).