The effect of aerogel anisotropy on superfluid ^{3}He-A

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It has been predicted that uniaxially compressed silica aerogel orients the angular momentum, $\hat{l}$, in superfluid ^{3}He-A, along the strain axis.[1] Here we report clear experimental evidence that $\hat{l}$ in the A-phase is oriented perpendicular to the strain axis contrary to the theory. We introduced anisotropic impurity into superfluid ^{3}He-A using 20% elastic mechanical compression of two different samples, of highly uniform, isotropic, 98.2% porosity aerogel. Our pulsed nuclear magnetic resonance (NMR) measurements of the spectrum frequency shift, linewidth, and tip angle dependence indicate an axial state on cooling with long range orientational order of the orbital angular momentum, uniformly established throughout the whole sample. The temperature, magnetic field, and tip-angle dependence of the frequency shift demonstrate that the aerogel anisotropy orients the orbital angular momentum perpendicular to the strain axis for both orientations of magnetic field parallel and perpendicular to the strain. Additionally, our comparison of NMR measurements before and after the compression reveal a novel effect of the aerogel anisotropy on superfluid phase stability. While the B-phase is the equilibrium state in the isotropic aerogel in the zero field limit, aerogel anisotropy stabilizes a temperature window of a new superfluid state at low magnetic field. The stability of this new phase decreases with increasing field, disappearing completely at a critical field H_c near 1000 G. At higher fields the A-phase becomes stable indicating a competition between aerogel anisotropy and the magnetic field for stabilization of the A-phase.

1. Volovik, G. E. (2008). "On Larkin-Imry-Ma State of ^{3}He-A in Aerogel". J. Low Temp. Phys., 150, 453.

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