Stability of Impurity Phases of Superfluid ^{3}He

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It is well established that superfluid ^{3}He within highly porous silica aerogel can be understood in terms of a model of correlated scattering of ^{3}He quasiparticles from the aerogel strands, including both transition temperature and amplitude of the order parameter. Additionally, the texture of the order parameter can be affected. Until recently, quantitative interpretation of nuclear magnetic resonance (NMR) observations has been complicated by extraneous effects on the texture from inhomogeneous and ill-characterized aerogel. Our recent NMR experiments with homogeneous aerogel samples permit identification of the order parameter texture and as a consequence, a clear identification of the superfluid phases themselves. These are impurity phases of the axial and isotropic p-wave states, more familiarly known as the A and B-phases of pure ^{3}He. There are predictions that anisotropic scattering should favor anisotropic states, and conversely for isotropic scattering. To explore this idea, we have made a homogeneous anisotropic aerogel and we have discovered that the A-phase can be stabilized over the entire available range of pressure and temperature down to 0.6 mK. This is in contrast to a homogeneous isotropic aerogel where it is the isotropic superfluid state that is stable, except for a narrow temperature region near the transition temperature. We have compared effects on the superfluid phases from two types of homogeneous, anisotropic aerogel samples, one with uniaxial compression, and one that is stretched. Stability of the A-phase only holds for the stretched aerogel.

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