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Engineering the glass phase of superfluid ^{3}He-A with disorder[1]

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It is established theoretically that an ordered state with continuous symmetry is inherently unstable to arbitrarily small amounts of disorder [1, 2]. Based on this idea it was predicted [3] that ^{3}He-A in high porosity aerogel would become a superfluid glass, provided the aerogel has no global anisotropy that breaks the continuous symmetry of the system. We report here our nuclear magnetic resonance (NMR) measurements on ^{3}He in an aerogel sample, characterized to be extremely homogeneous and isotropic. When the superfluid state is generated by cooling from the normal state, the long range orientational order of the intrinsic superfluid orbital angular momentum is destroyed, confirming the existence of a superfluid glass of ^{3}He-A[3]. In this disordered glass state, the NMR response of the superfluid state vanishes and the order parameter structure of the superfluid is completely hidden, a behavior of potential significance for understanding exotic superconductors such as URu_2Si_2. In contrast, ^{3}He-A generated by warming from superfluid ^{3}He-B has perfect long-range orientational order, providing a mechanism for switching off this effect. Furthermore, by uniaxial compression of $\approx 20\%$ on the same sample we introduce uniform global anisotropy into this aerogel which breaks the 3-D continuous symmetry and restores perfect orientational order along the compression axis. However, in the plane perpendicular to the compression axis, the remaining 2-dimensional continuous symmetry gives rise to an in-plane glass state.

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