

Evidence of Diluted Superfluid ^3He in Aerogel

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After the first experimental report by Kim *et al.* [1] on the possible mixing of a few percent of ^4He in liquid ^3He confined in aerogel in the concentrated side of the phase diagram, various attempts were made to clarify if ^4He was homogeneously mixed into liquid ^3He . Heat capacity measurement [2] supported the proposed phase diagram of Ref [1]. Torsional oscillator and sound measurement [3] has shown the existence of phase-separated droplet of ^4He in the regime of 11% or more of ^4He density. However it is still unclear if ^4He is homogeneously mixed into liquid ^3He in the region of less ^4He .

In investigating superfluid ^3He in 97.5%-porosity aerogel with NMR/MRI techniques, we eliminated the effect of solid ^3He by covering the surface of silica strands with 2.5 atomic layers of ^4He . However, in case we added excess amount of ^4He , we observed interesting behavior. Superfluid transition temperature, which is 1.5 mK with proper 2.5 layers coating, became lower as introducing more amount of ^4He . The magnetization of normal phase decreased as well. For the case where superfluid transition temperature was as low as 0.9mK, spin diffusion coefficient was increased by a factor of 1.5 both in high temperature region, where ^3He - ^3He scattering dominates, and in low temperature region, where ^3He -aerogel scattering dominates. The modification suggests that a Landau parameter F_0^a is modified towards less ferromagnetic direction. This indicates that ^4He is homogeneously mixed into liquid ^3He rather than coexisting as a phase separated droplet. Simultaneously the susceptibility must be reduced due to the modification of F_0^a . Combining with the measured magnetization, we estimated the concentration of ^4He in this diluted superfluid ^3He as 8%. This is the first confirmation of the existence of diluted superfluid ^3He in aerogel.

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