Superfluid *A*-like and *B*-like phases, and their Coexistent State of liquid ^{3}He in Aerogel

K.Obara, Y.Nago, R.Kado, H.Nakagawa, H.Yano, O.Ishikawa, and T.Hata
Graduate School of Science, Osaka City University, Osaka, 558-8585, Japan

Aerogel provides an interesting system to investigate superfluidity of liquid ^{3}He, because the average distance between the silica strands is comparable to the superfluid coherence length, and the diameter of each silica strand is *minute*. Therefore, aerogel acts as an impurity which does not destroy the superfluidity completely but does suppress the transition temperature T_C and the superfluid density ρ_s/ρ. Moreover, it has been discovered recently that aerogel pins the phase boundary between the *A*-like and the *B*-like phases. We used two methods to investigate superfluid states: cw NMR to distinguish the *A*-like phase from the *B*-like phase, and the fourth sound resonance technique to study ρ_s/ρ directly.

On cooling from normal state, we found three characteristic temperatures (*see* FIG.1); (1) T_C, the superfluid transition temperature, (2) T_{B+}, at which the *B*-phase appears, (3) T_{A-}, at which the *A*-like phase disappears. Here, $T_{A-} < T < T_{B+}$ is the region where the *A*-like and the *B*-like phase coexist. The *A*-*B* transition occurs in a temperature band. In this band the *A*-like phase gradually converts to the *B*-like phase only in the cooling process. On the other hand, the *B*-like phase converts to the *A*-like phase in another temperature band near T_C, only in warming process, in FIG. 2. The fraction of *A*-like phase and characteristic temperatures are well reproducible, although the *A*-*B* transition is the first ordered phase transition. We also performed so-called *turn-around* experiment; we cool the system from normal liquid to the certain temperature T_T and then warm up. When we choose this temperature to be $T_{A-} < T_T < T_{B+}$, as illustrated with the green arrow in FIG. 2,the *A*-phase fraction maintains its value at T_T during the warming process up to meet the red curve. No change of the *A*-like phase fraction is an evidence of the pinning of the *A*-*B* phase boundary due to the aerogel strands. Possible structures of the phase boundary will be discussed.

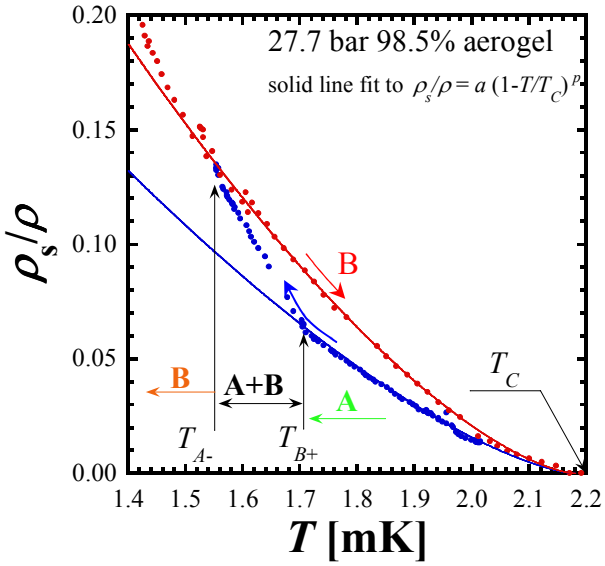

FIG.1 Hysteresis loop of superfluid fraction in 98.5% aerogel.

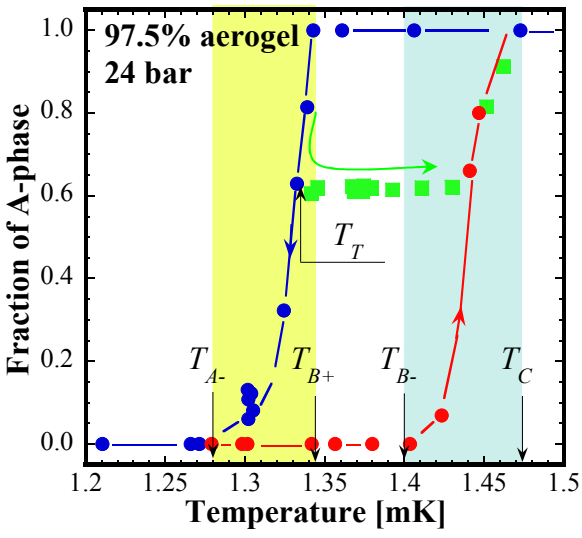

FIG.2 Conservation of *A*-like phase fraction in *turn-around* process.