The Surface Density of States of Superfluid ^{3}He for Different Surface Boundary Conditions

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In unconventional superconductors and superfluids, scattering of quasi-particle modifies the local density of states significantly from the bulk one leading to the formation of Andreev bound states in the vicinity of surface. So, it is a very interesting experimental issue to study the surface density of states (SDOS) in superfluid ^{3}He. Recently, we obtained a clear evidence of the surface Andreev bound states at a diffusive wall by measuring the temperature dependence of the transverse acoustic impedance of superfluid ^{3}He using AC-cut quartz transducers [1]. Weak singularities, such as a kink in the real component and a peak in the imaginary component, appeared at a particular temperature where acoustic energy is equal to $\Delta + \Delta^*$. Δ^* is the upper edge of the surface bound state.

The SDOS crucially depends on a boundary condition of a wall [2]. By decreasing the surface roughness, Δ^* moves to Δ, and finally SDOS becomes gapless. So far past experiments were performed only at a diffusive surface. Surface boundary condition can be controlled by coating the ^{4}He thin layers. We started to measure the impedance with coating of 2.7 layers ^{4}He. Compared to the pure sample, the singularities shift to higher temperature and variations of the impedance becomes smaller. These changes are qualitatively in agreement with the theory. The smaller variations come from the increase of specularity and the temperature shifts corresponds to the fact the Δ^* moves to Δ.

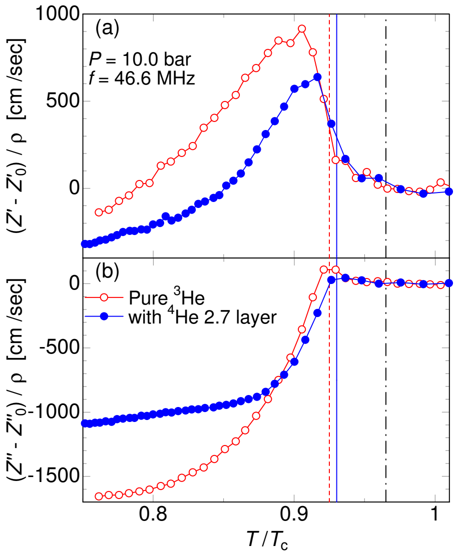

Fig. 6: Real and imaginary parts of the transverse acoustic impedance for superfluid ^{3}He-B near the wall. Open symbols are pure ^{3}He data and solid symbols are data with coating of 2.7 layers ^{4}He

[1] Y. Aoki, Y. Wada, M. Saito, R. Nomura, Y. Okuda, Y. Natato, M. Yamamoto, S. Higashitani and K. Nagai, Phys. Rev. Lett. **95**, 075301 (2005); M. Saito, Y. Wada, Y. Aoki, S, Murakawa, R. Nomura and Y. Okuda, Phys. Rev. B **74** 220505 (2006).

[2] Y. Nagato, M. Yamamoto and K. Nagai, J. Low Temp. Phys. **110**, 1135 (1998).