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著者(和文)	和才将大
Author(English)	masahiro wasai
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Magnetic Response of the Surface Bound State of Superfluid 3He

Masahiro Wasai

Department of Physics,
Tokyo Institute of Technology,

Abstract

Superfluid ^{3}He is the first discovered p-wave spin triplet superfluid and its bulk properties are well understood. Near the wall of the BW state of the superfluid, the unique quasi-particle state is formed due to the odd parity of the order parameter, which is called as the Surface Andreev Bound State (SABS). The density of state of SABS is formed below the bulk gap energy and is confined very close to the wall.

Though the theoretical prediction of SABS was done pretty long time ago, no experiment was performed. Recently, however, our group has succeeded in observing SABS by the transvers acoustic impedance and revealed the properties of SABS for the first time. After that, from the side of theory of condensed matter physics, it is predicted that the quasi-particles in SABS can be regarded as the Majorana fermions, whose antiparticles are their particles.

The present thesis work is to clarify the magnetic response of SABS by measuring magnetic field effect on the acoustic impedance when the field is applied perpendicular to the surface, for the purpose of identifying the Majorana property. The tiny anomaly in the imaginary part of the impedance is clealy observed, which should correspond to the gap near the zero energy opened by the magnetic field. The result is analyzed with the recent theory and the reasonable agreement is obtained. The time reversal symmetry of the system is broken by the magnetic field and then it results in the opening of the gap near zero energy. This picture is consistent with the Majorana property of SABS.