Observation of the Free Surface of Superfuid ^{4}He under Rotation by 2D Surface Electrions and 2D Ion Pool under the Surface

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The detail of the free surface profile of superfluid with quantum vortex has been interested since the first discovery of it. For the purpose of study the an interaction between two-dimensional surface electrons (SEs) and the vortex, we built the mechanically stable rotating dilution refrigerator. The refrigerator makes us possible to measure the transport property of the SEs without any noise caused by mechanical vibration at the rotating angular velocity up to 5 rad/sec and wide temperature range down to $\sim$ 10 mK.

Recently, Hakonen *et al* shows the depth of the dimple can be enhanced in the presence of the surface state electrons by electro-hydrodynamic instability at critical external pressing electric field E_C [1]. The field estimated as $E_C \sim 2800$ V/cm in the case of the vortex of ^{4}He. This E_C is a vicinity of the other critical electric field for macroscopic dimple lattice formation with a characteristic wave length of ripplon [2]. It might be expected that ripplon softening induced by a vortex occurs at around E_C. In order to observe the enhanced vortex dimple, we are measuring the magnetoconductibity of SEs using the conventional Sommer and Tanner method. In the figure 1, preliminary results of the pressing field (E) dependence of the mobility in the E up to 1700 V/cm at 700 mK is shown. The mobility is calculated by Drude model. The experimental results of the transport property of SEs around E_C and possible future scenario to study the free surface with quantum vortex will be presented.

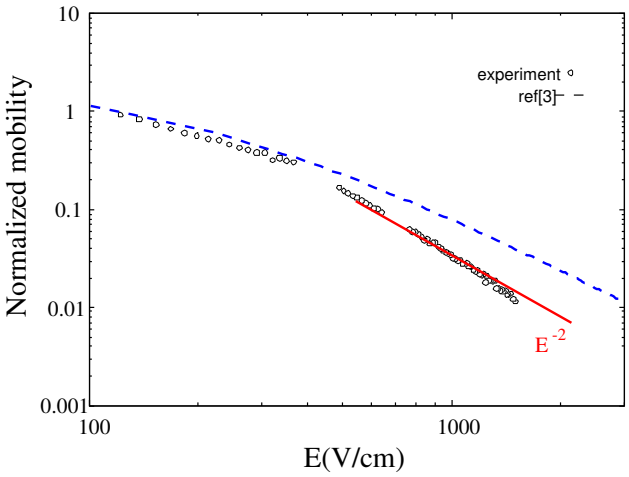

Fig. 4: Normalized mobility of SEs on liquid ^{4}He at rest vs pressing electric field. T = 700 mK, f = 100 kHz. The magnetic field was applied from 300 to 2000 G. The mobility was normalized by the obtained one at E = 110 V/cm. The dashed line was calculated by Saitoh ' s model (ref[3]).

[1] P. J. Hakonen, J. S. Penttilä, and E. B. Solin, J. Low Temp. Phys. **96** (1994).
[2] P. Leiderer and M. Wanner, Phys. Lett. **73A** 189 (1979).
[3] Motohiko Saitoh, J. Phys. Soc. Jpn. **42** 201 (1977).