Search for Supersolidity in Monolayer ^{4}He on Graphite

Y. Kubota[a], R. Toda[b], M. Kamada[a], S. Nakamura[a], T. Matsui[a], and Hiroshi Fukuyama[a,b]

[a]Department of Physics, The University of Tokyo, Japan
[b]Cryogenic Research Center, The University of Tokyo, Japan

Recent heat capacity measurements for the second layer of ^{4}He adsorbed on ZYX graphite, an exfoliated graphite with much larger platelet size than Grafoil, clearly show the existence of a commensurate phase (C2) at a density $\rho_{C2} = 19.7$ nm^{-2} in between a low density liquid phase and a high density incommensurate phase [1]. The C2 phase is the lowest density quantum solid ever found with substantially fast exchanges of atoms and vacancies. Therefore, it is a hopeful candidate for the novel supersolid phase where crystalline order coexists with superfluidity. Previous torsional oscillator measurements of the second layer of ^{4}He by three different groups using Grafoil show frequency shifts below 300 mK at densities near ρ_{C2} suggesting unusual superfluidity [2]. However, the observed reentrant density variations of superfluid response are rather different each other, and the shifts are too small to convince the supersolidity. This is presumably because of large uncertainties in their density scales and poor connectivity of platelet boundaries in Grafoil. Here, we report details of experimental setup and preliminary results of our new torsional oscillator measurement down to 10 mK on the second layer of ^{4}He. The oscillator made of coin silver containing ZYX substrate with a surface area of 4.6 m^2 has $f = 786.819$ Hz and $Q = 1.1 \times 10^5$.

[1] S. Nakamura, *et al.*, to be published.
[2] P. A. Crowell and J. D. Reppy, Phys. Rev. B **53**, 2701 (1996); Y. Shibayama *et al.*, J. Phys. Conf. Ser. **150**, 032096 (2009); J. Saunders, private communication.

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