New Heat-Capacity Measurements of the Possible Order-Disorder Transition in the 4/7-phase of 2D Helium

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Helium atoms in the second layer on graphite are supposed to localize at the 4/7 commensurate density with respect to the first layer. Though its low temperature magnetic behavior is well-studied with various experimental techniques in the case of ^{3}He 4/7 phase,[1] we have little knowledge about the expected order-disorder transition at high temperatures. Previous heat-capacity measurements revealed anomalies with a maximum at $T \sim 1.0$ K and 1.5 K for ^{3}He and ^{4}He, respectively. However, the anomalies are not sharp enough presumably broadened by the poor crystallinity of exfoliated graphite substate (Grafoil) used in those measurements as in the case of the $\sqrt{3} \times \sqrt{3}$ phase in first layer. Or, they might simply represent some specific energy-scale not related to the order-disorder transition. Moreover, in the case of ^{4}He, the recent first-principles calculation claimed the absence of the 4/7 phase.[2] To unmask this controversy, we have developed a new heat-capacity measuring system with ZYX graphite which is known to have much better crystallinity than Grafoil, and started data collection for ^{4}He 4/7 phase. We will report preliminary data as well as a detailed description of instrumentation including a mechanical heat-switch operated by hydraulic pressure of superfluid ^{4}He.

[1] H. Fukuyama, J. Phys. Soc. Jpn., **77**, 111013 (2008).
[2] P. Corboz, M. Boninsegni, L. Pollet, and M. Troyer, Phys. Rev. B, **78**, 245414 (2008).