Specific Heat Measurement of the Gapless Spin Liquid State in 2D ^{3}He

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The second layer of ^{3}He adsorbed on a surface of graphite is known to form a low density commensurate (C2) phase with a triangular lattice structure sometimes called the 4/7 phase at low temperatures (T). Previous experiments[1,2] show that the ground state of this phase is a promising candidate for the gapless quantum spin liquid (QSL) without long range order and spin excitation gap. This is based mainly on the observed double peak structure of specific heat (C) with a seemingly $C \propto T$ behaviour and the continuous and gradual increase of magnetic susceptibility at low-T. To test this hypothesis, we are measuring C of the C2 phase adsorbed on graphite preplated with a bilayer of HD at T well below a typical strength of various multiple spin exchange interactions ($|J_P| \approx 100$ mK) among the nuclear spins ($I = 1/2$). Data so far obtained indicate that the $C \propto T$ dependence holds down to 0.4 mK below a broad single maximum around 5 mK. They are indicative of the formation of Spinon Fermi surface in the gapless QSL and the high sensitivity of $|J_P|$ to density in quantum solids. We are now extending the measurement down to 0.1 mK and preparing an NMR measurement of the spin-spin relaxation time (T_2) in order to obtain direct information on the spin dynamics of QSL which is usually difficult to acquire from electronic counterpart materials. Preliminary data show that T_2 gradually decreases around T corresponding to the broad C maximum and saturates at the lowest-T.

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2. R. Masutomi *et al.*, Phys. Rev. Lett. **92**, 025301 (2004).

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