Spin-spin Relaxation Time Measurements of 2D ^{3}He on Graphite

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Monolayer ^{3}He adsorbed on Grafoil (exfoliated graphite) preplated with monolayer ^{4}He is an ideal two-dimensional (2D) fermion system. Some years ago, we measured spin-spin relaxation time (T_2) of 2D ^{3}He in the second layer by the spin echo technique of pulsed-NMR near localization and found unusual behavior not explained by a simple first-order transition between liquid and solid phases. We now extended our measurements to the pure fluid density region ($0.7 \leq \rho_2 \leq 5.3\,\mathrm{nm}^{-2}$) where the magnetization shows an expected temperature dependence for Fermi degeneracy with $150 \leq T_F \leq 300$ mK. The T_2 value measured at $T = 100$ mK and $f = 5.5$ MHz shows a broad maximum of 5.7 ms around $\rho_2 = 2\,\mathrm{nm}^{-2}$. This can be related to the fact that the effective Fermi velocity becomes maximum near that density. On the other hand, we observed an unexpected measuring frequency (f) dependence of T_2, i.e., the inverse T_2 varies in proportion to f at least in the range of $1.16 \leq f \leq 5.5$ MHz. This is curious since basically T_2 should be independent of f as long as $f \ll k_B T_F / h$ ($\approx$ several GHz). This could be explained by spin diffusion in a microscopic magnetic field inhomogeneity caused by the huge diamagnetism and mosaic angle spread of Grafoil substrate. A similar frequency dependence of T_2 was also reported in the earlier pulsed-NMR study of submonolayer solid ^{3}He.[1] We are now preparing new measurements at much lower frequencies where the intrinsic T_2 can be determined with good precision by extrapolating to zero frequency.

[1]B. Cowan, L.A. El-Nasr, and M. Fardis, Jpn. J. App. Phys. **26**, 309 (1987).