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Magnetic Relaxation and Minority Spin Condensate in Spin-Polarized Superfluid ^{3}He A_1[1]

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The magnetic relaxation phenomena in superfluid ^{3}He A_1 phase are studied using a magnetic fountain pressure detector in which a large reservoir is connected to a small sensor chamber through two superleak channels of height 18 μm. Superflow in simultaneous mass/spin current is driven by an externally applied magnetic field. Measurements of the relaxation of the induced fountain pressure are carried out under a variety of conditions including pressure(3 - 29 bar), temperature, static field(up to 8 T) and ^{4}He(5 monolayers) coverage. The relaxation of the fountain pressure arises from the time dependent spin density in the sensor chamber. The observed relaxation time τ varies from 80 s near the upper transition temperature, T_{c1}, to less than 0.1 s near the lower transition temperature, T_{c2}. The measured relaxation rate increases starting near the middle of A_1 phase and more rapidly as the T_{c2} is approached. The ^{4}He coverage is observed not to affect the measured spin relaxation rate and this indicates that the relaxation is a bulk liquid effect. The rapid increase in relaxation rate is interpreted in terms of the Leggett-Takagi[1] mechanism of intrinsic spin relaxation arising from a small but increasing presence of minority spin pair condensate[2](with pair magnetic moment aligned in the opposite direction to the applied field) in A_1 phase as T_{c2} is approached. It is concluded that the conventional view of the superfluid A_1 phase being composed of condensate pairs with magnetic moment aligned strictly along the applied field is inadequate.

[1] A.J. Leggett and S. Takagi, Ann. Phys. **106**, 79(1977).

[2] H. Monien and L. Tewordt, J. Low Temp. Phys. **60**, 323(1985).

[1]In collaboration with A. Yamaguchi, S. Kobayashi and H. Ishimoto. Supported in part by NSF, MEXT and JSPS.