Spin Relaxation and Minority Spin Condensate in Superfluid ^{3}He A_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.

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