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Relaxation Rate of Superfluid 3He using Kinetic Equation for Bogoliubov Quasiparticles

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ABSTRACT

Helium is an inert gas and it has two isotopes ^4He and ^3He. ^4He is abundant in nature where as ^3He is rarely found. ^4He is a Bose particle and it follows Bose Einstein Statistics. ^3He is a Fermi particles and it follows Fermi Dirac Statistics and also Pauli Exclusion Principal. At low temperature both are in liquid form. These two liquids are also called Quantum liquids. In liquid ^3He, phase transition occurs at very low temperature, about 2.7 mK. Between 3 mK to 100 mK liquid ^3He is a normal liquid and below 3mK they are in a super-fluid meso phase called ^3He-A phase and ^3He-B phase. In 1982-85 group of scientist led by Nozires developed a Kinetic Equation taking the scattering amplitude into account with different collision integral. We have used in our calculation the same theory to calculate Bogoliubov quasi-particles relaxation rate using s-p approximation. The quasi-particles relaxation rate in mathematical form is written as

$$\frac{1}{\tau_P} = \frac{1}{\tau_{N(0,T)}}\left[I_0 + \gamma_0\,(I_1 + \ I_2\,)\frac{\Delta^2(T)}{\Delta_0^2} + \delta_0 I_3\frac{\Delta^4(T)}{\Delta_0^4}\right]$$

Where $\gamma_{0\,,}\Delta_0\ and\ \ \delta_0$ are parameters given by $\delta_0 = \langle W_1\rangle/\langle W\rangle$, $\gamma_0 = \langle W_D\rangle/\langle W\rangle$, $\Delta_0 = \Delta(T=0)$. Δ_0 is the energy gap parameter. The various W function which is taken as average or expectation values are related with different type of scattering amplitude like $W = \frac{1}{4}\pi[3A_t^2 + A_s^2]$ where A_t and A_s are anti-symmetric and symmetric amplitude. I is known as dimensionless isotropic collision integral. $\tau_{N(0,T)}$ is the quasi-particle life time at the Fermi surface in normal state. Our result indicates that the ratio τ_N/τ is decrease as a function of ΔT/T and becomes zero almost at value ΔT/T=70. On the other hand Experimental result indicates that the value of ratio decreases and after ΔT/T = 40 it increases rapidly. Our result is nearby experimental value although we could not get the thread of enhancement because the collision integral in our calculation has been perform with s-p approximation which means that we only take the small values of scattering amplitude and leaves the higher value.

Keywords: Superfluid, Quantum Liquid, Bose Particle, Fermi Particles.

REFERENCES

1. I. M. Khalatnikov, *Introduction to theory of Superfluidity* (Benjamin, New York, 1965).
2. A. J. Leggett, *Rev. Mod. Phys.* 47 , 331 (1975).
3. C. J. Pethick, H. Smith and P. Bhattacharyya, *Phys. Rev.* B 15, 3384 (1977).
4. Y. A. Ono, J. Hara, K. Nagai and K. Kawamura, *J. Low. Temp. Phys.* 27, 513 (1977).
5. G. Banerli *et. Al. J. Low. Temp. Phys. 82*, 187 (1998).
6. G. Volvovik, *Exotic Properties of Superfluid* ^{3}*He,* World Scientific, Singapore (1992).