Energy dissipation and librating motion of superfluid ^{3}He-B in the $T \to 0$ limit

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One of the challenges of the modern research on the dynamics of quantized vortices is the identification of dissipation mechanisms in superfluids with almost no normal component. It is generally believed that the essential role in the dissipation is played by the energy cascade of Kelvin waves, helical excitations on vortex lines, which transfers the kinetic energy from the macroscopic scales larger than the intervortex distance to small scales where the microscopic dissipation mechanism like quasiparticle emission by vortex cores terminates the cascade. So far the experimental verification of this picture is missing. We have studied the librating motion of a cylindrical sample of the superfluid ^{3}He-B, that is rotation of the sample around its axis with a periodically modulated angular velocity, in the temperature range $0.14 - 0.20T_c$. The modulation excites inertial waves in the liquid and Kelvin waves on vortex lines as seen from the decrease of vortex polarization. The polarization is determined from its influence on the order-parameter texture, probed by Bose-Einstein condensates of magnon quasiparticles. When the modulation of rotation velocity is stopped, the energy stored in the inertial waves is dissipated and the vortex polarization is restored. By calibrating the energy using the known free energy difference in solid-body rotation at different velocities we can extract the dissipation rate per vortex line in absolute units. We present dissipation measurements as a function of temperature, pressure, and rotation velocity, and discuss the relation of our results to the picture of the Kelvin-wave cascade.

Section: VT - Vortices and turbulence

Keywords: vortices, superfluid turbulence, Kelvin waves