Steady state and decay of quantum turbulence generated in channel flows and detected by second sound attenuation

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Abstract

Quantum turbulence is studied in superfluid ^{4}He under classical flow conditions. Turbulence is generated by a flow through a 7×7 mm square channel with a flow conditioner either with an additional grid or without it. The flow is generated mechanically by squeezing a stainless steel bellows. Vortex line density is measured by attenuation of second sound in both steady state and decay for a range of temperatures 1.17 – 2.16 K. In the steady state, temperature-independent scaling of the vortex line density with flow velocity of the form $L \propto V^{3/2}$ is observed. In the decay the expected late-time behaviour $L \propto t^{-3/2}$ is observed. Explanation for both of these observations is based on a quasi-classical model of quantum turbulence, that allows the extraction of the effective kinematic viscosity ν_{eff}, which approximately agree with the values available in the literature. Two models based on counterflow theory are also explored and the effect of inhomogeneous vortex line distribution on the measurement technique is studied.