Experiments on quantum turbulence in superfluid He-4

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The physical properties of superfluid ^{4}He are dominated by quantised vortices. They are all identical, with a core of sub-atomic radius around which superfluid flows with a circulation of $\kappa = h/m_4$ where h is Planck's constant and m_4 is the ^{4}He atomic mass. Energy dissipation by e.g. a moving object usually occurs through the production of quantised vortices - a process that occurs at critical velocities that are lower by orders of magnitude than the Landau critical velocity needed for the creation of rotons. Free ends do not exist, so vortices either join back on themselves to form continuous loops, or they terminate on the walls of the container or solid objects within it. In the latter case they are "pinned" to protuberances to minimise their length and thus energy. At higher temperatures towards that of the superfluid transition, thermal energy may be sufficient to shake a vortex off its pinning site, in which case it may slide across the surface until it re-pins to another protuberance. There is some evidence [1, 2] that, astonishingly, the vortices may also de-pin at extremely *low* temperatures. We describe an experiment to try to confirm this unexpected phenomenon, and to explore it, if it really exists. The research is based on a novel kind of oscillator [3] in which, in the absence of vortices, the superfluid remains at rest while the cell surfaces move. Both vortex creation, and the dragging of vortex ends across surfaces, will result in energy dissipation which should be detectable through the resultant changes in the frequency and width of the resonance. The experiment will be described and preliminary results will be reported and discussed.

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