Experimental investigations of liquid helium flows

Selected turbulent flows of He II, the superfluid phase of liquid ^{4}He, are investigated experimentally. The second sound attenuation technique is employed to directly probe the tangle of quantized vortices, thin topological defects within the superfluid, while relatively small particles made of solid hydrogen are dispersed in He II to visualize the overall flow of the liquid via the particle tracking velocimetry. Considering the known particle-vortex interaction mechanisms, steady thermal counterflow in a square channel is investigated. Significant inhomogeneity of the vortex tangle density along the channel height (near the flow-generating heater) is shown to develop. The means of energy transport in turbulent flows of He II are found strikingly different from those taking place in turbulent flows of viscous fluids. Moreover, individual particles in counterflow are observed to intermittently switch between two distinct motion regimes along their trajectories. The regimes are identified and qualitatively described. Steady counterflow jets in He II are realized and the spatial arrangement of the underlying vortex tangle is explored. Finally, macroscopic vortex rings are thermally generated and observed in He II. A method for tracking their propagation in the fluid is developed and their dynamics is shown to be classical-like. The quantized vortex tangle present in the rings and their turbulent wakes is found to be self-similar, highly reproducible, but non-trivial to interpret.