Quantum turbulence, nonlinear acoustics and nanoscale flows: overview of recent progress in the superfluidity group

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Superfluid helium-4 supports several phenomena unique to quantum fluids, such as quantization of circulation, second sound (a wave in temperature) or inviscid flows in nanoscale channels. In this talk I will cover recent experimental results on these topics. First, we will explore the unique ability of superfluid helium to create stationary spherically symmetric 3D flows converging/diverging from a point, which occur in nature e.g., in explosions or in some astrophysical flows. Such flow can be generated by a heat source and probed by second sound, which, when combined with rotation, also provided evidence of long-lived angstrom-thin quantized vortices spanning macroscopic distances. Next, using the fact that both pressure and temperature support longitudinal waves (first and second sound, respectively), I will show the first observation of all-acoustic Brillouin scattering of first and second sounds in an acoustic resonator, which paves the way for control over temperature fluctuations akin to those enabled by optomechanics over nanoscale mechanical motion. Finally, I will briefly present an overview of results obtained using nanofluidic acoustic resonators — from vortex pinning, through superfluid optomechanics to superfluid flows in sub-nanometre channels.