Vortex Dynamics in Superconductors and Fermi Superfluids

N.B. Kopnin[a,b]

[a]Low Temperature Laboratory, Aalto University, 00076 AALTO, Finland
[b]L.D. Landau Institute for Theoretical Physics, Moscow, Russia

We discuss forces which act on vortices moving in Fermi superfluids such as superconductors, superfluid Helium 3, etc. Using the microscopic theory we derive the force balance equation and identify three various mechanisms of vortex interaction with the environment: (i) Interaction with the superfluid component which produces the Magnus (or Lorentz) force, (ii) Scattering of normal excitations from the vortex potential giving rise to the transverse Iordanskii force[1] and to a small part of the friction force, and (iii) Scattering of normal excitations from quasiparticles localized in the vortex core[2]. This mechanism produces the transverse spectral flow force and the main contribution to the viscous friction force. Both of these forces are highly sensitive to the quasiparticle mean free path that controls the crossover from dissipative to Hamiltonian vortex dynamics as a function of the sample purity and/or of temperature.

[1]S.V. Iordanskii, Annals of Phys. **29**, 335 (1964); Sov. Phys. JETP **22**, 160 (1966)
[2]N.B. Kopnin, *Theory of Nonequilibrium Superconductivity* (Oxford, 2001); Rep. Prog. Phys. **65**, 1633 (2002)