The coupled dynamics of micron-size particles and quantized vortices

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Recently, thermal counterflow quantum turbulence[1] was experimentally sturdied by Paoletti *et al*. who visualized not only the normal flow but also the superflow by using solid hydrogen tracers. The tracer particles divide into two groups. In one group a particle is trapped by, and follows the motion of, the vortices; in the other group a particle is free and, owing to viscosity, follows the motion of the normal fluid. In this way Paoletti *et al*. obtained the velocity distributions of the normal fluid and the vortices. We study the coupled dynamics of particles and vortices, and their velocity distributions. The dynamics of vortices is described by the usual vortex filament model. The dynamics of a free particle is given by Newton's equation of motion with the Stokes drag force and the inertial force of the fluid. A trapped particle obeys Newton's equation with the addition of the vortex tension force. We solve these equation of motion simultaneously to obtain a dynamical behavior and velocity distribution similar to that observed experimentally[1].

[1]M.S. Paoletti, R.B. Fiorito, K.R. Sreenivasan, and D.P. Lathrop J. Phys. Soc. Jpn. **77**, 111007 (2008).