NON LOCAL EFFECTS IN POLARIZED ANISOTROPIC COUNTERFLOW SUPERFLUID TURBULENCE

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ABSTRACT

The physical picture of counterflow superfluid turbulence is a disordered tangle of quantized vortex lines. This tangle is produced and sustained by a heat flux crossing the system. When such a heat flux, or counterflow velocity, is high enough, vortices appear and evolve [1, 6]. In the former literature the vortex tangle is described by using only a scalar quantity, dependent on the imposed heat flux, the average vortex line density per unit volume. Recent experiments and numerical simulations show that the tangle is not homogeneous nor isotropic, especially in non steady states, or in the simultaneous presence of counterflow and rotation. In general situations the vortex tangle must be considered as a dynamical quantity, for which an evolution equation must be given. Here, a thermodynamical model of inhomogeneous counterflow superfluid turbulence is presented that chooses as fundamental fields the energy density, the heat flux, and a complete vorticity tensor, including its scalar part, its symmetric trace-less part and its antisymmetric part. Assuming that the dynamical evolution of the vorticity tensor is much faster than the dynamical equation of the heat flux, one obtains an evolution equation for the heat flux that is reminiscent of the Guyer and Krumhansl model [7, 8].

REFERENCES

[1] Barenghi, C.F., Donnelly, R.J., Vinen, W.F.: Quantized Vortex Dynamics and Super fluid Turbulence. Springer, Berlin (2001).
[2] Nemirovskii S. K., 2013, Quantum turbulence: Theoretical and numerical problems, Physics Reports, 524, 85-202
[3] Swanson, C., E., Barenghi, C., F., Donnelly, R., J.: Rotation of a tangle of quantized vortex lines in He II. Phys. Rev. Lett. **50**, 190-193 (1983).
[4] Tsubota, M., Araki, T., Barenghi, C., F.: Vortex Tangle Polarized by Rotation. Jour. of Low Temp. Phys. **134**, 471-476 (2004).
[5] Jou, D., Mongiovì M. S.: Phenomenological description of counterflow superfluid turbulence in rotating containers. Phys. Rev. B **69**, 094513 (7 pages) (2004).
[6] Jou, D., Mongiovì, M. S.: Description and evolution of anisotropy in superfluid vortex tangles with counterflow and rotation. Phys. Rev. B **74**, 054509 (2006).
[7] Guyer, R. A., Krumhansl, J. A.: Solution of the linearized phonon Boltzmann equation. Phys. Rev. **148**, 766-778 (1966).
[8] Guyer, R. A., Krumhansl, J. A.: Thermal conductivity, second sound and phonon hydrodynamic phenomena in nonmetallic crystals. Phys. Rev. **148**, 778-788 (1966).2

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