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Hydrodynamical model for anisotropic counterflow superfluid turbulence

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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 is high enough, vortices appear and evolve. 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, we deepen a thermodynamical model of inhomogeneous counterflow superfluid turbulence worked out in a previous paper [1] considering the particular case of counterflow (presence of heat flow but absence of mass flow). The model 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. Restriction for constitutive relations are obtained using Liu method of Lagrange multipliers. Assuming that the dynamical evolution of the vorticity tensor is much faster than that of the heat flux, we derive an evolution equation for the heat flux of Guyer-Krumhansl type. This leads to a new physical interpretations of some terms responsible for the attenuation of second sound.

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