Higher-order statistics and intermittency of a two-fluid HVBK quantum turbulent flow

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The Hall-Vinen-Bekharevich-Khalatnikov (HVBK) model is widely used to numerically study quantum turbulence in superfluid helium. Based on the two-fluid model of Tisza and Landau, the HVBK model describes the normal (viscous) and superfluid (inviscid) components of the flow using two Navier-Stokes type equations, coupled through a mutual friction force term.

Budget equations are assessed through Direct Numerical Simulations of the HVBK flow based on accurate pseudo-spectral methods. Values from 0.1 to 10 are considered for the ratio of the normal and superfluid densities. We analyse the importance of each term in budget equations and emphasize their role in energy exchange between normal and superfluid components. Some interesting features are observed: i) transport and pressure-related terms are dominant, similarly to single-fluid turbulence; ii) the mathematical signature of the FRN effect is weak in the transport of the third-order moment, despite the low value of the Reynolds number; iii) for very low temperatures, the normal fluid behaves as a fluid of vanishing viscosity, since the mutual friction annihilates the effects of viscosity. We also derive an equation for the velocity flatness F for small scales. We show that F of both the normal fluid and superfluid gradually increases when temperature decreases, thus corroborating the picture of the locking between the two fluids.

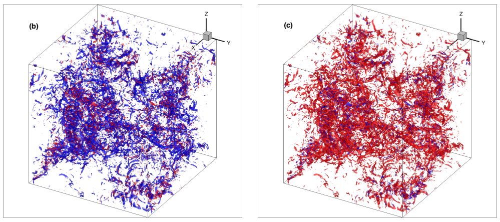

Figure 1: Snapshot of the iso-contour of the energy flux applied by the friction force to the (a) normal fluid and (b) superfluid: (blue) energy gain, (red) energy loss.

Support from the French ANR grant ANR-18-CE46-0013 QUTE-HPC and from CRIANN (Centre Régional Informatique et d'Applications Numériques de Normandie) is greatfully acknowledged.

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