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Classical and non-classical turbulent superfluid flows

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Using a classical field method, we study numerically the turbulence which is created in the evolution of a Bose gas from highly nonequilibrium initial condition to its decay into a vortex-free state. By analysing the vortex line density, the energy spectrum and the velocity correlation function, we determine that the turbulent tangle of quantum vortices resulting from the thermal quench lacks the coherent structures and the Kolmogorov scaling which are typical of ordinary (classical) fluids, and which have also been observed in superfluid helium when driven by grids or propellers. Instead, the turbulence created by the thermal quench turbulence has properties akin to a random flow, and is more similar to another turbulent regime called ultra-quantum (or Vinen) turbulence which has been observed in superfluid helium.