Observables Evolution of a Turbulent Quantum Fluid

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The temporal evolution of multiple observables of interest was extracted from a computer simulation of a Bose-Einstein Condensate (BEC) trapped by a harmonic potential and containing a pair of doubly charged anti-parallel vortices. These observables help to outline a more complete understanding of the evolution of the system, such as the emergence of a turbulent regime excited by the interaction of quantum vortices. The momentum distribution and energy spectrum evolution analysis shows that, from a given moment onwards, a turbulence regime is established, characterized by the presence of cascades of energy and particles and evidenced by the presence of power laws of known scales. Vinen's ultraquantum turbulence regime, first observed in experiments carried out in liquid helium and characteristic of superfluids, was also detected in the simulation as a result of the interaction of vortices. Through the directional analysis of the momentum distribution, it is shown that the isotropy of the momentum distribution is reached as soon as the turbulent regime starts, despite the strong spatial anisotropy of the system geometry. Extracting the fluxes of energy and particles through the classes of momenta from the simulation, an oscillatory behavior, characteristic of the breathing mode of the system, is obtained. In particular, the particle flux presents a positive and practically constant region in the range of momenta in which the Vinen turbulence regime is identified, indicating the presence of a direct particle cascade.