Scale-Separation Scheme for Simulating Superfluid Turbulence: Kelvin-Wave Cascade

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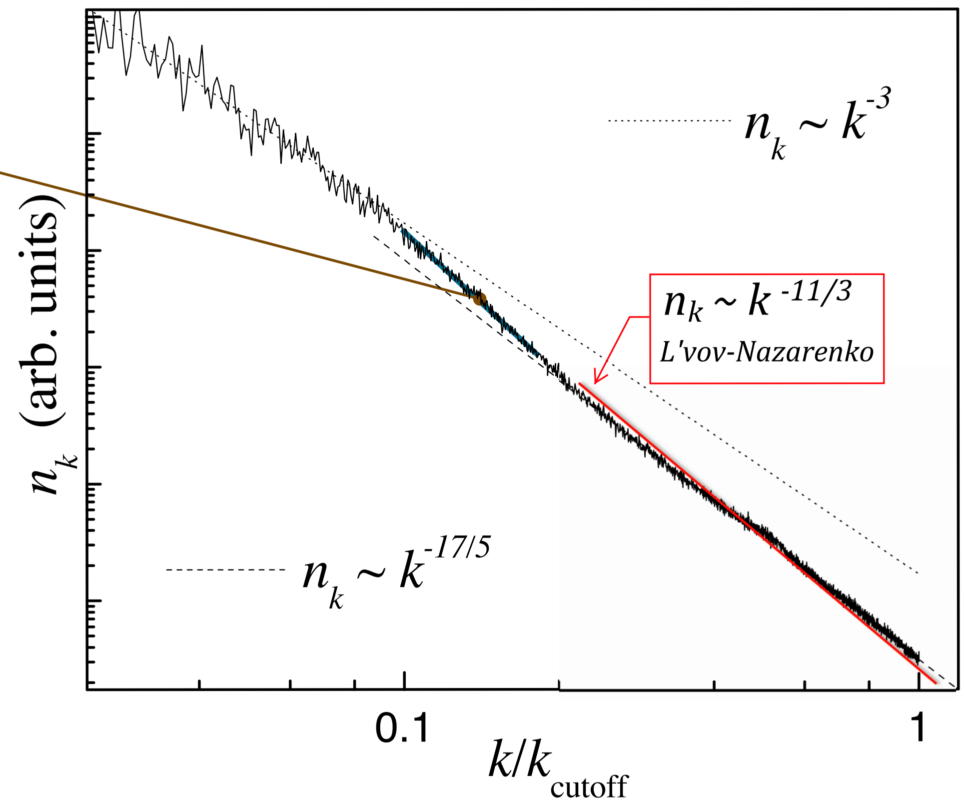
Propagating wave front, not a part of the quasi-steady-state inertial range!



to perform one step in time for a given element of a line, one has to address all the line elements. In this Letter, we observe that this extensive addressing is actually extremely excessive, and can be easily eliminated at the expense of a *controllable* systematic error.

We employ the following trick to circumvent the problem of the transient period. We start with occupation numbers that progressively exceed the quasi-steady-state ones in the direction of shorter wavelengths. With such an initial condition, the cascade develops in the form of a wave in the momentum space propagating from the region of higher wave numbers towards the region of lower wave numbers, the distribution *behind* the wave corresponding to the quasi-steady-state cascade.

17/5 with an absolute error less than 0.1, in excellent agreement with the prediction of Ref. [7].

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The 17/5 spectrum of the Kelvin-wave cascade

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Direct numeric simulation of the Biot-Savart equation readily resolves the 17/5 spectrum of the Kelvin-wave cascade from the 11/3 spectrum of the non-local (in the wavenumber space) cascade scenario by L'vov and Nazarenko. This result is a clear-cut visualisation of the unphysical nature of the 11/3 solution, which was established earlier on the grounds of symmetry.

We clearly see that the distribution $n_k \sim k^{-11/3}$ is being re-structured into $n_k \sim k^{-17/5}$, the transient having the form of a wave propagating from large to smaller wavenumbers, in a direct analogy with the picture seen in Ref. [4].