Phase Transitions in Turbulence

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We consider turbulence within the Gross-Pitaevsky model and look into the creation of a coherent condensate via an inverse cascade originating at small scales. The growth of the condensate leads to a spontaneous breakdown of statistical symmetries of overcondensate fluctuations: First, isotropy is broken, then a series of phase transitions marks the changing symmetry from twofold to threefold to fourfold.We describe respective anisotropic flux flows in the k space. At the highest level reached, we observe a short-range positional and long-range orientational order (as in a hexatic phase). In other words, the more one pumps the system, the more ordered the system becomes. The phase transitions happen when the system is pumped by an instability term and does not occur when pumped by a random force. We thus demonstrate nonuniversality of an inverse-cascade turbulence with respect to the nature of small-scale forcing.