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Phase transitions to condensate formation in two-dimensional turbulence[1] MORITZ LINKMANN, Fachbereich Physik, Philipps-University of Marburg, GUIDO BOFFETTA, Dipt. Fisica, University of Torino, Italy, M. CRISTINA MARCHETTI, Dept. Physics, UC Santa Barbara, USA, BRUNO ECKHARDT, Fachbereich Physik, Philipps-University of Marburg — Two-dimensional (2d) and quasi-2d flows occur at macro- and mesoscale in a variety of physical systems. Examples include stratified layers in Earth's atmosphere and the ocean, soap films and more recently also dense bacterial suspensions, where the collective motion of microswimmers induces patterns of mesoscale vortices. A characteristic feature of 2d turbulence is the occurrence of an inverse energy cascade. In absence of large-scale friction the inverse energy cascade results in the formation of large-scale coherent structures, so-called condensates. We here study the formation of the condensate as a function of the kind and amplitude of the forcing. Direct numerical simulations show that the condensate appears in a phase transition. For prescribed energy dissipation the transition is second order; for active matter, where the forcing is due to a small-scale instability, the transition is first order. The phase transition separates two markedly different types of 2d dynamics: in turbulence with a condensate, energy input is mostly balanced by dissipation in the condensate and intermediate scales follow an inertial cascade; without a condensate dissipation is spread over the intermediate scales and the properties of the energy transfer are different and non-universal.

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Moritz Linkmann
Fachbereich Physik, Philipps-University of Marburg

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