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Critical Transitions in Thin Layer Turbulence[1] SANTIAGO BENAVIDES, EAPS, Massachusetts Institute of Technology, ALEXANDROS ALEXAKIS, LPS, Ecole Normale Superieure, Paris, France — We investigate a model of thin layer turbulence that follows the evolution of the two-dimensional motions $\mathbf{u}_{2D}(x,y)$ along the horizontal directions (x,y) coupled to a single Fourier mode along the vertical direction (z) of the form $\mathbf{u}_q(x,y,z) = [v_x(x,y)\sin(qz), v_y(x,y)\sin(qz), v_z(x,y)\cos(qz)]$, reducing thus the system to two coupled, two-dimensional equations. Its reduced dimensionality allows a thorough investigation of the transition from a forward to an inverse cascade of energy as the thickness of the layer $H = \pi/q$ is varied.Starting from a thick layer and reducing its thickness it is shown that two critical heights are met (i) one for which the forward unidirectional cascade (similar to three-dimensional turbulence) transitions to a bidirectional cascade transferring energy to both small and large scales and (ii) one for which the bidirectional cascade transitions to a unidirectional inverse cascade when the layer becomes very thin (similar to two-dimensional turbulence). The two critical heights are shown to have different properties close to criticality that we are able to analyze with numerical simulations for a wide range of Reynolds numbers and aspect ratios.

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