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Vortices within vortices: Hierarchical vortex structures in experimental, two-dimensional flow[1] DOUGLAS H. KELLEY, NICHOLAS T. OUELLETTE, Yale University — The topology of a fluid flow is concisely described by its critical points (locations of zero flow) and the manifolds (streamlines) that connect them. Streamlines that carry fluid away from a critical point and then return it to the same critical point from another direction are known as homoclinic manifolds. Rare in three-dimensional flow, homoclinic manifolds are common in two-dimensional flow and form unambiguous topological boundaries useful for defining vortex edges. Approximating two-dimensional flow with an electromagnetically driven, stably stratified solution in a 90 cm x 90 cm pan, we use particle tracking to measure the velocity field and locate its critical points and their manifolds. Strikingly, homoclinic manifolds are often nested — the flow contains vortices within vortices. Its regions can thus be classified by an embedding number, an integer defined as the depth of vortex nesting. We will discuss the dynamics of this hierarchical vortex embedding number, particularly as a function of flow speed (Reynolds number).

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