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Universal features of hydrodynamic Lyapunov modes in extended systems with continuous symmetries

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We study the Lyapunov instability of spatially extended systems with continuous symmetries. Numerical and analytical evidence is presented to show that hydrodynamic Lyapunov modes (HLMs) do exist in lattices of coupled Hamiltonian and dissipative maps. More importantly, we find that HLMs in these two class of systems are different with respect to their spatial structure and their dynamical behavior. To be concrete, the corresponding dispersion relations of Lyapunov exponent versus wavenumber are characterized by $\lambda \sim k$ and $\lambda \sim k^2$, respectively. Moreover, the HLMs in Hamiltonian systems are propagating, whereas those of dissipative systems show only diffusive motion. Extensive numerical simulations of various systems, including coupled map lattices (CMLs), the dynamical XY model, and the Kuramoto-Sivashinsky equation confirm that the existence of HLMs is a very general feature of extended dynamical systems with continuous symmetries and that the above-mentioned differences between the two classes of systems are universal.

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[1] H.L. Yang and G. Radons, *Phys. Rev. Lett.* **96**, 074101 (2006).