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Spontaneous symmetry breaking of action in complex systems
GEORGI GEORGIEV, Assumption College and Tufts University — In simple systems the action has a single minimum for the motion of a particle along a geodesic, compared to all other paths. In complex systems, motion along a geodesic has higher action, compared to an infinite set of symmetric longer trajectories, due to constraints. For infinitely long paths, action rises to infinity. On this "Mexican hat" surface, a system spontaneously chooses one of the infinite number of minimum action trajectories, during its phase transition from a simple to a complex system. The initial geodesic path of a free particle is the "vacuum," or "ground state" of the complex system. The action of the flow is minimized along a network as compared to motion in a different geometry. This leads to a flow network representation of a complex system, where the trajectories in the system are along flow paths with least action. A flow network implies a constant inflow and outflow of energy and can exist only in open systems far from equilibrium. We consider several examples in developing this formalism, which is useful for understanding and managing complex systems.

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