

Irreversibility in non-reciprocal chaotic systems

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How is the irreversibility of a high-dimensional chaotic system related to its dynamical behavior? In this paper, we address this question by developing a stochastic-thermodynamics treatment of complex networks that exhibit chaos. Specifically, we establish an exact relation between the averaged entropy production rate—a measure of irreversibility—and the autocorrelation function for an infinite system of neurons coupled via random non-reciprocal interactions. We show how, under given noise strength, the entropy production rate can signal the onset of a transition occurring as the coupling heterogeneity increases beyond a critical value via a change in its functional form upon crossing this point. Furthermore, this transition happens at a fixed, noise-independent entropy production rate, elucidating how robust energetic cost is possibly responsible for optimal information processing at criticality.