Emergence of chaos in complex networks of damped-driven nonlinear systems

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Characterizing the emergence of chaotic dynamics of complex networks is an essential task in nonlinear science with potential important applications in many fields such as neural control engineering, microgrid technologies, and ecological networks. Here, with the aid of a hierarchy of low-dimensional effective models, we theoretically characterize the interplay among heterogeneous connectivity, variation of the impulse transmitted by a homogeneous periodic excitation, and its driving period in the emergence and persistence of spatio-temporal chaos in starlike networks of damped-driven bistable systems, while they exhibit regular behavior when uncoupled. Numerical experiments fully confirmed the theoretical predictions showing how the onset and strength of chaos undergo resonancelike behaviors because of the conjoint effects of the connectivity degree and the driving impulse, on one hand, and the conjoint effects of the connectivity degree and the driving period, on the other, both in the significant weak-coupling regime in which the networks present asynchronous states. Remarkably, scale-free networks of the same systems retain the main features of the starlike network scenario, thus suggesting its universal character.

[1] S. P. Cornelius, W. L. Kath, and A. E. Motter, Nat. Commun. **4**, 1942 (2013).

[2] I. Klickstein, A. Shirin, and F. Sorrentino, Phys. Rev. Lett. **119**, 268301 (2017).