A complex syntony: driving chimera states networks with external stochastic signals.

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Abstract

Chimera states have been widely investigated as models for synchronization phenomena in networks of coupled oscillators. It is known that they are powerful representations of real-world complex systems, such as the brain or social interactions. On the other hand, real-world complex systems interact with each other and their surrounding environment in nontrivial ways, making them difficult to describe and study. While the interactions between different networks of chimera states have been extensively studied in multi-layer systems, a comprehensive understanding of the environment's synchronizing effects on chimera state networks is still missing. Here we propose a new framework for analysing the effect of the external environment on single-layer chimera state networks by driving the system with random external univariate and multivariate signals. While the chimera state collapse to a fully synchronized state in finite un-driven networks is a well-known phenomenon, we also observe an increase of collapses when the network is driven by external signals. For this reason, we measure the mean-life time of chimera states and the external driving' synchronizing power. In the case of univariate signals driving, we utilize white, uniformly distributed and autoregressive noises, discovering that the aforementioned measures change in function of the system's parameters: the coupling strength, the signal's variance and the magnitude of the autocorrelation. Although the presence of driving makes chimera states much more unstable, we are able to identify a region in the system's parameter space where the synchronizing power of the univariate signals does not cause the chimera states to collapse. In the case of multivariate noise, we also examine the extent to which observations derived from univariate driving analysis can be generalized to the multivariate approach. Moreover, we focus on the impact that the cross-correlation between components of the same multivariate signal has on the chosen measures. Finally, we plan to apply the information gleaned from this analysis by driving the chimera state network with real-world signals, such as EEG recordings from epilepsy patients.