Condensed Matter > Disordered Systems and Neural Networks

Synchronization Transition of Identical Phase Oscillators in a Directed Small-World Network

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We numerically study a directed small-world network consisting of attractively coupled, identical phase oscillators. While complete synchronization is always stable, it is not always reachable from random initial conditions. Depending on the shortcut density and on the asymmetry of the phase coupling function, there exists a regime of persistent chaotic dynamics. By increasing the density of shortcuts or decreasing the asymmetry of the phase coupling function, we observe a discontinuous transition in the ability of the system to synchronize. Using a control technique, we identify the bifurcation scenario of the order parameter. We also discuss the relation between dynamics and topology and remark on the similarity of the synchronization transition to directed percolation.

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