Title:	Small-world networks exhibit pronounced intermittent synchronization
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Abstract:	We report the phenomenon of temporally intermittently synchronized and desynchronized dynamics in Watts-Strogatz networks of chaotic Rössler oscillators. We consider topologies for which the master stability function (MSF) predicts stable synchronized behaviour, as the rewiring probability (p) is tuned from 0 to 1. MSF essentially utilizes the largest non-zero Lyapunov exponent transversal to the synchronization manifold in making stability considerations, thereby ignoring the other Lyapunov exponents. However, for an N-node networked dynamical system, we observe that the difference in its Lyapunov spectra (corresponding to the N – 1 directions transversal to the synchronization manifold) is crucial and serves as an indicator of the presence of intermittently synchronized behaviour. In addition to the linear stability-based (MSF) analysis, we further provide global stability estimate in terms of the fraction of state-space volume shared by the intermittently synchronized state, as p is varied from 0 to 1. This fraction becomes appreciably large in the small-world regime, which is surprising, since this limit has been otherwise considered optimal for synchronized dynamics. Finally, we characterize the nature of the observed intermittency and its dominance in state-space as network rewiring probability (p) is varied. The last few years have witnessed a tremendous amount of research being directed towards the existence and stability of synchronized dynamics on complex networks. Amongst various topologies, small-world (SW) networks have been found to be quite conducive for the optimal manifestation of synchronized motion. However, in this work, we present a case which appears to contradict the aforementioned result. In particular, we find that, although the synchronized state does occur in SW networks, it seems to occupy only a small fraction of the overall state-space volume. Moreover, a significant fraction of the state-space is actually occupied by intermittently synchronized dynamics. Therefore, it becomes crucial to revisit the problem of synchronization in SW networks from the perspective of state-space volumes and identify the reason underlying the emergence of such intermittency in SW topologies, which are otherwise considered optimal for synchronized dynamics.
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