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Moment-Based Analysis of Synchronization in Small-World Networks of Oscillators

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In this paper, we investigate synchronization in a small-world network of coupled nonlinear oscillators. This network is constructed by introducing random shortcuts in a nearest-neighbors ring. The local stability of the synchronous state is closely related with the support of the eigenvalue distribution of the Laplacian matrix of the network. We introduce, for the first time, analytical expressions for the first three moments of the eigenvalue distribution of the Laplacian matrix as a function of the probability of shortcuts and the connectivity of the underlying nearest-neighbor coupled ring. We apply these expressions to estimate the spectral support of the Laplacian matrix in order to predict synchronization in small-world networks. We verify the efficiency of our predictions with numerical simulations.

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