Complex Ensemble Dynamics after Breakup of Synchrony

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Abstract

We consider dynamics of oscillator ensembles with global nonlinear coupling, where nonlinearity in understood in a sense that the coupling changes from attractive to repulsive with increase of a bifurcation parameter. First we analyze a modification of the Kuramoto-Sakaguchi model

\[ \dot{\phi}_k = \omega_k + \varepsilon r \sin(\Theta - \phi_k + \beta(\varepsilon, r)), \]

where \( r e^{i\Theta} = N^{-1} \sum_k e^{i\phi_k} \) is the mean field and \( \beta(\varepsilon, r) \) is a monotonically growing function, e.g. \( \beta = \beta_0 + \varepsilon^2 r^2 \). We analyze the system with the help of the Watanabe-Strogatz and Ott-Antonsen theories. We discuss such effects as partial synchrony, non-monotonic dependence of the mean field amplitude on the order parameter, and multistability.

We continue with the analysis of Stuart-Landau oscillators with nonlinear mean field coupling. For identical oscillators, we obtain the bifurcation diagram and study novel quasiperiodic states which appear after destruction of synchrony via the Hopf bifurcation. We also demonstrate existence of such states in the model of mean field coupled Hindmarsh-Rose neurons.

References


