Stochastic Kuramoto Oscillators with Inertia and Higher-order Interactions

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The impact of noise in coupled oscillators with pairwise interactions has been extensively explored. We study second-order Kuramoto model with higher-order interactions and Gaussian white noise. The study investigates noise-induced transitions in
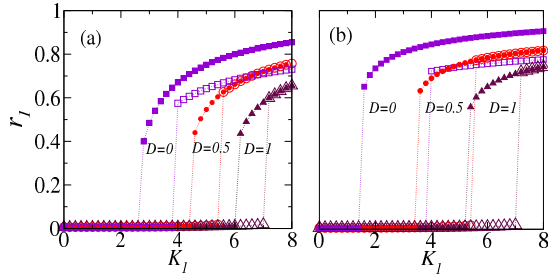

Figure 3: First-order phase transition an increase in D, shifts forward(backward) transition points towards higher value.
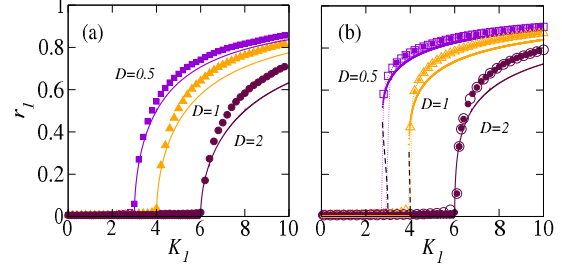

Figure 4: For an overdamped system as D increases second order transition happens even in the presence of higher-order interactions.

the model. Further, investigate that an increase in noise strength shifts the forward (backward) critical point associated with an abrupt jump from an incoherent to a coherent state (and vice versa) toward higher coupling values (Fig. 3). Additionally, in an overdamped system, we analytically predict all (un)stable states using the OttAntonsen approach. Also, even in the presence of higher-order interactions, note a shift from first-order to second-order phase transitions as noise strength increases (Fig. 4).

Model: We consider a stochastic Kuramoto model with $2-$simplex interactions and inertia. The equation of motion of N globally coupled oscillators is given as,

$$m\ddot{\theta}_i = -\dot{\theta}_i + \Omega_i + \frac{K_1}{N}\sum_{j=1}^{N}\sin(\theta_j - \theta_i) + \frac{K_2}{N^2}\sum_{j=1}^{N}\sum_{k=1}^{N}\sin(2\theta_j - \theta_k - \theta_i) + \xi_i(t).$$

References

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