Stability of Phase-Locked States in Signed Kuramoto Networks: Structure versus Adaptation

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Abstract

Adaptive Kuramoto models admit a variety of nontrivial phase-locked configurations, including antipodal and rotating-wave states. A central open question is whether the observed persistence of such configurations can be attributed to intrinsic properties of the associated signed interaction networks, or whether it relies essentially on adaptive coupling dynamics.

In this talk, we address this question by studying the stability of antipodal and rotating-wave phase configurations on fixed signed networks that preserve the same phase symmetries but are not generated by adaptive dynamics. We will show that for two canonical classes of static signed networks, stability is highly constrained, with unstable modes persisting under parameter variations generically. Furthermore, we characterize how adaptive coupling influences invariant sets and basins of attraction for the configurations where stability is permitted.

Taken together, these results demonstrate that while static network structure imposes severe constraints on the stability of phase-locked configurations, adaptive coupling dynamics organize and delineate their robustness when stability is permitted.

References

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