Heterogeneous Nucleation in Adaptive Networks

Invited Talk 16

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We investigate the influence of adaptation disparity and phase lag on the heterogeneous nucleation leading to multi-step and single-step phase transitions in a finite size adaptive network due to frequency disorders. We elucidate that the adaptation disparity predominates the effect of frequency disorder in seeding the heterogeneous nucleation. Further, a large phase lag facilitates almost a continuous spectrum of partially and fully synchronized frequency clusters, and multistability among them. We also find that the underlying mechanisms of heterogeneous nucleation due to the adaptation disparity and phase lag parameters are distinctly different from that observed only in the presence of disorders. We also investigate the phase transition in a multiplexed adaptive network due to the heterogeneous nucleation in a single layer. We find that layers with uniform distribution of the natural frequency follow the synchronization transition exhibited by the layers with disorders upon increasing the interlayer coupling strength. The synchronization index and the snapshots of the coupling weights elucidate the distinct types of synchronization transitions seeded by heterogeneous nucleation due to the disorders. Further, we find that the interlayer coupling enhances the synchronization in an intermediate range of the interlayer coupling strength, thereby elucidating that the former determines the synchronization transition in the multiplex networks. Furthermore, we also analytically deduce the macroscopic evolution equations for the cluster dynamics using the collective coordinates framework and show that resulting reduced dynamics mimic the observed heterogeneous phase transitions of the adaptive network under adaptation disparity and phase lag. Further, we deduce the upper bound for the coupling strength for the existence of two intra-clusters explicitly in terms of the adaptation disparity and phase lag parameters for the onset of the abrupt single-step transition. We also use the collective coordinates framework to deduce the evolution equations for the collective coordinates that govern the cluster dynamics leading to the phase transition to the synchronization, which agrees very well with the numerical results from the original multiplex network.

References

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