EMERGENCE OF CHIMERA LIKE STATES IN REACTION-DIFFUSION ISING SYSTEMS

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In this work, we investigate the conditions under which chimera-like states emerge in Ising systems. Specifically, we analyze an Ising chain with periodic boundary conditions in contact with a thermal bath at temperature T. To incorporate the non-locality required for the emergence of chimera states in other systems, we consider a non-equilibrium scenario with competing dynamics resembling a reaction-diffusion system, where both diffusion and reaction mechanisms are non-local. More precisely, non-local diffusion is modeled as spin-exchange interactions between units separated by a distance (of at most) R_K, implemented via Kawasaki dynamics. Meanwhile, reaction processes occur among units separated by a distance between R_K and R_G, governed by spin-flip Glauber dynamics. This approach is designed to mimic the complex interactions in actual networked systems such as the brain, where electrical (diffusive) and chemical (reactive) neuronal interactions compete to generate diverse complex spatio temporal synchronization patterns. Depending on relevant parameters of the system and on the relative importance of reaction and diffusion mechanisms, we observed the emergence of chimera-like states, characterized by relatively stable moving domains of spins with different magnetizations. We analyze in deep both analytically and by means of extensive numerical simulations the behaviour of the system at $T = 0$ and when non-local diffusion is only present and compute the phase diagram of the system. We found a rich phenomenology including regions in which only chimeras exist, regions in which both chimera-like states and stable spin domains coexist and regions in which chimeras are metastable and decay into stable spin domains with fixed magnetization after some time. When reaction is also present in the system chimeras always appear among domains of different magnetization, which are unstable and invariably drive the system toward a uniform magnetization. This work provides fundamental insights and conditions of how complex synchronization patterns as those including coherent and uncoherent activity could emerge in actual networked systems as it is the brain.

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