Chimeras and Clusters in Globally Coupled Chaotic Maps

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We show that chimera states, where differentiated subsets of synchronized and desynchronized dynamical elements coexist, can emerge in networks of robust chaos maps subject to global interactions. Robust chaos means the absence of periodic windows in a region of the parameter space of the map. We find that chimera states are related to the formation of dynamical clusters in the system. Both chimera and cluster states are interpreted as multistable responses of the local dynamics, which can be seen as a single map subject to a chaotic drive. By studying the dynamics of a single driven-map model as a function of parameters, the collective behavior of systems of maps subject to either external or autonomous global interactions can be predicted: complete and generalized synchronization, clusters, chimeras, and incoherence (Fig. 1). This scheme is applied to globally coupled networks of hyperbolic chaotic oscillators possessing robust chaos. Our results reveal that, under some circumstances, hyperbolicity does not impede the formation of chimera states, as it had been previously hypothesized.

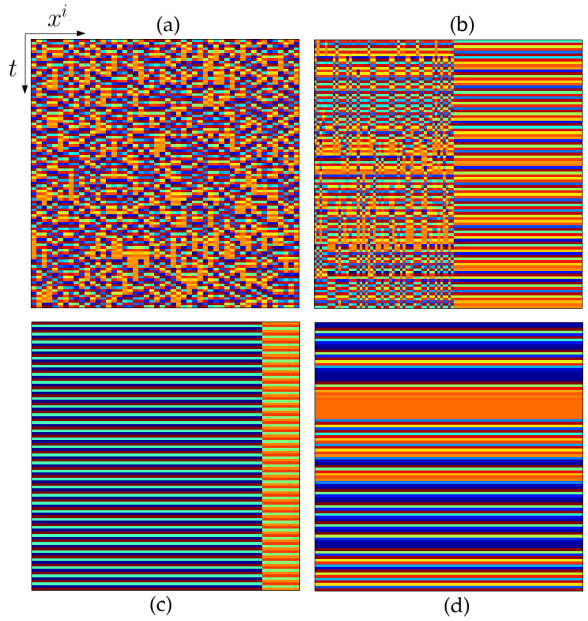

Figure 1: Asymptotic evolution of the states x^i given by a color code (horizontal axis) as a function of time (vertical axis) for the system $x^i_{t+1} = (1-\epsilon) f(x^i_t) + \frac{\epsilon}{N} \sum_{j=1}^{N} f(x^j_t)$, with robust chaos local map $f(x) = \frac{1-b^{(1-x)x}}{1-\sqrt[4]{b}}$, size $N = 100$ and $b = 0.5$, for different values of the global coupling parameter ϵ. Ramdon initial conditions are uniformly distributed in the interval $x \in [0, 1]$. After discarding 10^4 transients, 100 iterates are displayed. (a) Incoherence, $\epsilon = 0.15$. (b) Chimera state, $\epsilon = 0.198$. (c) Two-cluster state, $\epsilon = 0.39$. (d) Complete synchronization, $\epsilon = 0.62$.