Chimera patterns in ecological networks

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The chimera state is an intriguing and counterintuitive spatiotemporal state that has been in the center of active research over the past decade [1, 2]. In this state the population of coupled *identical* oscillators spontaneously splits into two incongruous domains: In one domain the neighboring oscillators are synchronized, whereas in another domain the oscillators are desynchronized. Recent experimental observation of chimera states have established their robustness in natural and man-made systems. The first experimental observation of chimeras was reported in optical systems [3] and chemical oscillators [4]. Later, chimeras have been observed experimentally in mechanical systems, electronic, optoelectronic delayed-feedback and electrochemical oscillator systems. The strong current interest in chimeras may be attributed to their possible connection with several phenomena in nature, like unihemispheric sleep of dolphins and certain migratory birds, ventricular fibrillation, and power grid networks. Recently, chimera patterns have been found in models from SQUID metamaterials and quantum systems showing their omnipresence in the macroscopic as well as in the microscopic world.

In the present work we show that various chimera patterns are possible in the network of ecological oscillators. Considering a network of Rosenzweig–MacArthur oscillators we explore and demonstrate the influence of several nonlocal coupling schemes in inducing chimera states. We identify the possible transitions between the spatiotemporal patterns that arise due to the interplay of coupling strength and coupling topology. In particular we consider a nonlocal coupling characterized by a rectangular kernel and establish the occurrence of chimera. Next, we consider a more realistic coupling topology, namely the distance dependent power-law coupling. In general, distance-dependent interaction is an ubiquitous form through which natural systems interact in physical and biological sciences (e.g., the electromagnetic and gravitational interactions obey an inverse square law; the long-distance movements of butterflies *Euphydryas aurinia* follow an inverse power-law [5]).

Figure 1 shows the representative spatiotemporal patterns and snapshots depicting the transitions between several chimera patterns with the variation of a specific coupling parameter. In Ref. [6] it has been predicted that species invasion attempts can be capable of breaking the synchrony in coupled ecological networks and may produce chimera states. Our results actually support that prediction, and we are able to demonstrate the existence of various chimera patterns in an ecological network using a realistic coupling scheme.

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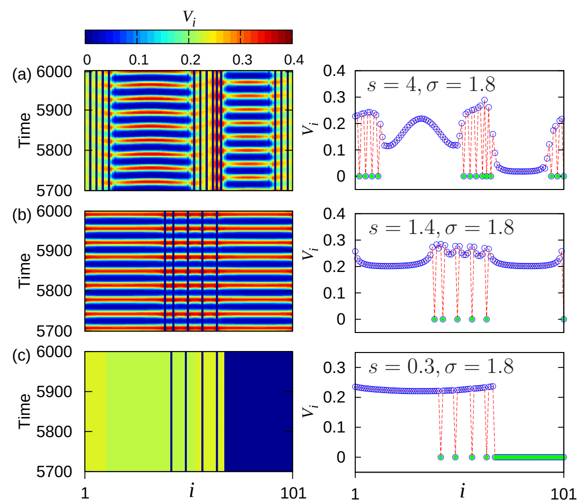

Figure 1: Representative spatiotemporal patterns (left) and snapshots (right) of (a) Amplitude chimera (b) Chimeralike coexistence of oscillation and detah and (c) Chimera death.

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