Robust chimera states in SQUID metamaterials

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Chimera states is a fascinating counter-intuitive phenomenon of partially coherent and partially incoherent behavior. This finding is a striking manifestation of symmetry breaking, since oscillators break synchrony even when they are identical and symmetrically coupled. This counterintuitive phenomenon was first observed in 2002 by Kuramoto and Battogtokh in systems of identical phase oscillators. During the last decade, chimera states have been theoretically investigated in a wide range of networks, where different kinds of coupling schemes varying from regular nonlocal to completely random topology have been considered.

The increasing number of studies on chimera states is impressive, ranging from physical and chemical, to biological and technological systems. Potential applications of chimera states in nature include the phenomenon of unihemispheric sleep in birds and dolphins, bump states in neural systems, power grids, and social systems.

Works on chimera states in superconducting systems, which is the focus of our study, are very scarce. We report on the emergence of robust multi-clustered chimera states in a dissipative-driven system of symmetrically and locally coupled identical SQUID (Superconducting QUantum Interference Device) oscillators. The snake-like resonance curve of the single SQUID is the key to the formation of the chimera states and is responsible for the extreme multistability exhibited by the coupled system that leads to attractor crowding at the geometrical resonance (inductive-capacitive) frequency. Until now, chimera states were mostly believed to exist for nonlocal coupling. Our findings provide theoretical evidence that nearest neighbor interactions are indeed capable of supporting such states in a wide parameter range in both one and two spatial dimensions.SQUID metamaterials are the subject of intense experimental investigations and we are highly confident that the complex dynamics demonstrated in this manuscript can be confirmed in the laboratory.

[l] Hizanidis et al., Phys. Rev. E **94**, 032219 (2016).
[2] Hizanidis et al., EPJST **225**, 1231 (2016).
[3] Lazarides et al., Phys. Rev. B **91**, 054303 (2015).