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Symmetric States Requiring System Asymmetry in Oscillator Networks[1]

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Spontaneous synchronization has long served as a paradigm for behavioral uniformity that can emerge from interactions in complex systems. When the interacting entities are identical and their coupling patterns are also identical, the complete synchronization of the entire network is the state inheriting the system symmetry. As in other systems subject to symmetry breaking, such symmetric states are not always stable. In this presentation, I will report on our discovery of the converse of symmetry breaking—the scenario in which complete synchronization is not stable for identically coupled identical oscillators but becomes stable when, and only when, the oscillator parameters are judiciously tuned to nonidentical values, thereby breaking the system symmetry to preserve the state symmetry. Aside from demonstrating that diversity can facilitate and even be required for uniformity and consensus, this suggests a mechanism for convergent forms of pattern formation in which initially asymmetric patterns evolve into symmetric ones.

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