Synopsis: Time to Get In Sync

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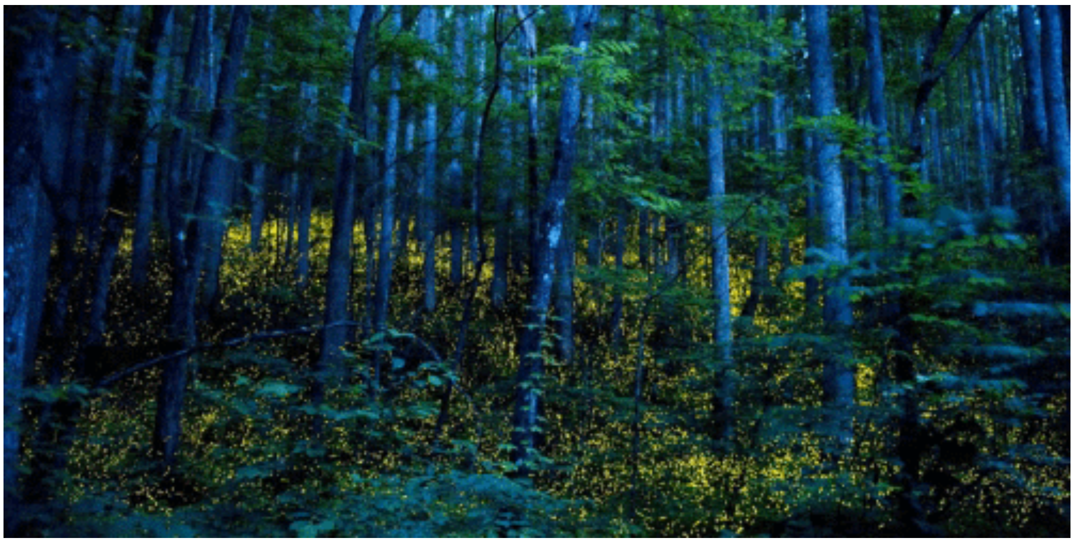
An analysis of a model that might describe fireflies and neurons shows the path to synchronization occurring in groups of charge-and-fire oscillators.



Firefly.org

The flashing light of fireflies can be a collective affair: for some species, the initially random on-off flickering of the insects eventually occurs in unison. Now, a toy model proposed by Steven Strogatz, from Cornell University, New York, and his colleagues provides a step towards understanding the evolution of this type of synchronization over time. Although their model doesn't provide a realistic description of fireflies, it could help researchers estimate the time required for synchronization to set in within the insects and in other systems, such as cardiac pacemaker cells, neurons, and wireless sensor networks.

Instead of fireflies and neurons, Strogatz and co-workers consider a group of many identical charge-and-fire oscillators, each of which can have a voltage between 0 and 1. The oscillators continuously ramp up in voltage from 0 to 1, discharge, and then drop to 0 to start again. The authors make the oscillators talk to each other by assuming that when one discharges, it scrambles the voltages of all of the others to random values, but then instantly forces those close to the discharge threshold to synchronize. Oscillators in an already synchronized cluster are reset as a group, so once a cluster of oscillators is in sync, it stays that way.

Using analytical equations, the researchers calculate, at different time steps and for roughly 50,000 oscillators, the number of clusters containing two, three, and more synchronized oscillators, providing snapshots of synchronization spreading through the group. The model has a number of tunable parameters, such as the function that describes the oscillators' ramp up, and it could be tailored to describe specific systems.

This research is published in **Physical Review Letters**.

–Jessica Thomas

Subject Areas

Nonlinear Dynamics

Synchronization as Aggregation: Cluster Kinetics of Pulse-Coupled Oscillators
Kevin P. O'Keeffe, P.L. Krapivsky, and Steven H. Strogatz
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