SCIENCE NEWS 1998 February 21, 1998 Vol. 153 No. 8 p. 116

Added Noise Keeps Waves Going

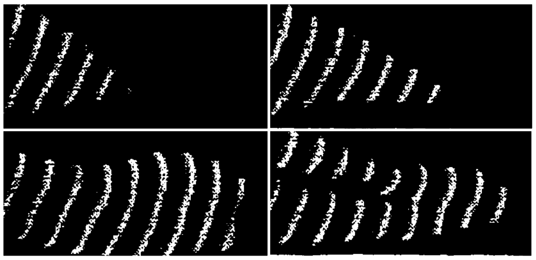
Usually a nuisance, noise sometimes aids the transmission of a signal.

Researchers have now demonstrated in the laboratory that random fluctuations in the concentration of a chemical across a surface can enhance the propagation of waves of another chemical's activity in a thin gel. "Noise actually helps," says chemist Kenneth Showalter of West Virginia University in Morgantown.

Showalter and his coworkers Sándor Kádár and Jichang Wang report their results in the Feb. 19 NATURE.

The observation of enhanced wave propagation in a chemical medium represents a new avenue in the study of a phenomenon called stochastic resonance (SN: 2/23/91, p. 127), in which the addition of noise can boost a weak signal to detectable levels.

"This is the first experimental demonstration of stochastic resonance that occurs in a system spread over a surface [and changing with time]," says Frank Moss of the Center for Neurodynamics at the University of Missouri-St. Louis. The findings also provide a model of how internal noise may sustain long-range chemical waves in networks of brain cells (SN: 11/23/96, p. 330).



Showalter *et al.*/NATURE

Sequence of images showing the influence of noise—in the form of a speckled pattern of varying light intensity illuminating a surface—on the propagation of waves in a specially prepared silica gel. At low noise levels, the wave dies out (top left and right). An optimal amount of noise facilitates wave propagation (bottom left), whereas excessive noise causes the wave to break up (bottom right).

Showalter and his coworkers studied a photosensitive version of a chemical system known as the Belousov-Zhabotinsky reaction, in which rising and falling chemical concentrations appear as visible waves traveling through a thin layer of silica gel. Shining light on the gel produces a chemical that quenches wave propagation.

The researchers initially adjusted the light intensity to suppress wave activity. They then replaced that uniform illumination with a grid in which intensity varied from cell to cell and from time to time in each cell, yet maintained an average intensity across the grid that inhibited activity.

By increasing the amplitude of the random fluctuations, "you get qualitative changes in the wave behavior," Showalter says. "As the [optical] noise increases, the wave propagates farther and farther [along] the medium until there is sustained wave propagation." Eventually, however, the noise overwhelms the system and the waves break up.

The waves represent a kind of order that emerges out of the background of flickering light and reaches a maximum at a particular level of noise, Moss remarks.

Moss and his collaborators have detected a similar phenomenon in networks of glial cells, which fill the spaces between neurons in the brain. The researchers studied the passage of waves of calcium ions from cell to cell in cultured glia under the influence of local fluctuations in the concentration of a neurotransmitter. Where the concentration of the neurotransmitter reaches a threshold, calcium waves begin to form, Moss says.

Moss, Peter Jung of Ohio University in Athens, Ann Cornell-Bell of Viatech Imaging in Ivoryton, Conn., and Kathleen S. Madden of the Foundation for International Nonlinear Dynamics in Bethesda, Md., describe their results in the February JOURNAL OF NEUROPHYSIOLOGY.

"There seems to be a definite link between our chemical system and this network of brain cells," Showalter says. "Calcium waves could represent some sort of long-range, noise-mediated signaling in brain tissue."

—*I. Peterson*