177c Micropatterning Chemical Oscillations: Waves, Autofocusing and Symmetry Breaking in a Purely Oscillatory System

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Chemical waves – that is, traveling concentration variations in nonlinear chemical systems far from equilibrium – have been widely studied for their relevance to nonlinear and chaotic dynamics, biological signaling, human health (cardiac, neural) and industrial processes (solid fuel combustion, catalytic oxidation, polymerization). To date, most research has focused on waves traveling through excitable media and initiated from simple geometries; in contrast, wave propagation in systems exhibiting bulk oscillations but not excitability has not been thoroughly investigated, largely because of experimental difficulties associated with the creation and control of phase gradients necessary to achieve wave propagation. Here, we (i) introduce an experimental technique based on Wet Stamping (WETS) that overcomes these limitations and allows patterning of two-dimensional arrays of chemical oscillators; and (ii) demonstrate that purely oscillatory chemical systems can not only emit waves from arbitrary microgeometries, but can also give rise to a rich variety of wave-behaviors not seen in excitable media: wave acceleration, coupling and synchronization in oscillators arrays, kinetic autofocusing and twist-symmetry breaking. These complex phenomena result from the dependence of the oscillation frequency on the local concentrations of chemicals and on the system's geometry. As we show, they can be generalized to all oscillating systems that fulfill a set of requirements concerning (i) the functional dependence of the oscillation period on the concentration of a chemical that triggers oscillations and (ii) the relationship between characteristic oscillation and diffusion times. These and other conclusions are supported by numerical simulations as well as generic scaling arguments.