Waves in the BZ-reaction: experiments and CA simulations

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In everyday-interaction between experimentalists and theorists, we performed measurements and CA simulations of periodic and turbulent waves in an excitable medium.
The experiments were carried out with the ruthenium-catalyzed Belousov-Zhabotinsky reaction, which has the advantage that its periodic and chaotic modes can be controlled by light [1-3] or by oxygen [4]. Simulations were performed with a cellular automaton based on a quasi-stochastic spatial discretization [5]. Such a discretization is used to solve the problem of numerical anisotropy involving the propagation from cell-shape into wave-shape. The influence of light or oxygen was incorporated into the CA rules by considering that these agents displace the $\dot{u}=0$ nullcline (u: autocatalytic substance) towards lower u-values.

The following phenomena were investigated:
i) Target patterns and spiral waves. A calibration, allowing to express CA units in terms of physical units, leads to quantitative agreement between measurements and simulations.
ii) Wave–splitting (backfiring) after a light pulse, leading to self–annihilation of a spiral, as well as to soliton–like behaviour.
iii) Wavefront instabilities leading to spatio–temporal chaos, namely aperiodic 'rippled' wavefronts, as well as wave disruptions. Experimentally, we found that these phenomena occur only if above the gel, which immobilizes the catalyst, there is an aqueous solution with all reactants except the catalyst. The CA calculations — including these two compartments — yielded patterns comparable to the experimental observations.

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