Summary

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Experimental and computational examinations of the trajectories of spiral wave cores were performed in excitable systems whose excitability is modulated in proportion to the integral of the activity in a sensory domain. The experimental observations were carried out using the light-sensitive Belousov-Zhabotinsky (BZ) reaction. The light-sensitive catalyst was $\mathrm{Ru(bpy)}_3^{2+}$. For this reaction an increase in light results in a decrease in excitability. The numerical work was performed using a generic piecewise-linear excitable system model.

The sensory domains used were in the shape of either equilateral or isosceles triangles. The behaviour of the spiral core was determined as a function of the domain size and the ratio of the base length and height of the triangle. These types of domain exhibit a distinctly different series of bifurcations as compared with other domain geometries studied so far on account of this domain shape having vertices opposite sides. In particular, novel forms of lobed limit cycles occur which are destroyed and then re-form as the domain size is varied.

We also introduce the concept of express and stagnation zones which are regions where the trajectory moves particularly rapidly or slowly, respectively. Although these regions can be very prominent for triangular domains, they also occur for other domain geometries such as squares. They are of interest in the manipulation of spiral waves since, like stable fixed points, stagnation zones are to be avoided if the spiral wave is to be moved rapidly from one place to another.

To give a global picture of the behaviour of the spiral core for a particular domain, a vector plot indicating the spiral core drift velocity on a lattice of points in and around the domain is generally used. Such plots can be rather complicated and to facilitate their interpretation we have developed a colour-coding scheme for the arrows and the background based on the normalized divergence of the vector field at each point. This makes it easier to distinguish between attracting and repelling limit cycles and makes stagnation zones particularly prominent.

Finally, we have formulated a simple method which is referred to as the plane wave approximation (PWA) that can be used to account for some of the behaviour seen far from the sensory domain. In this approach, the parts of the spiral wave crossing the sensory domain are treated as a series of plane waves. The PWA allows one to determine the directions in which express and stagnation zones lie far from the domain, and also account for how prominent these zones are. The limit cycles that the spiral core tends to are sometimes composed partly of attracting express zones. The PWA can also be used to find the distances of these regions from the domain.