Reduction approach to a reaction-diffusion system for collective motions of camphor boats

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The collective motion of camphor boats in the water channel exhibits both a homogeneous and an inhomogeneous state, depending on the number of boats. The motion of each camphor boat is described by a traveling pulse in a reaction-diffusion model proposed in Nagayama et al. (2004), in which camphor boats are assumed to be interact each other by the change of surface tension by diffusive molecules on the water surface. In order to verify the inhomogeneous motion of camphor boats, we have to study the linearized eigenvalue problem and see the destabilization of the homogeneous flow. However, the eigenvalue problem is too difficult to analyze even if the number of camphor boats is 2. Then we would like to derive a reduced system from the original model and analyze it by applying the center manifold theorem.

Several reaction-diffusion systems can generate a solution with a pulse shape. Pulse-pulse interaction is treated mathematically in Ei et al. (2002), in which a reduced system of an ODE form is derived from a reaction-diffusion model by applying a center manifold theorem. Since the delta functions naturally arise in our model, the theory established in L2-framework cannot be applied directly. In this talk, we modify the previous results in Ei et al. (2002) and propose a new approach of reduction to systems with the delta function.