FORMATION PROCESS OF SPIRAL PATTERNS IN AN OSCILLATORY MEDIA

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Spiral pattern is a typical pattern observed in dissipative systems. It is well known that there are two types of spiral patterns, one is formed in excitable media and the other in oscillatory media. In excitable media, spiral patterns are obtained by somewhat artificial way. On the other hand, spiral patterns in oscillatory media seem to be born spontaneously from random initial state.

We concentrate on the nucleation process and the growth process of spiral patterns in oscillatory media using a simple reaction diffusion model which includes the Bonhoeffer-van der Pol type dynamics.

$$\begin{cases} \dfrac{\partial u}{\partial t} = D_u \nabla^2 u + u(1-u^2) - v \\ \dfrac{\partial v}{\partial t} = D_v \nabla^2 v + b(u-\beta) \end{cases} \tag{1}$$

The condition for the formation of spiral pattern is shown by the 2D and 1D simulations of the model (Figure 1). At the same time, we obtain the condition determining the orientation of spiral pattern.

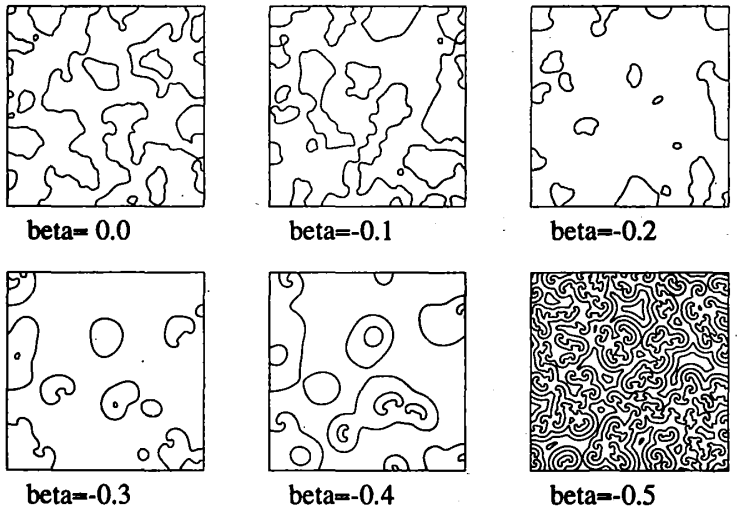

Figure 1: Snapshots of 2-D simulations of equation (1) with different β.$[b = 1, t = 2500]$

We have developed a visualization system for describing the evolution of the oscillatory media using the amplitude expression and animation system, which is definitely useful

to understand the computational results. Using this method, we clearly observe the growth process of spiral patterns as well as the slow motion and the pair annihilation of singularities. Moreover, we find the phase turbulence caused by birth cascade of new singularities around the older ones (Figure 2).

In addition, it is shown theoretically that the spiral patterns should be normal-oriented in the vicinity of the Hopf bifurcation point using the Stuart-Landau equation and our results.

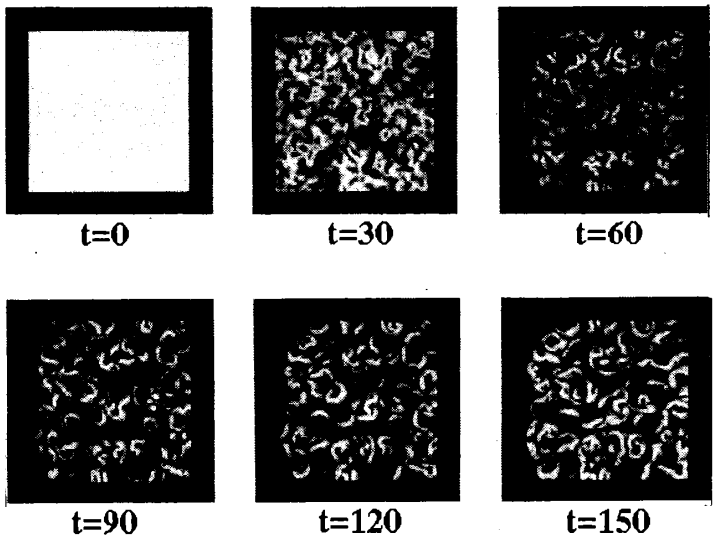

Figure 2: Time evolution of the phase turbulence. $[\beta = 0.525, b = 0.5]$
These figures are amplitude expression. White domain means oscillate with small amplitude field.

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