Abstract

Title of Dissertation: Effects of Inhomogeneities in the Complex Ginzburg-Landau Equation

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We investigate the effects of inhomogeneities on two-dimensional pattern forming systems. We use the two-dimensional complex Ginzburg-Landau equation as a generic model for pattern formation, and introduce both long length scale and short length scale inhomogeneities.

We study the effects of a long length scale static inhomogeneity on spiral wave dynamics. We find that the inhomogeneity leads to the formation of dominant spiral domains that suppress other spiral domains. The spiral vortices slowly drift in the presence of an inhomogeneity with a velocity that is proportional to the local parameter gradients. We derive an expression for the spiral vortex drift velocity and present examples of both fixed point and limit cycle attractors of the spiral vortices.

In contrast to the long length scale inhomogeneity, we introduce a spatially localized inhomogeneity into the two-dimensional complex Ginzburg-Landau equa-

tion. This inhomogeneity can produce two types of target wave patterns, stationary and breathing. In both cases, far from the target center, the field variables correspond to an outward propagating periodic traveling wave. In the breathing case, however, the region in the vicinity of the target center experiences a periodic temporal modulation at a frequency in addition to that of the wave frequency of the far away outward waves. Thus, at a fixed point near the target, the breathing case yields quasiperiodic time variation of the field. We investigate the transition between stationary and breathing targets and note the existence of hysteresis. We also discuss the competition between the two types of target waves and spiral waves.