

Contents

Introduction	1
0.1 Objectives	2
1 Preliminary concepts	3
1.1 Bifurcations	3
1.2 Normal forms	3
1.3 Chaos	6
1.3.1 Lyapunov exponents	6
1.3.2 Spatiotemporal chaos	7
1.4 Turbulence	7
2 Pattern formation	9
2.1 Turing instabilities	9
2.2 The Swift-Hohenberg model	12
2.2.1 General remarks	12
2.2.2 One dimensional dynamics	14
2.2.3 Two dimensional dynamics	15
3 The Complex Ginzburg-Landau equation	19
3.1 Plane wave solutions	20
3.2 Localized solutions	21
3.3 Chaotic regimes	21
3.3.1 Spatiotemporal intermittency	21
3.3.2 Phase turbulence	23
3.3.3 Defect turbulence	24
3.4 Two-dimensional dynamics	24
4 The liquid crystal light valve experiment	26
4.1 Nematic liquid crystals	26
4.1.1 Electrical properties	27
4.1.2 Optical properties	27
4.2 Experimental setup	28
4.2.1 Optical components	29
4.3 Experimental observations	31
4.3.1 Pattern formation	31
4.3.2 Spatiotemporal chaos	31

4.4	Theoretical description	32
4.5	Translational coupling	35
5	Route to the complexity	37
5.1	The one-dimensional SHTC	38
5.1.1	Convective instability	38
5.1.2	Phenomenology of states	39
5.1.3	Normal form	41
5.2	Two dimensional SHTC	43
5.2.1	Convective instability	43
5.2.2	Phenomenology of states	45
5.2.3	Normal form	46
5.3	Generalizations	48
5.4	Relation to the LCLV	52
5.4.1	Experimental proposition	53
6	The Lugiato-Lefever equation with Raman interaction	55
6.1	The longitudinal Lugiato-Lefever equation	55
6.2	The Raman scattering	57
6.3	Convective instability	58
6.4	Reducing the complexity	60
	Conclusion	63
A	Transition to Spatiotemporal Intermittent and Defect Turbulence in Systems under Translational Coupling	71