Contents

1. Introduction 1

Part I Methods

2. Reductive Perturbation Method 5
2.1 Oscillators Versus Fields of Oscillators 5
2.2 The Stuart-Landau Equation 8
2.3 Onset of Oscillations in Distributed Systems 13
2.4 The Ginzburg-Landau Equation 17

3. Method of Phase Description I 22
3.1 Systems of Weakly Coupled Oscillators 22
3.2 One-Oscillator Problem 24
3.3 Nonlinear Phase Diffusion Equation 28
3.4 Representation by the Floquet Eigenvectors 29
3.5 Case of the Ginzburg-Landau Equation 32

4. Method of Phase Description II 35
4.1 Systematic Perturbation Expansion 35
4.2 Generalization of the Nonlinear Phase Diffusion Equation 41
4.3 Dynamics of Slowly Varying Wavefronts 46
4.4 Dynamics of Slowly Phase-Modulated Periodic Waves 54

Part II Applications

5. Mutual Entrainment 60
5.1 Synchronization as a Mode of Self-Organization 60
5.2 Phase Description of Entrainment 62
5.2.1 One Oscillator Subject to Periodic Force 62
5.2.2 A Pair of Oscillators with Different Frequencies 65
5.2.3 Many Oscillators with Frequency Distribution 66
5.3 Calculation of Γ for a Simple Model 67
5.4 Soluble Many-Oscillator Model Showing Synchronization-Desynchronization Transitions 68

Bibliografische Informationen
http://d-nb.info/840858078

digitalisiert durch DEUTSCHE NATIONAL BIBLIOTHEK

5.5 Oscillators Subject to Fluctuating Forces 78
5.5.1 One Oscillator Subject to Stochastic Forces 78
5.5.2 A Pair of Oscillators Subject to Stochastic Forces 80
5.5.3 Many Oscillators Which are Statistically Identical 82
5.6 Statistical Model Showing Synchronization-Desynchronization Transitions 82
5.7 Bifurcation of Collective Oscillations 84

6. Chemical Waves 89
6.1 Synchronization in Distributed Systems 89
6.2 Some Properties of the Nonlinear Phase Diffusion Equation 91
6.3 Development of a Single Target Pattern 93
6.4 Development of Multiple Target Patterns 101
6.5 Phase Singularity and Breakdown of the Phase Description 103
6.6 Rotating Wave Solution of the Ginzburg-Landau Equation 106

7. Chemical Turbulence 111
7.1 Universal Diffusion-Induced Turbulence 111
7.2 Phase Turbulence Equation 114
7.3 Wavefront Instability 120
7.4 Phase Turbulence 127
7.5 Amplitude Turbulence 132
7.6 Turbulence Caused by Phase Singularities 137

Appendix 141
A. Plane Wave Solutions of the Ginzburg-Landau Equation 141
B. The Hopf Bifurcation for the Brusselator 144

References 149

Subject Index 155