Introduction

Dissipative structure is peculiar to nonequilibrium open systems. It is maintained by the balance of the influx of energy and matter with dissipation, and in many cases it appears on a macroscopic scale. For this reason, the most natural theoretical description of these phenomena should begin with a consideration of macro-level, nonlinear evolution equations such as the Navier–Stokes equation. Each chapter in Part I is based on this consideration. Of course, one can argue that there exists the problem of determining the microscopic physical source of macroscopic dissipative structure. However, in the end, this problem is equivalent to that of determining the statistical mechanical basis of the behavior of the macroscopic evolution equations themselves. Following this line of reasoning, questions regarding the microscopic physical source of dissipative phenomena can be separated from the study of dissipative phenomena themselves. Such microscopic considerations are beyond the scope of this book.

Dissipative structures and other nonequilibrium patterns have become the subject of serious study in physics only recently. Earnest research in this field did not begin until the 1970s. The approach used in the study of nonequilibrium patterns employs a phenomenological/qualitative manner of thinking which represents a bold departure from the physics that existed prior to this study, and as such, this approach represents an important success. Through this approach, a new theoretical framework has developed, while new terms have arisen for the purpose of describing complex natural phenomena.

There is no all-powerful theoretical method to treat the phenomena of nonequilibrium patterns. However, one standard and fairly well-established method consists of an approach based on reduced equations. The validity of this approach is now widely accepted. These reduced equations are produced through the application of a particular procedure whose purpose is to extract the most important features of the nonlinear equations describing the evolution of patterns. In Part I, concrete discussion of nonequilibrium patterns is based on and formed from study of reduced equations obtained phenomenologically through very simple considerations. The foundations of reduction theory are presented in Chap. 5.

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