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Pattern Formation: An Introduction to Methods by Rebecca Hoyle, Cambridge University Press, Cambridge, 2006, pp. x + 422. Scope: textbook. Level: advanced undergraduate and postgraduate.

The natural world is full of patterns, many of which are strikingly beautiful. An intriguing feature is that remarkably similar-looking patterns can arise in entirely different contexts. For example, sand ripples created by the desert wind take much the same form as the stripes on a zebra's flanks; and both resemble convection rolls and the stripe patterns that develop by aggregation in a thin layer of small particles on a horizontally-shaken substrate. In each case there is a pattern of stripes incorporating defects such as dislocations. A strong implication of such correspondences is that the underlying mathematics in each of these examples must also be very similar. A vigorous research activity is in progress to try to understand the formation and evolution of patterns, and the reasons why one kind of pattern is preferred over another in any particular case.

Rebecca Hoyle's book originated in a lecture course that she gave in Cambridge. It is intended to provide an introduction to the range of methods now available for the analysis of natural patterns, at level suitable for postgraduates or final year undergraduates. Her emphasis is on using symmetries to describe universal classes of pattern, rather than in treating particular physical examples.

The book opens with introductory remarks about what is meant by a pattern – structures that strike the eye as being regular in some way, often being spatially periodic, at least locally. The introductory chapter gives a short survey of the kinds of natural patterns that occur. In addition to stripes, there are e.g. squares and hexagons, rotating spirals and pulsating target patterns. The author offers several examples including irregular hexagonal patterns on giraffes and in convecting cooking oil (and provides a recipe for the latter experiment), spiral patterns in the Belousov-Zhabotinsky reaction, Turing patterns in reaction-diffusion systems, and Faraday waves (standing wave patterns on the surface of a vertically vibrated layer of fluid). The rest of the book is devoted to a more detailed and rigorous devlopment of these initial ideas.

Chapters 2 and 3 provide the necessary background in bifurcation theory and group theory, respectively, both of which are needed for analysis of the patterns. Chapters 4–11 are the real meat of the book. They bring together a number of different methods. The topics covered include bifurcations with symmetry, simple lattice patterns, superlattices and hidden symmetries, spatial modulation, instabilities of stripes, travelling plane waves, spirals, large-aspect-ratio systems and the Cross-Newell equation. The treatment is necessarily detailed and mathematical, but the author goes to considerable lengths to explain what is going on as clearly as possible.

The book is attractively produced and well-written in an engaging style. There are exercises for the student at the ends of chapters 2–11, an extensive bibliography, and a good index. I suspect that general physics undergraduates, even in their final year, will find the main part of the text quite demanding; it is more for mathematicians and theoretical physicists. However, any physicist should be able to read the first chapeter with interest and enjoyment, and he or she can then dip into the sections of chapters 2–11 relevant to his or her particular interests. The author is to be congratulated on producing a fine book that promises to be of continuing value to the diverse group of scientists and mathematicians interested in pattern formation and, in particular, to PhD students entering this fascinating area of interdisciplinary investigation.

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