A Kinetic View of Statistical Physics, by Pavel L. Krapivsky, Sidney Redner and Eli Ben-Naim, Cambridge, Cambridge University Press, 2010, 504 pp., £45.00 (hardback), ISBN 978-0-521-85103-9. Scope: monograph. Level: advanced undergraduate, postgraduate, researcher.

Physical theories combine to support and complement each other. In many investigations we may neglect the high-energy phenomena of the standard model. Then we may apply well known theories of matter at low energy. Some such theories present closed formal structures apparently faithfully mirroring the structure of reality. Classical mechanics and Maxwellian electromagnetism are complete formal structures apparently isomorphic with the human world. Other theories, such as quantum mechanics and statistical mechanics give only recipes for treating specific situations. In quantum systems, measurements complicate the application of the formalism, and in thermal physics the concept of ensemble causes ambiguities in interpreting the results of the theories.

There are, however, research activities which do not fall into any of these categories. The present book suggests an example of such an emerging field. It collects a large amount of material which has resulted from a variety of physical models. It may serve to define a novel field of research. It combines material scattered in a multitude of sources. In many applications, we have got used to the possibility of simulating physical models on computers. The material in this book offers interesting alternative analytic approaches, which provide independent insights into the physics of nonlinear systems. Numerically obtained data may then be used to interpret the analytic results and determine their range of validity.

The central features may be described as the treatment of time evolution equations for classical variables representing physical concepts. There are neither quantum observables nor any ensembles. The evolution equations are, however, nonlinear rate equations, which are introduced by heuristic arguments. Derivations from microscopic models are usually neither possible nor necessary. The physics interpretations are intuitively obtained using phenomenological arguments. Here the contact with observations is adequately presented. Many physically interesting and topically relevant systems are introduced.

The theory of coupled nonlinear equations has got a long and respectable history. A lot of analytic methods and asymptotic results have evolved over the years. Only few cases admit exact solutions and hence various limits become important: asymptotic behaviour for long times, large numbers of unit systems and critical points play central roles. Some features have been around for long times. We find discussions of mean field dynamics, Boltzmann equations, Lotka–Volterra mode competition and Glauber models together with more novel equations referring to later introduced features of physical systems.

The mathematical results collected offer a broad spectrum of methods and tools developed over recent decades. They include dimensional arguments, scaling considerations and perturbation approximations including asymptotic expansions in various limits. Without indulging in formal manipulations, the book manages to introduce a multitude of theoretical approaches to the behaviour of nonlinear systems.

The discussion is introduced by summaries of diffusion and collisionally induced kinetics. From this start, we proceed to more novel phenomena: aggregation, fragmentation, adsorption, and coarsening. Concepts of spin dynamics, disorder and hysteresis are treated. The book finally closes the argument with chapters on population dynamics and random networks. Originally these launched the whole field of research.

One can learn a lot from this book. It presents well the heuristic considerations needed to build phenomenological equations. These mirror the properties of their origin and their approximate treatments may be suggested by the behaviour expected on physical grounds. The matter, however, becomes more interesting, in the cases when counterintuitive features emerge from the treatment: sometimes approximations fail qualitatively. Also, at critical points, logarithmic corrections may appear. Many results and methods may efficiently be utilised in treatments of systems to emerge in future research. Still, the physical consequences of the various results would have benefited from concluding discussions of their observational manifestations. As it is, the treatment often ends by listing final equations without discussions.

The book is a most useful collection of methods to treat nonlinear physical systems. It presents a large number of topical models investigated together with their analytic treatments. A suitable choice of topics may define a modern course on physics of matter. Alternatively, a graduate student or researcher may find results relevant just for the problems encountered in his own research. It generalises the traditional investigations of nonlinear physical phenomena to include results from much recent research.

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