Lattice-Gas Cellular Automata, Simple Models of Complex Hydrodynamics, Collection Aléa Saclay: Monographs and Tests in Statistical Physics, by **D. H. Rothman, S. Zaleski** (Cambridge University Press, Cambridge, 1997, 297 pp.) GB£ 45.00 US$ 69.95 hc ISBN 0 521 55201 X

The field of lattice gases started in 1985 when Frisch, Hasslacher and Pomeau proposed a simple molecular dynamics model with large scale behavior similar to that of a viscous fluid and therefore a new way to simulate the Navier-Stokes equations. Since then many variants of the initial model have been proposed and tested to simulate a wide range of experimental situations that may interest workers in various fields of science and technology. The results have been published in the general scientific literature and in proceedings of very specialised meetings.

Two of the actors of this field have written a broad review that will help newcomers to the field and hopefully to popularize it not only for those interested by the fundamental questions involved in the relationship between microscopic and macroscopic properties but also for engineers looking for efficient ways to solve hard problems.

The book covers essentially three broad subjects: the principles of the method, how to describe systems with several phases and flows in porous media as an example of complex hydrodynamics.

The first five chapters give the principles of lattice gases and through an analysis of their behaviour at large scale show what are the requirements in terms of symmetry and dynamics at the microscopic level to lead to Navier-Stokes behavior for an isotropic viscous fluid. The presentation uses a good mixture of physical insight and mathematical discussions (some results on properties of tensors are recalled in appendices).

Chapters 6 and 7 briefly present the lattice-Boltzmann method which may be seen as an extension of lattice gases in which basic quantities are populations of particles instead of occupation numbers limited to 0 or 1. The gain in signal/noise and in the possibility to choose at will the free parameters of the models justifies in many cases the use of this technique which turns out in practice to be as easy to implement as the strictly boolean lattice gases.

Contrary to the early workers in the field who thought lattice gases might be useful for large scale fluid flows simulations, the authors have worked to successfully propose models well suited to describe multiphase flows. Chapter 8 presents ways to represent convection-diffusion phenomena in fluid mixtures. In chapter 9 collisions are modified to obtain the formation of fronts between different phases with the existence of a surface tension which can be "measured" using Laplace's law. Its theoretical value is derived in chapters 10 and 11 using the lattice Boltzmann method in two and three dimensions.

Introducing non local interactions, reminiscent of attractive interactions between particles in a real fluid, may lead to phase separation between high and low density regions (liquid/gas) as shown in chapter 12.

All the tools to simulate complex flows are then used to consider the case of porous media. Chapter 13 presents a summary of the work of the authors. This chapter shows the power of the lattice gas and lattice Boltzmann methods to obtain detailed "experimental" data complementary to what can be obtained in real experiments and thus get a better understanding of the limits of validity of results like Darcy's law.

Chapters 14 and 15 consider the foundations of lattice-gas theory, first in terms of the existence of equilibrium states then in the derivation of equations describing the dynamics at large time scales. This involves the extension of the Chapman-Enskog approximate treatment of classical gases to lattice gases. This chapter will be particularly useful for readers who wish to propose extended models to simulate new situations.

The last three chapters are devoted to phase separation. "Experimental data" on the dynamics of growth of bubbles in a lattice gas is discussed in terms of power laws. Fluctuations of interfaces are analyzed as is done for a real interface using light scattering techniques leading to the existence of some kind of effective temperature. Finally examples of complex patterns are discussed.

As indicated at the beginning this book gives a very good review of the main results obtained in the field of lattice-gas models. It will help newcomers to get started. Many of the results shown in the book are impressive and should attract people who commonly use standard approaches. May be some information about the efficiency of computer codes (with details for parallel computing environments) would have been useful even if such kind of information gets out of date very quickly due to the very fast evolution of computers and numerical techniques.

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