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Book Review: *Random Walks and Random Environments, Vol. 2, Random Environments*

Random Walks and Random Environments, Vol. 2, **Random Environments.** B. D. Hughes, Clarendon Press, Oxford, 1996.

The scientific literature surrounding percolation theory is vast and includes studies ranging from materials science applications to pure mathematics. In between these extremes there is interest in percolation by physicists in the context of molecular modeling of transport in inhomogeneous systems. Hughes offers a personal account of percolation theory from a perspective which emphasizes mathematical results in a form digestible to physical scientists and physical arguments in a form palatable to mathematicians. Although the final result of this ambitious undertaking is often rather dry, the text should provide a valuable reference source on the applications and theory of percolation and certain problems arising in the transport of disordered materials.

Chapter 1 provides a general introduction to percolation theory. Basic terminology and concepts are defined concisely and some guidance to the literature is given. The summary of known results about percolation draws on rigorous mathematical, numerical, and formal perturbative studies. Although the discussions of particular topics are clear, their motivation often seemed weak, so that the introductory chapter was taxing to read. This chapter works very well as a reference source, however. Chapter 2 provides economical descriptions of mathematical (typically bounding methods) techniques favored in more theoretically oriented studies of percolation. Much of the development is again rather dry, but there are interesting discussions on ergodic theory and the uniqueness of the infinite percolation-cluster which highlight this chapter. The pace of the text picks up substantially in Chapters 3 and 4, which provide comprehensive summaries of bounds, conjectures, empirical formulas, and numerical data for the percolation threshold and equilibrium critical exponents, respectively. These chapters contain useful compilations of percolation theory data and those compilations alone make the text worth purchasing. It was especially interesting to see tabulations of numerical lattice data taken from a range

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of sources, based on widely different numerical methods. The discussion of renormalization group theory, conformed field theory, and finite-size scaling results in Chapter 4 is brief, given the importance of these topics in recent developments of percolation theory. Hughes gives a very nice discussion of random resistor networks in Chapter 5 and further tabulations of percolation exponents related to electrical transport. The account of the various theoretical arguments for the transport exponents is well written and very helpful for bringing order to this highly dispersed journal literature. An important limitation of this chapter is that only lattice calculations are summarized and physically important issues relating to the existence of universality in continuum versus lattice percolation models are not addressed. Chapter 6 restricts its attention to a narrow class of lattice random walk models with disorder. Most of the results are for one-dimensional models having primarily mathematical interest, so that the general problem of random walks in random environments is treated rather incompletely. De Gennes' idea of using walkers ("ants") as probes of disordered structures is developed in the final chapter. Chapter 7 was well motivated and the discussion very much to the point.

This text is a valuable source of information about percolation theory and transport in disordered materials based on the lattice model approach. The treatments of individual topics are generally well written and are packed with useful information. Unfortunately, the motivation connecting topics is often unclear, making the text more useful as a reference book than as a course text.

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