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# Book Review: *Defects and Geometry in Condensed Matter Physics*

**Defects and Geometry in Condensed Matter Physics.** D. R. Nelson, Cambridge University Press, Cambridge, 2002.

This book is a collection of contributions by D. R. Nelson presented at conferences, workshops and summer schools on the role of defects and topological excitations in several problems of condensed matter physics such as elasticity, superfluidity, superconductivity, glass transition and polymer physics. This books exposes the common grounds of several, apparently disconnected, problems of actual relevance in condensed matter theory. This is an ambitious goal that the book accomplishes quite successfully, sometimes at the price of quite elaborated math.

Professor Nelson is well known for his many contributions in this field of research. This book gathers most of his contributions during the last 20 years. The book is structured into 9 chapters each chapter dealing with some of the aforementioned problems. Each of these chapters is by itself self-contained as they represent contributions already published in other volumes, therefore each chapter of the book can be read independently.

Chapter 1 is a very nice introduction to the basic ideas of fluctuations, renormalization and universality covering from hydrodynamics to critical phenomena. Particularly illuminating is the discussion of the universal negative value Poisson ratio in fluctuating membranes. Chapter 2 is an exhaustive chapter discussing defect mediating Kosterlitz–Thouless transitions, applied to two-dimensional superfluidity and statistical mechanics of melting. Particularly interesting is the explanation of the Kosterlitz–Thouless theory for the XY model and the derivation of the universal jump of the superfluid density at the critical temperature. Chapters 3 and 4 present an alternative view of the glass transition problem in two and three dimensions respectively as consequence of a dynamical arrest driven by topological defects. This view has been advocated to explain the origin of dynamical frustration found in glass former systems: the geometric tile that locally minimizes the energy induces frustration because it cannot fill up



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the whole lattice. The theoretical framework developed in these chapters builds up on a Landau free energy expansion expressed in terms of the Fourier density components, an approach that has been also used in liquid theories. It must be said that Chapters 3 and 4 are mainly theoretical, therefore their relevance remains unclear as no general comparison with experimental results on the glass transition is given. Chapter 5 is specially interesting as it is devoted to polymerized membranes and tethered surfaces. There are many experimental realization of these systems, e.g., liquid membranes (such as cells or microemulsions) or solid membranes (such as surface gels). These surfaces tend to show a crumpling transition as a consequence of the competition between bending energy and entropy. Chapters 6 and 7 develop in more detail the ideas covered in Chapter 2, sometimes even overlapping its contents. Chapter 7 discusses in detail vortex lines in type II superconductors and the pinning of these lines by defects. The content of this chapter is later further developed in Chapter 8 where a full analysis of the statistical mechanics of entanglement of flux lines is presented. Particularly interesting in both Chapters 7 and 8 is the discussion of bosonization techniques to tackle the dynamics of flux lines. Finally, Chapter 9 is devoted to several aspects of the directed polymer problem, among them the analysis by transfer matrix techniques.

It must be said that the book by Dr. Nelson is very useful to those researchers working in the field, however the inexpert reader may find difficult to follow some of the covered topics as they generally assume a good basis of knowledge. Most of the chapters cover the topics in a very exhaustive way by giving a lot of references and detailed calculations. Some contributions included in this volume are bit old (for instance Chapter 2) and so are the references given. Sometimes the reader is left with the uneasy doubt whether some issues presented in the book and unsolved in that time have been finally resolved. Overall this book will be undoubtedly useful to those readers particularly interested in the development of these ideas during the last twenty years. The book by Dr. Nelson will be welcomed by the scientific community, it is certainly a necessary item in the library of any condensed matter physicist working on this and and related areas.

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