

Preface

It has been two decades since David Thouless's book, "*Topological Quantum Numbers in Nonrelativistic Physics*" appeared in print. I was among the handful of students lucky enough to have sat in the classroom as he presented the materials of his evolving book as lectures to graduate students. The memory of the experience has planted in me an idea to write a book of my own someday. Luckily enough, this would be it.

The bubble memory devices of the 1960s and 1970s must have presented great excitement to the scientists of the era, but like relics buried beneath the ground and forgotten, they remained little known to posterity until their re-incarnation in MnSi and other chiral hosts in 2009. Together with the revival of the science came a new name: the "skyrmion." In the bubble memory days, topology was hardly on anyone's lips; today, it is the rote jargon. Indeed, ignorance of the Berry phase no longer serves as a good excuse because it is now the stuff of graduate, and even undergraduate, curricula. A book that can help material science-oriented students to navigate the (old) sea of skyrmions in the (modern) ship of topology seems to be in order.

While the original intent was to explain skyrmions, the book appears to have evolved into a textbook that tries to instill the modern tool-sets of condensed matter theory, using the science of skyrmions as a platform and an excuse. In truth, many of the theories I discuss in the book have been available for decades, but given the popularity of skyrmions in recent years, those theories can benefit from a certain amount of refurbishing in their manner of presentation. One can thus use this book as a reference book on skyrmions in chiral magnets, or on the "theoretical essentials" that happen to have been invested in the study of skyrmions. Either way, the book would see its purpose fulfilled.

Quite a few heavyweight expositions on the field-theoretical approach to condensed matter problems are in circulation. The level of field theory used in this book is no match to those volumes. This is in part due to the author's own lack of expertise in such matters, and in part due to the relative simplicity of skyrmion physics compared to other modern disciplines of condensed matter. Several edited volumes on skyrmion science have also been published in keeping with the rapid

progress of the field. This book is intended to maintain a healthy distance from the “trendy” volumes by removing discussions of latest experimental results, which are thoroughly covered in other books and review articles. The manner of exposition is overtly pedagogical; I am convinced that skyrmions happen to be as good an excuse as any other physical platform in which to learn the modern tools of theoretical condensed matter physics.

Skyrmions have become ubiquitous in condensed matter physics. They can be found in a wide variety of magnets, in spinor cold atoms, and in liquid crystals. There are also momentum-space manifestations of skyrmions, as in two-dimensional topological band insulators, and in three-dimensional Weyl semi-metals. Here, however, I exclude most such examples, focusing on skyrmions in chiral magnets and cold atoms, finding it safer to talk about the themes where I seem to have genuine voice of confidence to share.

Suwon, Korea (Republic of)
September 2017

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Skyrmions in Condensed Matter

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2017, XV, 177 p. 25 illus., 14 illus. in color., Hardcover

ISBN: 978-3-319-69244-9