“Physics in Canada” Book Review
“La Physique au Canada” Critique de livre

Elements of Slow-Neutron Scattering by J. M. Carpenter and C.-K. Loong, Cambridge University Press (2015), ISBN 978-0-521-85781-9, price 200.95.

Neutron scattering research has a long and storied tradition in Canada, and almost all readers of Physics in Canada will be familiar with the Nobel Prize awarded for the pioneering work of Bertram N. Brockhouse. In recent years the field has been reinvigorated in North America with the construction of the accelerator based Spallation Neutron Source and upgraded facilities at the major American reactor based sources. Thus the scientific opportunities are plentiful, and the arrival of a fresh new book on the subject is very timely. Elements of Slow-Neutron Scattering, Basics, Techniques, and Applications, is a collaborative effort of J. M. Carpenter, whom many regard as the “father of pulsed neutron scattering”, and C.-K. Loong, who enjoyed a long and distinguished career as a practitioner of the technique. They have produced a very ambitious book, more than 500 pages long, with an enormous amount of supplemental information at the website http://slowneutronscattering.com. The book refers frequently to the website, which, in turn has keywords cross-indexed to the book chapters. This combination was quite an undertaking!

To misquote a hackneyed phrase, “this ain’t your thesis supervisor’s neutron scattering book”. Most books on the subject start out with a short overview of the neutron itself, possibly some elementary information about sources, detection and instruments, then move onto scattering cross-sections, diffraction, and then more specialized applications. Elements of Slow-Neutron Scattering seems to begin this way, then, (boom!), the reader of chapter 1 is immersed in a detailed discussion of neutron transport theory. By the time I made it to the Greuling-Goertzel approximation my head was spinning. I was surprised to see this much detailed material in the opening chapter, but setting aside its placement in the opening chapter, this is significant information that is not easily accessible elsewhere. This is followed up in the second chapter by an exposition of neutron sources, moderators, and pulsed source line-shapes. From that point on the book moves into more familiar territory, first covering scattering theory, then instruments, optical devices and detectors. The book is rounded out with several chapters on applications, including crystallography, lattice dynamics and chemical spectroscopy, magnetic structures and excitations, and disordered and large scale structures.

For the most part the book is very readable, with mild eccentricities that I suspect most readers will find enjoyable although a few may find them distracting. Examples include a short digression in the introduction, “for want of a better place to do so”, mentioning that Tesla discovered x-rays before Roentgen but failed to publish, and later on starting the discussion of the neutron’s magnetic moment with a quantum state vector written explicitly in terms of quark states. Most books on neutron scattering take the spin 1⁄2 as a given and leave it at that. In places the authors seem to have melded the rigor of a mathematically inclined physicist and the practical approach of an engineer with the soul of a philosopher-poet.

One might ask how this book compares with others available covering similar material as there are many now available. This reviewer will pick out some representative examples. For many years, the comprehensive books Theory of Thermal Neutron Scattering by Marshall and Lovesey and Lovesey's two-volume follow-up Theory of Neutron Scattering from Condensed Matter have been definitive and detailed expositions of the theoretical aspects of slow neutron scattering. A more accessible book for those starting out is Squires' Introduction to the Theory of Thermal Neutron Scattering. Readers desiring an understanding of the information gleaned from neutron scattering but relatively uninterested in details of the experiments themselves would probably be satisfied by one of these.

More experimentally oriented books include the specialized Neutron Scattering with a Triple-Axis Spectrometer by Shirane, Shapiro, and Tranquada, the much broader survey Experimental Neutron Scattering by Willis and Carlile, and with many examples of applications Furrer, Mesot, and Strässle's Neutron Scattering in Condensed Matter Physics. Of these, the range of material in the book by Willis and Carlile is most similar to that covered in Elements of Slow-Neutron Scattering, but in most instances Carpenter and Loong dive much more deeply into the details of the mathematics and the theory behind the measurements. To this reviewer a real strength of Elements of Slow-Neutron Scattering is that it maintains the rigor of Marshall and Lovesey while conveying a vast amount of information concerning experimental practice.

I expect that Elements of Slow-Neutron Scattering should be in high demand by physicists and other scientists who would like to utilize neutron methods as a significant part of their research program. Professional neutron scatterers, especially those engaged in building or improving instruments, will absolutely want to have this book on their shelves. Students or others seeking a quick overview of the technique may prefer something different, but with proper guidance Elements of Slow-Neutron Scattering will be a useful resource for a graduate level course. The on-line supplemental information is a most interesting innovation. The material might be easier to use if the web-site included a text search feature, but that is a minor quibble. I will definitely recommend this book to students, colleagues, and anyone else with a strong interest in neutron scattering.

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