Theoretical Fluid Mechanics, Richard Fitzpatrick, Iop Publishing Ltd, 2017; pp. 0; ISBN: 978-0750315524; Price: 75.63. (Live: 1)

SENIOR LEVEL

Algèbre linéaire et applications (5° Éd.) (Manuel + MonLab xL), LAY David, LAY Steven R., MACDONALD Judi J., Pearson, 2017; pp. 530; ISBN: 9782761376525; Price: 109.95. (Live: 1)

Astrophysics of Red Supergiants, Emily Levesque, Iop Publishing Ltd, 2018; pp. 100; ISBN: 978-0750313308; Price: 176.88. (Live: 1)

High Time-Resolution Astrophysics, Editors: Tariq Shahbaz, Jorge Casares Velázquez, Teodoro Muñoz Darias, Cambridge University Press, 2018; pp. 208; ISBN: 978-1107181090; Price: 160.95. (Live: 1)

String Theory in a Nutshell: Second Edition [v], Elias Kiritsis, Princeton University Press, 2019; pp. 888; ISBN: 9780691155791; Price: 128.99. (Live: 1)

Topological and Non-Topological Solitons in Scalar Field Theories, Yakov M. Shnir, Cambridge University Press, 2018; pp. 278; ISBN: 978-1108429917; Price: 166.95. (Live: 1)

Book Reviews / *Critiques de livres*

Book reviews for the following books have been received and posted to the *Physics in Canada* section of the CAP's website: http://www.cap.ca.

Des revues critiques ont été reçues pour les livres suivants et ont été affichées dans la section "La Physique au Canada" de la page web de l'ACP:http://www.cap.ca.

Molecular Engineering Thermodynamics, by Juan J. de Pablo and Jay D. Schieber, Cambridge University Press, 2014, pp. 505, ISBN 978-0-521-76562-6, price 120.00.

The authors state in the preface that "Traditional boundaries between science and engineering are becoming blurred, and versatility in engineering is necessarily built upon a broader understanding of far–reaching scientific principles". I wholeheartedly agree with the authors on this point, and my perception is that engineering education in most of the developed world (apart from Canada) is moving in this direction. However, I perceive that such blurring from the science perspective is active here, and the book provides a good introduction to important practical applications of thermodynamics that are of potential interest to members of the Canadian applied physics community.

The book addresses the perceived need for a modification of thermodynamics education by combining the mathematical foundations of macroscopic thermodynamics and its molecular-based underpinnings, accompanied by illustrative applications to problems in physics, chemistry and biology. The authors indicate that they have used the book for a two-semester undergraduate course and a for one-semester graduate course, directed at chemical, biological and biomedical engineers, materials scientists and chemists.

The topics covered are based on those of a typical chemical engineering curriculum, which arose historically due to the importance of the petroleum industry. For example, phase equilibrium plays a prominent role, for which the emphasis on the fugacity concept is evident. One consequence is the lack of any treatment of electrolyte solutions, which would readily evolve from an emphasis on the chemical potential itself, as well as provide a foundation for the treatment of phase equilibria.

Chapter 1 gives a short introduction to the scope of thermodynamics, and lays out the topics of the subsequent chapters. It also contains a list of 23 "relevant questions for thermodynamics", designed to whet the student's interest in what is to come, followed by a short review of the important concepts of Work and Energy.

Chapter 2 outlines the postulates of thermodynamics, introducing the First Law (Postulate I) and Second Laws (Postulate IV), and the definitions of temperature, heat, pressure and chemical potential in terms of mathematical derivatives of the internal energy function U (N, V, T). It relates the concepts of Work and imperfect differentials. The state postulate, relating the number of independent intensive thermodynamic variables required to fix all others, is implied but not stated explicitly in the context of their Postulate III. Postulate V sets the zero of S, followed by a digression on the link between entropy and statistical mechanics. A disappointment to this reviewer (see my earlier comment concerning fugacity) is that the introduction of the chemical potential, one of the most important quantities in chemical thermodynamics, is by means of its formal definition as the partial derivative of U with respect to Ni at constant S, V and N_j, j being different from i.

Chapter 3 contains many useful mathematical topics, beginning with Legendre Trans forms, Extremum Principles, the Maxwell Relations and thermodynamic manipulations using the method of Jacobians described in an Appendix. The chapter ends with interesting one- and two-dimensional applications to rubber bands, DNA unzipping, and adsorption.

Chapter 4 begins with a discussion of stability criteria, in preparation for a brief section on single–component vapor-liquid equilibria (VLE). This is the first mention of this chemical engineering "workhorse", which plays a prominent role in chemical engineering education. There follows a section on crystalline solids and a description of the phase diagram of a pure substance. Chapter 5 extends the treatment to flow systems, based on the control volume concept (although this term is not used in the text), and the conservation equations for an open system are given in the Appendix. Applications are presented to the thermodynamics of power cycles and the vapor-compression refrigeration cycle.

Chapter 6 gives an introduction to classical statistical mechanics, and Chapter 7 discusses its implementation in terms of classical molecular force field models. Chapter 8 is devoted to the concept of fugacity and vapor-liquid equilibrium (solid–liquid equilibrium is also covered.) Emphasis instead on the chemical potential would provide a unifying concept that would make the teaching of the concepts in Chapters 9 (Activity and equilibrium) and 10 (Reaction equilibrium) far more understandable to the student.

Chapter 10 on Reaction equilibrium (somewhat belatedly) introduces the concept of standard property changes, which are intimately linked to the notion of reference states. It might be more useful to introduce the reference state concept much earlier, in conjunction with the chemical potential and energy–related properties in general. Chapters 11 and 12 present applications to polymers and surfaces.

Many worked examples are provided in the text, and interesting problems are provided at the end of each chapter. The Appendices contain useful material on mathematical foundations, fluid equations of state, the differential equations of mass, momentum, energy and entropy balance equations for spatially distributed systems, and thermochemical tables.

William Smith, University of Guelph

OPTICAL MAGNETOMETRY, by Dmitry Budker and Derek F. Jackson Kimball, Cambridge University Press, 2013, ISBN 978-1-107-01035-2, price 471.25.

This book is a collection of pedagogical chapters on the physics and techniques in optical magnetometry. Each chapter is written by experts in the respective topic in optical magnetometry. This is an excellent reference book to start from if you want to learn about a particular application or technique in optical magnetometry.

The introductory chapters are devoted to understanding the sources of noise and uncertainty that limit the sensitivity in magnetometry measurements. Many of the optical magnetometers rely on measuring the Faraday rotation of the light polarization as it passes through a magnetic field. We learn that the sensitivity of the magnetic field measurement in this method depends on contributions from photon shot noise of the probing light, and from atomic spin-projection noise.

There are chapters devoted to understanding different types of magnetometers including nuclear magnetic resonance (NMR) type magnetometers on alkali vapours, spin-exchange-relaxation-free (SERF) magnetometers, and optical magnetometers using modulated light. The chapter on NMR type magnetometers has a useful review of the Bloch equation, and tracking of magnetization of an atomic vapour in a magnetic field.

Several chapters deal with systematic effects and detailed experimental conditions needed to make the magnetometers work. For example, there is a chapter on magnetic shielding that is required when measuring very small magnetic fields. Of particular interest to me, was the chapter on tests of fundamental physics, that reviews the sensitivity of different magnetometer systems that are being used in neutron electric dipole moment experiments.

Finally, there are several chapters, that provide reviews of different applications of magnetometry. These are quite interesting applications, including remote detection, space magnetometry, detecting biomagnetic fields, and geophysical applications. The final chapter is on commercial magnetometers, and their history.

In conclusion, I would recommend this book to anyone interested in learning the physics of optical magnetometers. The chapters provide excellent reviews of different aspects of optical magnetometry, and include detailed references to further reading on the state of the art in the topic.

Blair Jamieson, Associate Professor of Physics, University of Winnipeeg

REVIEW OF 100 YEARS OF SUBATOMIC PHYSICS, by Ernest M Henley, Stephen D Ellis, Ernest M. Henley and Stephen D. Ellis, World Scientific, 2013, pp. 560, ISBN 978-981-4425-80-3, price 49.08.

When I first saw this title on the list of books available for review on the CAP web site, I immediately sent in a request for a copy. I've been working in experimental particle physics for more than 40 years and, like many people in the late stages of their career, I have become increasingly interested in the history of my field. I was hoping for a technical narrative describing the key developments of nuclear and particle physics over the last century that would fill in any gaps in my knowledge and, more importantly, be a source that I could recommend to incoming students to provide them with a context for their research. I was disappointed.

This book is a collection of contributions from leading workers in subatomic physics, edited by Ernest Henley and Stephen Ellis from the University of Washington. There are 19 chapters, starting with a short overview by Steven Weinberg and ending with a review of string theory and M theory by John Schwarz. The articles in between are evenly divided between topics in nuclear and particle physics; some are worth reading and others can be safely passed over.

I enjoyed the too-short history of colliders by Lyn Evans - the man who directed the building of the LHC - and the chapter on large underground detectors for proton-decay searches and neutrino physics by Kate Scholberg. However I am less enthusiastic about the section on 4-pi detectors by Christopher Tully. He seems not to have read the instructions - there is nothing about the historical evolution of full-coverage detectors, starting with detectors like the seminal SLAC-LBL Mark I at SPEAR. Instead he has written a comprehensive description of the elements of the ATLAS and CMS detectors at the LHC. It's a worthwhile contribution and something I can recommend to students but I don't think it's what the book is supposed to be about. This is in contrast to the chapter on jets and QCD, nicely written by Stephen Ellis and Davison Soper - they followed the instructions and have provided an excellent account of the evolution of this topic. Rabindra Mohapatra and Lincoln Wolfenstein have provided similarly brief and historically interesting overviews of weak interactions and neutrino physics, respectively. There is also a well-written summary of parity and time-reversal tests in nuclear physics, by David Hertzog and Michael Ramsey-Musolf.

Some topics are completely absent. One example is the search for dark matter particles and axions. It has been going on for more than a quarter of the last century so it should rightly have a place in this book but somehow has been left off the list.

Despite its shortcomings, the book is a valuable resource. As a collection of review articles it can be a place to get a quick overview of some topics and most of the chapters have excellent bibliographies. Although not for the purpose I originally had in mind, I would definitely recommend it to an incoming graduate student. It seems the book I'm looking for has not yet been written.

David Hanna, McGill University

THE LITTLE BOOK OF BLACK HOLES, by Steven S. Gubser and Frans Pretorius, Princeton University Press, 2017, pp. 200, ISBN 9780691163727, price 24.99.

The "Little Book of Black Holes" at 200 pages is indeed as the title promises a concise book filled with very interesting stories about black holes and their behavior. The book has seven chapters, each discussing some aspect of black hole physics and one epilogue. The first two chapters introduce the reader to the theory of special relativity and general relativity; basics for learning physics of black holes. The next five chapters each discuss details of the Schwarzschild black hole solution, the Kerr black hole solution, the observation of black holes (e.g., Cygnus X-1, Sagittarius A*), black hole collisions and black hole thermodynamics. The epilogue is a letter to Albert Einstein informing him of the recent physics uncovered, including the discovery of gravity waves. It brings forth the excitement the authors have as young physicists; co-writers of the cosmic story started by the great physicist.

Given the expertise of the authors, this is the best place to learn about particle trajectories near black holes, the ergo sphere and space dragging of rotating black holes, their collisions and emission of energy in the form of gravitational waves. Some of the descriptions are fantastically precise (e.g., "The free falling probe will measure a time of 2,638 seconds to reach the ISCO from its initial position of 150 million kilometers, and then an additional 122 seconds to reach the horizon"), and you don't have to read a formidable technical article in a scientific journal. The style of writing is very smooth, and the book is pitched at the level accessible to science geeks, or young physics students, for whom Maxwell's equations are not a mystery, yet they do not have to be experts in special theory of relativity. The chapters on black hole orbits are some of the best descriptions I have seen in literature (though without equations). Given the discovery of gravitational waves this book is very timely. Many of the details about gravitational wave's discovery (e.g., gravitational wave detectors are blind to one of the polarizations); are facts easily found here: a reader will find difficult to find these from the plethora of existing technical papers and websites.

The chapter on black hole thermodynamics is equally insightful in the introduction to the quantum and black hole entropy. The incompatibility of quantum fields at the horizon with general relativity or the `Information loss' problem of Hawking radiation however doesn't come across as the dramatic focus in the discussion.

In the end, the book is a treasure to have, and read whenever one has a craving for black hole orbits and ergo spheres. The book can be completed in one day, and thus is ideal to take along during travels. The most impressive aspect of the book in my opinion is the use of illustrations. These are very clear drawings, and impactful depictions of the physics explained. If you wish to buy the book (it is reasonably priced at $24.95), this might be one of the reasons.

Arundhati Dasgupta, University of Lethbridge