“Physics in Canada” Book Review

“La Physique au Canada” Critique de livre

“Extreme Physics” by Jeff Colvin and Jon Larsen, Cambridge University Press, 2014, pp xii+405, ISBN 978-1-107-01967-6, Price 215.19.

“Extreme physics” aims at providing an overview of physical processes governing matter under conditions of relevance to laboratory plasmas, with a particular emphasis on computational methods. The book starts with general definitions of the “extreme” conditions of matter, followed by a very brief review of plasma physics in which kinetic theory, Coulomb collisions, Debye shielding and the electron plasma wave are presented in only 28 pages. Then follow chapters on the interaction between laser light and plasma, hydrodynamics, shocks, equations of state, atomic physics, thermal and radiative energy transport, and magnetohydrodynamics. The physics described in these initial ten chapters is often short shrift, and the topics presented range in scope from elementary, to more advanced. Omitting exercises at the end of every chapter, the number of pages per chapter ranges from 21 to 34. This brief summary provides an interesting reminder of the many processes of relevance to plasma physics, but I suspect that it would be insufficient for a reader unfamiliar with the subject. The preface states “Focusing on computational modeling, the book discusses topics such as …”. This “focus just on theory and computation” is also mentioned in the first chapter (p. 3 last paragraph before 1.1.2). With only the two last chapters on computational approaches totaling 61 pages however, it is not clear that the focus really is on computational modelling. The last two chapters do present some interesting general guidelines for developing computer models, but several aspects, such as finite difference approximations of derivatives, or the solution of a tridiagonal system of equations, are too elementary to appeal or be useful to students already appraised of computational methods. The book also contains a number of inaccuracies or typos as for example, “... these are shielded out in a distance short compared to lambda_D, …” (p. 52 middle of last paragraph). This is incorrect because shielding of small potential perturbations takes place over a distance of order of the Debye length, and shielding of large perturbations takes place over larger distances. On page 135 second to last line, “Kronecker delta function” should read “Dirac delta function”. On page 277 line 12 from the top, the inequality sign is wrong following “at very low frequencies” , and Delta is missing in front of x (p. 332, second to last line). Those are but a few examples, and severa; more can be found.

When I started reading this book I was intrigued and eager to find out more about the properties of matter under “extreme” conditions. I did not find what I expected, and I remain largely on my apetite. Perhaps the main criticism that can be made is that the authors attempted to do too much in too short a book. Considering the plethora of books on introductory plasma physics and numerical methods, this book could have been more relevant and useful if it had assumed an adequate background in basic plasma physics and electromagnetism, and concentrated on the

more advanced topics in matter under extreme conditions of density, temperature or magnetic fields. Advanced computational methods applicable to these conditions could then have been treated in more depth, by considering 2D and 3D modelling techniques under realistic conditions. Despite these shortcomings, I can see that “Extreme Physics” could be used as a reference in a course in which lectures would complement the material presented in the text.

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