Book Reviews / *Critiques de livres*

A Student Manual for "A First Course in General Relativity", by Robert B. Scott, Cambridge University Press, 2016, pp. 310, ISBN 9781139795449, price 29.95.

This is an excellent companion volume for anyone contemplating teaching a first course in General Relativity. Ideally the course manual should be the corresponding book by Bernard Schutz called "A first course in general relativity" also published by Cambridge University Press. The book by Schutz is an excellent first course in General Relativity, which presents the subject by first explaining in detail special relativity in the first 4 chapters followed by 8 chapters which gently lead the student into the complexity of General Relativity where it starts with the definition of curved manifolds followed by physics in curved spacetime, to Einstein's equations and then followed by applications to gravitational radiation, spherical solutions for stars, black holes and ending with a short introduction to cosmology.

Scott's Student Manual follows Schutz' book exactly, chapter by chapter, indeed the chapter headings in the two books are identical. There are according to Scott, 388 exercises in Schutz's book. Scott suggests that the interested learner do each and every one of them. In Scott's book, he does give the solution of most of the exercises of Schutz and he gives many more solved supplementary exercises, in addition to some exercises for which the solutions are not provided. Scott uses the notation Eq. (n.m) to denote the exercises/equations in Schutz's book while the notation eqn. (n.m) to denote exercises/equations in the Student Manual. The solutions are always placed in a grey background so that it is clear when one is reading a solution as opposed to the exercises themselves. Scott goes into significant detail in explaining the solution, hence some might find the solutions a bit laborious, however, they are very pedagogic. Scott does this expressly, his aim being "to be complete, to spell it all out". Scott also has provided an accompanying Maple worksheet, which is available for download from the Cambridge University Press website.

The first 4 chapters of Scott's book are on special relativity. The subject is presented to the reader through many exercises that are based on very fundamental aspects, starting with exercises on the basic definition of natural units, then the principles of special relativity: that no observer can measure the absolute velocity of any other observer and that the speed of light is universal, invariant for all inertial observers. These are followed by two chapters of exercises on the notions of vectors and tensors in Minkowski spacetime and ending with a chapter on the definition of a perfect fluid in special relativity.

Then come the exercises on the heart of the matter, General Relativity. The next four chapters, 5 through 8, give exercises on the mathematical structure and the notions of differential geometry leading to the Einstein equations. I have done several of the problems in each of the chapters and I find some of them quite challenging. I compared my solutions to those offered by Scott and I am happy and relieved to know that they compare pretty well with those provided, the difference being largely that Scott gives far more details! There are in depth exercises on the first corrections to the Newtonian theory and how they arise in Einstein's theory, which is very educative.

The final four chapters, 9 through 12, are exercises on the fundamental applications of Einstein's theory, to gravitational radiation, solutions (spherical) for stars, black holes and cosmology. These chapters capture the essence of the excitement of General Relativity. They correspond to predictions of Einstein's theory that go beyond the Newtonian theory, including time dependent phenomena, strong gravity and gravitational collapse, event horizons and a first exposure to cosmology. The exercises are again very detailed and expose the various pedagogical aspects of the rather theoretical analyses in Schutz's book.

Thus, in summation, this book is a perfect companion to a textbook for teaching a first course in General Relativity. Ideally, it goes hand in glove with the book by Schutz. However, it could be used as a source book of exercises to accompany any similar course based on another book (like that of Hartle or Carrol). The instructor could use the book to assign solved problems and unsolved problems suitable for homework problems.

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A Well-Ordered Thing, by Michael Gordin, Princeton University Press, 2019, ISBN:978-0-691-17238-5, pp. 351, price 22.58.

Michael Gordin's "A Well-Ordered Thing" is a carefully researched and scholarly account of the life and surroundings of Dmitrii Mendeleev, the late 19th century co-inventor of the periodic table. Gordin covers Mendeleev's academic beginnings, his famous work on the periodic table, and takes time to discuss the lesser-known pursuits of Medeleev: his economic and political thought, his work in industry and in service to the Russian empire, and his investigation into the Spiritualism movement. Mendeleev's diverse interests are used to explore the setting Mendeleev lived in; indeed, Gordin emphasizes that the book is not so much the story of Mendeleev as it is an examination of imperial St. Petersburg.

Due to its emphasis on St. Petersburg, the book is a biography of a scientist without being a scientific biography. With the exception of the famous periodic law, to which Gordin devotes a chapter, Mendeleev's scientific thought is presented in an incidental way. Further, the scientific context in which Medeleev worked is never discussed in detail. Consequently, Gordin's priorities may not align with those of a scientist-reader. Nonetheless, the book contains some interesting scientific details. Gordin stresses that Medeleev's thinking on the periodicity of properties of the elements stemmed from a pedagogical need: to organize the known elements into a form suitable for a first-year chemistry textbook. I also found Medeleev's views on the ether to be of interest. Medeleev believed the ether was composed of particles which could be placed in the periodic table and attempted to predict properties of the ether by using his periodic law, just as he had predicted the existence and properties of unknown elements.

Gordin explores in depth Mendeleev's economic and political thought, and his role in shaping imperial policy. Gordin stresses how, to Mendeleev, scientific societies were models for how technical expertise could be employed by the empire. The book emphasizes Medeleev's "Imperial Turn", a transition from a focus on local affairs in St. Petersburg to a top-down approach to enacting reform. In Gordin's analysis, this turn was initiated by Mendeleev's rejection from the St. Petersburg Academy of Sciences, as Mendeleev had taken the Academy to be a model of how reform could be organized locally. Gordin also argues that the ensuing outrage in the popular press made Mendeleev's reputation.

"A Well-Ordered Thing" aims to explore imperial St. Petersburg through one of its great citizens. In his writing, Gordin has emphasized analysis over narrative. In some places the analysis felt stretched or obvious. For instance, Gordin draws a parallel between Mendeleev's work on gases and his meteorological work, noting that in both cases he was "amassing data on irregularities in order to determine laws", but the parallel could have been made to nearly any scientific work. As well, the lack of narrative left me without a clear sense of Mendeleev as a person. In general, though the historical analysis makes interesting points, especially regarding Mendeleev's rejection from the Academy and consequent Imperial Turn, and the book largely succeeds in its aim.

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Fearful Symmetry: The Search for Beauty in Modern Physics, by A. Zee, Princeton University Press, 2016, ISBN 9780691173269, pp. 376, price 31.99.

There are few popular physics books which are worth recommending to a student beginning a new subject. Tony Zee's "Fearful symmetry" is one of them. This book should be productive reading for students studying particle physics or group theory in physics. This is not only because the book presents technical material honestly, but also because the book reads easily. To achieve this, Zee maintains the unusual writing style he is known for in his textbooks - short and pointed sections colored with references to art, literature and anecdote.

Zee covers some of the usual ground for a popular physics book, for instance quantum mechanics, relativity, and the Standard Model. Additionally, however he reaches topics rarely touched: groups, non-abelian gauge theory, spontaneous symmetry breaking and supersymmetry. By presenting these topics and tying them to a unifying theme of symmetry and the aesthetic sense of the theorist, Zee presents one of the most recognizable portraits of work as a theoretical physicist available in popular work.

To Zee, beauty, largely as expressed through symmetry, is a powerful guiding force in theoretical physics. Also running throughout the work is a persistent reference to God or a Designer. Usually among theorists such references are linguistic conveniences or metaphors (as was the case for Einstein, a frequent source of such usages), though this subtlety is an inevitable point of confusion. In Zee's case however the references are more than metaphor, as he believes in a presence of some kind responsible for creating the universe. Indeed, Zee views the aesthetics of the universes design, as evidenced through the role of symmetry, along with the basic fact of the universe's comprehensibility as evidence for this deistic view.

Zee's views on deism and aesthetics contribute much of the uniqueness of the book. At times though Zee risks portraying theoretical physics as a mystic art, and it is worth emphasizing a counterbalancing view. My own view is that theoretical physics is not at all divorced from observation - and so not at all a mystic art - even in a case such as string theory. In that case, theorists have chosen to focus on the core principles of quantum mechanics and gravity and work mathematically to tie them together into a consistent theory. Those principles however are well grounded in experiment. Momentarily ignoring some details and beginning from basics is sometimes necessary to make conceptual jumps. In fact, Zee makes a similar point in the context of general relativity - Einstein did not arrive at his theory by studying observations of the orbit of Mercury, but by revisiting long known simple observations.

While Zee's views may not align precisely with my own, he has written an excellent book. It will be of interest not only to the new student, but also to any artist or layperson interested in beauty. Zee has made great progress in making the beauty of symmetry in physical law accessible for a wide audience.

Alex May,
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JCEP

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