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A General Relativity Workbook

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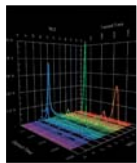
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but such standard material can be easily found elsewhere. Complements on energy flow in polarizable media, macroscopic polarization, and charge oscillators add useful information. The chapter sets the necessary background for the subsequent topics and is similar to treatments in well-known textbooks like John David Jackson's *Classical Electrodynamics* (3rd edition, Wiley, 1998).

Chapters 3 and 4, which deal with surface waves and the equivalent circuit picture, make up the book's core. In chapter 3 the authors present the theory of electromagnetic surface modes, with an emphasis on surface plasmons in planar geometry. They derive the main formulas for surface modes with retardation and discuss surface plasmon polariton dispersion, attenuation constants, and more. Particularly strong features include the detailed formulas for and examples of surface plasmons in real metals and the full account of dissipation effects.

The electrical engineering presentation in chapter 4 covers transmission lines, waveguides, and more complex circuit elements. It also addresses surface plasmons as oscillations in resonant circuits made of lumped elements, principally inductors and capacitors. The detailed description, using matrix analysis, of electromagnetic wave propagation nicely sets up the discussion, based on a comparison to lumped circuits, of nanoscale plasmonic systems—for example, slit apertures and nanospheres.

The fifth and final chapter deals with classical and quantum treatments of atomic emission and absorption, radiative damping, the Schrödinger equation, Einstein's theory of stimulated and spontaneous emission, and related topics; a subsequent complement covers blackbody radiation. The chapter is well written, but its relation to the others is not clearly spelled out. The book is rounded out by appendices on electromagnetic systems of units, vector calculus, cylindrical and spherical coordinates, phasors, and special functions.

Researchers in nanophotonics and plasmonics will find references, formulas, and detailed derivations that often do not appear in specialized reviews. Students and researchers with specific interests will find it useful to go through the derivations and extract the relevant conclusions. However, it would have been helpful if the main results and equations were highlighted with boxes or some other graphical element—perhaps the authors or the pub-

lisher will do that in a second edition.

Light-Matter Interaction will find a useful place in the libraries of students and researchers in the field and could be used as a main or supporting textbook in a one-semester course for undergraduate or graduate students in physics, photonics, or electrical engineering—or even better, in a course with a mixed audience of students from those disciplines.

Lucio Claudio Andreani
University of Pavia
Pavia, Italy

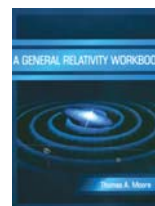
A General Relativity Workbook

Thomas A. Moore
University Science Books, 2013.
\$62.50 paper (476 pp.).
ISBN 978-1-891389-82-5

Albert Einstein's theory of general relativity leads to such spectacular predictions as black holes, gravitational waves, and the Big Bang in the early universe, all of which are at the forefront of theoretical and observational physics. Thomas Moore's recent text, *A General Relativity Workbook*, provides an excellent introduction to general relativity and its fascinating implications for cosmology, black hole physics, and gravitational waves. A professor of physics at Pomona College in California, Moore has mainly focused his research on the generation and detection of gravitational waves. He has also authored *A Traveler's Guide to Spacetime: An Introduction to the Special Theory of Relativity* (McGraw-Hill, 1995) and the six-volume text *Six Ideas That Shaped Physics* (McGraw-Hill, 2002).

A General Relativity Workbook is ideally suited for a one-semester, undergraduate-level introductory course in general relativity. The book assumes only a basic knowledge of calculus, classical mechanics, and electromagnetism, and does not require prior knowledge of differential geometry or tensor calculus. Each of the 39 chapters corresponds to a 50-minute class section, which makes it particularly handy for use as a textbook.

After a brief introduction of the principal ideas behind general relativity, the book presents a review of special relativity, followed by five chapters in which tensor fields and the index notation are introduced and explained in detail and Maxwell's equations in ten-



sor form are derived. Next is a discussion, based on a variational principle, of spacetime geodesics. With those concepts in hand, the reader is already capable of diving into the next eight chapters and understanding the most important physical properties of the Schwarzschild metric. Those chapters include a nice discussion on particle and photon orbits and their applications to the perihelion precession of Mercury and gravitational lensing, a demonstration that the Schwarzschild metric describes a black hole, and some heuristic comments on black hole thermodynamics.

Later chapters are devoted to the definition of curvature (based on the relativistic interpretation of tidal forces through geodesic deviation) and to a discussion of Einstein's field equations, including a derivation of the Schwarzschild solution. The book culminates with three independent sections on main applications of general relativity: six chapters on cosmology, five on gravitational waves, and five on spinning black holes.

A novel aspect of *A General Relativity Workbook* is its overview-and-box layout: Each chapter contains a clear motivation, an overview of the key concepts and results, a box section that guides the reader through the derivation of the details and includes space for calculation, and homework problems.

At a few spots in the book, the discussion has been oversimplified. For example, the introduction of the "absolute gradient," more commonly known as the covariant derivative, and the central role it plays in the mathematical realization of the equivalence principle is not rigorous. A student or scientist wishing to acquire a more thorough understanding of the theoretical or mathematical aspects of general relativity should read a more advanced book, like Sean Carroll's *Spacetime and Geometry: An Introduction to General Relativity* (Addison-Wesley, 2003), Norbert Straumann's *General Relativity* (2nd edition, Springer, 2013), or Robert Wald's *General Relativity* (University of Chicago Press, 1984).

In any case, I think anyone interested in learning about this fascinating theory will find *A General Relativity Workbook* to be captivating. The book's lively style and novel design make it as easy as possible for students and nonexperts to grasp the physical concepts behind the theory. And Moore's decision to discuss the physical properties of the Schwarzschild metric before introducing the

more complicated mathematics required for deriving it from Einstein's field equations paid off. Furthermore, the book contains a wealth of useful exercises and homework problems, including ones about such exciting and modern topics as cosmic rays, gravitational lensing, inflation, and gravitational radiation from binary pulsars.

I strongly recommend *A General Relativity Workbook* to instructors teaching general relativity and to their students.

Olivier Sarbach

*University of Michoacán
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