A Student's Guide to Einstein's Major Papers

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phenomena continues throughout the book and is one of its chief merits.

Next, Weinberg introduces the mathematical machinery of state vectors, Hilbert space, observables, and transition amplitudes, with an emphasis on the role of symmetries. Strikingly, though, Paul Dirac's bra–ket notation is eschewed almost entirely, because, as Weinberg explains in the preface, "for some purposes it is awkward." That may be so, but given its ubiquity in the physics literature, it is disappointing that students will get so little exposure to it in this book.

Both students and experts will be particularly interested in the section "Interpretations of Quantum Mechanics," which discusses the Copenhagen, many-worlds, and decoherent-histories interpretations in some detail. Weinberg's striking conclusion, which he admits is "not universally shared," is that "today there is no interpretation of quantum mechanics that does not have serious flaws." That will no doubt provoke further debate, and the section is a good primer for those who would like to follow future developments.

From here, the book moves on to material that is mostly standard for a graduate-level course. But Weinberg presents it with a high level of rigor and clarity and with numerous discussions of related physics not always found in other textbooks: for example, magic numbers in nuclei, how the parity of the pion was determined, and the existence of both left- and right-handed sugars as an example of symmetry breaking. He also gives a complete treatment of the quantization of the electromagnetic field using Dirac's formalism for constrained systems. Calculations of radiative transition rates in atoms then take us back to the phenomena that originally prompted the development of quantum mechanics. The book concludes with a chapter on "Entanglement" that contains derivations of several forms of the Bell inequalities and an all-too-brief discussion of quantum computing.

In the 24 October 2002 *New York Review of Books*, Weinberg wrote of the tension between "cultures of the image and cultures of the word." He declared, "I am an unreconstructed believer in the importance of the word, or its mathematical analogue, the equation." This book clearly reflects that belief, as it contains not a single figure: There are no pictures, diagrams, plots, or graphs of any kind. Furthermore, Weinberg is completely comfortable with dense notation and expects that his readers will be as well: In the chapter "General Scattering Theory," we encounter an *S*-matrix element labeled with 14 subscripts. These aspects of the book, along with a relatively modest set of end-of-chapter problems, may temper its appeal as a primary textbook, especially for students with limited preparation.

Overall, *Lectures on Quantum Mechanics* must be considered among the very best books on the subject for those who have had a good undergraduate introduction. The integration of clearly explained formalism with cogent physical examples is masterful, and the depth of knowledge and insight that Weinberg shares with readers is compelling.

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A Student's Guide to Einstein's Major Papers

Robert E. Kennedy
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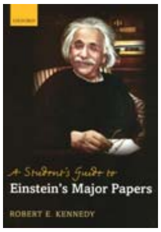

Physics professors often refer to Albert Einstein's work when teaching relativity, quantum mechanics, or statistical mechanics. I have never given his original papers to my students to supplement their learning, but that will change. I appreciate the importance of having undergraduates read classic and original physics literature, and I have tried to inspire my experimental physics students by assigning Albert Michelson's 1880 description of his measurement of the speed of light or Robert Millikan's 1911 oil-drop paper. I have egged the students on to try and do better than Michelson or Millikan using modern technology.

Some of Einstein's classic papers could also motivate undergraduates, if the physics were fully explained. For instructors who choose to expose their students to Einstein's scientific articles, Robert E. Kennedy's *A Student's Guide to Einstein's Major Papers* will be a welcome supplement. Kennedy focuses on Einstein's four classic papers published in the annus mirabilis of 1905, his doctoral thesis (published in 1906), and his 1916 general relativity paper.

The original papers, unfortunately, do not appear in the book, though free versions can be found on the internet. With great care, Kennedy explains the papers' physics and equations and fills in the gaps in Einstein's derivations. When necessary, he translates Einstein's equations into modern notation. Kennedy also corrects some misconceptions; he observes, for example, that Einstein presented the equivalence of mass and energy, but did not write it as $E = mc^2$.

The book provides a brief history of Einstein's life before 1905 and a backdrop of physics history leading up to that remarkable year in physics. It also presents historical background on each paper before commencing with the explanations. The text's conclusion summarizes Einstein's contributions to the development of quantum mechanics; however, absent any related Einstein article to work through, that chapter feels out of place.

I know from personal interactions that Kennedy, an emeritus professor at Creighton University in Nebraska, has a deep dedication to physics education. He obviously spent a significant amount of time preparing his book so that readers could fully understand the important physics Einstein introduced. But does Kennedy's book contribute anything that has not already been covered by Abraham Pais in *"Subtle Is the Lord . . .": The Science and the Life of Albert Einstein* (Oxford University Press, 1982)? Kennedy makes a point of working through practically every equation that appears in the six papers—to some extent, he has created a workbook that will help readers unravel those papers. Pais distills the most important points associated with the important papers, and is far more detailed on Einstein's history.

The perfect audience for Kennedy's guide would be physics professors on sabbatical. Most physicists would enjoy it, but working through the physics is time consuming and nontrivial, even if ultimately rewarding. I would be hesitant to give Kennedy's book to undergraduates, except perhaps in the context of a senior thesis project. A motivated teacher could certainly use it as a tool to help guide students through a reading of a particular paper. However, in my view, only four of the six original papers are appropriate for undergraduates: "On a heuristic point of view concerning the production and transformation of light," "On the electrodynamics of moving bodies," "On the movement of small particles suspended in stationary liquids required by the molecular-kinetic theory of heat," and "Does the inertia of a body depend upon its energy content?" These four papers, with the help of Kennedy's book, could be very well understood by undergraduates. Einstein's PhD thesis, "A new determination of molecular dimensions," would, in my opinion, be too cumbersome for most undergraduates.

Of the several good ways to teach general relativity to undergraduates (see my article with Thomas Moore in Physics Today, June 2012, page 41), I would not consider giving them Einstein's original 1916 paper to be one. But for students who already have experience with general relativity, reading the original paper along with Kennedy's explanations would be a wonderful experience. I look forward to presenting some of Einstein's papers to my students next year, and I will definitely use *A Student's Guide to Einstein's Major Papers* as a resource.

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The God Problem

How a Godless Cosmos Creates

Howard Bloom
Prometheus Books, Amherst, NY, 2012.
$28.00 (575 pp.).
ISBN 978-1-61614-551-4

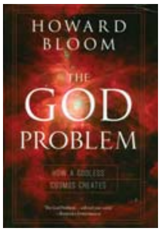
What is the problem that science writer Howard Bloom aims to address in *The God Problem: How a Godless Cosmos Creates*? The subtitle gives an indication. Basically, it is to give a naturalistic account of the world we see around us, a world abounding with intricate structure. In short: Is God necessary?

That problem has a long and distinguished history. The poem *De rerum natura* (*On the Nature of Things*), written in the first century BC by Lucretius, is a classical statement that anticipates several modern scientific ideas, promotes atomism, and accounts for creation without a creator. The following excerpt (translated by Martin Ferguson Smith) illustrates his ideas:

> But because throughout the universe from time everlasting countless numbers of [atoms], buffeted and impelled by blows, have shifted in countless ways, experimentation with every kind of movement and combination has at last resulted in arrangements such as those that created and compose our world.

As the sciences of physics and biology developed, weighty objections to that point of view arose that were only (perhaps) adequately addressed in the 20th century.

Isaac Newton argued that the regular system of planets requires finely tuned initial conditions. Writing in 1692 to scholar and theologian Richard Bentley, his University of Cambridge colleague, Newton concluded, "this must have been the effect of counsel." James Clerk Maxwell marveled at the uniformity of atoms and molecules. In his 1875 *Encyclopaedia Britannica* article on atoms, he hinted at a similar conclusion:



> The various processes of nature to which these molecules have been subjected since the world began have not been able in all that time to produce any appreciable difference between the constants of one molecule and those of another. . . .
>
> The formation of the molecule is therefore an event not belonging to that order of nature under which we live. . . . It must be referred to the epoch, not of the formation of the earth or of the solar system, but of the establishment of the existing order of nature.

In an 1802 article in *Natural Theology*, distinguished theologian and churchman William Paley eloquently expressed a then widely held (and still influential) argument that the marvelous order we find in the biological world indicates design:

> Suppose I had found a watch upon the ground, and it should be inquired how the watch happened to be in that place. . . . There must have existed, at some time, and at some place or other, an artificer or artificers . . . who comprehended its construction, and designed its use. . . .
>
> . . . every manifestation of design, which existed in the watch, exists in the works of nature; with the difference, on the side of nature, of being greater or more, and that in a degree which exceeds all computation.

Science can now propose meaningful answers to all those objections. Big Bang cosmology tracks down the origin of the universe to a simple, remarkably uniform condition early in its history. Small inhomogeneities grew in amplitude through gravitational instability and eventually collapsed and fragmented to produce the galaxies, stars, and planets we see today. Dissipation through radiation allows the formation of stable systems, without the need for fine adjustment. The standard model of particle physics, which embodies quantum field theory, accounts for the uniformity of molecules in rich detail and for the structure of matter in general. And the Darwin–Wallace theory of evolution by natural selection, conceptually grounded in Mendelian genetics and explained physically by Francis Crick and James Watson, answers Paley.

Nor is mind (or consciousness, free will, or the soul) a safe refuge for the supernatural. It has come to seem quite plausible, at least since the works of Alan Hodgkin, Andrew Huxley, and Alan Turing, that human thought is grounded in electrochemical processes that manipulate patterns of activation in the brain.

Of course, none of that prevents one from asking why or from interpreting the consensus in a God-friendly manner. Heroes of physics, including Galileo Galilei, Johannes Kepler, Newton, Michael Faraday, Maxwell, and Max Planck, sincerely considered their endeavor as an exploration of God's handiwork or of God's mind. Albert Einstein and Stephen Hawking expressed that sentiment too, though perhaps with tongue in cheek.

There are great and serious stories to be told here, both historical and intellectual. Unfortunately, Bloom's book does not focus on the central thread but wanders far off course and follows several bizarre tangents. I will mention two.

Throughout the book, many pages are devoted to passionate denials of "*A* = *A*." All those denials, needless to say, are based on silly misunderstandings of that logical principle. (They're almost as silly as Ayn Rand's manic affirmations of it!)

And according to Bloom, the ultimate basis of physical behavior is sociality: "Each quark comes with an etiquette book built into it that tells it who to rush forward and embrace." Headings in the book include "How Gossip Grows the Universe," "The Case of the Obsessive-Compulsive Cosmos," Are you sure you want to remove A student's guide to Einstein's major papers from your list? A student's guide to Einstein's major papers. by Robert E. Kennedy. Published 2012 by Oxford University Press in Oxford, New York .Â "Theory of the gravitational field". "Material phenomena". Einstein and quantum mechanics. Edition Notes. Includes bibliographical references and index. A.student's.Guide.to.Einstein's.MAjor.PApers.2012-MAntesh. File Size : 3.40 MB | File Count : 1 | Create Time : 2017-03-31. A Student's Guide to Einstein's Major Papers 2012 -Mantesh.pdf 3.40 MB. Options MAde simple -A Beginner's Guide to TrAding Options for success 2012 -MAntesh. File Size : 3.83 MB | File Count : 1 | Create Time : 2015-08-16.Â Erik M. Buck - LeArning OpenGL Es for iOs - A HAnds-on Guide to Modern 3D GrAphics ProgrAmming - 2012.pdf. File Size : 4.91 MB | File Count : 1 | Create Time : 2015-08-10. A Student's Guide to Einstein's Major Papers 2012 -Mantesh.pdf 4.91 MB. For the Love of Letters - A 21st-century Guide to the Art of Letter Writing-MAntesh. File Size : 1.28 MB | File Count : 1 | Create Time : 2015-12-05.

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