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# Relativity: The Special and the General Theory

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# Einstein's take on his much-celebrated theories

## Relativity
### The Special and the General Theory

Albert Einstein
100th anniversary ed.
Princeton U. Press, 2015. $26.95
(320 pp.). ISBN 978-0-691-16633-9

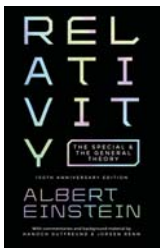
*Reviewed by Nelson Christensen*

A century ago, Albert Einstein published his description of general relativity. A decade before that, he presented special relativity. The public was curious to know more about those theories, so Einstein commenced work on a book that explained special and general relativity. It was a huge success. The first version was published in German in 1917, and it has been reprinted in many other languages and editions over the years. The first English version, titled *Relativity: The Special and the General Theory*, was published in 1920. Einstein updated the book a few times, adding material to the appendix section when new experimental results supported general relativity.

To mark the centennial of general relativity, the 1961 English translation by Robert W. Lawson has been republished as *Relativity: The Special and the General Theory*, 100th anniversary edition. This new offering was edited by Hanoch Gutfreund and Jürgen Renn, who have included much background information that adds historical context to the text. (The article by Renn and Michel Janssen on page 30 of this issue traces Einstein's path to his field equations.)

The description of special relativity in Einstein's book is pleasurable and easy to read. I can imagine students in my special relativity course reading Einstein's description and taking away a better understanding of the subject. As to whether the general public can understand the work, I think Einstein's own recommendation says it best: "The work presumes a standard of education corresponding to that of a university matriculation examination, and, despite the shortness of the book, a fair amount of patience and force of will on the part of the reader." That recommendation still holds true, in my opinion.

Einstein goes through the classic comparisons of measurements made by an observer on a train moving at a constant velocity and another at rest on an embankment next to the train tracks. Given the coordinate systems of those two observers, Einstein derives, among other things, time dilation, length contraction, and the Lorentz transformations. All the derivations are gentle and intuitive. I immensely enjoyed Einstein's insight in this part of the book. More difficult derivations and technical explanations are left to an appendix, but even those would be easily understood by undergraduate physics students.




The general relativity section of the book was also fun to read. I especially enjoyed Einstein's own words describing the difference between spacetime and coordinates, "which have not the least direct physical significance." He also provides a clear introduction to the consequences of curved space; I expect that description will give some much-needed intuition to those encountering non-Euclidean geometry for the first time.

I teach general relativity and conduct research in the field, so I have the necessary background to be able to sit back and enjoy the well-written and insightful text. However, I do not think the general relativity section will be easy for people who have not previously spent some time thinking about the subject. In the introduction to the 1921 Polish translation of *Relativity*, philosopher Maksymilian Tytus Huber noted that it "is not *popular* in the usual sense, but rather, as someone said jokingly, *popular with physicists*." The general relativity section of Einstein's book will certainly be popular with physicists.

Among the gems that were added to the post-1917 editions is a nice summary of Arthur Eddington's 1919 measurement of the deflection of light by the Sun's gravitational field. It is also enjoyable to hear directly from Einstein about the evolution in his cosmological understanding of the universe. Alexander Friedmann's solutions in general relativity convinced Einstein that an expanding universe was possible and that he could discard his "cosmological term." Einstein also writes positively about Edwin Hubble's observations, which confirmed that the universe was expanding, but he expressed reservations about the implied age of the universe—$10^9$ years—which Einstein recognized as being too young. Such considerations, written in Einstein's own words, are fascinating to read.

In a few areas Einstein's descriptions run counter to our modern interpretation of special and general relativity. We will forgive the author for those rare and minor missteps. The reader will recognize that over the past century special and general relativity have survived stringent tests.

Editors Gutfreund and Renn provide a good historical introduction to Einstein's book, explaining how it came into being and how it became hugely popular after the splash made by Eddington's observations. They summarize the book's numerous publications in a section that also includes descriptions of Einstein's interactions with scientists from around the world.

Most physicists should enjoy this book; so, too, should educated members of the public with sufficient "patience and force of will." Einstein is to be commended for his successful physical theories and also for his pleasant descriptions of them.

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## Introduction to General Relativity, Black Holes, and Cosmology

Yvonne Choquet-Bruhat
Oxford U. Press, 2015. $99.95
(279 pp.). ISBN 978-0-19-966645-4

Yvonne Choquet-Bruhat is a giant of mathematical general relativity. In 1952 she proved a groundbreaking theorem on the existence of solutions to the Einstein field equations. Since then she has obtained many results in general relativity, partial differential equations, classical field theory, and fluid dynamics. Now in her nineties, she shows no signs of slowing down, and even finds time to write textbooks.