General Relativity

A Geometric Approach

Malcolm Ludvigsen

General Relativity: A Geometric Approach, Malcolm Ludvigsen, Cambridge University Press, 1999, 052163976X, 9780521639767, 217 pages. Starting with the idea of an event and finishing with a description of the standard big-bang model of the Universe, this textbook provides a clear, concise and up-to-date introduction to the theory of general relativity, suitable for final-year undergraduate mathematics or physics students. Throughout, the emphasis is on the geometric structure of spacetime, rather than the traditional coordinate-dependent approach. This allows the theory to be pared down and presented in its simplest and most elegant form. Topics covered include flat spacetime (special relativity), Maxwell fields, the energy-momentum tensor, spacetime curvature and gravity, Schwarzschild and Kerr spacetimes, black holes and singularities, and cosmology. In developing the theory, all physical assumptions are clearly spelled out and the necessary mathematics is developed along with the physics. Exercises are provided at the end of each chapter and key ideas in the text are illustrated with worked examples. Solutions and hints to selected problems are also provided at the end of the book. This textbook will enable the student to develop a sound understanding of the theory of general relativity, and all the necessary mathematical machinery..

An Introduction to General Relativity , L. P. Hughston, K. P. Tod, 1990, Mathematics, 183 pages. More emphasis is placed on an intuitive grasp of the subject and calculational facility than on rigorous exposition in this introduction to general relativity for mathematics ....

Black Holes The Membrane Paradigm, Kip S. Thorne, Richard H. Price, Douglas A. MacDonald, Jan 1, 1986, Science, 367 pages. A pedagogical introduction to the physics of black holes. The membrane paradigm represents the four-dimensional spacetime of the black hole's "event horizon" as a two ....

Gravitation an introduction to current research, Louis Witten, 1962, , 481 pages. .

Relativity, Gravitation and Cosmology A Basic Introduction, Ta-Pei Cheng, 2005, Science, 339 pages. An introduction to Einstein's general theory of relativity, this work is structured so that interesting applications, such as gravitational lensing, black holes and cosmology ....

Relativity demystified , David McMahon, Jan 1, 2006, , . Now anyone can grasp Einstein's great theory of relativity -- without formal training, unlimited time, or a genius IQ. In Relativity Demystified, theoretical physicists (and ....

Classical General Relativity Proceedings of the Conference on Classical (non-quantum) General Relativity, City University, London, 21-22 December 1983, William B. Bonnor, Jamal N. Islam, M. A. H. MacCallum, 1984, Science, 269 pages. This volume is made up of papers presented at the Conference on Classical General Relativity held at the City University, London, in December 1983. New tests, arising from ....

Advanced General Relativity , John Stewart, Nov 26, 1993, Science, 228 pages. A self-contained introduction to advanced general relativity..

Einstein's Mirror , Anthony J. G. Hey, Patrick Walters, Jul 31, 1997, Science, 291 pages. The Theory of Special Relativity is one of the most profound discoveries of the twentieth century. Einstein's Mirror blends a simple, nonmathematical account of the theory of ....

Relativity, Thermodynamics, and Cosmology , Richard Chace Tolman, 1987, Science, 501 pages. A distinguished American physicist and teacher delivers a landmark study thatdevelops three essential scientific themes on each subject..

General relativity a first course for physicists, John Legat Martin, 1996, Science, 193 pages. .

Spinors and Space-time: Spinor and twistor methods in space-time ..., Volume 2 Spinor and twistor methods in space-time geometry. volume 2, Roger Penrose, Wolfgang Rindler, 1986, , 501 pages. .

Introduction to general relativity , Ronald Adler, Maurice Bazin, Menahem Schiffer, 1975, Science, 549 pages. .

Introducing Einstein's Relativity , Ray d'Inverno, 1992, Science, 383 pages. The aim of this textbook is to provide students with a sound mathematical introduction coupled to an understanding of the basic ideas and equations of Einstein's famous theory ....

Mathematical Problems of General Relativity I , Demetrios Christodoulou, Jan 1, 2008, Mathematics, 147 pages. The domain of application of Einstein's general relativity theory is astronomical systems. One of the mathematical methods analyzed and exploited in the present volume is an ....

Starting with the idea of an event and finishing with a description of the standard big-bang model of the Universe, this textbook provides a clear, concise and up-to-date introduction to the theory of general relativity, suitable for final-year undergraduate mathematics or physics students. Throughout, the emphasis is on the geometric structure of spacetime, rather than the traditional coordinate-dependent approach. This allows the theory to be pared down and presented in its simplest and most elegant form. Topics covered include flat spacetime (special relativity), Maxwell fields, the energy-momentum tensor, spacetime curvature and gravity, Schwarzschild and Kerr spacetimes, black holes and singularities, and cosmology. In developing the theory, all physical assumptions are clearly spelled out and the necessary mathematics is developed along with the physics. Exercises are provided at the end of each chapter and key ideas in the text are illustrated with worked examples. Solutions and hints to selected problems are also provided at the end of the book. This textbook will enable the student to develop a sound understanding of the theory of general relativity, and all the necessary mathematical machinery.

"This short, elegant book describes the major ideas of special and general relativity with unprecedented clarity and mathematical depth.... Ludvigsen's book is a very good addition to the library of anyone who is interested in general relativity, black holes, and cosmology. Many who learned or studied general relativity from other sources would gain from the depth and beauty of the geometrical approach so beautifully described here." Physics Today

"A valuable effort has been made towards keeping mathematical language and machinery as simple as possible, always introducing the mathematical tools required at each step. On the other hand, all physical assumptions are clearly spelled out and their translation into mathematics is carefully made..." Mathematical Reviews

I have taught electromagnetism at the advanced graduate level, and am reasonably familiar with classical differential geometry and general relativity (e.g. as presented by Weinberg). I am finding Ludvigsen's book a tough read, though a worthwhile one. A considerable amount both of the physics background and the mathematics background of the subject is omitted or treated very briefly. Three paragraphs cover the Coulomb potential *and* the plane wave, for instance. Definitions tend to be ostentive - by example.

There are endorsements on the back of this from Roger Penrose and Bernhard Schutz. The two neatly parenthesise the problem with this book, which is that in order to follow it, you need first to read Schutz's 'Geometrical methods', but once you have read Schulz you can skip Ludwigsen, and have a crack at Penrose (or, more reasonably, Wald) instead.

This should be a nice book (and Roger's blurb is probably earned - but Rog is not the audience). The author is enchanted - understandably - by the beauty of both relativity and differential geometry, but he tries to do too much in the number of pages he has, forgetting that mathematical ladders are much less intimidating looking down than looking up.

This is a good book, with a pronounced mathematical accent and many useful and solvable problems. It can be considered as a textbook, though there are some points which deserve corrections, for example: (a) In p. 36, the Author characterized the Lorentz transformation too shortly, and he calls it "Lorenz transformation". This is especially strange since in the neighbouring Denmark (Ludvigsen's address in the book is in Sweden) there was a great physicist L.V. Lorenz, 1829-1891, inventor of the Lorenz condition, creator of the electromagnetic theory of light (1867, independently of Maxwell), and co-author of the famous Lorenz-Lorentz formula -- together with H.A. Lorentz of Holland to whom pertains the above transformation. Eight lines below Ludvigsen introduces "Levi-Cevita" tensor (named after T. Levi-Civita, and this is a pseudo-tensor = axial tensor). These errors are not misprints (see Index, p. 216, and the text in the pages given there). (b) The Author uses, of course, real coordinates (not the ancient imaginary time), so it is inadequate to picture the Lorentz transformation as a sheer trigonometric rotation of space-time axes (cf. figs. 4.7, 5.3). (c) In the very title of the book the subtitle ("A Geometric Approach") seems to be artificial since general relativity practically is a synonym of geometry: the well-proportioned abundance of figures in the book is not identical to geometry. Imagine that Euclid would entitle his books as "The Elements. A Geometric Approach"... But the book by Ludvigsen is definitely a success, though it needs some editing more. I highly recommend it to students.

it's a brief introduction to the physics of gravity, not the mathematics. by the word geometric, the author means indepedence from coordinate, but he doesn't use tools of modern differential geometry(curvature form, connection, fiber bundle, pullback). it deals Killing field, Schwarzschild, and Kerr, but anti-deSitter nor variational formulation. if you want a mathematically elegant treatment, look for other books.

abstract index notation acceleration affine parameter affine tangent vector angular momentum asymptotically flat axisymmetric black hole called clock comoving components condition connecting vectors conservation consider const constant contract coordinate system corresponding cosmological principle covector curvature tensor curve defined definition density derivative energy energy-momentum tensor equivalent event example exists flat spacetime four-momentum four-velocity vector frequency Furthermore future-pointing galaxies geometric given gives gravitational field hence implies inertial particles Killing field linear mass metric motion Newtonian null cone null congruence null geodesic null rays null vector orbit orthogonal past-pointing Peter photon physical properties Rabcd radius Raychaudhuri equation region respect to gab satisfies scalar Schwarzschild spacetime shear-free sin2 singularity space spacelike spacelike vector spaceship spherical symmetry star surface tangent vector temperature tensor field theorem timelike tion two-spheres unique unit universe vector field velocity world line zero

A clear, concise and modern textbook introducing the theory of general relativity for final-year undergraduate maths or physics students. The emphasis is on the geometric structure of spacetime rather than the traditional coordinate-dependent approach. Exercises are provided (with solutions and hints) and key ideas are illustrated with worked examples.

Part I. The Concept of Spacetime: 1. Introduction; 2. Events; Part II. Flat Spacetime and Special Relativity: 3. Flat spacetime; 4. The geometry of flat spacetime; 5. Energy; 6. Tensors; 7. Tensor fields; 8. Field equations; Part III. Curved Spacetime and Gravity: 9. Curved spacetime; 10. Curvature and gravity; 11. Null congruences; 12. Asymptotic flatness and symmetries; 13. Schwarzschild; 14. Black holes and singularities; Part IV. Cosmology: 15. The spacetime of the universe; 16. Relativistic cosmology; Solutions and hints to selected exercises; Bibliography; Index.

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