From The Lorentz Transformation To The Dirac Equation A Whirlwind Tour Of Special Relativity

Models of Particles and Moving Media deals with the use of mathematical models to study electrical interactions with moving particles and moving media. Topics covered range from space-time and the Galilean transformation to the Lorentz transformation of time and space and of Maxwell's equations. Forces and wave interaction with uniformly moving circuits and continua are also considered, along with non-uniform motion of charged particles in prescribed electric and magnetic fields. Comprised of seven chapters, this book begins with an overview of some of the ways in which motion can be described, with particular reference to the concept of space-time and the Galilean transformation. The discussion then turns to the Lorentz transformation of time and space, giving emphasis on the transformation of coordinates, time dilation and the Lorentz contraction, and conservation of mass and energy. After an analysis of the Lorentz transformation of Maxwell's equations, forces and wave interaction with uniformly moving circuits and continua are reviewed, along with non-uniform motion of charged particles in prescribed electric and magnetic fields. The book concludes by describing the use of the Lagrangian model and the Eulerian model to determine the motion of many interacting particles and the motion of charged and conducting fluids, respectively. This monograph is written primarily for students and researchers in the fields of mathematics and physics.

This book, first appearing in German in 2004 under the title Spezielle Relativitätstheorie für Studienanfänger, offers access to the special theory of relativity for readers with a background in mathematics and physics comparable to a high school honors degree. All mathematical and physical competence required beyond that level is gradually developed through the book, as more advanced topics are introduced. The full tensor formalism, however, is dispensed with as it would only be a burden for the problems to be dealt with. Eventually, a substantial and comprehensive treatise on special relativity emerges which, with its gray-shaded formulary, is an invaluable reference manual for students and scientists alike.Some crucial results are derived more than once with different approaches: the Lorentz transformation in one spatial direction three times, the Doppler formula four times, the Lorentz transformation in two directions twice; also twice the unification of electric and magnetic forces, the velocity addition formula, as well as the aberration formula. Beginners will be grateful to find several routes to the goal; moreover, for a theory like relativity, it is of fundamental importance to demonstrate that it is self-contained and without contradictions.Author's website: www.relativity.ch.

This book on Special Relativity, with unique chapters on the Dirac equation and General Relativity, is especially suitable for a one-semester undergraduate physics course on Special Relativity (with perhaps some coverage of the qualitative features of General Relativity). It can also be used in a combination of undergraduate courses including modern physics, particle physics, optics, and Quantum Mechanics; or in classical mechanics at the physics graduate level. The book also includes coverage of the history of relativity, particularly with respect to developments in electricity and magnetism, particle physics, and cosmology. This is the revised second edition.

Writing a new book on the classic subject of Special Relativity, on which numerous important physicists have contributed and many books have already been written, can be like adding another epicycle to the Ptolemaic cosmology. Furthermore, it is our belief that if a book has no new elements, but simply repeats what is written in the existing literature, perhaps with a different style, then this is not enough to justify its publication. However, after having spent a number of years, both in class and research with relativity, I have come to the conclusion that there exists a place for a new book. Since it appears that somewhere along the way, mathem- ics may have obscured and prevailed to the degree that we tend to teach relativity (and I believe, theoretical physics) simply using “heavier” mathematics without the inspiration and the mastery of the classic physicists of the last century. Moreover current trends encourage the application of techniques in producing quick results and not tedious conceptual approaches resulting in long-lasting reasoning. On the other hand, physics cannot be done a ? la carte stripped from philosophy, or, to put it in a simple but dramatic context A building is not an accumulation of stones! As a result of the above, a major aim in the writing of this book has been the distinction between the mathematics of Minkowski space and the physics of r- ativity.

We present a quantity called Mixed number which is the sum of a scalar and a vector quantity. We have developed a Mixed number Lorentz transformation using Mixed number. Most general Lorentz transformation has some limitations but Mixed number Lorentz transformation is free from those limitations. We have applied Mixed number Lorentz transformation in the following different cases - i) Relativistic aberration ii) Reflection of light by a moving mirror iii) Relativistic Doppler s effect iv) Transformation of the characteristics of a wave The phenomenon of Relativistic aberration, Reflection of light by a moving mirror, Relativistic Doppler s effect and Transformation of the characteristics of a wave have been clearly explained by special and most general Lorentz transformation and by Mixed number Lorentz transformation. Using Mixed number Lorentz transformation we have observed that the formulae of relativistic aberration, reflection of light by a moving mirror, relativistic Doppler s effect and transformation of the characteristics of a wave are simpler than the formulae given by most general Lorentz transformation.

This book includes most details of the foundation of special relativity (SR). The author put the related information in three groups. The first group is the outline of SR, from Michelson-Morley experiment (MMX), Lorentz Transformation (LT), the problem of combining equations to SR itself. The second group explains the related mathematics. The third group is a conclusion of SR that explains even if the time equation of LT is not a combination of spatial equations of LT and inverse LT, LT is still a very tiny portion of Galilean Transformation (GT). At the end of the book, the author pointed out a correction to LT, and that correction changes the time equation of SR from t'=t/? to t'=?t. To make this book more attractive, the author talked about a jingle starting from roses and some philosophy of happiness. Hope you like it.

This textbook for a calculus-based physics course for non-physics majors includes end-of-chapter summaries, key concepts, real-world applications, and problems.

This unique book presents a particularly beautiful way of looking at special relativity. The author encourages students to see beyond the formulas to the deeper structure. The unification of space and time introduced by Einstein's special theory of relativity is one of the cornerstones of the modern scientific description of the universe. Yet the unification is counterintuitive because we perceive time very differently from space. Even in relativity, time is not just another dimension, it is one with different properties The book treats the geometry of hyperbolas as the key to understanding special relativity. The author simplifies the formulas and emphasizes their geometric content. Many important relations, including the famous relativistic addition formula for velocities, then follow directly from the appropriate (hyperbolic) trigonometric addition formulas. Prior mastery of (ordinary) trigonometry is sufficient for most of the material presented, although occasional use is made of elementary differential calculus, and the chapter on electromagnetism assumes some more advanced knowledge. Changes to the Second Edition The treatment of Minkowski space and spacetime diagrams has been expanded. Several new topics have been added, including a geometric derivation of Lorentz transformations, a discussion of three-dimensional spacetime diagrams, and a brief geometric description of "area" and how it can be used to measure time and distance. Minor notational changes were made to avoid conflict with existing usage in the literature. Table of Contents Preface 1. Introduction. 2. The Physics of Special Relativity. 3. Circle Geometry. 4. Hyperbola Geometry. 5. The Geometry of Special Relativity. 6. Applications. 7. Problems III. 8. Paradoxes. 9. Relativistic Mechanics. 10. Problems II. 11. Relativistic Electromagnetism. 12. Problems III. 13. Beyond Special Relativity. 14. Three-Dimensional Spacetime Diagrams. 15. Minkowski Area via Light Boxes. 16. Hyperbolic Geometry. 17. Calculus. Bibliography. Author Biography Tevian Dray is a Professor of Mathematics at Oregon State University. His research lies at the interface between mathematics and physics, involving differential geometry and general relativity, as well as nonassociative algebra and particle physics; he also studies student understanding of "middle-division" mathematics and physics content. Educated at MIT and Berkeley, he held postdoctoral positions in both mathematics and physics in several countries prior to coming to OSU in 1988. Professor Dray is a Fellow of the American Physical Society for his work in relativity, and an award-winning teacher.

This book explains the Lorentz mathematical group in a language familiar to physicists. While the three-dimensional rotation group is one of the standard mathematical tools in physics, the Lorentz group of the four-dimensional Minkowski space is still very strange to most present-day physicists. It plays an essential role in understanding particles moving at close to light speed and is becoming the essential language for quantum optics, classical optics, and information science. The book is based on papers and books published by the authors on the representations of the Lorentz group based on harmonic oscillators and their applications to high-energy physics and to Wigner functions applicable to quantum optics. It also covers the two-by-two representations of the Lorentz group applicable to ray optics, including cavity, multilayer and lens optics, as well as representations of the Lorentz group applicable to Stokes parameters and the Poincaré sphere on polarization optics.

This book offers an essential bridge between college-level introductions and advanced graduate-level books on special relativity. It begins at an elementary level, presenting and discussing the basic concepts normally covered in college-level works, including the Lorentz transformation. Subsequent chapters introduce the four-dimensional worldview implied by the Lorentz transformations, mixing time and space coordinates, before continuing on to the formalism of tensors, a topic usually avoided in lower-level courses. The book's second half addresses a number of essential points, including the concept of causality; the equivalence between mass and energy, including applications; relativistic optics; and measurements and matter in Minkowski space-time. The closing chapters focus on the energy-momentum tensor of a continuous distribution of mass-energy and its co-variant conservation; angular momentum; a discussion of the scalar field of perfect fluids and the Maxwell field; and general coordinates. Every chapter is supplemented by a section with numerous exercises, allowing readers to practice the theory. These exercises constitute an essential part of the textbook, and the solutions to approximately half of them are provided in the appendix.

Special relativity and quantum mechanics, formulated early in the twentieth century, are the two most important scientific languages and are likely to remain so for many years to come. In the 1920's, when quantum mechanics was developed, the most pressing theoretical problem was how to make it consistent with special relativity. In the 1980's, this is still the most pressing problem. The only difference is that the situation is more urgent now than before, because of the significant quantity of experimental data which need to be explained in terms of both quantum mechanics and special relativity. In unifying the concepts and algorithms of quantum mechanics and special relativity, it is important to realize that the underlying scientific language for both disciplines is that of group theory. The role of group theory in quantum mechanics is well known. The same is true for special relativity. Therefore, the most effective approach to the problem of unifying these two important theories is to develop a group theory which can accommodate both special relativity and quantum mechanics. As is well known, Eugene P. Wigner is one of the pioneers in developing group theoretical approaches to relativistic quantum mechanics. His 1939 paper on the inhomogeneous Lorentz group laid the foundation for this important research line. It is generally agreed that this paper was somewhat ahead of its time in 1939, and that contemporary physicists must continue to make real efforts to appreciate fully the content of this classic work.

This book on Special Relativity, with unique chapters on the Dirac equation and General Relativity, is especially suitable for a one-semester undergraduate physics course on Special Relativity (with perhaps some coverage of the qualitative features of General Relativity). It can also be used in a combination of undergraduate courses including modern physics, particle physics, optics, and Quantum Mechanics; or in classical mechanics at the physics graduate level. The book also includes coverage of the history of relativity, particularly with respect to developments in electricity and magnetism, particle physics, and cosmology.

A beloved introductory physics textbook, now including exercises and an answer key, explains the concepts essential for thorough scientific understanding In this concise book, R. Shankar, a well-known physicist and contagiously enthusiastic educator, explains the essential concepts of Newtonian mechanics, special relativity, waves, fluids, thermodynamics, and statistical mechanics. Now in an expanded edition—complete with problem sets and answers for course use or self-study—this work provides an ideal introduction for college-level students of physics, chemistry, and engineering; for AP Physics students; and for general readers interested in advances in the sciences. The book begins at the simplest level, develops the basics, and reinforces fundamentals, ensuring a solid foundation in the principles and methods of physics.

This book is an attempt to bring the full range of relativity theory within reach of advanced undergraduates, while containing enough new material and simplifications of old arguments so as not to bore the expert teacher. Roughly equal coverage is given tospecial relativity, general relativity, and cosmology. With many judicious omissions it can be taught in one semester, but it would better serve as the basis of a year's work. It is my hope, anyway, that its level and style of presentation may appeal also to wider c1asses of readers unrestricted by credit considerations. General relativity, the modern theory of gravitation in which free particles move along "straightest possible" lines in curved spacetime, and cosmology, with its dynamics for the whole possibly curved uni verse, not only seem necessary for a scientist's balanced view of the world, but offer some of the greatest intellectual thrills of modern physics. Nevertheless, considered luxuries, they are usu ally squeezed out of the graduate curriculum by the pressure of specialization. Special relativity escapes this tag with a ven geance, and tends to be taught as a pure service discipline, with too little emphasis on its startling ideas. What better time, there fore, to enjoy these subjects for their own sake than as an und- v vi PREFACE graduate? In spite of its forbidding mathematical reputation, even general relativity is accessible at that stage.

The subject of this book is the mechanics of Lorentz transformations which is commonly investigated under the title of special relativity theory. The motive for setting the subject of investigation as Lorentz transformations instead of special relativity is objectivity. However, we also investigate special relativity thoroughly as a possible interpretation of the mechanics of Lorentz transformations. The book originates from a collection of personal notes and tutorials about topics and applications related to modern physics and tensor calculus. The book includes many solved problems as well as extensive sets of exercises whose solutions are available in another book. The book also contains a number of high quality graphic illustrations. A rather thorough index is also added to the book to enable keyword search and provide a useful list for the main technical terms of this subject. Cross referencing is used extensively where these cross references are hyperlinked in the digital versions. The book can be used as a guiding text or as a reference for a first course on the mechanics of Lorentz transformations or as part of a course on modern physics or tensor calculus or even special relativity.

About the Book The book has an interesting topic that would attract curiosity. To read it only high school mathematics is needed. But physics concepts may be challenging. However, that is not a problem for those keen thinkers who pursue scientific truth with passion. Which giant will you stand by: Einstein or Newton? You would make the right decision after reading. There are 8 Sections in the main part of the book: In Section 1. The primary concepts of space and time are described. The most important concepts are “attached space”, “overlapping space” and “identity of universe instant”. GT (Galilean Transformation) is a natural product from the primary concepts of space and time and there is no room left for LT (Lorentz Transformation). In Section 2. Under Einstein’s Postulate of “absolute velocity of light”, LT is formally deduced. In searching the light wavefront sphere the missing light source system is found to be a normal Galilean system that would lead a group of Lorentz systems by determining their space and time through LT. That means LT totally relies on light source system. In Section 3. Using light source system as a stepping stone Lorentz system can be explored. It has been found that Lorentz space dilating outwards from its central plane while the systemic part of Lorentz time contracting toward the initial instant. However, the Transformation Principle of “identical spatial spot at identical instant” forbids these strange things happening, so that no way for LT to gain “real meaning”. In Section 4. The Assertion of “moving rod contracts and moving clock slower” and other paradoxes, as well as the relativistic mechanics, have been discussed and analyzed. It is ascertained that all are the product from a serious conceptual error of “applying LT wrongly on second party body”. In Section 5. It is recognized that, causing the so-called relativity of simultaneity, the local-time part of Lorentz time varies along the î-axis in Lorentz space at a universe instant t but, once preset at initial instant, would never change. That is a shocking finding that the Lorentz local-time actually is a false time of no flux, and hence the whole Lorentz time with a false part becomes untrustworthy. The consequence cannot be more serious. The whole building of SR would collapse immediately as a fundamental stone has to be withdrawn. In Section 6. The famous M-M Experiment has been re-interpreted carefully. After clarifying all historical mistakes involving the false concept of ether, the M-M Experiment is ascertained that, apart from negating the existence of ether, it confirms the concept of light source Galilean system but has no any support for SR. In section 7. The Doppler Effect of sound is introduced first for the sake of contrasting. Then light’s Doppler Effect is profoundly analyzed. Comes out a conclusion that Doppler Effect and SR’s Postulate are bound to be mutually exclusionary. It is another shocking finding that there would be no Doppler Effect for light if SR’ Postulate is true, but if light really has Doppler Effect then SR’s Postulate must be wrong. The existence of Doppler Effect in astronomy is unarguable evidence denying the Postulate and SR. In section 8. With so many fatal problems, SR has to be justified as a pseudoscience. In tracking Einstein’s path to SR, it is discovered that he proposed the Postulate without reasonable logic in first. No wonder SR would end in a verdict of a pseudoscience.

It is shown that Galilean parametrical transformation exists. This transformation preserves the unchanged form of Maxwell's equations in the inertial frames. Parametrical transformation is an alternative to the Lorentz transformation. Both transformations yield the same predictions at small relative velocities of inertial frames. The mathematical formalism of Galilean parametrical transformations simpler and clearer than the formalism of the Lorentz transformation. All phenomenon have a clear physical interpretation. A new interpretation of the Lorentz transformation is proposed. The new interpretation is free from paradoxes.

In this concise primer it is shown that, with simple diagrams, the phenomena of time dilatation, length contraction and Lorentz transformations can be deduced from the fact that in a vacuum one cannot distinguish physically straight and uniform motion from rest, and that the speed of light does not depend on the speed of either the source or the observer. The text proceeds to derive the important results of relativistic physics and to resolve its apparent paradoxes. A short introduction into the covariant formulation of electrodynamics is also given. This publication addresses, in particular, students of physics and mathematics in their final undergraduate year.

Introducing Special Relativity provides an easy and rewarding way into special relativity for first and second year university students studying physics. The author establishes the fundamentals of relativity at the outset of this book so readers fully understand the principles and know how to them before moving on to subjects, like time dilation, that often are a source of difficulty for students. The primary topics addressed include conserved relativistic energy and momentum, applications of the Lorentz transformation, and developments in 20th-century physics. This volume also reviews some of the early experiments in the development of special relativity.

University Physics is designed for the two- or three-semester calculus-based physics course. The text has been developed to meet the scope and sequence of most university physics courses and provides a foundation for a career in mathematics, science, or engineering. The book provides an important opportunity for students to learn the core concepts of physics and understand how those concepts apply to their lives and to the world around them. Due to the comprehensive nature of the material, we are offering the book in three volumes for flexibility and efficiency. Coverage and Scope Our University Physics textbook adheres to the scope and sequence of most two- and three-semester physics courses nationwide. We have worked to make physics interesting and accessible to students while maintaining the mathematical rigor inherent in the subject. With this objective in mind, the content of this textbook has been developed and arranged to provide a logical progression from fundamental to more advanced concepts, building upon what students have already learned and emphasizing connections between topics and between theory and applications. The goal of each section is to enable students not just to recognize concepts, but to work with them in ways that will be useful in later courses and future careers. The organization and pedagogical features were developed and vetted with feedback from science educators dedicated to the project. VOLUME III Unit 1: Optics Chapter 1: The Nature of Light Chapter 2: Geometric Optics and Image Formation Chapter 3: Interference Chapter 4: Diffraction Unit 2: Modern Physics Chapter 5: Relativity Chapter 6: Photons and Matter Waves Chapter 7: Quantum Mechanics Chapter 8: Atomic Structure Chapter 9: Condensed Matter Physics Chapter 10: Nuclear Physics Chapter 11: Particle Physics and Cosmology

The assertion about the possibility of motion faster than light does not contradict the special relativity. In order to develop the special relativity, is sufficient to assume independence of the speed of light on the reference frame. From equations of special relativity, it follows that object moving faster than light in vacuum cannot be carrier of causal relationship. In the reference frame S3, moving with superluminal speed relative to the reference frame S2, temporal and spatial axes are swapped. Therefore, causal relationships in reference frames S2 and S3 are different. There exists a reference frame S1, moving relative to the reference frame S2 with speed v

That Einstein's insight was profound goes without saying. A strildng indication of its depth is the abundance of unexpected riches that others have found in his work - riches reserved for those daring to give serious attention to implications that at first sight seem unphysical. A famous instance is that of the de Broglie waves. If, in ac cordance with Fermat's principle, a photon followed the path of least time, de Broglie felt that the photon should have some phys ical means of exploring alternative paths to determine which of them would in fact require the least time. For this and other rea sons, he assumed that the photon had a nonvanishing rest mass, and, in accordance with Einstein's E = h v, he endowed the photon with a spread-out pulsation of the form A Sin(27TEt/h) in the photon's rest frame. According to the theory of relativity such a pulsation, every where simultaneous in a given frame, seemed absurd as a physical entity. Nevertheless de Broglie took it seriously, applied a Lorentz transformation in the orthodox relativistic tradition, and found that the simultaneous pulsation was transformed into a wave whose phase velocity was finite but greater than c while its group velocity was that of the particle. By thus pursuing Einsteinian concepts into thickets that others had not dared to penetrate, de Broglie laid the brilliant foundations of wave mechanics.

Lorentz Transformation (LT) for High School Students Einstein tried to prove LT back to 1905 and 1920 in vain. On page 1209 of University Physics (the Book 1 on page 12 of this book) the authors adopted the easiest way to prove LT. The way they failed is the same as the way Einstein failed in 1920 which is related to the function theory of mathematics. Why LT is so hard to prove? The answer depends on how much do you care about physics. I know that the author of this book do care about physics. The author of this book explained in detail about what Einstein was missing in each of two proofs and how the easiest way was trapped within function theory of mathematics, all in one of author's earlier books. After that, he thought, if he was able to point out the key errors in some famous proofs of LT, why didn't he try to prove LT by himself? The author has spent most of his leisure time on LT for about nine years and this book is the answer to above question. In this book, the author used some algebra and a few Cartesian coordinates. I know that both of them are all within high school mathematics. The result of the proof is that: When v = 0, where v is the relative speed between S and S', then LT is (t', x', y', z') = (t, x, y, z) for all events. When v > 0, then LT is (t', x', y', z') = (t, - vt, y, z). Yes, mathematically speaking, LT is so simple. I believe that you will find no mistake in any step of the proof. The proof is absolutely worth the price of this book. If you really care about physics, you will love the proof! It is very neat."