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KEY=SPECIAL - KLEIN ALEXIS

HYPERBOLIC TRIANGLE CENTERS

THE SPECIAL RELATIVISTIC APPROACH

Springer Science & Business Media After A. Ungar had introduced vector algebra and Cartesian coordinates into hyperbolic geometry in his earlier books, along with novel applications in Einstein’s special theory of relativity, the purpose of his new book is to introduce hyperbolic barycentric coordinates, another important concept to embed Euclidean geometry into hyperbolic geometry. It will be demonstrated that, in full analogy to classical mechanics where barycentric coordinates are related to the Newtonian mass, barycentric coordinates are related to the Einsteinian relativistic mass in hyperbolic geometry. Contrary to general belief, Einstein’s relativistic mass hence meshes up extraordinarily well with Minkowski’s four-vector formalism of special relativity. In Euclidean geometry, barycentric coordinates can be used to determine various triangle centers. While there are many known Euclidean triangle centers, only few hyperbolic triangle centers are known, and none of the known hyperbolic triangle centers has been determined analytically with respect to its hyperbolic triangle vertices. In his recent research, the author set the ground for investigating hyperbolic triangle centers via hyperbolic barycentric coordinates, and one of the purposes of this book is to initiate a study of hyperbolic triangle centers in full analogy with the rich study of Euclidean triangle centers. Owing to its novelty, the book is aimed at a large audience: it can be enjoyed equally by upper-level undergraduates, graduate students, researchers and academics in geometry, abstract algebra, theoretical physics and astronomy. For a fruitful reading of this book, familiarity with Euclidean geometry is assumed. Mathematical-physicists and theoretical physicists are likely to enjoy the study of Einstein’s special relativity in terms of its underlying hyperbolic geometry. Geometers may enjoy the hunt for new hyperbolic triangle centers and, finally, astronomers may use hyperbolic barycentric coordinates in the velocity space of cosmology.

ANALYTIC HYPERBOLIC GEOMETRY

MATHEMATICAL FOUNDATIONS AND APPLICATIONS

World Scientific This is the first book on analytic hyperbolic geometry, fully analogous to analytic Euclidean geometry. Analytic hyperbolic geometry regulates relativistic mechanics just as analytic Euclidean geometry regulates classical mechanics. The book presents a novel gyrovector space approach to analytic hyperbolic geometry, fully analogous to the well-known vector space approach to Euclidean geometry. A gyrovector is a hyperbolic vector. In the resulting "gyrolanguage" of the book, one attaches the prefix "gyro" to a classical term to mean the analogous term in hyperbolic geometry. The book begins with the definition of gyrogroups, which is fully analogous to the definition of groups. Gyrogroups, both gyrocommutative and nongyrocommutative, abound in group theory. Surprisingly, the seemingly structureless Einstein velocity addition of special relativity turns out to be a gyrocommutative gyrogroup operation. Introducing scalar multiplication, some gyrocommutative gyrogroups of gyrovectors become gyrovector spaces. The latter, in turn, form the setting for analytic hyperbolic geometry just as vector spaces form the setting for analytic Euclidean geometry. By hybrid techniques of differential geometry and gyrovector spaces, it is shown that Einstein (Mobius) gyrovector spaces form the setting for Beltrami-Klein (Poincare) ball models of hyperbolic geometry. Finally, novel applications of Mobius gyrovector spaces in quantum computation, and of Einstein gyrovector spaces in special relativity, are presented.

BARYCENTRIC CALCULUS IN EUCLIDEAN AND HYPERBOLIC GEOMETRY

A COMPARATIVE INTRODUCTION

World Scientific The word barycentric is derived from the Greek word barys (heavy), and refers to center of gravity. Barycentric calculus is a method of treating geometry by considering a point as the center of gravity of certain other points to which weights are ascribed. Hence, in particular, barycentric calculus provides excellent insight into triangle centers. This unique book on barycentric calculus in Euclidean and hyperbolic geometry provides an introduction to the fascinating and beautiful subject of novel triangle centers in hyperbolic geometry along with analogies they share with familiar triangle centers in Euclidean geometry. As such, the book uncovers magnificent unifying notions that Euclidean and hyperbolic triangle centers share. In his earlier books the author adopted Cartesian coordinates, trigonometry and vector algebra for use in hyperbolic geometry that is fully analogous to the common use of Cartesian coordinates, trigonometry and vector algebra in Euclidean geometry. As a result, powerful tools that are commonly available in Euclidean geometry became available in hyperbolic geometry as well, enabling one to explore hyperbolic geometry in novel ways. In particular, this new book establishes hyperbolic barycentric coordinates that are used to determine various hyperbolic triangle centers just as Euclidean barycentric coordinates are commonly used to determine various Euclidean triangle centers. The hunt for Euclidean triangle centers is an old tradition in Euclidean geometry, resulting in a repertoire of more than three thousand triangle centers that are known by their barycentric coordinate representations. The aim of this book is to initiate a fully analogous hunt for hyperbolic triangle centers that will broaden the repertoire of hyperbolic triangle centers provided here.

ESSAYS IN MATHEMATICS AND ITS APPLICATIONS

IN HONOR OF VLADIMIR ARNOLD

Springer This volume, dedicated to the eminent mathematician Vladimir Arnold, presents a collection of research and survey papers written on a large spectrum of theories and problems that have been studied or introduced by Arnold himself. Emphasis is given to topics relating to dynamical systems, stability of integrable systems, algebraic and differential topology, global analysis, singularity theory and classical mechanics. A number of applications of Arnold’s groundbreaking work are presented. This publication will assist graduate students and research mathematicians in acquiring an in-depth understanding and insight into a wide domain of research of an interdisciplinary nature.

ESSAYS IN MATHEMATICS AND ITS APPLICATIONS

IN HONOR OF STEPHEN SMALE´S 80TH BIRTHDAY

Springer Science & Business Media The volume is dedicated to Stephen Smale on the occasion of his 80th birthday.Besides his startling 1960 result of the proof of the Poincar´e conjecture for all dimensionsgreater than or equal to five, Smale’s ground breaking contributions invarious fields in Mathematics have marked the second part of the 20th century andbeyond. Stephen Smale has done pioneering work in differential topology, globalanalysis, dynamical systems, nonlinear functional analysis, numerical analysis, theoryof computation and machine learning as well as applications in the physical andbiological sciences and economics. In sum, Stephen Smale has manifestly brokenthe barriers among the different fields of mathematics and dispelled some remainingprejudices. He is indeed a universal mathematician. Smale has been honoredwith several prizes and honorary degrees including, among others, the Fields Medal(1966), The Veblen Prize (1966), the National Medal of Science (1996) and theWolfPrize (2006/2007).

PROBLEMS AND RECENT METHODS IN OPERATOR THEORY

American Mathematical Soc. This volume contains the proceedings of the Workshop on Problems and Recent Methods in Operator Theory, held at the University of Memphis, Memphis, TN, from October 15–16, 2015 and the AMS Special Session on Advances in Operator Theory and Applications, in Memory of James Jamison, held at the University of Memphis, Memphis, TN, from October 17–18, 2015. Operator theory is at the root of several branches of mathematics and offers a broad range of challenging and interesting research problems. It also provides powerful tools for the development of other areas of science including quantum theory, physics and mechanics. Isometries have applications in solid-state physics. Hermitian operators play an integral role in quantum mechanics very much due to their “nice” spectral properties. These powerful connections demonstrate the impact of operator theory in various branches of science. The articles in this volume address recent problems and research advances in operator theory. Highlighted topics include spectral, structural and geometric properties of special types of operators on Banach spaces, with emphasis on isometries, weighted composition operators, multi-circular projections on function spaces, as well as vector valued function spaces and spaces of analytic functions. This volume gives a succinct overview of state-of-the-art techniques from operator theory as well as applications to classical problems and long-standing open questions.

ANALYTIC HYPERBOLIC GEOMETRY AND ALBERT EINSTEIN'S SPECIAL THEORY OF RELATIVITY (SECOND EDITION)

World Scientific This book presents a powerful way to study Einstein's special theory of relativity and its underlying hyperbolic geometry in which analogies with classical results form the right tool. The premise of analogy as a study strategy is to make the unfamiliar familiar. Accordingly, this book introduces the notion of vectors into analytic hyperbolic geometry, where they are called gyrovectors. Gyrovectors turn out to be equivalence classes that add according to the gyroparallelogram law just as vectors are equivalence classes that add according to the parallelogram law. In the gyrolanguage of this book, accordingly, one prefixes a gyro to a classical term to mean the analogous term in hyperbolic geometry. As an example, the relativistic gyrotrigonometry of Einstein's special relativity is developed and employed to the study of the stellar aberration phenomenon in astronomy.Furthermore, the book presents, for the first time, the relativistic center of mass of an isolated system of noninteracting particles that coincided at some initial time t = 0. It turns out that the invariant mass of the relativistic center of mass of an expanding system (like galaxies) exceeds the sum of the masses of its constituent particles. This excess of mass suggests a viable mechanism for the formation of dark matter in the universe, which has not been detected but is needed to gravitationally 'glue' each galaxy in the universe. The discovery of the relativistic center of mass in this book thus demonstrates once again the usefulness of the study of Einstein's special theory of relativity in terms of its underlying hyperbolic geometry.

NONLINEAR ANALYSIS

STABILITY, APPROXIMATION, AND INEQUALITIES

Springer Science & Business Media The volume will consist of about 40 articles written by some very influential mathematicians of our time and will expose the latest achievements in the broad area of nonlinear analysis and its various interdisciplinary applications.

MATHEMATICAL COMBINATORICS, VOL. 3/2012

INTERNATIONAL BOOK SERIES

Infinite Study Papers on Bitopological Supra B-Open Sets, Finsler Space with Randers Conformal Change –Main Scalar, Geodesic and Scalar Curvature, Around The Berge Problem And Hadwiger Conjecture, Odd Harmonious Labeling of Some Graphs, and other topics. Contributors: Agboola A.A.A., Akwu A.O., Oyebo Y.T., M.Lellis Thivagar, B.Meera Devi, H.S.Shukla, Arunima Mishra, Keerti Vardhan Madahar, Ikorong Anouk Gilbert Nemron, G.Mahadevan, Selvam Avadayappan, J.Paulraj Joseph Et Al, and others.

COLLECTED PAPERS

PAPERS OF MATHEMATICS OR APPLIED MATHEMATICS

Infinite Study This volum includes 37 papers of mathematics or applied mathematics written by the author alone or in collaboration.They were written during the years 2010-2014, about the hyperbolic Menelaus theorem in the Poincare disc of hyperbolic geometry, and the Menelaus theorem for quadrilaterals inhyperbolic geometry, about some properties of the harmonic quadrilateral related to triangle simedians and to Apollonius circles, etc.

A GYROVECTOR SPACE APPROACH TO HYPERBOLIC GEOMETRY

Morgan & Claypool Publishers The mere mention of hyperbolic geometry is enough to strike fear in the heart of the undergraduate mathematics and physics student. Some regard themselves as excluded from the profound insights of hyperbolic geometry so that this enormous portion of human achievement is a closed door to them. The mission of this book is to open that door by making the hyperbolic geometry of Bolyai and Lobachevsky, as well as the special relativity theory of Einstein that it regulates, accessible to a wider audience in terms of novel analogies that the modern and unknown share with the classical and familiar. These novel analogies that this book captures stem from Thomas gyration, which is the mathematical abstraction of the relativistic effect known as Thomas precession. Remarkably, the mere introduction of Thomas gyration turns Euclidean geometry into hyperbolic geometry, and reveals mystique analogies that the two geometries share. Accordingly, Thomas gyration gives rise to the prefix "gyro" that is extensively used in the gyrolanguage of this book, giving rise to terms like gyrocommutative and gyroassociative binary operations in gyrogroups, and gyrovectors in gyrovector spaces. Of particular importance is the introduction of gyrovectors into hyperbolic geometry, where they are equivalence classes that add according to the gyroparallelogram law in full analogy with vectors, which are equivalence classes that add according to the parallelogram law. A gyroparallelogram, in turn, is a gyroquadrilateral the two gyrodiagonals of which intersect at their gyromidpoints in full analogy with a parallelogram, which is a quadrilateral the two diagonals of which intersect at their midpoints. Table of Contents: Gyrogroups / Gyrocommutative Gyrogroups / Gyrovector Spaces / Gyrotrigonometry

MATHEMATICS WITHOUT BOUNDARIES

SURVEYS IN PURE MATHEMATICS

Springer The contributions in this volume have been written by eminent scientists from the international mathematical community and present significant advances in several theories, methods and problems of Mathematical Analysis, Discrete Mathematics, Geometry and their Applications. The chapters focus on both old and recent developments in Functional Analysis, Harmonic Analysis, Complex Analysis, Operator Theory, Combinatorics, Functional Equations, Differential Equations as well as a variety of Applications. The book also contains some review works, which could prove particularly useful for a broader audience of readers in Mathematical Sciences, and especially to graduate students looking for the latest information.

ANALYTIC HYPERBOLIC GEOMETRY IN N DIMENSIONS

AN INTRODUCTION

CRC Press The concept of the Euclidean simplex is important in the study of n-dimensional Euclidean geometry. This book introduces for the first time the concept of hyperbolic simplex as an important concept in n-dimensional hyperbolic geometry. Following the emergence of his gyroalgebra in 1988, the author crafted gyrolanguage, the algebraic language that sheds natural light on hyperbolic geometry and special relativity. Several authors have successfully employed the author’s gyroalgebra in their exploration for novel results. Françoise Chatelin noted in her book, and elsewhere, that the computation language of Einstein described in this book plays a universal computational role, which extends far beyond the domain of special relativity. This book will encourage researchers to use the author’s novel techniques to formulate their own results. The book provides new mathematical tools, such as hyperbolic simplexes, for the study of hyperbolic geometry in n dimensions. It also presents a new look at Einstein’s special relativity theory.

BEYOND PSEUDO-ROTATIONS IN PSEUDO-EUCLIDEAN SPACES

Academic Press Beyond Pseudo-Rotations in Pseudo-Euclidean Spaces presents for the first time a unified study of the Lorentz transformation group SO(m, n) of signature (m, n), m, n ∈ N, which is fully analogous to the Lorentz group SO(1, 3) of Einstein’s special theory of relativity. It is based on a novel parametric realization of pseudo-rotations by a vector-like parameter with two orientation parameters. The book is of interest to specialized researchers in the areas of algebra, geometry and mathematical physics, containing new results that suggest further exploration in these areas. Introduces the study of generalized gyrogroups and gyrovector spaces Develops new algebraic structures, bi-gyrogroups and bi-gyrovector spaces Helps readers to surmount boundaries between algebra, geometry and physics Assists readers to parametrize and describe the full set of generalized Lorentz transformations in a geometric way Generalizes approaches from gyrogroups and gyrovector spaces to bi-gyrogroups and bi-gyrovector spaces with geometric entanglement

SPECIAL RELATIVITY AND HOW IT WORKS

John Wiley & Sons Based on his successful work "Special Relativity and Motions Faster than Light", Moses Fayngold has written a thorough presentation of the special theory of relativity. The unique feature of the textbook is its two-leveled structure helping students to master the material more effectively: the first level presents a qualitative discussion of a problem, while the second one contains its rigorous treatment. Fayngold points out the connection between fundamental principles and known phenomena. In three new chapters on 'Relativity at Work' (Electromagnetism, Optics, Quantum Mechanics), he not only shows what relativity is, but also how it works. The scope of new material extends to include a chapter on Causality and on Applied Relativity, including astrophysical and accelerator topics. Backed throughout by numerous examples and exercises.

NON-EUCLIDEAN GEOMETRIES

JÁNOS BOLYAI MEMORIAL VOLUME

Springer Science & Business Media "From nothing I have created a new different world," wrote János Bolyai to his father, Wolgang Bolyai, on November 3, 1823, to let him know his discovery of non-Euclidean geometry, as we call it today. The results of Bolyai and the co-discoverer, the Russian Lobachevskii, changed the course of mathematics, opened the way for modern physical theories of the twentieth century, and had an impact on the history of human culture. The papers in this volume, which commemorates the 200th anniversary of the birth of János Bolyai, were written by leading scientists of non-Euclidean geometry, its history, and its applications. Some of the papers present new discoveries about the life and works of János Bolyai and the history of non-Euclidean geometry, others deal with geometrical axiomatics; polyhedra; fractals; hyperbolic, Riemannian and discrete geometry; tilings; visualization; and applications in physics.

THE GEOMETRY OF SPECIAL RELATIVITY

CRC Press The Geometry of Special Relativity provides an introduction to special relativity that encourages readers to see beyond the formulas to the deeper geometric structure. The text treats the geometry of hyperbolas as the key to understanding special relativity. This approach replaces the ubiquitous γ symbol of most standard treatments with the appropriate hyperbolic trigonometric functions. In most cases, this not only simplifies the appearance of the formulas, but also emphasizes their geometric content in such a way as to make them almost obvious. Furthermore, many important relations, including the famous relativistic addition formula for velocities, follow directly from the appropriate trigonometric addition formulas. The book first describes the basic physics of special relativity to set the stage for the geometric treatment that follows. It then reviews properties of ordinary two-dimensional Euclidean space, expressed in terms of the usual circular trigonometric functions, before presenting a similar treatment of two-dimensional Minkowski space, expressed in terms of hyperbolic trigonometric functions. After covering special relativity again from the geometric point of view, the text discusses standard paradoxes, applications to relativistic mechanics, the relativistic unification of electricity and magnetism, and further steps leading to Einstein’s general theory of relativity. The book also briefly describes the further steps leading to Einstein’s general theory of relativity and then explores applications of hyperbola geometry to non-Euclidean geometry and calculus, including a geometric construction of the derivatives of trigonometric functions and the exponential function.

A NEW PERSPECTIVE ON RELATIVITY

AN ODYSSEY IN NON-EUCLIDEAN GEOMETRIES

World Scientific Starting off from noneuclidean geometries, apart from the method of Einstein''s equations, this book derives and describes the phenomena of gravitation and diffraction. A historical account is presented, exposing the missing link in Einstein''s construction of the theory of general relativity: the uniformly rotating disc, together with his failure to realize, that the Beltrami metric of hyperbolic geometry with constant curvature describes exactly the uniform acceleration observed. This book also explores these questions: How does time bend? Why should gravity propagate at the

speed of light? How does the expansion function of the universe relate to the absolute constant of the noneuclidean geometries? Why was the Sagnac effect ignored? Can Maxwell''s equations accommodate mass? Is there an inertia due solely to polarization? Can objects expand in elliptic geometry like they contract in hyperbolic geometry?

ENCYCLOPAEDIA OF MATHEMATICS

VOLUME 6: SUBJECT INDEX — AUTHOR INDEX

Springer Science & Business Media This ENCYCLOPAEDIA OF MATHEMATICS aims to be a reference work for all parts of mathe matics. It is a translation with updates and editorial comments of the Soviet Mathematical Encyclopaedia published by 'Soviet Encyclopaedia Publishing House' in five volumes in 1977-1985. The annotated translation consists of ten volumes including a special index volume. There are three kinds of articles in this ENCYCLOPAEDIA. First of all there are survey-type articles dealing with the various main directions in mathematics (where a rather fine subdivi sion has been used). The main requirement for these articles has been that they should give a reasonably complete up-to-date account of the current state of affairs in these areas and that they should be maximally accessible. On the whole, these articles should be understandable to mathematics students in their first specialization years, to graduates from other mathematical areas and, depending on the specific subject, to specialists in other domains of science, en gineers and teachers of mathematics. These articles treat their material at a fairly general level and aim to give an idea of the kind of problems, techniques and concepts involved in the area in question. They also contain background and motivation rather than precise statements of precise theorems with detailed definitions and technical details on how to carry out proofs and constructions. The second kind of article, of medium length, contains more detailed concrete problems, results and techniques.

DETERMINISTIC CHAOS IN GENERAL RELATIVITY

Springer Science & Business Media Nonlinear dynamical systems play an important role in a number of disciplines. The physical, biological, economic and even sociological worlds are comprised of com plex nonlinear systems that cannot be broken down into the behavior of their con stituents and then reassembled to form the whole. The lack of a superposition principle in such systems has challenged researchers to use a variety of analytic and numerical methods in attempts to understand the interesting nonlinear interactions that occur in the World around us. General relativity is a nonlinear dynamical theory par excellence. Only recently has the nonlinear evolution of the gravitational field described by the theory been tackled through the use of methods used in other disciplines to study the importance of time dependent nonlinearities. The complexity of the equations of general relativity has been (and still remains) a major hurdle in the formulation of concrete mathematical concepts. In the past the imposition of a high degree of symmetry has allowed the construction of exact solutions to the Einstein equations. However, most of those solutions are nonphysical and of those that do have a physical significance, many are often highly idealized or time independent.

GENERAL PHYSICS, RELATIVITY, ASTRONOMY AND MATHEMATICAL PHYSICS AND METHODS

SPECIAL RELATIVITY

AN INTRODUCTION WITH 200 PROBLEMS AND SOLUTIONS

Springer Science & Business Media 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.

A SIMPLE NON-EUCLIDEAN GEOMETRY AND ITS PHYSICAL BASIS

AN ELEMENTARY ACCOUNT OF GALILEAN GEOMETRY AND THE GALILEAN PRINCIPLE OF RELATIVITY

Springer There are many technical and popular accounts, both in Russian and in other languages, of the non-Euclidean geometry of Lobachevsky and Bolyai, a few of which are listed in the Bibliography. This geometry, also called hyperbolic geometry, is part of the required subject matter of many mathematics departments in universities and teachers' colleges-a reflec tion of the view that familiarity with the elements of hyperbolic geometry is a useful part of the background of future high school teachers. Much attention is paid to hyperbolic geometry by school mathematics clubs. Some mathematicians and educators concerned with reform of the high school curriculum believe that the required part of the curriculum should include elements of hyperbolic geometry, and that the optional part of the curriculum should include a topic related to hyperbolic geometry. I The broad interest in hyperbolic geometry is not surprising. This interest has little to do with mathematical and scientific applications of hyperbolic geometry, since the applications (for instance, in the theory of automorphic functions) are rather specialized, and are likely to be encountered by very few of the many students who conscientiously study (and then present to examiners) the definition of parallels in hyperbolic geometry and the special features of configurations of lines in the hyperbolic plane. The principal reason for the interest in hyperbolic geometry is the important fact of "non-uniqueness" of geometry; of the existence of many geometric systems.

ANALYTIC HYPERBOLIC GEOMETRY AND ALBERT EINSTEIN'S SPECIAL THEORY OF RELATIVITY

A NEW PERSPECTIVE ON RELATIVITY

AN ODYSSEY IN NON-EUCLIDEAN GEOMETRIES

World Scientific Starting off from noneuclidean geometries, apart from the method of Einstein's equations, this book derives and describes the phenomena of gravitation and diffraction. A historical account is presented, exposing the missing link in Einstein's construction of the theory of general relativity: the uniformly rotating disc, together with his failure to realize, that the Beltrami metric of hyperbolic geometry with constant curvature describes exactly the uniform acceleration observed. This book also explores these questions: * How does time bend? * Why should gravity propagate at the speed of light? * How does the expansion function of the universe relate to the absolute constant of the noneuclidean geometries? * Why was the Sagnac effect ignored? * Can Maxwell's equations accommodate mass? * Is there an inertia due solely to polarization? * Can objects expand in elliptic geometry like they contract in hyperbolic geometry?

ORBITAL MECHANICS FOR ENGINEERING STUDENTS

Elsevier Orbital Mechanics for Engineering Students, Second Edition, provides an introduction to the basic concepts of space mechanics. These include vector kinematics in three dimensions; Newton’s laws of motion and gravitation; relative motion; the vector-based solution of the classical two-body problem; derivation of Kepler’s equations; orbits in three dimensions; preliminary orbit determination; and orbital maneuvers. The book also covers relative motion and the two-impulse rendezvous problem; interplanetary mission design using patched conics; rigid-body dynamics used to characterize the attitude of a space vehicle; satellite attitude dynamics; and the characteristics and design of multi-stage launch vehicles. Each chapter begins with an outline of key concepts and concludes with problems that are based on the material covered. This text is written for undergraduates who are studying orbital mechanics for the first time and have completed courses in physics, dynamics, and mathematics, including differential equations and applied linear algebra. Graduate students, researchers, and experienced practitioners will also find useful review materials in the book. NEW: Reorganized and improved discusions of coordinate systems, new discussion on perturbations and quarternions NEW: Increased coverage of attitude dynamics, including new Matlab algorithms and examples in chapter 10 New examples and homework problems

SCIENTIFIC AND TECHNICAL AEROSPACE REPORTS

Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database.

BACK-IN-TIME AND FASTER-THAN-LIGHT TRAVEL IN GENERAL RELATIVITY

Springer For the past 20 years causality violations and superluminal motion have been the object of intensive study as physical and geometrical phenomena. This book compiles the results of its author and also reviews other work in the field. In particular, the following popular questions are addressed: Is causality protected by quantum divergence at the relevant Cauchy horizon? How much "exotic matter" would it take to create a time machine or a warp drive? What is the difference between a "discovered" time machine and a created one? Why does a time traveler fail to kill their grandfather? How should we define the speed of gravity and what is its magnitude?

BEYOND THE EINSTEIN ADDITION LAW AND ITS GYROSCOPIC THOMAS PRECESSION

THE THEORY OF GYROGROUPS AND GYROVECTOR SPACES

Springer Science & Business Media "I cannot define coincidence [in mathematics]. But 1 shall argue that coincidence can always be elevated or organized into a superstructure which perfonns a unification along the coincidental elements. The existence of a coincidence is strong evidence for the existence of a covering theory. " -Philip 1. Davis [Dav81] Alluding to the Thomas gyration, this book presents the Theory of gy rogroups and gyrovector spaces, taking the reader to the immensity of hyper bolic geometry that lies beyond the Einstein special theory of relativity. Soon after its introduction by Einstein in 1905 [Ein05], special relativity theory (as named by Einstein ten years later) became overshadowed by the ap pearance of general relativity. Subsequently, the exposition of special relativity followed the lines laid down by Minkowski, in which the role of hyperbolic ge ometry is not emphasized. This can doubtlessly be explained by the strangeness and unfamiliarity of hyperbolic geometry [Bar98]. The aim of this book is to reverse the trend of neglecting the role of hy perbolic geometry in the special theory of relativity, initiated by Minkowski, by emphasizing the central role that hyperbolic geometry plays in the theory.

INTRODUCTION TO HYPERBOLIC GEOMETRY

Springer Science & Business Media This book is an introduction to hyperbolic and differential geometry that provides material in the early chapters that can serve as a textbook for a standard upper division course on hyperbolic geometry. For that material, the students need to be familiar with calculus and linear algebra and willing to accept one advanced theorem from analysis without proof. The book goes well beyond the standard course in later chapters, and there is enough material for an honors course, or for supplementary reading. Indeed, parts of the book have been used for both kinds of courses. Even some of what is in the early chapters would surely not be nec essary for a standard course. For example, detailed proofs are given of the Jordan Curve Theorem for Polygons and of the decomposability of poly gons into triangles, These proofs are included for the sake of completeness, but the results themselves are so believable that most students should skip the proofs on a first reading. The axioms used are modern in character and more "user friendly" than the traditional ones. The familiar real number system is used as an in gredient rather than appearing as a result of the axioms. However, it should not be thought that the geometric treatment is in terms of models: this is an axiomatic approach that is just more convenient than the traditional ones.

RELATIVISTIC HYDRODYNAMICS

Oxford University Press This book provides a lively and approachable introduction to the main concepts and techniques of relativistic hydrodynamics in a form that will appeal to physicists at advanced undergraduate and post-graduate levels. The book is divided in three parts. The first part deals with the physical aspects of relativistic hydrodynamics, touching fundamental topics such as kinetic theory, equations of state, linear and nonlinear waves in fluids, and the treatment ofnon-ideal fluids. The second part provides an introductory but complete description of those numerical methods currently adopted in the solution of the relativistic hydrodynamic equations. Finally, the thirdpart is devoted to applications and considers several physical and astrophysical systems for which relativistic hydrodynamics plays a crucial role. The book is especially recommended to astrophysicists, particle physicists, and applied mathematicians.

HYPERBOLIC GEOMETRY

Springer Science & Business Media Thoroughly updated, featuring new material on important topics such as hyperbolic geometry in higher dimensions and generalizations of hyperbolicity Includes full solutions for all exercises Successful first edition sold over 800 copies in North America

U.S. GOVERNMENT RESEARCH REPORTS

FLAVORS OF GEOMETRY

Cambridge University Press Lectures on hyperbolic geometry, dynamics in several complex variables, convex geometry, and volume estimation.

ENERGY RESEARCH ABSTRACTS

BEYOND THE EINSTEIN ADDITION LAW AND ITS GYROSCOPIC THOMAS PRECESSION

THE THEORY OF GYROGROUPS AND GYROVECTOR SPACES

Springer Evidence that Einstein's addition is regulated by the Thomas precession has come to light, turning the notorious Thomas precession, previously considered the ugly duckling of special relativity theory, into the beautiful swan of gyrogroup and gyrovector space theory, where it has been extended by abstraction into an automorphism generator, called the Thomas gyration. The Thomas gyration, in turn, allows the introduction of vectors into hyperbolic geometry, where they are called gyrovectors, in such a way that Einstein's velocity additions turns out to be a gyrovector addition. Einstein's addition thus becomes a gyrocommutative, gyroassociative gyrogroup operation in the same way that ordinary vector addition is a commutative, associative group operation. Some gyrogroups of gyrovectors admit scalar multiplication, giving rise to gyrovector spaces in the same way that some groups of vectors that admit scalar multiplication give rise to vector spaces. Furthermore, gyrovector spaces form the setting for hyperbolic geometry in the same way that vector spaces form the setting for Euclidean geometry. In particular, the gyrovector space with gyrovector addition given by Einstein's (Möbius') addition forms the setting for the Beltrami (Poincaré) ball model of hyperbolic geometry. The gyrogroup-theoretic techniques developed in this book for use in relativity physics and in hyperbolic geometry allow one to solve old and new important problems in relativity physics. A case in point is Einstein's 1905 view of the Lorentz length contraction, which was contradicted in 1959 by Penrose, Terrell and others. The application of gyrogroup-theoretic techniques clearly tilt the balance in favor of Einstein.

ANALYTIC HYPERBOLIC GEOMETRY IN N DIMENSIONS

AN INTRODUCTION

CRC Press The concept of the Euclidean simplex is important in the study of n-dimensional Euclidean geometry. This book introduces for the first time the concept of hyperbolic simplex as an important concept in n-dimensional hyperbolic geometry. Following the emergence of his gyroalgebra in 1988, the author crafted gyrolanguage, the algebraic language that sheds natural light on hyperbolic geometry and special relativity. Several authors have successfully employed the author’s gyroalgebra in their exploration for novel results. Françoise Chatelin noted in her book, and elsewhere, that the computation language of Einstein described in this book plays a universal computational role, which extends far beyond the domain of special relativity. This book will encourage researchers to use the author’s novel techniques to formulate their own results. The book provides new mathematical tools, such as hyperbolic simplexes, for the study of hyperbolic geometry in n dimensions. It also presents a new look at Einstein’s special relativity theory.

RELATIVISTIC GRAVITY RESEARCH

WITH EMPHASIS ON EXPERIMENTS AND OBSERVATIONS

Springer 17 readable articles give a thorough and self-contained overview of recent developments in relativistic gravity research. The subjects covered are: gravitational lensing, the general relativistic n-body problem, observable effects in the solar system, gravitational waves and their interferometric detection, very-long-baseline interferometry, international atomic time, lunar laser- ranging measurements, measurement ofthe gravitomagnetic field of the Earth, fermion and boson stars and black holes with hair, rapidly rotating neutron stars, matter wave interferometry, and the laboratory test of Newton's law of gravity.Any scientist interested in experimentally or observatio- nally oriented relativistic gravity will read the book with profit. In addition, it is perfectly suited as a complementary text for courses on general relativity and relativistic astrophysics.

COSMOLOGY FOR THE CURIOUS

Springer This book is a gentle introduction for all those wishing to learn about modern views of the cosmos. Our universe originated in a great explosion – the big bang. For nearly a century cosmologists have studied the aftermath of this explosion: how the universe expanded and cooled down, and how galaxies were gradually assembled by gravity. The nature of the bang itself has come into focus only relatively recently. It is the subject of the theory of cosmic inflation, which was developed in the last few decades and has led to a radically new global view of the universe. Students and other interested readers will find here a non-technical but conceptually rigorous account of modern cosmological ideas - describing what we know, and how we know it. One of the book's central themes is the scientific quest to find answers to the ultimate cosmic questions: Is the universe finite or infinite? Has it existed forever? If not, when and how did it come into being? Will it ever end? The book is based on the undergraduate course taught by Alex Vilenkin at Tufts University. It assumes no prior knowledge of physics or mathematics beyond elementary high school math. The necessary physics background is introduced as it is required. Each chapter includes a list of questions and exercises of varying degree of difficulty.

GEOMETRY WITH AN INTRODUCTION TO COSMIC TOPOLOGY

Jones & Bartlett Learning The content of Geometry with an Introduction to Cosmic Topology is motivated by questions that have ignited the imagination of stargazers since antiquity. What is the shape of the universe? Does the universe have and edge? Is it infinitely big? Dr. Hitchman aims to clarify this fascinating area of mathematics. This non-Euclidean geometry text is organized intothree natural parts. Chapter 1 provides an overview including a brief history of Geometry, Surfaces, and reasons to study Non-Euclidean Geometry. Chapters 2-7 contain the core mathematical content of the text, following the ErlangenProgram, which develops geometry in terms of a space and a group of transformations on that space. Finally chapters 1 and 8 introduce (chapter 1) and explore (chapter 8) the topic of cosmic topology through the geometry learned in the preceding chapters.