Minimal Submanifolds in Pseudo-Riemannian Geometry

HENRI ANCIAUX



Minimal Submanifolds In Pseudo Riemannian Geometry

Robert Everist Greene, Shing-Tung Yau

Minimal Submanifolds In Pseudo Riemannian Geometry:

Minimal Submanifolds In Pseudo-riemannian Geometry Henri Anciaux, 2010-11-02 Since the foundational work of Lagrange on the differential equation to be satisfied by a minimal surface of the Euclidean space the theory of minimal submanifolds have undergone considerable developments involving techniques from related areas such as the analysis of partial differential equations and complex analysis On the other hand the relativity theory has led to the study of pseudo Riemannian manifolds which turns out to be the most general framework for the study of minimal submanifolds However most of the recent books on the subject still present the theory only in the Riemannian case For the first time this book provides a self contained and accessible introduction to the subject in the general setting of pseudo Riemannian geometry only assuming from the reader some basic knowledge about manifold theory Several classical results such as the Weierstrass representation formula for minimal surfaces and the minimizing properties of complex submanifolds are presented in full generality without sacrificing the clarity of exposition Finally a number of very recent results on the subject including the classification of equivariant minimal hypersurfaces in pseudo Riemannian space forms and the characterization of minimal Lagrangian surfaces in some pseudo K hler manifolds are given Minimal Submanifolds in Pseudo-Riemannian Geometry Henri Anciaux, 2011 Since the foundational work of Lagrange on the differential equation to be satisfied by a minimal surface of the Euclidean space the theory of minimal submanifolds have undergone considerable developments involving techniques from related areas such as the analysis of partial differential equations and complex analysis On the other hand the relativity theory has led to the study of pseudo Riemannian manifolds which turns out to be the most general framework for the study of minimal submanifolds However most of the recent books on the subject still present the theory only in the Riemannian case For the first time this textbook provides a self contained and accessible introduction to the subject in the general setting of pseudo Riemannian geometry only assuming from the reader some basic knowledge about manifold theory Several classical results such as the Weierstrass representation formula for minimal surfaces and the minimizing properties of complex submanifolds are presented in full generality without sacrificing the clarity of exposition Finally a number of very recent results on the subject including the classification of equivariant minimal hypersurfaces in pseudo Riemannian space forms and the characterization of minimal Lagrangian surfaces in some pseudo Khler manifolds are given

Pseudo-riemannian Geometry, Delta-invariants And Applications Bang-yen Chen,2011-03-23 The first part of this book provides a self contained and accessible introduction to the subject in the general setting of pseudo Riemannian manifolds and their non degenerate submanifolds only assuming from the reader some basic knowledge about manifold theory A number of recent results on pseudo Riemannian submanifolds are also included The second part of this book is on invariants which was introduced in the early 1990s by the author The famous Nash embedding theorem published in 1956 was aimed for in the hope that if Riemannian manifolds could be regarded as Riemannian submanifolds this would then yield

the opportunity to use extrinsic help However this hope had not been materialized as pointed out by M Gromov in his 1985 article published in Asterisque The main reason for this is the lack of control of the extrinsic invariants of the submanifolds by known intrinsic invariants In order to overcome such difficulties as well as to provide answers for an open question on minimal immersions the author introduced in the early 1990s new types of Riemannian invariants known as invariants which are very different in nature from the classical Ricci and scalar curvatures At the same time he was able to establish general optimal relations between invariants and the main extrinsic invariants Since then many new results concerning these invariants have been obtained by many geometers. The second part of this book is to provide an extensive and comprehensive survey over this very active field of research done during the last two decades Pseudo-Riemannian Geometry, [delta]-invariants and Applications Bang-yen Chen, 2011 The first part of this book provides a self contained and accessible introduction to the subject in the general setting of pseudo Riemannian manifolds and their non degenerate submanifolds only assuming from the reader some basic knowledge about manifold theory A number of recent results on pseudo Riemannian submanifolds are also included The second part of this book is on invariants which was introduced in the early 1990s by the author The famous Nash embedding theorem published in 1956 was aimed for in the hope that if Riemannian manifolds could be regarded as Riemannian submanifolds this would then yield the opportunity to use extrinsic help However this hope had not been materialized as pointed out by M Gromov in his 1985 article published in Asterisque The main reason for this is the lack of control of the extrinsic invariants of the submanifolds by known intrinsic invariants In order to overcome such difficulties as well as to provide answers for an open question on minimal immersions the author introduced in the early 1990s new types of Riemannian invariants known as invariants which are very different in nature from the classical Ricci and scalar curvatures At the same time he was able to establish general optimal relations between invariants and the main extrinsic invariants Since then many new results concerning these invariants have been obtained by many geometers The second part of this book is to provide an extensive and comprehensive survey over this very active field of research done during the last two decades Handbook of Pseudo-Riemannian Geometry and Supersymmetry Vicente Cortés, 2010 The purpose of this handbook is to give an overview of some recent developments in differential geometry related to supersymmetric field theories The main themes covered are Special geometry and supersymmetry Generalized geometry Geometries with torsion Para geometries Holonomy theory Symmetric spaces and spaces of constant curvature Conformal geometry Wave equations on Lorentzian manifolds D branes and K theory The intended audience consists of advanced students and researchers working in differential geometry string theory and related areas The emphasis is on geometrical structures occurring on target spaces of supersymmetric field theories Some of these structures can be fully described in the classical framework of pseudo Riemannian geometry Others lead to new concepts relating various fields of research such as special Kahler geometry or generalized geometry **Extrinsic Geometry of Foliations** Vladimir

Rovenski, Paweł Walczak, 2021-05-22 This book is devoted to geometric problems of foliation theory in particular those related to extrinsic geometry modern branch of Riemannian Geometry The concept of mixed curvature is central to the discussion and a version of the deep problem of the Ricci curvature for the case of mixed curvature of foliations is examined The book is divided into five chapters that deal with integral and variation formulas and curvature and dynamics of foliations Different approaches and methods local and global regular and singular in solving the problems are described using integral and variation formulas extrinsic geometric flows generalizations of the Ricci and scalar curvatures pseudo Riemannian and metric affine geometries and computable Finsler metrics. The book presents the state of the art in geometric and analytical theory of foliations as a continuation of the authors life long work in extrinsic geometry. It is designed for newcomers to the field as well as experienced geometers working in Riemannian geometry foliation theory differential topology and a wide range of researchers in differential equations and their applications It may also be a useful supplement to postgraduate level work and can inspire new interesting topics to explore Biharmonic Submanifolds And Biharmonic Maps In Riemannian Geometry Ye-lin Ou, Bang-yen Chen, 2020-04-04 The book aims to present a comprehensive survey on biharmonic submanifolds and maps from the viewpoint of Riemannian geometry It provides some basic knowledge and tools used in the study of the subject as well as an overall picture of the development of the subject with most up to date important results Biharmonic submanifolds are submanifolds whose isometric immersions are biharmonic maps thus biharmonic submanifolds include minimal submanifolds as a subclass Biharmonic submanifolds also appeared in the study of finite type submanifolds in Euclidean spaces Biharmonic maps are maps between Riemannian manifolds that are critical points of the bienergy They are generalizations of harmonic maps and biharmonic functions which have many important applications and interesting links to many areas of mathematics and theoretical physics Since 2000 biharmonic submanifolds and maps have become a vibrant research field with a growing number of researchers around the world with many interesting results have been obtained This book containing basic knowledge tools for some fundamental problems and a comprehensive survey on the study of biharmonic submanifolds and maps will be greatly beneficial for graduate students and beginning researchers who want to study the subject as well as researchers who have already been working in the field **Differential Geometry Of** Warped Product Manifolds And Submanifolds Bang-yen Chen, 2017-05-29 A warped product manifold is a Riemannian or pseudo Riemannian manifold whose metric tensor can be decomposed into a Cartesian product of the y geometry and the x geometry except that the x part is warped that is it is rescaled by a scalar function of the other coordinates y The notion of warped product manifolds plays very important roles not only in geometry but also in mathematical physics especially in general relativity In fact many basic solutions of the Einstein field equations including the Schwarzschild solution and the Robertson Walker models are warped product manifolds The first part of this volume provides a self contained and accessible introduction to the important subject of pseudo Riemannian manifolds and submanifolds. The second part presents a detailed

and up to date account on important results of warped product manifolds including several important spacetimes such as Robertson Walker's and Schwarzschild's The famous John Nash's embedding theorem published in 1956 implies that every warped product manifold can be realized as a warped product submanifold in a suitable Euclidean space. The study of warped product submanifolds in various important ambient spaces from an extrinsic point of view was initiated by the author around the beginning of this century. The last part of this volume contains an extensive and comprehensive survey of numerous important results on the geometry of warped product submanifolds done during this century by many geometers

Geometry of Submanifolds Bang-Yen Chen, 2019-06-12 The first two chapters of this frequently cited reference provide background material in Riemannian geometry and the theory of submanifolds Subsequent chapters explore minimal submanifolds submanifolds with parallel mean curvature vector conformally flat manifolds and umbilical manifolds The final chapter discusses geometric inequalities of submanifolds results in Morse theory and their applications and total mean curvature of a submanifold Suitable for graduate students and mathematicians in the area of classical and modern differential geometries the treatment is largely self contained Problems sets conclude each chapter and an extensive bibliography provides background for students wishing to conduct further research in this area This new edition includes the author's corrections Total Mean Curvature And Submanifolds Of Finite Type (2nd Edition) Bang-yen Chen, 2014-10-29 During the last four decades there were numerous important developments on total mean curvature and the theory of finite type submanifolds This unique and expanded second edition comprises a comprehensive account of the latest updates and new results that cover total mean curvature and submanifolds of finite type The longstanding biharmonic conjecture of the author's and the generalized biharmonic conjectures are also presented in details. This book will be of use to graduate students and researchers in the field of geometry Recent Advances in the Geometry of Submanifolds Bogdan D. Suceavă, Alfonso Carriazo, Yun Myung Oh, Joeri Van der Veken, 2016-09-14 This volume contains the proceedings of the AMS Special Session on Geometry of Submanifolds held from October 25 26 2014 at San Francisco State University San Francisco CA and the AMS Special Session on Recent Advances in the Geometry of Submanifolds Dedicated to the Memory of Franki Dillen 1963 2013 held from March 14 15 2015 at Michigan State University East Lansing Ml The focus of the volume is on recent studies of submanifolds of Riemannian semi Riemannian Kaehlerian and contact manifolds Some of these use techniques in classical differential geometry while others use methods from ordinary differential equations geometric analysis or geometric PDEs By brainstorming on the fundamental problems and exploring a large variety of questions studied in submanifold geometry the editors hope to provide mathematicians with a working tool not just a collection of individual contributions This volume is dedicated to the memory of Franki Dillen whose work in submanifold theory attracted the attention of and inspired many geometers Geometry of Cauchy-Riemann Submanifolds Sorin Dragomir, Mohammad Hasan Shahid, Falleh R. Al-Solamy, 2016-05-31 This book gathers contributions by respected experts on the theory of isometric

immersions between Riemannian manifolds and focuses on the geometry of CR structures on submanifolds in Hermitian manifolds CR structures are a bundle theoretic recast of the tangential Cauchy Riemann equations in complex analysis involving several complex variables The book covers a wide range of topics such as Sasakian geometry Kaehler and locally conformal Kaehler geometry the tangential CR equations Lorentzian geometry holomorphic statistical manifolds and paraguaternionic CR submanifolds Intended as a tribute to Professor Aurel Bejancu who discovered the notion of a CR submanifold of a Hermitian manifold in 1978 the book provides an up to date overview of several topics in the geometry of CR submanifolds Presenting detailed information on the most recent advances in the area it represents a useful resource for mathematicians and physicists alike Differential Geometry: Riemannian Geometry Robert Everist Greene, Shing-Tung Yau, 1993 The third of three parts comprising Volume 54 the proceedings of the Summer Research Institute on Differential Geometry held at the University of California Los Angeles July 1990 ISBN for the set is 0 8218 1493 1 Part 3 begins with an Geometry And Topology Of Submanifolds Vii: Differential overview by R E Greene of some recent trends in Riemannia Geometry In Honour Of Prof Katsumi Nomizu Franki Dillen, Udo Simon, Ignace Van De Woestyne, Leopold Verstraelen, Martin Magid, 1995-05-09 This volume on pure and applied differential geometry includes topics on submanifold theory affine differential geometry and applications of geometry in engineering sciences The conference was dedicated to the 70th birthday of Prof Katsumi Nomizu Papers on the scientific work and life of Katsumi Nomizu are also included Submersions, Riemannian Maps in Hermitian Geometry, and their Applications Bayram Sahin, 2017-01-23 Riemannian Submersions Riemannian Maps in Hermitian Geometry and their Applications is a rich and self contained exposition of recent developments in Riemannian submersions and maps relevant to complex geometry focusing particularly on novel submersions Hermitian manifolds and K a hlerian manifolds Riemannian submersions have long been an effective tool to obtain new manifolds and compare certain manifolds within differential geometry For complex cases only holomorphic submersions function appropriately as discussed at length in Falcitelli Ianus and Pastore s classic 2004 book In this new book Bayram Sahin extends the scope of complex cases with wholly new submersion types including Anti invariant submersions Semi invariant submersions slant submersions and Pointwise slant submersions also extending their use in Riemannian maps The work obtains new properties of the domain and target manifolds and investigates the harmonicity and geodesicity conditions for such maps It also relates these maps with discoveries in pseudo harmonic maps Results included in this volume should stimulate future research on Riemannian submersions and Riemannian maps Systematically reviews and references modern literature in Riemannian maps Provides rigorous mathematical theory with applications Presented in an accessible reading style with motivating examples that help the reader rapidly progress **Geometry of Submanifolds** and Applications Bang-Yen Chen, Majid Ali Choudhary, Mohammad Nazrul Islam Khan, 2024-03-26 This book features chapters written by renowned scientists from various parts of the world providing an up to date survey of submanifold theory

spanning diverse topics and applications The book covers a wide range of topics such as Chen Ricci inequalities in differential geometry optimal inequalities for Casorati curvatures in quaternion geometry conformal Ricci Yamabe solitons submersion on statistical metallic structure solitons in f R T gravity metric affine geometry generalized Wintgen inequalities tangent bundles and Lagrangian submanifolds Moreover the book showcases the latest findings on Pythagorean submanifolds and submanifolds of four dimensional f manifolds The chapters in this book delve into numerous problems and conjectures on submanifolds providing valuable insights for scientists educators and graduate students looking to stay updated with the latest developments in the field With its comprehensive coverage and detailed explanations this book is an essential resource for anyone interested in submanifold theory Differential Geometry Elisabetta Barletta, Sorin Dragomir, Mohammad Hasan Shahid, Falleh R. Al-Solamy, 2025-07-07 This book Differential Geometry Foundations of Cauchy Riemann and Pseudohermitian Geometry Book I C is the third in a series of four books presenting a choice of topics among fundamental and more advanced in Cauchy Riemann CR and pseudohermitian geometry such as Lewy operators CR structures and the tangential CR equations the Levi form Tanaka Webster connections sub Laplacians pseudohermitian sectional curvature and Kohn Rossi cohomology of the tangential CR complex Recent results on submanifolds of Hermitian and Sasakian manifolds are presented from the viewpoint of the geometry of the second fundamental form of an isometric immersion The book has two souls those of Complex Analysis versus Riemannian geometry and attempts to fill in the gap among the two The other three books of the series are Differential Geometry Manifolds Bundles Characteristic Classes Book I A Differential Geometry Riemannian Geometry and Isometric Immersions Book I B Differential Geometry Advanced Topics in Cauchy Riemann and Pseudohermitian Geometry Book I D The four books belong to an ampler book project Differential Geometry Partial Differential Equations and Mathematical Physics by the same authors and aim to demonstrate how certain portions of differential geometry DG and the theory of partial differential equations PDEs apply to general relativity and quantum gravity theory These books supply some of the ad hoc DG and PDEs machinery yet do not constitute a comprehensive treatise on DG or PDEs but rather authors choice based on their scientific mathematical and physical interests These are centered around the theory of immersions isometric holomorphic and CR and pseudohermitian geometry as devised by Sidney Martin Webster for the study of nondegenerate CR structures themselves a DG manifestation of the Contact Geometry of Slant Submanifolds Bang-Yen Chen, Mohammad Hasan Shahid, Falleh tangential CR equations Al-Solamy, 2022-06-27 This book contains an up to date survey and self contained chapters on contact slant submanifolds and geometry authored by internationally renowned researchers The notion of slant submanifolds was introduced by Prof B Y Chen in 1990 and A Lotta extended this notion in the framework of contact geometry in 1996 Numerous differential geometers have since obtained interesting results on contact slant submanifolds The book gathers a wide range of topics such as warped product semi slant submanifolds slant submersions semi slant hemi slant Riemannian submersions quasi

hemi slant submanifolds slant submanifolds of metric f manifolds slant lightlike submanifolds geometric inequalities for slant submanifolds 3 slant submanifolds and semi slant submanifolds of almost paracontact manifolds The book also includes interesting results on slant curves and magnetic curves where the latter represents trajectories moving on a Riemannian manifold under the action of magnetic field It presents detailed information on the most recent advances in the area making it of much value to scientists educators and graduate students Inequalities in Geometry and Applications Gabriel-Eduard Vîlcu, 2021-03-09 This book presents the recent developments in the field of geometric inequalities and their applications The volume covers a vast range of topics such as complex geometry contact geometry statistical manifolds Riemannian submanifolds optimization theory topology of manifolds log concave functions Obata differential equation Chen invariants Einstein spaces warped products solitons isoperimetric problem Erd's Mordell inequality Barrow's inequality Simpson inequality Chen inequalities and q integral inequalities By exposing new concepts techniques and ideas this book will certainly stimulate further research in the field Introduction to Lorentz Geometry Ivo Terek Couto, Alexandre Lymberopoulos, 2021-01-05 Lorentz Geometry is a very important intersection between Mathematics and Physics being the mathematical language of General Relativity Learning this type of geometry is the first step in properly understanding questions regarding the structure of the universe such as What is the shape of the universe What is a spacetime What is the relation between gravity and curvature Why exactly is time treated in a different manner than other spatial dimensions Introduction to Lorentz Geometry Curves and Surfaces intends to provide the reader with the minimum mathematical background needed to pursue these very interesting questions by presenting the classical theory of curves and surfaces in both Euclidean and Lorentzian ambient spaces simultaneously Features Over 300 exercises Suitable for senior undergraduates and graduates studying Mathematics and Physics Written in an accessible style without loss of precision or mathematical rigor Solution manual available on www routledge com 9780367468644

The book delves into Minimal Submanifolds In Pseudo Riemannian Geometry. Minimal Submanifolds In Pseudo Riemannian Geometry is a vital topic that needs to be grasped by everyone, ranging from students and scholars to the general public. This book will furnish comprehensive and in-depth insights into Minimal Submanifolds In Pseudo Riemannian Geometry, encompassing both the fundamentals and more intricate discussions.

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- 3. In chapter 2, this book will delve into the foundational concepts of Minimal Submanifolds In Pseudo Riemannian Geometry. This chapter will elucidate the essential principles that need to be understood to grasp Minimal Submanifolds In Pseudo Riemannian Geometry in its entirety.
- 4. In chapter 3, this book will examine the practical applications of Minimal Submanifolds In Pseudo Riemannian Geometry in daily life. The third chapter will showcase real-world examples of how Minimal Submanifolds In Pseudo Riemannian Geometry can be effectively utilized in everyday scenarios.
- 5. In chapter 4, this book will scrutinize the relevance of Minimal Submanifolds In Pseudo Riemannian Geometry in specific contexts. This chapter will explore how Minimal Submanifolds In Pseudo Riemannian Geometry is applied in specialized fields, such as education, business, and technology.
- 6. In chapter 5, this book will draw a conclusion about Minimal Submanifolds In Pseudo Riemannian Geometry. This chapter will summarize the key points that have been discussed throughout the book.

 This book is crafted in an easy-to-understand language and is complemented by engaging illustrations. This book is highly recommended for anyone seeking to gain a comprehensive understanding of Minimal Submanifolds In Pseudo Riemannian

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