

Istanbul Technical University

— Abstract Book —

International Workshop on Theory of Submanifolds

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Preface

International Workshop on Theory of Submanifolds (IWTS'16) was held in Istanbul, Turkey at Faculty of Science and Letters, Istanbul Technical University from June 2 to June 4, 2016. It was second edition of such workshops, the first workshop whose name was International Workshop on Finite Type Submanifolds (IWFTS'14) was organized in Istanbul, Turkey from September 3 to September 5, 2014. IWTS'16 had 34 participants from different countries and parts of Turkey. This meeting had brought together mathematicians interested in differential geometry and its applications. The aim of this workshop was giving lectures on new results about theory of submanifolds and exchanging ideas. The organizers gratefully acknowledge a partial financial support by Scientific and Technological Research Council of Turkey (TUBITAK) and Istanbul Technical University.

The Chairman of Organizing Committee

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Acknowledgment. In this workshop, some of the results obtained during TUBITAK research Project '*Y_EUCL2TIP* (Project No: 114F199)' will be presented.

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Generalized Paracontact Metric Manifolds

Cornelia-Livia Bejan, Şemsi Eken Meriç and Erol Kılıç

Abstract

Almost paracontact manifolds have been introduced by Sato, as a dual version of almost contact structures. Then Sato defined almost paracontact Riemannian structures as almost paracontact structures compatible with a Riemannian metric. Later on, Kaneyuki-Kozai defined almost paracontact metric structures as being almost paracontact structures anti-compatible with a semi-Riemannian metric of signature (k, k) . We take a generalization of both the above notions and we study on this new context paraholomorphic maps, harmonicity, paracontact-planar curves and other related topics.

2000 MSC Codes. Primary 53C15; Secondary 53B05, 53C22, 53C43.

Keywords: paracontact structures on manifold, linear connection, geodesics, planar curve, harmonic map.

Acknowledgments

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Recent Developments on Riemannian Submersions from Hermitian Geometry

Bayram Şahin

Abstract

Riemannian submersions between Riemannian manifolds were studied by O'Neill [12] and Gray[8]. It has been a useful tool to compare the geometry of two manifolds. On the other hand, holomorphic submersions (or Hermitian submersions) have been defined by Watson between two almost Hermitian manifolds and he showed that the base manifold and each fiber have the same kind of structure as the total space, in most cases [23]. We note that almost Hermitian submersions have been extended to the almost contact manifolds [5], locally conformal Kähler manifolds[11] and quaternion Kähler manifolds [10] (see:[7] for details concerning Riemannian submersions between Riemannian manifolds equipped with additional structures of complex, contact, locally conformal or quaternion Kähler).

In this talk, we present recent results on anti-invariant submersions, semi-invariant submersions, slant submersions, pointwise slant submersions, semi-slant submersions and hemi-slant submersions defined on almost Hermitian manifolds. We also present a Lie-theoretical approach defined recently.

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Biharmonic Submersions

İrem Küpeli Erken and Cengizhan Murathan

Abstract

The theory of Riemannian submersions was initiated by O'Neill [16] and Gray [12]. One of the well known examples of a Riemannian submersion is the projection of a Riemannian product manifold on one of its factors. Presently, there is an extensive literature on the Riemannian submersions with different conditions imposed on the total space and on the fibres. A systematic exposition could be found in A.Besse's book [3]. Semi-Riemannian submersions were introduced by O'Neill [17]. Magid classified semi-Riemannian submersions with totally geodesic fibres from an anti-de Sitter space onto a Riemannian manifold [15].

The main interest of the present paper is to prove the dual results for semi-Riemannian submersions, i.e., a semi-Riemannian submersion from a 3-dimensional space form into a surface is biharmonic if and only if it is harmonic.

2000 MSC Codes. Primary 53B20, 53B25, 53B50; Secondary 53C15, 53C25

Keywords: Semi-Riemannian submersions, biharmonic 3-manifolds

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Biconservative Surfaces

Cezar Oniciuc

Abstract

Biconservative immersions are the Riemannian immersions $\varphi : (M, g) \rightarrow (N, h)$ with $\operatorname{div} S_2^\varphi = 0$, where S_2^φ is the stress-energy tensor field corresponding to the bienergy functional. We will survey recent results concerning the biconservative immersions in Riemannian manifolds, with a special emphasis on biconservative surfaces in 3-dimensional space forms.

2000 MSC Codes. Primary 53A10; Secondary 53C40, 53C42.

Keywords. Biconservative surfaces, mean curvature function, real space forms.

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f -Biminimal Submanifolds

Cihan Özgür

Abstract

We consider f -biminimal curves and hypersurfaces in a Riemannian manifold and give some examples of f -biminimal surfaces. We also consider f -biminimal Legendre curves in Sasakian space forms and give an example.

2000 MSC Codes. Primary 53C40; Secondary 53C25, 53C42

Keywords: f -biminimal immersion, f -biminimal curve, f -biminimal surface, Legendre curve

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Ideal Lagrangian submanifolds

Joeri Van der Veken

(joint work with Bang-Yen Chen, Franki Dillen and Luc Vrancken)

Abstract

We give an overview of recent developments on curvature inequalities for Lagrangian submanifolds of complex space forms. The set of optimal inequalities yields the notion of ideal submanifolds and we discuss classification results regarding ideal Lagrangian submanifolds in complex space forms, mainly focussing on the flat space \mathbb{C}^n .

2010 MSC Codes: Primary 53B25; Secondary 53C55, 53D12

Keywords: Lagrangian submanifold, complex space form, curvature inequality, ideal submanifold

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Quaternions and Their Characterizations

Kadri Arslan

Abstract

The quaternion was first introduced by William Rowan Hamilton as a successor to complex numbers. The quaternions have been used in various areas of mathematics. Most recently, quaternions have enjoyed prominence in computer science and kinematics, because they are the simplest algebraic tools for describing rotations in three and four dimensions. In the present study we a brief survey of real quaternions and their applications.

2000 MSC Codes. Primary 53C40; Secondary 53C42.

Keywords:Quaternion

Acknowledgments

We thank to organizers for their hospitality.

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Quasi-minimal Lorentz Surfaces with Pointwise 1-type Gauss Map in Pseudo-Euclidean 4-Space

Velichka Milousheva and Nurettin Cenk Turgay

Abstract

In recent times, great attention is paid to surfaces in pseudo-Euclidean spaces with neutral metric, since pseudo-Riemannian geometry has many important applications in Physics. A surface in a pseudo-Riemannian manifold is called *quasi-minimal* if its mean curvature vector is lightlike at each point of the surface. Quasi-minimal surfaces in pseudo-Euclidean spaces have been very actively studied in the last few years. In Minkowski 4-space the analogue of quasi-minimal surface is the so-called *marginally trapped* surface which plays an important role in General Relativity. Marginally trapped surfaces satisfying some extra conditions have been intensively studied recently in connection with the rapid development of the theory of black holes in Physics. The classification of marginally trapped surfaces with pointwise 1-type Gauss map in the Minkowski 4-space \mathbb{E}_1^4 is obtained independently in [1] and [3].

In this talk we present our study on quasi-minimal Lorentz surfaces with pointwise 1-type Gauss map in the pseudo-Euclidean 4-space with neutral metric \mathbb{E}_2^4 . The talk is based on paper [2]. First we describe the quasi-minimal surfaces with harmonic Gauss map proving that each such surface is a flat surface with parallel mean curvature vector field. Next we give explicitly all flat quasi-minimal surfaces with pointwise 1-type Gauss map. Further, we prove that a non-flat quasi-minimal surface with flat normal connection has pointwise 1-type Gauss map if and only if it has parallel mean curvature vector field.

We note that in the Minkowski space \mathbb{E}_1^4 all marginally trapped surfaces with pointwise 1-type Gauss map have flat normal connection, while in the pseudo-Euclidean space \mathbb{E}_2^4 there exist quasi-minimal surfaces with non-flat normal connection and pointwise 1-type Gauss map. We give necessary and sufficient conditions for a quasi-minimal surface with non-flat normal connection to have pointwise 1-type Gauss map. Our main result presents the complete classification of quasi-minimal surfaces with non-flat normal connection and pointwise 1-type Gauss map.

Finally, we give an explicit example of a quasi-minimal surface with non-flat normal connection and pointwise 1-type Gauss map. This is also an example of a quasi-minimal surface with non-parallel mean curvature vector field.

2010 MSC Codes. Primary 53B30; Secondary 53A35, 53B25

Keywords: Pseudo-Euclidean space, Lorentz surface, quasi-minimal surface, finite type Gauss map, parallel mean curvature vector field

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Generalized Quaternions and Rotational Surfaces with Pointwise 1-Type Gauss Map

Yusuf Yaylı

Abstract

In this paper, by using generalized quaternions we determine rotational surfaces and study flat rotational surfaces with pointwise 1-type Gauss map in four dimensional generalized space $E_{\alpha\beta}^4$. Also, in some special cases we obtain the characterizations of flat rotational surfaces with pointwise 1-type Gauss map in four dimensional Euclidean space E^4 and pseudo Euclidean space E_2^4 .

2000 MSC Codes. Primary 53B25,; Secondary 53C40.

Keywords: Generalized Quaternions, Rotational Surface, Gauss map, Pointwise 1-type Gauss map.

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Recent results on biconservative submanifolds in semi-Euclidean spaces

Abhitosh Upadhyay and Nurettin Cenk Turgay

Abstract

In this talk, we first present a short survey on classification results of biharmonic submanifolds. Then, we show our recent results on the classification of biconservative hypersurfaces in \mathbb{E}_2^5 .

2000 MSC Codes. Primary 53C42; Secondary 53C42

Keywords: Null 2-type submanifolds, biharmonic submanifolds, biconservative hypersurfaces, pseudo-Euclidean space

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On the unicity of the solutions to a certain quasi-linear partial differential equation

Alma Luisa Albuje Brotons

Abstract

Given a domain $\Omega \subseteq \mathbb{R}^2$, we consider the differential operator given by

$$Q(u) = \operatorname{div} \left(\frac{Du}{\sqrt{1-|Du|^2}} \right) - \operatorname{div} \left(\frac{Du}{\sqrt{1+|Du|^2}} \right),$$

where $u \in \mathcal{C}^2(\Omega)$, and D , div and $|\cdot|$ stand for the gradient, the divergence and the Euclidean norm on \mathbb{R}^2 . We are interested in studying the solutions to the equation

$$Q(u) = 0, \tag{1}$$

satisfying $|Du| < 1$.

Spacelike surfaces in the Lorentz-Minkowski space \mathbb{L}^3 can be endowed with two different Riemannian metrics, the metric induced by the Euclidean space \mathbb{R}^3 and the metric inherited from the Lorentz-Minkowski space \mathbb{L}^3 . Consequently, we can consider two different mean curvature functions on a spacelike surface, H_R and H_L .

On the other hand, any spacelike surface can be locally described as a spacelike graph over a domain $\Omega \subseteq \mathbb{R}^2$. Let Σ_u be the spacelike graph determined by the function u . It is easy to check that if Σ_u satisfies $H_R = H_L$, then u is a solution of (1) with $|Du| < 1$. For this reason, we will refer to (1) as the $H_R = H_L$ surface equation. This equation is a quasi-linear elliptic partial differential equation, everywhere except at those points at which Du vanishes, where the equation is parabolic.

In this talk we will show some uniqueness results for entire solutions to the $H_R = H_L$ surface equation, as well as for the Dirichlet problem related to it.

The results presented in this talk are part of a joint work with Magdalena Caballero [1], and with Magdalena Caballero and Enrique Sánchez [2].

2000 MSC Codes. Primary 35J93; Secondary 53C50, 53C42

Keywords: mean curvature; Dirichlet problem; entire spacelike graphs; ruled surfaces; parabolicity.

Acknowledgments

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Biconservative Lorentz Hypersurfaces Having Complex Eigenvalues

Deepika Kumari

Abstract

In this paper, we study some characteristics of biconservative Lorentz hypersurfaces M_1^n in \mathbb{E}_1^{n+1} with non-diagonalizable shape operator having complex eigenvalues for all distinct principal curvatures. Also, we study the geometry of biconservative Lorentz hypersurfaces with constant length of second fundamental form having complex eigenvalues. We prove that every such biconservative Lorentz hypersurface in \mathbb{E}_1^{n+1} having six distinct principal curvatures has constant mean curvature.

2000 MSC Codes. Primary 53D12; Secondary 53C40; 53C42

Keywords: Pseudo-Euclidean space, Biharmonic submanifolds, Biconservative hypersurfaces, Mean curvature vector.

Acknowledgements

The author is grateful to Dr. Ram Shankar Gupta for discussions and his useful suggestions for the work. Also, the author thanks Guru Gobind Singh Indraprastha University for providing IPRF fellowship to pursue research.

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On the surfaces with the same mean curvature in R^3 and L^3

Magdalena Caballero Campos

Abstract

Spacelike surfaces in the Lorentz-Minkowski space L^3 can be endowed with two different Riemannian metrics, the metric inherited from L^3 and the one induced by the Euclidean metric of R^3 . It is well known that the only surfaces with zero mean curvature with respect to both metrics are open pieces of the helicoid and of spacelike planes, [2]. We consider the general case of spacelike surfaces with the same mean curvature with respect to both metrics. Our central result states that those surfaces have non-positive Gaussian curvature in R^3 , and if the mean curvature does not vanish at a point, then the surface is locally non-convex at that point. As an application of this result, jointly with an argument on the existence of elliptic points, we present two geometric consequences for those surfaces, and a uniqueness result.

This talk is based on a joint work with Alma L. Albuje [1].

2000 MSC Codes. Primary 53C50; Secondary 53C42

Keywords: spacelike surface; mean curvature;

Acknowledgments

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A note on timelike surfaces in Minkowski 3-spaces

Alev Kelleci, Mahmut Ergüt and Nurettin Cenk Turgay

Abstract

Let U denote the projection of the fixed direction k on the tangent plane of the surface M . Then U is called a canonical principal direction if it is a principle direction of M with corresponding principal curvature is different from zero. In this talk, we characterize and classify time-like surfaces endowed with a canonical principal direction in the Minkowski 3-space.

2000 MSC Codes. Primary 53B25; Secondary 53B30, 53C50

Keywords: Minkowski space, time-like surface, principal direction, angle function

Acknowledgments

This paper is a part of PhD thesis of the first named author who is supported by The Scientific and Technological Research Council of Turkey (TUBITAK) as a PhD scholar. The third named author is also supported by TUBITAK (Project Name: ‘Y_EUCL2TIP’, Project Number: 114F199)

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Classification of surfaces in a pseudo-sphere with 1-type pseudo-spherical Gauss map

Burcu Bektaş, Joeri Van der Veken and Luc Vrancken

Abstract

In this work, we discuss spacelike and Lorentzian surfaces of arbitrary codimension in a pseudo-sphere with 1-type pseudo-spherical Gauss map. Firstly, we give a global classification of Riemannian surfaces in $\mathbb{S}_s^m(1)$ with 1-type pseudo-spherical Gauss map. Then, we examine Riemannian surfaces with harmonic pseudo-spherical Gauss map which are characterized as solutions of an explicit system of partial differential equations. Finally, we consider Lorentzian surfaces with arbitrary codimension in a pseudo-sphere whose pseudo-spherical Gauss map is 1-type, in particular harmonic.

2000 MSC Codes. Primary 53C40; Secondary 53C42, 53C50.

Keywords: pseudo-sphere, Gauss map, finite type map, harmonic map

Acknowledgments

This work is partially supported by the Belgian Interuniversity Attraction Pole P07/18 (Dygest) and was carried out while the first author visited KU Leuven supported by The Scientific and Technological Research Council of Turkey (TUBITAK) under grant 1059B141500244.

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The Geometry of Anti-invariant Submersions From Locally Product Riemannian Manifolds

Hakan Mete Taştan, Fatma Özdemir and Cem Sayar

Abstract

In this study, we focus on anti-invariant and Lagrangian submersions from locally product Riemannian manifolds. We also study the first variational problems for such submersions and give some results.

2000 MSC Codes. Primary 53C15; Secondary 53B20

Keywords: Anti-invariant submersion, Lagrangian submersion, horizontal distribution, locally product Riemannian manifold, deformations.

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f -Biharmonic Integral Submanifolds in Sasakian Space Forms

Fatma Karaca

Abstract

We find the necessary and sufficient conditions for integral submanifolds in a Sasakian space form to be f -biharmonic and give some examples.

2000 MSC Codes. Primary 53C40; Secondary 53C25

Keywords: f -biharmonic submanifold, integral submanifold, Sasakian space form

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Rotational Surfaces with Pointwise 1-Type Gauss Map in Four Dimensional Pseudo-Euclidean Space

Ferdağ Kahraman Aksoyak and Yusuf Yaylı

Abstract

In this paper, we study rotational surfaces of elliptic, hyperbolic and parabolic types with pointwise 1-type Gauss map in four dimensional pseudo Euclidean space \mathbb{E}_2^4 .

2000 MSC Codes. Primary 53B25; Secondary 53C50

Keywords: Rotational Surfaces, Gauss map, Pointwise 1-type Gauss map, Pseudo-Euclidean Space.

Acknowledgments

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Submanifolds with nonpositive extrinsic curvature

Samuel Canevari, Guilherme Freitas and Fernando Manfio

Abstract

In this talk we will present the main results of the recent work [1]. More precisely, we prove that complete submanifolds, on which the weak Omori-Yau maximum principle for the Hessian holds, with low codimension and bounded by cylinders of small radius must have points rich in large positive extrinsic curvature. The lower the codimension is, the richer such points are. The smaller the radius is, the larger such curvatures are. This work unifies and generalizes several previous results [2] on submanifolds with nonpositive extrinsic curvature.

2010 MSC Codes. Primary 53C40, 53C42; Secondary 53A07, 53A35

Keywords: nonpositive extrinsic curvature, cylindrically bounded submanifolds, Otsuki's Lemma, Omori-Yau maximum principle

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Integrability of the horizontal distribution of a Lagrangian submersion in almost contact manifolds

Hakan Mete TAŞTAN

Abstract

In this paper, we define the notion of Lagrangian submersion for an almost contact metric manifold. After then, we investigate of the integrability of the horizontal distribution of a such submersion in several almost contact structures.

2000 MSC Codes. Primary 53C15; Secondary 53B20.

Keywords: Riemannian submersion, Lagrangian submersion, horizontal distribution, Sasakian manifold, Kenmotsu manifold.

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On isotropic Weyl manifold with semi-symmetric recurrent metric connection

Mustafa Deniz Türkoğlu and Fatma Özdemir

Abstract

In this work, we define an isotropic Weyl manifold with semi-symmetric recurrent metric connection denoted by IWSR and prove that a IWSR manifold is locally conformal to an Einstein manifold with semi-symmetric recurrent-metric connection.

2000 MSC Codes. Primary 53B15; Secondary 53B50

Keywords: Isotropic Weyl Manifold, Semi-Symmetric Recurrent Metric Connection

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On anti-invariant Riemannian submersion from Sasakian manifolds

Hakan Mete Taştan, Sibel Gerdan

Abstract

We investigate the geometry of anti-invariant Riemannian submersions from normal almost contact manifolds. We give Clairaut conditions for such submersions. We also study the first variational problems for anti-invariant Riemannian submersions admitting vertical Reeb vector field when the total manifold is Sasakian.

2000 MSC Codes. Primary 53C15; Secondary 53B20

Keywords:Riemannian submersion, Lagrangian submersion, horizontal distribution, Sasakian manifold, Kenmotsu manifold.

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Rotational surfaces with constant mean curvature in pseudo-Euclidean 4-space with neutral metric

Yana Aleksieva, Velichka Milousheva

Abstract

Constant mean curvature surfaces in arbitrary spacetime are important objects for the special role they play in the theory of general relativity. The study of constant mean curvature surfaces (CMC surfaces) involves not only geometric methods but also PDE and complex analysis, that is why the theory of CMC surfaces is of great interest not only for mathematicians but also for physicists and engineers.

In this talk we present our study on Lorentz rotational surfaces of elliptic, hyperbolic, and parabolic type in the four-dimensional pseudo-Euclidean space with neutral metric \mathbb{E}_2^4 and give the classification of all such surfaces with non-zero constant mean curvature. The talk is based on paper [1].

[2010] MSC Codes. Primary 53B30, Secondary 53A35, 53B25

Keywords: Pseudo-Euclidean 4-space with neutral metric, CMC surfaces, rotational surfaces

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Recent results obtained during the project ‘Y_EUCL2TIP’

Nurettin Cenk Turgay, Elif Özkara Canfes and Uğur Dursun

Abstract

In this poster presentation, we would like to show some of families of submanifolds that we obtained during the TUBITAK project ‘Y_EUCL2TIP’. We give some classes of submanifolds with finite type Gauss map. We also present a survey of results on biconservative submanifolds.

Kaehler-Weyl Manifolds With Quarter Symmetric Connection

İlhan Gül and Elif Özkara Canfes

Abstract

In this work, we study quarter symmetric connection on Kaehler-Weyl manifolds and present new results.

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