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Generalized normalized delta-Casorati curvature for statistical submanifolds in quaternion Kaehler-like statistical space forms

Mohd. Aquib

Short abstract. In 2017, C. W. Lee at el. derived optimal Casorati inequalities with normalized scalar curvature for statistical submanifolds of statistical manifolds of constant curvature. In this paper, we generalizes those inequalities. In fact, we obtain the bounds for the generalized normalized δ-Casorati curvatures for statistical submanifolds in Quaternion Kaehler-like statistical space form.

Geodesic orbit metrics in certain homogeneous bundles over Stiefel manifolds

Andreas Arvanitoyeorgos

Abstract. Let $(M=G/H,g)$ be a homogeneous Riemannian manifold. A geodesic $\gamma(t)$ through the origin $o=eH$ is called homogeneous if it is an orbit of a 1-parameter subgroup G, i.e. $\gamma(t)=\exp(tX).o$ for some $0\neq X\in\mathbf{g}$, the Lie algebra of G. Then $M=G/K$ is called g.o. space (or space with homogeneous geodesics) if any geodesic of M is homogeneous. A Riemannian manifold (M,g) is called g.o. manifold (or a manifold with homogeneous geodesics) if any geodesic of M is an orbit of a 1-parameter subgroup of the full isometry group of (M,g). Some examples of g.o. manifolds are the symmetric spaces, naturally reductive spaces, normal homogeneous spaces and weakly symmetric spaces.

The main problem is the following: Let G/H be a homogeneous manifold with G compact. Find the (non-normal) g.o. metrics g on G/H. There is a signifficant amount of works related to this problem. Recently, the case when H is Abelian or semisimple has been studied by N.P. Souris and Yu. Nikonorov respectively.

In the present talk we will present some results for the case where H is semisimple. In particular, we will examine the g.o. property for the spaces $SO(n)/SO(k_1)\times\ldots\times SO(k_s)$, $U(n)/U(k_1)\times\ldots\times U(k_s)$ and $Sp(n)/Sp(k_1)\times\ldots\times Sp(k_s)$, where $k_1+\ldots+k_s\leq n$. If $k_1+\ldots+k_s<n$, then each of these spaces can be viewed as a total space over a corresponding Stiefel manifold, with ber being a real/quaternionic ag manifold.

This is a joint work with Nikolaos Panagiotis Souris and Marina Statha.

Geometric obstructions for doubly warped product poitwise bi-slant submanifolds in locally conformal almost cosymplectic manifolds

Mohd Aslam

Abstract. In this paper, we establish some geometric inequalities for the squared mean curvature in terms warping functions of a doubly warped product pointwise bi-slant submanifold of a locally conformal almost cosymplectic manifold with a quarter symmetric metric connection. The equality case in the statement of inequalities is also considered. Moreover, some applications of obtained results are derived.

Geometry analysis-based models for digital image segmentation

Tudor Barbu

Abstract. This research work surveys high-level mathematical models for automatic image segmentation. They include both parametric and geometric segmentation methods. Thus, parametric Active Contours models, which are based on variational schemes, are described first. Then, the geometric or geodesic Active Contour models are presented here. Region-based image segmentation techniques using variational PDE models or geometric models like those based on level-set surfaces are described next. Our own contributions in this image analysis domain are also disscussed.

New chanllenges in the nonlinear mathematical methods

Haci Mehmet Baskonus, Armando Ciancio

Short abstract. In the last several decades, experts from all over the world have directed their studies in better understanding the deeper properties of real world problems. Thus, to study on the various aspects of soliton theory became one of the most studied fields of nonlinear science, Therefore, in this talk, we study these topics and also present some important methods.

Surfaces on orthonormal frame bundle with Wagner lift metric

Edward Samuel Becerra Rojas, Mikhail Malakhaltsev, Alexander Haimer Trejos Serna

Abstract. Let (M,g) be a two-dimensional oriented Riemannian manifold. On the total space $SO(M,g)$ of the positive orthonormal frame bundle of (M,g) one can take a metric tensor field G, called Wagner lift metric [J.R. Arteaga Bejarano, M. Malakhaltsev and A.H. Trejos Serna, *Isometry group and geodesics of the Wagner lift of a Riemannian metric on two-dimensional manifold*, Lobachevskii Journal of Mathematics, 33(4), (2012), 293-311]. We calculate the invariants of certain surfaces in $(SO(M,g),G)$, in particular the mean curvature, and thus find some interesting examples of minimal surfaces in a three-dimensional Riemannian manifold.

Some type of geometric flows on Riemannian and semi-Riemannian spaces

Arindam Bhattacharyya

Short abstract. In this talk various type of geometric flows such as Ricci flow, Yamabe flow and Einstein flow will be discussed in the contexts of Riemannian and semi-Riemannian spaces.

Discrete Finsler geometry and its applications

Behroz Bidabad and Maral Khadem Sedaghat

Abstract. Discrete differential geometry is the study of the corresponding notions of differential geometry that allows the use of geometry for computer programing. It has many recent applications in different branches of science and technology. In this work, we study the discrete Finsler geometry and its applications. Namely, we define the discrete Finslerian metric, the discrete Gaussian curvature on a weighted triangular mesh, the Finslerian discrete Ricci flow, and Ricci energy on the weighted triangular mesh. We prove that Finslerian discrete Ricci energy is strictly convex so it has a unique global minimum and the Finslerian discrete surface Ricci flow converges to this global minimum. Finally, we study the convergence of Finslerian discrete Ricci flow and prove the existence and uniqueness of the solutions and estimate its convergence rate.

Local minima for some functionals in the Calculus of Variations

Giovanni Molica Bisci

Abstract. In the last years, elliptic equations involving a nonsmooth term have attracted several outstanding mathematicians and the interest towards this kind of problems has grown more and more, not only for their intriguing analytical structure, but also in view of their applications in a wide range of contexts. Motivated by this wide interest in the literature, the leading purpose of this talk is to contribute to the understanding of nonsmooth elliptic equations, mainly related to a wide class of functionals defined through multiple integrals of Calculus of Variations. Applications to quasilinear boundary value problems will be analized and some open problems will be briefly discussed.

A study of the Tzitzeica curve's equation

Nicoleta Bîlă

Abstract. The Tzitzeica curve equation is an intriguing nonlinear ordinary differential equation arising in differential geometry that is satisfied by a space curve for which the ratio of its torsion and the distance from the origin to its osculating plane at an arbitrary point of the curve is constant. The class of curves has been introduced by the Romanian geometer Gheorghe Tzitzeica in 1911 in his study on affine invariants. Nowadays, there are known only few example of Tzitzeica curves defined explicitly in terms of the elementary functions. Interestingly, although the Tzitzeica curves have occurred occasionally in the mathematics literature, the ordinary differential equation defining these curves has not been studied extensively so far, maybe due to the fact that the Tziteica curves are defined by a nonlinear third-order ordinary differential equation whose unknowns are the curves defining functions. The aim of this talk is to present several techniques for finding Tzitzeica curves. A side condition involving the Wronskian of the curve's defining functions is considered along with a linear third-order linear ordinary differential equation and new solutions are derived. A new algorithms for finding explicit Tzitzeica curves is presented along with new Tzitzeica curves. Symmetry reductions related to the Tzitzeica's curve equation are analyzed as well.

Volume forms and first integrals for geodesically equivalent Finsler metrics

Ioan Bucătaru

Short abstract. Two geodesically equivalent Finsler metrics, on the same n-dimensional manifold, determine a set of n volume forms on the projective sphere bundle. The proportionality factors, between these volume forms, are geodesically invariant functions and hence they are first integrals. We provide an explicit formula for these first integrals using the characteristic polynomial of a (1,1)-type tensor derived from the angular metric.

Dual jet *h*-normal *N*-linear connections in time-dependent Hamilton geometry

Vladimir Balan, Mircea Neagu, Alexandru Oană

Short abstract. Within the framework of dual jet time-dependent Hamilton geometry, the local adapted components of the *h*-normal *N*-linear connection are determined, and the corresponding *d*-torsion and *d*-curvature are analyzed.

Relativistic Schrodinger equation and probability currents for spinless particles

David Carfi

Abstract. In this work, we face the problem of quantizing the relativistic Hamiltonian of a spinless particle (electrons, photons, etc.). In tempered distribution state spaces, we find the natural way to define the relativistic Hamiltonian operator and its associated relativistic Schrodinger equation. Then we deduce the equivalent relativistic continuity equation for the Born probability density and study some its different (but equivalent) expressions. We determine the possible probability currents and flux velocity fields associated with the particle dynamics. We provide the relativistic invariant expression for both relativistic Schrodinger equation and probability flux continuity equations.

Almost η-Ricci-Bourguignon Solitons on submersions from Riemannian submersions

Sudhakar Kumar Chaubey, Mohd. Danish Siddiqi, Sunil Yadav

A**bstract.** This research article attempts to explain the characteristics of Riemannian submersions in terms of almost η-Ricci-Bourguignon soliton, almost η-Ricci soliton, almost η-Einstein soliton, and almost η-Schouten soliton with the potential vector field. Also, we discuss the various conditions for which the target manifold of Riemannian submersion is η-Ricci-Bourguignon soliton, almost η-Ricci soliton, almost η-Einstein soliton, and almost η-Schouten soliton with the potential vector field and Killing vector field. Finally, we illustrate an example which verifies our results.

Oriented projective shape analysis

Seunghee Choi, Robert Paige, Vic Pătrăngenaru

Abstract. The pinhole camera is the ubiquitous model for well-focused imaging systems. This model describes how points in three dimensions are projected onto the camera's two-dimension image plane which represents a digital image, for instance. The geometric features of this projection have classically been described in terms of projective geometry. This framework is physically unrealistic in the sense that one ignores directional information, i.e. it is not assumed that the scene being imagined lies in front of the camera as we know it must. In has been noted in the computer vision literature that this is a problem and in fact results in greater sensitivity to measurement error. We take this directional information into account and develop the notion of oriented projective shape space. Simulation studies show that the resulting extrinsic statistical techniques for image data have greater statistical power then comparable statistical techniques which ignore directional information.

Some geometric inequalities on Metallic Riemannian manifolds

Majid Ali Choudhary

Short abstract. In this study, we prove some geometric inequalities giving relation between the Casorati curvature and the normalized scalar curvature for submanifold immersed into metallic Riemannian space forms endowed with semi-symmetric metric connection. In addition to above result, the characterization of submanifolds for which the equality holds is obtained. We also discuss some special cases of these inequalities.

A derivation of stress-strain relations, heat equation and balance equation of energy for visco-elastic media in classical irreversible thermodynamics

Vincenzo Ciancio

Abstract. By using a procedure of classical irreversible thermodynamics variable some possible interactions among heat conduction, viscous-elastic flows for media are studied. By introducing as an vectorial dynamic variable ξ, which influences thermal and diffusion phenomena, phenomenological equation for these variables are derived. A general vector, J consisting of heat flux, is introduced and it is shown that, in isotropic media, J can be split in two parts: the former governed by Fourier's law and the latter which satisfies Maxwell-Cattaneo-Vernotte equation. The balance equation of energy for visco-elastic media is obtained.

From Euclidean geometry to manifold theory and some basic properties of the curvature tensors in Riemannian geometry

Uday Chand De

Short abstract. In the present talk we explain how the notion of manifolds come from Euclidean geometry. Next some basic properties of curvature tensors in Riemannian geometry have been discussed. In particular, 2-dimensional and 3-dimensional Riemannian spaces have been considered.

On *CR* submanifolds of spheres

Mirjana Djoric

Abstract. When a manifold is endowed with a geometric structure, we have more opportunities to explore its geometric properties. The seven-dimensional unit sphere has the remarkable property of being a Sasakian manifold, with the almost contact metric structure (φ, ξ, η, g). We study its contact *CR* submanifolds, namely those that carry a φ-invariant distribution such that its orthogonal complement in the tangent space is φ-anti-invariant. Also, we recall some results about the *CR* submanifolds of six-dimensional sphere. There is a nearly Kähler almost complex structure *J* on the six-dimensional unit sphere, defined by the multiplication of Cayley numbers. A submanifold of a manifold with an almost complex structure is *CR*, if it has a holomorphic distribution such that its orthogonal complement in the tangent space is a totally real distribution. We present several examples of *CR* submanifolds of spheres which satisfy the equality sign in some Chen type inequalities.

Curvature properties of Riemannian manifolds with skew-circulant structures

Iva Dokuzova

Abstract. We consider a 4-dimensional Riemannian manifold M endowed with a right skew-circulant tensor structure *S*, which is an isometry with respect to the metric *g* and the fourth power of *S* is minus identity. We determine a class of manifolds (*M*,*g*,*S*), whose curvature tensors are invariant under *S*. For such manifolds we obtain properties of the Ricci tensor. Also we get expressions of the sectional curvatures of some special 2-planes in a tangent space of (*M*,*g*,*S*).

Spin 2 particle with anomalous magnetic moment in Riemann space-time, restriction to massless case, gauge symmetry

Igor Dudko, Vasiliy Kisel, Olya Vasilyuk, Vik'tor Red'kov

Abstract. The theory of massive and massless fields of spin 2 has always attracted attention, after the fundamental investigations of W. Pauli and M. Fierz. The most of these investigations have been performed by usinge 2-nd order equations. It is most likely that F.I. Fedorov is the one which who did the first study, by considering the 1-st order equations. It turned out that the spin 2 particle requires for its description a 30-component set of tensors. Besides, F.I. Fedorov proposed a more general theory, which is based on a 50-component set of tensors. It turned out that this theory describes the spin 2 particle with anomalous magnetic moment. In the present paper, we consider this theory in the presence of an arbitrary electromagnetic field, within a Riemannian space-time background. We first study the 50-component theory for a massive spin 2 particle. In such a generalized theory, there arises a non-minimal interaction with the curved space-time background through Ricci and Riemann tensors. It is important that the theory under consideration allows for a new and generalized massless limit for the spin 2 field. This fact is of special interest because, as it is well known, the conventional Pauli-Fierz theory for massless fields does not possess gauge symmetry in curved space-time, in particular, in models with zero Ricci tensor. We have shown that the a generalized theory possesses gauge symmetry in all the space-time models for which the Ricci tensor vanishes, a case which is the most interesting in physical applications of General Relativity.

Curvature properties of (t-z) -type plane wave metric

Sabina Eyasmin

Abstract. The objective of this paper is to obtain the curvature properties of (t - z)-type plane wave metric studied by Bondi, Pirani and Robinson in 1959. For this a general (*t*-*z*)-type wave metric [H. Bondi, E. Pirani, E. and Robinson, I., *Gravitational waves in General Relativity III. Exact plane waves*, Proc. Roy. Soc. 251, 1267 (1959), 519-533] is considered and the condition for which it obeys Einstein's empty spacetime field equations is obtained. It is found that the rank of the Ricci tensor of (*t*-*z*)-type plane wave metric is 1 and is of Codazzi type. Also it is proved that it is not recurrent but Ricci recurrent, conformally recurrent and hyper generalized recurrent. Moreover, it is semisymmetric and satisfies the Ricci generalized pseudosymmetric type condition $P.P = 1/3\ Q(Ric;P)$. It is interesting to note that, physically, the energy momentum tensor describes a radiation field with parallel rays and geometrically it is a Codazzi tensor and semisymmetric. As special case, the geometric structures of Taub's plane symmetric spacetime metric are deduced. Comparisons between (*t*-*z*)-type plane wave metric and pp-wave metric with respect to their geometric structures are viewed.

Chordality: from graphs to simplicial complexes

Gioia Failla

Abstract. This work is an interplay between algebraic combinatorics, graph theory and algebraic geometry. The *r*-th Veronese variety has been intensively studied in classical algebraic geometry. Recently the squarefree r-th Veronese subring of the polynomial ring over any field has been studied by many authors (J. Herzog, T. Hibi, K.A. Adripasito and others), since it is closely related to simplicial complexes (for *r=2*, the second squarefree Veronese subring is related to the simple complete graph). We study the simplicial complex associated to the third squarefree Veronese subring, we introduced new concepts and properties in order to find families of pure simplicial subcomplexes of dimension 2, that are connected, ridge-chordal and satisfying a certain combinatorial property P. From the algebraic point of view we study the intersection degree of the third squarefree Veronese subring, proving a structure theorem for the generators of certain pricipal colon ideals of the subring.

On symmetry reduction and some classes of invariant solutions of the (1+3)-dimensional inhomogeneous Monge-Ampère equation,

Vasyl Fedorchuk, Volodymyr Fedorchuk

Abstract. A solution of many problems of the geometry, theoretical physics, meteorology and oceanography has been reduced to the investigation of the Monge-Ampère equations in spaces of different dimensions and different types. In our talk, we study the relationship between structural properties of the three-dimensional nonconjugate subalgebras of the same rank of the Lie algebra of the Poincaré group P(1,4) and the properties of reduced equations for the (1+3)-dimensional inhomogeneous Monge-Ampère equation. Some classes of invariant solutions are constructed. We present a comprehensive account of our obtained results.

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Hopf bifurcations and dynamics in energy models: new results and perspectives

Mariangela Gangemi, Massimiliano Ferrara, Bruno Antonio Pansera, Luca Guerrini

Abstract. In this talk we will examine the consequences of including distributed delays in an energy model. In particular, we will present a model that has been developed starting from C.L. Dalgaard and H. Strulik's model (2011), a mathematical model of an economy viewed as a transport network for energy. The new model has been developed by C. Bianca et al. (2013a), modifyingthe model by C.L. Dalgaard and H. Strulik (2011) with theassumption that the energy conservation formula would be influenced by a time delay; they have showed that the dynamics of the systemis characterized by a delay differentialequation. The stability behaviour of the resulting equilibrium for our dynamic system is analyzed including models with Dirac, weak and strong kernels. Applying the Hopf bifurcation theorem we will determine conditions under which limit cycle motion is born in such models. The results indicate that distributed delays have an ambivalent impact on the dynamical behaviour of systems, either stabilizing or destabilizing them.Afterwards, based on V.I.Yukalov et al. (2009), C. Bianca et al. (2013b) have adapted their ideas and proposed a generalization by introducing a logistic-type equation for population with delayed carrying capacity. In their study they have analyzed the consequences of replacing time delays with distributed time delays. C. Bianca et al. (2013b) have showed that the destructive impact of the agents on the carryingcapacity leads the system dynamic behaviour to exhibit stability. switches and Hopf bifurcations to occur.Now we will organize a new proposal in this direction.

On a Bernstein-type theorem for minimal surfaces with Matsumoto metric

Ranadip Gangopadhyay and Bankteshwar Tiwari

Short abstract. In this paper we characterize a minimal surface with Matsumoto metric and prove a Bernstein-type theorem for surfaces which are graphs of smooth functions. We also obtain the partial differential equation that characterizes the minimal translation surfaces and show that plane is the only such surface.

Kenmotsu metric as conformal η-Ricci soliton

Dipen Ganguly

Abstract. The present paper is to deliberate the class of Kenmotsu manifolds which admits conformal η-Ricci soliton. Here, we have characterized conformal eta-Ricci soliton on Kenmotsu manifolds. We have also studied gradient conformal η-Ricci soliton on Kenmotsu manifold. We have discussed the invariance of conformal η-Ricci soliton on Kenmotu manifolds under generalized *D*-conformal deformation. Finally we have constructed an example for the existence of conformal η-Ricci soliton in Kenmotsu manifold.

Nonexistence of local conservation laws for generalized Swift-Hohenberg equation

Pavel Holba

Short abstract. In this talk we prove that the generalized Swift-Hohenberg equation with nonlinear right-hand side, a natural generalization of the Swift-Hohenberg equation arising in physics, chemistry and biology and describing inter alia pattern formation, has no nontrivial local conservation laws. Further details can be found in the paper P. Holba, J. Math. Chem. 59 (2021), 1474–1478 (arXiv:2001.05766).

Certain submanifolds of generalized space forms

Shyamal Kumar Hui

Short abstract. In this talk we discuss totally umbilical, *f*-biharmonic and bi-*f*-harmonic submanifolds of generalized space forms. This talk also includes two optimal inequalities for the Casorati curvatures of submanifolds of generalized space forms.

On the second moment stability of delayed switching linear systems

Issam El-Hamdi

Short abstract. This Talk presents simple-to-check condition to assure the second moment stability for delayed switching linear systems. The switching signal acting on the autonomous system is driven by stochastic process. The considered delay assumes a particular form and varies stochastically which produces a intervals that follow independent, identically distributed stochastic processes.

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The eigenvalues problem for helicity operator for a spin 2 particle in cylindric coordinates

Alina Ivashkevich, Olya Vasiluyk, Anton Buryy, Viktor Red'kov

Abstract. The explicit form of the helicity operator for the symmetric 2-nd rank tensor describing the spin 2 particle is specified in cylindrical coordinates. The presence of the external uniform magnetic field is taken into account. After separating the variables, the system of 10 differential first order equations is derived. It is split into two independent subsystem of of 4 and 6 equations. The system of four equations is solved straightforwardly in terms of confluent hypergeometric functions, and the corresponding eigenvalues and eigenfunctions are determined. The subsystem of six equations can be reduced to one ordinary differential equation of the 4-th order. Its Frobenius type solutions may be constructed, and their study is in progress; it is expected to find the eigenvalues of the helicity operator by using the known transcendency condition for Frobenius solutions.

On the matrix equation for a spin 2 particle in pseudo-Riemannian space-time. II. Separating the variables in spherical coordinates.

Alina Ivashkevich, Anton Buryy, Elena Ovsiyuk, Vladimir Balan, Vasiliy Kisel, Viktor Red'kov

Abstract. In the present paper we develop the theory of the massive spin 2 field, extended to the generally covariant theory within the Tetrode-Weyl-Fock-Ivanenko tetrad method. Such an equation is specified in spherical coordinates of the Minkowski space. We separate the variables by diagonalizing the square and the third projection of the total angular momentum, at this the formalism of Wigner D-function is applied instead of spin-weight harmonics. As a result, we derive the radial system of differential equations of the first order. From these we derive the 2-nd order radial equation for components referring to symmetric tensor of and scalar involved in description of the spin 2 field. The radial system is divided into two more simple subsystem which describe states with opposite spatial parities. We find in closed form some exact solutions for such subsystems. Restriction in radial equation to the massless spin 2 field is possible. Extension of the developed procedure of separating the variables to arbitrary space-time model with spherical symmetry does not require new ideas.

η-Ricci-Yamabe solitons on anti-invariant submanifolds of trans-Sasakian manifold admitting Zamkovoy connection

Payel Karmakar

Short Abstract. In this talk, η-Ricci-Yamabe solitons on Ricci flat, concircularly flat, *M*-projectively flat and pseudo-projectively flat anti-invariant submanifolds of trans-Sasakian manifold admitting Zamkovoy connection have been discussed.

Flag curvature of left invariant (α,β)-metrics of tangent Lie groups

Gauree Shanker, Jaspreet Kaur

Short abstract. We provide an explicit formula for computing the flag curvature of left-invariant m-Kropina metrics; we study the flag curvature for lifted left invariant metrics in the 4-dimensional Lie group case.

Screen bi-slant lightlike submanifolds of indefinite Kaehler manifolds

Tejinder Kumar, Sangeet Kumar

Abstract. In our talk, we examine screen bi-slant lightlike submanifolds of indefinite Kaehler manifolds. We obtain a characterization result for the existence of screen bi-slant lightlike submanifolds of indefinite Kaehler manifolds. Then, we derive a necessary and sufficient condition for the induced connection on a screen bi-slant lightlike submanifold to be a metric connection. Further, we derive the integrability conditions for the various distributions associated with such submanifolds. Finally, we focus on the study of totally umbilical screen bi-slant lightlike submanifolds of indefinite Kaehler manifolds.

Some measures of noncompactness and their applications

Eberhard Malkowsky

Abstract. Measures of noncompactness are very useful tools in functional analysis, for instance in metric fixed point theory and the theory of operator equations in Banach spaces. They are also used in the studies of functional equations, ordinary and partial differential equations, fractional partial differential equations, integral and integro--differential equations, optimal control theory, and in the characterizations of compact operators between Banach spaces. We present an axiomatic introduction to measures of noncompactness on bounded subsets of complete metric spaces, and also the alternative axiomatic approaches by Banaś and Goebel and by Akhmerov et al. for measures of noncompactness in Banach spaces. As examples, we consider the Kuratowski, Hausdorff and separation measures of noncompactness and their most important properties. The Kuratowski measure of noncompactness is used in Darbo's fixed point theorem. Furthermore we study the notion of measures of noncompactness of operators between Banach spaces and some of their properties. Finally we give a few applications to the characterization of compact linear operators between certain BK spaces and to some results concerning the solvability of intergral equations.

Almost Ricci-like solitons with torse-forming vertical potential of constant length on almost contact B-metric manifolds

Mancho Manev

Short abstract. A generalization of Ricci-like solitons with torse-forming potential, which is constant multiple of the Reeb vector field, is studied. The conditions under which these solitons are equivalent to almost Einstein-like metrics are given. Some results are obtained for a parallel symmetric second-order covariant tensor. Finally, an explicit example of an arbitrary dimension is given and some of the results are illustrated.

Curvature inheritance symmetry in Finsler spaces

Chayan Kumar Mishra

Abstract. Katzin et al. [G. H. Katzin, J. Levine, and W. R. Davis, J. Math. Phys. 10, 617 (1969)] introduced curvature collineations (CC), defined by a vector, satisfying $\pounds_v R^i_{jkh}=0$, where R^i_{jkh} is the Riemann curvature tensor of a Riemannian space V_n and $\pounds_v$ denotes the Lie derivative. They proved that a CC is related to a special conformal motion which implies the existence of a covariant constant vector field. Unfortunately, recent study indicates that the existence of a covariant constant vector restricts V_n to a very rare special case with limited physical use. In particular, for a fluid space time with special conformal motion, either stiff or unphysical equations of state are singled out. Moreover, perfect fluid space times do not admit special conformal motions. This information was not available, in 1969, when CC symmetry was introduced. CC is generalized to another symmetry called ''curvature inheritance'' (CI) satisfying $\pounds_v R^i_{jkh}=2\alpha R^i_{jkh}$, where α is a scalar function. They prove that a proper CI (i.e., $\alpha\neq 0$) has direct interplay with the physically significant proper conformal motions. Some other authors S. P. Singh. extended the concept of curvature inheritance in Finsler space[8]. Projective curvature inheritance in Finsler Spaces [9]. The aim of this paper is to discuss the curvature inheriting symmetry in Finsler space and Torse-forming curvature inheritance in Finsler space.

Semple Towers in algebraic geometry – how to interpret them in differential geometry?

Piotr Mormul

Abstract. In his paper *Chains of points in the Semple Tower*, M. Lejeune-Jalabert recapitulated the main construction proposed in J. G. Semple's paper from the year 1954:

• At each point P on the n-th stage $M(n)$ of the tower over a nonsingular variety M of dimension r, there is a linear subspace FP of dimension r of the tangent space to $M(n)$ at P, which contains the tangents to every n-th derivate of a curve C in M, which happens to pass through P. This FP is called focal. The next stage $M(n+1)$ is thus defined to be *the model of focal 1-st order element E1 on* $M(n)$, namely pairs (P,L) where L is a line in the focal space FP at P on $M(n)$. In the paper *Multi-dimensional Cartan prolongation and special k-flags* (2004) there is given the definition of a generalized Cartan prolongation:

•• If D is a rank $(n+1)$ distribution on a manifold M, then, regarding D as a vector bundle, its projectivization π: $\boldsymbol{P}D \to M$ is a bundle over M, whose typical fiber $(\boldsymbol{P}D)_p$ is the space of 1-dimensional linear subspaces of the $(m+1)$-dimensional vector space D_p. Thus, the fibers of $\boldsymbol{P}D$ are isomorphic to $\boldsymbol{PR}^m$ as projective m-spaces. There is a canonical rank-$(m+1)$ distribution $D^{(1)}$ on $\boldsymbol{P}D$ defined by setting $D^{(1)}{}_\xi = (\pi')^{-1}(\xi)$ for each linear subspace $\xi \subset D_p$. This distribution $D^{(1)}$ is called the [generalized] Cartan prolongation of D.

These two approaches, • and ••, are fairly close to each other. It will be explained in the talk – how close they are, and which might be the added value.

Lorentzian contact Hom-Lie algebras

Leia NourmohammadiFar, Esmaeil Peyghan

Short abstract. In the present paper, we introduce Lorentzian almost contact Hom-Lie algebras. Also, we give the notion of Lorentzian Sasakian Hom-Lie algebras. We present examples of such structures. The curvature tensor properties of Lorentzian Sasakian Hom-Lie algebras are investigated. It is proved that if the Ricci tensor of Lorentzian Sasakian Hom-Lie algebras is η-parallel, then the scalar curvature is constant.

Hydrogen atom in spherical space, Dirac theory, exact solutions and energy spectrum

Elena Ovsiyuk, Vladimir Balan, Artem Koralkov

Abstract. The known systems of radial equations describing the relativistic hydrogen atom on the base of the Dirac equation in spherical Riemann space, is investigated. The relevant 2-nd order differential equation has six regular singular points; its solutions of Frobenius type are constructed. To produce the quantization rule for energy values, we use the known condition which separates the transcendental Frobenius solutions. The convergence of the involved series is studied analytically. The squared integrability of solutions is numerically verified.

Spin 1/2 particles with two mass parameters in external Coulomb field

Elena Ovsiyuk, Vladimr Balan, Artem Koralkov, Artur Safronov

Abstract. The generalized equation for a spin 1/2 particle with two mass parameters is studied in presence of the external Coulomb field. After separating the variables, the problem reduces to a system of 8 the first order differential equations. Taking into account the diagonalization of the space reflection operator, we derive two independent subsystems of 4 equations, referring to states with opposite parity. In each case, we derive two systems of linked 2-nd order equations, referring to states with different parities. They lead to 4-th order differential equations for separate functions. Their solutions of Frobenius type are constructed, which involve power series with 13-terms recurrent relations. Two solutions are shown to appropriately describe physical bound states in the system. As a quantization rule we apply the known transcendency condition, so deriving two analytical formulas for energy levels. They are similar to relativistic spectra for ordinary spin 1/2 particle, but being governed respectively by different masses, M_1 and M_2.

Geometry of lift metrics and lift connections on tangent bundle,

Esmaeil Peyghan, Davood Seifipour

Short abstract. The purpose of this paper is study of lift metrics and lift connections on TM. Also we investigate the statistical and Codazzi couples of TM and their geometric consequences. At the end we prove one theorem about 1-Stein and Osserman structure on TM, whenever TM is equipped with a lift connection.

Discrete geometry and Lagrangians

Marcela Popescu, Paul Popescu, Higinio Ramos

Short abstract. Our aim is to consider a given continuous Lagrangian and to construct directly discrete approximations of the corresponding Euler-Lagrange equation. This is done without considering a discrete Lagrangian and a variational process, nor by using a difference equation of geodesics. Some numerical examples are included to compare the performance of the proposed approximations versus the classical Veselov approach.

Invariant connections on Lie groups (II)

Gabriel-Teodor Pripoae and Cristina-Liliana Pripoae

Short abstract. In this paper, our study [Invariant connections on Lie groups (I), BJGA 2019, no.1, 51-64] is extended, for investigation of the sets of the left invariant and of the bi-invariant connections on Lie groups, endowed with some additional properties: symmetry, flatness, Ricci-flatness, mixed flatness, etc. Examples of some special (and sometimes new) types of invariant connections are provided.

Golden generic lightlike submanifolds of a Golden semi-Riemannian manifolds

Megha Pruthi, Sangeet Kumar

Abstract. In the present talk, we study the concept of golden generic lightlike submanifolds of a golden semi-Riemannian manifold. After defining golden generic lightlike submanifold, we present one non-trivial example of this class of lightlike submanifolds. Then, we derive necessary and sufficient conditions for the induced connection of golden generic lightlike submanifolds to be a metric connection. Further, we establish a characterization result for the integrability of the distributions associated with golden generic lightlike submanifolds. We also show that for a totally umbilical golden generic lightlike submanifold, the distribution D is always integrable. Finally, we analyze minimal generic lightlike submanifolds of a golden semi-Riemannian manifold.

Results on quasi-*Einstein metric

Savita Rani, Ram Shankar Gupta

Short abstract. We study quasi-*Einstein metric on Sasakian/(κ,μ)-manifolds. We show that on Sasakian manifolds the *-Ricci operator commutes with tensor field φ and quasi-*Einstein Sasakian metric is *-flat. Further, we study (κ<1,μ)-manifolds with quasi-*Einstein metric and obtain that such manifold is *-flat or locally isometric to En+1 × Sn(4) or *Einstein.

On the mixed scalar curvature of almost multi-product manifolds

Vladimir Rovenski

Abstract. Riemannian manifolds with $k>2$ orthogonal complementary distributions (called Riemannian almost multi-product manifolds) appear in such topics as multiply warped products and the webs composed of several foliations. In this talk, we introduce a curvature invariant (called mixed scalar curvature) of a Riemannian almost multi-product manifold and consider two topics with it.

1. We prove a new integral formula with this curvature, generalizing the classical result for $k=2$, and give applications to splitting and isometric immersions of Riemannian manifolds.

2. We find Euler-Lagrange equations for an Einstein-Hilbert type action with respect to the adapted variations of metric, and present them in a beautiful form of the Einstein equation.

References

[1] V. Rovenski, *Integral formulas for a Riemannian manifold with several orthogonal complementary distributions*, Global J. of Advanced Research on Classical and Modern Geometries, Vol. 10, (2021), Issue 1, 32-43.

[2] V. Rovenski, *The Einstein-Hilbert type action on almost k-product manifolds*, Balkan J. Geom. and Its Appl. 26, 1, (2021), 81-92.

On concircular transformations and the Ricci tensor

Samaneh Saberali

Short abstract. We characterize Finsler manifolds admitting a concircular transformation such that the difference of the two Ricci tensors is a constant multiple of the metric.

Study of *-Yamabe solitons on Kenmotsu manifolds with quarter-symmetric metric connection

Soumendu Roy

Short abstract. The talk discusses *-Yamabe solitons on Kenmotsu manifolds with respect to quarter-symmetric metric connection. We describe the characteristics of the soliton on the manifold, assuming that it satisfies certain conditions.

Eigenvalues of (p,q)-Laplace system along the forced mean curvature flow

Apurba Saha, Shahroud Azami, Shyamal Kumar Hui

Abstract. We consider a smooth, compact and strictly convex hypersurface (M^n,g) without boundary embedded in $\mathbf{R}^{n+1}$ and the corresponding metric $g(t)$ as a solution of the forced mean curvature flow. We study the evolution formula of the first nonzero eigenvalue of the (p,q)-Laplace system along the forced mean curvature flow. Under certain imposed conditions, we infer various monotonicity formulas for the first eigenvalue of the (p,q)-Laplace system along the forced mean curvature flow.

New integrable systems in four independent variables from contact geometry

Artur Sergyeyev

Abstract. We present a large new class of integrable in the sense of soliton theory partial differential systems in four independent variables (4D), thus showing inter alia that there is significantly more of such systems than it appeared before. In particular, we show that the class in question, found using a novel kind of Lax pairs related to contact geometry, contains two new explicit infinite families of 4D integrable systems and a first example of a 4D integrable system with a nonisospectral Lax pair which is algebraic rather than rational in the spectral parameter. For further details please see A. Sergyeyev, Lett. Math. Phys. 108 (2018), no. 2, 359-376 (arXiv:1401.2122) and A. Sergyeyev, Appl. Math. Lett. 92 (2019), 196-200 (arXiv:1812.02263).

Lorentzian concircular structure manifolds and Ricci solitons

Absos Ali Shaikh

Abstract. This lecture is delineated with the study of Lorentzian concircular structure (briefly, LCS) manifolds and Ricci solitons. A CS-spacetime is a 4-dimensional connected smooth LCS-manifold. It is shown that in a CS-spacetime, the fluid has vanishing vorticity and vanishing shear. It is found that in an LCS-manifold *grad* α is an irrotational vector field, where α is a non-zero smooth scalar function. It is proved that in a CS-spacetime with generator vector field ξ obeying Einstein equation, $T(\xi; \xi) > 0$ or<0 according as $\rho>\alpha^2$ or $\rho< \alpha^2$, where ρ is a scalar function and T is the energy momentum tensor. Also, it is shown that if X is a non-null spacelike (respectively, timelike) vector field on a CS-spacetime with scalar curvature r and cosmological constant Λ, then $T(X, X) > 0$ if and only if $r > 2\Lambda$ (resp. $r <2\Lambda$), and further $T(X;X) = 0$ if and only if $r = 2\Lambda$. The nature of the scalar curvature of an LCS-manifold admitting Yamabe soliton is obtained. Also, it is proved that an LCS-manifold admitting η-Ricci soliton is η-Einstein and its scalar curvature is constant if and only if α is constant. Further, it is shown that if β is a scalar function with $\beta = -(\xi\rho)$ and $2\alpha\rho - \beta$ vanishes, and then the gradients of α, β, ρ are co-directional with the generator ξ. In a perfect fluid CS-spacetime admitting η-Ricci soliton, it is proved that the pressure density p and energy density σ are constants, and if it agrees Einstein field equation, then the scalar curvature is constant if and only if the energy density is constant. If such a spacetime possesses Ricci collineation, then it must admits an almost η-Yamabe soliton and the converse holds when the Ricci operator is of constant norm. Also, in a perfect fluid CS-spacetime satisfying Einstein equation, it is shown that if Ricci collineation is admitted with respect to the generator ξ, then the matter content cannot be perfect fluid, and further $\kappa(p - \sigma) \neq 2\Lambda$ with gravitational constant κ implies that ξ is a Killing vector field. Finally, in an LCS-manifold, it is proved that if the CL-curvature tensor is conservative, then scalar potential and the generator vector field are co directional, and if the manifold possesses pseudosymmetry due to the CL-curvature tensor, then it is an η-Einstein manifold.

Existence of geodesics in homogeneous (α,β)-spaces.

Gauree Shanker, Seema Jangir, Jaspreet Kaur

Short abstract. In this paper, we find necessary and sufficient condition for a non zero vector to be a geodesic vector in homogeneous generalized *m*-Kropina space and homogeneous Matsumoto space.

Study on warped product of screen real lightlike submanifolds of golden semi-Riemannian manifolds

Gauree Shanker, Ramandeep Kaur, Ankit Yadav

Short abstract. We investigate the geometry of the warped product of screen real lightlike submanifolds of golden semi-Riemannian manifolds.

Semi-transversal lightlike submanifolds of indefinite nearly Kahler manifolds

Gauree Shanker, Ankit Yadav, Ramandeep Kaur

Short abstract. In our work, we prove the non-existence of totally umbilical proper semi-transversal lighlige submanifolds of Kahler manifolds of constant type with constant holomorphic sectional curvature.

Some problems on sprays

Zhongmin Shen

Short abstract. In this talk, we discuss several geometric quantities of sprays and their relationship. In particular, we discuss sprays of isotropic curvature and scalar curvature, and sprays with flat Ricci curvature. The study on sprays will lead to a better understanding on Finsler metrics.

Generalized Wintgen inequality for submanifolds in standard warped product manifolds

Aliya Naaz Siddiqui, Ali Hussain Alkhaldi, Kamran Ahmad and Lamia Saeed Alqahtani

Abstract. Roth [Bull. Aust. Math. Soc. 95 (2017), 495-499] gave a result for DDVV inequality submanifolds of warped product manifolds. Then Murathan et al. [J. Geom. 109 (2018), 30] obtained the Wintgen-like inequality for statistical submanifolds of statistical warped product manifolds. Recently, Gorunus et al. [Inter. Elec. J. Geom. 12(1) (2019), 43-56] established the generalized Wintgen inequality for Legendrian submanifolds in almost Kenmotsu statistical manifolds. Thus, in the present talk, we find the generalized Wintgen inequality for a Legendrian submanifold in the standard warped product manifolds.

Solitons and gradient solitons on perfect fluid spacetime in $f(R,T)$ gravity

Mohd Danish Siddiqi

Abstract. In this research paper, we study about perfect fluid spacetime in $f(R,T)$ gravity with Killing velocity vector field in terms of Ricci soliton, gradient Ricci soliton, Yamabe soliton, and gradient Yamabe soliton. Besides this, we evaluate a specific situation when the potential vector filed is of gradient form, we extract a modified Poisson, and Liouville equation from the Ricci soliton equation. In addition, we explore some harmonic significance of Ricci soliton on perfect fluid spacetime in $f(R,T)$ gravity with a harmonic potential function.

Generalized geometrical structures on cosmological models

Panayiotis Stavrinos

Abstract. Some fundamental cosmological models as Friedmann-Robertson-Walker, Schwarschild and Scalar-Tensor theories are presented equipped with generalized geometrical structures of locally-anisotropic character. Friedmann equations are derived in different models by generalized field equations. We show that the introduction of a vector or scalar field in the metric stucture of spacetime deforms the traditional field equations and influences the evolution and the acceleration of the universe which are given in the framework of general relativity. In addition, this field perturbes the geodesic equation and can spontaneously break the Lorentz symmetry. Finally, generalized Raychaudhuri equations are presented and the field equations are obtained on the tangent bundle for a weak anisotropic field. From one kind cosmological model some applications are provided.

Harmonic Finsler manifolds of (α,β)-type

Ebtsam Hassan Taha

Short abstract. Within the framework of Finsler spaces, we construct a new class of harmonic and asymptotically harmonic Finsler manifolds of (α, β)-type. This class is defined by a Riemannian metric α and a special 1-form β.

Lambert functions in the analysis of composed white and $1/f$ noises in physical systems

Horia-Nicolai Teodorescu

Short abstract. We describe a new application where Lambert W functions plays a role. The noise-equilibrium frequency of a physical process (or device) is defined as that frequency where the combinations of white and $f^{-\alpha}$ are equal. Finding the noise-equilibrium frequency leads to Lambert function. When the parameters of the described system are seen as equation parameters, a set of surfaces describe the respective family of physical systems.

Analysis of a predator-prey model for pathogenic viruses

Gheorghe Țigan

Short abstract. A three-dimensional predator-prey model for describing interactions between white blood cells and a pathogenic virus is proposed and studied. The interactions are modelled by a refined predator-prey method. A mathematical analysis based on dynamical systems theory is used to study different properties of the model.

Dynamics of a four-dimensional economic model with control

Gheorghe Țigan, Oana Brandibur, Ariana Găină

Short abstract. The interdependencies between interest rates, investment demands and inflation rates in a given economy have a continuous dynamics. A control law to a three dimensional model is proposed in the present work. The behavior of the new four dimensional system is studied. In particular, transcritical, pitchfork and Hopf bifurcations are obtained.

Slant helices in Minkowski 3-space E^3_1 with Sasai's modified frame fields

Siraj Uddin, Mica Stankovic, Mohd Iqbal, Sarvesh Kumar Yadav, Mohd Aslam

Short abstract. In this paper, we study slant helix using modified orthogonal frame in Minkowski space E^3_1 with timelike, lightlike and spacelike axes. We also study a general slant helix with the Killing vector field axis. Furthermore, we give a non-trivial example and find the relations for curvature and torsion of f-biharmonic slant helix.

Approximation of flatness on Riemannian manifolds

Constantin Udrişte, Gabriel-Teodor Pripoae, Ionel Țevy, Iulia Elena Hirică

Abstract. This paper covers four problems of differential geometry:

(i) introducing and studying the Euler–Lagrange prolongations of flatness PDEs solutions (best approximation of flatness) via associated least squares Lagrangian densities and integral functionals on Riemannian manifolds;

(ii) analyzing some decomposable multivariate dynamics represented by Euler–Lagrange PDEs of least squares Lagrangians generated by flatness PDEs and Riemannian metrics;

(iii) giving examples of explicit flat extremals and non-flat approximations;

(iv) finding some relations between geometric least squares Lagrangian densities.

A new Ricci curvature tensor and kind of promising non-Riemanian quantity

Semail Ülgen, Esra Sengelen, Zhongmin Shen

Short abstract. In this talk we discuss several Ricci curvature tensors and their relationship with the Ricci curvature and some non-Riemannian quantities. By these Ricci curvature tensors, we shall have a better understanding on the non-Riemannian quantities.

Flatness PDEs on affine manifolds

Constantin Udrişte, Gabriel-Teodor Pripoae, Ionel Ţevy, Iulia Elena Hirică

Abstract. The first goal is to study some strong partial differential equations (PDEs) that imply curvature-flatness, in the cases of both symmetric and non-symmetric connection. Although the curvature-flatness idea is classic for symmetric connection, our main theorems about flatness solutions are completely new, leaving for a while the point of view of differential geometry and entering that of PDEs. The second goal is to introduce and study some strong partial differential relations associated to curvature-flatness. The third goal is to introduce and analyze some vector spaces of exotic objects that change the meaning of a generalized Kronecker delta projection operator, and to discover new PDEs implying curvature-flatness.

On WDVV equations

Jakub Vašíček, Raffaele Vitolo

Short abstract. In this talk we show that, in low dimensions, the WDVV equations are bi-Hamiltonian. The invariance of the bi-Hamiltonian formalism is proved for N=3. More examples in higher dimensions show that the result might hold in general. The invariance group of the bi-Hamiltonian pairs that we find for WDVV equations is the group of projective transformations.

Some operators on the generalised Hahn space

Vesna Veličković

Abstract. We establish the characterisations of the classes of bounded linear operators from the generalised Hahn sequence space h_d, where d is an unbounded monotone increasing sequence of positive real numbers, into the spaces w_0^p, w^p and w_∞^p of sequences that are strongly summable to zero, strongly summable and strongly bounded by the Cesàro method of order one and index p for $1\leq p<\infty$. Furthermore, we give estimates for the Hausdorff measure of noncompactness of bounded linear operators from h_d into w^p and identities for the Hausdorff measure of noncompactness of bounded linear operators from h_d to w_0^p. We use these results to characterise the classes of compact operators from h_d to w_0^p and w^p. Finally, we provide an example for some applications of our results and visualisations in crystallography.

A distributed delay model which describes the thyroids - pituitary axis

Loredana Flavia Vesa, Mihaela Neamţu

Abstract. A mathematical model with distributed time delays describing the hypothalamus-pituitary-thyroid axis in autoimmune (Hashimoto's) thyroiditis is built and analyzed. In the modeling process, we consider four variables: the concentration of thyroid stimulating hormone TSH(t), the concentration of free thyroxine FT4(t), the functional size of thyroid gland T(t), the concentration of anti-thyroid antibodies Ab(t). The delayed model is analyzed regarding the stability and bifurcation behavior. Numerical simulations are carried illustrating the effectiveness of our results and conclusions.