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Holomorphy via integral geometry

The talk will be devoted to the problem of characterization of holomorphic, or, more generally, Cauchy-Riemann functions and manifolds in terms of vanishing Abel-Radon transform, integrating holomorphic differential 1-forms over varieties of curves.

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New results on functions convex in one direction

We continue the study of the class of functions convex in one direction. In particular, we provide a new distortion theorem and find the connection between geometric features of the image and Bloch's property. We also establish analytic conditions which determine such geometric properties of those functions as the location of their images in either a half-plane or a strip, and their containing either a half-plane or a strip. Our approach is based on the fact that these functions are linearization models for dynamical systems of parabolic type.

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Quasiisometry from different points of view

In the talk we provide various characterizations of quasiisometric homeomorphisms in $\mathbb{R}^n$ raised by geometric, metric, analytic and modular approaches.

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Dynamics of quasiconformal fields

A uniqueness theorem is established for autonomous systems of ODEs, $\dot{x} = f(x)$, where f is a Sobolev vector field with additional geometric structure, such as delta-monotonicity or reduced quasiconformality. Specifically, through every non-critical point of f there passes a unique integral curve.

A joint work with L. Kovalev and J. Onninen.

Stanislawa Kanas

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Harmonic mappings related to some fixed analytic functions

A definition of the harmonic Schwarzian derivative, using the differential geometry of associated minimal surface, has been proposed by Chuaqui, Duren and Osgood (Chaquai M., Duren P. and Osgood B., *The Schwarzian derivative for harmonic mappings*, J. Analyse Math. **91**(2003), 329–351). In connection with harmonic Schwarzian derivative we define the harmonic pre-Schwarzian derivative, which in the analytic case becomes f''/f'.

Among others we study bounds of the norm of the harmonic pre-Schwarzian derivative for harmonic functions $f = h + \bar{g}$ with fixed function h.

A joint work with D. Klimek-Smęt (Maria Curie-Skłodowska University, Poland).

Gabriela Kohr

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Generalized Loewner differential equations in several complex variables. Applications

In this talk we survey recent results in the theory of univalent subordination chains and the generalized Loewner differential equations on the Euclidean unit ball in $\mathbb{C}^n$. We discuss the most general form of the initial value problem for the transition mapping, and we deduce the existence and uniqueness of solutions. We also determine the form of the standard solutions to the generalized Loewner differential equation associated with non-normalized subordination chains with normalization given by a time-dependent linear operator. Finally various applications will be provided.

This talk is based on joint work with Ian Graham (Toronto), Hidetaka Hamada (Fukuoka) and Mirela Kohr (Cluj-Napoca).

Mirela Kohr

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Potential theory for elliptic boundary value problems on Lipschitz domains

In this talk we consider special boundary value problems of transmission type for elliptic operators on Lipschitz domains in compact Riemannian manifolds and various function spaces. A layer potential method is used to prove that these problems are well-posed. Compactness and invertibility results of related layer potential operators are also presented.

Vesna Manojlović

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Gromov hyperbolicity and quasihyperbolic geodesics

We characterize Gromov hyperbolicity of the quasihyperbolic metric space (Ω, k) by geometric properties of the Ahlfors regular length metric measure space (Ω, d, μ). The characterizing properties are called the Gehring–Hayman condition and the ball–separation condition.

A joint works with Pekka Koskela and Päivi Lammi.

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The Schwarz type inequalities for plane harmonic mappings in the unit disk

The classical harmonic counterpart of the Schwarz Lemma stands that for every harmonic mapping F of the unit disk $\mathbb{D}$ into itself keeping the origin fixed the following inequality holds

$$|F(z)| \leq \frac{4}{\pi} \arctan |z|, \quad z \in \mathbb{D}.$$

In this presentations we discuss such type of inequalities under various assumptions on $F : \mathbb{D} \to \mathbb{D}$, like e.g.:

(i) F is the harmonic extension to $\mathbb{D}$ of a homeomorphic self-mapping f of the unit circle $\mathbb{T}$ onto itself which admits a quasiconformal extension to $\mathbb{D}$;

(ii) F is the harmonic extension to $\mathbb{D}$ of a homeomorphic self-mapping f of $\mathbb{T}$ onto itself which keeps the points z, satisfying $z^3 = 1$, fixed.

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On a variant of a result by Pavlović for harmonic mappings of the unit disk onto bounded convex domains

For a sense-preserving univalent harmonic self-mapping F of the unit disk, Pavlović showed that F is quasiconformal iff F is bi-Lipschitz. He gave another characterization,too, for the quasiconformality of F by means of some properties of the boundary-valued mapping of F.

In this presentations we discuss a variant of the result by Pavlović for sense-preserving univalent harmonic mappings of the unit disk onto bounded convex domains.

This is a joint work with Dariusz Partyka.

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Quasiconformal extension of strongly spirallike functions

Fait, Krzyz, and Zygmunt showed that a strongly starlike function of order α extends to a $\sin(\pi\alpha/2)$-quasiconformal mapping of the complex plane. We generalized this result to strongly spirallike functions of order α with the same dilatation bound.

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Sub-Riemannian structures corresponding to Kahlerian metrics on the universal Teichmuller space and curve

We consider the group of sense-preserving diffeomorphisms Diff S^1 of the unit circle and its central extension, the Virasoro-Bott group, with their respective horizontal distributions chosen to be Ehresmann connections with respect to a projection to the smooth universal Teichmüller space and the universal Teichmüller curve associated to the space of normalized univalent functions. We find formulas for the normal geodesics with respect to the pullback of the invariant Kählerian metrics, namely, the Velling-Kirillov metric on the class of normalized univalent functions and the Weil-Petersson metric on the universal Teichmüller space. The geodesic equations are sub-Riemannian analogues of the Euler-Arnold equation and lead to the CLM, KdV, and other known non-linear PDE.

A joint work with Erlend Grong and Irina Markina.

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Teichmüller's extremal problem in the n-space

Teichmüller's classical mapping problem for plane domains concerns finding a lower bound for the maximal dilatation of a quasiconformal homeomorphism which holds the boundary pointwise fixed, maps the domain onto itself, and maps a given point of the domain to another given point of the domain. For a domain $D \subset \mathbb{R}^n, n \geq 2$, we consider the class $Id_K(\partial D)$ of all K- quasiconformal maps of D onto itself with identity boundary values. Teichmüller solved this problem for $n = 2, D = \mathbb{R}^2 \setminus \{0, 1\}$, and gave a sharp upper bound for $s_D(x, f(x))$ for $x \in D, f \in Id_K(\partial D)$ in terms of the hyperbolic metric s_D. Thereafter this problem has been discussed by many authors. For the case of the unit ball $D = \mathbb{B}^n$ a solution is given in [MV]. Given a map $f \in Id_K(\partial D), D \subset \mathbb{R}^n, n \geq 2$, and a point $x \in D$, we show [VZ] that the maximal dilatation of f has a lower bound in terms of the distance of x and $f(x)$ in the distance ratio metric. For instance, convex domains, bounded domains and domains with uniformly perfect boundaries are studied.

[MV] V. Manojlović and M. Vuorinen: *On quasiconformal maps with identity boundary values.* Trans. Amer. Math. Soc. 363(2011), 2467-2479.

[VZ] M. Vuorinen and X. Zhang: *Distortion of quasiconformal mappings with identity boundary values.*- arXiv:1203.0427

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Complex integral geometry

The problems investigated in this report are partially connected with the well known Ulam problem from Scottish book.

We study the properties of a set provided that the properties of its intersections with families of some sets are known.

Theorem 1. For an acyclic compact $K \subset \mathbb{R}^n$ to be convex, it is necessary and sufficient that all its sections by supporting m-plane for fixed $m, 1 \leq m \leq n-1$, are acyclic.

Theorem 2. For an acyclic compact $K \subset \mathbb{C}^n$ with non-empty interior to be $\mathbb{C}$-convex, it is necessary and sufficient that all its sections by supporting complex m-plane for fixed $m, 1 \leq m \leq n-1$, are acyclic, and in the case $m = n-1$ they must be $\mathbb{C}$-convex.

Definition. A set $E \subset \mathbb{C}^n$ is called linearly convex, if for every point $z \in \mathbb{C}^n \backslash E$ there exists a hyperplane l such that $z \in l \subset \mathbb{C}^n \backslash E$.

The sphere problem. Does there exist (or not) a linearly convex compact in $\mathbb{C}^2$, for which all cohomology groups coincide with the corresponding cohomology group of two-dimensional sphere S^2?

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[Z] Yuri Zelinskii, *Multivalued Mappings in Analysis*, Naukova dumka, Kyiv, 1993. - 264 p. (in Russian).