GENERAL INFORMATION

Conference Venue

Our conference venue **Haus der Kirche** is a conference center of the Protestant Church of Germany. It is situated in *Bad Herrenalb*, a health resort in the northern part of the Black Forest. The town centre with its spa gardens, mineral springs and some remains of a medieval monastery as well as the train station are all within walking distance from the conference venue. The street address is *Evangelische Akademie Baden, Dobler Str. 51, 76332 Bad Herrenalb, Germany.*

For a street map of Bad Herrenalb see the inside of the front cover.

Meals, Drinks and Conference Dinner

Breakfast is served from 7.15 to 9.00 am.

Lunch is served at 12.30 noon and **dinner** at 6.30 pm.

During **coffee breaks** water, coffee and tea will be available. Water will also be available during all meals. Other drinks are available at any time but are not covered. There are several fridges and shelves with drinks throughout the house with an honesty box beside them. It is also possible to get a sheet of paper from the reception desk on which you can mark your consumed drinks and pay when you check out.

If you have any special **dietary requirements** or food allergies, please discuss these directly with the hotel staff or let us know.

On Thursday evening you are cordially invited to a **conference dinner barbecue** starting at 7 pm to celebrate a hopefully inspiring and enjoyable conference.

Pandemic regulations

Upon arrival you will be asked whether you are vaccinated, recovered from Covid-19 or whether you have recently been tested (within the last 72 hours). If none of this applies you will be tested on the spot.

In order to protect yourself and others please **keep your distance** to other people whenever possible and wear a **face mask** at all times when you move in the conference center. It is ok to remove your mask while seated in the lecture hall or during meals.

Wireless Internet Access

Wireless internet access is provided free of charge for all participants within the conference venue. There is an *open* network *BADEN-WLAN*, which you can access directly without any login. And there is the *secure* network *BADEN-sWLAN*, for which you need to register as a user. Upon registration you will receive an e-mail with a confirmation code and your login credentials.

Session Format and Talk Style

For the sake of lively discussion, please respect the following maximal talk times allocated to your presentations:

Plenary lectures: 40 minutes talk time;
Invited and contributed lectures: 30 minutes talk time.

The lecture hall is equipped with a computer and a video projector. There is also some black or white board available. We recommend to prepare slides as the board may be too small to rely on it for a whole talk. Please upload the slides of your talk (preferably in pdf-format) to the computer in the lecture room well before the start of the session allocated to your presentation. It is also possible to send the file by email to cisg2020@math.kit.edu (preferably on the day before your session).

Poster Session

Posters are displayed for the duration of the conference.

There is a dedicated **Poster Presentation Session** on Monday from 17:50 - 18:20. Abstracts of the posters can be found in this booklet starting from page 33.

Monday, 6 September 2021

09:00 – 09:10		**Welcome**
09:10 – 10:00	**PL Ludwig**	*Valuations on convex functions*
10:00 – 10:40	**Mussnig**	*Integral geometric formulas for functional intrinsic volumes*
coffee break		
11:10 – 11:50	**Sperl**	*Glass Transition Singularities*
11:50 – 12:30	**Markwitz**	*State estimation for marked temporal point processes with an alternating renewal process mark distribution*
lunch break		
14:30 – 15:20	**PL Bárány**	*Cells in the box and a hyperplane*
15:20 – 16:00	**Roysdon**	*General measure extensions of projection bodies and generalized Zhang-type inequalities*
coffee break		
16:30 – 17:10	**Naszódi**	*John's ellipsoid for log-concave functions and functional quantitative Helly-type theorems*
17:10 – 17:50	**Thäle**	*A new story about an old problem: on random convex chains and polygons*
17:50 – 18:20		**Poster Presentation Session**
dinner		

Plenary lecture	Monika Ludwig	09:10 – 10:00

Valuations on convex functions

Monika Ludwig
(Technische Universität Wien)

A functional Z defined on a space of real-valued functions $\mathcal{F}$ is called a *valuation* if

$$\mathrm{Z}(f \vee g) + \mathrm{Z}(f \wedge g) = \mathrm{Z}(f) + \mathrm{Z}(g)$$

for all $f, g \in \mathcal{F}$ such that the pointwise maximum $f \vee g$ and the pointwise minimum $f \wedge g$ are in $\mathcal{F}$. The important classical notion of valuations on convex, compact sets is a special case of the rather recent notion of valuations on function spaces.

We present new results on valuations on the space of super-coercive convex functions on $\mathbb{R}^n$. In particular, a new proof of the Hadwiger theorem (following the approach of Klain in the classical setting) and the Klain-Schneider theorem on convex functions will be discussed.

Based on joint work with Andrea Colesanti and Fabian Mussnig.

Talk	Fabian Mussnig	10:00 – 10:40

Integral Geometric Formulas for Functional Intrinsic Volumes

Fabian Mussnig
(University of Florence)

Recently a new complete class of functional intrinsic volumes was established and characterized in a Hadwiger theorem for convex functions. For a convex, lower semicontinuous function $u : \mathbb{R}^n \to (-\infty, \infty]$ such that $\lim_{|x|\to\infty} \frac{u(x)}{|x|} = +\infty$ they are of the form

$$u \mapsto \int_{\mathbb{R}^n} \zeta(|\nabla u(x)|)[\mathrm{D}^2 u(x)]_{n-i}\,\mathrm{d}x$$

if in addition $u \in C^2(\mathbb{R}^n)$. Here, $i \in \{0, \dots, n\}$, $[\mathrm{D}^2 u(x)]_{n-i}$ is the $(n-i)$-th elementary symmetric function of the eigenvalues of the Hessian matrix $\mathrm{D}^2 u(x)$ and $\zeta : (0, \infty) \to \mathbb{R}$ is continuous with bounded support but may have a singularity at 0 which depends on the index i. In this talk we present new integral geometric formulas which correspond to classical formulas for intrinsic volumes.

Joint work with Andrea Colesanti and Monika Ludwig.

Talk	Matthias Sperl	11:10 – 11:50

Glass Transition Singularities

Matthias Sperl
(Deutsches Zentrum für Luft- und Raumfahrt Köln)

I shall review (1) the physics of the glass problem where non-trivial dynamics occurs over logarithmic time scales, (2) the dynamics – in particular asymptotic solutions – following from the singularities of the approximate mode-coupling theory (MCT), and (3) discuss the connection to kinetically constrained lattice models where some exact solutions are known. In an outlook the relevance of such singularities for static granular packings shall be demonstrated.

Talk	Robin Markwitz	11:50 – 12:30

State estimation for marked temporal point processes with an alternating renewal process mark distribution

Robin Markwitz
(Universiteit Twente)

In the last years, state estimation methods have been developed to deal with missing data problems for spatio-temporal point processes. These allow gaps in the observation space to be estimated through the use of likelihood-based Bayesian inference methods. In this particular setup, a temporal model constrained by a fixed number of points is proposed, inspired by aoristic crime data methods in criminology. This model is a marked point process, with the mark being an interval that refers to the range of time within which an unknown point resides. The marked intervals are generated using an alternating renewal process. A form for the posterior density with respect to a Poisson point process is proposed and derived based on the likelihood created by matching intervals to points. Properties of the model such as convergence and measure-theoretic viability are verified. Subsequently, Markov chain Monte Carlo methods are applied to estimate the posterior distribution of the unknown points.

Joint work with Marie-Colette van Lieshout.

Plenary lecture	Imre Bárány	14:30 – 15:20

Cells in the box and a hyperplane

Imre Bárány
(Alfréd Rényi Institute, Budapest)

It is well known that a line can intersect at most $2n-1$ cells of the $n \times n$ chessboard. What happens in higher dimensions: how many cells of the d-dimensional $[0,n]^d$ box can a hyperplane intersect? We also prove the integer analogue of the following fact. If K, L are convex bodies in $\mathbb{R}^d$ and $K \subset L$, then the surface area K is smaller than that of L. Joint work with Peter Frankl.

Talk	Michael Roysdon	15:20 – 16:00

General measure extensions of projection bodies and generalized Zhang-type inequalities

Michael Roysdon
(Tel Aviv University)

The inequalities of Petty and Zhang are affine isoperimetric-type inequalities providing sharp bounds for $\mathrm{vol}_n^{n-1}(K)\mathrm{vol}_n(\Pi^\circ K)$, where ΠK is a projection body of a convex body K is the convex body with support function given by

$$h_{\Pi K}(\theta) = \mathrm{vol}_{n-1}(K|\theta^\perp), \quad \theta \in \mathbb{S}^{n-1},$$

where $\theta^\perp$ denotes the hyperplane orthogonal to the direction θ. The upper bound, due to Petty, and referred to as Petty's projection inequality attains equality only when K is an ellipsoid, and the lower bound is due to Zhang and equality occurs only when K is a simplex.

In this talk, we present a number of generalizations of Zhang's inequality to the setting of measures. In addition, we introduce extensions of the projection body operator Π to the setting of arbitrary measures, that is, given a measure μ on $\mathbb{R}^n$ with continuous density φ, $\Pi_\mu K$ is the convex bodies whose support function is given by

$$h_{\Pi_\mu K}(\theta) = \frac{1}{2}\int_{\partial K} |\langle \theta, n_K(y)\rangle| \phi(y) dy,$$

where ∂K denotes the boundary of K and $n_K(y)$ denotes the outer unit normal of ∂K at y. We remark that the support function $h_{\pi_\mu K}$ has been deeply studied in the literature, and is an example of a generalized zoniod when φ is taken to be even.

Based on joint work with Dylan Langharst (Kent State University), Michael Roysdon (Tel Aviv University), Artem Zvavitch (Kent State University).

Talk	**Márton Naszódi**	**16:30 – 17:10**

John's ellipsoid for log-concave functions and functional quantitative Helly-type theorems

Márton Naszódi
(Eötvös Loránd University Budapest)

We extend the notion of the largest volume ellipsoid contained in a convex body to the setting of log-concave functions. As an application, we prove quantitative Helly-type results about the integral of the pointwise minimum of a family of log-concave functions.

Joint work with Grigory Ivanov.

Talk	**Christoph Thäle**	**17:10 – 17:50**

A new story about an old problem: on random convex chains and polygons

Christoph Thäle
(Ruhr University Bochum)

In this talk I describe recent progress on an old problem: the central limit theorem for the number of vertices of a random polygon in a polygon. The story starts with a description of the number of vertices of a random convex chain, a random variable which has surprising connections with PF sequences and orthogonal polynomials. Afterwards I explain how this result can be transferred to the the number of vertices of a random polygon in a polygon in a presumably optimal way.

Tuesday, 7 September 2021

09:00 – 09:50	**PL Sturm**	*Random Riemannian geometry in 4 dimensions*
09:50 – 10:30	**Volcic**	*Area filling curves*
coffee break		
11:00 – 11:40	**Kotrbatý**	*Hodge-Riemann relations for valuations and geometric inequalities*
11:40 – 12:20	**Wannerer**	*The explicit decomposition of the space of translation-invariant valuations into $SO(n)$-types*
lunch break		
14:30 – 15:20	**PL Edelsbrunner**	*Average and Expected Distortion of Voronoi Paths and Shapes*
15:20 – 16:00	**Wagner**	*Irreducible Minkowski Tensors for Astrophysical Applications (online lecture)*
coffee break		
16:30 – 17:10	**Yepes Nicolás**	*On further inequalities for the Wills functional of convex bodies*
17:10 – 18:00	**PL Böröczky**	*From the Betke-Weil inequalities to a Reverse Alexandrov-Fenchel conjecture (online lecture)*
18:00 – 18:40	**Langi**	*An isoperimetric problem for three-dimensional parallelohedra and translative, convex mosaics*
dinner		

Plenary lecture	Theodor Sturm	09:00 – 09:50

Random Riemannian geometry in 4 dimensions

Theodor Sturm
(Universität Bonn)

For large classes of even-dimensional Riemannian manifolds (M, g), we construct and analyze conformally invariant random fields. These centered Gaussian fields $h = h_g$, called *co-polyharmonic Gaussian fields*, are characterized by their covariance kernels k which exhibit a precise logarithmic divergence: $\left|k(x,y) - \log \frac{1}{d(x,y)}\right| \leq C$. They share a fundamental quasi-invariance property under conformal transformations. In terms of the co-polyharmonic Gaussian field h, we define the *quantum Liouville measure*, a random measure on M, heuristically given as

$$d\mu_g^h(x) := e^{\gamma h(x) - \frac{\gamma^2}{2} k(x,x)} \, d\mathsf{vol}_g(x) \,,$$

and rigorously obtained a.s. as weak limit of the RHS with h replaced by suitable regular approximations $h_\ell, \ell \in \mathbb{N}$. In terms on the quantum Liouville measure, we define the *Liouville Brownian motion* on M and the *random GJMS operators*.

Finally, we present an approach to a conformal field theory in arbitrary even dimensions with an ansatz based on Branson's Q-curvature: we give a rigorous meaning to the *Polyakov–Liouville measure*

$$d\boldsymbol{\nu}_g^*(h) = \frac{1}{Z_g^*} \exp\left(-\int \Theta\, Q_g h + m e^{\gamma h} d\mathsf{vol}_g\right) \exp\left(-\frac{a_n}{2} \mathfrak{p}_g(h,h)\right) dh$$

and we derive the corresponding conformal anomaly.

The class of admissible manifolds is conformally invariant. It includes all compact 2-dimensional Riemannian manifolds, all compact non-negatively curved Einstein manifolds of even dimension, and large classes of compact hpyervbolic manifolds of even dimension. However, not every compact even-dimensional Riemannian manifold is admissible.

Our results rely on new sharp estimates for heat kernels and higher order Green kernels on arbitrary compact manifolds.

Joint work with Lorenzo Dello Schiavo, Ronan Herry, Eva Kopfer.

Talk **Aljosa Volcic** **09:50 – 10:30**

Area filling curves

Aljosa Volcic
(University of Calabria)

I would like to talk about continuous injective curves defined on $[0,1]$ which cover a set of positive measure, the area filling curves, more modest than Peano' and Hilbert's space filling curves. They are usually called Osgood curves, but we found that Lebesgue invented them earlier. In a joint work with a student (Maria Chiara Nasso) we propose a variant of Knopp's construction of area-filling curves and prove that a definition given in a paper by Stromberg and Tseng is not consistent.

Talk **Jan Kotrbatý** **11:00 – 11:40**

Hodge-Riemann relations for valuations and geometric inequalities

Jan Kotrbatý
(Goethe-Universität Frankfurt)

One of the most important pillars of Alesker's algebraic theory of valuations on convex bodies is the Poincaré duality. In particular, as found by Joe Fu, it is this property that induces a fundamental relation between the product of valuations and kinematic formulas. Application of this principle has led to the discovery of numerous new integral geometric formulas, going far beyond the reach of classical methods.

Within the talk, our recent results will be presented that show that an even stronger property—namely, a version of the Hodge-Riemann relations—holds in the valuation algebra. It was first observed by Semyon Alesker that in special cases this abstract algebraic statement acquires a remarkable geometric meaning; in fact, we will show that the Hodge-Riemann relations subsume both classical and new inequalities between mixed volumes of convex bodies, in particular, the Aleksandrov-Fenchel inequality.

Some of the results were obtained in cooperation with Thomas Wannerer.

Talk **Thomas Wannerer** **11:40 – 12:20**

The explicit decomposition of the space of translation-invariant valuations into SO(n)-types

Thomas Wannerer
(Friedrich-Schiller-Universität Jena)

The Alesker-Bernig-Schuster theorem asserts that each irreducible representation of the orthogonal group appears with multiplicity at most one as a subrepresentation of the space of continuous translation-invariant valuations with fixed degree of homogeneity and parity. Moreover, the theorem describes in terms of highest weights which irreducible representations appear with multiplicity one.

In this talk, we present a refinement of this result, namely the explicit construction of a highest weight vector in each irreducible subrepresentation. From this we obtain several geometric consequences. The most interesting is a proof of the Hodge-Riemann relations, which have previously been established by Kotrbatý only in the case of even valuations and for valuations of degree one. This removes the assumption of central symmetry in the isoperimetric-type inequalities for mixed volumes recently discovered by Alesker. Moreover, we obtain a new and more elementary proof of the Hard Lefschetz theorems of Bernig-Broecker and Alesker. Based on joint work in progress with Jan Kotrbatý.

Plenary lecture **Herbert Edelsbrunner** **14:30 – 15:20**

Average and Expected Distortion of Voronoi Paths and Shapes

Herbert Edelsbrunner
(Institute of Science and Technology Austria)

We generalize the concept of the Voronoi path of a line to more general shapes and compute the distortion constant, which describes how it changes volumeon average. Although initially asked for a Poisson point process, the distortion is a characteristic of the space rather than the point process. In other words, the constant ratio of the perimeter of a circle and its pixelation—and the analogous ratios for spheres in three and higher dimensions—hold for all smoothly embedded shapes on average.

Joint work with Anton Nikitenko.

Talk **Jenny Wagner** **15:20 – 16:00**

Irreducible Minkowski Tensors for Astrophysical Applications (online lecture)

Jenny Wagner
(thegravitygrinch.blogspot.com, Heidelberg)

The structure of planar objects can be comprehensively quantified by a set of irreducible Minkowski tensors (IMTs). Compared to other choices of basis functions, e.g. multipoles, IMTs have many advantages. For instance, they are robust against noise and defined over the object contours, so that no window functions are required for their calculation.

In this talk, I will present astrophysical use cases to introduce the recently implemented software package `papaya2` and the corresponding features integrated in the online analysis tool `morphometer`. `papaya2` provides a versatile toolbox to analyse any kind of grey-valued image data via its IMTs and to show the evolution of IMTs over a user-defined set of threshold levels. The applications range from the classification of astronomical objects with a clear boundary for a single threshold level, like distinguishing stars from galaxies, to probing the structure of galaxy surface brightness profiles on multiple scales by tracking the IMTs over multiple threshold levels. Our IMT analysis tools are independent of a specific preprocessing. The necessary preprocessing steps, e.g. denoising and deconvolution, can thus be independently performed and adapted to various applications. Only the creation of the contour is currently fixed by a marching squares algorithm and I will address the impact of the regular and interpolated versions on the IMT evaluation.

Further information:

papaya2: 2D Irreducible Minkowski Tensor computation
`https://doi.org/10.21105/joss.02538`

Online analysis tool and webpage
`www.morphometry.org`

Based on collaboration with Sebastian Kapfer, Fabian Schaller, and Michael Klatt.

Talk	Jesús Yepes Nicolás	16:30 – 17:10

On further inequalities for the Wills functional of convex bodies

Jesús Yepes Nicolás
(Universidad de Murcia)

The Wills functional of a convex body, defined as the sum of its intrinsic volumes, turned out to have many interesting applications and properties. In this talk, making a profit from the fact that it can be represented as the integral of a log-concave function, which is furthermore the Asplund product of other two log-concave functions, we will derive new properties of the Wills functional. Among others, we will show some Brunn-Minkowski and Rogers-Shephard type inequalities for this functional, as well as that the cube of edge-length 2 maximizes it among all 0-symmetric convex bodies in John position.

This is about joint work with David Alonso-Gutiérrez and María A. Hernández Cifre.

Plenary lecture	Károly Böröczky	17:10 – 18:00

From the Betke-Weil inequalities to a Reverse Alexandrov-Fenchel conjecture (online lecture)

Károly Böröczky
(Alfréd Rényi Institute, Budapest and University of California Davis)

A fundamental paper due to Uli Betke and Wolfgang Weil from 1991 provides two optimal upper bounds of the mixed area $A(K, L)$ of two convex domains K and L in terms of their perimeters, where the first upper bound considers the general case, and the second considers the case when $L = -K$. The elegant inequalities had applications in stochastic geometry, still, the equality case when $K = -L$ was not characterized.

On the one hand, I will discuss how to characterize equality in the Betke-Weil inequality for $A(K, -K)$, obtaining even a stability version. On the other hand, generalizing the Betke-Weil inequality for $A(K, L)$, a conjecture proposing a Reverse Alexandrov-Fenchel inequality in any dimension is presented together with some fundamental special cases we have verified, including an extension of a recent inequality by Artstein-Avidan, Florentin, Ostrover.

Talk **Zsolt Langi** **18:00 – 18:40**

An isoperimetric problem for three-dimensional parallelohedra and translative, convex mosaics

Zsolt Langi
(Budapest University of Technology and Economics)

A d-dimensional parallelohedron is a convex polytope whose translates tile the d-dimensional Euclidean space. The family of 3-dimensional parallelohedra is an important subfamily of zonotopes and its members belong to the best known polyhedra within and outside mathematics. Despite this fact, apart from the celebrated proof of Kepler's Conjecture by Hales, which yields, in particular, that among 3-dimensional parallelohedra of unit volume, the one with maximal inradius is the regular rhombic dodecahedron, there is no known isoperimetric result for this family.

In this talk we investigate isoperimetric-type problems for 3-dimensional parallelohedra. Our main result states that among unit volume 3-dimensional parallelohedra, the one with minimal mean width is the regular truncated octahedron. In addition, we establish a connection between the edge lengths of 3-dimensional parallelohedra and the edge densities of the translative mosaics generated by them, and use our method to prove that among translative, convex mosaics generated by a parallelohedron with a given volume, the one with minimal edge density is the face-to-face mosaic generated by cubes.

Wednesday, 8 September 2021

09:00 – 09:50	**PL Schulte**	*Limit theorems for Boolean models and Poisson cylinder processes*
09:50 – 10:30	**Gusakova**	*Sharp inequalities for the mean distance of random points in convex bodies*
coffee break		
11:00 – 11:40	**Besau**	*Asymptotic normality for the volume of random polytopes in non-euclidean geometries*
11:40 – 12:20	**Hörrmann**	*Understanding robust classification via convex geometry*
lunch break		
13:30 – 18:30	**Excursions/ Free time**	
dinner		
20:15	**Carbone**	**PIANO CONCERT LECTURE**
		(see page 37 for the programme)

Plenary lecture	Matthias Schulte	09:00 – 09:50

Limit theorems for Boolean models and Poisson cylinder processes

Matthias Schulte
(Hamburg University of Technology)

The Boolean model is obtained as union of all grains of a stationary Poisson process of compact convex sets in $\mathbb{R}^d$. It can be generalised by taking the union set of a stationary Poisson process of cylinders with $(d-m)$-dimensional bases and m-dimensional direction spaces. The aim of this talk is to study geometric functionals such as the intrinsic volumes of the intersection of a Boolean model or the union set of a Poisson cylinder process with a compact convex observation window. The focus is on the asymptotic behaviour for increasing observation windows. In the first part of the talk, variance asymptotics and central limit theorems for geometric functionals of Poisson cylinder processes are studied. The results are compared with those for Boolean models. The second part of the talk is devoted to a class of heavy-tailed Boolean models. For this situation limit theorems with alpha-stable limiting distributions are derived.

The first part of the talk is based on joint work with Carina Betken and Christoph Thäle.

Talk	Anna Gusakova	09:50 – 10:30

Sharp inequalities for the mean distance of random points in convex bodies

Anna Gusakova
(Ruhr University Bochum)

For a convex body $K \subset \mathbb{R}^d$ the mean distance $\Delta(K) = \mathbb{E}|X_1 - X_2|$ is the expected Euclidean distance between two independent and uniformly distributed in K random points X_1, X_2. In this talk I will present an optimal lower and upper bound for the ratio between $\Delta(K)$ and the first intrinsic volume $V_1(K)$ of K (normalized mean width). We will discuss the sharpness of obtained estimates by considering the degenerate extremal cases.

This is a joint work with Gilles Bonnet, Christoph Thäle and Dmitry Zaporozhets (arXiv:2010.03351).

Talk	Florian Besau	11:00 – 11:40

Asymptotic normality for the volume of random polytopes in non-euclidean geometries

Florian Besau
(Vienna University of Technology)

In this talk we will take a look at the recent progress in the asymptotic theory of random polytopes in non-euclidean geometries, with a focus on spherical convex geometry.

In particular I will present results on the asymptotic normality of the volume of random polytopes, which was recently established in joint work with Daniel Rosen and Christoph Thäle.

Talk	Julia Hörrmann	11:40 – 12:20

Understanding robust classification via convex geometry

Julia Hörrmann
(ETH Zürich)

Understanding and avoiding the appearance of adversarial examples to machine learning classifiers is one of the major recent challenges in machine learning. We present the crucial concept of robust classification and some of its relations to convex geometry.

Thursday, 9 September 2021

09:00 – 09:40	**Kiderlen**	*Local functionals and uniqueness in Crofton's formula*
09:40 – 10:20	**Rataj**	*Mean flag measures for stationary random sets*
coffee break		
10:50 – 11:30	**Schuster**	*Minkowski endomorphisms*
11:30 – 12:30	**Hug/Last**	*Some historical comments on convex, integral and stochastic geometry*
lunch break		
14:30 – 15:20	**PL Milman**	*Flowers, again flowers I like*
15:20 – 16:00	**Buchta**	*The duality of the volumes and the numbers of vertices of random polytopes*
coffee break		
16:30 – 17:30	**PL Gardner**	*Geometric tomography: contributions of Rolf Schneider and Wolfgang Weil, and an update on open problems (online lecture)*
17:30 – 18:10	**Hofstätter**	*Asplund endomorphisms and the Blaschke–Santaló inequality*
19:00	**conference dinner barbecue**	

Talk **Markus Kiderlen** **09:00 – 09:40**

Local Functionals and Uniqueness in Crofton's Formula

Markus Kiderlen
(University of Aarhus)

Crofton's intersection formula states that the $(n-j)$th intrinsic volume of a convex body in $\mathbb{R}^n$ can be obtained as an invariant integral of the $(k-j)$th intrinsic volume of sections with k-planes. This talk discusses the question if the $(k-j)$th intrinsic volume can be replaced by other functionals, that is, if the measurement function in Crofton's formula is unique – at least if certain natural conditions are imposed on it. We investigate this question for *local functionals*, a class of mappings introduced by W. Weil in [1, 2].

The answer is negative: we show that the sums of the $(k-j)$th intrinsic volume and certain translation invariant continuous valuations of homogeneity degree k yield counterexamples. If the measurement function is local, these turn out to be the only examples when $k=1$ or when $k=2$ and we restrict considerations to even measurement functions. Additional examples of local functionals can be constructed when $k \geq 2$.

Joint work with R. Eriksen.

[1] W. Weil. Integral geometry of translation invariant functionals, I: The polytopal case. *Adv. in Appl. Math.*, 66:46–79, 2015.
[2] W. Weil. Integral geometry of translation invariant functionals, II: The case of general convex bodies. *Adv. in Appl. Math.*, 83:145–171, 2017.

Talk **Jan Rataj** **09:40 – 10:20**

Mean flag measures for stationary random sets

Jan Rataj
(Charles University Prague)

Curvature densities of stationary random closed sets (satisfying necessary regularity conditions) can be successfully used to express mean curvatures of intersections with bounded windows, but only in the case of *stationary* random sets where the principal kinematic formula is available. In the anisotropic case, the curvature densities are not sufficient since in the translative integral formula the contributions of the random set and window do not factorize into a product. Instead, we can use *flag measures* investigated and propagated by Wolfgang Weil; these measures live on a space of "flags" and their projections are curvature measures. We apply the intersection formula for the mean curvature for excursion

sets of Gaussian stationary random fields, where we obtain slight extensions of the well-known formulas due to Adler and Taylor.

Talk	Franz Schuster	10:50 – 11:30

Minkowski Endomorphisms

Franz Schuster
(Vienna University of Technology)

In 1974 Rolf Schneider defined Minkowski endomorphisms as the continuous Minkowski additive operators on convex bodies that are translation and SO(n) equivariant and initiated a systematic study with lasting impact to this day. In this talk, I will discuss some classical and more recent classification results of Minkowski endomorphisms as well as present new isoperimetric inequalities for them from a joint work with Georg Hofstätter that uncover some unexpected phenomenon.

Talk	Hug/Last	11:30 – 12:30

Some historical comments on Convex, Integral and Stochastic Geometry

Daniel Hug and Günter Last
(Karlsruhe Institute of Technology)

Plenary lecture	Vitali Milman	14:30 – 15:20

Flowers, again flowers I like

Vitali Milman
(University of Tel Aviv)

Talk	Christian Buchta	15:20 – 16:00

The Duality of the Volumes and the Numbers of Vertices of Random Polytopes

Christian Buchta
(Universität Salzburg)

An identity due to Efron dating from 1965 relates the expected volume of the convex hull of n random points to the expected number of vertices of the convex hull of $n+1$ random points. Forty years later this identity was extended from expected values to higher moments. The generalized identity has attracted considerable interest. Whereas the left-hand side of the generalized identity—concerning the volume—has an immediate geometric interpretation, this is not the case for the right-hand side—concerning the number of vertices. A transformation of the right-hand side applying an identity for elementary symmetric polynomials overcomes the blemish. The arising formula reveals a duality between the volumes and the numbers of vertices of random polytopes.

Plenary lecture	Richard J. Gardner	16:30 – 17:30

Geometric tomography: Contributions of Rolf Schneider and Wolfgang Weil, and an update on open problems (online lecture)

Richard J. Gardner
(Western Washington University, Bellingham)

The talk comprises a collection of reflections and remarks about geometric tomography. The mathematical content focuses on several open problems, including Nakajima's problem on constant width and brightness, the slicing problem, and Mahler's problem. The valuable contributions of Rolf Schneider and Wolfgang Weil to geometric tomography are summarized. A few photos dating back to 1970 will be shown, courtesy of Paul Goodey and Jörg Wills.

Talk **Georg Hofstätter** **17:30 – 18:10**

Asplund Endomorphisms and the Blaschke–Santaló inequality

Georg Hofstätter
(Technische Universität Wien)

Minkowski endomorphisms, that is, continuous and Minkowski additive maps on convex bodies compatible with rigid motions, were introduced by Schneider in 1974 and have long been a focus of interest in convex geometry. In this talk, we introduce the new notion of Asplund endomorphisms that generalizes Minkowski endomorphisms to the setting of (coercive) log-concave functions, extending Minkowski additivity to additivity with respect to the Asplund sum. We construct a large family of monotone Asplund endomorphisms, each restricting to a monotone Minkowski endomorpism on indicators of convex bodies.

Moreover, we prove a family of analytic inequalities for the constructed Asplund endomorphisms, each inequality being stronger than the functional Urysohn inequality. The strongest one among our new family of inequalities is the functional Blaschke–Santaló inequality (for even functions). By restricting the inequalities to indicators, corresponding geometric inequalities for monotone Minkowski endomorphisms (including the classical Urysohn inequality) are recovered in an asymptotically optimal form.

This is based on joint works with F.E. Schuster and J. Knörr.

Friday, 10 September 2021

09:00 – 09:50	**PL Bernig**	*Intrinsic volumes of Kaehler manifolds*
09:50 – 10:30	**Knörr**	*Smooth and mixed Hessian valuations on convex functions*
coffee break		
11:00 – 11:40	**Molchanov**	*Limit theorems for generalised convex hulls*
11:40 – 12:20	**Thorisson**	*Embeddings into Brownian motion*
lunch		

Plenary lecture	Andreas Bernig	09:00 – 09:50

Intrinsic volumes of Kaehler manifolds

Andreas Bernig
(University of Frankfurt)

Intrinsic volumes of compact convex sets can be defined via Steiner's tube formula. Weyl's principle extends this notion to Riemannian manifolds. In the modern language of valuations on manifolds, the intrinsic volumes form a canonical algebra of valuations associated to Riemannian manifolds which is compatible with isometric embeddings. In a joint work with J. Fu (Georgia), G. Solanes (Barcelona) and T. Wannerer (Jena) we introduce a Kaehler analogue of intrinsic volumes: a canonical algebra of valuations associated to Kaehler manifolds which is compatible with holomorphic isometric embeddings. In particular, this explains the phenomenon that the algebras of invariant valuations on complex-projective, complex-hyperbolic and hermitian spaces are pairwise isomorphic, which was earlier observed by explicit computations. Some applications in integral geometry of complex space forms are given.

Talk	Jonas Knörr	09:50 – 10:30

Smooth valuations on convex functions

Jonas Knörr
(Technische Universität Wien)

In recent years, valuations on functions arose as a natural generalization of valuations on convex bodies and due to their intimate relation with convex bodies, valuations on convex functions have been one of the main objects of interest. I will discuss how the space of dually epi-translation invariant valuations on convex functions can be related to its geometric counter part, the space of translation invariant valuations on convex bodies. This connection allows us to translate some structural results for translation invariant valuations into corresponding results for dually epi-translation invariant valuations. Most notably, we obtain a description of a dense subspace of smooth valuations that admit a very simple geometric representation.

Talk	Ilya Molchanov	11:00 – 11:40

Limit theorems for generalised convex hulls

Ilya Molchanov
(University of Bern)

The K-hull of a compact set $A \subset \mathbb{R}^d$, where $K \subset \mathbb{R}^d$ is a fixed compact convex body, is the intersection of all translates of K that contain A. A set is called K-strongly convex if it coincides with its K-hull. We propose a general approach to the analysis of facial structure of K-strongly convex sets, similar to the well developed theory for polytopes. We then apply our theory in the case when $A = \Xi_n$ is a sample of n points picked uniformly at random from K. We show that in this case the set of $x \in \mathbb{R}^d$ such that $x + K$ contains the sample Ξ_n, upon multiplying by n, converges in distribution to the zero cell of a certain Poisson hyperplane tessellation. From this results we deduce convergence in distribution of the corresponding f-vector of the K-hull of Ξ_n to a certain limiting random vector, without any normalisation, and also the convergence of all moments of the f-vector. The results on weak convergence are extended to the case when translations of K are replaced by actions of a matrix group.

Talk	Hermann Thorisson	11:40 – 12:20

Embeddings into Brownian motion

Hermann Thorisson
(University of Iceland)

We outline a method of embedding patterns into the path of a two-sided Brownian motion. The patterns can for instance be a given distribution (the Skorokhod embedding), a particular type of excursion, or the Brownian bridge. The method is unbiased which means that conditionally on the pattern the one-sided processes developing backward and forward from the pattern are independent Brownian motions. The method relies on finding appropriate local times for the pattern. We expect the method to work also for embedding patterns in planar and spatial Brownian motion.

Poster Contributions

Posters are displayed for the duration of the conference.

There is a dedicated **Poster Presentation Session** on Monday afternoon, where each poster is introduced in a three-minute note.

Poster 1 **Jakob Henkel**

Affine Minkowski valuations

Jakob Henkel
(Universität Jena)

The projection body is a Minkowski valuation that maps convex bodies of a vector space V to convex bodies in its dual space. It is continuous, translation invariant and $\mathrm{SL}(V)$ equivariant and, according to a result by M. Ludwig, it is characterized by these properties. If one changes the codomain to the set of convex bodies in another $\mathrm{SL}(V)$ representation W, there are further valuations such as the difference body for $W = V$ and valuations formed from the volume and the Euler characteristic for $W = \mathbb{R}$. This arises the question whether there are more representations such that a valuation with these properties exists. We show that a non trivial valuation as above is a multiple of the projection body or difference body or is formed from the volume and the Euler characteristic. This is a joint work with T. Wannerer.

Poster 2 **Christian Jung**

Approximation of Polycrystals by Generalized Voronoi Tessellations

Christian Jung
(Technical University Kaiserslautern)

When analyzing industrial materials, one is often interested in computer-based models of their microstructure. Our interest lies in 2-dimensional EBSD images of aluminum and 3-dimensional images of metal foams. As it turns out, the microstructure of these cellular materials resembles the structure of tessellations. Thus, approximating this microstructure by a variety of tessellation models is the aim of our work. In particular, the generalized balanced power diagram has proven to capture the materials' anisotropic microstructure in a desirable manner. Initial approximations are computed using parameter values obtained from principle component analysis. Afterwards, they are improved via stochastic optimization.

Poster 3 **Eduardo Lucas Marín**

On discrete L_p Brunn-Minkowski type inequalities

Eduardo Lucas Marín
(Universidad de Murcia)

Brunn-Minkowski's theorem says, in one of its forms, that the volume $\mathrm{vol}\big((1-\lambda)K+\lambda L\big)^{1/n}$, for $K, L \subset \mathbb{R}^n$ compact and convex sets, is a concave function in λ. This result has been the key for the development of the so-called L_p-Brunn-Minkowski theory, which had its starting point in several works by Firey. In 2012, Lutwak, Yang and Zhang showed that there is a pointwise definition of the p-addition $+_p$, for $1 \leq p < \infty$, which allowed to p-sum arbitrary subsets of the Euclidean space (not necessarily convex nor compact). Furthermore, they proved the corresponding L_p-Brunn-Minkowski inequality

$$\mathrm{vol}\big((1-\lambda)\cdot K +_p \lambda \cdot L\big)^{p/n} \geq (1-\lambda)\mathrm{vol}(K)^{p/n} + \lambda \mathrm{vol}(L)^{p/n}$$

for bounded sets $K, L \subset \mathbb{R}^n$; here, $\lambda \cdot K := \lambda^{1/p} K$ is the p-scalar multiplication. The 'convex body case' of this inequality goes back to Firey.

In this poster we show discrete versions of the above inequality for the so-called lattice point enumerator, i.e., $\mathrm{G}_n(K) = |K \cap \mathbb{Z}^n|$, both in a geometrical and in a functional setting. In particular, we prove that

$$\mathrm{G}_n\big((1-\lambda)\cdot K +_p \lambda \cdot L + (-1,1)^n\big)^{p/n} \geq (1-\lambda)\mathrm{G}_n(K)^{p/n} + \lambda \mathrm{G}_n(L)^{p/n}$$

for $p \geq 1$, any $K, L \subset \mathbb{R}^n$ bounded sets with integer points and all $\lambda \in (0,1)$. We also see that these new discrete analogues for $\mathrm{G}_n(\cdot)$ imply the corresponding results concerning the volume.

This is a joint work with M. A. Hernández Cifre and J. Yepes Nicolás.

Poster 4 **Francisco Marín Sola**

On Grünbaum type inequalities

Francisco Marín Sola
(Universidad de Murcia)

Given a compact set $K \subset \mathbb{R}^n$ of positive volume, if K is convex with centroid at the origin, then, a classical and powerful result by Grünbaum, says that one can find a lower bound for the ratio $\mathrm{vol}(K^-)/\mathrm{vol}(K)$ depending only on the dimension of K, where K^- denotes the intersection of K with a halfspace bounded by a hyperplane passing through its centroid.

In this poster, among other results, we show that fixing the hyperplane H, one can find a sharp lower bound for the ratio $\mathrm{vol}(K^-)/\mathrm{vol}(K)$ depending on the concavity nature of the function that gives the volumes of cross-sections (parallel to H) of K. When K is convex, this inequality recovers the previous result by Grünbaum. To this respect, we also show that the log-concave case is the limit concavity assumption for such a generalization of Grünbaum's inequality.

This is a joint work with Jesús Yepes Nicolás.

Poster 5 **Christian Richter**

On the monotonicity of the isoperimetric quotient for parallel bodies

Christian Richter
(Friedrich-Schiller-Universität Jena)

The isoperimetric quotient of the whole family of inner and outer parallel bodies of a convex body is shown to be decreasing in the parameter of definition of parallel bodies, along with a characterization of those convex bodies for which that quotient happens to be constant on some interval within its domain. This is obtained relative to arbitrary gauge bodies, having the classical Euclidean setting as a particular case.

Similar results are established for different families of Wulff shapes that are closely related to parallel bodies. These give rise to solutions of isoperimetric-type problems.

Furthermore, new results on the monotonicity of quotients of other quermass-integrals different from surface area and volume are obtained for the family of parallel bodies.

This is a joint work with Eugenia Saorín Gómez (University of Bremen, Germany).

Ingrid's PlayLiszt
Piano Concert Lecture

Ingrid Carbone, *piano*

Wednesday, 8. September 2021, 20:15 h

Programme

Franz Liszt (1811-1886)

Légendes, S 175/1
St. François d'Assise: la prédication aux oiseaux

Allegretto — Recitativo — Tempo I — Recitativo

Inspired by *Fioretti di San Francesco – Capitolo 16*

Années de pèlérinage. Troisième Année, S 163/4
Les Jeux d'eaux à la Villa d'Este

Allegretto

Inspired by Bible verses:
"... sed aqua, quam ego dabo eì, fiet in eo fons aquae salientis in vitam aeternam" (Evang: sec: Joannem 4-14)

Années de pèlérinage. Deuxième Année. Italie, S 161/7
Après une Lecture du Dante: Fantasia quasi Sonata

Andante maestoso - Presto agitato assai - Tempo I (Andante) - Andante (quasi improvvisato) - Andante - Recitativo - Adagio – Allegro moderato - Più mosso - Tempo rubato e molto ritenuto – Andante - Più mosso - Allegro - Allegro vivace – Presto - Andante (Tempo I)

Inspired by *Après une Lecture de Dante* (Victor Hugo)

Organization

Daniel Hug
Institute of Stochastics, Karlsruhe Institute of Technology,
Englerstr. 2, 76131 Karlsruhe, Germany
daniel.hug@kit.edu

Günter Last
Institute of Stochastics, Karlsruhe Institute of Technology,
Englerstr. 2, 76131 Karlsruhe, Germany
guenter.last@kit.edu

Steffen Winter
Institute of Stochastics, Karlsruhe Institute of Technology,
Englerstr. 2, 76131 Karlsruhe, Germany
steffen.winter@kit.edu

Bárány, Imre, Alfréd Rényi Institute, Budapest, Hungary
i.barany@ucl.ac.uk

Bernig, Andreas, Goethe University Frankfurt, Germany
bernig@math.uni-frankfurt.de

Besau, Florian, TU Vienna, Austria
florian.besau@tuwien.ac.at

Betsch, Steffen, Karlsruhe Institute of Technology, Germany
steffen.betsch@kit.edu

Böröczky, Károly, Alfréd Rényi Institute, Budapest, Hungary and University of California Davis, USA
boroczky.karoly.j@renyi.hu

Buchta, Christian, Salzburg University, Austria
christian.buchta@sbg.ac.at

Chebunin, Mikhail, Karlsruhe Institute of Technology, Germany
mikhail.chebunin@kit.edu

Carbone, Ingrid, University of Calabria, Italy
ingrid.carbone@unical.it

Ebner, Bruno, Karlsruhe Institute of Technology, Germany
bruno.ebner@kit.edu

Edelsbrunner, Herbert, IST Austria, Austria
edels@ist.ac.at

Ellmeyer, Simon, TU Vienna, Austria
simon.ellmeyer@tuwien.ac.at

Faifman, Dmitry, Tel Aviv University, Israel
faifmand@tauex.tau.ac.il

Gallego, Eduardo, Autonomous University of Barcelona, Spain
egallego@mat.uab.cat

Gardner, Richard, Western Washington University, USA
richard.gardner@wwu.edu

Gusakova, Anna, Ruhr University Bochum, Germany
anna.gusakova@rub.de

Henkel, Jakob, University of Jena, Germany
jakob.henkel@uni-jena.de

Hofstätter, Georg, TU Vienna, Austria
georg.hofstaetter@tuwien.ac.at

Hörrmann, Julia, ETH Zürich, Switzerland
julia.hoerrmann@web.de

Hug, Daniel, Karlsruhe Institute of Technology, Germany
daniel.hug@kit.edu

Jensen, Eva B. Vedel, Aarhus University, Denmark
eva@math.au.dk

Jung, Christian, TU Kaiserslautern, Germany
cjung@mathematik.uni-kl.de

Kiderlen, Markus, Aarhus University, Denmark
kiderlen@math.au.dk

Knörr, Jonas, TU Vienna, Austria
jonas.knoerr@tuwien.ac.at

Kotrbaty, Jan, Goethe University Frankfurt, Germany
kotrbaty@math.uni-frankfurt.de

Lángi, Zsolt, Budapest University of Technology, Hungary
zlangi@math.bme.hu

Last, Günter, Karlsruhe Institute of Technology, Germany
guenter.last@kit.edu

Lienau, Matthias, Hamburg University of Technology, Germany
matthias.lienau@tuhh.de

Lucas Marín, Eduardo, University of Murcia, Spain
eduardo.lucas@um.es

Ludwig, Monika, TU Vienna, Austria
monika.ludwig@tuwien.ac.at

Marín Sola, Francisco, University of Murcia, Spain
francisco.marin7@um.es

Markwitz, Robin, University of Twente, Netherlands
rlm@cwi.nl

Milman, Vitali, Tel Aviv University, Israel
milman@post.tau.ac.il

Molchanov, Ilya, University of Bern, Switzerland
ilya@stat.unibe.ch

Mussnig, Fabian, University of Florence, Italy
mussnig@gmail.com

Nagel, Werner, University of Jena, Germany
werner.nagel@uni-jena.de

Naszódi, Márton, Eötvös Loránd University Budapest, Hungary
marton.naszodi@math.elte.hu

Nestmann, Franz, Karlsruhe Institute of Technology, Germany
franz.nestmann2@kit.edu

Ortega, Oscar, TU Vienna, Austria
oscarortem@gmail.com

Pabst, Dominik, Karlsruhe Institute of Technology, Germany
dominik.pabst@kit.edu

Picker, Babette, Karlsruhe Institute of Technology, Germany
babette.picker@web.de

Rataj, Jan, Charles University Prague, Czech Republic
rataj@karlin.mff.cuni.cz

Richter, Christian, University of Jena, Germany

christian.richter@uni-jena.de

Rotem, Liran, Israel Institute of Technology, Israel
lrotem@technion.ac.il

Roysdon, Michael, Tel Aviv University, Israel
mroysdon@kent.edu

Sagmeister, Ádám, Eötvös Loránd University Budapest, Hungary
sagmeister.adam@gmail.com

Schneider, Rolf, University of Freiburg, Germany
rolf.schneider@math.uni-freiburg.de

Schuhmacher, Jakob, University of Jena, Germany
jakob.schuhmacher@uni-jena.de

Schulte, Matthias, Hamburg University of Technology, Germany
matthias.schulte@tuhh.de

Schuster, Franz, TU Vienna, Austria
franz.schuster@tuwien.ac.at

Solanes, Gil, Autonomous University of Barcelona, Spain
solanes@mat.uab.cat

Sperl, Matthias, German Aerospace Center, Cologne, Germany
matthias.sperl@dlr.de

Sturm, Karl-Theodor, University of Bonn, Germany
sturm@uni-bonn.de

Thäle, Christoph, Ruhr University Bochum, Germany
Christoph.thaele@rub.de

Thorisson, Hermann, University of Iceland, Iceland
hermann@hi.is

Trapp, Vanessa, Hamburg University of Technology
vanessa.trapp@tuhh.de

Ulivelli, Jacopo, University of Rome, Italy
jacopo.ulivelli@uniroma1.it

Volcic, Aljosa, University of Calabria, Italy
aljosa.volcic@unical.it

Wagner, Jenny, thegravitygrinch.blogspot.com, Heidelberg, Germany
jennywagner@imail.de

Wannerer, Thomas, University of Jena, Germany
thomas.wannerer@uni-jena.de

Willimzig, David, Karlsruhe Institute of Technology, Germany
david.willimzig@kit.edu

Winter, Steffen, Karlsruhe Institute of Technology, Germany
steffen.winter@kit.edu

Yepes Nicolás, Jesús, University of Murcia, Spain
jesus.yepes@um.es