PROGRAM OF THE NATIONAL MATHEMATICS MEETING ⋆ 1-2 SEPTEMBER AND PHD DAY ⋆ 31 AUGUST 2022

Conference homepage: https://nmm2022.puremath.no/

Conference location: Clarion Hotel The Edge in Tromsø city center

PhD day location: Teknologibygget Auditorium 1.022 (TEKNOBYGGET 1.022AUD) UiT

Vitenskapelig komité: Inga Berre (UiB), Kurusch Ebrahimi-Fard (NTNU), Boris Kruglikov (UiT), Nadia Larsen (UiO), Kristian Ranestad (UiO), Cordian Riener (UiT).

Organiseringskomité: Boris Kruglikov (UiT), Dennis The (UiT), Hilja Lisa Huru (UiT), Tine Hågensen (UiT), Trygve Johnsen (UiT), Cordian Riener (UiT), Hugues Verdure (UiT).

Stipendiat komité: Clara Hummel (UiT), Luc Ludovic Nicolas Hallali (UiT), Sebastian Debus (UiT), Michele Guerra (UiT), Nils Bochow (UiT).

SCHEDULE

Wednesday, August 31 – PhD day
Teknologibygget Auditorium 1.022

11:00 - 11:05	Opening of the PhD day. Welcome
11:05 - 11:40	Session 1 – Discussion: *Sharing of expectations and experiences*
11:40 - 12:30	Session 2 – Career perspectives, part 1 11:40 - 12:00 Eivind Schneider: *Postdoc experiences* 12:00 - 12:30 Baljinnyam Sereeter: *Differences between working in academia and in industry*
12:30 - 13:30	Lunch
13:30 - 14:00	Session 3 – Presentation of results from discussion in session 1
14:00 - 14:50	Session 4 – Career perspectives, part 2 14:00 - 14:50: Inger Lin Uttakleiv Ræder & Theresa Mikalsen: *Postdoc funding*
14:50 - 15:20	Coffee break
15:20 - 17:00	Session 5 – PhD presentations (8min presentation, 2min questions per speaker) 15:20 - 15:30 Ilia Zlotnikov, UiS: *On mobile sampling problem for planar curves* 15:30 - 15:40 Helge Knutsen, NTNU: *A Fractal Uncertainty Principle for the Short-Time Fourier Transform* 15:40 - 15:50 Belén García Pascual, UiB: *A mathematical model for organelle genes in cell biology* 15:50 - 16:00 Andreu Llabres I Brustenga, UiT: *Realization of supergeometries as superprolongations of geometric structures* 16:00 - 16:10 a small break 16:10 - 16:20 Erlend D. Børve, NTNU: *Vide underkategorier for gentle-algebraer* 16:20 - 16:30 Diego Caudillo, NTNU: *Graph counting signatures and bicommutative Hopf algebras* 16:30 - 16:40 William Honslien, NTNU: A^1*-toric topology: from geomag to topological spaces* 16:40 - 16:50 Lars M. Salbu, UiB: *Simplicial Complexes from Relations* 16:50 - 17:00 end of the program
From 18:30	Evening Program - Barbecue and drinks on the balcony of UiT Teknologibygget

Thursday, September 1
(All talks are 45 min + 5 min questions.)

10:30 - 11:00	Arrival. Morning coffee
11:00 - 11:05	Opening of NMM by TFS-PMN project leader Boris Kruglikov
11:05 - 11:10	Welcome by Unn Sørum from Tromsø Research Foundation (TFS)
11:10 - 12:00	Plenary lecture I: Irina Markina
12:05 - 12:10	Announcement of Viggo Brun prize 2022 by NMF leader Hans Munthe-Kaas
12:10 - 12:20	Laudatio - Music
12:20 - 13:10	Lecture by the Viggo Brun 2022 laureate (Zoom)
13:15 - 14:15	Lunch
14:15 - 15:05	Sectional talks I (chairs: Örs Rebák, Nils Bochow, Johnson Allen Kessy) Section 1: Aslak Buan Section 2: Iain George Johnston Section 3: Dennis The
15:10 - 16:00	Sectional talks II (chairs: Örs Rebák, Nils Bochow, Johnson Allen Kessy) Section 1: Sigrid Grepstad Section 2: Anne Kvernø Section 3: Andrey Piatnitski
16:00 - 16:30	Coffee break
16:30 - 17:20	Plenary lecture II: Sergey Neshveyev
17:25 - 17:30	Information about the dinner and how to reach it
20:00 - 22:30	Conference dinner

Friday, September 2
(All talks are 45 min + 5 min questions.)

09:00 - 09:05	Announcement of ES lecture
09:05 - 09:55	Elisabeth Stephansen lecture: Eugenia Malinnikova
09:55 - 10:25	Coffee break
10:25 - 11:15	Sectional talks III (chairs: Eivind Schneider, Alessandro Cotronei, Anna Poltronieri) Section 1: Sigbjørn Hervik Section 2: Markus Szymik Section 3: Elisabeth Köbis
11:20 - 12:10	Sectional talks IV (chairs: Eivind Schneider, Alessandro Cotronei, Anna Poltronieri) Section 1: Didier Pilod Section 2: Trygve Johnsen Section 3: Irina Didenkulova
12:10 - 13:10	Lunch
13:10 - 14:00	Lecture by the Viggo Brun 2020 laureate: John Christian Ottem
14:05 - 14:55	Plenary lecture III: Elena Celledoni
14:55 - 15:00	Closing of NMM. Farewell from OC by Cordian Riener
15:00 - 15:30	Afternoon coffee. Departure

TITLES & ABSTRACTS

Aslak Bakke Buan (NTNU)

Title: **Comparing categories of representations - some variations of tilting theory**

Abstract: The module theory of a finite dimensional algebra, can often be described in terms of representations of quivers (= directed multi-graphs) and their related path algebras.

Based on some simple examples of (factors of) path algebras, I will try to illustrate why *tilting*, and some of its variations, play an important role in this theory. Some derived categories also turn up naturally when dealing with tilting. I will try to explain why and how.

Most results will be from 80's and 90's, but some recent progress will be mentioned.

Elena Celledoni (NTNU) – plenary lecture

Title: **Deep learning of diffeomorphisms for optimal reparametrizations of shapes**

Abstract: The geometric shape is of major importance in object recognition. One way to represent objects mathematically is to consider them as parametric curves or surfaces defined on some compact domain. Since the same shape may be outlined by different parametrizations, shape distances are typically defined taking the infimum over all possible parametrizations, i.e. over the group of orientation preserving diffeomorphisms. Because we are optimizing over an infinite dimensional Lie group this is a computationally demanding task.

In this talk, we construct approximations of orientation-preserving diffeomorphisms by composition of elementary diffeomorphisms. We restate the reparametrization problem such that it may be solved by training a residual neural network. We derive universal approximation results and obtain bounds for the Lipschitz constant of the obtained compositions of diffeomorphisms. We end the talk showing numerical results obtained with a PyTorch implementation of the proposed approach.

Ira Didenkulova (UiO)

Title: **Tsunami in the coastal zone: extreme runup height**

Abstract: Tsunami is defined as a long wave in the ocean, which may be induced by various sources. The overview of different mechanisms of tsunami generation is given. Depending on the mechanism of generation and specifically on the size of the source, different models (mostly dispersive and nondispersive shallow water models) are used. The most hazardous effect of tsunami is observed in the coastal zone and on the beach. The process of tsunami wave oscillations on the beach is called runup. As the wave transforms significantly during its propagation in the ocean of the variable depth, tsunami manifestations on the coast vary a lot even regardless the mechanism of generation. Here we discuss different effects and factors, which influence the maximum runup height on a beach. It is shown that not only wave height and wave length are important but also wave asymmetry (the steepness of the moving water front). We also discuss special sea bottom geometries which lead to extreme tsunami amplifications and runup. Effects of wave breaking, dispersion and dissipation and its impact on wave runup are also briefly discussed.

Elisabeth Köbis (NTNU)

Title: **Aspects of Set Optimization with Applications to Uncertain Programming**

Abstract: In this talk, we give an introduction to set optimization and its concepts and methods used. A special focus is put on set relations, as these are crucial ingredients in the so-called set approach. We will mention some recent topics that are under research, for example, scalarization methods, variable domination structures as well as approximate solution concepts. We will also present solution procedures in terms of generalized Jahn-Graef-Younes methods. As an application to uncertain programming, we explain how methods from set optimization can be used to recover robust solutions, i.e., solutions that work well in the worst-case scenario.

Sigrid Grepstad (NTNU)

Title: **A product of sines and its surprising behaviour**

Abstract: In this talk we consider products of the form

$$P_n(\alpha) = \prod_{r=1}^{n} 2|\sin \pi r\alpha|$$

for irrationals α, focusing on the asymptotic behaviour of P_n as $n \to \infty$. In 1959, Erdös and Szekeres raised the question of whether $\liminf P_n = 0$ for *all* values of α [2]. Lubinsky confirmed that this is indeed the case for all α with sufficiently large continued fraction coefficients, and expressed certainty that it must be true in general [5].

Surprisingly, it turns out that this is not the case; the asymptotic behaviour of P_n depends on the continued fraction expansion of α in a very delicate way, to the effect that for certain α we have $\liminf_n P_n(\alpha) > 0$ [1, 3, 4].

References

[1] C. Aistleitner, N. Technau, A. Zafeiropoulos, *On the order of magnitude of Sudler products.* (2020). To appear in American Journal of Mathematics.
[2] P. Erdös, G. Szekeres, *On the product* $\prod_{k=1}^{n}(1 - z^{a_k})$. Acad. Serbe Sci. Publ. Inst. Math., 13 (1959), 29–34.
[3] S. Grepstad, L. Kaltenböck, M. Neumüller, *A positive lower bound for* $\liminf_{N\to\infty} \prod_{r=1}^{N} 2|\sin \pi r\phi|$. Proc. Amer. Math. Soc. 147 (2019), 4863–4876.
[4] M. Hauke, *On extreme values for the Sudler product of quadratic irrationals*, pre-print: arXiv:2111.12974.
[5] D. Lubinsky, *The size of* $(q;q)_n$ *for* q *on the unit circle.* J. Number Theory 76 (1999), no. 2, 217–247.

Sigbjørn Hervik (UiS)

Title: **Pseudo-Riemannian geometry and polynomial curvature invariants**

Abstract: I will discuss the problem of using polynomial curvature invariants to distinguish pseudo-Riemannian spaces. This problem was in the core of the NFR-funded project "Pseudo-Riemannian Geometry and Polynomial Curvature Invariants: Classification, Characterisation and Applications". I will highlight some of the results and explain some of the techniques used to address this question. Keywords for the talk are: differential geometry, Lie group theory, real geometric invariant theory, Wick-rotations, metric deformations, Kundt spacetimes.

Trygve Johnsen (UiT)

Title: **Matroids and error-correcting codes**

Abstract: An error-correcting code is a set of (code)words representing information, that is encoded in such a way that when transmitted to a receiver over a noisy channel, 100% correct information can be obtained even if small errors occur during the transmission. "Peeling off" the errors is called decoding. The codewords are usually vectors in $\mathbb{F}^n$ for a fixed finite field $\mathbb{F}$ (Hamming codes), or $(m \times n)$-matrices over such a field (rank-metric codes).

To study and produce such codes with large tolerance for errors, and fast and reliable decoding algorithms, many parts of pure mathematics come into play. This is often, in some sense, just a matter of simple linear algebra over finite fields. But also Galois theory, algebraic geometry, a little topology, and quite a lot of (algebraic) combinatorics can actually be applied in interesting ways. In this talk we look at the interplay between (linear) Hamming codes and matroids (a concept from combinatorics) and if time permits rank-metric codes and so-called q-matroids.

Iain George Johnston (UiB)

Title: **Maths and mitochondria: stochastic modelling in evolution and disease**

Abstract: Mitochondria are cellular compartments responsible for processing the chemical energy we, and other forms of complex life, need to survive. They exist in dynamic populations inside each of our cells, subject to the tumultuous, diffusive environment of cell biology. When they go wrong, we inherit devastating and incurable diseases. Tools from discrete stochastic processes, coupled with inference and model selection, can be used to describe, analyse, and predict biologically and medically important features of these populations. I'll talk about our work applying stochastic models to understand the inheritance and onset of mitochondrial diseases, various inference approaches to connect these models with heterogeneous data, and how extensions of these mathematical approaches can shed light on central questions in evolutionary biology.

Anne Kværnø (NTNU)

Title: **A high order exponential integrator for semilinear SDEs with additive noise**

Abstract: In this talk, we discuss the numerical solution of a semilinear SDE with additive scalar noise, on the form

$$dX(t) = AX(t)dt + f(t, X(t))dt + g(t)dW(t)$$

where $A \in \mathbb{R}^{d\times d}$ is a constant matrix, and $W(t)$ is a scalar Wiener process.

We will shortly discuss how the order theory for exponential integrators derived in [1] can be simplified and adjusted to the problem in question and present a mean square order 1.5 method based on these conditions.

The method has been applied to a semi-discretized diffusion-reaction PDE with boundary noise, and some implementation issues will be discussed.

References

[1] Alemayehu Adugna Arara, Kristian Debrabant, and Anne Kværnø. Stochastic B-series and order conditions for exponential integrators. *Numerical Mathematics and Advanced Applications, Lecture Notes in Computational Science and Engineering 126. Springer*, 419 – 427, 2019.

Eugenia Malinnikova (Stanford / NTNU) – Elizabeth Stephansen lecture

Title: **Laplace eigenfunctions and the frequency function method**

Abstract: A classical idea in the study of eigenfunctions of the Laplace-Beltrami operator is that they behave like polynomials of degree corresponding to the eigenvalue. We will discuss several properties of eigenfunctions which confirm this idea, including the Bernstein and Remez inequalities. As a corollary, we will formulate a local version of the celebrated Courant theorem on the number of nodal domains of eigenfunctions. The proofs of the inequalities rely of the frequency function of solution to elliptic PDEs. In the talk, we will also review some striking properties of this frequency function.

Irina Markina (UiB) – plenary lecture

Title: **On rolling of manifolds**

Abstract: In the talk, we will introduce the notion of rolling one manifold over another. The idea of the rolling map originated as a simple mathematical model of rolling a ball over a plate with the constraints of no-slip and no-twist motion in the works of K. Nomizu (1978), V.I.Arnold (1986), R.Bryant and L.Hsu (1993). The geometric features are closely related to the distributions of E.Cartan type (1910). Later this idea was extended to the rolling of Riemannian manifolds of any dimension, as an isometry map preserving the parallelism of vector fields. After the historical overview and the necessary definitions, we also mention some applications in the interpolation and construction of stochastic processes on manifolds.

Sergey Neshveyev (UiO) – plenary lecture

Title: **Quantization of Lie groups and their homogeneous spaces**

Abstract: The problem of quantization of Lie bialgebras in the formal setting was solved in full generality in the 1990s by Etingof and Kazhdan. The picture is much less complete in the analytic setting, as well as for homogeneous spaces. In my talk I will review some recent advancements in this area, concentrating on symmetric spaces and a class of Frobenius Lie groups.

John Christian Ottem (UiO) – Vigo Brun 2020 lecture

Title: **The Rationality Problem for Hypersurfaces**

Abstract: I will discuss some recent results on hypersurfaces in projective space, algebraic cycles and the 'rationality problem'.

Andrey Piatnitski (UiT)

Title: **Spectral properties of zero order convolution type operators**

Abstract: We consider a convolution operator with an integrable kernel which is perturbed by a potential decaying at infinity. Assuming that the perturbed operator is self-adjoint and that the potential is a continuous function we study both the essential and the discrete spectra of this operator. In particular, we provide sufficient conditions for non-emptiness of the discrete spectrum and estimate the number of discrete eigenvalues.

Didier Pilod (UiB)

Title: **Finite point blowup for the critical generalized Korteweg-de Vries equation**

Abstract: In the last twenty years, there have been significant advances in the study of the blow-up phenomenon for the critical generalized Korteweg-de Vries (gKdV) equation, including the determination of sufficient conditions for blowup,the stability of blowup in a refined topology and the classification of minimal mass blowup. Exotic blow-up solutions with a continuum of blow-up rates and multi-point blow-up solutions were also constructed. However, all these results, as well as numerical simulations, involve the bubbling of a solitary wave going at infinity at the blow-up time, which means that the blow-up dynamics and the residue are eventually uncoupled. Even at the formal level, there was no indication whether blowup at a finite point could occur for this equation.

After reviewing the theory of blow-up for the critical gKdV equation in the first part of the talk, we will answer this question by constructing solutions that blow up in finite time under the form of a single-bubble concentrating the ground state at a finite point with an unforeseen blow-up rate. Finding a blow-up rate intermediate between the self-similar rate and other rates previously known also reopens the question of which blow-up rates are actually possible for this equation.

This talk is based on a joint work with Yvan Martel (École Polytechnique/France).

Markus Szymik (NTNU)

Title: **Quandles. Real Algebra and Symmetries**

Abstract: It is a truism that groups are generally the mathematical structure that best describes symmetries, and I will not argue against that. I will, however, present arguments that quandles, a closely related algebraic structure, sometimes beat them at that, as I will illustrate with applications to knot spaces and Galois symmetries.

Dennis The (UiT)

Title: **Exceptionally simple super-PDE**

Abstract: In 1893, Cartan and Engel gave the first geometric realisations of the (complex) exceptional simple Lie algebra G_2, namely as the symmetries of various differential geometric structures. I will describe generalizations of this story to the other exceptional simple Lie algebras, and more recently the exceptional simple Lie superalgebras $\mathsf{G}(3)$ (joint work with Kruglikov & Santi) and $\mathsf{F}(4)$ (joint work with Santi).
