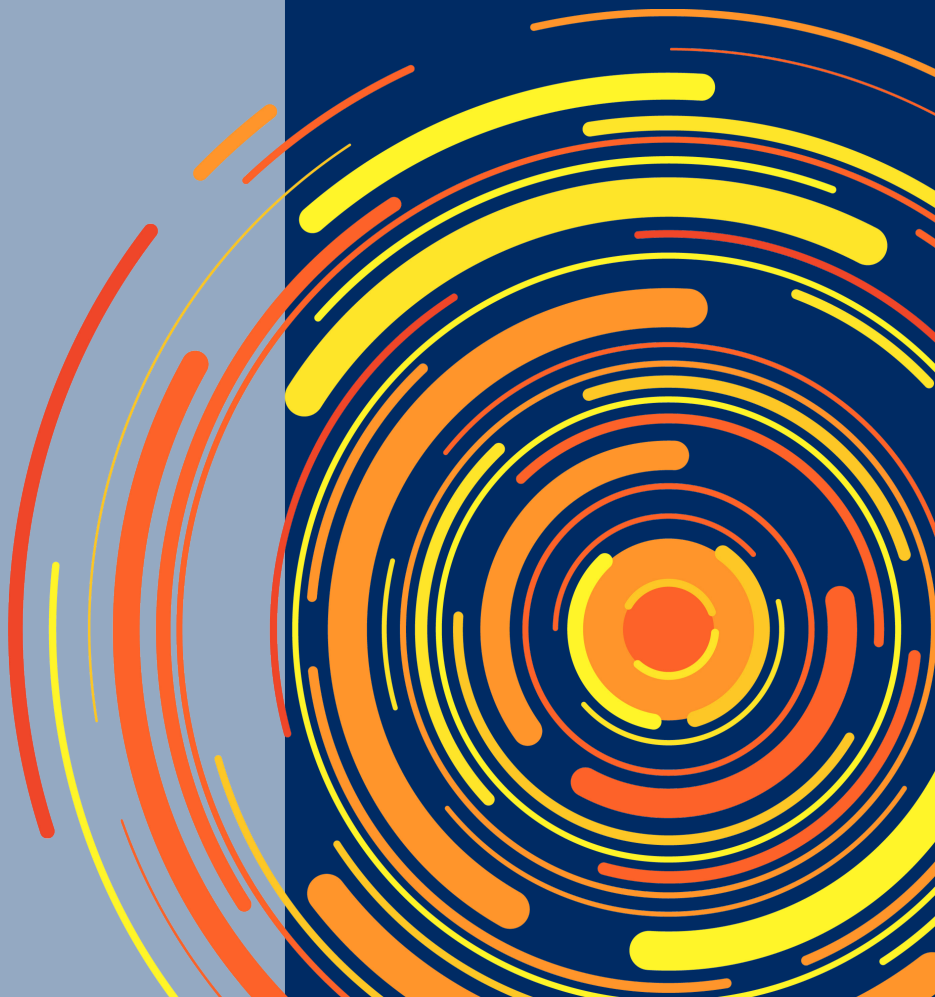
Conference Booklet

Schedule & Abstracts

Heat Kernels and Stochastic Analysis

Aarhus University
29 June–3 July 2026



VILLUM FONDEN

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Introduction

The conference will center on stochastic analysis and heat kernel theory, two deeply interconnected areas with a long tradition of mutual influence. Its goal is to bring together early-career researchers and established experts from around the world to stimulate new research directions, encourage collaboration, and facilitate the exchange of ideas and techniques bridging probability theory and harmonic analysis.

Organizing committee

- Fabrice Baudoin (Aarhus University)
- Li Chen (Aarhus University)
- Baptiste Devyver (Université Grenoble Alpes)
- Emmanuel Russ (Institut mathématiques de Marseille)
- Jing Wang (Purdue University)

Scientific committee

- Zhen-Qing Chen (University of Washington)
- Takashi Kumagai (Waseda University)
- Laurent Saloff-Coste (Cornell University)
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Conference Schedule

Monday

Time	Speaker / event	Length	Title / notes
08:30–8:50	Registration	20 min	
08:50–9:00	Announcements	10 min	
09:00–09:50	Jun Kigami	50 min	Heat kernel lower bound estimates for pure jump processes via averaged jump kernels
09:50–10:40	Maria (Masha) Gordina	50 min	Limit laws in metric measure spaces
10:40–11:10	Coffee break	30 min	
11:10–11:40	Aobo Chen	30 min	Stability of heat kernel bounds under pointed Gromov–Hausdorff convergence
11:40–12:10	Meng Yang	30 min	Local and non-local p-energies on metric measure spaces
12:10–13:30	Lunch + coffee	80 min	
13:30–14:20	Alexander Teplyaev	50 min	Convergence of Dirichlet Forms and Monotonicity on Non-Smooth Spaces
14:20–15:10	Naotaka Kajino	50 min	Two-sided heat kernel bounds for $\sqrt{8/3}$-Liouville Brownian motion
15:10–15:40	Coffee break	30 min	
15:40–16:10	Ryosuke Shimizu	30 min	Singularity phenomena for energy measures and Sobolev spaces on fractals
16:10–17:00	Patricia Alonso-Ruiz	50 min	The isoperimetric inequality on fractals
17:00–17:30	Guang Yang	30 min	Coupling Methods on Riemannian Manifolds: From Fundamental Gap Estimates to Uniform Propagation of Chaos

Tuesday

Time	Speaker / event	Length	Title / notes
09:00–09:50	Feng-Yu Wang	50 min	Entropy-Cost Inequality for McKean–Vlasov SDEs with Singular Interactions
09:50–10:40	Samy Tindel	50 min	Directed polymers in higher-dimensional Gaussian environments
10:40–11:10	Coffee break	30 min	
11:10–12:00	Cheng Ouyang	50 min	Parabolic Anderson Model beyond Euclidean Spaces
12:00–12:30	Effie Papageorgiou	30 min	L^p-asymptotic behavior of isotropic transition densities on homogeneous trees
12:30–13:30	Lunch + coffee	60 min	
13:30–14:20	Cyril Labbé	50 min	Small disorder limit of 1d random Schrödinger operators
16:00	Social program		Old Town museum tour

Wednesday

Time	Speaker / event	Length	Title / notes
09:00–09:50	Zhen-Qing Chen	50 min	Coupled time-fractional parabolic equations and probabilistic representation
09:50–10:40	El Maati Ouhabaz	50 min	A multiplicative inequality related to the Riesz transform on general Riemannian manifolds
10:40–11:10	Coffee break	30 min	
11:10–11:40	Phanuel Mariano	30 min	Dirichlet eigenfunction and heat kernel estimates for unbounded domains
11:40–12:10	Qi Hou	30 min	Heat kernel estimates for left-invariant diffusions on infinite dimensional compact groups
12:10–13:30	Lunch + coffee	80 min	
13:30–14:20	Robert Neel	50 min	Coupling diffusions in sub-Riemannian geometry
14:20–15:10	Céline Lacaux	50 min	Parabolic Anderson Model driven by Lévy-Fractional noise on Sierpiński Gasket
15:10–15:40	Coffee break	30 min	
15:40–16:30	Ivan Gentil	50 min	Mathematical research and its connections to technology, according to Günther Anders.
16:30–17:00	Magalie Bénéfice	30 min	Separation cut-off phenomenon for Brownian motions in high dimensional harmonic manifolds
17:00–17:30	Teije Kuijper	30 min	Brownian motion and stochastic areas on full flag manifolds
17:30–18:30	Posters	60 min	Poster session; see poster list below
18:30	Conference dinner		Mathematics cantine

Thursday

Time	Speaker / event	Length	Title / notes
09:00–09:50	Satomi Watanabe	50 min	Collisions of simple random walks on the range of a four-dimensional simple random walk
09:50–10:40	Sebastian Andres	50 min	Anchored Nash inequalities and heat kernel bounds for random conductance models with long-range jumps
10:40–11:10	Coffee break	30 min	
11:10–11:40	Shiping Cao	30 min	Boundary trace theorems for reflected jump processes
11:40–12:10	Liangbing Luo	30 min	Logarithmic Sobolev inequalities on infinite-dimensional reduced Heisenberg groups
12:10–13:30	Lunch + coffee	80 min	
13:30–14:20	David Tewodrose	50 min	Spectral properties of symmetrized AMV Laplacians
14:20–15:10	Ismaël Bailleul	50 min	Φ^4 measures on 3-dimensional manifolds
15:10–15:40	Coffee break	30 min	
15:40–16:30	Michel Bonnefont	50 min	Large time behaviour for the semigroup of the kinetic Brownian motion in the plane
16:30–17:00	Emily Dautenhahn	30 min	Heat kernel estimates on glued graphs

Friday

Time	Speaker / event	Length	Title / notes
09:00–09:50	Luca Capogna	50 min	Neural Networks for Threshold Dynamics Reconstruction
9:50–10:40	Seiichiro Kusuoka	50 min	Properties of the quantum fields constructed by the rotation-invariant approximation
10:40–11:10	Coffee break	30 min	
11:10–12:00	Tai Melcher	50 min	Poincaré and log Sobolev inequalities with weighted Γ operators
12:00–12:50	Erlend Grong	50 min	Score matching and sub-Riemannian bridges
12:50–13:30	Lunch + coffee	40 min	

Wednesday poster session

Poster presenter	**Poster title**
Andrea Vanessa Hurtado Quiceno	Hypocoercive Langevin dynamics on the Lie group SE(2)
Brian Chao	Dirichlet eigenfunction and heat kernel estimates on annular domains
Dharmendra Kumar Chaurasia	Heat equations driven by mixed local-nonlocal operators with exponential nonlinearity
Donghwi Seo	A Probabilistic Approach to Shape Monotonicity Problems
Hongyi Chen	Martin Boundary and Weak Disorder
Marie Bormann	A Dynkin condition for manifolds with boundary
Xavier Ramos Olivé	Heat kernel and spectral estimates under integral curvature bounds
Christian Rose	Gaussian upper heat kernel bounds on graphs with unbounded geometry
Zijin Liu	Rigidity of the sub-Riemannian heat kernel on S^{2n+1}

Talk Abstracts

Heat kernel lower bound estimates for pure jump processes via averaged jump kernels

Jun Kigami

Schedule: Monday, 09:00–09:50

We derive heat kernel lower bound estimates for symmetric pure jump processes on general volume doubling metric measure spaces with possible degenerate and/or singular jump kernels, where no off-diagonal estimate has been available, using averaged jump kernels. The main result is applied to derive a lower bound estimate for the transition density function of the trace of Brownian motions on Sierpiński gaskets on the bottom of the Sierpiński gasket. This is joint work with Z.-Q. Chen.

Limit laws in metric measure spaces

Maria (Masha) Gordina

Schedule: Monday, 09:50–10:40

We will survey recent results on limit laws for stochastic processes on metric measure spaces. The main object is a Hunt process corresponding to a Dirichlet form on such a space, and such limit laws (small and large deviations, heat content asymptotics, Chung's law, and related asymptotics) are closely related to the boundary problems for the corresponding infinitesimal generator in a metric ball. This setting includes a number of examples.

Stability of heat kernel bounds under pointed Gromov–Hausdorff convergence

Aobo Chen

Schedule: Monday, 11:10–11:40

Assuming uniform sub-Gaussian heat kernel bounds for a sequence of metric measure spaces, we construct a conservative, strongly local, regular symmetric Dirichlet form on the pointed Gromov–Hausdorff limit space and show that it also satisfies a sub-Gaussian heat kernel bound. In addition, we prove that the associated energy forms converge in the Mosco sense along a subsequence.

Local and non-local p-energies on metric measure spaces

Meng Yang

Aarhus University

Schedule: Monday, 11:40–12:10

For any $p > 1$, we study subordination phenomena for local and non-local regular p-energies on metric measure spaces. Under suitable geometric assumptions, we show that if a local regular p-energy satisfies a Poincaré inequality together with a cutoff Sobolev inequality with scaling function Ψ, then any non-local p-form given by a jumping kernel with scaling function Υ, where Υ lies *strictly above* Ψ *at small scales*, induces a regular p-energy satisfying a non-local Poincaré inequality and a cutoff Sobolev inequality with a scaling function Ξ explicitly determined by Ψ and Υ. Our results also apply to examples whose jumping kernels have light tails with polynomial decay at infinity. We further establish an analogous subordination phenomenon from non-local regular p-energies to non-local regular p-energies. These results provide a nonlinear extension of the classical subordination principle beyond the Dirichlet form framework.

Convergence of Dirichlet Forms and Monotonicity on Non-Smooth Spaces

Alexander Teplyaev

Schedule: Monday, 13:30–14:20

This talk will discuss the role of monotonicity in the convergence and approximation of Dirichlet forms on fractals and more general non-smooth spaces. We will describe several settings in which monotone approximation provides a natural framework for constructing limiting Dirichlet forms and studying their analytic properties. The first setting arises in Kigami's theory of resistance forms, where monotonicity is a central ingredient in the construction of limiting objects. A second class of examples comes from projective limit type spaces, including diamond fractals and Laakso spaces, where Dirichlet forms are obtained through compatible approximations. We will emphasize applications of these convergence results to spectral analysis and heat kernel behavior. Time permitting, we will also discuss related questions for sub-Riemannian Dirichlet forms. The talk will include results of Jun Kigami and Patricia Alonso-Ruiz, as well as joint work with Maria Gordina and Marco Carfagnini.

Two-sided heat kernel bounds for $\sqrt{8/3}$-Liouville Brownian motion

Naotaka Kajino

Schedule: Monday, 14:20–15:10

The γ-Liouville Brownian motion (γ-LBM) is the canonical diffusion process on a γ-Liouville quantum gravity (γ-LQG) surface, where $\gamma \in (0, 2)$ is a parameter. The $\sqrt{8/3}$-LQG sphere, considered as the isomorphism class of a random compact metric measure space, has been proved by Miller and Sheffield (2021) to have the same law as the Brownian sphere, which in turn was proved by Le Gall (2013) and Miermont (2013) to appear as the scaling limit of a uniform random n-face quadrangulation of the sphere as n tends to infinity.

This talk will present the main result of arXiv:2507.13269 establishing, for the heat kernel of the $\sqrt{8/3}$-LBM on the $\sqrt{8/3}$-LQG sphere, two-sided off-diagonal sub-Gaussian bounds which are sharp up to polylogarithmic factors in the exponential. This is joint work with Sebastian Andres (Technische Universität Braunschweig), Konstantinos Kavvadias (Massachusetts Institute of Technology), and Jason Miller (University of Cambridge).

Singularity phenomena for energy measures and Sobolev spaces on fractals

Ryosuke Shimizu

Kyoto University

Schedule: Monday, 15:40–16:10

We consider $(1, p)$-Sobolev spaces, the corresponding self-similar p-energy functionals and p-energy measures on self-similar fractals. The case $p = 2$, which gives rise to strongly local regular Dirichlet forms associated to Brownian motion on fractals, has been extensively studied since the late 1980s. In this talk, I will present new singularity phenomena concerning L^p-analogues of such energy forms, including the singularity of p-energy measures for a class of p.c.f. self-similar sets with very good geometric symmetry, as well as the singularity of $(1, p)$-Sobolev spaces on the Laakso diamond space among distinct values of p.

This talk is based on joint works with Naotaka Kajino (Kyoto University), Riku Anttila (University of Jyväskylä), and Sylvester Eriksson-Bique (University of Jyväskylä).

The isoperimetric inequality on fractals

Patricia Alonso Ruiz

Schedule: Monday, 16:10–17:00

With its long history and practical applications, the isoperimetric inequality serves as a geometric tool whose proof has connected geometry with many areas of mathematics. If you happen to work with an underlying space that presents fractal features, possibly different at different scales, you might need to pause and think about its formulation: Which volume? Which perimeter measure? And what relationship between them can one expect?

This talk will review these questions in the context of fractal metric measure spaces, including some that comprise different scaling. The ideas rely on a beautiful proof original to Ledoux connecting Brownian motion and functions of bounded variation. The talk is based on joint work with Fabrice Baudoin (Aarhus University).

Coupling Methods on Riemannian Manifolds: From Fundamental Gap Estimates to Uniform Propagation of Chaos

Guang Yang

Schedule: Monday, 17:00–17:30

Coupling methods have become one of the most versatile probabilistic tools for studying quantitative properties of diffusion processes. In this talk, I will discuss how couplings on Riemannian manifolds can be used to address two seemingly different problems arising in geometric analysis and interacting particle systems. First, I will present a probabilistic approach to the fundamental gap problem on spheres. The second part concerns McKean–Vlasov diffusions on complete Riemannian manifolds with Ricci curvature bounded from below.

Entropy-Cost Inequality for McKean–Vlasov SDEs with Singular Interactions

Feng-Yu Wang

Schedule: Tuesday, 09:00–09:50

We first recall the study of entropy-cost inequality for diffusion processes, then introduce the bi-coupling method to estimate entropy between different diffusion processes, and finally apply this technique to establish the entropy-cost inequality for McKean–Vlasov SDEs with singular interactions.

Directed polymers in higher-dimensional Gaussian environments

Samy Tindel

Schedule: Tuesday, 09:50–10:40

Directed polymer models describe the behavior of a long chain molecule in a random medium, where the path of the polymer is influenced by a competition between energy gained from the environment and the natural entropy of the chain. This class of models has deep connections to statistical physics, and their mathematical study relies on a combination of classical probability methods and stochastic analysis.

In this talk I will start with a general introduction to directed polymer models, giving all the necessary background and notation from scratch. I will then describe a framework for studying continuous polymers in higher dimensions, driven by a broad class of Gaussian random environments. A central object in the analysis is a linear stochastic partial differential equation whose solution encodes the statistical weight of the polymer paths.

The main results I will discuss include, if time permits, structural properties of the partition function such as stationarity and a natural flow property; a sharp criterion distinguishing two qualitatively different regimes, depending on whether the polymer path is essentially free or strongly influenced by the environment; and a diffusive limit theorem at high temperature in dimension three and above, showing that the polymer behaves like Brownian motion in the weak disorder regime. This work extends a classical one-dimensional theory by Alberts–Khanin–Quastel to a much broader higher-dimensional setting.

Parabolic Anderson Model beyond Euclidean Spaces

Cheng Ouyang

Schedule: Tuesday, 11:10–12:00

We survey several recent results on the parabolic Anderson model on non-Euclidean spaces and aim to illustrate how geometry and topology affect the behavior of the solution. The talk is based on joint works with Fabrice Baudoin, Hongyi Cheng, Li Chen, Che-Hung Huang, Robert Neel, Samy Tindel, and Jing Wang.

ℓ^p asymptotic behavior of isotropic transition densities on homogeneous trees

Effie Papageorgiou

Universität Paderborn

Schedule: Tuesday, 12:00–12:30

We study the large-time ℓ^p behavior of transition densities of an isotropic random walk in homogeneous trees, which are infinite, connected, acyclic graphs in which every vertex has the same degree, and can be thought of as discrete counterparts of hyperbolic space. Caloric functions of interest are then convolutions of these transition densities with a finitely supported initial condition, and we are interested in their large time behavior in ℓ^p norm.

For each $p \in [1, \infty]$, we introduce a notion of a p-mass function and prove that caloric functions with compactly supported initial data asymptotically decouple as the product of this mass function and the transition density. Using tools of Fourier analysis available on such graphs, we show that this function even boils down to a constant, still depending on p, if the initial condition is radial, that is, depends only on the distance to the origin. Determining the spatial concentration of the densities in p-norm plays an important role, in turn clarifying the interplay between the exponential volume growth of the graph and heat diffusion. The results extend to affine buildings, even exotic ones beyond the Bruhat–Tits framework.

Joint work with B. Trojan.

Properties of the quantum fields constructed by the rotation-invariant approximation

Seiichiro Kusuoka

Schedule: Tuesday, 13:30–14:20

In this talk, we consider the properties of the quantum fields constructed by the rotation-invariant approximation and the singular SPDE method. The singular SPDE method enables us to take the limits of the continuous approximation sequences, and we apply the advantage of the continuous approximations. The properties are included in the axioms of the Euclidean quantum field theories, and in particular the regularity property, also called the temperedness or the distribution property, and the reflection positivity. We also give a remark on the singularity of the three-dimensional Φ^4-measure with respect to the free field. This talk is based mainly on joint works with Sergio Albeverio.

Small disorder limit of 1D random Schrödinger operators

Cyril Labbé

Université Paris Cité and Sorbonne Université, CNRS, Laboratoire de Probabilités, Statistique et Modélisation; Institut Universitaire de France (IUF)

Schedule: Tuesday, 14:20–15:10

We will consider random Schrödinger operators in dimension 1, which can be seen as perturbations of the discrete or continuous Laplacian with random potentials called disorders. For a large class of potentials, it is known that the operator satisfies Anderson localization: its spectrum is pure point with exponentially decaying eigenfunctions. In this talk, we will investigate the small disorder limit of these operators and we will see that random Dirac operators arise generically. Based on joint works with Laure Dumaz (DMA, ENS).

Coupled time-fractional parabolic equations and probabilistic representation

Zhen-Qing Chen

Schedule: Wednesday, 09:00–09:50

Anomalous diffusion is observed across diverse natural systems, ranging from cellular signaling and animal foraging to contaminant transport in groundwater, and is closely related to time-fractional equations. In the first part of this talk, I will discuss these connections, specifically how fractional models arise naturally as scaling limits of random walks. I will then present some recent results on time-dependent, time-fractional parabolic equations and their probabilistic representations.

A multiplicative inequality related to the Riesz transform on general Riemannian manifolds

El Maati Ouhabaz

Schedule: Wednesday, 09:50–10:40

Given a complete Riemannian manifold M, we extend a multiplicative inequality of Th. Coulhon and X. T. Duong and prove that for every $p \in (1, 2]$ and every $\varepsilon > 0$,

$$\|\nabla f\|_p^2 \leq C_\varepsilon \|\Delta^{\frac{1}{2}+\varepsilon} f\|_p \|\Delta^{\frac{1}{2}-\varepsilon} f\|_p.$$

The estimate is dimension free. We also study Littlewood–Paley–Stein functionals both for the Laplace–Beltrami operator on functions and for the Hodge–de Rham Laplacian on differential forms and prove their relationship to the boundedness of the Riesz transform.

Dirichlet eigenfunction and heat kernel estimates for unbounded domains

Phanuel Mariano

Schedule: Wednesday, 11:10–11:40

We study upper and lower bounds for the Dirichlet heat kernels of locally inner uniform domains with positive bottom of spectrum. We show the existence of a Perron–Frobenius eigenfunction related to the bottom of the spectrum. We then use a Doob h-transform technique to prove two-sided estimates on the Dirichlet eigenfunction. Our method relies on a precise analysis of the survival probability of the Doob h-process to estimate the eigenfunction. Once we have these estimates, we can then prove volume doubling and Poincaré inequality for the Doob h-process, which imply two-sided estimates on the Dirichlet heat kernel. These estimates hold uniformly for all points in space and for all time. The model domains we consider include unbounded periodic domains and asymptotically tube-like domains. This talk is based on joint work with Brian Chao, Laurent Saloff-Coste, and Jing Wang.

Heat kernel estimates for left-invariant diffusions on infinite dimensional compact groups

Qi Hou

Beijing Institute of Mathematical Sciences and Applications (BIMSA)

Schedule: Wednesday, 11:40–12:10

Infinite dimensional compact connected metrizable groups are projective limits of compact Lie groups. Many of them arise as infinite products of compact Lie groups, such as products of circles or SU(2). On such product groups, the heat kernel measures of many bi-invariant Laplacians are the laws of independent Brownian motions on the factors. The Kakutani dichotomy theorem for product type measures thus applies, and satisfactory characterizations of such heat kernels have been obtained, pointing to a variety of properties ranging from genuine infinite dimensional phenomena to finite dimensional ones. Contrary to this diagonal case, the heat kernels of left-invariant Laplacians or sub-Laplacians are not well-understood, because most standard tools in finite dimensions do not carry over. In this talk I will present some attempts to analyze the heat kernel behaviors for left-invariant elliptic or subelliptic diffusions, via comparisons of intrinsic distances or Dirichlet forms at various levels. This talk is based on joint works with Laurent Saloff-Coste.

Coupling diffusions in sub-Riemannian geometry

Robert Neel

Schedule: Wednesday, 13:30–14:20

We discuss the state of various coupling arguments in sub-Riemannian geometry, focusing on model cases. Based on joint work with Liangbing Luo, Ludovic Sacchelli, and Gaspard Li.

Parabolic Anderson Model driven by Lévy-Fractional noise on Sierpiński Gasket

Céline Lacaux

Avignon University, LMA UPR 2151

Schedule: Wednesday, 14:20–15:10

In this talk, we are interested in parabolic Anderson models driven by Lévy-Fractional noise on the Sierpiński gasket K:

$$\partial_t u(t,x) = \Delta u(t,x) + \beta u(t,x)\dot{Z}_\delta(t,x), \qquad t \in \mathbb{R}_+,\ x \in K,$$

where Δ denotes the Dirichlet Laplacian on K and $\dot{Z}_\delta$ a space–time Lévy noise. More precisely, $\dot{Z}_\delta$ is a Lévy white in time and is a Lévy fractional field in space, having second order moments. Using Poisson chaos expansion, we establish the existence and uniqueness of a mild solution u. We also provide some L^p estimates for its moments.

This talk is based on joint work with Fabrice Baudoin and Juan Jiménez.

Mathematical research and its connections to technology, according to Günther Anders

Ivan Gentil

Schedule: Wednesday, 15:40–16:30

We will see how Günther Anders had a deep understanding of technic understood as technology. Since mathematicians love to generalize, we will explore how scientific research—particularly mathematical research—can be seen through Anders' ideas. Optimal transportation and gradient flows are main examples in my mathematical research.

Separation cut-off phenomenon for Brownian motions in high dimensional harmonic manifolds

Magalie Bénéfice

Schedule: Wednesday, 16:30–17:00

The cut-off phenomenon for Markov processes is about the abrupt transition to equilibrium. During this talk, I aim to explain how this phenomenon can be studied in the case of Brownian motions in Riemannian manifolds by considering the absorption time of some well constructed dual processes with domain values. In particular this method is quite well adapted for harmonic manifolds, for which the volume form is radial. I will thus give some results obtained in this particular case.

This is joint work with Koléhè Coulibaly-Pasquier.

Brownian motion and stochastic areas on full flag manifolds

Teije Kuijper

Schedule: Wednesday, 17:00–17:30

This talk will discuss the area processes and their asymptotics on the complex and quaternionic flag manifolds. A Brownian motion on these manifolds can be represented as a diffusion obtained from a unitary and symplectic Brownian motion, respectively. This representation is then used to derive an explicit formula for the characteristic function of the joint distribution of the stochastic areas on the full flag manifolds in terms of Jacobi polynomials on the simplex. The limit laws are then shown to be multivariate Cauchy and normal distributions, respectively. Using deep connections between area functions on the flag manifolds and winding functionals on spheres, new results about simultaneous Brownian windings on spheres and their asymptotics are established. If time permits, a matrix extension to complex partial flag manifolds with blocks of equal size will briefly be discussed. This talk is based on joint work with Fabrice Baudoin, Nizar Demni, and Jing Wang.

Collisions of simple random walks on the range of a four-dimensional simple random walk

Satomi Watanabe

Schedule: Thursday, 09:00–09:50

We discuss collisions of multiple independent simple random walks on a graph. Whether the number of collisions is finite or infinite serves as an indicator of the structure of the underlying graph. It is easy to prove that two independent simple random walks collide infinitely many times almost surely on transitive recurrent graphs, while some intransitive recurrent graphs lack this property. In this talk, we investigate the number of collisions of three random walks on a graph, inspired by the recent article by Croydon and De Ambroggio. The graph of interest is the random graph given as the trajectory of a four-dimensional simple random walk. We will see that, with probability one, a realization of the random graph has the infinite triple collision property.

Anchored Nash inequalities and heat kernel bounds for random conductance models with long-range jumps

Sebastian Andres

Schedule: Thursday, 09:50–10:40

In this talk we present an anchored version of the Nash inequality for discrete non-local divergence-form operators with degenerate weights. These inequalities allow one to control the L^2-norm of a function in terms of Dirichlet forms associated with random walks having possibly unbounded jump rates. From those Nash inequalities we deduce on-diagonal upper heat kernel estimates for a class of random conductance models with degenerate jump rates that allow long-range jumps and are assumed to be ergodic and to satisfy a suitable moment condition. This talk is based on joint work with Xin Chen (Shanghai), Martin Slowik (Mannheim), and Kun Yin (Shanghai).

Boundary trace theorems for reflected jump processes

Shiping Cao

Schedule: Thursday, 11:10–11:40

On domains in general metric measure spaces, assuming two-sided mixed stable-like heat kernel estimates, we study the trace of reflected jump Dirichlet forms onto the boundary. We establish the Besov space type characterization of the domain of the trace Dirichlet form, assuming the boundary is equipped with a doubling measure that satisfies a lower scaling property. Additionally, under a capacity density condition of the boundary, we can prove the doubling and lower scaling properties of the harmonic measures, and derive estimates for the jump kernel of the trace Dirichlet form. This is joint work with Zhen-Qing Chen and Takashi Kumagai.

Logarithmic Sobolev inequalities on infinite-dimensional reduced Heisenberg groups

Liangbing Luo

Schedule: Thursday, 11:40–12:10

The logarithmic Sobolev inequality was first introduced and studied by L. Gross on Euclidean space, and since then it has found many applications. In particular, many existing results concern the question of how the constant in the logarithmic Sobolev inequality depends on the geometry of the underlying space. As for many such infinite-dimensional groups curvature bounds, or classical Bakry–Émery estimates, are not available, we use different techniques.

Spectral properties of symmetrized AMV Laplacians

David Tewodrose

Schedule: Thursday, 13:30–14:20

The symmetrized Asymptotic Mean Value (AMV) Laplacians extend the Laplace operator from $\mathbb{R}^n$ to metric measure spaces through appropriate averaging integrals. On complete Riemannian manifolds, they provide an alternative approximation of the Laplace–Beltrami operator. In this talk, I will present recent results obtained with Manuel Dias (VUB) about the spectral properties of these operators on compact doubling metric measure spaces. Our results notably apply to suitable unions of intersecting Riemannian manifolds.

Φ^4 measures on 3-dimensional manifolds

Ismaël Bailleul

Schedule: Thursday, 14:20–15:10

The Φ^4 probability measures are the Euclidean analogues of some simple non-trivial quantum field theory. I will explain what they are and how one constructs them on a boundary-less compact 3-dimensional Riemannian manifold, as the invariant probability measures of a Markovian dynamics in a space of fields. These probability measures are intrinsically related to the Riemannian geometry of the manifold, and the heat kernel of the Laplace–Beltrami operator and some related operators play a role in their construction.

Large time behaviour for the semigroup of the kinetic Brownian motion in the plane

Michel Bonnefont

Schedule: Thursday, 15:40–16:30

We establish an integration by parts formula for the semi-group in time $T > 0$ of the kinetic Brownian motion in the Euclidean plane together with its speed in the circle. The stochastic differential equation of our kinetic Brownian motion is driven here by one real-valued Brownian motion constructed with an orthonormal basis of $L^2([0,T],\mathbb{R})$ and an independent sequence of $\mathcal{N}(0,1)$ random variables. Our method is based on an explicit computation of a Malliavin dual in the Gaussian space. We are mainly interested in large time T. From our integration by parts, we obtain gradient estimates including a reverse Poincaré inequality for the semi-group. As a direct consequence, we also obtain a Liouville property for the generator of the kinetic Brownian motion and its speed: all bounded harmonic functions are constant.

Heat kernel estimates on glued graphs

Emily Dautenhahn

Schedule: Thursday, 16:30–17:00

In this talk, we discuss heat kernel estimates on graphs that can be thought of as a finite number of "sufficiently nice" pieces glued together in a "sufficiently nice" way. We will make precise the notion of "sufficiently nice," which includes that each piece satisfies the parabolic Harnack inequality, as well as certain notions of transience and uniformity. A simple example of the type of graphs we consider is taking three pieces, a copy of $\mathbb{Z}^4$, one of $\mathbb{Z}^5$, and one of $\mathbb{Z}^6$, and gluing these pieces together by identifying their x_1-axes. Some of the tools used to obtain these results are hitting probability computations and Faber–Krahn inequalities, and we also describe the challenges in handling more complicated examples. This is joint work with Laurent Saloff-Coste.

Neural Networks for Threshold Dynamics Reconstruction

Luca Capogna

Department of Mathematical Sciences, Smith College, Northampton, MA, USA

Schedule: Friday, 09:00–09:50

This talk introduces a novel framework for solving the inverse problem of identifying threshold dynamics from observed data, with a particular focus on diffusion-generated motion. Thresholding schemes, most notably the Merriman–Bence–Osher (MBO) algorithm, provide a link between heat kernel convolutions and the evolution of interfaces by mean curvature. In a joint project with Elisa Negrini (UCLA), Wei Zhu (Georgia Tech), Almanzo Gao (Stanford), and Abi Bowering (MIT), we explore how these classical geometric flows and related cellular automata can be reconstructed from video frames using specialized deep learning architectures.

We introduce two convolutional neural network (CNN) architectures designed to learn these governing laws directly from video frames. The first, the MBO network, utilizes a recurrent CNN structure with shared, trainable kernels and thresholds to capture dynamics specific to a given evolution. The second, a meta-learning MBO network, employs a hypernetwork approach to generalize across diverse and unseen dynamics by adaptively generating parameters for each input.

I will discuss the performance of these models on both synthetic datasets and real-world applications, such as ice melting and fire front propagation. Our results demonstrate that these networks can effectively reconstruct and extrapolate evolving boundaries even under noisy conditions with minimal supervision.

Stochastic homogenization of diffusions in turbulence driven by non-local symmetric Lévy operators

Jian Wang

Schedule: Friday, 09:50–10:40

We investigate the stochastic homogenization of a class of turbulent diffusions generated by nonlocal symmetric Lévy operators with divergence-free drift fields in ergodic random environments, where neither the drift fields nor their associated stream functions are assumed to be bounded. A pivotal step in our proof is the establishment of $W^{1,q}_{\mathrm{loc}}$ estimates with $q \in (1,2)$ for the corresponding correctors, under mild prior regularity conditions imposed on the Lévy measure and the stream function.

Poincaré and log Sobolev inequalities with weighted Γ operators

Tai Melcher

Schedule: Friday, 11:10–12:00

For a class of diffusions, we introduce a Γ operator modified by a random weight for which we can prove a Poincaré inequality for the distribution of the diffusion at time t. These modified operators seem natural in the sense that, for some example diffusions with stationary distributions, the limit may be taken as time goes to infinity, yielding a Poincaré estimate for the stationary measure and known rates of convergence. Log Sobolev inequalities may also be proved for the same modified Γ operator. This is forthcoming work with David Herzog.

Score matching and sub-Riemannian bridges

Erlend Grong

Schedule: Friday, 12:00–12:50

We discuss how to simulate bridge processes by conditioning a stochastic process on a manifold whose generator is a hypoelliptic operator. This operator is, up to a drift term, the sub-Laplacian of a bracket-generating sub-Riemannian structure, meaning in particular that it has positive smooth density everywhere. The logarithmic gradient of this density is called the score, and we need the score for the generator of the bridge process of such sub-Riemannian diffusions. We therefore discuss several methods for how we can estimate the score using a neural network.

The results are from joint work with Stefan Sommer (Copenhagen) and Karen Habermann (Warwick).

Poster Abstracts

Hypocoercive Langevin dynamics on the Lie group SE(2)

Andrea Vanessa Hurtado Quiceno

Kaiserslautern

We consider Langevin-type diffusions on Lie groups of rigid motions, where the dynamics couple position and orientation, and the noise acts only in a subset of directions, leading to degeneracy. While hypocoercivity for related models in Euclidean settings is well understood, we aim to develop an intrinsic formulation on the underlying Lie group and to identify the geometric mechanisms responsible for convergence to equilibrium.

Starting from the planar motion group SE(2), we express the generator in terms of invariant vector fields and exploit the natural projection onto the kernel of the symmetric part to derive an effective macroscopic behaviour through averaging over the rotation subgroup. Building on this approach, we investigate the three-dimensional case SE(3), where the geometry is more involved, and additional structural features appear. The results for SE(3) are currently in progress.

Dirichlet eigenfunction and heat kernel estimates on annular domains

Brian Chao

We study Brownian motion in an annulus, killed upon hitting the boundary. In the regime where the ratio of the outer radius to the inner radius is close to one, we obtain uniform Dirichlet heat kernel estimates. Our approach relies on a detailed analysis of the first Dirichlet eigenfunction, together with an appropriate discretization of annuli in Euclidean space. We also obtain two-sided estimates on the first Dirichlet eigenvalue and eigenfunction of any annulus. Additionally, our results extend to more general annular domains whose spherical base is a subset of the sphere. This is joint work with Laurent Saloff-Coste.

Heat equations driven by mixed local-nonlocal operators with exponential nonlinearity

Dharmendra Kumar Chaurasia

Banaras Hindu University

We investigate the Cauchy problem for a heat equation driven by the mixed local-nonlocal operator $L := -\Delta + (-\Delta)^s$, $s \in (0,1)$, with exponential nonlinearity

$$\partial_t u(x,t) + Lu(x,t) = f(u(x,t)), \qquad (x,t) \in \mathbb{R}^d \times (0,\infty),$$

where $f : \mathbb{R} \to \mathbb{R}$ exhibits exponential growth at infinity and satisfies $f(0) = 0$. We establish local well-posedness in a suitable Orlicz space in the case where $f(u) \sim e^{|u|^p}$ as $|u| \to \infty$, with $p > 1$. We further prove the existence of global solutions for small initial data under the assumption that f satisfies the growth condition $|f(u)| \sim |u|^m$ near the origin. Moreover, we derive large-time decay estimates in Lebesgue spaces, showing that the behavior of the nonlinearity near the origin determines the decay rate of solutions and highlights a unique asymptotic transition that bridges local and non-local diffusion theories.

A Probabilistic Approach to Shape Monotonicity Problems

Dong-Hwi Seo

Universidad de Granada

A shape monotonicity problem asks which shape yields a better value for a given functional. As a model case, we consider eccentric annuli of fixed radii and study the monotonicity of the first Dirichlet eigenvalue with respect to the distance between the centers.

We further investigate shape monotonicity problems for eccentric annuli with mixed boundary conditions. To study these problems, we analyze the associated heat kernels and develop probabilistic methods.

Martin Boundary and Weak Disorder

Hongyi Chen

We show that for the nonlinear multiplicative stochastic weak equation in weak disorder, the set of invariant measures with bounded second moment are in one-to-one correspondence with the family of bounded harmonic functions. This reveals a new relationship between stochastic PDE dynamics and potential theory.

A Dynkin condition for manifolds with boundary

Marie Bormann

We propose a Dynkin-type condition for smooth Riemannian manifolds with boundary. We show that this condition implies bi-Lipschitz equivalence with a Bakry–Émery weighted Riemannian manifold via a time change. As a consequence, we obtain various results, including a uniform local doubling property as well as lower bounds on the Neumann spectral gap and logarithmic Sobolev constant. The local doubling property also yields a new precompactness theorem for manifolds with boundary. This is based on joint work with David Tewodrose.

Heat kernel and spectral estimates under integral curvature bounds

Xavier Ramos Olivé

We will present several results related to analysis on manifolds under integral curvature assumptions. This work focuses on how local geometric control, especially in the form of integral Ricci curvature bounds, influences global analytic quantities such as heat kernels and the eigenvalues of Laplace-type operators.

In the poster, we will discuss recent gradient estimate techniques that can be used to study the heat kernel on domains of Riemannian manifolds and on smooth metric measure spaces. We will also indicate how these methods lead to spectral consequences, including sharp eigenvalue estimates and spectral gap estimates under weak geometric hypotheses.

The aim is to highlight the interplay between geometry, diffusion, and spectral theory, and to emphasize connections with heat kernel methods that may be of interest to researchers working in geometric analysis, stochastic analysis, harmonic analysis, and related areas.

Gaussian upper heat kernel bounds on graphs with unbounded geometry

Christian Rose

We present recent results about continuous-time heat kernel upper bounds on graphs equipped with counting measure, i.e., with possibly unbounded geometry. Distances are measured with respect to intrinsic metrics. In this setting, relative Faber-Krahn inequalities are equivalent to the conjunction of Gaussian upper bounds and volume doubling on large scales. It turns out that for a reasonable characterization the dimensions of Faber-Krahn inequalities in balls have to vary and depend on the maximal vertex degree inside the considered ball. If the vertex degree does not grow too fast, the Faber-Krahn inequality is bounded. Further, a Gaussian upper heat kernel bound for so-called antitrees having unbounded vertex degree is presented. The results are optimal compared to the heat kernel on the integers.

Rigidity of the sub-Riemannian heat kernel on S^{2n+1}

Zijin Liu

This project studies the heat kernel rigidity problem on the sub-Riemannian sphere S^{2n+1}. We aim to prove that if a metric measure space (M, μ) equipped with two semi-distances (r, θ) admits a heat kernel that takes the same form as the standard sub-Riemannian heat kernel, then it must be bundle-isometric to the sphere S^{2n+1} equipped with the Hopf fibration $S^1 \to S^{2n+1} \to \mathbb{CP}^n$. The key challenge is to use the sub-Riemannian heat kernel to canonically recover the symmetry group $U(n+1)$.

Tuesday Social Program: Visit to Den Gamle By (Old Town Museum)

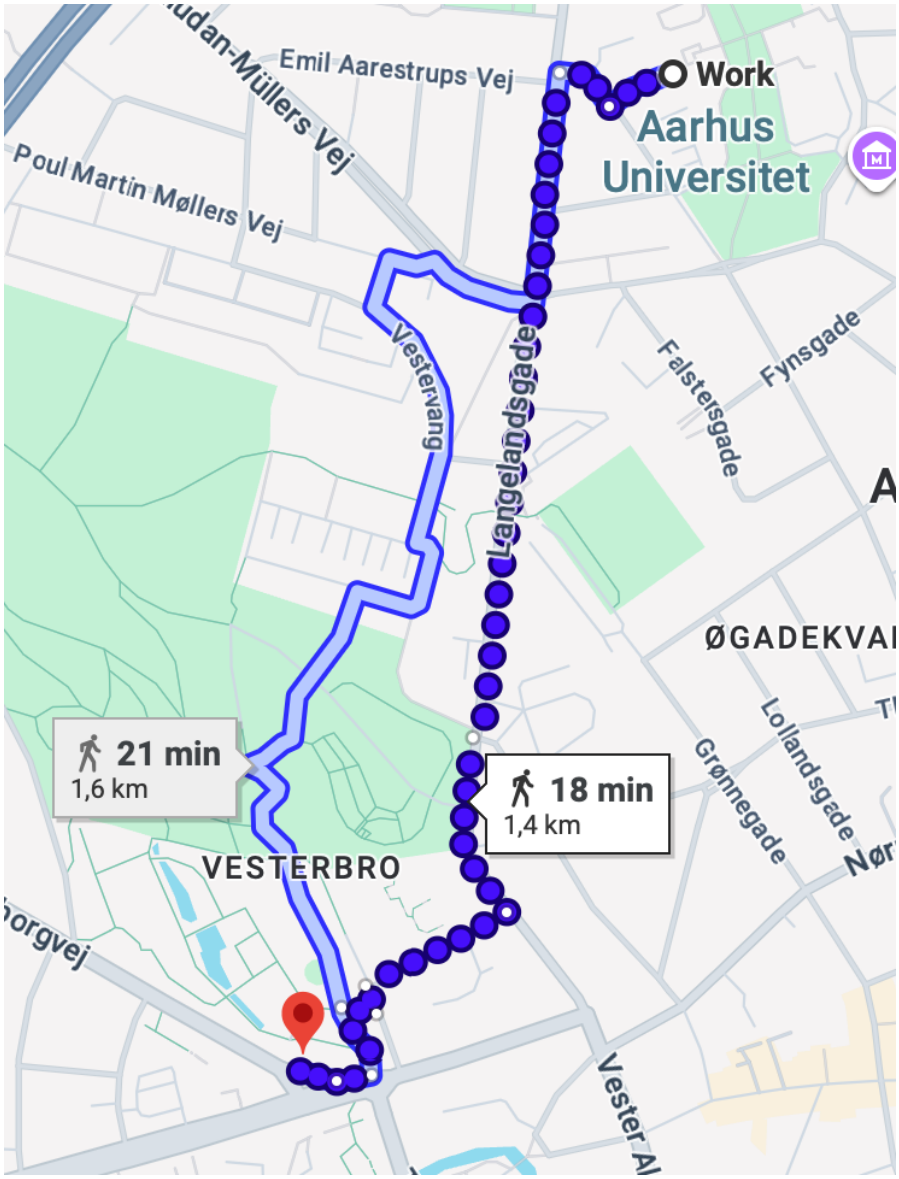
Embark on a fascinating time journey through 400 years of Danish history: From the present with the pizzeria and the rainbow family, the welfare society and the broad-mindedness of the 1970s and modern times in the 1920s with the car dealership and Schou's Soap House to the old market town with the merchant's house, the shoemaker and the distillery.

In Den Gamle By, you become one with history, and you are able to smell, taste and feel your way forward while exploring the streets and passages, look into people's homes and strike a bargain in one of the historical shops.

Throughout the museum, you will meet people in historical costume who will show you around and tell you about the exhibits. It's almost like being there yourself.

Location: Den Gamle By (The Old Town Museum), Aarhus.

Walking route from the conference venue: approximately 18 minutes (1.4 km), as shown on the map below.



Walking route from the conference location to Den Gamle By.