Durham University

Durham Symposium on Metric Geometry, Analysis and Probability
13 – 17 July 2026

Programme

大和日英基金 DAIWA ANGLO-JAPANESE FOUNDATION

LONDON MATHEMATICAL SOCIETY EST. 1865

UKRI UK Research and Innovation

cost EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

FWF Austrian Science Fund

mSPACE

https://conference.ippp.dur.ac.uk/e/1554

Monday 13 July	Tuesday 14 July	Wednesday 15 July	Thursday 16 July	Friday 17 July
09:00 - 09:30 Opening Remarks				
09:30 - 10:30 Ketterer	09:30 - 10:30 Ohta	09:30 - 10:30 Harvey	09:30 - 10:30 Fujioka	09:30 - 10:30 Dello Schiavo
Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
11:00 - 12:00 Borza	11:00 - 12:00 Endo	10:50 - 11:20 Sálamo Candal	11:00 - 12:00 Alattar	10:50 - 11:50 Osborne
		11:30 - 12:00 Tadman		12:00 - 13:00 Shioya
Lunch	Lunch	Lunch	Lunch	Lunch
13:30 - 14:30 Takatsu	13:30 - 14:30 Vincini	Excursion	13:30 - 14:00 Dias	
			14:10 - 14:40 Pelayo Alvaredo	
14:40 - 15:40 Gittins	14:40 - 15:40 Nakamura		14:50 - 15:20 Lanners	
Coffee Break	Coffee Break & Poster Session		Coffee Break & Poster Session	
16:30 - 17:30 Li	16:30 - 17:30 Kuwae		16:30 - 17:30 Tashiro	

Convergence of Lorentzian spaces and curvature bounds for generalized cones

Monday, 13 July 2026 09:30 (1 hour)

Presenter: KETTERER, Christian (Maynooth)

In this talk I will introduce a notion of convergence for Lorentzian prelength spaces called ℓ-convergence. I present a theorem showing that timelike curvature and curvature-dimension bounds are preserved under ℓ-convergence of Lorentzian geodesic spaces. Then, I use ℓ-convergence to study generalized cones, and I show timelike curvature and curvature-dimension bounds. The assumptions are sharp and don't require smoothness. Finally, there is an ℓ-pre-compactness theorem for the class of smooth generalized cones with a uniform lower bound on the full Ricci tensor.

An introduction to sub-Lorentzian geometry

Monday, 13 July 2026 11:00 (1 hour)

Presenter: BORZA, Samuël (Vienna)

Sub-Lorentzian geometry is the non-holonomic analogue of Lorentzian geometry and the Lorentzian counterpart of sub-Riemannian geometry. The theory was anticipated in Strichartz's monograph on sub-Riemannian geometry, but was not systematically studied until the seminal contributions of Grochowski in the early 2000s. Sub-Lorentzian geometry remains largely unexplored, with many fundamental questions still to be addressed. This stands in sharp contrast to the well-developed sub-Riemannian theory, which has become central to metric geometry and the theory of hypoelliptic operators. This talk will give an overview of the current state of sub-Lorentzian geometry, highlighting its relevance to physics as an alternative geometric framework to Kaluza–Klein theory for unifying Einstein's theory of gravity and electromagnetism, recent achievements such as optimal-transport-based notions of curvature, and its role within the broader program of developing a synthetic theory of Lorentzian length spaces and metric spacetimes.

Curvature obstructions to concavity preservation for the porous medium flows

Monday, 13 July 2026 13:30 (1 hour)

Presenter: TAKATSU, Asuka (Tokyo)

We discuss how concavity properties are preserved under the porous medium flows on a Riemannian manifold, clarifying the effects of diffusion nonlinearity and curvature. In particular, curvature yields an obstruction: if the sectional curvature is negative at a given point, no concavity property is preserved. However, if the curvature is non-zero, concavity properties can only be preserved if they are stronger than those associated with the diffusion nonlinearity.
This talk is based on joint work with Kazuhiro Ishige and Yoshiumi Tateoka.

Upper bounds for Steklov eigenvalues of warped product manifolds

Monday, 13 July 2026 14:40 (1 hour)

Presenter: GITTINS, Katie (Durham)

In this talk we explore the interplay between the eigenvalues of the Steklov problem and the geometry of the underlying manifold via geometric upper bounds for the Steklov eigenvalues. We present isoperimetric-type upper bounds for the Steklov eigenvalues of warped product manifolds. In addition, we investigate the maximisation of the Steklov eigenvalues when the warping functions are subject to certain geometric constraints. Time-permitting, we present results regarding upper bounds for the Steklov eigenvalues, ratios, and gaps in the particular case of balls with revolution-type metrics. Key themes throughout will be the investigation of the optimality of these upper bounds, and in some cases we obtain quantitative stability improvements.
The results in this talk are based on joint works with Jade Brisson, Bruno Colbois, Alexandre Girouard, and Jean Lagacé.

W-entropy formula and rigidity theorem on metric measure spaces

Monday, 13 July 2026 16:30 (1 hour)

Presenter: LI, Xiangdong (Chinese Academy of Sciences)

Inspired by the work of Gromov and others, geometric analysis on metric measure spaces has become an important research topic in the interplay between geometry, analysis, and probability theory. An interesting question is whether one can extend Perelman's W-entropy formula from smooth Ricci flow to non-smooth metric measure spaces. In this talk, I will present recent progress on this problem.

Nonlinear heat flow on Finsler manifolds

Tuesday, 14 July 2026 09:30 (1 hour)

Presenter: OHTA, Shin-ichi (Osaka)

This talk will be a survey of nonlinear heat flow on Finsler manifolds. We discuss analytic and geometric applications as well as fundamental difficulties. Partly based on several joint works with Karl-Theodor Sturm and Kohei Suzuki.

Simplicity of the Second Dirichlet Eigenvalue on Non-Equilateral Triangles

Tuesday, 14 July 2026 11:00 (1 hour)

Presenter: ENDO, Ryoki (Niigata)

A conjecture of Laugesen and Siudeja asserts that the second Dirichlet eigenvalue of the Laplacian is simple for every non-equilateral triangle. This talk presents a computer-assisted proof of this conjecture. The argument combines rigorous numerical eigenvalue bounds with two methods for singular regimes in the space of triangles: a difference quotient approach for nearly equilateral triangles, where the relevant eigenvalues form a tight cluster, and an asymptotic analysis for collapsing triangles, where the eigenvalues diverge.

Representation of pyramids through extended mm-spaces

Tuesday, 14 July 2026 13:30 (1 hour)

Presenter: VINCINI, Simone (Vienna)

Pyramids are a generalisation of mm-spaces, introduced by Gromov in the study of sequences of spaces with unbounded dimension. The space of pyramids provides a compactification of the space of mm-spaces, but pyramids come as an abstract object without any geometric representation. Extended topological metric measure (emm-) spaces, introduced by Ambrosio, Gigli and Savaré, are geometric objects that, thanks to the decoupling between their metric and topological structures, allow to study infinite dimensional spaces such as the Wiener space.

We show how every pyramid can be represented by an emm-space in a natural way. This representation is not unique in general: we provide counterexamples but we prove that concentrated pyramids (a more regular subclass) admits a unique representative. We show that the convergence of concentrated pyramids can be studied geometrically through the study concentrated emm-spaces, their emm-representations, extending convergence in concentration for mm-spaces. Finally, we provide some example of (concentrated or not) emm-spaces and discuss some stability results.

This is a work in collaboration with N. Gigli and K. Suzuki.

Inequalities for symmetric convex bodies via the Brascamp–Lieb theory

Tuesday, 14 July 2026 14:40 (1 hour)

Presenter: NAKAMURA, Shohei (Birmingham)

This talk is based on joint work with Emanuel Milman (Technion) and Hiroshi Tsuji (Institution of Science Tokyo).

The Brascamp–Lieb inequality (for multilinear functionals), originally introduced in 1976 as a generalization of Young's convolution inequality, has since been found to be useful across a wide range of fields. For example, in 1991, within convex geometry, Ball showed that the Brascamp–Lieb inequality implies the reverse isoperimetric inequality. More recently, it has played a critical role in harmonic analysis, particularly in the context of the Fourier restriction conjecture and the Kakeya conjecture (e.g. Bennett—Carbery—Tao).

In this talk, we focus on inequalities for symmetric convex bodies within convex geometry. Specifically, we consider the Blaschke–Santaló inequality and its multilinear version, a Talagrand-type inequality for the Wasserstein barycenter, the Gaussian correlation inequality and its strengthened version. On the analytic side, we also include a Laplace transform bound and an improvement of Borell's reverse hypercontractivity.

We will report on new developments obtained by reinterpreting this collection of inequalities from the perspective of the Brascamp–Lieb inequality.

On higher order Morrey's inequalities over RCD(K,N)-spaces

Tuesday, 14 July 2026 16:30 (1 hour)

Presenter: KUWAE, Kazuhiro (Fukuoka)

I will talk on a higher order Morrey's inequality in the framework of RCD(K,N)-spaces for $K \in \mathbb{R}$ and $N \in \mathbb{N}$. I introduce an alternate version of the second order Sobolev space $W^{2,p}(X)$, which contains amply many functions even when $p > N$. This is a joint work with Jun Kitagawa (Michigan State University).

Co-ordinates on Lorentzian length spaces with lower curvature bounds

Wednesday, 15 July 2026 09:30 (1 hour)

Presenter: HARVEY, John (Cardiff)

Lorentzian length spaces with lower timelike curvature bounds have a number of similarities with their positive signature counterparts, Alexandrov spaces. For example, geodesics do not branch and, under reasonable hypotheses, the triangle comparison condition holds true in the large. In this talk, I outline how to adapt the Alexandrov notion of strainers to the Lorentzian setting and demonstrate that Lorentzian length spaces with a lower timelike curvature bound contain an open dense set which is a manifold. This is joint work with Tobias Beran, Felix Rott and Clemens Sämann.

Comparison theory for Lipschitz spacetimes

Wednesday, 15 July 2026 10:50 (30 minutes)

Presenter: SÁLAMO CANDAL, Marta (Vienna)

In this talk, I will present comparison theorems for Lipschitz spacetimes in sharp form: timelike Brunn–Minkowski, timelike Bishop–Gromov, and timelike Bonnet–Myers. The two first results are obtained as a consequence of our main theorem, in which we show that a globally hyperbolic spacetime with locally Lipschitz continuous metric and timelike distributional Ricci curvature bounded from below obeys the timelike measure contraction property. The timelike Bonnet–Myers is obtained parallely using the localization technique from convex geometry. Our framework covers a remarkable class of examples of spacetimes, including impulsive gravity waves, thin shells, and matched spacetimes. This talk is based on joint work with Mathias Braun.

Hodge Theory on Alexandrov and RCD Spaces

Wednesday, 15 July 2026 11:30 (30 minutes)

Presenter: TADMAN, Lewis (Durham)

Classically, differential forms are defined using the smooth structure of the manifold. In the singular setting, there is no global smooth structure on which to base this definition. For an Alexandrov space, Lott used the open, dense Lipschitz manifold of full measure to define an analogous theory of L^2 differential forms and associated operators. However, in the more general RCD framework, one cannot do this; instead, one appeals to Gigli's theory of cotangent modules. In this talk, as finite dimensional Alexandrov spaces are RCD (thanks to the work of Petrunin, Zhang-Zu) we will discuss the similarities and differences of these frameworks, and how they differ from the smooth setting. We will further state some properties of the various Laplace-type operators arising in both frameworks.

Busemann geometry after Alexandrov geometry

Thursday, 16 July 2026 09:30 (1 hour)

Presenter: FUJIOKA, Tadashi (Fukuoka)

I will discuss recent developments in the geometry of Busemann spaces, building on the geometry of Alexandrov/CAT spaces. Partly based on joint work with Shijie Gu (Northeastern University, China) and Kenshiro Tashiro (The University of Osaka).

Deforming Lipschitz Homeomorphisms

Thursday, 16 July 2026 11:00 (1 hour)

Presenter: ALATTAR, Mohammad (Durham)

In this talk, we will discuss the theory of deforming Lipschitz Homeomorphisms. We will give applications to Lipschitz geometry and Alexandrov geometry, where we extend and refine the work of Perelman, Sullivan and Siebenmann to the Lipschitz category.

Spectral properties of symmetrized AMV Laplacians

Thursday, 16 July 2026 13:30 (30 minutes)

Presenter: DIAS, Manuel (Brussels)

The symmetrized Asymptotic Mean Value (AMV) Laplacians extend the classical Laplace operator from Rn to metric measure spaces through suitable averaging integrals. I will present an overview of this Laplacian in different contexts, namely Riemannian manifolds Finsler manifolds and unions of manifolds and how it relates to other known Laplacians in this context. I will also go through results obtained with David Tewodrose (VUB) on the spectral properties of these operators on compact doubling metric measure spaces and manifolds with boundary.

Revisiting Dvoretzy's Theorem

Thursday, 16 July 2026 14:10 (30 minutes)

Presenter: PELAYO ALVAREDO, Victoria (Madrid)

Dvoretzky's theorem is one of the classical results of high-dimensional geometry: every sufficiently high-dimensional normed space contains almost Euclidean subspaces of logarithmic dimension. Geometrically, this means that compact convex symmetric sets have high dimensional sections that are close to being elliptical.

In this talk, we discuss two extensions of this result. In the first one, we give complex and quaternionic versions of the theorem. The second direction is geometric. We interpret the original Dvoretzky's Theorem in terms of the radial function of the convex set. Then, using the Hopf fibration, we show that, under a suitable convexity condition, Dvoretzky's theorem gives almost Euclidean behavior for functions on appropriate projective subspaces.

Diffusion Geometry: Bridging the Gap between Riemannian Geometry and Modern Data Science

Thursday, 16 July 2026 14:50 (30 minutes)

Presenter: LANNERS, David (Durham)

Classical methods for geometric data analysis typically rely on constructing appropriate meshes, triangulations or lattices. This process is often computationally expensive, sensitive to noise, and restricted to the "manifold hypothesis". This talk presents joint work with Iolo Jones that introduces a new, mesh-free framework called diffusion geometry that operates directly on collections of points in $\mathbb{R}^n$.

By reformulating calculus and Riemannian geometry in terms of diffusion processes, we introduce a general recipe for computing standard objects, such as gradients, differential forms, geodesic distances, and sectional curvature, with potential implications for lattice field theory computations and simulations of quantum gravity. Moreover, this data driven approach provides a pathway towards computing parallel transport and invariants such as holonomy, that have previously been out of reach for computational methods.

Super-polynomial Weyl's law for compact $\mathrm{RCD}(K,\infty)$ spaces

Thursday, 16 July 2026 16:30 (1 hour)

Presenter: TASHIRO, Kenshiro (Osaka)

It is known that the asymptotic behavior of eigenvalue counting function $N(\lambda)$ for a metric measure space, with suitable assumptions, captures its Hausdorff dimension. In this talk, we discuss the asymptotic behavior of $N(\lambda)$ for compact $\mathrm{RCD}(K,\infty)$ spaces. First, we show that $N(\lambda) \lesssim e^{\lambda^{\frac{1}{2}}}$ for every compact $\mathrm{RCD}(K,\infty)$ spaces. This is compared with a crude polynomial upper bound $N(\lambda) \lesssim \lambda^{\frac{N}{2}}$ for a compact $\mathrm{RCD}(K,N)$ space with finite N, which reflects its finite dimensionality. Second, we give examples of compact $\mathrm{RCD}(K,\infty)$ spaces with $N(\lambda) \sim e^{\lambda^s}$ for $s \in (0,1/4)$. The example is motivated by a generalized Grushin structure whose singular set has infinite Hausdorff dimension.

This talk is based on an ongoing joint work with Samuël Borza and Kohei Suzuki.

Massive Particle Systems, Wasserstein Brownian Motions, and the Dean–Kawasaki SPDE

Friday, 17 July 2026 09:30 (1 hour)

Presenter: DELLO SCHIAVO, Lorenzo (Rome)

Let W be a conservative, ergodic Markov diffusion on some arbitrary state space M, converging exponentially fast to equilibrium. We consider:

(1) Systems of up to countably many massive particles in M, with finite total mass. Each particle is subject to an independent instance of the noise W, with volatility the inverse mass carried by the particle. We prove that the corresponding infinite system of SDEs has a unique solution, for every starting configuration and every distribution of the masses in the infinite simplex.

(2) Solutions to the Dean–Kawasaki SPDE with singular drift, driven by the generator L of W. We prove that the equation may be given rigorous meaning on M, and that it has a unique "distributional" solution. This extends Konarovskyi–Lehmann–von Renesse's "ill-posedness vs. triviality" to the case of infinitely many massive particles.

(3) Diffusions with values in the space P of all probability measures on M, driven by the geometry induced by L.

(4) In the case when M is a manifold, differential-geometric and metric-measure Brownian motions on P induced by the geometry of optimal transportation and reversible for a normalized completely random measure.

We show that all these objects coincide.

This talk is based on arXiv:2411.14936

Regularization of Mean Field Game Partial Differential Inclusions

Friday, 17 July 2026 10:50 (1 hour)

Presenter: OSBORNE, Yohance (Durham)

Mean Field Games (MFG) are models for Nash equilibria in games of optimal control involving a continuum of players. MFG are typically characterized by a system of PDEs which describes the nonlinear relationship between the optimal actions of individual players and the distribution of players in the game. The MFG system is given by a Hamilton–Jacobi–Bellman (HJB) equation, for the generic player's control optimization, that is coupled nonlinearly with a Kolmogorov–Fokker–Planck (KFP) equation that determines the player density. To model MFG where players have access to possibly non-unique optimal controls and the Hamiltonian is nondifferentiable, we recently proposed that the MFG PDE system be relaxed to a Partial Differential Inclusion (PDI) system based on measurable selections of the partial subdifferential of the Hamiltonian.

In this talk, we study second-order MFG PDI with convex, Lipschitz continuous, but possibly nondifferentiable Hamiltonians, and their approximation by systems of classical MFG PDE with regularized Hamiltonians. Under broad conditions on the problem data, we prove that, up to subsequences, the solutions of the regularized problems converge to solutions of the MFG PDI. In particular, we show the convergence of the value functions in the H^1-norm and of the densities in L^q-norms. Under stronger hypotheses on the problem data, we also establish rates of convergence between the solutions of the original and regularized problems, without requiring any higher regularity of the solutions. We give concrete examples that demonstrate the sharpness of several aspects of the analysis.

Beginning of coarse geometry of metric measure spaces

Friday, 17 July 2026 12:00 (1 hour)

Presenter: SHIOYA, Takashi (Tohoku)

In this talk, I will discuss joint work with Takayuki Okuda (Hiroshima University) on the coarse geometry of metric measure spaces. Using ideas from optimal transport theory, we introduce a notion of measured coarse equivalence and define a corresponding variant of the uniformly finite homology of Block and Weinberger, called measured Block-Weinberger homology. We prove that this homology is invariant under measured coarse equivalence and, under the local doubling condition, that the vanishing of its 0-th homology is equivalent to non-amenability. The proofs combine techniques from optimal transport theory and the disintegration of measures. Some examples will also be presented.
