IMS Annual Scientific Meeting 2024
Queen's University Belfast
29 – 30 August 2024

The third *Annual Scientific Meeting of the Irish Mathematical Society* to be held in the 21st century at Queen's University Belfast took place on Thursday 29th and Friday 30th August 2024 in the Mathematical Sciences Research Centre. The meeting joined the *British Mathematical Colloquium* in April 2004 and, in September 2014, it was followed by an *International Workshop on Operator Theory*. The local organising team in 2024 consisted of Thomas Hüttemann, Martin Mathieu and Salissou Moutari.

Financial support was gratefully obtained from the Irish Mathematical Society, the School of Mathematics and Physics of Queen's University, the Mathematical Sciences Research Centre as well as from the UKIE Section of SIAM for the best poster prize.

Four plenary lectures were delivered by Prof. Martin Bridson, FRS (Oxford) on *Soap films, snowflake discs and annuli: the geometry of decision problems in group theory*; Prof. Miguel Bustamante (UCD) on *Open problems on the dynamics of nonlinear resonant wave systems: from FPUT recurrence to gravity water waves, atmospheric waves and millennia-long solar cycles*; Prof. Claire Gormley (UCD) on *Apposite statistical models for network data*; and Prof. Silvia Sabatini (Cologne) on *Positive monotone symplectic manifolds with symmetries*.

The life and work of the late Professor Seán Dineen was remembered in a joint presentation by Pauline Mellon (UCD) and Ray Ryan (UG).

The Society's AGM was held at midday on 30th August and a joint dinner, which doubled-up as a retirement dinner for Prof. Martin Mathieu, was held the previous evening.

Nearly all of the approximately 60 participants at IMS2024.

Twelve further 25 minute contributed talks and a poster session completed the scientific programme. Contributed talks were as follows:

- Patrick Browne (TUS):
  Erdös–Ko–Rado type problems in root systems.
- Padraig Ó Catháin (DCU):
  Monomial representations and complex Hadamard matrices.
- Oisín Flynn-Connolly (Université Sorbonne Paris Nord)
  Higher invariants in homotopy theory.

- Brendan Guilfoyle (MTU):
  Zeros of polynomials and isolated umbilic points.
- Fintan Hegarty (UG):
  Mathematics for content-based language learning.
- Gabor Kiss (QUB):
  Timely Testing and Treatment in Gonorrhoea Control: Insights from Mathematical Modelling.
- Peter Lynch and Michael Mackey (UCD):
  Counting Sets with Surnatural Numbers.
- Michael McAuley (TU Dublin):
  Geometry of Gaussian fields.
- Joshua Maglione (UG):
  Igusa zeta functions and hyperplane arrangements.
- Andrew D. Smith (UCD):
  Spirals in Spaces of Holomorphic Functions.
- Richard J. Smith (UCD):
  The extreme point problem in Lipschitz-free spaces.
- Yinshen Xu and Miguel D. Bustamante (UCD):
  Singularity of bounded vortex-stretching fluid under rotational symmetry.

The UKIE Section of SIAM sponsored a prize of €100 for the best poster, which was awarded to Joseph Dillon (Nashville). The full list of poster presentations is:

- Elife Cetintaş (Wuppertal):
  The term 'structure' in mathematical discourse from 1889 to 1942. A bibliometric study by using the Jahrbuch über die Fortschritte der Mathematik.
- Joseph Dillon (Nashville):
  Symmetry and the Riemann zeta function.
- Fergal Murphy (UCC):
  Invariant Polynomials in Harmonic Analysis.
- Zgisis Sakellaris (UCC):
  Near-resonant approximation for the rotating stratified Boussinesq system.

A full record of the meeting is available at `http://ims2024.martinmathieu.net/IMS2024-programme-booklet-final.pdf`

Abstracts of Invited Talks:

Soap films, snowflake discs and annuli: the geometry of decision problems in group theory

Martin Bridson

University of Oxford

Plateau's Problem, rooted in the study of soap films, concerns the nature of discs and minimal surfaces with a given boundary loop. The shimmering appeal of such questions contrasts sharply with the typical reaction to the study of complexity and decision problems in group theory. In this talk, I shall explain how insights of Gromov forged powerful links between these two seemingly disparate pursuits. I shall explain some highlights of the resulting surge of activity, with emphasis on 2- and 3-dimensional spaces and the novel geometries that came to light through the study of Word Problems for groups. I will end by sketching the state of the art concerning the less-understood theory of annuli in geometry and Conjugacy Problems in group theory.

Open problems on the dynamics of nonlinear resonant wave systems: from FPUT recurrence to gravity water waves, atmospheric waves and millennia-long solar cycles

Miguel Bustamante

University College Dublin

In this talk I will present a survey of my research on the dynamics of nonlinear wave systems in the context of wave-wave resonances and their role in solving open problems such as: the Fermi-Pasta-Ulam-Tsingou recurrence, the experimental search for resonances in gravity water waves and atmospheric planetary waves, and the explanation of millennia-long solar cycles.

I will show how, by navigating the boundaries between hyperchaos and integrability, this research is connected with the phenomenon of phase synchronisation in networks and with the theory of integrable systems. Also, I will explain how this work was impacted by areas of 'pure' mathematics, such as number theory, in the search for exact resonances in nonlinear wave systems.

Apposite statistical models for network data

Claire Gormley

University College Dublin

Interactions between entities (*e.g.*, social actors, regions of the brain, phones, countries) are frequently represented using network data. These interactions take a variety of forms, *e.g.*, they may be binary or count, directed or undirected. Additionally, there may be very many or very few entities and they typically form interactions in heterogeneous ways.

Statistical models are useful for modelling such network data as, *e.g.*, they allow us to learn about the processes generating the network data, about patterns within them and/or to predict future network data. Latent position models are apposite and widely used statistical models for network data. Latent position models assume each entity is positioned in a latent space and the likelihood of interactions between entities depends on their relative positioning in the latent space.

This talk will outline some challenges in latent position modelling and propose potential solutions. For example, inferring the dimension of the latent space is difficult and, for simplicity, two dimensions are often used. Here a Bayesian nonparametric framework is employed, inducing shrinkage of the variance of the latent positions across higher dimensions, providing automatic inference on the latent space dimension. Interactions can take different forms, here addressed by developing apposite logistic and Poisson models, for binary and count valued interactions respectively. Heterogeneity within entities is addressed through a mixture modelling framework, providing a clustering of entities. Inference for such latent position models is computationally expensive; here utilising novel surrogate proposal distributions within an Markov chain Monte Carlo (MCMC) algorithm, and a variational inference approach for large networks, are proposed.

These latent position model developments are explored through simulation studies, and practical utility is illustrated through application to real network datasets. Open source software assists with implementation of the developed modelling tools.

This is joint work with Dr Xian Yao Gwee and Dr Michael Fop (University College Dublin).

Positive monotone symplectic manifolds with symmetries

Silvia Sabatini

University of Cologne

Positive monotone symplectic manifolds are the symplectic analogues of Fano varieties, namely they are compact symplectic manifolds for which the first Chern class equals the cohomology class of the symplectic form. In dimension 6, if the positive monotone symplectic manifold is acted on by a circle in a Hamiltonian way, a conjecture of Fine and Panov asserts that it is diffeomorphic to a Fano variety.

In this talk I will report on recent classification results of positive monotone symplectic manifolds endowed with some special Hamiltonian actions of a torus, showing some evidence that they are indeed (homotopy equivalent/homeomorphic/diffeomorphic to) Fano varieties.

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