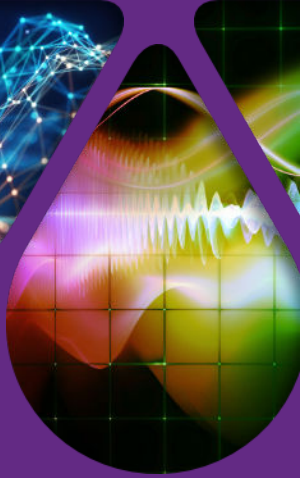
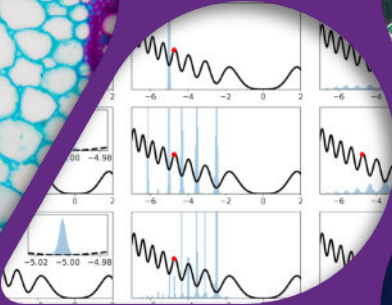
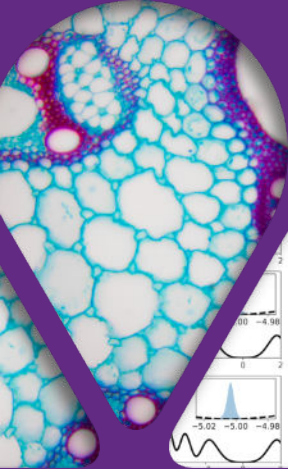


# Annual Report 2023-2024



## Mission Statement

*The Newton Gateway to Mathematics acts as a vehicle for knowledge exchange between the mathematical sciences and potential users of mathematics, including industry, government, business and other academic disciplines, both in the UK and internationally. It does this by facilitating interactions and activities such as programmes of work, research and training events, as well as bespoke projects. The Newton Gateway to Mathematics aims to widen access to mathematics generally, to shorten pathways to impacts for academic research, and to support education and training in areas where mathematical skills are needed.*

## What Makes the Newton Gateway to Mathematics Different?

The Newton Gateway to Mathematics is a knowledge intermediary for the mathematical sciences. Although based at the *Isaac Newton Institute for Mathematical Sciences (INI)* and supported by the *University of Cambridge*, the Newton Gateway is an independent body serving the whole of the UK mathematical sciences community and reaches out to and engages with all users of mathematics – in industry, business, public sector and other scientific disciplines. With extensive access to multiple communities across the UK and globally, the Gateway can respond in an agile and flexible manner. It works as a delivery partner to facilitate the exchange, translation and dissemination of knowledge. Using effective communications and proven methodologies, the Gateway develops and runs activities such as workshops and meetings, bringing people and organisations together in order to share knowledge and stimulate further research and collaboration.

## Engaging with Users of Mathematics

The Newton Gateway to Mathematics is the impact initiative of the *Isaac Newton Institute for Mathematical Sciences (INI)* based at the *University of Cambridge*. It works with the whole of the UK mathematical sciences community to extend the reach and highlight the importance of mathematics to all potential users such as other academic disciplines and researchers in business/industry and the public sector. User engagement is therefore a key focus, helping to understand the community and end-users in order to collaborate effectively.

The Newton Gateway to Mathematics delivers a range of activities, such as research scoping workshops and knowledge dissemination events

across a number of different themes and sectors including biology and healthcare systems, environment and energy, financial risk, security sectors, Big Data and public policy.

As part of all of these collaborations, the Newton Gateway to Mathematics develops programmes of work, disseminates information and develops strategic relationships, to ensure effective translation of science to the user. This has helped partners to understand and gain consensus on the challenges that need to be overcome and facilitate other interdisciplinary collaborations to enrich the existing communities.



# Foreword

The Gateway held an event to celebrate its tenth anniversary in November 2023, having marked its actual anniversary in March 2023 with a short campaign of activity on social media. This event celebrated the anniversary more formally and included talks that highlighted the breadth of Gateway activities and some key partnerships and successes. These talks covered examples of delivery of *Open for Business* events in support of *INI* Programmes, work through *Innovate UK Analysis for Innovators Programme* and a session where Early Career Researchers spoke about their engagement opportunities through Gateway events and activities.

The Gateway has been proactive in developing some new activities over the past year as well as its continued delivery of events that support *INI* Research Programmes. One particular highlight has been the development of a collaboration with *Martingale Foundation* on its new programme, *Solve for X*, which is a multi-year development challenge promoting collaboration and progression of key professional skills. The Gateway collaborated on the first *Solve for X* training camp in June 2024, where Scholars attended a four-day training camp where they worked with experienced academic professionals to guide them through the process of applying their mathematical knowledge in an industry context. The Scholars developed solutions to industry problems and pitched their proposed solutions to a panel of experts from academia and industry.

In March 2024, the Gateway was delighted to be invited to exhibit at the *Maths Summit*, which was hosted at London's *Science Museum* and was

delivered by the *Campaign for Mathematical Sciences*. The event brought together mathematicians, politicians, policy makers, business and media to discuss how the mathematical sciences can better contribute to research, innovation and prosperity.

A number of presentations and panel sessions took place over the day, with talks from leading mathematicians, academics and policy makers that explored some key strategic challenges faced by the community and looked at opportunities for increased engagement. The Gateway was one of a number of exhibitors helping to showcase the role that mathematics plays in all aspects of life. The Gateway had the opportunity to hear from many inspirational speakers and was able to connect with others from industry, academia and the public sector.

Since February 2024, the Gateway has been working with the recently established *Mathsci-comm* network, which aims to connect those working in, and with a stake in, communicating complex mathematics and data science to a variety of non-expert audiences. This includes researchers, media and communications professionals, those working in policy in government and non-government organisations. The network has been established following the January 2023 *Communicating Mathematics for the Public* event, which was jointly developed and delivered by the Newton Gateway. Since then, some of those involved have been working together on the next steps, including the development of the network which hosts regular facilitated meetings and is planning for a follow-on event in November 2024 that will explore

what success looks like when communicating mathematical and data sciences.

In April 2024, the Gateway partnered with the *Prob\_AI* Hub which is funded by the *Engineering and Physical Sciences Research Council (EPSRC)* and which aims to transform the way we develop and use artificial intelligence (AI) tools. It aims to bring together leading researchers from mathematics, statistics and computational AI to develop the mathematical foundations of probabilistic AI. The Gateway will be working with the *Prob\_AI* Hub on some additional joint delivery in the year ahead.

The Gateway has continued to support delivery with and by the wider mathematical sciences community infrastructure – working with *ICMS*, *Innovate UK* and the *KE Hub*. At a number of events, where representation was required by all four organisations, the Gateway has worked in partnership to develop a joint presentation that one of the four has subsequently delivered. This has ensured that a joined-up approach is presented and that duplication of reporting is minimised, for example, of *V-KEMS Virtual Study Groups* which are supported by each organisation. The Gateway led the development of delivery of such a presentation at *BAMC (British Applied Mathematics Colloquium)* in April 2024 in Newcastle.

In November 2023, the Gateway presented at a Knowledge Exchange Day, hosted by the *Institute for Mathematical Innovation* at the *University of Bath*. The Gateway highlighted opportunities for engagement between academics, industry, and experts in KE, in particular helping to promote

the *Innovate UK Analysis for Innovators Programme*. The Gateway's role in *V-KEMS (the Virtual Forum for Knowledge Exchange in the Mathematical Sciences)* has continued over the year with ongoing interaction with the partners and academics involved.

The Gateway continued to work closely with the *Knowledge Exchange Hub for the Mathematical Sciences (KE Hub)* which has the aim to scale up and accelerate knowledge exchange activity in the mathematical sciences in the UK. The Gateway Manager sits on the Executive Team of the *KE Hub* and, with others, helps identify, develop and deliver relevant opportunities for engagement. The Gateway was key to the development and delivery of the *KE Hub's* successful launch event in December 2023 and continues to collaborate on joint activity and opportunities for delivery.

The Gateway delivered six *Open for Business* knowledge exchange events linked to six *INI* Research Programmes. These activities are specifically designed to bring together industrial, commercial and governmental organisations with mathematical scientists. They are run as part of an ongoing *INI* Programme and help to extend the reach of research being undertaken by academics who are at *INI* for an extended period. Two of the *OfB* events were delivered as part of *INI* Satellite Programmes, in partnership with the *Alan Turing Institute*, which helped to expand the reach of *INI* and the Gateway.

Through its role as a Partner in the *Innovate UK Analysis for Innovators Programme*, the Gateway has continued to engage with UK businesses that

## Foreword

it hasn't necessarily worked with before. This Programme gives UK businesses access to cutting-edge expertise to help solve problems that they have been unable to tackle using standard technologies and techniques. Academics from the Gateway *Scientific Advisory Panel* or those associated to it, provide input to this activity and have taken forward projects with individual companies, some of which have concluded over the reporting year, with positive outcomes for the company involved.

Ongoing engagement with the *UKHSA* took place over the year through its *Mathematical Modelling PhD Student Placements* scheme. In the third round of internships, the *UKHSA* appointed eight PhD Students to join their Early Career Researcher (ECR) programme as ECR Analysts - Advanced Epidemiological Modellers for 3 months. As well as work experience, the placement also provided the candidates a pastoral and development programme, together with opportunities for technical skills development.

The Gateway is the UK representative within *EU-MATHS-IN* a European network that aims to establish connections between stakeholders working in industrial mathematics. The Gateway's

*Scientific Advisory Panel* acts as the network for the UK and have presented case studies and exemplars at the annual conference.

Through ongoing engagement activity, the Newton Gateway has continued to extend its reach across different sectors. Activities have been delivered in partnership with other organisations, as detailed within this Annual Report, which has ensured further collaborative opportunities with new connections made across a breadth of sectors and subjects.

The Newton Gateway to Mathematics is very grateful for the support given by *INI*, the *University of Cambridge* and our colleagues, partners and stakeholders. Having marked its tenth anniversary in 2023, we look forward to continuing to work with new stakeholders across the mathematical sciences landscape and welcoming delegates at our events at *INI* and elsewhere.

## 10th Anniversary of the Newton Gateway to Mathematics



The Gateway has spent the past decade connecting mathematical research with industry, businesses, the public sector and other scientific disciplines.

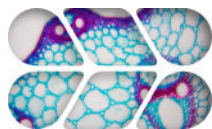
In March 2023, the Newton Gateway to Mathematics celebrated its 10th anniversary. This was marked with the publication of a 10th Anniversary flyer and a short campaign of activity on social media, including an *INI* podcast interview with Gateway Manager, Clare Merritt, looking back at the past, and ahead to the future of the Gateway. Further to this, *Plus Magazine*, who report on activities to a wide audience, published a dedicated Newton Gateway to Mathematics webpage, which contains articles and podcasts that are part of this collaboration.

On 14th November 2023, the anniversary was celebrated more formally at the *Isaac Newton Institute* with an afternoon of talks.

Talks highlighted the breadth of Gateway activities and some of our key partnerships and successes. These talks covered examples of delivery of *Open for Business* events in support of *INI* Programmes and illustrated areas of work that the Gateway has been particularly proud of. These demonstrated where the Gateway had added real value and impact, for example our work in support of pandemic modelling through the *Virtual Forum for Knowledge Exchange in Mathematical Sciences (V-KEMS)* and the *JUNIPER Partnership*. Talks also illustrated our work through *Innovate UK Analysis for Innovators Programme* and a session where Early Career Researchers spoke about their engagement opportunities through Gateway events and activities.

The talks were followed by a networking session and a formal dinner at *Clare College*.

# Gateway Activities from August 2023 - July 2024



7-9 September 2023

## 6th Edwards Symposium - Soft Matter for the 21st Century

The *Edwards Symposium Series* reached its seventh year in 2023, recognising the life and work of Professor Sir Sam Edwards FRS. The Symposium continues to build on Sir Sam's realisation that broad classes of soft materials are governed by unifying physical principles, arising from the geometry, topology and qualitative behaviour of their microscopic components, regardless of their detailed molecular or chemical character.

This workshop focused on the following soft matter areas: Granular Materials and Plasticity, Subcellular Biophysics, Programmable Soft Matter

and Statistical Physics of Rare Events. In keeping with previous symposiums, these themes posed fundamental questions in basic science that were addressed by distinguished academic speakers. Their wider relevance was reflected in presentations given by industrial participants whose oral presentations, posters and informal discussions informed the discussions and are leading to future collaborations of benefit to both sides.

It was hosted as an in-person event, with some virtual elements, at the *Centre of Mathematical Sciences*, Cambridge and was funded in part by the generous support of *Capital Fund Management*.



16-18 January 2024

## Food Security - Virtual Study Group

Food security presents the challenge of ensuring that everyone in the world has at all times, physical and economic access to sufficient safe and nutritious food. This three-day Virtual Study Group was developed by the Gateway on behalf of *V-KEMS* and supported by the *KE Hub* and *ICMS*, and focused on investigating causes of food insecurity, a global issue in which agriculture, supply chains and climate change play a key role.

During the study group, several issues preventing global food security were explored, including those related to Food Production, Food Waste and Shortages. Over the course of the event, potential solutions were developed and these were presented on the final day. A summary report was subsequently published, which highlighted the discussions that took place and the initial findings.

7-9 February 2024

## Mathematics Workshop: Theory of Electromagnetic Activity



Freedom of operation in the electromagnetic environment (EME) is crucial to future civilian and military activities, and yet is increasingly challenging as the environment becomes both more congested (by growth in demand), and more contested (by increased disruptive / covert capability). Continual innovation is crucial to maintain such freedoms, and this 3-day residential workshop aimed to bring experts from diverse fields to share knowledge and address key challenges in electromagnetic activities as part of the wider *EME Hub* programme of work,

and to spur new avenues of research, pilot studies and networking activities across the spectrum.

The workshop was delivered in collaboration with the national *EME Hub* and aimed to give participants the opportunity to engage with five signposted challenges constructed by leading UK mathematicians, namely: efficient automated decision-making; playing games with uncertainty; reliable and robust semantic communications; limits in realising EM deception; automated scheduling in an uncertain environment.

9 April 2024

## Prob\_AI Hub Launch Event



The *Prob\_AI* Hub is a new world-leading research hub, funded by the *Engineering and Physical Sciences Research Council (EPSRC)* which aims to transform the way we develop and use artificial intelligence (AI) tools. The Hub aims to bring together leading researchers from mathematics, statistics and computational AI to develop the mathematical foundations of probabilistic AI. This will lead to more accurate AI models, greater transparency of the limits of AI models' predictions, and efficiency improvements that will help reduce the energy demand of AI models.

and relevant individuals from industry and government and to hear about funding opportunities, PDRA and PhD positions.

The Hub is led by *Lancaster University*, and involves the Universities of *Bristol*, *Cambridge*, *Edinburgh*, *Manchester* and *Warwick*.

*"The launch event for the Prob\_AI hub was an excellent event that enabled us to share the research challenges and themes of the Hub, and why they are important, to a range of academic, industrial and public sector researchers. At a stage when the Hub was just being set-up it was a great relief to me to have the Newton Gateway involved in organising and running this event. They were amazingly professional and reliable and ensured the event was well-attended and ran smoothly and effectively."*

*Paul Fearnhead*  
Prob\_AI Hub Lead

The launch took place at the Wellcome Collection, London and talks highlighted the importance of and potential for probabilistic approaches to AI, described research projects being undertaken across the Hub's main research challenge areas and their connection to some motivating applications. The event provided the opportunity for participants to network with senior scientists

# Knowledge Exchange Activities for INI Research Programmes

The *Isaac Newton Institute* sponsors Knowledge Exchange activity, referred to as 'Open for Business' (*OfB*) knowledge exchange events, as a part of its continuing objective of bringing academic researchers involved with its research programmes into contact with industrial, commercial and government organisations and individuals.

These activities, which are delivered by the Newton Gateway to Mathematics, provide opportunities for cross-fertilisation between the activities of users from industry and the public sector, and the research focus of the Institute. *OfB* events are structured to enable the formation of new public-private partnerships, collaborative research and to assist in identifying the common challenges that have greatest potential for research, knowledge exchange, public policy and commercial impact.

Six *OfB* events were hosted during the reporting year which were developed and delivered with the academic organisers of six *INI* research programmes that took place over this period. These Programmes were: *Mathematics of Movement: An Interdisciplinary Approach to Mutual Challenges in Animal Ecology and Cell Biology*; *New Statistical Physics in Living Matter: Non Equilibrium States Under Adaptive Control*; *Black Holes: Bridges Between Number Theory and Holographic Quantum Information*; *Anti-Diffusive Dynamics: From Sub-Cellular to Astrophysical Scales*; *Heavy Tails in Machine Learning and Diffusions in Machine Learning: Foundations, Generative Models and Non-Convex Optimisation*.

The Gateway was pleased to be able facilitate a number of different interactions over the year, which helped to make connections between the organisers, participants and speakers of the six Programmes that would have been unlikely to happen otherwise.

18 October 2023

## Connecting Micro to Macro in Epidemiological Models



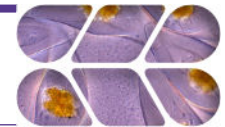
The movement and interactions of individuals is a key driver of epidemics in animal and human populations, as highlighted by the *COVID-19* pandemic. Although the dynamics of epidemics span multiple spatiotemporal scales, modelling approaches tend to focus on a particular spatiotemporal resolution. To understand the complexity of disease spread, the dynamics at all scales need to be accounted for. Given the tracking revolution in the last decades and the ensuing highly resolved movement data in animals and humans, the time is ripe to develop tools and techniques that account for the microscopic dynamics of infection transmission

events bridging the gap to the macroscopic models at the population scales.

This *OfB* event was part of the programme on the *Mathematics of Movement: An Interdisciplinary Approach to Mutual Challenges in Animal Ecology and Cell Biology*. It aimed to build links between movement modellers, epidemic disease modelling and those working in public health and featured a series of talks that covered modelling epidemics within enclosed settings – hospitals, schools, prisons, modelling of epidemics on networks, and modelling of human mobility in the context of epidemics.

24 October 2023

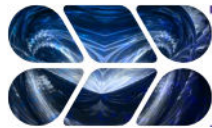
## Walls Across Kingdoms: Mechanics, Growth and Function of Cell Walls



Plants and microbes are surrounded by polymer-based walls that play a central role in how these single and multi-celled organisms grow and reproduce. The chemical composition and structure of these walls can be extremely complex and variable over time and space, yet at the same time they retain higher level order which is thought to underpin their function.

brought mathematicians, statistical and biological physicists, plant and microbial biologists, and industry practitioners together to explore recent research aimed at understanding the mechanistic role of the plant and microbial wall in growth and disease. It featured a series of talks and discussions in four sessions covering mechanics, growth, function and applications in industry as well as a poster session.

This *OfB* event was part of the programme on *New Statistical Physics in Living Matter: Non Equilibrium States Under Adaptive Control*. It



8 November 2023

## Machine Learning: Portents and Possibilities

Over the last half decade, we have seen Machine Learning (ML) and its applications come into their own when it comes to exploring and processing the ever-increasing cache of information that is being pooled from and into almost every aspect of modern human interaction and activity. From signal processing to search engines and smart interactive portals to art creation, as well as proving mathematical theorems, ML is fast becoming intricately intertwined with our lives and times. Across fields, we are thus witnessing not just a transformation of mechanisms of thought by ML, but ML itself being changed, and expanded and diversified into various new roles and modalities customised to the questions in each field.

This *OfB* event was part of the programme on *Black Holes: Bridges Between Number Theory and Holographic Quantum Information* and aimed to discover functionalities of common interest and mutual benefit to academia and industry as part of new collaborative frameworks for a new era. The event included talks by representatives of academia and from industry, based on the theme of ML apps and industrial objectives, followed by panels on ML applications and problem solving.



21 February 2024

## The Gateway to Fusion Power

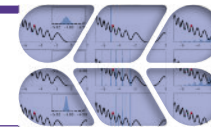
Magnetic confinement fusion (MCF) physics is entering a challenging new era, as fusion power moves toward commercialisation. Simply achieving good confinement is now insufficient. Instead, satisfactory power handling and boundary control must now be combined, in a viable scenario for Core-Boundary integration. Furthermore, all this must be achieved in a burning plasma, with a substantial alpha particle component.

This *OfB* event explored such advanced scenarios and the challenges they present to the development of mathematical models. It focused on the future of MCF - specifically the scientific challenges which confront fusion energy system

development with special lectures that discussed the physics of burning plasmas, modelling of mesoscopic dynamics, new quiescent but high-performance edge plasmas, new approaches exploiting novel magnetic field shapes, and new approaches using low aspect ratio spherical tori. The event concluded with a panel discussion of a diverse group of experts where all workshop participants were invited to participate in the discussion. This event was held at the *National STEM Learning Centre* in York during the workshop *Layering in Magnetised Plasmas* which was part of the *INI* Programme on *Anti-Diffusive Dynamics: from Sub-cellular to Astrophysical Scales*.

26 April 2024

## Connecting Heavy Tails and Differential Privacy in Machine Learning



Heavy-tailed distributions are often associated with observations that deviate significantly from the mean, making them suitable for modelling phenomena with outliers. This association has led the machine learning and statistics communities to typically view heavy-tailed behaviours in a negative light, attributing them to the creation of outliers or numerical instability, however, heavy tails are pervasive across various domains.

This *OfB* event took place within the *INI* programme on *Heavy Tails in Machine Learning* and was delivered in partnership with the *Alan Turing*

*Institute*. It aimed to provide a meeting ground to facilitate interactions and exchanges between representatives of academia, research and industry. Talks highlighted cutting-edge research in data science and bridged theoretical insights with practical applications, shedding light on the role of heavy-tails in machine learning and of differential privacy in data protection compliance.

17 July 2024

## Generative AI and Applications: Next Steps



Diffusion processes are now among the most prevalent mathematical tools in machine learning (ML), demonstrating significant impact and success across various ML subfields, including generative models, sampling techniques, and nonconvex optimisation. The remarkable effectiveness of diffusion-based methodologies has generated considerable interest in their mathematical underpinnings and spurred the development of innovative diffusion-based algorithms. This rising prominence underscores an immediate need for fundamental research to thoroughly comprehend and evaluate the application of these tools in ML, particularly given their implementation in real-world scenarios.

This *OfB* event was developed in partnership with the *Alan Turing Institute* and took place within the *INI* programme on *Diffusions in Machine Learning: Foundations, Generative Models and Non-Convex Optimisation*. It was designed to unite emerging talents, academics and industry experts with a dedicated focus on Generative AI applications and facilitated a forward-looking discussion on the future of Generative AI.

# Activities to Support National Initiatives

## UK Knowledge Exchange Hub for Mathematical Sciences (KE Hub)

The KE Hub is part of the UK's national Mathematical Sciences infrastructure and exists to promote, facilitate, and support knowledge exchange activities between Academia and Business, Industry, & Government. Its core aims are to:

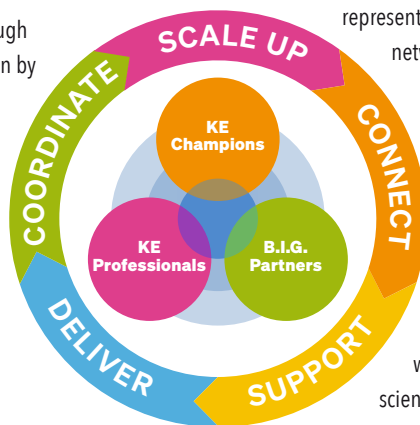
- Massively **scale up** KE activity in the UK, leveraging the experience of the mathematical science national infrastructure.
- **Connect people** by drawing together researchers, practitioners, end-users and professionals into Forums which interface with the various activities.
- **Support** existing KE activity in the community whilst growing the network by nurturing an untapped pool of researchers, practitioners, and end-users.
- **Deliver** activities through linked projects overseen by a central team.
- **Coordinate** support for mathematical science KE projects from beginning to end.

Over the past two years, the Gateway has worked

closely with the *KE Hub* - Professor Chris Breward, Scientific Director and Rachael Harris, KE Manager. The Gateway Manager sits on the Executive Team of the *KE Hub* which includes representatives from *ICMS*, *Innovate UK* as well as eight Super Champions, (seven academics with significant and diverse KE Experience and one expert Knowledge Exchange Professional). The team are leading key projects to help identify, develop and deliver relevant opportunities for engagement. The Gateway team are also active members of the Hub's *KE Professional's Forum* which meets monthly to explore specific challenges and share best practice.

In December 2023, the Gateway was a key stakeholder in the development and delivery of the *KE Hub's* official launch event which was held at Aston University and attended by over 80

representatives from *KE Hub* networks as well as other key representatives from the UK mathematical sciences landscape. The Gateway supported development and delivery of the event as well as presenting examples of its key role within the mathematical sciences KE community.



## Virtual Forum for Knowledge Exchange in the Mathematical Sciences (V-KEMS)

The Gateway's role in *V-KEMS* (the *Virtual Forum for Knowledge Exchange in the Mathematical Sciences*) has continued with ongoing interaction with the partners and academics involved. *V-KEMS* was established in response to the *COVID-19* pandemic with the aim to identify a range of virtual approaches to help address challenges from business and industry, the third sector, and other groups outside academia. More recently *V-KEMS* focus has been on activities related to challenges that society is facing.

The *KE Hub* and *ICMS* have provided underpinning funds for *V-KEMS* to further develop the Virtual Study Group (VSG) activity in the UK. The Gateway worked with *V-KEMS* partners on the development of VSGs in late 2023 and early 2024.

- **Maths For Justice Virtual Study Group**, 20-22 November 2023

This VSG used mathematical, statistical, and machine learning tools to examine issues related to the justice system and to establish and strengthen links between the mathematics and the justice communities. It was developed by the *Institute for Mathematical Innovation (IMI)* at the *University of Bath* and funded by the *KE HUB* and *ICMS*.

- **Food Security Virtual Study Group**,

16-18 January 2024

This VSG brought mathematical scientists and other disciplines together to solve challenges of food insecurity and to promote sustainable practices. It focused on investigating causes of food insecurity, a global issue in which agriculture, supply chains and climate change play a key role. It was developed and delivered by the *Newton Gateway to Mathematics* and funded by *ICMS*.

- **The Future of the High Street Virtual Study Group**, 21-23 May 2024

Many town centre high streets have been in decline for decades leaving them with boarded-up shops, the absence of local traders, and few shoppers due to their migration to out-of-town shopping malls. In this VSG, the focus was on the application of mathematical sciences to explore how regeneration could be catalysed. It was being developed and delivered by *Innovate UK* and funded by *ICMS*.

More information on *V-KEMS* activity can be found on the website [www.vkemsuk.org](http://www.vkemsuk.org) and through social media at [https://x.com/V\\_KEMS](https://x.com/V_KEMS).

# Activities to Support National Initiatives

## Innovate UK Analysis for Innovators Programme

The Gateway has been a Partner in the *Innovate UK Analysis for Innovators* Programme since 2022. This programme gives UK businesses of any size access to cutting-edge R&D expertise and facilities to help solve problems that they have been unable to tackle using standard technologies and techniques. These could relate to product reliability, cost or lifetime for an existing product, process or service.

Through its established relationships with universities across the UK, within the *Innovate UK Analysis for Innovators* Programme, the Gateway is able to connect businesses with the most appropriate mathematical and statistical modellers. Members of the Gateway *Scientific Advisory Panel* or those affiliated with it are working with the Gateway to take forward funded projects.

In addition to providing the contractual hub for these specific projects with the UK academic mathematical scientists, the Gateway is able to help facilitate other engagement mechanisms to help broker interaction with mathematical science research expertise more widely. This brings additional capability to the Programme, to provide fundamental mathematical and statistical modelling in addition to existing partners who mainly supply physical testing, and/or computer simulation expertise.

Since 2022, through this Programme, the Gateway has facilitated meetings with nearly

230 companies to talk about the specific problem that they have. The Gateway has worked on funded projects with 24 different businesses and 12 academic teams which has secured funding of over £900,000 for delivery by the mathematical sciences community. Solutions that have been generated have illustrated the real value that mathematics has brought to the Programme and the genuine savings in resources that these could provide for the companies involved.

One project that took place this year was with *Virustatic* in partnership with the *National Physical Laboratory (NPL)* and *University of Oxford's* industrial filtration modelling group. This project brought together a world-class research team to generate data and test improvements to protocols that presented a step change in how filtration is tested and generate data to inform how future face masks are designed.

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*"It was an absolute pleasure working with the Newton Gateway and the University of Oxford. The teams experience, knowledge and enthusiasm for the project came through in every meeting and the results from the project have given us valuable insights into face covering efficacy and has provided a tool for better designing pandemic face masks for the future. We sincerely hope to partner with them again in future projects."*

*Dr. Joseph Houghton  
Senior Scientific R&D Manager, Virustatic*

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## Mathematical Modelling PhD Student Placements at UKHSA

Since 2021, the Gateway has supported the UK Health Security Agency (*UKHSA*) in the recruitment of candidates for their PhD student placement scheme. This scheme was part of the *UKHSA's* Early Career Researcher (ECR) programme, which aimed to improve organisational capability by bringing in specialist and expert skills to *UKHSA* and served to attract a pipeline of future talent and strengthen organisational links with academia. The internships were mostly within the Infectious Disease Modelling team, which works at the forefront of the response to major outbreaks, including COVID-19 and Mpox.

The Gateway drove the advertising campaign for the placements, with support from Innovate UK, and supported the recruitment process from sifting applications through to the interviews. The Isaac Newton Institute and the Gateway also assisted the *UKHSA* to provide Institutional 'buyout' for the students' PhD stipend for the duration of the placement.

To date, the Gateway and *UKHSA* have partnered on three internship rounds, recruiting a total of 21 students for 3-month placements between 2021 and 2024. Unlike in the first round where all six candidates undertook their placements together in one 3-month period, for the subsequent internships, the start dates of the candidates were staggered so the *UKHSA* could benefit from the interns over a longer period of time.

As well as providing applied mathematical/science work experience to ECRs, training the next generation of modellers, the placement provided the 21 candidates with a pastoral and development programme, together with opportunities to expand their technical skillset and directly influence public health security policy within the UK. Candidates experienced research outside of academia, working on both research projects and operational delivery and could go on to graduate their PhDs with relevant, paid, work experience, and a step into the Civil Service.

# Activities to Support National Initiatives

## Solve for X - Martingale Foundation

In 2024, the Gateway was delighted to begin a collaboration with *Martingale Foundation* on its new programme, **Solve for X**, that challenges Scholars to tackle interdisciplinary real-world challenges in mathematical sciences. Over 70% of PhD graduates will leave academia within three years of completing study, with many of these graduates going on to highly successful and influential roles within industry, private and public sector.

The *Martingale Postgraduate Scholarship* includes access to a prestigious development and leadership programme alongside postgraduate study. The programme provides training and experiences beyond what is usually on offer to a postgraduate student. *Solve for X* is a key component of this experience, delivered in partnership with the *Isaac Newton Institute for Mathematical Sciences*, *Newton Gateway to Mathematics* and hosted by *St John's College, Cambridge*.

*Solve for X* is a multi-year development challenge which promotes collaboration and progression of key professional skills. Applying an innovative approach that bridges the success of study groups and doctoral training centres, *Solve for X* integrates key elements of these formats into one programme for *Martingale Scholars*. It offers a holistic approach to skill-building and career progression, with Scholars participating in a residential retreat featuring group work, training sessions, and culminating in pitch presentations to an expert panel.

The Newton Gateway worked with *Martingale Foundation* to develop and deliver the first *Solve for X* training camp in June 2024.

At Masters level, Scholars attended a four-day training camp that provided fundamental skills for working with organisations beyond academia, such as industry. Groups worked with experienced academic professionals to guide them through the process of applying their mathematical knowledge in an industry context. The Scholars worked to develop solutions to industry problems that had been solved through mathematical collaborations in the past, enabling them to think outside the box and develop key skills in working with industry within a supportive and supervised environment. On the final day, Scholars pitched their proposed solutions to a panel of experts from academia and industry, with an award given to the best team pitch.

More information on the *Solve for X* programme can be found on the website <https://martingale.foundation/programme/solve-for-x/>.

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*"Martingale Foundation is thrilled to partner with the Newton Gateway to deliver our flagship Solve for X programme. Their invaluable support has been key to the programme's success, offering Martingale Scholars a unique opportunity to apply their skills to real-world industry challenges in a highly supportive environment. We look forward to continuing this fruitful collaboration and growing the programme's impact in the future."*

*Cassandra Hugill  
Chief Executive, Martingale Foundation*

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## EU-MATHS-IN - Mathematics for Industry in Europe

The Newton Gateway to Mathematics is the UK representative within *EU-MATHS-IN* - a European network that aims to establish connections between stakeholders working in industrial mathematics. The *EU-MATHS-IN* network is composed of national networks across Europe and European organisations that share a common set of objectives towards developing the interface between mathematics and industry.

The Gateway acts as the Hub for the UK and administers and facilitates UK representation through the Gateway's Scientific Advisory Panel.

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*"It is obviously of benefit to the UK mathematical sciences community to have access to the research opportunities and funding in Europe, and the Gateway's role as UK National Network within EU-MATHS-IN makes this a possibility."*

*Dr Martine Barons  
University of Warwick*

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This includes:

- Disseminating and collation of information
- Communication of impact
- Collating further case studies
- Facilitating events and discussion fora where appropriate
- Making relevant links with industry
- Ensuring complementary activity, not duplication, with The European Consortium for Mathematics in Industry (*ECMI*).
- Promoting EU-MATHS-IN broadly across the UK.



# Participation

The Gateway continued to engage across a wide range of sectors, with 796 delegates attending the eleven events that it developed and delivered between August 2023 and July 2024. Events were predominantly in-person, but for the majority of these, the Gateway offered the ability for delegates to attend and participate in a hybrid format.

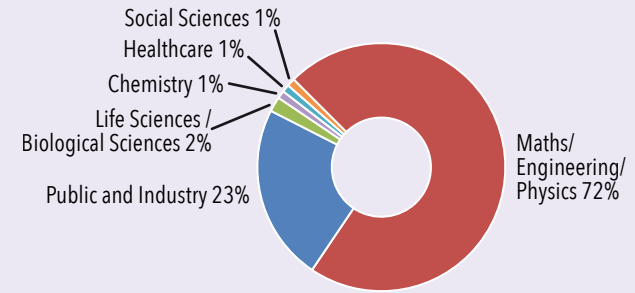
The diversity of sectors the Newton Gateway activities attracted continues to expand and includes biotechnology, data analytics and science, epidemiology, energy, engineering, environment, healthcare, information technology, medical imaging, security, technology and transport. The Gateway also engages with a significant number of researchers in disciplines other than the mathematical sciences.

Over this year, the events that the Gateway delivered attracted a higher proportion of academic attendees. Part of the Gateway role through its activities is to ensure engagement

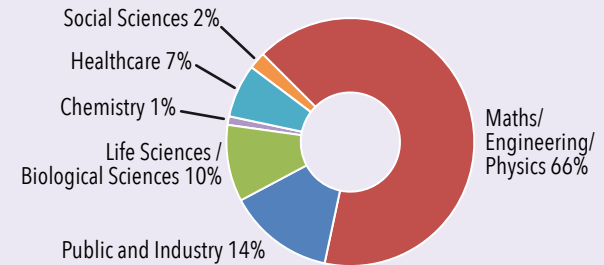
with the wider mathematical community and multiple disciplines and sub-fields and this focus continues. Gateway and Open for Business events continues to be attended by delegates from a wide range of academic disciplines, so enabling discussion linked to other relevant fields of research. The Gateway role in the Innovate UK Analysis for Innovators Programme has enabled the Gateway to meet and engage with a wider range of businesses, not just those where projects have been taken forward.

The virtual option to attend events continues to enable an increased diversity of attendees, including Early Career Researchers and those from overseas who are more easily able to engage via the virtual nature of the events.

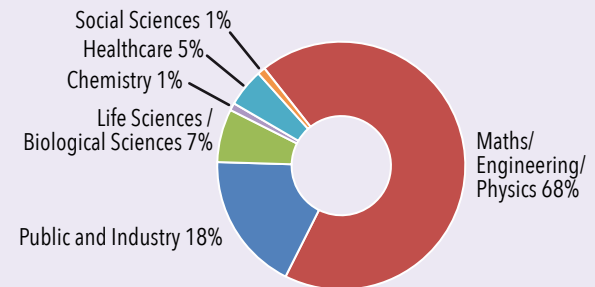
These charts show attendance (in person and virtually) at Gateway delivered events, divided by affiliation.



**Gateway Events**



**OfB Events**



**Gateway and OfB Events combined**

## Grants and Funding

The finances for the Newton Gateway are managed by the *Isaac Newton Institute*. For more information, please refer to the *Isaac Newton Institute Annual Report*.

The Newton Gateway to Mathematics is an integral component of the *Isaac Newton Institute* and therefore financial support is provided by *INI* to enable the Gateway to continue to develop and expand its current service to the mathematical sciences community. Some events and associated administrative cost are funded via *INI's UKRI* funding streams.

The *University of Cambridge* has also contributed to the funding of the Newton Gateway to Mathematics through the *Higher Education Innovation Funding* scheme, which has partially covered administrative costs. Direct costs for specific Gateway activities are funded through partnerships with stakeholders including from industry and the public sector, philanthropy and participant registration fees.

## Staff and Management

Responsibility for the budget and financial planning is overseen by *INI's Management Committee* and undertaken on a day-by-day basis by Newton Gateway staff. The Gateway reports to the *INI Director* who in turn is responsible to the *Management Committee*.

The Newton Gateway is supported in delivering activity by the Gateway Advisory Board and *Scientific Advisory Panel*, who advise on programmes and activities and help with quality assurance in aspects of delivery and operations. The key aim is to help ensure that the highest levels of delivery and operations are achieved throughout Gateway activity and its effectiveness is fully maximised.

### Newton Gateway to Mathematics Staff (at July 2024)

The **Gateway Manager**, Clare Merritt, has overall responsibility for managing the Gateway and for developing contacts with mathematical and non-mathematical academics, with industry, business and public sector. This role is pivotal in identifying potential research and collaborative opportunities of mutual benefit to mathematicians and end-users, such as industry, business and Government.

The **Senior Knowledge Exchange Coordinator**, Claire Bonner, supports diversification of Newton Gateway to Mathematics activities, coordinates and develops events and marketing activity with industry and academics. Claire leads some specific programmes of work, including user engagement on behalf of Newton Gateway to Mathematics Partners. Claire also leads on Gateway Governance and the Innovate UK Analysis for Innovators Programme of Work.

The **Scientific Knowledge Exchange Coordinator**, Sofia Sanz Del Pino, provides technical research and knowledge exchange

support to Gateway activities. This involves scientific and technical exploration and analysis of Gateway delivery, in particular the translation and dissemination of scientific details and information to a broader audience. Sofia leads on the development of the Open for Business events that are delivered in support of *INI Research Programmes*.

### Scientific Knowledge Exchange

**Coordinator**, Dr Maha Kaouri, provides technical research and knowledge exchange support to Gateway activities, helping to translate scientific details to our broad audience. Maha also provides scientific and technical exploration and analysis for Gateway and *INI* delivery.

### The Events and Marketing Assistant

Stine Molteberg provides support to the Gateway for the day-to-day coordination of events and related activities. She supports marketing activity as well as providing financial administration.

# Governance

The **Newton Gateway to Mathematics Advisory Board** has Members from industry and public bodies to help advise on strategic matters and on the overall development of the Newton Gateway to Mathematics.

Members have helped to facilitate the delivery of a number of activities and programmes of

work and act as “Ambassadors” for the Gateway in discussion and interaction with other partners.

The Board meets twice a year in Cambridge and reports are subsequently provided to *INI Management Committee* meetings, to provide supplementary information on Gateway activity and delivery.

## Advisory Board Membership (at July 2024):

Name	Organisation
Alan Champneys	<i>Representative of Gateway Scientific Advisory Panel</i>
Nick Easton (Chair)	<i>BAE Systems Applied Intelligence</i>
Dawn Geatches	<i>Innovate UK</i>
Vera Hazelwood	<i>AstraZeneca</i>
Lauren Hyndman	<i>International Centre for Mathematical Sciences (ICMS)</i>
Joanna Jordan	<i>Freelance Mathematics Knowledge Exchange</i>
Clare Merritt	<i>Newton Gateway to Mathematics - Manager</i>
Imran Nasim	<i>IBM</i>
Robert Leese	<i>Smith Institute</i>
Tom Rackham	<i>UK Civil Service</i>
Sian Thomas	<i>Department for Business and Trade</i>
Ulrike Tillmann	<i>Isaac Newton Institute - Director</i>

The **Newton Gateway to Mathematics Scientific Advisory Panel** provides input and guidance on specific scientific or research matters related to Newton Gateway to Mathematics activities. Members are all academics and operate largely in a virtual capacity via email and telephone and are responsive to ad-hoc questions and requests for guidance from the Newton Gateway to Mathematics.

The Chair is invited to attend Newton Gateway

to Mathematics Advisory Board meetings. All Members of the *Scientific Advisory Panel* are invited to meet with the *Advisory Board* every 12 months to ensure they have the opportunity to input more strategically to the range and nature of Newton Gateway to Mathematics activities.

Membership is regularly reviewed to ensure it reflects the breadth of disciplines that the Gateway can work on and a fuller geographical spread of representation by Members.

## Scientific Advisory Panel Membership (at July 2024):

Name	Organisation
Philip Aston	<i>University of Surrey</i>
Martine Barons	<i>University of Warwick</i>
Chris Breward	<i>University of Oxford</i>
Peter Challenor	<i>University of Exeter</i>
Alan Champneys (Chair)	<i>University of Bristol</i>
Christine Currie	<i>University of Southampton</i>
Chris Dent	<i>University of Edinburgh</i>
Rosemary Dyson	<i>University of Birmingham</i>
Des Higham	<i>University of Edinburgh</i>
Rebecca Hoyle	<i>University of Southampton</i>
Jane Hutton	<i>University of Warwick</i>
Arieh Iserles	<i>University of Cambridge</i>
Katerina Kaouri	<i>Cardiff University</i>
William Lee	<i>University of Huddersfield</i>
Gabriel Lord	<i>Radboud University (and Heriot-Watt University)</i>
Anotida Madzvamuse	<i>University of British Columbia</i>
Adele Marshall	<i>Queen's University Belfast</i>
Jeremy Oakley	<i>University of Sheffield</i>
Surajit Ray	<i>University of Glasgow</i>
Manuchehr Soleimani	<i>University of Bath</i>
Meric Srokosz	<i>National Oceanography Centre</i>
Emily Walsh	<i>University of the West of England</i>
Adrian Weller	<i>University of Cambridge</i>

# Future Development

The Newton Gateway to Mathematics aims to respond in a speedy and focused way to new ideas and approaches but recognises the need for a targeted and continuous approach to the delivery of longer-term knowledge exchange activities in the mathematical sciences. The series of Thematic Knowledge Exchange Programmes are designed to stimulate and

support research activities and include workshops, consultations and project meetings. These include Mathematics of Big Data, Mathematics for Biology and Healthcare Systems, Mathematics for the Environment and Energy, Mathematics for Financial Services, and Mathematics for the Space and Security Sectors.

## Activity from September – December 2024

With its ongoing commitment of playing a key national role in mathematical sciences knowledge exchange, the Newton Gateway to Mathematics has developed the following activities in collaboration with stakeholders, funders and other academic partners.

**Preventing Future Pandemics: Key Challenges for Mathematical Modelling to Improve Pandemic Preparedness**  
(13 August 2024)

**Open for Business Day: Modelling and Applications of Anomalous Diffusions**  
(5 September 2024)

**8th Edwards Symposium - Statistical Physics of Soft and Multicomponent Systems**  
(11 - 13 September 2024)

**UK Graduate Modelling Camp 2024**  
(23 - 27 September 2024)

**Mathematics Communication Training**  
(1 - 2 October 2024)

**Formal Specification and Validation at Scale**  
(21 - 22 October 2024)

**Detecting Anomalous Structure in Streaming Data Settings (DASS) Launch Event**  
(6 November 2024)

**Quantum Computing: Applications and Challenges**  
(12 November 2024)

**Communicating Mathematical and Data Sciences - What does Success Look Like?**  
(21 November 2024)



**Newton Gateway**  
to Mathematics

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