

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 *INI* and 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.

Gateway activities see a continued emphasis on partnership and collaboration with other organisations, which is an effective way of engaging with a wider group of stakeholders, helping to reduce duplication.

The Gateway has continued in the delivery of the *Edwards Symposium Series* working with the *Edwards Centre for Soft Matter at Cambridge* and supported by *Unilever* and *CFM (Capital Fund Management)*.

Since 2016, the Gateway has been the user engagement partner for the *Cantab Capital Institute for the Mathematics of Information (CCIMI)* and also works with the *EPSRC Cambridge Mathematics of Information in Healthcare (CMIH)* Hub which was launched in 2020. These partnerships result in the organisation and running of a number of series of events as well as promotion of collaborative opportunities across an expanding community.

Through its role as a Partner in the *Innovate UK Analysis for Innovators* Programme, the Gateway is engaging with businesses to help provide innovative mathematical and statistical solutions to problems that have been unable to solve standard technologies and techniques.

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 reached an important milestone in March 2023, when it marked its tenth anniversary. It was established in 2013 by Professor John Toland and Dr Christie Marr, then Director and Deputy Director of INI, to help to bridge the gap between those engaged in frontier mathematical research and those working in more applied areas, by stimulating the interchange of knowledge and ideas. Since then, it has been involved in numerous projects and initiatives, many of which are highlighted below and elsewhere in this report. To mark this happy occasion, to look back at the past and ahead to the future, Dan Aspel, INI Communications Manager was joined by Gateway Manager, Clare Merritt for an insightful conversation.

Over the year, the Gateway has adapted to a number of staff changes. In September 2022, Jane Leeks relocated having accepted a new role elsewhere. Jane was the first manager of the Newton Gateway in 2013 and successfully steered its development to the well-recognised conduit for knowledge exchange in the mathematical sciences that it is. Clare Merritt, who had been the Senior Knowledge Exchange Coordinator and worked at the Gateway since 2014, was subsequently appointed as the new Manager. More information about the current staff can be read later in this report.

In the previous two years, much of Gateway activity focused on collaborative virtual delivery in response to the COVID-19 pandemic and one notable event this year built upon one of these earlier activities. In January 2023, the Gateway delivered *Communicating Mathematics for the Public* which investigated the role of various parties in the communication route between mathematicians, statisticians

and the general public and brought together not only mathematical communicators, but also representatives from the media and government. The success of the event is highlighted in this report and the Gateway is excited about the partnership opportunities to build upon this in the future.

The Gateway delivered six *Open for Business* knowledge exchange events linked to five Research Programmes held at INI. 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.

The Gateway was pleased to again work with the EPSRC funded *StatScale* programme with researchers at *Lancaster University* and the *University of Cambridge*. An event at the *Wellcome Collection* in London, showcased research highlights from the programme, the impact of the research and opportunities for organisations to engage with its findings.

The Gateway helped develop and deliver three longer residential activities over the year. In September 2022, the *6th Edwards Symposium* took place, bringing together those from industry and academia to highlight the latest developments in soft matter science. In March 2023, the Gateway hosted a *Mathematical Challenges in Defence and Security* workshop in partnership with *Dstl*. This event gave participants the opportunity to explore six new challenges statements in depth which had been developed by *Dstl* and presented by problem owners. In July 2023, the annual *UK Graduate Modelling Camp* took place in person

in partnership with the *Industrially Focused Mathematical Modelling (InFoMM) Centre for Doctoral Training* from the *University of Oxford*. Over the course of 5 days, 30 PhD students worked on 5 real life problems, culminating in the presentation of potential modelled solutions at the end of the event.

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

The Gateway and *INI* has provided support to the *UKHSA's Mathematical Modelling PhD Student Placements* scheme. In the second round of internships, the *UKHSA* appointed seven 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's role in *V-KEMS* (the *Virtual Forum for Knowledge Exchange in the Mathematical Sciences*) continued with ongoing interaction with the partners and academics involved. A number of *Virtual Study Groups* are planned for later in 2023 and early 2024.

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.

Over the past year, the Gateway has worked closely with the *Knowledge Exchange Hub for the Mathematical Sciences (KE Hub)* which will 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.

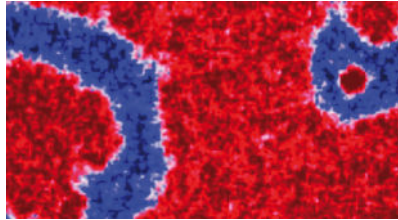
Through ongoing engagement activity, the Newton Gateway has continued to extend its reach across different sectors. Activities have been delivered in partnership with other organisations, as detailed within this Annual Report, which has ensured further collaborative opportunities with new connections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

Gateway Activities from August 2022 – July 2023

7-9 September 2022

6th Edwards Symposium – Soft Matter for the 21st Century



2022 was the sixth year in the *Edwards Symposium Series* which was set up as a tribute to the life and work of Professor Sir Sam Edwards FRS, one of the great scientific minds of the 20th Century. The event highlighted the latest developments in soft matter science with a particular (but not exclusive) emphasis on theoretical and mathematical models, and on how these models can inform industrial processes, materials, and design.

Talks focused on cellular assemblies, geophysical soft matter, nonequilibrium phase transitions, liquid crystals and LC elastomers, and soft matter for health. These themes posed fundamental questions in basic science that were addressed by distinguished academic speakers and their industrial relevance was reflected by industrial participants whose presentations, posters and informal discussions informed the discussions.

The series has been funded in part by ongoing generous support from *Unilever*. The Symposium welcomed participants back in-person to the *Centre for Mathematical Sciences* in Cambridge.

23 November 2022

Cantab Capital Institute for Mathematics of Information – Connecting with Industry



This one-day annual industry engagement event of the *Cantab Capital Institute for the Mathematics of Information (CCIMI)* brought together academics and those from industry working to advance data science. It aimed to showcase the research being carried out at the Institute and enabled delegates to hear more detail about some of the current project collaborations and industry challenges that *CCIMI* is exploring.

The talks highlighted *CCIMI* projects with associated industrial speakers and explored the big questions in data science, especially where mathematics is most suited to help provide answers. As in previous years, there was also a session hosted by *CCIMI* students which they developed and delivered as a group. The event took place in a hybrid format with opportunities for physical and virtual posters to be displayed as well as online discussion and interaction.

24-25 January 2023

Communicating Mathematics for the Public



Mathematics is a tool used to explain both simple and complex ideas using logic and reasoning to a variety of audiences, which include not only mathematics students or other professionals, but also journalists, policy makers and the public. This event explored the challenges in communicating important mathematics to the public through a variety of streams, including the media and government. It built on a successful *Virtual Study Group on The Public Perception of Science* delivered in May 2022, which had brought mathematical scientists and other disciplines together to solve challenges related to trustworthy communication, communicating mathematics and misinformation.

The January 2023 *Communicating Mathematics for the Public* event was developed collaboratively with Thomas King (*Royal Statistical Society Data Ethics and Governance Section*) and Kevin McConway (*The Open University*) and supported by the *Council for the Mathematical Sciences, Government Analysis Function, Institute of Mathematics & its Applications* and the *Royal Statistical Society*.

This two-day workshop explored the challenges in communicating important mathematics to the public through a variety of streams, including the media and government. Three main themes were explored - mediating processes; good practice; and learning from experience.

The event investigated the role of various parties in the communication route between mathematicians/statisticians and the public, bringing together over 100 delegates, not only mathematical and statistical communicators, but also representatives from the media and government. Highlights included talks from civil servants about uncertainty communication and digital accessibility, an interactive session with over fifteen 3-minute rapid-fire interviews, as well as talks by *BBC More or Less Editor*, Richard Vadon, as well as Hannah Fry, Emily Shuckburgh and David Spiegelhalter.

INI and Newton Gateway were delighted to have supported this flagship event, which prompted a number of follow on activities. *Plus Magazine*, which is part of the *Millenium Mathematics Projects*, spoke at the event and subsequently produced a practical guide to writing about anything for anyone, based on their experience and including reference to a number of the talks given at the event.

The Gateway is working with others to consider developing longer term activity. Proposals suggested following the event include collaboration with government, skills development for ECRs in mathematics, policy primer for mathematicians, mathematical ambassadors, and academic programmes in maths communications.

Gateway Activities from August 2022 – July 2023

15-16 March 2023

Mathematical Challenges in Defence and Security



This two-day event held at Robinson College, Cambridge, was organised in response to the Integrated Review Refresh 2023. This updated the government's security, defence, development and foreign policy priorities and committed billions of pounds of investments into science and technology over the next five years.

Scientists from *Dstl* are involved in shaping the next research portfolio. This event gave participants the opportunity to explore six new challenge statements in depth, that were developed by *Dstl* and presented by problem owners. The challenges presented were sampling cyber data; network alignment and matching; recreating time series from Allan Deviation; image reconstruction from rotating apertures, propagation of uncertainty under non-linear transforms; and constrained allocation of sensors. The breakout sessions enabled mathematicians to

"The workshop on Mathematical Challenges in Defence and Security was a fantastic event that enabled Dstl to share challenges with a broad group of academic mathematicians. The work of the Newton Gateway facilitating this workshop ensured that it was the best possible environment for collaboration and has led to some innovative solutions that Dstl hope to be able to fund"

Emma Bowley
Dstl

generate ideas for solutions having gained a greater understanding of the challenges presented.

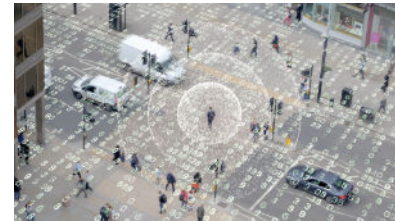
The challenges presented were subsequently taken forward as part of a *Dstl* funding call for short project delivery with funding of up to £50,000 available for the follow-on work on each challenge. Those academics that attended the event worked together to submit a number of strong applications.

The event was delivered with *Dstl* and participants came from a number of diverse fields including (but not limited to) signal processing, optimisation, operational research, imaging and vision, control theory, wave theory, machine learning, electrical and communications engineering.

The Gateway is working with *Dstl* on a proposal to develop a follow-on challenge workshop to be delivered in Spring 2024.

20 April 2023

Statistical Scalability for Data Streams: Recent Advances, Applications and Impact



The *StatScale* programme brought together researchers at *Lancaster University* and the *University of Cambridge*, with a number of committed project partners from 2016-2023.

The central goal of *StatScale* was to deliver the next generation of statistical solutions required to harness insight from streaming data. These streaming data challenges arise in numerous fields from consumer products to transport networks and energy systems.

This event showcased research highlights from *StatScale*, the impact of this research and opportunities for organisations to engage with its findings. Talks were given by academics and industrial partners, featuring some of the statistical breakthroughs in research. The event was hosted at the *Wellcome Collection* in London.

"The Statscale event brought together a wide range of delegates, from researchers, to industrial, scientific and public sectors practitioners. It was great to hear about uptake of methods and applications as diverse as monitoring astronaut fitness, from NASA, to detecting anomalies on the UK's broadband network. The team at the Newton Gateway ensured that it ran smoothly and successfully."

Professor Idris Eckley

10 May 2023

Phase Transitions and Correlated Random Processes



The seventh annual academic conference of the *Cantab Capital Institute for the Mathematics of Information (CCIMI)*, focused on the advances in the mathematics of phase transitions and correlated random processes. Launched in 2016, *CCIMI* accommodates research activity on fundamental mathematical problems and methodology for understanding, analysing, processing and simulating data.

This one-day conference brought together academics working to advance understanding of random processes and provided an update on the research and collaborations taking place

at *CCIMI* specifically related to phase transitions and correlated random processes.

There was a session of short 'brief introductions' to current research questions and posters by PhD students in *CCIMI*.

The event interested those working on probabilistic models, as well as the applications of random processes in a wide range of fields.

Gateway Activities from August 2022 – July 2023

21 June 2023

Cambridge Mathematics of Information in Healthcare Hub - Academic Engagement Event

The *EPSRC Cambridge Mathematics of Information in Healthcare (CMIH)* Hub was launched in 2020. It focuses on some of the most challenging public health problems of our time, including cancer, cardiovascular disease and dementia. There is a core mathematical component that is common to data challenges across these clinical disciplines, which the Hub evaluates and address through its interdisciplinary collaborations. The overarching objective is to develop data analytics algorithms and provide the associated theory that is directly linked to the requirements in the clinic for healthcare decision making.

This event was the third user engagement event of *CMIH* and brought together researchers from mathematics, statistics, computer science and medicine, with clinicians and relevant industrial stakeholders. It showcased the research and engagement of *CMIH* over the past 3 years.

Talks focused on the key theme of the *CMIH* Hub, which is the development of robust and clinical applicable algorithms for analysing healthcare data in an integrated fashion. It included talks that highlighted open challenges and successes from *CMIH* Hub researchers and presented other potential collaborative opportunities, as well as projects being developed elsewhere related to healthcare data analytics.

10-14 July 2023

UK Graduate Modelling Camp



The annual *UK Graduate Modelling* camp took place in person in partnership with the *Industrially Focused Mathematical Modelling (InFoMM) Centre for Doctoral Training* from the *University of Oxford*. The camp was open to all UK based PhD students and designed to promote a broad range of problem-solving skills, such as mathematical modelling & analysis, scientific computation & critical assessment of solutions. It provided the students with hands-on experience of mathematical modelling under the guidance of experienced instructors and mentors.

Over the five days, nearly 30 students from 18 Institutions worked on 5 mentor set challenges that were inspired by real-world problems that had arisen in industry or science. Scientific communication was an important part of the camp and all participants were expected to contribute. Prizes were awarded by the *IMA* and the Gateway for the Best Group Presentation (awarded to the *Lipid Raft Formation* group) as well as the Top Student from each of the five groups.

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.

Due to the pandemic, *OfB* events hadn't been delivered since late 2019, so the Gateway was pleased to be able to work with INI Programme organisers again.

Six *OfB* events were hosted during the reporting year which were developed and delivered with the academic organisers of five INI research programmes that took place over this period. These Programmes were *Dispersive Hydrodynamics: Mathematics, Simulation and Experiments, With Applications in Nonlinear Waves; Frontiers in Dynamo Theory: From the Earth to the Stars; Rich and Nonlinear Tomography – a Multidisciplinary Approach; Mathematical Theory and Applications of Multiple Wave Scattering* and *The Mathematical and Statistical Foundation of Future Data-Driven Engineering*.

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 Programmes that would have been unlikely to happen otherwise.



Knowledge Exchange Activities for INI Research Programmes

24 October 2022

From Dispersive Hydrodynamics to Forecasting, Machine Learning and Back



Dispersive hydrodynamics is a mathematical framework originally developed to describe multiscale nonlinear wave phenomena in dispersive media. This framework has further expanded and currently covers a range of phenomena including both dynamic and stochastic aspects of wave propagation. It is now a vibrant and continuously developing field, with a variety of physical applications.

This event focused on applications of dispersive hydrodynamics related to weather, climate forecasting, oceanography (such as rogue waves in the ocean) as well as random networks and machine learning. It brought together mathematicians and scientists working at the forefront of dispersive hydrodynamics and its applications, with end users from industry to further investigate potential connections.

The event took part at the end of one of a series of workshops in the *Dispersive Hydrodynamics: Mathematics, Simulation and Experiments, with Applications in Nonlinear Waves* Programme.

15-16 November 2022

Liquid Metal Batteries



In the scientific scene, liquid metal batteries (LMB) share some common threads with the flow of metals and plasma in planets and stars. Material science and chemistry is central to getting LMBs to work and there is significant scientific overlap in the fields of stability theory and the computation of liquid metal magnetohydrodynamics.

This two-day hybrid event brought together mathematicians and scientists working at the forefront of dynamo theory and its applications, including Professor Donald Sadovay a pioneer of LMB technology, with end users from industry to further investigate opportunities for LMBs. If these become a commercial reality, they will provide cheaper and cleaner alternatives to traditional batteries and allow us to bridge the intermittent nature of wind and solar energies.

Talks covered updates on the progress achieved in recent years in terms of scientific research and industrial development and provided a discussion platform for knowledge exchange. The event was developed in collaboration with the *Solstice* project on sodium-zinc molten salt batteries for low-cost stationary storage and took place within the *Frontiers in Dynamo Theory: from the Earth to the Stars* INI Programme.

12 December 2022

Physical Applications of Dispersive Hydrodynamics

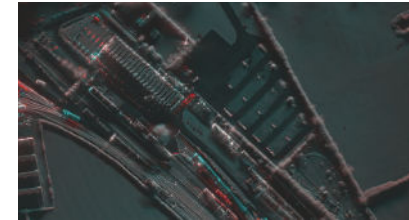


This second knowledge exchange event delivered within the *Dispersive Hydrodynamics: Mathematics, Simulation and Experiments, with Applications in Nonlinear Waves* Programme, focused on physical applications of dispersive hydrodynamics relating to optics, oceanography and magnetism.

The one-day hybrid event, hosted at the *Møller Institute*, Cambridge, followed on from the final workshop within the six-month Research Programme. The workshop focused on exposing the underlying mathematical similarities between phenomena which occur on vastly different scales, bringing together applied mathematicians, physicists and engineers that share similar mathematical models. The *OfB* event outlined the key questions considered within the Research Programme, together with a series of talks showcasing recent applications of dispersive hydrodynamics related to fluid dynamics including oceanic phenomena and nonlinear optics.

21-23 February 2023

New Mathematical Frontiers for Multi-Dimensional Radar Systems



This three-day workshop brought together specialists in multi-dimensional radar systems with leading mathematicians across a wide range of applicable disciplines; enabling new dialogue between disciplines, breaking down communication barriers to help a greater understanding, and provided the foundations of a new community of practice.

Topics covered recent developments in radar systems which often enable – and are driven by – using radars for more challenging applications such as imaging through walls, foliage, and other obscurants; detecting and recognising low observable objects; or adapting to operate in a congested and contested electromagnetic environment. With the increased complexity of multi-dimensional radar data, comes new fundamental mathematical challenges – how it is modelled, what information it contains, and how to process or share the resulting new large quantities of data.

A roundtable discussion highlighted a number of recommendations, including the value of introducing a knowledge transfer role to provide an interface and translation function between the different communities.

Knowledge Exchange Activities for INI Research Programmes

31 May 2023

Wave Scattering in Complex Matter: Advances in Material Characterisation and the Design of Materials



The solution of problems in wave scattering is fundamental to the realisation of the potentially transformative innovations that can be achieved by manipulating wave behaviour, such as invisibility cloaks, faster communications, characterising materials, and many more. This event explored the latest innovations in imaging, material characterisation and design of novel materials, related to a wide range of applications such as non-destructive testing of pipes, communications, food, water treatment and defence.

This one-day event was delivered within the *Mathematical Theory and Applications of Multiple Wave Scattering* Research Programme and brought together communities of practice and theory to address, through a series of talks and discussions, theoretical problems and progress the practical applications of the technologies.

7 June 2023

Digital Twins for Engineering Applications - The Emerging Science and Technology



A digital twin is a computer model that simulates an object or process in the physical world. This could be a jet engine, bridge, wind turbine, Formula One car, supply chain, biological system, factory, or even an entire city. The digital twin is regularly updated with sensor data from its physical counterpart, and by analysing the twin, decision makers can gain insights into the behaviour of the physical system, allowing them to improve its design and/or functioning.

As the science of digital twinning develops, artificial intelligence (AI) will play an ever more important role in their design, development, and deployment – whether in optimising the design of the twins themselves, or in identifying hidden patterns and structures in their output data. As such, digital twins are providing powerful use cases for AI and are beginning to radically reshape our understanding of complex systems in numerous domains.

This one-day event was delivered as part of the *Research Programme on the Mathematical and Statistical Foundation of Future Data-Driven Engineering* and organised in partnership with the *Alan Turing Institute*. A series of talks covered the latest research and innovation in digital twinning for engineering, and discussion opportunities helped foster cross-disciplinary connections.

Activities to Support National Initiatives

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 year, the Gateway has continued to work 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 KTN* 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.



Activities to Support National Initiatives

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 in support of recovery from the pandemic and related challenges that society is facing.

The KE Hub has provided underpinning funds and administrative support for V-KEMS to further develop the Virtual Study Group activity in the UK. The Gateway is working with V-KEMS partners on the development of Virtual Study Groups that will take place later in 2023 and early in 2024.

More information on V-KEMS activity can be found on the website www.vkemsuk.org and through its Twitter account www.twitter.com/V_KEMS.

Innovate UK Analysis for Innovators Programme

The Gateway has been a Partner in the *Innovate UK Analysis for Innovators* Programme since 2022. This is a programme that 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 product lifetime, but are 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. Academics from the Gateway Scientific Advisory Panel or those associated to it, have taken forward funded projects with individual companies.

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.

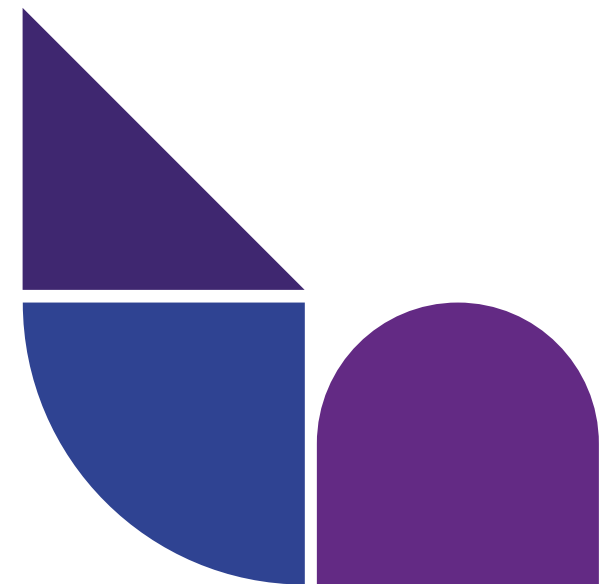
Since 2022, through this Programme, the Gateway has facilitated meetings with nearly 125 companies to talk about the specific problem that they have. The Gateway has worked on funded projects with 16 different businesses and 11 academic teams, which has secured funding of over £600,000 for delivery by 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. The Gateway is working with *Innovate UK KTN* to collate case studies that illustrate these tangible outcomes from mathematical input to these industrial based challenges.

One project that was completed this year was with Friction Flow Measurement Ltd, who were able to use mathematical expertise to solve problems the company had been experiencing

with its flowmeter. Friction Flow worked with Professor William Lee and Dr Ann Smith from the University of Huddersfield.

"The team from Newton Gateway and the University of Huddersfield understood my problem quickly and used their extensive mathematical experience to refine and improve on the algorithms used within my flowmeter to make it run faster and more efficiently during operation. I'm very happy with the results and look forward to partnering with them again in future projects."

Craig Marshall
Friction Flow Measurement



Activities to Support National Initiatives

INI Support of the Mathematical Modelling PhD Student Placements at UKHSA

Since 2021, the Gateway has supported the *UK Health Security Agency* in their hiring of PhD students for their Mathematical Modelling PhD student placement scheme. This scheme is part of the *UKHSA's* Early Career Researcher programme, which aims to improve organisational capability by bringing in specialist and expert skills to *UKHSA* and serves to attract a pipeline of future talent and strengthen organisational links with academia.

Following the successful first round of internships in 2022, a second round commenced in early 2023. The *UKHSA* sought seven PhD Students with strong backgrounds in data analysis, statistics, mathematics, biological sciences or social research, to join their programme as ECR Analysts - Advanced

Epidemiological Modellers for 3 months. As well as work experience, the placements provide 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.

The Newton Gateway drove the advertising campaign for the placements, with support from *Innovate UK KTN*, and supported the recruitment process from sifting applications through to the interviews. In December 2022, seven candidates were successfully appointed, with staggered start dates across 2023. The *UKHSA* are looking to have a third round of internships to commence in early 2024.

"In the UKHSA Infectious Disease Modelling Team we highly value the variety of skills and opinions the students bring during their placements, and over the last two years the students have played a key role in the delivery of multiple research projects."

Dr Christopher Overton,
UK Health Security Agency.

"I am so grateful for the experience I had at UKHSA. Not only did the work I did during my placement end up inspiring a chapter of my doctoral thesis, but I strengthened my technical skills through undertaking real-time modelling of the SARS-CoV-2 epidemic in the UK. Additionally, my self-confidence grew substantially over this period, and I know that this experience has empowered me to undertake further policy-related analyses."

Ms Ruth McCabe
University of Oxford.

Participation

The Gateway continued to engage across a wide range of sectors, with 794 delegates attending the fourteen events that it developed and delivered between August 2022 and July 2023. 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.

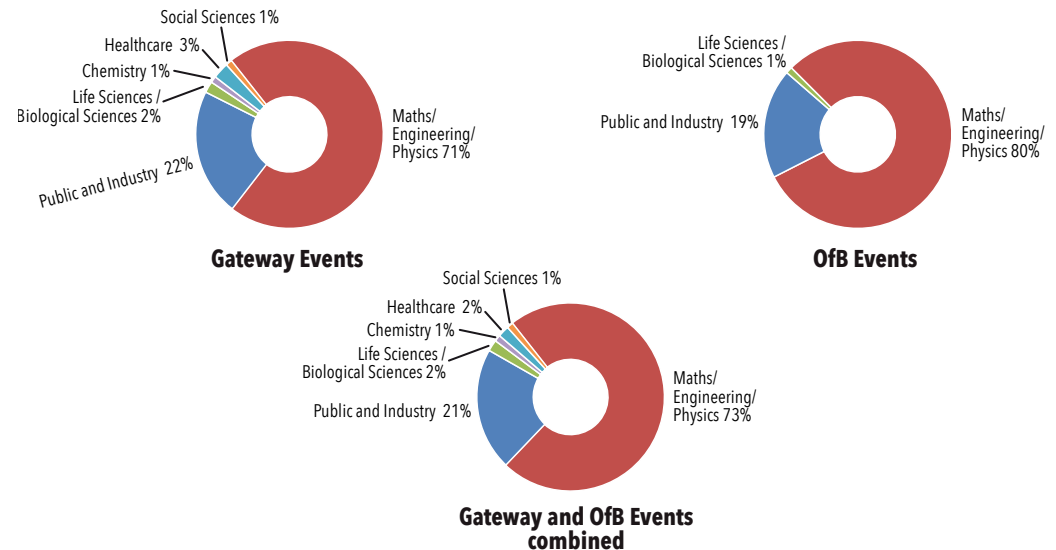
The diversity of sectors the Newton Gateway activities attracted continues to expand and includes biotechnology, data analytics and science, epidemiology, energy, engineering, environment, healthcare, information technology, medical imaging, security, technology and transport. The Gateway also engages 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 during the pandemic was

to ensure engagement with the wider mathematical community and multiple disciplines and sub-fields and this focus continues. Gateway and *Open for Business* events were 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 people 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.



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 2023)

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.

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.

Dr Maha Kaouri is on leave from the Gateway until Spring 2024.

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 2023):

Name	Organisation
Matt Butchers	Department of Science, Innovation and Technology
Alan Champneys	Representative of Gateway Scientific Advisory Panel
Nick Easton	BAE Systems Applied Intelligence
Dawn Geatches	Innovate UK's Knowledge Transfer Network (KTN)
Lauren Hyndman	International Centre for Mathematical Sciences (ICMS)
Joanna Jordan	Freelance Mathematics Knowledge Exchange
Peter Landrock (Chair)	Cryptomathic
Robert Leese	Smith Institute
Clare Merritt	Newton Gateway to Mathematics - Manager
Tom Rackham	UK Civil Service
Sian Thomas	Department for Business and Trade
Ulrike Tillmann	Isaac Newton Institute - Director

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 2023):

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

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 2023

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.

7th Edwards Symposium – New Paradigms in Soft Matter and Statistical Physics

(13 – 15 September 2023)

Connecting Micro to Macro in Epidemiological Models

(18 October 2023)

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

(24 October 2023)

Machine Learning: Portents and Possibilities

(8 November 2023)

Newton Gateway to Mathematics
Isaac Newton Institute
20 Clarkson Road
Cambridge CB3 0EH
01223 765580
gateway@newton.ac.uk
<https://gateway.newton.ac.uk/>