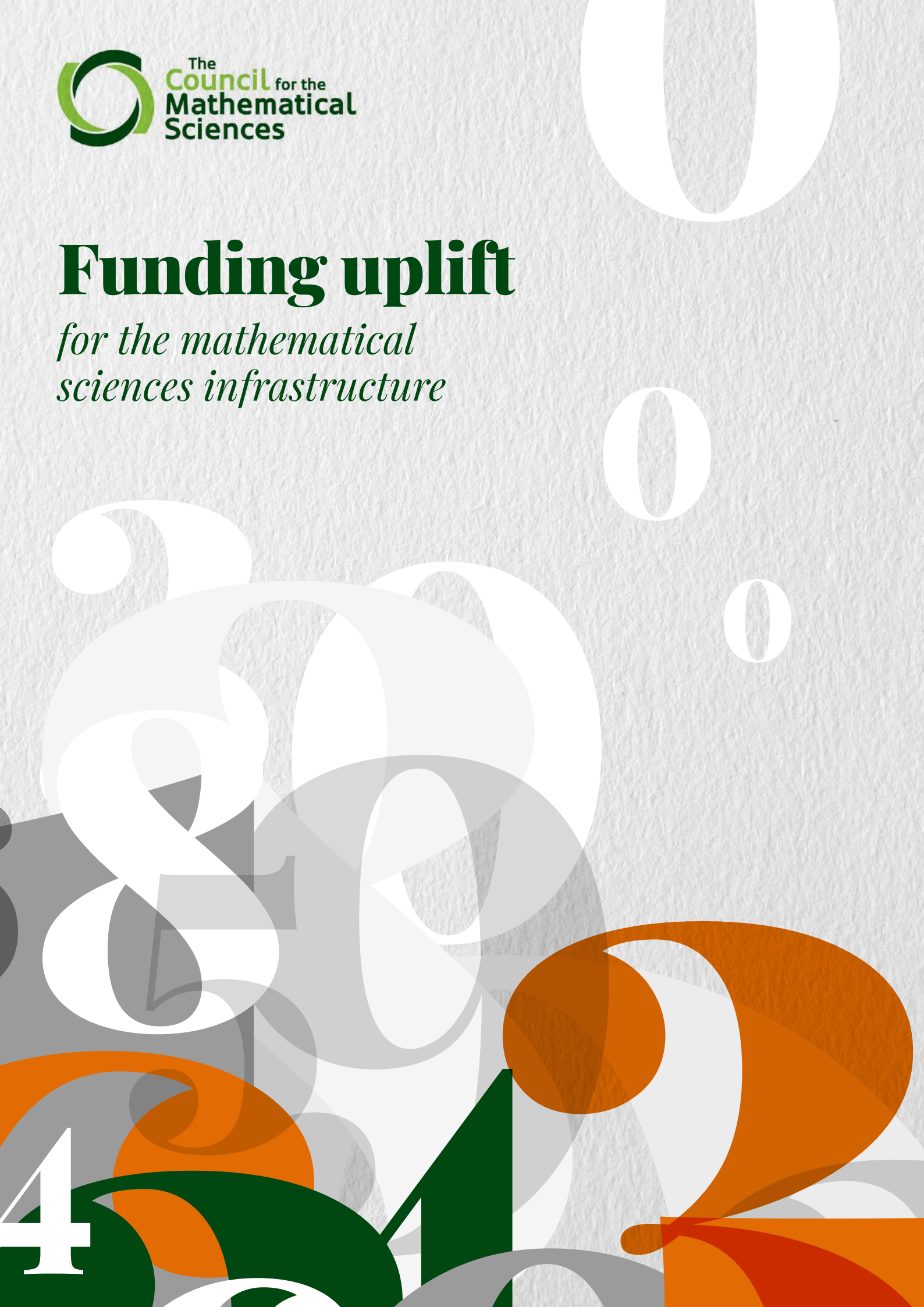
The Council for the Mathematical Sciences

Funding uplift

for the mathematical sciences infrastructure



On 27 January 2020, the government announced additional funding for the mathematical sciences, to be delivered by EPSRC, part of UK Research and Innovation.

"It is fantastic to see how UK Mathematical Sciences has made full use of the £124m additional funding, from nurturing early-career talent to investing in its national infrastructure. This article gives a taste of the exciting science, new initiatives, and impact across the discipline, and I look forward to seeing the full extent of the benefits of this investment in the years to come."

Professor Alison Etheridge, Chair of the Council for Mathematical Sciences

"Research in mathematical sciences is key for the advancement of all areas of science and technology, and plays a central role in solving real-world problems, as well as being a vital area of science in itself. The Additional Funding for Mathematical Sciences programme has enabled a significant increase in investment within this field of research across the breadth of the discipline. The funding has benefitted researchers across career stages at a wide range of different size institutions across the UK and has supported equality, diversity, and inclusion activities."

Dr Katie Blaney, Head of Mathematical Sciences, UKRI EPSRC

ps *All stories compiled by Dr Joanna Jordan, who is very grateful to the many researchers who have generously given their time to contribute to this article, and to Professor Rachel Bearon (University of Liverpool) for her constructive feedback on an earlier draft.*

Funding uplift for the mathematical sciences infrastructure

This flagship investment in the UK's world-leading mathematical sciences community focuses on enabling adventurous new ideas, training and nurturing the next generation of researchers, and increasing participation by supporting more research projects, fellowships and doctoral awards.

It includes a funding boost to significantly augment and expand activities at the three Mathematical Sciences Institutes: The Heilbronn Institute for Mathematical Research (HIMR), The International Centre for Mathematical Sciences (ICMS), and The Isaac Newton Institute (INI).

The **Heilbronn Institute** is a partnership between UK academia and GCHQ, designed primarily to support UK activities in security and intelligence. It has a unique structure in which Fellows divide their time between 'internal' classified work and 'external' publishable work. The Institute employs Research Fellows, supports PhD Studentships, and sponsors research activities. The UKRI award has enabled a rough doubling in volume of each of these activities, with commensurate rewards for the internal work and for the UK mathematics community. The principal benefits to security and intelligence have been significant but are classified and cannot be described here.

Over two years of additional activities funded by the UKRI award:

- 18 Heilbronn Research Fellows were appointed, and 4 further Fellowships were extended.
- 42 PhD Studentships were awarded within the Heilbronn Doctoral Partnership (HDP), extending over 17 Universities distributed widely across the United Kingdom.
- Approximately 75 UK-based research activities were funded at a total of nearly £400k.

The value to the UK of these activities cannot be adequately compressed into short stories. Nevertheless a few such stories follow.

- The expanded HDP has permitted an improvement in diversity, including from approximately 20% to 30% in gender diversity. The HDP Summer Workshop imparts knowledge exchange and a range of transferable skills such as team-based problem solving to the Heilbronn students.
- From the 75 funded research activities, just two are selected as exemplars. (a) A group of UK-based and overseas mathematicians developed a new approach to the Erdős–Szemerédi sum/product conjecture for integers. This work is a springboard for further research (including PhD projects) within a much broader (inter) national community. (b) HIMR was one of about five funding bodies to support the second edition of the '*Women in Number Theory and Geometry*' retreat. The principal target was to help construct a strong community of women in graduate mathematics, through selected talks and discussions.
- In an example of inter-Institute collaboration, HIMR now funds a programme of Heilbronn Visiting Fellowships at satellite meetings of the Isaac Newton Institute (INI). HIMR was also pleased to receive excellent organisational and facilities support from INI and ICMS for the first run of its HDP Summer Workshop.

Further information on the mission and activities of the Heilbronn Institute, and the benefits of the UKRI award, is available in the HIMR Annual Reports.

"The UKRI award permits the Heilbronn Institute to expand its key role in UK security and intelligence, and to develop as a national institute dedicated to the development of excellence across UK mathematics. The award is a far-sighted recognition of the importance of fundamental research, and it supports large cohorts of students and fellows as they build scientific careers and, in turn, foster future generations. The ultimate impact of this investment will require a longer-term vision."

Professor Geoffrey Grimmett, Chair of Heilbronn Institute for Mathematical Research.

The **Isaac Newton Institute** (INI) is a globally renowned Institution where the world's leading mathematicians come together to engage in pioneering research. As an international visitor centre it runs long-term research programmes on themes across the whole of the mathematical sciences with applications over a wide range of science and technology. It attracts leading mathematical scientists from the UK and overseas to interact in research over an extended period accentuated by research schools, workshops, and deep dives. The **Newton Gateway** to Mathematics is the impact initiative of INI, and acts as a knowledge intermediary for the mathematical sciences. It reaches out to, and engages with, the users of mathematics – in industry, business, public sector, and other scientific disciplines, bridging the gap between those engaged in frontier mathematical research and those working in more applied areas. It has been a key member of **V-KEMS** (the Virtual Forum for Knowledge Exchange in the Mathematical Sciences) developing and delivering virtual events, including **Virtual Study Groups**.

The UKRI award has enabled additional research programmes to be run at INI in Cambridge as well as a whole new series of satellite programmes held at locations throughout the UK. New schemes, such as the **INI Network Support**, have been rolled out where there is grass roots demand. In addition to maximising knowledge exchange (KE) and impact for these additional INI activities, the Newton Gateway itself embarked on several new initiatives cementing its position as a national provider of KE in the mathematical sciences. In addition the INI and the Newton Gateway are playing a key role in setting up and the coordination of national initiatives, such as the Academy for the Mathematical Sciences and the KE-Hub.

Examples of these new initiatives include the launch of:

- **Additional Programmes at INI** Throughout this year there are 3 instead of the usual 2 programmes running concurrently using the nearby Moeller Centre to house one of the programmes. The 6 six-month programmes cover a variety of mathematics and applications under descriptive and inviting headings such as The mathematical and statistical foundation of future data-driven engineering, Mathematics of movement: an interdisciplinary approach to mutual challenges in animal ecology and cell biology, and Uncertainty quantification and stochastic modelling of materials.
- **Satellite Programmes** that further strengthen the INI's commitment towards increasing activity across the UK. These programmes allow research groups to attract global attention in their field by organising a long-term visitor programme where their institution. The inaugural programme Geophysical fluid dynamics; from mathematical theory to operational prediction took place at the University of Reading in September 2022, and in 2023 two further programmes will take place at Aberystwyth University and on Skye. Four more satellite programmes are already planned for 2024 at University of East Anglia, Northumbria and the Alan Turing Institute.

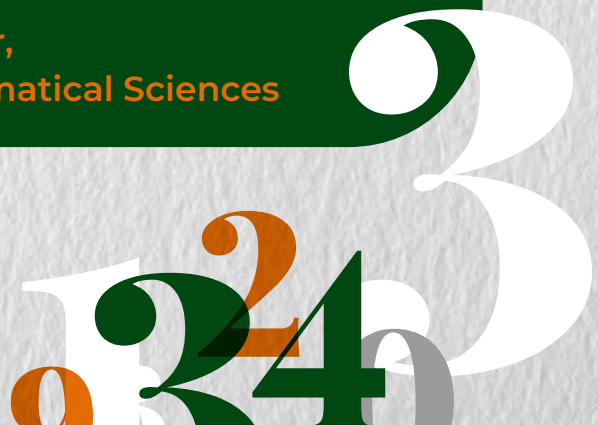
- **INI-Simons Postdoctoral Fellowships in Mathematics**, a scheme to enable exceptional early-career researchers to gain experience, foster independence, and forge new connections, a goal which has been amply achieved by the seven recipients of fellowships so far. Six more are expected in the new academic year. These post-doctoral positions allow the young researchers to take part in one of the INI programmes for half a year and the rest of their one-year fellowship at any UK institution of their choice. Initially funded through the Simons Foundation as a Covid recovery measure, this is now entirely supported through the Additional EPSRC Grant.
- **INI Network Support**, a flexible scheme directed at existing and new research networks of varying sizes and with different needs. Under this highly popular scheme, over £250k have been committed to support 17 such national and international networks for two years each ranging from previously purely virtual network JUNIPER (Joint UNIversities Pandemic and Epidemiological Research), to the well-established COW, and to the brand new Probabilistic Numerical Methods network. Post pandemic this scheme will accelerate interaction and collaborations, and it is expected that a further similar number of networks will be supported by the end of the year.
- An incubator for the **Academy for the Mathematical Sciences** (AcadMathSci) which "*will be an authoritative and persuasive voice for the whole of the mathematical sciences*." An Executive Committee and Executive Director – seconded from the INI for two years – have recently been appointed to carry out the feasibility and set-up phase.
- The **Knowledge Exchange Hub** which has been set up with the Manager in post for eight months supporting V-KEMS and study groups. Inspired by the Bond review "Era of Mathematics" the KE-Hub aspires to become a "national centre in impactful mathematics".

- **Additional Newton Gateway activities** Since last year, it is an official partner of A4I, UKRI's Analysis for Innovator Programme, and successfully contracted 11 projects for universities and industrial partners. Furthermore it has brokered internships for doctoral students to UKHSA, the UK Health Security Agency, in two rounds of six each. The additional money also allowed it to expand its usual activities delivering, for example, the intriguing Open for Business event Liquid Metal Batteries and the highly successful one off event Communicating Mathematics for the Public.
- **Collaboration with *Plus***, a free online popular science magazine, to raise awareness and appreciation of cutting-edge mathematics that is being carried out at INI among the general public. Over a 100 online articles have been supported through the Additional Grant via the INI.

Further, and more detailed, information on the investment is available as part of INI's Annual Reports and the Newton Gateway's Annual Reports.

"The uplift in our funding has made an enormous difference. It allowed us to schedule more long-term programmes thus reducing a backlog of several years. It also enabled us to put a spotlight on diverse research groups around the country through the new satellite scheme. This in turn encouraged us to be more adventurous and ambitious in our programming. At the same time we have been able to follow demand and fill in funding gaps as with our INI Network Support scheme. But most crucially, the set-up of the Academy and the KE-Hub will lead to a step change of the UK landscape for the mathematical sciences in future."

Professor Ulrike Tillmann, Director,
Isaac Newton Institute for Mathematical Sciences



The International Centre for Mathematical Sciences (ICMS) stimulates and promotes the mathematical sciences through diverse international workshops, strategic events, and public engagement activities. Its events programme attracts leading mathematical scientists from the UK and internationally – connecting mathematical communities across the world. Through its **Knowledge Exchange** (KE) activity and academic support, ICMS connects workshops with the industrial and public sectors, hosts study groups and online KE activity such as V-KEMS, and has new follow-on funding that allows workshop participants to test emerging ideas via short projects.

The funding awarded to the ICMS, led by Heriot-Watt University and the University of Edinburgh, is enabling a substantial increase in research activity and support for the people pipeline, with targeted initiatives for early-career researchers, and on responsible innovation; equality, diversity and inclusion; knowledge exchange; and public engagement.

The EPSRC funding has enabled an almost doubling of the number of its popular and successful research workshops and Research-in-Groups (RiGs) – for small groups of researchers to spend up to a month in Edinburgh on a specific research project – that it can support. In addition, it has supported several novel initiatives, including:

- **ICMS**@, where a workshop can be hosted anywhere in the UK while ICMS staff continue to provide support for the workshop's preparation and logistics. The Centre is intensifying efforts to use this scheme to encourage the participation of researchers based in regions that have historically had difficulty accessing synergistic activities.
- **Knowledge Exchange** (KE) Catalyst Programme, a new mechanism to support an academic secondment to develop a new KE partnership in direct collaboration with an industry or public sector partner.

- **Mathematics for Humanity** which is devoted to education, research, and scholarly exchange with direct relevance to the ways in which mathematics can contribute to the betterment of humanity. The Centre is currently soliciting proposals from around the globe, from both pure and applied mathematicians with new ideas for using mathematics to make a difference in human well-being, from climate justice to democracy to sustainable economies. It aims to bring in groups of researchers working on distinct but related themes for mutually beneficial interaction. The project is being overseen by a scientific committee of world-leading mathematicians, including two Fields medallists.
- **Visiting Fellows Programme** This provides funds for researchers from low and middle income countries to visit the UK as well as distinguished mathematicians to visit and interact with mathematical scientists in several institutions. Part of the intention is to make the visits for research workshops more sustainable by encouraging key participants to stay longer in the country.
- **Public Engagement** The ICMS has instituted a programme for Visiting Fellows in the Arts. The first appointment is currently in place with a composer who is collaborating with mathematicians to produce a work that incorporates mathematical ideas and makes them accessible. A recording and performance is planned for late 2023. A number of different lecture series have become possible, including one that focuses on equality, diversity, and inclusivity, and another, the Mary Somerville Lectures, that emphasises the deep relationships between mathematics and other domains of inquiry.

"The ICMS is currently implementing plans to bring its impact in the UK and in the world up to an entirely new level in all areas of its activities, research, knowledge exchange, and public engagement. Its current plans to serve the needs of the mathematical community in line with the best visions of the future and principles of equality, diversity, and inclusion are greatly aided by the additional funding from the UKRI."

Professor Minhyong Kim, Director,
International Centre for Mathematical Sciences.

Increased inclusivity and collaboration

A common theme from all institutions is their investment in technology for remote participation in, and the recording of, lectures, seminars, and workshops, thus making these events more accessible, inclusive, and sustainable.

Similarly, all institutions are using the additional funding to support increased collaboration. One such example is V-KEMS (the Virtual Forum for Knowledge Exchange in the Mathematical Sciences), a joint venture between the ICMS, INI, Newton Gateway to Mathematics, and Innovate UK KTN. Established in March 2020, V-KEMS has developed ambitious new mechanisms to rapidly bring together mathematical scientists to address COVID-19 challenges. These have included: COVID safety in rail, universities, and when hosting large events; COVID impact on foodbanks; and the impact of COVID on cardiovascular waiting lists. V-KEMS won the 2021 Praxis Auril “KE Team of the Year” award.