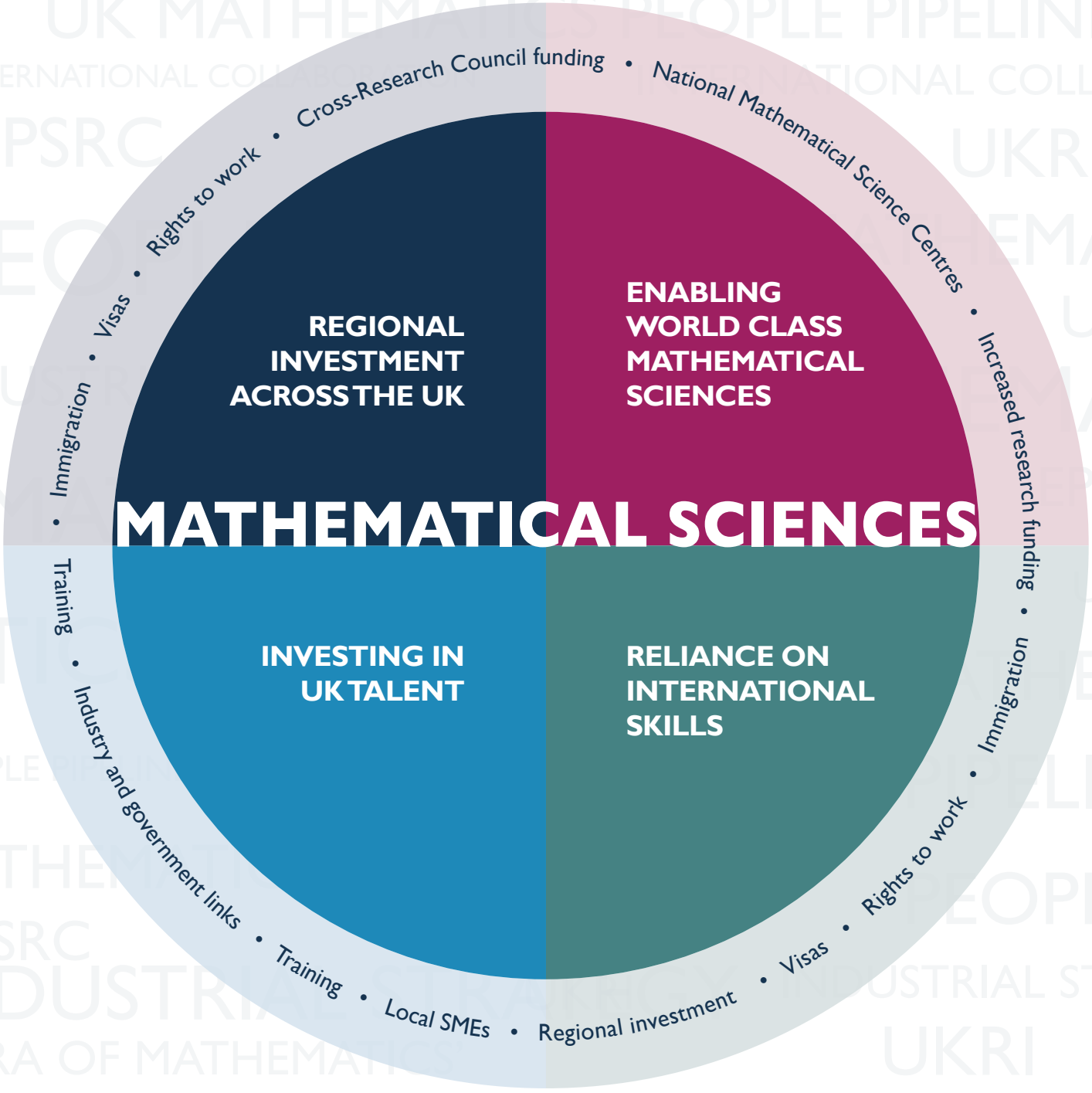
LONDON MATHEMATICAL SOCIETY
EST. 1865

Mathematical Sciences: The Key to Economic Success

Invest in the UK: Invest in Mathematical Sciences



INTRODUCTION

Mathematical Sciences is the foundation of all science and data disciplines. A healthy research science sector relies heavily on the knowledge and skills base of Mathematical Sciences.

The UK Industrial Strategy[1] places central focus on the need to strengthen the foundations of the UK's productivity and the fundamentals required to support a skilled and innovative economy: Mathematical Sciences is at the very heart of this.

The UK needs to maintain its role as a leader in the global economy where worldwide trends and challenges such as artificial intelligence and low-carbon technologies require innovative and collective solutions. The current level of investment in UK Mathematical Sciences research and training is not meeting the demand from new and ongoing industries. This demand will only grow.

> Fluidity and ease of movement of Mathematical Sciences researchers is central to the UK being a global leader in developing solutions to global trends. At the same time the UK needs to fund ever increasing numbers of UK mathematicians if it wants to seize the opportunities presented and maintain its global position. To build economic growth there needs to be a spread of investment in Mathematical Sciences across the UK to provide students and regional Small and Medium Enterprises (SMEs) with local access to Mathematical Sciences expertise. Ensuring sufficient funding to deliver world-class Mathematical Sciences research will be key to the economic success of the UK.

By identifying some collaborative actions the Mathematical Sciences community, UKRI and the Government can work together to ensure that world class Mathematical Sciences is available to underpin, inform and enhance the UK Industrial Strategy both now and in the future.

[1] 'Industrial Strategy: Building a Britain fit for the future', HM Government, 2017.

1. UK MATHEMATICAL SCIENCES PEOPLE PIPELINE: RELIANCE ON INTERNATIONAL SKILLS

The UK is a world-leading research nation with a globally connected research base. Collaboration with European and wider international partners is key to our strength in science and research: more than half of the UK's research output involves such collaboration[2].

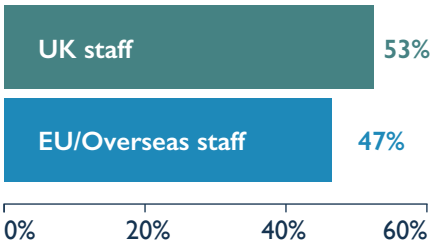
The Royal Society has noted that "The UK's reputation for excellence attracts people from around the world and allows it to compete with other scientifically excellent nations for international talent."[3] This is certainly true for Mathematical Sciences.

At present 53% of Mathematical Sciences staff in UK universities are from the UK, with 27% of EU origin and 20% from 'Other overseas'[4]. The UK is clearly reliant on Mathematical Sciences staff from overseas, particularly towards the start of the people pipeline.

The UK's Mathematical Sciences people pipeline is dependent on the UK having in place an appropriate, welcoming and supportive immigration system for academics. At present academics moving to the UK from outside the EU must apply for a Tier 2 visa at a cost estimated by the Royal Society to be 11% of an average annual salary[3]. The cost can be particularly onerous for those bringing families. A Tier 2 visa also comes with a minimum salary threshold of £30k per year which is above the amounts paid for many postdoctoral positions. The current visa system is prohibitive on multiple levels and potentially detrimental to the flow of people to the UK, particularly at early career stages, and to the collaboration and exchange of ideas that is vital to a thriving national research community.

By removing restrictive barriers to academics moving to the UK, the government can safeguard the health of the Mathematical Sciences people pipeline and ensure the continued excellence of UK Mathematical Sciences research.

UK Academic Mathematical Sciences Staff by Nationality*



*HESA data 2017-18

RECOMMENDATIONS:

- Remove any statutory barriers to movement of academics.
- Revise the minimum salary threshold for visas to realistically reflect the sector.
- Ensure that the cost of a visa is at a reasonable rate.

[2] Chris Skidmore, Minister of State for Universities and Science (Department for Business, Energy and Industrial Strategy); announcement of Adrian Smith Review, 26 March 2019.
[3] 'UK research and the European Union', Royal Society, June 2018.
[4] HESA data 2017-18.

2. UK MATHEMATICAL SCIENCES PEOPLE PIPELINE: **INVESTING IN UK TALENT**

At the same time as welcoming EU and overseas mathematicians and collaborators there needs to be a clear focus on investing in young UK mathematical talent to encourage a substantial increase in the number of UK home students training to become the world-leading mathematicians of the future, assuring the expertise that will maintain the UK's position as a global leader in years to come.

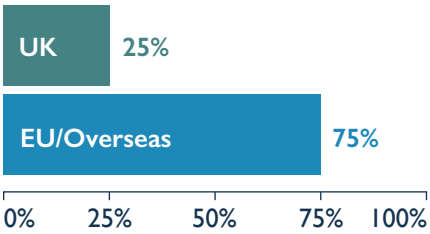
A recent study by the LMS found that the current balance of Mathematical Sciences postdoctoral researchers is 25% from the UK and 75% from EU/overseas (the latter being 43%/32%)[5]. Addressing this lack of UK trained mathematicians will take many years, and reliance on a predominantly EU and overseas workforce must be recognised and facilitated in the interim.

Numbers of UK Mathematical Sciences students have remained relatively stable, at around 500 PhD students each year since at least 2012-13[4]. It has, however, been repeatedly identified since as far back as the EPSRC International Review of Mathematical Sciences in 2010 that the UK needs not only to maintain its Mathematical Sciences people pipeline but to grow this substantially in order to remain globally competitive and to meet the growing demands of UK research and industry[6]. This still remains the case nine years on.

A number of the most important growing industries in the UK are heavily reliant on Mathematical Sciences and many of these, including the Life Sciences and Data Sciences, have already identified reported Mathematical Sciences skills shortages[7]. The Bond Review[8] recently identified the need for a minimum of 100 extra Mathematical Sciences PhD places to help support fundamental research and knowledge exchange.

Currently students are tending to study closer to home. To enable students who wish to train as mathematicians to access the best research and teaching locally there needs to be a more even distribution of investment in Mathematical Sciences higher education institutions across the UK rather than within a few large, consolidated centres as currently. With funding being so geographically restricted at present potential Mathematical Sciences students have to either move long distances or in some cases choose an entirely different field of study thereby becoming lost to the Mathematical Sciences people pipeline.

UK Mathematical Sciences Postdocs by Nationality*



*LMS Postdoctoral Researchers study (2019)

RECOMMENDATIONS:

- Improve the regional distribution of Mathematical Sciences funding in higher education institutions.
- Increase the number of Mathematical Sciences home students.
- Increase PhD funding for Mathematical Sciences.

[5] '2017 Survey of Postdoctoral Researchers in the Mathematical Sciences in the UK', London Mathematical Society, 2019.
[6] 'International Review of Mathematical Sciences', EPSRC, 5–10 December 2010.
[7] 'Mathematical Sciences: Driving the UK Economy', the Council for the Mathematical Sciences, 26 January 2016.
[8] 'The Era of Mathematics: An Independent Review of Knowledge Exchange in the Mathematical Sciences', Professor Philip Bond, 27 April 2018.

3. DELIVERING AN INNOVATIVE ECONOMY: REGIONAL INVESTMENT ACROSS THE UK

Mathematical Sciences expertise at a local level is critical to regional development and the growth of regional economies. Having excellent Mathematical Sciences research and teaching departments in most higher education institutions across the UK would ensure that specialist research and knowledge exchange was locally available to regional businesses and industry. This would encourage closer collaboration between academia and industry and develop a growing awareness amongst the SME community of the benefits and opportunities afforded by collaboration and interaction with mathematicians, providing innovative solutions to business problems. The Bond Review proposed that relationships be facilitated between institutions and local SMEs to provide a direct supply of academics and research into industry.

At present the share of Mathematical Sciences funding for the early career pipeline is disproportionately concentrated in specific larger institutions and the South East. LMS data[5] shows that the East of England, the South East, and London regions obtain the greatest benefit from postdoctoral level funding. Out of a total of 12 regions surveyed these three regions have almost half of the current 756 UK Mathematical Sciences postdoctoral population. While this might be expected, it does create a feedback loop where funding is continually concentrated into larger institutions, thus having a continuous negative impact on smaller regions.

In addition, certain geographical regions are reliant on EU funding for their postdoctoral mathematicians, for example 30% of total postdoctoral funding in the West Midlands, as well as 22% in Yorkshire and Humberside and 14% in Scotland, comes from the EU. These regions are likely to be disproportionately affected should there be any loss of such funding.

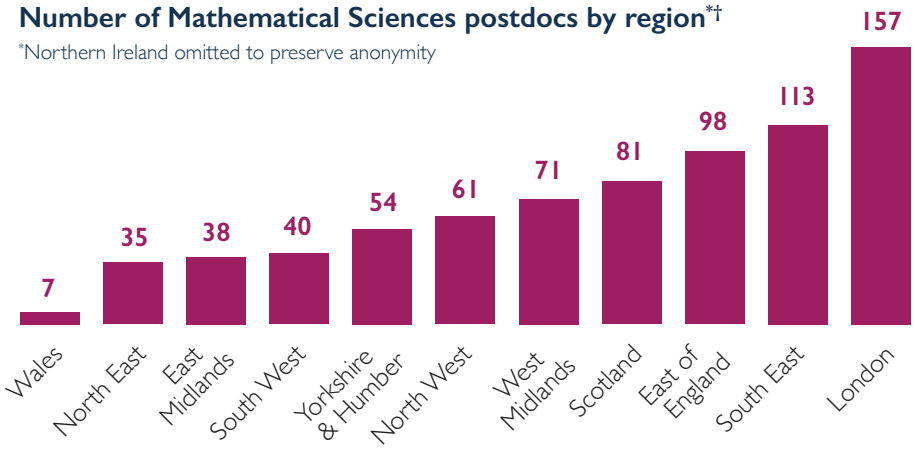
By redressing the balance of investment in Mathematical Sciences across all regions prosperity can be improved and shared more widely. This would make excellence in Mathematical Sciences teaching and research available locally, enabling an increase in the numbers of UK Mathematical Sciences home students, and facilitating the growth potential of SMEs and thereby the economy of the country.

RECOMMENDATIONS:

- Improve the regional spread of Mathematical Sciences funding UK-wide.
- Ensure no region is left behind by changes to the funding landscape.
- Facilitate relationships between the Mathematical Sciences community and local SMEs.

Number of Mathematical Sciences postdocs by region*†

*Northern Ireland omitted to preserve anonymity



†LMS Postdoctoral Researchers Study (2019)

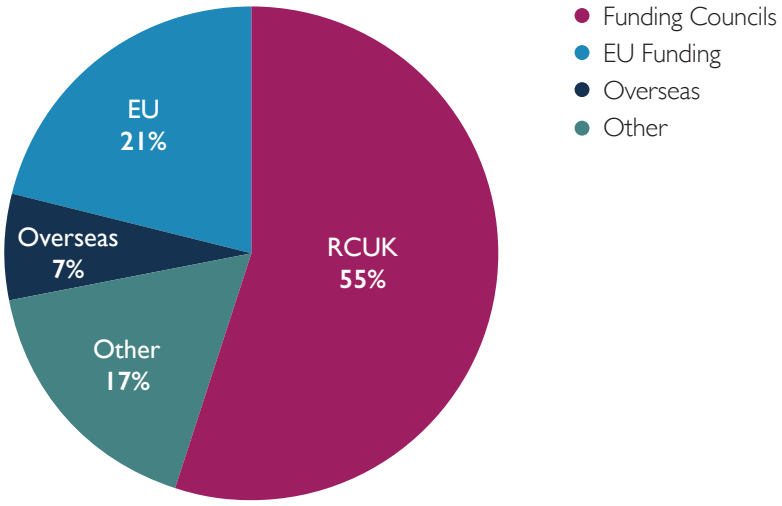
4. DELIVERING AN INNOVATIVE ECONOMY: ENABLING WORLD-CLASS MATHEMATICAL SCIENCES

The UK is in the top 4 of global innovation nations and we draw in more internationally mobile research and development (R&D) than other large countries, with a total of 16 per cent of UK R&D investment financed from abroad[2].

At present the UK is a world-class centre of Mathematical Sciences research. In the REF2014 over 80% of UK Mathematical Sciences research outputs were recognised as excellent or internationally world-leading[7]. However there is a reliance on EU and overseas funding for Mathematical Sciences research. In addition industry funding for the Mathematical Sciences has significantly decreased over the last few years from £8 million in 2015/16 to £2.2 million in 2017/18 but with levels of funding from RCUK and the EU having remained much the same.

The current funding landscape in the UK shows significant overseas funding for Mathematical Sciences with £21.5m research income from the EU and £7.1m from other overseas sources[4]. Together these account for 28% of the total research income to Mathematical Sciences compared with 55% from UK Research Council funding and 17% from other sources including health, industry and charities. If this EU and overseas funding were to cease the UK Government would need to consider how to meet the corresponding gap. Not doing so would significantly diminish UK Mathematical Sciences research and have a seriously damaging impact on industry, the economy and the UK's international research standing.

Funding sources for Mathematical Sciences*



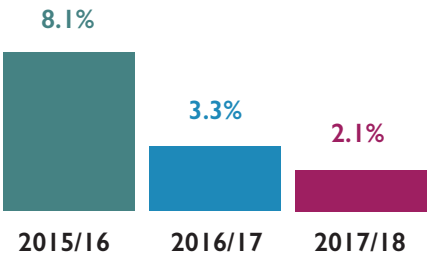
*HESA research grants and contracts data 2017/18

Industry funding for Mathematical Sciences as a percentage of total research funding has dropped significantly from 8.1% in 2015/16 to 3.3% in 2016/17 and now stands at 2.1%[4]. This compares with current figures of 8.7% for Electrical Engineering and Computer Science, and 6.7% for Chemistry. New industries such as the low carbon economy, data science, engineering and pharmaceuticals are driving the UK economy: Mathematical Sciences skills and knowledge are vital to all of these.

Government along with the Mathematical Sciences community should explore means of increasing funding and training support from UK industry by working collaboratively with businesses. Accessing new sources of government and industry funding will not only allow the Mathematical Sciences people pipeline to flourish, but will ensure productive exchange of knowledge, the direct input of Mathematical Sciences fundamental research and skills into industry, and the growth of small and large enterprises.

The return on investment for Mathematical Sciences is £588 for every £1 invested (by comparison Chemistry returns £246, Engineering £88 and Physics £31)[9]. By recognising that Mathematical Sciences underpins and informs all of the science disciplines and wider industry and by improving and reinforcing the funding into Mathematical Sciences the UK Government can work with the Mathematical Sciences community to guarantee world-class innovation and research to the benefit and prosperity of the whole country, ensuring the UK's continued place as a world leader in Mathematics excellence for generations to come.

Decrease in industry funding as % of total funding in Mathematical Sciences*



*HESA research grants and contracts data 2017/18

RECOMMENDATIONS

- A clear plan for ensuring sustained levels of funding for Mathematical Sciences.
- An increase to Mathematical Sciences funding from government and industry sources.
- Engagement of mathematicians with Industrial Strategy stakeholders.

[9] 'Mathematical Sciences: The Route To Economic Prosperity', London Mathematical Society, 2017.

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