Institution: Cardiff University

Unit of Assessment: 10

a. Overview

The School structures and manages its research activity around five groups:

• **Analysis and Differential Equations**, which focuses on spectral theory (analytic and computational), inverse problems, graphs, matrix and operator pencils, nonlinear PDEs, homogenization, and analytic number theory.

• **Applied Mathematics**, with strengths in fluid and solid mechanics, CFD and computational rheology, numerical analysis, and the mathematics of materials.

• **Mathematical Physics**, spanning operator algebras and noncommutative geometry, algebraic geometry, differential graded categories, derived categories, combinatorial theory, K-theory, general relativity and gravitation, and quantum field theory.

• **Operational Research**, which focuses on healthcare modelling, timetabling and scheduling, queuing systems, and optimization.

• **Statistics**, spanning time series analysis, multivariate data analysis, stochastic global optimization, stochastic processes and random fields, signal processing, data mining and machine learning.

Each group has strong effective scientific leadership by a Head of Group (HoG), and provides a supportive environment for the training of their postgraduate research students (PGRs) and the development of their research associates (RAs). There are weekly group seminars/workshops during term, and members of the group organise national and international meetings on a regular basis. Many such meetings are held in partnership with the Wales Institute of Mathematical and Computational Sciences (WIMCS). The School Research Committee sets research policy and selects the recipients of PGR scholarships. The Committee includes HoGs and cross-staff representation at both senior and early-career level.

In the latter stages of the REF period, under the leadership of the new VC, Cardiff University was re-structured into 3 colleges each led by a Pro-Vice Chancellor. Research work carried out in UoA 10 is now primarily within the College of Physical Sciences and Engineering. The University is committed to providing major investment, in the region of £200-250m, in staff, PGR students and capital development to support the delivery of research excellence and impact as outlined in its new 5-year research strategy.

b. Research strategy

Research vision: The School is committed to generating research at the highest levels of international excellence in the mathematical sciences. Our goals are to inform academic scholarship through fundamental enquiry and to contribute to the wider influence and impact of the subject through collaboration with other disciplines, industry and the public sector.

Our research strategy is to exploit synergies at the frontiers between pure mathematics, applied mathematics, statistics and operational research, and to contribute to the wider influence of mathematical research through collaboration with research users. To achieve this the School will:

- extend our research groups through new academic appointments financed by expanded undergraduate numbers;
- extend our coverage in theoretical areas which form the intellectual bedrock of mathematics;
- encourage more fellowship applications from current staff and attract high-calibre externally funded researchers;
- continue further interdisciplinary collaborations with researchers and users in the fields of medicine, healthcare and industrial mathematics;
- enhance our core research themes that impact on health, security and wealth generation;
- support ambitious collaborative research proposals by exploiting existing connections and engaging world leaders;
- continue to support staff to organise conferences and workshops and to coordinate scientific programmes at the Isaac Newton Institute (INI);

- increase the recruitment of high-calibre PhD students, and engage in the College's new initiatives targeting the recruitment of international students;
- enhance the quality of doctoral training.

This strategy builds on the progress made since RAE2008 with achievement of excellence evidenced by **significant improvement in key performance indicators**:

- significant strategic investment in new staff with over 50% of our staff appointed since RAE2008 (33% of the FTE staff in REF1a are ECRs) adding high-calibre research capacity and ensuring sustainability;
- a rise in average research income from £267k p.a. for the RAE2008 period compared with £1,058k p.a. for the REF assessment period (an increase of over of over 290% p.a.);
- a 57% increase of in the average number of PhDs awarded p.a. as compared to RAE2008;
- an increase of 58% in the number of RAs in post during the REF period as compared to RAE2008 (from 19 to 30).

This performance has resulted from the School's objectives for the 5 years following RAE2008:

- strengthen its existing five research groups;
- host more major international meetings;
- seek new funding streams for PhD students and RAs;
- promote interdisciplinary research.

All five research groups have been strengthened through new appointments. The appointments of Cherdantsev, Dirr, Dragoni, Lettington, Logvinenko and Pugh, in particular, have strengthened research activity in pure mathematics. The School's new ECR appointments have increased our capacity for interdisciplinary research.

The formation of WIMCS and its funding by HEFCW, which had scarcely started in 2008, provided the School with the strategic finance to grow an already vibrant research culture through the appointment of high quality researchers. Cardiff University received £1.3m for mathematics and a further £1m for interdisciplinary collaborations from WIMCS (2007-2011). WIMCS provided the initial funding for 3 senior and 3 junior appointments within the School, while University funding ensured the sustainability of this investment by making the posts permanent. WIMCS also funded or part-funded several RA posts as well as a visiting professorship for Smilansky. Research workshops and a visitor programme extending over its five research clusters served to enhance the research culture of the School. Details of major international meetings hosted are provided in (e) below but we highlight two meetings WIMCS organized jointly with the INI for Mathematical Sciences on *Computational Challenges in PDEs* held in Swansea and *Non-Commutative Geometry* held in Cardiff.

WIMCS also provided the foundation for a mathematical sciences base to support interdisciplinary research projects and collaborations. The focus of the most recent WIMCS initiative, Health Modelling Centre Cymru (hmc²) launched in 2011 and directed by Harper at Cardiff, is on high quality research, translating that research into effective outcomes, building capacity, and promoting interaction between mathematical and computational modelling and better health delivery. Research contracts with healthcare providers have already been secured to provide new streams of income supporting PhD and postdoctoral appointments in the School. Much of the capacity for hmc² came from an EPSRC S&I grant of £5.4m to support Operational Research at Lancaster, Nottingham, Cardiff and Southampton - LANCS. With additional funding provided by the University, the resources were sufficient to fund four lecturers, four RA positions, and five PhD studentships. The sustainability of this major investment was secured by making the 4 lectureships permanent.

New funding streams for PhD students have been achieved through the LANCS initiative; external funders such as Hewlett-Packard (HP), Office for National Statistics (ONS) and the NHS; interdisciplinary studentships and match funding using School resources.

The School has developed interdisciplinary collaborations with a number of other Schools at

Cardiff. These collaborations have been reinforced through joint research grants and PhD students. Examples of interdisciplinary collaborative grants are:

- convection in the Earth's mantle (Earth Sciences);
- inverse problems in brain imaging (Cardiff University Brain Research Imaging Centre);
- modelling social media identity formation and behaviour (Computer Science and Informatics; Social Sciences)
- inverse problems for magnetic induction tomography (Computer Science and Informatics).

The School has jointly supervised and funded PhD students with Earth Sciences, Computer Science and Informatics and Medicine.

c. People, including:

i. Staffing strategy and staff development

Staffing strategy. Our staffing vision is to sustain a vibrant and supportive research environment within the School of Mathematics so that researchers at all career stages have opportunities for development to pursue avenues of research that address fundamental problems in the mathematical sciences and contribute to human endeavour through involvement in wider society and the economy.

The School's research strategy relies upon the recruitment, development and retention of high-calibre research staff. This **staffing strategy** has been underpinned through **capacity building as a result of the WIMCS and LANCS initiatives** (all professorial and lectureship appointments were made permanent) and sustained by additional income from two new MSc courses and a 15% increase in undergraduate FTE allocations. These initiatives were combined with our natural succession planning process to ensure that when replacing staff who left, as well as when making other new appointments, we always enhanced our research profile and coherence, achieved the best balance between senior staff and ECRs, ensured our long-term sustainability and augmented our capacity for inter-disciplinary research. Since 2008, the School has made **16 new academic appointments.** Recruitment at senior levels is used strategically to develop or sustain established research strengths in the School. For example, Harper was appointed to a Chair in Operational Research and Dirr to a Readership in Mathematical Analysis.

External grant research income has allowed the appointment of **30 RAs across the REF period**, reflecting the success of the School's new policies to enhance the quality of grant applications. Two EPSRC Postdoctoral Fellows were based in the School, one of whom was made a permanent member of staff. In addition, the School hosted 8 Marie Curie Fellows.

Excellence in research is rewarded through promotions, provides further evidence of the support given to research staff. During the REF period, there were two promotions to Senior Lecturer, two to Reader and one to Chair. In addition, two members of staff on the Teaching and Scholarship career pathway were transferred to the Teaching and Research career pathway after demonstrating evidence of excellence in research. All staff in the School benefit from a workload model which is used to preserve equity and ensure that credit is given to research-related activities such as RA and PGR supervision, preparation of research proposals and generation of research outputs. Lecturers on probation are supported by a reduced teaching load during their probationary period. Allowances are also made for staff with heavy administrative responsibilities and large research grants. In this way all researchers in the School are supported, irrespective of their career stage.

Staff development. The School is committed to supporting and developing staff at all stages of their research careers to enable them to realise their full potential. The School provides this support in a number of ways. Each member of staff belongs to a research group which provides support and internal peer review for research grant applications, conference presentations and organisation of conferences and workshops. Early career appointments are allocated a mentor who will support them through their probationary period, advising them on procedures for grant applications, relevant funding bodies and opportunities, and monitoring their progress during their first three years in post. The strong scientific leadership of HoGs has supported ECRs in their career development such as preparation of successful fellowship applications. All staff benefit from annual appraisal in which research progress is reviewed against objectives, and specific training

requirements are identified.

The School is supported in the development of its staff by a comprehensive range of courses and training provided by the University through its **Career Development Skills programme, Research Development and Leadership and Management courses**. Two ECRs in the School were selected to participate in leadership and development programmes such as the **Cardiff Futures** programme, which is an opportunity for academic staff to develop their career paths and to discover and explore how they might contribute to shaping the future of the University (www.cardiff.ac.uk/humrs/staffinfo/leadership/cardifffutures/). The University's commitment to supporting the career development of its researchers has been recognised by the European Commission, which awarded Cardiff its HR Excellence in Research Award in 2010. This accreditation was renewed in 2012, in recognition of the University's progress in implementing the Concordat to Support the Career Development of Researchers.

The School implements the principles of the **Concordat for the Career Development of Researchers** as part of the integrated approach promoted by the University. In terms of research-related activities, research staff are treated in the same way as other academic members of the School: they are included on the main mailing list for School information, invited to participate in School meetings, both formal and informal, and represented on the School Research Committee.

The School allocates 40% of recovered indirect costs from externally funded research grants to individual investigators as a financial incentive to researchers, who have discretion to use these for research support such as part-funding of PGR studentships. ECRs without research grants are allocated funding for conference attendance and a budget for consumables. In this way, all research staff are encouraged to promote their research at conferences, to make academic visits, to invite their collaborators to visit Cardiff and to organize meetings in Cardiff. All grant proposals are subject to **rigorous internal peer review (IPR)** to provide proposers with feedback on proposals under development and to ensure that the quality of submissions is as strong as possible in terms of quality of ideas and presentation. This is a mechanism for developing grant writing skills amongst staff, particularly ECRs and those with little experience of applying for research funding in the UK, and sharing best practice between colleagues. After the introduction of IPR, the success rate of applications to EPSRC increased from 33% (2008/09) to 50% (2010/11 and 2011/12) and 42% in 2012/13. Those involved in the IPR of a proposal also assist the applicant in framing their response to the comments of the peer reviewers. These support and feedback mechanisms are intended to provide an important element in the mentoring and career development of new staff.

Cardiff University's Research, Innovation and Enterprise Services provides the support necessary for all technical and financial matters relating to grant applications and also run workshops throughout the year on how to make grant applications to different bodies. They have a representative on the School Research Committee to provide advice on research matters.

The School encourages staff, where eligible, to apply for EPSRC and ERC Fellowships, and assists all candidates who wish to hold their fellowship at Cardiff for the selection process by conducting mock interviews. All academic staff in the School can apply for paid study leave to stimulate research and to encourage the establishment of collaborative links with international researchers. During the review period, every formal application for study leave was granted.

The University and the School are fully committed to promoting equal opportunities and supporting diversity. Cardiff University holds an Athena SWAN bronze award for its commitment to women in science and the School will be submitting an application in November 2014. During the REF period the School has appointed 2 women to permanent academic posts (Dragoni and Mihai). In addition, 12 of the RAs in post during the REF period were women (40% of the total). Flexible working for all staff is supported, where possible, following discussion with the HoG/Head of School as appropriate. Research-active staff can also consolidate teaching duties where possible into one semester to allow fuller concentration on research in the other semester.

ii. Research students

The recruitment, management and supervision of high quality research students are important elements of the research life of the School. The School's strategy to **PGR recruitment** is to attract high-quality students with the potential to be excellent researchers. Applications are considered by a School panel, and offers are made on the basis of academic merit and supervisory match, with the key objectives of recruiting the best applicants and of following the evolving research strengths in the School. The School is committed to increasing the number of EPSRC funded studentships by match-funding the resources awarded through its DTG allocation. A 61% increase in our DTG allocation from 2012 has allowed us to double the number of studentships in 2013 and 2014 to 6.

All research students undertake **training** defined in a written Programme of Study drawn up when they commence their studies, including formal taught courses which are examined. Formal training includes courses provided within the School and through taught courses consortia. The School contributes to the academic programme and management of the MAGIC and NATCOR consortia. The School has contributed MAGIC courses in Numerical Analysis, Spectral Theory and Functional Analysis and NATCOR courses in Stochastic Modelling and Heuristics. PhD students in statistics can take courses offered by APTS. Through the FP6 Marie Curie Research Training Network in Noncommutative Geometry (EU-NCG) led by Cardiff, 8 Focused Semesters with half year programmes of visitor programmes and events were organized by the partners. This ensured a balanced treatment of all research areas in Noncommutative Geometry and the ability to interact with other research groups beyond our own experts, particularly in conjunction with dedicated research institutes like the ESI Vienna with its on-going programmes. This allowed, in particular, our graduate students to attend training events during the 4 years of the programme, and other graduate students to attend events at Cardiff.

There is an **extensive training programme** provided through the University's Graduate College (UGC) which is designed to offer postgraduate students opportunities to develop the skills they need to complete their research degree on time and to enhance their employability. The UGC operates the **Research Student Skills Development Programme**, delivering training in generic research skills such as presentation skills, project management, conferences, publishing, networking and viva preparation. Our PGR students each attended about 7 training sessions on average (some students taking 20 sessions or more) in the REF period. The UGC courses are also of interest to ECRs; 20 sessions were taken by 5 researchers in the REF period. Graduate students are encouraged to present their work at meetings in the School and at the annual WIMCS meeting at Gregynog each May. The University organizes an annual `Speaking of Science' conference at which PhD students present their work to an audience comprising other students, academic members of staff and a distinguished external speaker. All students who wish to be involved in tutorial work are trained for this task, through one-day workshops organized by the HEA at the start of the academic year and through weekly meetings held with module leaders.

Effective interaction between postgraduates and staff in the School is promoted through regular seminars/workshops and social events. There is a weekly 'postgraduate tea' which provides an informal setting for these interactions. Students are accommodated in offices in the School and share common room facilities with staff. There is a **PGR-staff panel** which meets twice per year at which discusses training needs are discussed. The **Cardiff University SIAM Student Chapter**, founded in 2012, has promoted the participation of PGRs in interdisciplinary activities.

The School operates a rigorous procedure for **monitoring** the progress of its research students. Formal progress monitoring is carried out by first and second supervisors, the Director of Postgraduate Research Studies and by the Research Committee. Assessment of the taught courses is integrated with the annual monitoring procedure, which is based on a substantial written report on their scientific progress, a seminar presentation and sets of 6-monthly progress reports and training needs assessments. Additionally, in the first year students must pass an end-of-year oral examination on their selected taught courses. This adds to the written and practical assessments by testing the student's ability to articulate what they have learned and to place their own research in a context of other mathematical subject areas.

d. Income, infrastructure and facilities

Our research has been sustained over the period by a **substantial increase in research grant income.** Research income spent during the REF period exceeded £5.2m, more than trebling the amount reported in RAE2008 (which was for a 6.5 year period). Our funding portfolio has been broad-based with EPSRC funding accounting for 50% of the total and other major contributions coming from UK central government bodies (26%), EU (14%), and UK-based charities (mainly the Leverhulme Trust – 6%). Notable among these are:

- EPSRC S&I grant of £5.4m to support the LANCS (Lancaster, Nottingham, Cardiff and Southampton) Initiative to enhance the "mathematical underpinnings of OR" and to "bridge theory and practice". With additional support from the universities themselves, a £13m investment was made (2008-2013). Cardiff's share of the grant amounted to £1.1m and was matched by a further £1.6m from the School.
- ERC starting grant on 'Quantum Fields and Curvature-Novel Constructive Approach via Operator Product Expansion', with an EU contribution of £654k, includes a post-doctoral research fellow and two full PhD studentship awards. The income for the EU-NCG network (total award €2.6m) funded postdoctoral and graduate Marie Curie Fellows.
- Our portfolio of healthcare modelling projects including recent awards totalling £381k from the Aneurin Bevan and Cardiff & Vale University Health Boards to establish new mathematical modelling units (these are in addition to previous awards during the period amounting to £135k from the Cardiff & Vale University Health Board).
- Interdisciplinary collaborative grant (with Computer Science at Cardiff and Engineering at Swansea) of £614k from EPSRC on Inverse Problems for Magnetic Induction Tomography. Cardiff's share of the grant amounted to £430k.

The School's high quality research and publications record is underpinned by continued investment in its research infrastructure and facilities. The School provides high quality office space and research support facilities to staff, including state of the art computer facilities. Following the considerable investment in academic staff and PGRs since RAE 2008, the University has accommodated the physical expansion of the School through the allocation of an additional floor in our building, providing **50% more space**. In addition to staff offices and seminar/meeting rooms, dedicated offices for hosting short and long term research visitors formed part of the additional physical space. Over 50 research visitors have been hosted during the period for visits of a week or more. The School has a room equipped for video conferencing and lectures via the Access Grid funded by EPSRC as part of the infrastructure funding for PGR taught course provision.

The University's Senghennydd Library, located in our building, provides information services for the School. In line with the University Library's collection development policy, the Senghennydd Library is increasing its electronic journal provision wherever possible. Researchers have continuous online access to these journals through the Cardiff Portal. There is also increased online delivery of other key library services.

The School invests around £60k per year on computing and IT infrastructure across research and teaching. This ensures that all researchers are equipped with research-quality computing equipment. Additional special-purpose workstations are also available to research students in the postgraduate laboratory. The School has two computer officers who provide software and hardware support for all research staff. In addition, all researchers in the School have direct access and support from the **Advanced Research Computing facility (ARCCA)** at Cardiff University, which provides HPC capacity with a "Raven" cluster of 2048 Intel Xeon 2.6 GHz cores each with 4Gb memory per core, as well as small, higher throughput clusters. This was one of the largest academic computational resources in the UK (2nd largest nationally at the time it was established in 2009) and remains one of the largest and efficient academic computational supercomputer facilities in the UK. The ARCCA facility has supported our research in Applied Mathematics and OR during the period. For example, it has been used to identify Nash equilibria in a game theoretical model of hospital interaction and to predict the dynamics of cavitation bubbles.

e. Collaboration or contribution to the discipline or research base

Research collaborations: The School has formal collaborations within Cardiff, within Wales, within the UK and internationally, as well informal collaborations which enhance the vitality of the

subject. Within Cardiff University, the School collaborates with the Schools of Computer Science and Informatics, Dentistry, Earth Science, Engineering and Medicine, as well as the Business School and the Cardiff University Brain Research Imaging Centre (CUBRIC).

WIMCS, in which Cardiff is the largest partner, was established in 2007 with a £5m award from HEFCW over 5 years. Cardiff Mathematics benefited through the appointment of 4 research professors and initial funding for the appointment of 4 other members of academic staff. WIMCS is organized around 5 clusters in Analysis (co-led by Marletta), Computational Modelling (co-led by Phillips), Mathematical Physics (led by Evans), Operational Research & Statistics (led by Harper), and Stochastic Analysis, which match the 5 research groups at Cardiff. In collaboration with the Leverhulme Trust, WIMCS supported a Thematic Year on Dissipative Spectral Theory (2012) led by Cherednichenko, Lyons and Marletta.

The School is a partner in the LANCS Initiative which has the strategic aim of strengthening and growing theoretical OR in the UK that will enhance the theoretical understanding of complex and uncertain real world problem solving environments leading to far-reaching academic, commercial and social impact. Other UK collaborations in which the School is or has been an active partner include the EPSRC networks MOPNET (Matrix and Operator Pencils, led by Marletta) and AGA (Analysis on Graphs and Applications, led by Brown). Phillips is a member of the EPSRC HEC UK Consortium On Mesoscale Engineering Sciences (UKCOMES). At the European level, Evans co-ordinated the EU-funded network EU-NCG (2006-11) on Noncommutative Geometry. With ten partners in Italy, Norway, Denmark, Germany, Belgium, France, Ireland, Austria and Romania, the network employed 23 Early Stage (PhDs) and 10 Experienced Researchers.

The School has an established culture of strategic collaboration with academic partners leading to joint grants and high-quality research outputs. The School currently collaborates with over **80 UK and international academic** partners on a range of fundamental and applied problems across the mathematical sciences that require the complementary expertise of the partners for their resolution. Collaborations that have led to high-quality co-authored research outputs in the current period include Imperial [Cherednichenko3, Savva1], Oxford [Mihai1], Cambridge [Blount1], Southampton [Harper2], Magdeburg [Aliev1], Bern [Marletta3], Rome [Dirr1], CNRS Sophia-Antipolis [Zhigljavsky3], Queensland [Leonenko2], Pittsburgh [Dragoni1], Alberta [Evans1, Evans2]. There are also over 10 active research collaborations with industry and other organizations including HP, Nielsen, NHS, ONS and EADS.

Interdisciplinary research: Cardiff pro-actively encourages and supports interdisciplinary research. The School has strong interdisciplinary collaborations, funded by EPSRC, with engineers at Swansea (Portfolio Partnership in Complex Flows and Complex Fluids, 2005-2009, Phillips) and at Warwick and Imperial (drag reduction strategies in turbulent boundary layers, 2009-2012, Davies). The EPSRC MOPNET network (2009-2012) includes engineers from Cardiff, Nottingham and Southampton, as well as physicists in Lancaster and has two engineers (McWhirter FRS (Cardiff) and Garvey (Nottingham)) on the network committee. The AGA network (Analysis on Graphs and Applications) includes several theoretical physicists and grew out of the 12-month program at the INI led by Brown, on the same topic. Our most recent EPSRC responsive mode grant is a collaboration between Mathematics and Computer Science in Cardiff, and Engineering in Swansea, on Magnetic Impedance Tomography.

How collaborations with research users inform our research: Research activity and strategy in healthcare modelling is informed by close collaboration with stakeholders in the health sector. For example, the ability to accurately forecast emergency demand and hospital resources based on seasonal fluctuations and meteorological events motivated our research on time-dependent queueing theory. The research has had a direct influence on the formulation of health policy, such as helping a number of hospitals plan for and schedule key resources. Exposure to a wide range of clinical, epidemiological and health service delivery problems through our collaboration with health care professionals facilitated by hmc^2 informs our research in mathematical and computational modelling techniques. For example, under a new contract with the Aneurin Bevan Health Board (ABHB), we have established a Modelling Unit associated with the Health Board's new Centre for

Improvement Focus and its Research and Development Directorate. The research priorities are and overseen by a joint steering group from ABHB and the University. To our knowledge, the initiation of such a joint venture between a University and a Health Board / NHS Trust and to have a mathematical modelling unit based within a Health Board on such a scale and level of investment from the NHS is unique within the UK. Cardiff is also a founding partner of the Cumberland Initiative (see www.cumberland-initiative.org), a network of communities (healthcare, business, and academic) building a National Centre with research expertise in health systems modelling from more than 15 universities, 12 NHS Trusts, and 10 industrial partners.

Our research in fluid dynamics is informed by our collaboration with stakeholders in the aerospace industry (Airbus/EADS). For example, issues arising from the use of waggle-wings for drag reduction, have motivated us to develop an interest in the instability modes of oscillatory Stokes layers when they modify a steady boundary layer.

Leadership: The research contributions made by staff in the School have been recognised by learned and professional societies. Evans, Griffiths, Huxley and Phillips have been elected Fellows of the Learned Society of Wales. Awards and prizes include the Basilis Xanthopoulos International Award for research on Gravitational Physics (Hollands, 2010), Beale Medal of the Operational Research Society (Griffiths, 2009) and Annual Award of the British Society of Rheology (Phillips, 2012). Other contributions to learned societies and research organisations during the REF period include LMS (Council, Marletta), CMS (OR representative, Griffiths), OR Society (Board of Directors and Chair of Publications Committee, Griffiths; General Council, Harper), and EPSRC (College members, Griffiths, Marletta and Phillips).

In terms of **professional leadership activities**, members of the School hold 16 editorships and editorial board memberships. New appointments to editorial boards during the period include Journal of Mathematical Physics, Theoretical and Computational Fluid Mechanics, Health Systems, Operations Research and Health Care, Mathematical Modelling and Applied Computing. **School members have performed a number of advisory roles.** Griffiths has been appointed a scientific advisor to the Chief Scientific Advisor for Wales. Harper is an advisory board member of the EURO working group on 'OR Applied to Health Services' (ORAHS) (2011-date). Smilansky served on the International Advisory Board of the Max Planck Institute for Dynamics and Self-Organization (Gőttingen).

The School's researchers have been very active in **the organization of conferences and workshops** (over 80 during the period - see www.cardiff.ac.uk/maths/newsandevents/index.html for details). Major conferences chaired by members of the School include the Annual European Rheology Conference (2009); ORAHS Annual International Conference on OR Applied to Health Services (2011); European Study Group with Industry (2011); INI/WIMCS Meeting on Non-Commutative Geometry (2012); WIMCS-Leverhulme Conference on Spectral Theory (2012). Cardiff will host BAMC 2014. Brown was a co-organiser of the INI Programmes on Inverse Problems and Spectral Theory of Relativistic Operators (the latter with Schmidt). Hollands co-organized a Programme on Quantum Field Theory on Curved Space-Times and Curved Target-Spaces in 2010 at the ESI Vienna. Logvinenko gave LMS Invited Lectures on Birational Geometry and Galois Groups in Edinburgh in 2013.

Members of the School have given **over 100 invited or plenary talks** at major conferences including: Free Boundary Problems (Stockholm, 2008: Dirr), 8th ISAAC International Congress (Moscow, 2011; Evans), SIMULTECH 2012 (special Healthcare Modelling Session keynote) (Rome, 2012, Harper), Resolution of Singularities and the McKay Correspondence (Nagoya, 2012, Logvinenko), International Workshop on Operator Theory and Applications (Berlin, 2010; Marletta), Stationarity in Statistics and Risk Management (Paris, 2012; Leonenko), Mathematical Aspects of Quantum Field Theory and Quantum Statistical Mechanics (Hamburg, 2012, Hollands), INI/WIMCS Meeting on Computational Challenges in Partial Differential Equations (Swansea, 2011, Phillips), Workshop on Small-Scale Hydrodynamics: Microfluidics and Thin Films (Banff, 2010, Savva). Griffiths gave the Beale Lecture (London, 2010).