Institution: City University London

Unit of Assessment: 10 Mathematical Sciences

a. Overview

The Department of Mathematics at City University London contains three Research Groups undertaking fundamental research in pure and applied mathematics: in representation theory, mathematical physics and mathematical biology. These three areas of research are supported by our existing infrastructure and are distinctive amongst our peers in the London area, nationally and internationally.

The Department has undergone substantial change since RAE 2008, focusing on areas of international importance. Previously a Centre within the School of Engineering & Mathematical Sciences, it is now a full Department. Research Groups have been enhanced and one new Group has been created. Following ten new academic appointments, the Department now comprises a dynamic group of research-excellent international academic and research staff with a relatively young age profile.

The number of staff included in the submission has consequently doubled since RAE 2008, from 8 to 16.05 full-time equivalents (FTEs). Alongside the permanent academic staff, significant contributions to research are being made by a semi-retired Professor (0.2 FTE), a strategic research appointment (0.25 FTE) and a full-time Research Fellow.

In the latter part of the assessment period, additional growth has been supported by one of the largest academic recruitment exercises in the UK, undertaken by City as a major component of the implementation of its Strategic Plan 2012-2016. The £35M recruitment initiative has resulted in the appointment of 141 new academic staff from across the world as of 31st October 2013. The University is also investing £35M and up to £130M respectively in transforming its IT infrastructure and systems and its estate. Exemplified by the investment in staff, Mathematics has been treated in the execution of the Plan as an area of strategic importance.

b. Research strategy

The research strategy of the School is to develop internationally leading and sustainable research in selected distinctive areas of strength. In Mathematics the focus is on both pure and applied fundamental research in areas of current relevance.

A systematic staff recruitment process has attracted excellent staff, creating three internationally competitive Research Groups of global distinction. Further growth is planned, to achieve 24 academic staff FTEs by 2018. This will include a redevelopment of fluid dynamics, one of the Department's traditional fields of strength, thus increasing opportunities for collaboration and cross-fertilisation with Engineering. This growth in academic staff numbers will support further improvement in visibility for the Department through an expansion of the existing MMath degree course into a full Masters programme reflecting the research strengths of Mathematics at City.

Since RAE 2008 the Department has been transformed. Aligned to City's Vision for 2016, the Department of Mathematics aims to be recognised as a conventional Mathematics group amongst the very best in the UK.

The membership, expertise and aims of the Research Groups are as follows:

Representation Theory

In the current REF period this Group has been significantly strengthened. With three newly appointed Chairs it is now poised to become a major international centre for representation theory.

Membership: **Professor Joe Chuang** (Professor, 1/2008), **Dr Anton Cox** (Reader), **Dr Maud De Visscher** (Lecturer), **Professor Radha Kessar** (Professor, 9/2012), **Professor Markus Linckelmann** (Professor, 9/2012), 2 postdoctoral researchers (Dr Chris Braun, Dr Chris Bowman) and 4 PhD students.

Expertise: The Group has a broad range of expertise in mainstream modern representation theory. The research focus is on gaining deep conceptual understanding of algebraic, combinatorial, geometric and topological structure. The main areas of expertise are: finite dimensional algebras

(all), symmetric groups and Hecke algebras (all), representations of finite (JC, ML, RK) and algebraic (AC, MD) groups, Brauer and other diagram algebras (AC,MD,ML), triangulated categories and dg categories (JC, RK, ML), fusion systems (ML, RK), operads and homotopy algebras (JC).

Visions, Objectives, Strategy: The Group's focus on closely related areas of international importance (finite dimensional algebras, symmetric groups and Hecke algebras, finite groups) and the participation of its members in international conferences and workshops as invited speakers and organisers and in journal editorial boards, will increasingly place it at the forefront of the global research community in representation theory. The Group has recently joined Imperial and Queen Mary as a permanent co-organiser of the prestigious London Algebra Colloquium, founded in 1950, and hosts the weekly series on a rotating basis. The EPSRC-funded UK branch of the 2012-2014 Anglo-Franco-German representation theory network is coordinated at City by RK. All members of the Group are regularly invited as main speakers at major international events, e.g., Mathematics of John Thompson (Cambridge 2013), 3rd International Symposium on Groups, Algebras and Related Topics (Beijing, 2013), Groups, Nonassociative Algebras and Combinatorics (Luminy, 2013), Groups 2012 (Bielefeld), ICRA XIV (Tokyo, 2010). JC and ML are organisers of the long-running series of conferences on Representations of Finite Groups in the Mathematical Research Institute Oberwolfach. JC and RK received the 2009 Berwick Prize of the London Mathematical Society for their joint work on modular representations of symmetric groups.

The Group also plays an important role in exciting developments in the modular representation theory. RK has, in joint work with Gunter Malle (University of Kaiserslautern, Germany) in 2013, affirmed one direction of Brauer's 55-year old Height Zero Conjecture. Her work sets the stage for an attack on the other counting conjectures, e.g., Alperin's famous weight conjecture; these could all be settled within the next five to ten years. City will play a key role in this development and, perhaps more importantly, in setting the agenda for the subsequent five years, with a focus on homological methods to gain genuine understanding of the counting conjectures.

The work of AC, MD and their collaborators on diagram algebras in the current REF period has shown the power of their structural approach through 'towers of recollement'. Particularly striking has been the determination of blocks and of decomposition numbers for Brauer algebras and walled Brauer algebras (2008, 2009, 2011). The main goal in the next five years is to realise these examples as part of a grand non-standard 'algebraic Lie theory' in which any generalised weight geometry is categorified by a suitable representation theory. This will be achieved in collaboration with JC, ML and RK, utilising their expertise on categorifications of Lie algebras and on category algebras.

MD and collaborators have recently proposed a completely new approach to the famous Kronecker problem, via one kind of diagram algebra, the partition algebra. Very little progress has been made on the problem in one hundred years despite the attentions of many experts. Early results suggest that the new methods will lead to a complete solution. Significant progress on the celebrated P vs NP problem is then expected. The Group plans to host a major international conference at City, accelerating the interactions between Representation Theory and Computer Science communities, creating a platform for future development. Dr Chris Bowman joined the Group as a Royal Commission for the Exhibition of 1851 Research Fellow in September 2013, working on this project.

The Group also plans to increase its involvement in fields related to representation theory, such as 'cohomological physics'; while highly active internationally, this area is under-represented in the UK. A three-year EPSRC grant (from August 2012) entitled 'Homological algebra of Feynman graphs' funds the postdoctoral researcher Dr Chris Braun and a workshop on the subject to be hosted at City in July 2014.

Mathematical Physics

With four new permanent appointments and the inclusion of Professor Carl Bender, this Group has also doubled in size, establishing a leading position in the field.

Membership: **Professor Andreas Fring** (Professor of Mathematical Physics), **Professor Carl Bender** (Professor of Physics, 0.25 FTE), **Dr Olalla Castro-Alvaredo** (Senior Lecturer), **Dr Vincent Caudrelier** (Lecturer), **Dr Alessandro De Martino** (Senior Lecturer, 9/2012), **Dr Benjamin Favier** (Postdoctoral researcher, 10/2013), **Dr Yang-Hui He** (Reader, 7/2010), **Professor Jiri Mathon**

(Professor of Mathematics, 0.2 FTE), **Dr Lara Silvers** (Senior Lecturer, 9/2009), **Dr Bogdan Stefanski** (Reader, 1/2009), 4 postdoctoral researchers and 8 PhD students.

Expertise: The Group's research activities are concentrated on topics in quantum field theory, quantum mechanics and string theory. Extensive expertise in various techniques and methods, developed originally in the context of integrable systems, creates a unique cohesive and vigorous environment. AF, OCA, VC, ADM and BS have a strong track record in the so-called form factor programme using exact scattering matrices where the ultimate aim is to compute physical quantities in a non-perturbative manner. While there are still some fundamental issues being considered, the main goal is now the application of these techniques, with AF and in part OCA focusing on the study of non-Hermitian systems with antilinear symmetry. This subject area was initiated 15 years ago by CB, a world-leading expert on many foundational aspects of quantum mechanics. Special focus is placed on certain non-commutative spacetime structures, as they unavoidably lead to non-Hermitian systems and can be viewed as providing a basis for string and M-theory or any other theory incorporating gravity into a quantum theory. These topics are studied in their own right by the recently appointed YHH and BS, who possess considerable expertise on methods of quantitative control over gauge/string correspondences with less than maximal supersymmetry. While YHH's main thrust is on the geometries underlying gauge theories, especially Calabi-Yau manifolds, BS utilises integrable techniques together with standard methods from string theory. The Group's theoretical expertise is complemented by work on applications in condensed matter physics including JM's investigations on spintronic systems and ADM's extensive studies on graphene nanostructures linked to a more general consideration of these systems on graphs by VC. LS and BF also have a compelling track record on problems in magnetohydrodynamics.

Visions, Objectives, Strategy: Building on previous success the Group will continue to make high quality contributions in the field and play a major role worldwide in Mathematical Physics. The work of OCA, Doyon (King's College London) and Cardy (University of Oxford) predicts universal features of entropy within the interpolation regime between the ultraviolet and infrared, which was hitherto not accessible. Expanding on these results places the Group in a unique position to address several unsolved problems involving quantum entanglement with potential applications to quantum computing.

The arrival of CB, one of the central figures in the study of PT-symmetric systems whose seminal 1998 paper on the subject has attracted more than 1400 citations, combined with AF's expertise in the field of non-Hermitian systems, has created the most influential group in this area of research. The Group plans to host a major international conference on the topic of non-Hermitian systems in 2015, which is expected to attract a larger audience and greater interest than the 2007 event at City (which was highly influential in the field). Many aspects of the fundamental questions in this field have been settled, thus the emphasis of further investigations will be on the application of the techniques. In particular the recent optical experiments carried out by groups in Florida and the Max Planck Institute in Germany open up exciting possibilities for interdisciplinary research at City, drawing on the expertise of Engineering colleagues working in the field of sensors. The significance of the area is reflected in a recent call by the US Department of Defence for proposals on the study of PT-symmetric matter (one of 23 selected topics), to which CB has responded.

Further applications in condensed matter physics will be addressed mainly by JM, ADM and VC. Some of the planned investigations will be fundamental in nature, with the new direction depending strongly on the outcome of some experiments taking place at the Max Planck Institute in Germany, testing the importance of ADM's and collaborator's recent proposal for a new solution of the 0.7 anomaly problem, now of more than 15 years' standing. The work of JM and the continuing line of research in the field of graphene by ADM and VC is expected to deliver both social and economic impact, since graphene is nowadays recognised to be a perfect building block for future spintronic devices. The Group will also make use of its expertise to respond to funding opportunities provided by the decision of the European Commission to make graphene one of Europe's first ten year, €1 billion Future Emerging Technology flagships.

YHH and BS will continue to be at the forefront of developments in modern aspects of string and M-theory. The work of BS, in particular his 2009 publication listed in REF2 (over 160 citations), has been instrumental in the community's understanding of how the integrability aspects of the gauge/string correspondence function in settings with reduced supersymmetry. One of the key goals

of his future research will be further pursuit of this area. YHH's focus on the same problem will be on the continuation of efficiently constructing dual gauge theory/string theory pairs in these settings using highly sophisticated representation theory and algebraic geometry. The programme is applicable in almost all known gauge theories relevant to the AdS/CFT correspondence.

LS and BF will continue to make further contributions to the area of magnetohydrodynamics by building on LS's successful LMS grant application for important conferences in the field and a recently acquired STFC conference grant. Funding opportunities for collaborative projects to benefit from synergy with the School's computational fluid dynamics group are being explored.

Mathematical Biology

Mathematical Biology is a new Research Group arising from the appointment of Professor Mark Broom and two further appointments.

Membership: **Professor Mark Broom** (Professor, 4/2010), **Dr Anne Kandler** (Lecturer, 9/2012), **Dr Andrea Baronchelli** (Lecturer, 8/2013) and 4 PhD students.

Expertise: The Group applies mathematical methods to increase our understanding of the biological world. The central focus is on the mathematical modelling of evolution.

MB's focus is on the application of game theory to the mathematical modelling of biology, especially using the concept of the Evolutionarily Stable Strategy (ESS), involving the development of fundamental theoretical work and the evolution of specific animal behaviour such as kleptoparasitism and biological signalling. A second significant area (AB, AK) is the modelling of processes of cultural evolution, in particular the processes of language dynamics and the evolution of social learning strategies, involving both theoretical modelling and the development of statistical tools. This is complemented by theoretical and applied investigations in network science (AB). Recent research effort has focused on evolutionary modelling on networks/graphs (AB, MB) and socially structured populations (AK). This includes the theoretical modelling of evolution on graphs and more general population structures and the modelling of human social systems on networks (e.g., Twitter). Dr Christoforos Hadjichrysanthou, a former PhD student of MB at City, won the 2013 Reinhart Heinrich prize, awarded by the European Society for Mathematical and Theoretical Biology for the best thesis in Mathematical or Theoretical Biology in 2013.

There is a strong focus on interdisciplinarity within the Group. Collaborations in other fields include anthropology, archaeology, artificial intelligence, biology and social sciences, as well as work with other mathematicians. Within the University, the Mathematical Biology Group is part of the interdisciplinary Mathematical and Computational Behaviour and Evolution Research Group (MCBE) with colleagues in Informatics. Members of the Group have a high profile at international conferences and their work has been covered in a variety of media including the *Boston Globe* (28th May 2012) and general science magazines such as *Discover* magazine (4th June 2012).

Visions, Objectives, Strategy: Following rapid expansion, the Group's short term strategy is to increase its visibility through membership of a new London-based network on evolution with University College London and Queen Mary, University of London. Plans include a conference and collaboration on funding applications, with emphasis on network modelling. This is linked to a new MSc in Decision Sciences which commences in 2014 and utilises the Group's expertise in game theory and agent-based modelling.

The vision is to publish high quality research and to establish the Group as a leader in the UK. This will be achieved through PhD student recruitment, obtaining grants and the development of a seminar programme. In addition, the Group aims to strengthen interdisciplinary links across City by building the MCBE Group into a more substantial Research Centre in the area of mathematical and computational models in the life sciences.

The Department is fully committed to supporting open access to its research. In October 2012, the University launched City Research Online, a digital repository which incorporates both bibliographic data and the full text of outputs which are automatically Google indexed. Two members of staff provide full support to researchers for upload of texts and copyright checking. The University requires the deposit of full text for all research articles published since January 2013. The Department has led the University in depositing articles, with 378 uploads as at November 2013, with an associated 8145 full text downloads out of a total of 142,999.

c. People, including:

i. Staffing strategy and staff development

City has been fully committed to the Concordat to Support the Career Development of Researchers since its original publication in 1996 and relaunch in 2008. The University received the European Commission HR Excellence in Research Award in May 2012 on the basis of its Concordat implementation plan. A key component was the introduction of new terms and conditions of employment for research staff from August 2012. These have made continuing contracts the norm for research staff in place of fixed-term contracts, and introduced parity with academic staff on pay progression, annual leave and sickness entitlement and access to promotion opportunities. Academic staff development is supported and monitored through annual appraisals and through the University Annual Research Quality Monitoring process which reviews the quality of research publications. The appraisal process for research staff also requires consideration of career development needs alongside project performance. City was cited as an example of good practice in the May 2013 Vitae review of HR Excellence in Research implementation plans.

Within this context the Department seeks to create an environment that encourages all members of staff to conduct research at the highest level, through publishing in leading international journals, applying and gaining research grants, collaborating with leading international researchers within their fields, receiving research invitations to other institutions and receiving invitations for conference presentations and keynote addresses. Mechanisms are in place to enable and support staff to achieve these expectations. The Department is committed to the principle of equality in all processes, as for instance reflected in the numbers of female and international staff, with 29% and 76% respectively.

Support: The Department supports applications for fellowships which support teaching replacement. The typical teaching load is three modules per year. Over the last few years, the structure and teaching of degree programmes has been optimised, offering staff more time for research. During term-time colleagues cover teaching for each other to allow for one-week absences to enable focus on research at key stages. Staff may apply for sabbatical leave for a period of time up to a maximum of one-seventh of service at the University to support more sustained activity with applications being approved by the School Board of Studies and Senate. Successful applications falling into the period of assessment were made by Cox and Fring, resulting in establishing further links to international institutions especially in Germany, South Africa and India.

Newly-appointed members are given reduced teaching and administration loads, typically no more than two modules in the first year for new lecturers.

The Department provides a research fund of £5,000 per year to support visitors and conference attendance. There is also a computer equipment budget of £5,000 per year which is exclusively used for staff and research student support.

Guidance: New staff are assigned a mentor who guides them through their probation period. They are equipped with new computers and are entitled to apply for financial support, typically £5,000, from a University pump-priming research fund. Recent successful examples include Broom, Castro-Alvaredo, Caudrelier, Silvers and Stefanski. All staff used the support to establish new research collaborations by visiting research institutions worldwide and inviting internationally well-known researchers.

The University operates an extensive annual Research and Enterprise Development Programme including workshops and courses on applying for grants, supervising doctoral students and managing research groups and grants which are mandatory for new staff.

Promotions: To aid staff development and ensure a fair promotion procedure, all staff are appraised annually by a senior academic. For this purpose a standard academic *CV* has been developed to enable staff to provide information about their academic achievements on a consistent basis across the University. During the assessment period Castro-Alvaredo and Silvers have been promoted to Senior Lecturer, Stefanski and Cox to Reader in Mathematics and Representation Theory, respectively, and Fring to Professor in Mathematical Physics.

Changes: Since RAE 2008, ten new permanent full-time appointments and one part-time have been

made as indicated in detail in Section b; one member of staff has moved from full-time to 0.2 FTE employment and Professor Paul Martin and Dr Christian Korff have left. Three of the recently recruited staff held EPSRC Advanced Fellowships during the REF period (Chuang, He and Stefanski).

With these new appointments the three Research Groups have reached the necessary critical mass and structure to carry out internationally-leading research on a sustainable long term basis.

ii Research students

Recruitment: The Department has recruited nineteen well-qualified PhD students from top institutions around the world, amongst them the Universities of Oxford and Cambridge; Imperial College London; University of Bologna, Italy; LMU München, Germany; University of São Paulo, Brazil and University of Calcutta, India. Studentships were widely advertised on websites, through fliers and via networking with research colleagues. An efficient fast-tracking procedure has enabled the Department to attract some students ahead of other leading institutions. The number of applications has risen each year and the Department is now in a position to select from the very best students around the world. During the period of assessment, 10 doctorates have been awarded.

University and School Support: In addition to grant income, research in Mathematics has benefited since RAE 2008 from substantial University investment resulting in one two-year University Fellowship, fourteen University or School-funded PhD Studentships, five Pump-Priming grants and several PhD fee waivers. Research is also promoted through a University-wide annual research competition with a main prize of £60,000, half-day events focusing on interdisciplinary areas and annual PhD student poster competitions. Castro-Alvaredo, Caudrelier and De Visscher were each awarded £5000 for entries to the University research competition and a Mathematics PhD student, P. Assis, was awarded a cash prize for a poster.

Research Student Training: Students are assigned to a lead and second supervisor within a Research Group. They are strongly encouraged to widen their horizons by attending our weekly research seminars in-house and at institutions in London, such as the London triangle seminars focusing mainly on aspects of string theory and the London Algebra Colloquium. Specialised courses are delivered by the London Taught Course Centre (LTCC), which offers 14 basic courses and 15 advanced courses, each with a typical length of ten hours. Students are expected to attend 3-4 courses per year, ensuring a minimum of 100 hours training during their studies, and are required to take an examination at the end of the year. Cox, Kerr and Stefanski are involved with teaching at the Centre. In-house, students may attend relevant lectures provided as part of the MMath programme and the MSc in Decision Sciences. Students participate in theme-oriented study groups and present their own work in a seminar after the first year to the Department. They are also strongly encouraged to present their work at national and internal schools, workshops and conferences. Support for this is provided by research grants and the Department's travel budget. After the first year the Department offers the opportunity for PhD students to gain teaching experience and improve their communication skills by tutoring undergraduate students. Assignments depend on progression and are co-ordinated by the Head of Department in liaison with supervisors.

The University also provides broad training on research methods and communication and presentation skills, along with an introduction to the research degree framework and online research skills support, two researcher development days per year and an annual research symposium. Further support for the development of generic research skills and personal transferable skills is provided by the City Graduate School, founded in August 2012, which among other objectives aims to facilitate cross-School collaboration and improve skills training provision and employability.

Student progression is closely monitored by the School's senior tutor for research through annual progress reports and by means of a recently introduced software system (the Research and Progress platform), whose use is mandatory for both supervisors and students. The system involves PhD students in the management of their own research projects with a flexible approach according to individual student needs. Key milestones are recorded, with required reporting on at least four meetings per term, an initial six-month report, an annual progress report, details of progression from MPhil to PhD status, intention to submit and transfer to writing-up status no later than year four.

d. Income, infrastructure and facilities

The Department is committed to expanding its current track record of successful applications for research, travel and conference grants, building on the experience of new staff and through collaborations and joint grant applications with colleagues from other Schools in applied research areas. The link established by Broom with the School of Informatics in the form of joint PhD supervision and the new MSc in Decision Sciences provide a strong foundation for these planned developments.

The School and University Research Office and Enterprise services provide support for identifying and accessing relevant funding opportunities as well as help with the submission of high quality proposals (including costing) and subsequent assistance with the management of successful grant applications. The Department's grant income during the assessment period is summarised in the following table:

	2008/09	2009/10	2010/11	2011/12
UK Research Councils	£283,000	£220,000	£264,000	£256,000
UK-based charities (open competitive)	£49,000	£23,000	£0	£15,000
UK-based charities (other)	£0	£13,000	£14,000	£25,000
UK industry	£69,000	£5,000	£0	£0
Non-EU other	£0	£2,000	£5,000	£0

In general, desktop computers and software for research are financed by personal grants; the School IT committee provides funding for complete replacements of computers every five years.

Journal subscriptions in the areas represented by the three Research Groups and specialist books are financed through the School's library fund. In addition, the Department runs a voucher scheme for staff and PhD students to purchase journal articles through City's electronic interlibrary loan system. The central library subscriptions to Scopus and the Web of Knowledge allow access to abstract and citation databases of peer-reviewed literature. The University has recently invested £1.5M in library collections including e-journals.

As exemplified by the investment in staff the Department has benefited enormously from strategic investments arising from both University and School Strategic Plans, enabling rapid development in research. Excellent academic and research staff are the Department's key assets.

e. Collaboration and contribution to the discipline or research base

Guests, seminars, workshops and conferences

The Department runs a weekly mathematical research seminar series covering topics from its three areas of expertise. This serves as an effective mechanism for establishing interaction between the Research Groups. Since RAE 2008 the Department has hosted more than 100 speakers from the UK, Europe, the USA, India, Canada and South Africa. Seminar speakers have included both eminent researchers such as Sir Michael Berry FRS and other Fellows of the Royal Society and postdoctoral researchers who are recent entrants to their field.

The Department has hosted workshops and conferences, strengthening collaborative research and contributing to internationalisation and dissemination of findings. During the assessment period these have included: 43rd BLOC meeting, December 2008; LMS-EPSRC short course on Derived Categories & Applications, September 2009; 16 Supersymmetries, May 2010; 51st BLOC meeting, December 2010; 15th UK meeting on integrable models, conformal field theory and related topics, April 2011; UK Meeting on Geophysical and Astrophysical Magnetohydrodynamics, June 2011; The Mathematics of String Theory and Gauge Theory, May 2012; The London triangle seminar, 2012/2013; London Algebra Colloquium, October 2013.

Members of the Department have served as members of Organising Committees of more than 20 international conferences and workshops. Examples are: Kessar is organising the EPSRC supported Anglo-Franco-German Representation Theory network meetings; Fring and Bender are members of the scientific organising committee of the conference series on Pseudo-Hermitian Hamiltonians in Quantum Physics; Broom is member of the scientific committee of the international conference on

Mathematical Models in Ecology and Evolution 2013.

The Department also has very strong international connections though long-term visitors and postdoctoral fellows, who benefit from the Department's expertise and enhance its research environment. These include: Dr G. Autès (PD), Dr B. Favier (PD), Dr P. Guilherme Castro (PD), Dr R. Reid-Edwards (PD), Dr A. Umerski (Open University) and Professor P. Kulish (Steklov Mathematical Institute, Russia) who also holds an honorary Professorship in the Department, all in Mathematical Physics; and Dr C. Brown (PD), Dr C. Bowman (PD) in Representation Theory.

Collaborations

The Department maintains active links in various forms to more than 70 universities and research institutions around the world, including the Universities of Oxford and Cambridge and Imperial College London in the UK, along with top research institutions such as Nankai University, China, Kyoto University, Japan, University of Calcutta, India, Stellenbosch University, South Africa, Stony Brook University, USA and numerous leading institutions in Europe. Collaborative work takes the form of published co-authored papers and both existing and planned or pending funded research grants.

Contributions to the discipline

All members of the Department act as regular reviewers for scientific journals, evaluators of research proposals, external examiners for research degrees and session Chairs for international conferences. Key contributions to the discipline in the assessment period include:

The Representation Theory Group contributed a total of 48 publications to its fields with particular achievements from **Chuang (**Berwick prize in 2009; editorial adviser LMS journals, member of LMS publication committee and web publishing consultation panel, the EPSRC Review College and Postdoctoral Panel and 6 organising committees of international conferences; organised 2 national meetings at City in 2008 and 2009 and a summer school in 2009); **Cox** (3 keynote lectures); **De Visscher (**co-organised Bristol-Leicester-Oxford-City Colloquium, 5 invited keynote lectures); **Kessar** (Berwick prize in 2009, 15 invited lectures, Editor for Proceedings of the Edinburgh Mathematical Society and Journal of Group theory, member of scientific committee of the British Mathematical Colloquium, adviser to 5 international research councils and societies); **Linckelmann** (adviser to 4 international research councils and societies, 3 invited keynote lectures).

The Mathematical Physics Group contributed a total of 201 publications to its fields with particular achievements from **Bender** (Distinguished Professor of Physics at Washington University in St. Louis; Professor of Physics, University of Heidelberg; former editor in chief Journal of Physics A; editorial board of Advances in Applied Mathematics, Journal of Mathematical Physics, American Institute of Physics Series on Computational and Mathematical Physics; Board of Trustees Association of Members of the Institute for Advanced Study, Princeton); **Castro-Alvaredo** (4 invited keynote lectures); **Caudrelier** (2 invited keynote lectures); **De Martino** (reviewer for the European Science Foundation, member of organising committee of the Capri Spring School); **Fring** (9 invited keynote lectures; advisory board of Journal of Physics A; editorial board ISRN; excellence in reviewing award from Annals of Physics, Mathematical Physics; guest editor for 3 special issues in Journal of Physics A; member of 10 organising committees of international conferences; organised international conference at City in 2011); **He** (Chang-Jiang Chair Professor of Physics at Nankai University China, editorial board Journal of Modern Physics, guest editor of Advances in High Energy Physics); **Silvers** (organised the national UKMHD meeting at City in 2011, 4 invited keynote lectures); **Stefanski** (EPSRC Review College; organised two international conferences at City in 2010 and 2012, 4 invited keynote lectures).

The Mathematical Biology Group contributed a total of 89 publications to its fields with particular achievements from **Baronchelli** (Elected Council Member of the Complex Systems Society; 2 keynote lectures); **Broom** (3 invited keynote lectures; editorial board member of Dynamic Games and Applications; formerly Associate Editor of PLoS Computational Biology; member of 3 organising committees of international conferences); **Kandler** (Gabriel W. Lasker prize for best paper published in Human Biology 2009; honorary Research Associate, University College London, Institute of Archaeology).