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APPENDICES

Please note that the following statistical information may be obtained from the Institute on request, or from **www.newton.cam.ac.uk/reports/0607/appendices.html**

John Ball, Chairman of the Scientific Steering Committee

I am very pleased to have this opportunity to record another successful year for the Isaac Newton Institute. Over the 12 months from August 2006, the Institute has supported six extended programmes: *Spectral Theory and Partial Differential Equations*; *Noncommutative Geometry*; *The Painlevé Equations and Monodromy Problems*; *Stochastic Computation in the Biological Sciences*; *Analysis on Graphs and its Applications*; and *Highly Oscillatory Problems*. These topics underline both the dynamic state of mathematics as a subject in its own right, and how all-pervasive its applications are. During these programmes, the Institute hosted 14 workshops, a further 6 were organised in locations other than Cambridge, and a total of 1207 visitors participated. You can read more about each programme in this *Annual Report*, which also contains a wealth of statistical data.

This has also been a period of significant change for the Institute. We thank John Kingman, who stepped down after five years as Director at the end of September 2006, and welcome David Wallace as his successor. We are also delighted that the Institute has been successful in its bid to EPSRC for renewal of core funding; it is a significant measure of EPSRC confidence in mathematics and its applications that it has committed £9.6 million to the Institute over six years to 2014.

The Scientific Steering Committee is conscious of its key role in maintaining the quality of scientific programmes into the future, and I thank my fellow members for their contributions to that. We are also grateful to all those who have proposed programmes, and to the many referees who have provided detailed reports on these proposals. These reports are a vital ingredient in the Committee's often difficult task in choosing between high quality proposals so as to ensure that programmes at the Institute are at the highest international level.

Finally, on behalf of the Scientific Steering Committee and all who benefit from the Institute, I thank the Institute staff for their exceptional efforts to enable all participants to gain maximum benefit from their visits.

David Wallace, Director of the Institute

During my first year, I have come to realise just how much a privilege and a responsibility it is to be Director: a privilege, because of the quality of people and science at the Institute, and a responsibility, to the UK community and beyond, to ensure that the substantial funds we receive are optimally spent in support of science and scientists of the highest quality and potential.

We have a great deal of help in doing so: from the Scientific Steering Committee which is at the heart of the peer review process for selecting programmes; from the National Advisory Board which has instigated a number of changes to the benefit of the UK community; and from the Management Committee, which oversees financial and operational effectiveness. I am extremely grateful to all the members of these committees for the time which they give to the Institute, and the experience that they bring.

We are also greatly dependent on the network of Correspondents, and we look forward to increasing further our links with them in the coming year.

The Institute would have no purpose without the commitment and enthusiasm of programme organisers and visitors, and their appreciation for the efforts of staff is most gratifying.

I add my own thanks to all the staff, who make this possible. They do a marvellous job. And I echo John Ball's thanks to John Kingman, for the good heart in which he left the Institute.

Finally, the Institute's ability to host programmes and scientists is crucially dependent on the financial support which we receive, from many sources. These supporters are identified in the Notes to the Accounts (see page 29), and it is a pleasure to thank them all.

Future Programmes

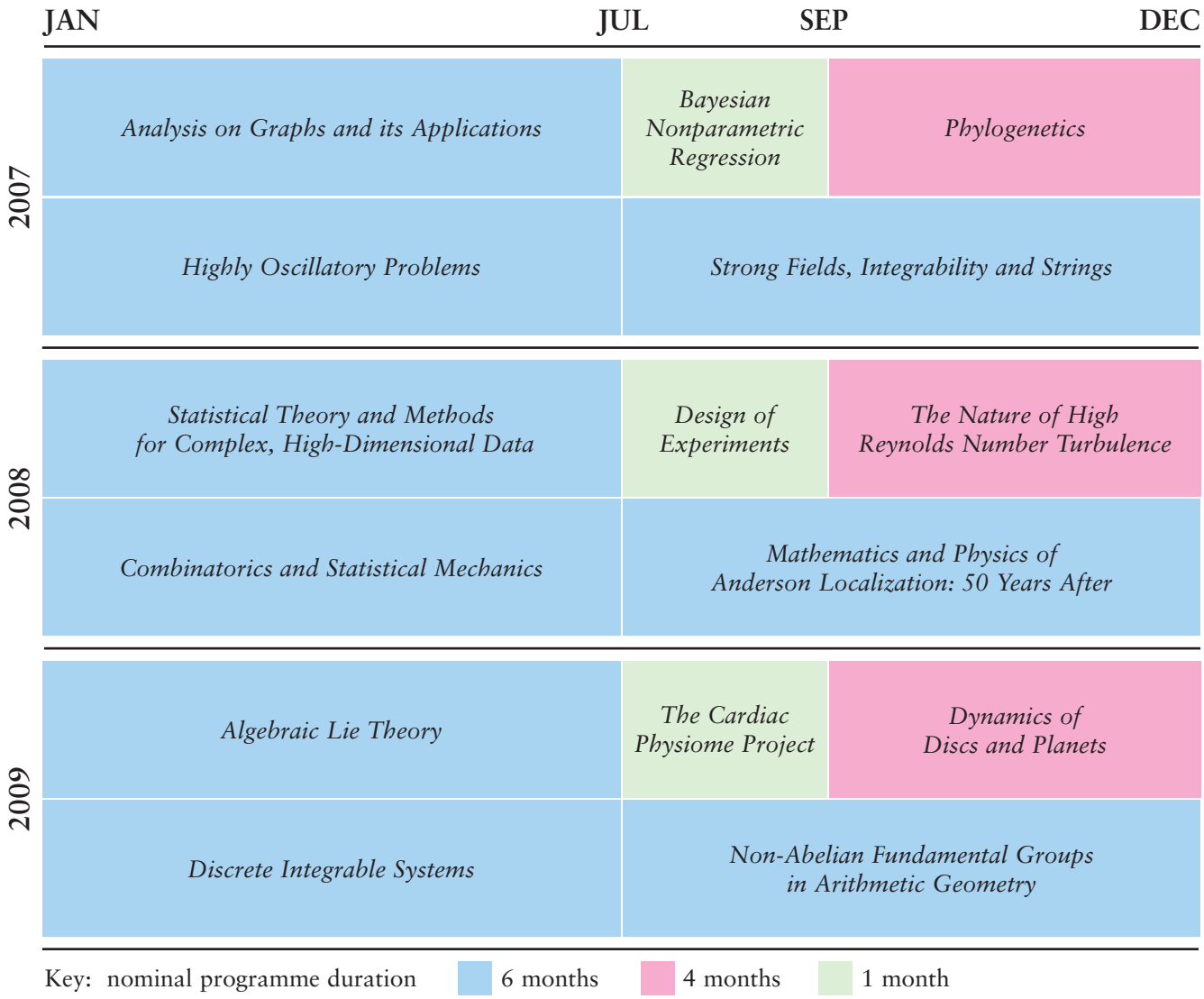
The schematic below shows the forthcoming programmes that have so far been selected by the Scientific Steering Committee. To participate only in a workshop, or for very short visits of up to two days, registration is all that is required. For fuller, long-stay participation in a programme, an invitation is usually required and applications are best made directly to the programme organisers in the first instance.

Further details of each of these programmes, including

- the scientific content and background
- the names of the organisers
- the names of those who have so far been invited to take part in the programme
- contact details
- dates of workshops that will take place during the programme, with detailed topics and further information

can be found on the Newton Institute website at **www.newton.cam.ac.uk/programmes/**

Further information on how to participate in Newton Institute programmes can also be found on the website at **www.newton.cam.ac.uk/participation.html**



Scientific Steering Committee

Membership of the Scientific Steering Committee at 31 July 2007 was as follows:

Sir John Ball FRS FRSE (Chairman)	University of Oxford
Professor KG Binmore CBE	University College London
Professor M Broué	Institut Henri Poincaré
Professor EK Burke	University of Nottingham
Professor PV Coveney FInstP FRSC	University College London
Professor CS Frenk FRS	University of Durham
Professor PJ Green FRS	University of Bristol
Professor JG McWhirter FRS FREng	QinetiQ
Professor EB Martin	University of Newcastle
Professor CM Series	University of Warwick
Professor LN Trefethen FRS	University of Oxford
Professor M-F Vigneras	University of Paris 7
Professor M Vingron	Max Planck Institute for Molecular Genetics
Sir David Wallace CBE FRS FREng (Secretary)	Director, Newton Institute

The Institute invites proposals for research programmes in any branch of mathematics or the mathematical sciences. The Scientific Steering Committee (SSC) meets twice each year to consider proposals for programmes (of 4-week, 4-month or 6-month duration) to run two or three years later. Proposals to be considered at these meetings should be submitted by 31 January or 31 July respectively. Successful proposals are usually developed in a process of discussion between the proposers and the SSC conducted through the Director, and may well be considered at more than one meeting of the SSC before selection is recommended. Proposers may wish to submit a shorter 'preliminary' proposal in the first instance with a view to obtaining feedback from the SSC prior to the submission of a full 'definitive' proposal.

Further details of the call for proposals, including guidelines for submission, can be found on the Institute's website at

www.newton.cam.ac.uk/callprop.html

The scientific planning and organisation of each programme are the responsibility of a team of three or four Organisers (aided in some cases by an Advisory Committee). The Organisers recommend participants in the programme, of whom at least twenty can be accommodated at any one time; they also plan short-duration workshops and conferences within the programme, to which many more participants may be invited. Each programme is allocated a budget for salary support, subsistence allowances and travel expenses.

The following members of the Scientific Steering Committee stepped down at the end of their term of service on 31 December 2006:

- Professor S Abramsky FRS FRSE (Oxford)
- Professor SK Donaldson FRS (Imperial)
- Professor BW Silverman FRS (Oxford)

The following new members were elected:

- Professor EK Burke (Nottingham)
- Professor PJ Green FRS (Bristol)
- Professor LN Trefethen FRS (Oxford)

SJ Wilkinson

Sir John Ball
Chairman of the SSC

Scientific Policy Statement

From its inception, it has been intended that the Newton Institute should be devoted to the Mathematical Sciences in the broad sense. In this respect the Institute differs significantly from similar institutes in other countries. The range of sciences in which mathematics plays a significant role is enormous, too large for an Institute of modest size to cover adequately at any one time. In making the necessary choices, important principles are that no topic is excluded *a priori* and that scientific merit is to be the deciding factor.

One of the main purposes of the Newton Institute is to overcome the normal barriers presented by departmental structures in Universities. In consequence, an important, though not exclusive, criterion in judging the 'scientific merit' of a proposed research programme for the Institute is the extent to which it is 'interdisciplinary'. Often this will involve bringing together research workers with very different backgrounds and expertise; sometimes a single mathematical topic may attract a wide entourage from other fields. The Scientific Steering Committee therefore works within the following guidelines:

(*a*) the mixing together of scientists with different backgrounds does not *per se* produce a successful meeting: there has to be clear common ground on which to focus;

(*b*) each programme should have a substantial and significant mathematical content;

(*c*) each programme should have a broad base in the mathematical sciences.

Research in mathematics, as in many other sciences, tends to consist of major breakthroughs, with rapid exploitation of new ideas, followed by long periods of consolidation. For the Newton Institute to be an exciting and important world centre, it has to be involved with the breakthroughs rather than the consolidation. This means that, in selecting programmes, a main criterion should be that the relevant area is in the forefront of current development. Since the Institute's programmes are chosen two to three years in advance, it is not easy to predict where the front line will be at that time. The best one can do is to choose fields whose importance and diversity are likely to persist and to choose world leaders in research who are likely to be able to respond quickly as ideas change.

Although the novelty and the interdisciplinary nature of a proposed programme provide important criteria for selection, these must be subject to the overriding criterion of quality. With such a wide range of possibilities to choose from, the aim must be to select programmes which represent serious and important mathematical science and which will attract the very best mathematicians and scientists from all over the world. However, the Institute is receptive also to proposals of an unorthodox nature if a strong scientific case is made.

Although the Institute operates on a world-wide basis and contributes thereby to the general advancement of mathematical science, it must also be considered in the context of UK mathematics. A natural expectation of all those concerned is that each programme will be of benefit to the UK mathematical community in a variety of ways. If the UK is strong in the field, UK scientists will play a major part in the programme; if the UK is comparatively weak in the field, the programme should help to raise UK standards, and instructional courses aimed primarily at younger researchers and research students will play a vital role here.

It is intended that each Institute programme will have long-term impacts well beyond the programme itself in terms of breakthroughs, new research directions and collaborations. In order to offer an opportunity to review progress, the Institute will whenever appropriate run a short follow-up event some years after a programme has finished.

Because of the wide base of support for the Newton Institute in the EPSRC and elsewhere, the Institute's programmes shall as far as possible represent an appropriate balance between the various mathematical fields. In order to retain the backing of the mathematical and scientific community, the Institute will run programmes over a wide range of fields and, over the years, achieve this balance. Such considerations, however, are secondary to the prime objective of having high quality programmes.

Programme Participation

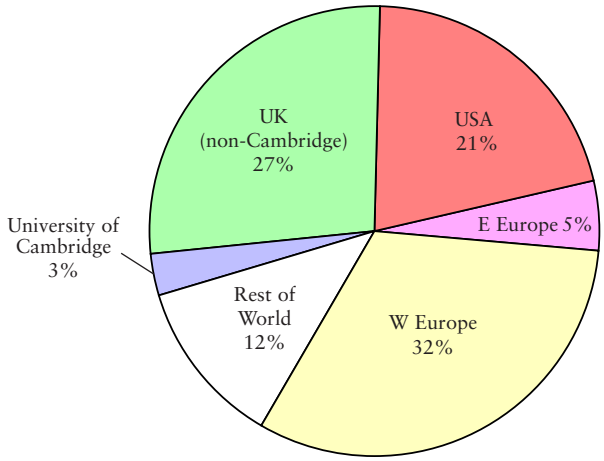
A total of 1207 visitors was recorded for 2006/07.

This includes 250 Visiting Fellows and 158 Programme Participants. These new categories for visitors replace the 'long-term' and 'short-term' categories of previous years which were determined simply by the duration of the visit; a Visiting Fellowship instead reflects *total* contribution to the programme in terms of international reputation and importance in the field as well as the length of stay. Within the six programmes during the year there were 20 workshops (periods of intense activity on specialised topics) which attracted a further 537 visitors (i.e., those not already attending the programme). Three follow-up events (see page 14) were also held, attracting more than 75 participants. In addition to workshops, which serve to widen UK participation in programmes, the Institute from time to time arranges less formal special academic meetings as well as talks for the general public, so further opening up the activities of the Institute. At least 187 visitors attended such events and took part informally in Institute activities.

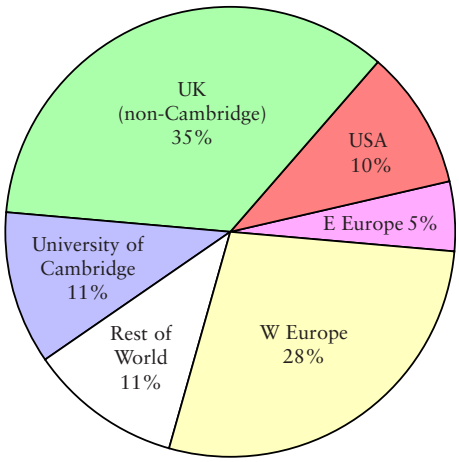
Within all the programmes, workshops and other activities, 557 seminars were given in total at the Institute during the year. The Institute also funds visits by overseas programme participants to other UK institutions to give seminars (see page 13), and 213 such seminars took place last year.

	Visiting Fellows	Mean stay (days)	Programme Participants	Mean stay (days)	Workshop Participants
Spectral Theory and Partial Differential Equations	10	19	34	10	57
Noncommutative Geometry	35	61	56	22	115
The Painlevé Equations and Monodromy Problems	19	19	7	19	70
Stochastic Computation in the Biological Sciences	29	31	9	15	210
Analysis on Graphs and its Applications	81	39	19	20	47
Highly Oscillatory Problems	76	47	33	43	38
Follow-up Events (see page 14)	–	–	–	–	75
Totals	**250**	**41**	**158**	**23**	**612**

The pie charts below show the percentages of Visiting Fellows, Programme Participants and Workshop Participants broken down by country of residence:

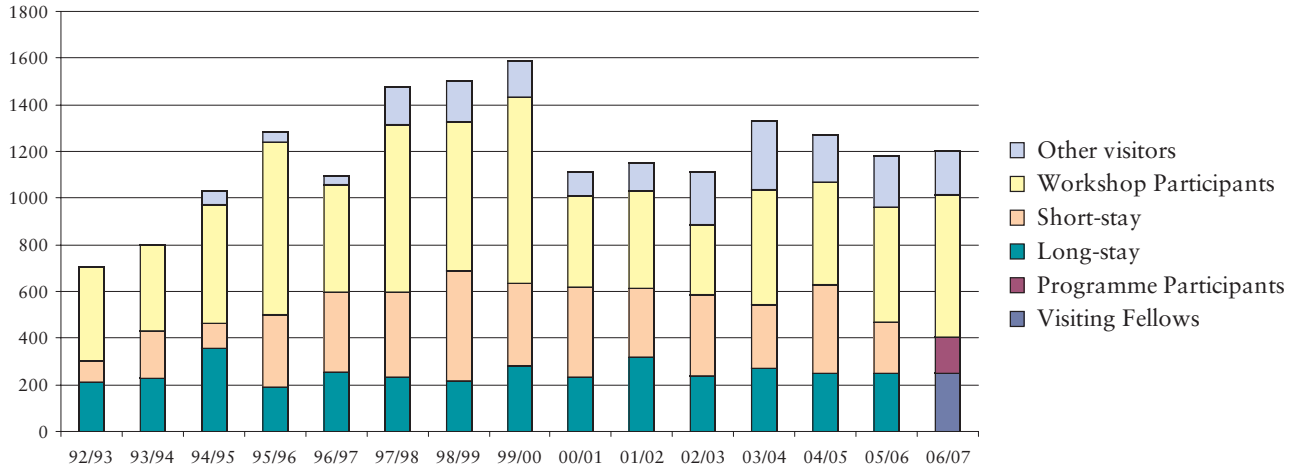


Visiting Fellows and Programme Participants

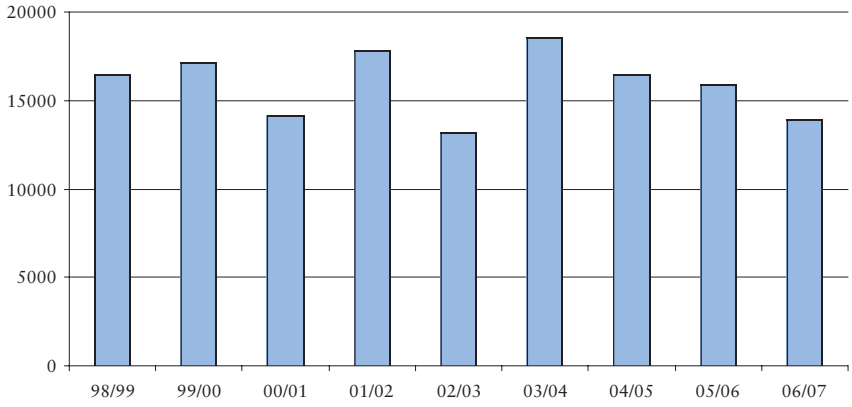


Workshop Participants

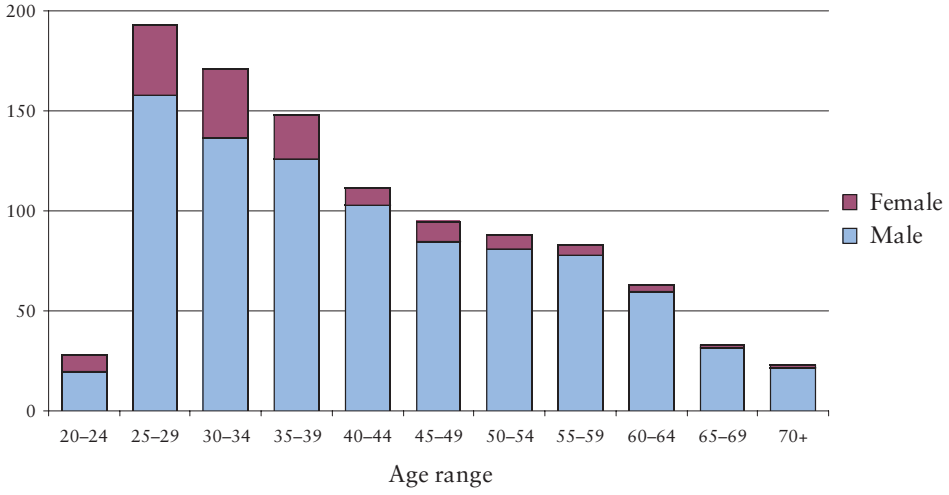
The following chart summarises the total participation figures since the Institute began:



The chart below summarises the total number of person-days for Visiting Fellows and Programme Participants combined (or long-stay and short-stay combined prior to 2006/07), *excluding* Workshop Participants. In particular, the figures do not include follow-up events, which is reflected in the relatively low total for 2006/07.

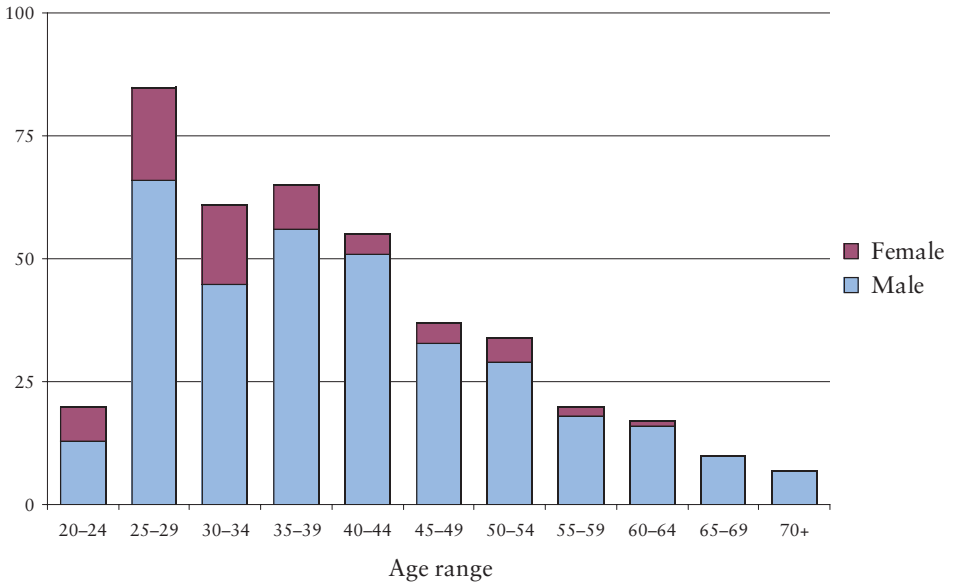


The numbers of all Visiting Fellows, Programme Participants *and* Workshop Participants combined in 2006/07 are shown below, broken down by age and gender:

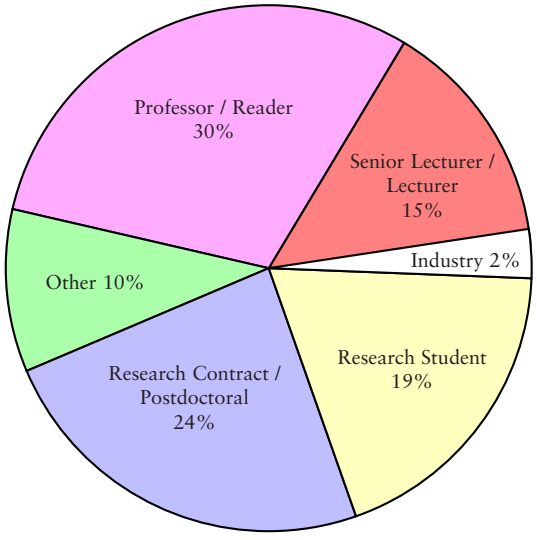


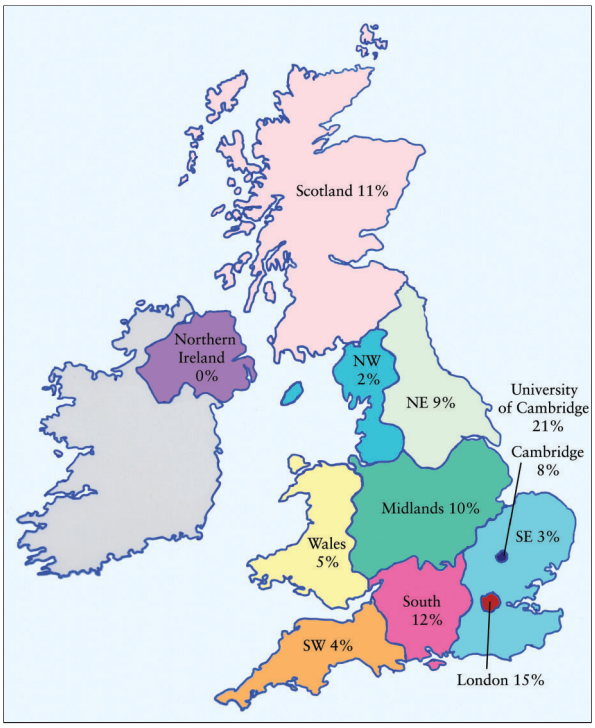
The statistics presented on this page relate only to visitors whose home institutions are in the UK: overseas visitors have been excluded.

The age range and gender balance of all Visiting Fellows, Programme Participants and Workshop Participants from UK institutions in 2006/07 are illustrated below:



The following diagrams indicate the academic status and geographical distribution of all Visiting Fellows, Programme Participants and Workshop Participants from UK institutions during 2006/07:





More detailed statistics, including visit dates, home institutions, seminars given and papers written are shown in the Appendices, available at

www.newton.cam.ac.uk/reports/0607/appendices.html

Management Committee

Membership of the Management Committee at 31 July 2007 was as follows:

Sir John Ball FRS FRSE	Chairman of the Scientific Steering Committee
Professor JW Bruce	London Mathematical Society
Professor WJ Fitzgerald	Council of the School of Technology
Professor WT Gowers FRS	Trinity College
Professor GR Grimmett	Head of Department, DPMMS
Mr D Harman	EPSRC
Professor PH Haynes	Head of Department, DAMTP
Dr RE Hunt (Secretary)	Deputy Director, Newton Institute
Professor PT Johnstone	St John's College
Professor PB Littlewood FRS	Council of the School of the Physical Sciences
Professor EKH Salje FRS (Chairman)	General Board
Sir David Wallace CBE FRS FREng	Director, Newton Institute

The Management Committee is responsible for overall control of the budget of the Institute, and for both its short-term and long-term financial planning. The Director is responsible to the Management Committee, which provides essential advice and support in relation to fund-raising activity, employment of the staff of the Institute, appointment of the organisers of programmes, housing, library and computing facilities, publicity, and general oversight of Institute activities.

Its aim is to facilitate to the fullest possible extent the smooth and effective running of the visitor research programmes of the Institute and all related activities. The Committee is especially concerned with the interactions between the Institute and its funding bodies, particularly the UK Research Councils, Cambridge University, the Cambridge Colleges, the London Mathematical Society, the Leverhulme Trust and others. It generally meets three times a year.

Staff of the Institute

The staff of the Institute at 31 July 2007 was as follows:

- Dr Mustapha Amrani, Computer Systems Manager
- Tracey Andrew, Programme and Visitor Officer
- Jonathan Chin, Deputy Computer Systems Manager
- Naomi Clark, Programme and Visitor Secretary
- Esperanza de Felipe, Housing Officer
- Kate Gilbert, Director's Administrative Assistant
- Steve Greenham, Technical Assistant
- Dr Robert Hunt, Deputy Director
- Doreen Rook, Finance and Clerical Assistant
- Chie Sibley Obata, Programme and Visitor Secretary
- Jane Smyth, Catering Assistant
- Sir David Wallace CBE FRS FREng, Director
- Christine West, Institute Administrator
- Sara Wilkinson, Librarian and Information Officer (on leave until August 2007)
- Stephen Williams, Senior Finance Officer

L Salje

Professor EKH Salje FRS
Chairman of the Management Committee

Institute News

EPSRC Grant

The Institute has since its foundation benefited from the generosity and foresight of the Engineering and Physical Sciences Research Council (EPSRC), which has devolved selection and review of the Institute's scientific programme to the Institute itself through the Scientific Steering Committee (see page 4). EPSRC provides the Institute with a substantial rolling grant, and in July 2007 EPSRC reaffirmed its support by awarding a new grant with total value £9.6m for the period March 2008 to February 2014, subject to a mid-term review. For the first time, EPSRC funding will be available for one-week workshops (including satellites) as well as for programmes themselves.

This grant will be the first to be received under the new Full Economic Costs (FEC) régime, which will help to provide sustainability to the Institute's finances.

Awards and Achievements

Sir John Kingman FRS, Director of the Institute from 2001 to 2006, was elected on 1 May 2007 as a Foreign Associate of the United States National Academy of Sciences.

Professor Ekhard Salje FRS, Chairman of the Institute's Management Committee and Head of the Department of Earth Sciences at the University of Cambridge, has been awarded the Cross of the Order of Merit of the Federal Republic of Germany, First Class. This is the highest tribute given to individuals for services to the state of Germany.

Lord Rees of Ludlow, President of the Royal Society and Astronomer Royal, who stepped down from the Institute's Management Committee in 2006 having served continuously since the foundation of the Institute, has been appointed by the Queen to the Order of Merit. The Order, founded in 1902 by King Edward VII, is a special mark of honour conferred by the Sovereign. Only 24 individuals may at any one time be members of the Order, apart from the Queen herself.

Dr Paul Fearnhead of Lancaster University, one of the organisers of the Newton Institute programme

John Robinson visiting the Institute in 2003 on the occasion of the installation of the Mathematical Gates in the Faulkes Gatehouse. From left to right: John Kingman, John Robinson, Damon de Laszlo and Keith Moffatt.

on *Stochastic Computation in the Biological Sciences* (see pages 22–23), was awarded both the 2006 Adams Prize by the University of Cambridge and the 2007 Guy Medal in Bronze by the Royal Statistical Society.

Six associates of the Newton Institute were elected to Fellowship of the Royal Society in 2007. Peter Littlewood, Head of the Cavendish Laboratory at the University of Cambridge, currently serves on the Institute's Management Committee and was an organiser of the *Strongly Correlated Electron Systems* programme in 2000. David Boger (Engineering, Melbourne), Michael Cates (Physics, Edinburgh), Anthony Hyman (Max Planck Institute of Molecular Cell Biology and Genetics, Dresden), John Peacock (Astronomy, Edinburgh) and Terence Tao (Mathematics, UCLA) have between them participated in nine programmes at the Newton Institute. We offer them all our congratulations.

Obituary

John Robinson, artist, died on 6 April 2007. Working from his studio in Devon, and later in Somerset, John first made his name as a sculptor of children and of sports figures. In the 1970s he moved on to more abstract forms, embarking on the *Universe Series* of symbolic sculptures eventually

comprising over 100 works, many of them influenced by mathematical or scientific concepts. The Institute is fortunate to have three pieces from the *Universe Series* entitled *Intuition*, *Genesis* and *Creation*, donated in 1995 and 1996. John also created the Mathematical Gates which are located in the Institute's Faulkes Gatehouse and form the entrance to the Centre for Mathematical Sciences at the University of Cambridge.

Public Understanding of Mathematics

During the Cambridge Science Festival, associated with National Science Week, a public lecture was given at the Institute on 24 March 2007 by Raymond Goldstein, Schlumberger Professor of Complex Physical Systems at the University of Cambridge. In his talk, entitled *How the Stalactite got its Shape*, he discussed his group's recent work both experimental and theoretical, including the unusual shapes into which stalactites naturally grow.

Publications arising from Newton Institute Programmes

Participants in Institute programmes reported during 2006/07 that, in total, 306 papers had been submitted or published that had arisen out of work either initiated during the programme, or of which a substantial part was carried out during the programme. A complete list is given in Appendix 5 (see the contents page).

A number of these papers were published in the Newton Institute's own Preprint Series, which participants are encouraged to use to ensure rapid dissemination of new results. A web page giving details of the Preprint Series is available at

www.newton.cam.ac.uk/preprints.html

Work carried out at the Newton Institute during the programme on *Structure Formation in the Universe* (July to December 1999) provided stimulus for the key ideas in a recently published book entitled *Endless Universe: Beyond the Big Bang* by PJ Steinhardt and N Turok, Doubleday, 2007.

A special issue of *Classical and Quantum Gravity* (August 2006) contained papers arising from the programme on *Global Problems in Mathematical Relativity* held at the Institute from August to December 2005 and from the related workshop on *Numerical Relativity* held at the Banff International Research Station in April 2005.

Raymond E Goldstein

Stalactites and other cave formations in Kartchner Caverns, Benson, Arizona

A focus issue of the *Journal of Statistical Mechanics: Theory and Experiment* (July 2007) highlighted results arising from the programme on *Principles of the Dynamics of Non-Equilibrium Systems* held at the Institute from January to June 2006.

Rothschild Visiting Professors

Through the generosity of NM Rothschild & Sons, each 4- or 6-month programme at the Institute is able to appoint a Rothschild Visiting Professor. These Professors are invariably among the most eminent world-wide in their field, and their presence at the Institute is inspirational.

Each Rothschild Visiting Professor is required to deliver one seminar during their tenure that is of general interest and will attract a wide range of mathematical scientists (not just those on the relevant Institute programme). This year's seminars were:

- *Noncommutative geometry and the structure of space-time*: A Connes (IHES)
- *Uncertainty and evidence in likelihoods for genetic linkage*: EA Thompson (Washington)
- *Universality for mathematical and physical systems*: P Deift (New York)
- *On the spectra and dynamics of operators with disorder*: M Aizenman (Princeton)

These seminars can be heard again on the web (see page 13).

National Advisory Board and UK Mathematics

Membership of the National Advisory Board as at 31 July 2007 was as follows:

Sir John Ball FRS FRSE	University of Oxford
Professor JW Bruce	University of Hull
Professor P Grindrod CBE	Lawson Software, Oxford
Dr RE Hunt	Deputy Director, Newton Institute
Sir Peter Knight FRS	Imperial College London
Professor JG McWhirter FRS FREng	QinetiQ
Professor EG Rees FRSE (Chairman)	University of Edinburgh
Professor GO Roberts	University of Lancaster
Dr FA Rogers	King's College London
Professor E Salje FRS	University of Cambridge
Professor SM Schaefer	London Business School
Professor JF Toland FRS FRSE	Director, ICMS
Sir David Wallace CBE FRS FREng	Director, Newton Institute

National Advisory Board

The National Advisory Board (NAB) advises the Director in all matters relating to the role of the Newton Institute as a National Institute for the Mathematical Sciences. In particular, it plays an invaluable part in ensuring that the Institute's activities are at all times geared towards maximum benefit for the entire UK mathematical community.

The membership, as at 31 July 2007, is given in the table above. The overlap with the Scientific Steering Committee and Management Committee is deliberate and intended to ensure good communication with the Board.

Some of the issues addressed by the NAB in the current year have been:

- The Institute's application to EPSRC for funding for 2008–2014 (subsequently successful: see page 10)
- EPSRC priority scientific areas
- Difficulties in renewing funding from STFC (the successor body to PPARC) and the European Union
- The numbers of invited participants who cancel their visits and their reasons for so doing
- The desire for increased participation from industry/commerce and by female researchers, and ways in which the associated difficulties can be addressed
- Increased use by the Institute of satellite workshops and follow-up events (see page 14)
- Online dissemination of seminars held at the Institute, including the possibility of real-time webcasting
- Governance of the Institute and the ongoing role of the NAB

Anyone with views about the national role of the Institute is invited to make these known to any member of the NAB.

Short Visits to the Institute

Any researcher associated with a UK University, academic institution or R&D group in industry or commerce may visit the Newton Institute for up to two days without an invitation, in order to attend seminars or to work with colleagues. All that is required is to sign in at the Institute's reception desk giving name, academic affiliation and the title of the programme that is of interest.

There is no need to warn the Institute in advance of such a visit, but it will make it easier for us to provide some facilities if a brief email is sent to info@newton.cam.ac.uk beforehand. Unfortunately we are unable to offer office space, accommodation or meals during such short visits, but visitors are

welcome to use the common areas of the building and our library.

More information is available at

www.newton.cam.ac.uk/shortvisits.html

UK Correspondents

The Newton Institute has for several years maintained a list of correspondents in UK Universities to act as a channel of communication between the Institute and the mathematical sciences community in the UK. This list has in recent years been extended to include relevant learned societies, commercial organisations and institutions not attached to Universities. All correspondents are regularly informed about activities of the Institute, and it is their responsibility to ensure that the information is disseminated to relevant individuals within their institution, whether in mathematics departments or in other scientific groups appropriate to each event. Correspondents also provide invaluable feedback, particularly at the annual meeting of correspondents held at the Institute. The names of all current correspondents can be found on page 15.

Seminars on the Web

To increase the benefit of Institute programmes to the UK mathematical community, seminars delivered during workshops or at special events at the Institute are recorded and made available on the web at

www.newton.cam.ac.uk/webseminars/

For most past seminars, audio files together with accompanying transparencies or PowerPoint files, etc., can be downloaded. Starting from September 2007, however, full **video** of every seminar will be available for either streaming or download. This will include tutorial workshops, such as *Gauge Fields and Strings* (part of the programme entitled *Strong Fields, Integrability and Strings* being held from July to December 2007) which will be aimed at graduate students and junior researchers in theoretical physics. In time the library of online seminars should build into a substantial national resource. At current rates over 500 seminars are being added *per annum*.

Seminars in the UK

Visiting Fellows on Newton Institute programmes are strongly encouraged to visit other institutions within the UK during their stay at the Institute, and many did so during 2006/07 (see page 6). To promote this activity, the Institute covers on request the travel costs within the UK for any overseas Fellow.

The Institute has set up a register of those Fellows who are willing to travel to other UK institutions to give seminars. Correspondents are urged to ensure that organisers of local seminar series know about and consult this register when planning their schedule of speakers. Potential speakers may be contacted directly using the details listed in the register, which can be found at

www.newton.cam.ac.uk/programmes/Speakers.html

Alternatively, advice on suitable speakers may be obtained from the organisers of any Institute programme via the Institute.

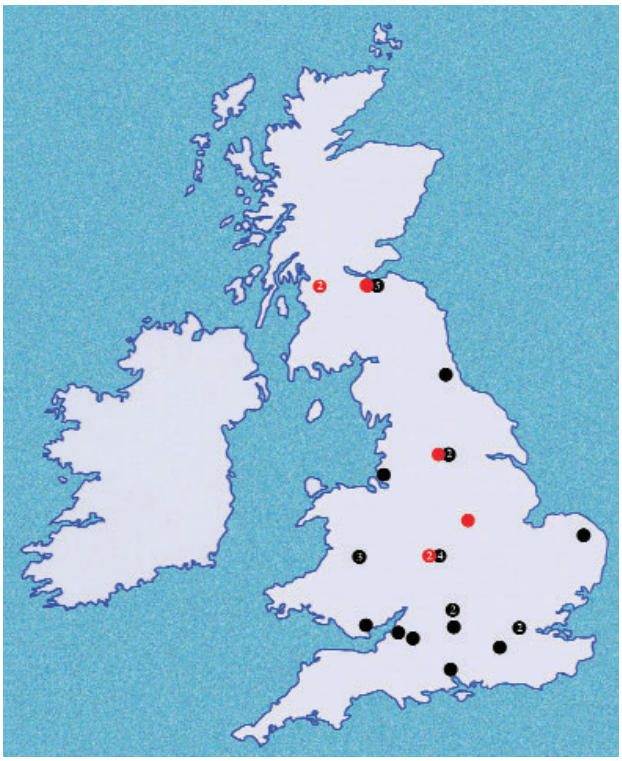
Junior Membership

The Institute recognises that junior researchers have much to contribute to and much to gain from Institute programmes and events. In order to maximise the information available to junior researchers, and to facilitate their involvement in Institute activities by offering additional funding opportunities, there is a special scheme for Junior Membership of the Newton Institute. To be eligible for membership you must be either a Research Student or within 5 years of having received your PhD (with appropriate allowance for career breaks), and you must work or study in a UK University or a related research institution.

Those wishing to become Junior Members should consult the Institute's web site at

www.newton.cam.ac.uk/junior.html

Junior Members will receive regular advance information regarding programmes, workshops, conferences and other Institute events. The Institute also makes available some of its general funds specifically to support junior researchers taking part in Institute activities. Junior Members may apply for grants from these funds. The types of involvement supported include attendance at



Distribution of Satellite Workshops

● *Planned* ● *Held*

workshops, conferences, etc., and visits of up to two weeks to work or study with longer-stay participants in the Institute's programmes. The Institute registered 107 new Junior Members in 2006/07; the current total is 517 as at the end of July 2007.

Satellite Workshops

The Institute encourages organisers of 4- or 6-month programmes to cooperate with local organisers in holding 'satellite' workshops at UK Universities and institutions outside Cambridge. Satellite workshops are on themes related to an Institute programme, and involve a significant number of longer-stay overseas participants from the Institute. They also, crucially, draw in and involve UK mathematicians and scientists who might not otherwise be able to participate substantially in the Institute programme; and they enable the expertise of the Institute's overseas participants to be shared more widely.

Satellite workshops have, to date, been held at Bath, Bristol, Brunel, Durham, East Anglia, Edinburgh, ICMS, Leeds, Liverpool, London, Oxford, Reading, Southampton, Surrey, Wales (Cardiff and Gregynog Hall) and Warwick. Future workshops are currently being planned at Glasgow, Leeds, the National e-Science Centre in Edinburgh, Nottingham and Warwick.

Costs for satellite workshops are typically approximately £10,000 (excluding the overseas travel costs of Institute participants, which are covered separately) and are shared evenly between the Institute and the host institution. From mid-2008 the host institution's share will be provided by EPSRC (see page 10).

The Institute is keen to continue to expand the geographical range of satellite workshop locations. Institutions interested in holding a workshop should contact either the organisers of the relevant programme or the Deputy Director, Dr RE Hunt (R.E.Hunt@newton.cam.ac.uk).

Follow-up Events

As stated in the Institute's Scientific Policy Statement (see page 5), it is intended that each Institute programme will have long-term impact well beyond the programme itself in terms of breakthroughs, new research directions and collaborations. The Institute has therefore become pro-active in arranging short follow-up events some years after programmes finish, whenever the original organisers are enthusiastic.

During 2006/07, three such events were held:

- A one-week workshop, 2–6 October 2006 at the Newton Institute, following up on the *Dynamics of Complex Fluids* programme in 1996
- A two-week workshop, 9–20 October 2006 at the Newton Institute, following up on the *Global Problems in Mathematical Relativity* programme in 2005
- A one-week workshop, 9–13 July 2007 at ICMS in Edinburgh, following up on the *Developments in Quantitative Finance* programme in 2005

Another follow-up event is currently being planned for the programme on *Logic and Algorithms* that was held in 2006, to take place at ICMS in July 2008.

Newton Institute Correspondents

Newton Institute Correspondents act as a channel of communication between the Institute and the UK mathematical sciences community (see page 13). Further nominations are encouraged.

Aberdeen	Dr A Sevastyanov	LSE	Dr M Luczak
Bath	Prof JF Toland	Manchester (Mathematics)	Prof M Prest
Birmingham	Dr IV Lerner	Manchester (Physics)	Prof AJ McKane
Brighton	Prof SW Ellacott	Napier	Prof T Muneer
Bristol	Dr F Mezzadri	Newcastle	Dr J Stoyanov
Brunel	Prof J Kaplunov	Nottingham	Dr Y Mao
Cambridge	Dr N Dorey	Open	Prof D Brannan
City	Dr O Kerr	Oxford	Dr J Norbury
Dundee	Dr G Hornig	Plymouth	Dr C Christopher
Durham	Prof WJ Zakrzewski	Portsmouth	Dr AD Burbanks
East Anglia	Prof G Everest	Queen Mary, London	Prof PJ Cameron
Edinburgh	Dr A Olde Daalhuis	Queen's	Prof AW Wickstead
Essex	Dr DB Penman	Reading	Dr EA Hanert
Exeter	Prof AM Soward	Royal Holloway, London	Dr CS Elsholtz
Glasgow	Dr C Athorne	St Andrews	Prof D Dritschel
Greenwich	Mr T Mann	Salford	Prof RD Baker
Heriot-Watt	Dr S Foss	Sheffield	Dr K Mackenzie
Hertfordshire	Dr S Kane	Southampton	Dr CJ Howls
Huddersfield	Dr A Crampton	Staffordshire	Prof BL Burrows
Hull	Dr JW Elliott	Stirling	Dr R Norman
Imperial College London	Prof M Plenio	Strathclyde	Prof M Ainsworth
Keele	Dr JJ Healey	Surrey	Dr PE Hydon
Kent	Prof PA Clarkson	Sussex	Prof K Zhang
King's College London	Dr A Recknagel	Ulster	Dr M McCartney
Lancaster	Dr S Power	University College London	Prof ER Johnson
Leeds	Prof A Pillay	West of England	Dr K Henderson
Leeds Metropolitan	Dr E Guest	Wales (Aberystwyth)	Dr R Douglas
Leicester	Dr F Neumann	Wales (Cardiff)	Dr KM Schmidt
Liverpool	Prof V Goryunov	Wales (Swansea)	Prof T Brzezinski
Liverpool John Moores	Prof PJG Lisboa	Warwick	Prof M Reid
Loughborough	Prof AP Veselov	York	Dr N MacKay

ATM	Dr P Andrews	Met Office	Dr MJP Cullen
British Computer Society	Dr M Rodd	Microsoft Research Group	Prof CM Bishop
Edinburgh Mathematical Society		OR Society	Mr R Hibbs
	Prof TH Lenagan	Proudman Oceanographic Laboratory	
EPSRC	Dr C Batchelor		Prof PJM Huthnance
ICMS	Prof J Toland	RAL	Prof I Duff
Institute of Actuaries	Ms P Simpson	Rothamsted Research	Dr M Semenov
IMA (Academic)	Prof D Abrahams	Royal Academy of Engineering	
IMA (Organisational)	Mr D Youdon		Prof J McWhirter
Institute of Physics	Dr G Watts	Royal Society	Prof M Taylor
LMS	Mr P Cooper	Royal Statistical Society	Mr P Gentry
Mathematical Association	Mr RH Barbour	Smith Institute	Dr H Tewkesbury

Spectral Theory and Partial Differential Equations

17 July to 11 August 2006

Report from the Organisers:
M van den Berg (Bristol), B Helffer (Orsay), A Laptev (Stockholm) and AV Sobolev (Birmingham)

SJ Wilkinson

B Helffer, AV Sobolev, A Laptev and M van den Berg

Spectral theory and partial differential equations stand at a meeting point of several different parts of mathematics and physics. Within mathematics they link spectral properties of elliptic and parabolic operators to the geometry and topology of the underlying manifold. Within physics they link, for example, the stability of matter to the properties of the potentials in the Schrödinger operators.

The programme concentrated on two global areas of spectral theory: Spectral Geometry, and the Spectral Theory of Schrödinger operators. The spectral geometric issues addressed during the programme were concerned with connection between the bottom of the spectrum, nodal lines, multiplicities of eigenvalues and the geometric properties of the region or manifold. Questions related to the Schrödinger operators covered the trace formulae (Lieb–Thirring inequalities, absolute continuity for multi-dimensional operators), theory of periodic operators (detailed properties of the band-gap spectrum, absolute continuity, the number of gaps) and scattering theory (scattering matrix properties, propagation of singularities). Many of these questions have important applications in physics (statistical physics, large particle systems, quantum mechanics, photonic crystals). This programme, together with its one-week workshop, allowed us to reflect on major achievements and to identify the key targets for the remainder of this decade. The programme emphasised the multidisciplinary character of research in this area, and capitalised on the interaction of experts working on different aspects of spectral theory. It attracted a large number of young researchers from the UK and other European countries, and we are confident that it will have a strong impact on the development of analysis and adjacent disciplines in the UK by reinforcing the interest in this vibrant area of mathematics.

The specific areas addressed were: open problems and possible new developments in Spectral Geometry (week 1); Theory of Schrödinger Operators (week 3); and Scattering Theory and Heat Semigroups (week 4). Recent rapid developments in the field of *Spectral Theory and its Applications* were summarised during the workshop in week 2. A total of 28 lectures surveyed these developments. In addition there were 11 contributions from young scientists to a poster session. The lecturers reported on recent results covering a wide range of topics: in particular, these included spectral gaps, nodal lines of eigenfunctions, large time heat kernel behaviour, scattering theory, universal eigenvalue bounds, periodic Schrödinger operators, spectral asymptotics, and semilinear and quasilinear PDEs.

In the three weeks outside the workshop, the number of seminars was strictly limited, allowing for intense collaboration and discussion among the participants.

The programme initiated many new directions of research in the field. These are illustrated by some details below.

- R Seeley, P Gilkey and M van den Berg investigated the heat flow in compact Riemannian manifolds with singular initial data, and the question was raised whether an asymptotic series for the heat content for small time exists, similar to the case with

smooth initial data. Seeley obtained in the meantime a suitable construction/representation of the parametrics for this problem, while van den Berg obtained possible extensions to non-compact, geodesically complete Riemannian manifolds. The work is in progress, and further developments will be highlighted at a conference in Blaubeuren later this year.

- Of particular interest was the lecture by L Polterovich entitled *Nodal inequalities on surfaces*. Polterovich studied the distribution of the extrema of a Laplace eigenfunction on a closed, compact surface. Inequalities by Kronrod and Yomdin played a crucial role in the investigation. Several remarkable inequalities featured. For example, if M is a planar domain and f is a smooth function on M, vanishing on the boundary of M, then can we prove that $\max|f| < (2\pi)^{-1}\int H_f$, where the integral is with respect to the surface measure on M and H_f is the operator norm of the Hessian of f? R Banuelos and others tried (so far in vain) to find a calculus proof of this fact. However, van den Berg and Banuelos obtained (independently) a weaker inequality which is nevertheless sharp in the case of a disc.
- V Buslaev and AV Sobolev discussed the possibility of joint work on the absolute continuity of periodic operators.
- R Banuelos and EB Davies discussed problems related to the spectral gap for the Steklov operator, and Banuelos suggested the use of stochastic calculus in the computation of the expected lifetime of an alpha stable process to obtain estimates for the spectral gap in the Steklov operator.
- M Levitin and L Parnovski collaborated to prove a class of new inequalities for the eigenvalues of the Dirichlet and Neumann Laplacians on regions in Euclidean space using commutator estimates. This work is in progress.
- P Gilkey gave a lecture on complex Osserman algebraic curvature tensors and Clifford families, and completed a manuscript on this subject.
- V Buslaev and A Pushnitski started work on a joint project on the classical mechanics analogue of the spectral shift function.
- G Rozenblum and AV Sobolev began a joint project on discrete spectrum asymptotics for the perturbed Landau operator.
- B Helffer, T Hoffman-Ostenhof and M van den Berg actively discussed spectral minimal partitions of open, bounded connected sets in Euclidean space.
- P Kuchment and AV Sobolev began writing a joint paper on the properties of band functions for periodic operators.

It is evident that research in spectral geometry is shifting from semiclassical analysis and large eigenvalue asymptotics to the structure of nodal domains, bottom of the spectrum of the Laplacian, in particular spectral gaps for Laplacians and other operators, and that some of the problems in this area have become tractable using a variety of techniques and tools.

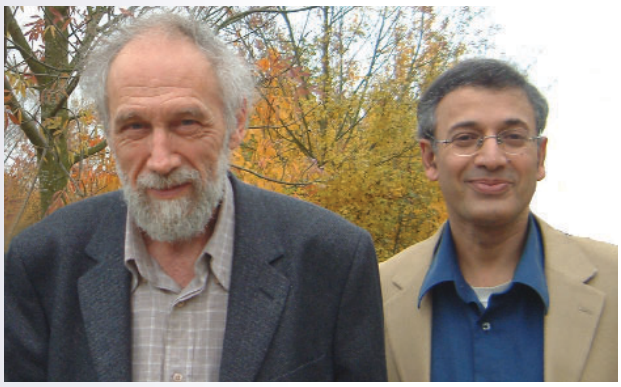
While spectral theory and partial differential equations have, for more than a century, been at the centre of attention of both the mathematics and physics communities, the programme highlighted rapid development across a broad range of subjects. Much recent progress has been made in the understanding of the asymptotic behaviour of spectral functions (spectral counting function, heat content, heat trace and heat kernels) and the general properties of periodic and magnetic Schrödinger operators. The programme gave the opportunity to focus attention on a number of important questions related to the nodal lines of Laplace and Schrödinger eigenfunctions, spectral gaps of these and other operators and properties of the band gap spectrum, absolute continuity and the number of gaps of periodic operators. Many of these questions have important applications in physics, and this was highlighted by lectures on, for example, the Casimir effect. Much progress and many new developments were reported, notably in new Cwickel–Lieb–Rozenbljum type inequalities. The workshop emphasised the multidisciplinary character of the field and capitalised on the interaction of more than 90 participants working on different aspects of spectral theory.

Noncommutative Geometry

24 July to 22 December 2006

Report from the Organisers:
A Connes (IHES), S Majid (Queen Mary, London) and A Schwarz (University of California Davis)

G Moore



A Connes and S Majid

Scientific Background

The continuum assumption of classical mechanics was already shattered in the 1920s with the discovery of the quantum nature of the microscopic mechanical system describing an atom. Such a system manifests itself through discrete spectral lines, and its basic laws are in direct contradiction with a continuum picture for its phase space. Heisenberg was the first to understand that for a microscopic mechanical system, the coordinates, namely real numbers such as the positions and momenta x, p, … that one would like to use to parameterize points of the phase space, actually do not commute. So one cannot use real number coordinates as in classical geometry; one needs some form of 'noncommutative' geometry in which the 'algebra of coordinates' is no longer commutative.

Although the first examples of noncommutative spaces came from quantum mechanics, there turn out to be a great many others of interest, such as the leaf spaces of foliations, the space of Penrose tilings, the noncommutative torus $\mathbb{T}^2_\theta$ which plays a role in the quantum Hall effect and in M-theory compactification, and the space of $\mathbb{Q}$-lattices related to a spectral interpretation of the zeros of the L-functions of number theory. The new theory of 'noncommutative geometry' that has developed in the last three decades adapts all classical geometric concepts and tools to this new class of geometric spaces, leading to far reaching generalizations such as cyclic cohomology and K-homology and extending, for example, the celebrated Atiyah–Singer index theory to such operators.

Also emerging in the 1980s were objects called 'quantum groups', which have contributed in part to what could be called an 'algebraic stream' to noncommutative geometry. One of the goals of the programme was to help reconcile the algebraic and the cyclic cohomology sides of noncommutative geometry. Another goal was to bring out the full range of its applications.

Structure of the Programme

Scientists working in noncommutative geometry come from diverse backgrounds spanning the entire gamut from theoretical particle physics to the most pure mathematics. One of our goals in structuring the programme was to create a genuine melting pot bringing together different expertise. Leading international figures represented the fields of operator algebras, cyclic cohomology, algebra, physics and quantum groups. We were particularly happy that some junior postdocs and PhD students played an active and extended part in the programme.

A special feature of the programme was a ten-hour lecture course by Connes on his new approach to the standard model of particle physics based on noncommutative geometry. Another feature was a public panel discussion on 7 September 2006 entitled *The Nature of Space and Time: An Evening of Speculation*, chaired by Jeremy Butterfield, a noted philosopher. Five panellists (Alain Connes, Michael Heller, Shahn Majid, Sir Roger Penrose and John Polkinghorne) presented and then discussed their deepest and more speculative thoughts on the nature of space and time, led by questions from the floor. The event has led to a book of essays.

The following three workshops took place during the programme.

Noncommutative Geometry and Cyclic Cohomology

31 July–4 August 2006

This first workshop focussed on the pure mathematics of noncommutative differential geometry, centered on cyclic cohomology. Some particular themes were strong progress in noncommutative Chern–Weil theory and the cyclic cohomology of Hopf algebras, the Baum–Connes conjecture and related developments in algebraic *K*-theory, and quantum group methods.

Noncommutative Geometry and Physics: Fundamental Structure of Space and Time

4–8 September 2006

This workshop, generously supported by the Templeton Foundation, aimed to bring together mathematicians and physicists to consider the fundamental nature of space and time. Are space and time a continuum, discrete or something different from both of these at the tiniest scales? Is time intrinsically generated? What is the picture of spacetime arising from string theory and quantum gravity? The central role of noncommutative geometry in answering these interesting questions was explored. The workshop included the public event described above and a day of interdisciplinary talks by Sir Roger Penrose, A Taylor at the Royal Observatory in Edinburgh and C Laemmerzahl.

Trends in Noncommutative Geometry

18–22 December 2006

This workshop aimed to expose some of the most exciting new developments relating noncommutative geometry to other topics in pure and applied mathematics. Topics included aperiodic patterns, the theory of foliations, fractal and infinite-dimensional geometry, number theory and algebraic geometry. Emphasis was on the algebra and number theory sides as particular areas of fruitful interaction. Other talks on aperiodic tilings and on quantum groups allowed us to cover what we felt were some of the most exciting trends for the future.

Outcome and Achievements

The programme achieved most of its stated goals. Several core participants described a considerable broadening of their understanding of noncommutative geometry. This had been a primary goal of the programme. Another goal achieved was to provide international exposure and contacts to UK researchers in noncommutative geometry at all levels.

M Subritzky

Aperiodic pinwheel pattern on buildings in Federation Square, Melbourne. When tiled on the plane, the triangles appear in an infinite number of rotations.

Turning to specific results and collaborations, one clear highlight was the completion of a breakthrough paper by A Connes, M Marcolli and A Chamsedine, which also formed the basis of Connes' lecture course. Theoretical physicists often consider the possibility of extra dimensions in spacetime beyond the 4 directly observed, but these usual Kaluza–Klein ideas imply unobserved physics due to coordinate transformations in the extra dimensions. If instead one adds noncommutative directions expressed in a simple finite-dimensional algebra one obtains a much better conceptual fit with what is observed in the standard model, namely gravity and Yang–Mills theory with nothing extra. In the recent work Connes overcame some technical problems in this approach to find for the first time exactly the right finite-dimensional algebra of 'extra dimensions'.

Also very visible and accessible was R Nest who completed several papers, including key ones with A Gorokhovsky and with B Tsygan on noncommutative geometry and formal deformations. His work on the Baum–Connes conjecture for quantum groups led to many interesting discussions with those coming from the algebraic theory of quantum group principal bundles. Another very visible participant was M Rieffel who made a breakthrough in one of his previously stalled key projects, which he credits to the excellent environment.

A full report on this programme can be found at

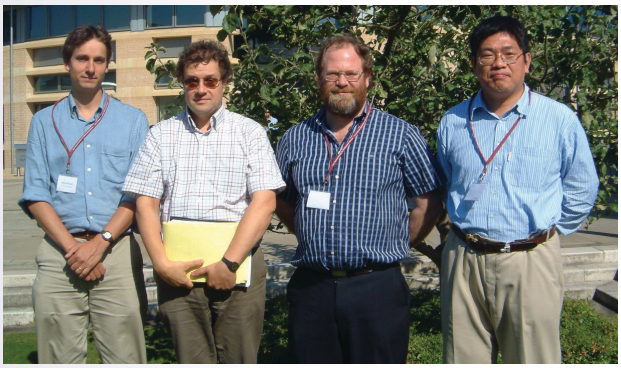
www.newton.cam.ac.uk/reports/0607/ncg.pdf

The Painlevé Equations and Monodromy Problems

4 to 29 September 2006

Report from the Organisers:
PP Boalch (ENS Paris), PA Clarkson (Kent), L Mason (Oxford) and Y Ohyama (Osaka)

G Moore



PP Boalch, L Mason, PA Clarkson and Y Ohyama

Background

The Painlevé equations and their solutions, the Painlevé transcendants, arise in many disparate parts of pure and applied mathematics and theoretical physics. Painlevé transcendents arise as partition functions in string theories, as correlation functions in statistical mechanics, as important solutions of differential equations from fluid dynamics and general relativity through to Einstein manifolds and monopole moduli spaces in differential geometry, and as generating functions for the topology of moduli spaces of Riemann surfaces and for enumerative problems in algebraic geometry. The Painlevé equations are an integrable system, and therefore have much underlying structure, but despite their integrability much of the general theory is still in a somewhat embryonic stage. Indeed the Painlevé transcendents are still some way from being understood so well as more classical special functions.

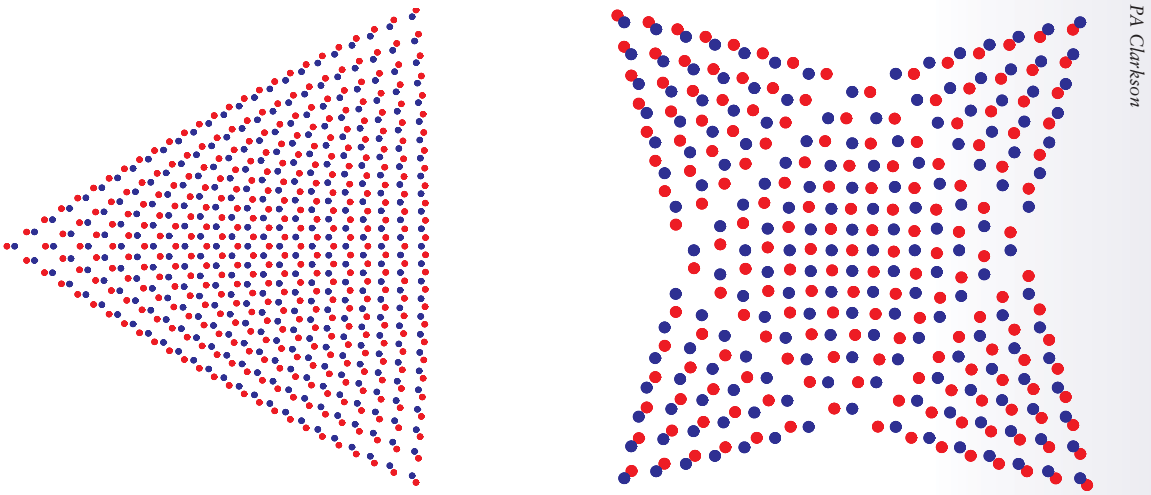
Some of the outstanding problems in the field are to understand fully the asymptotics and solve all the corresponding connection problems of the Painlevé transcendents: for example if one has a Painlevé transcendent with a certain behaviour at zero, then can we say how it behaves at infinity? More generally, the Painlevé equations can be viewed as the simplest cases of equations controlling monodromy-preserving deformations of linear differential operators on the Riemann sphere, and one can ask the same questions for any such (nonlinear) isomonodromy equations.

Some less concrete problems arise in understanding various applications of the Painlevé equations, for example in random matrix ensembles or the Tracey–Widom distribution controlling the largest increasing subsequences of random permutations. One can try for example to see directly an isomonodromic deformation in the original problem (which would explain clearly why we would expect to find a Painlevé solution in the answer).

Programme Structure

This month-long programme brought together three communities of researchers: the Japanese school, who are strongly influenced by methods from algebraic geometry and infinite group theory; members of the ENIGMA Marie Curie Research Training Network (the European Network in Geometry, Mathematical Physics and Applications); and leading UK researchers. The programme was focussed around two workshops in the middle two weeks.

The first workshop was designed for younger people and aimed to cover basic theory and background results in the area. It consisted of two long courses and seven shorter courses, plus a scattering of eight half-hour talks given by younger participants and a poster session. The long courses (given by K Okamoto and H Umemura) gave the main introduction to the Painlevé equation and to their differential Galois theory. The short courses covered other topics centred on the Painlevé equations such as their asymptotics, their special solutions, their relation to random matrices, their discrete analogues, their Hamiltonian structure and their relation to Riemann–Hilbert problems.



PA Clarkson

Left: The poles of a rational solution of the second Painlevé equation. Those with residue +1 are in blue and those with residue –1 in red. Right: The zeroes (red) and poles (blue) of a rational-oscillatory solution of the de-focussing nonlinear Schrödinger equation.

The second workshop aimed more at disseminating recent results by active workers in the field. It brought together an outstanding collection of researchers.

Outcomes

The introductory courses gave an excellent introduction to modern research in the field for graduate students, but also allowed experts in one field to learn about progress in neighbouring fields. The participants all mentioned important input into their research arising both from the lectures and from their interactions with other participants. Many of these interactions have led to further collaborations and papers, of which we mention just a few here.

N Joshi advanced her collaboration with F Nijhoff and M Mazzocco, finishing a joint paper with the former on *A Lax Pair for a lattice modified KdV equation*, and initiated a new collaboration with PA Clarkson. Clarkson worked on papers with S Harris on *Painlevé analysis and similarity reductions for the Magma equation* and with G Filipuk on *The fourth Painlevé hierarchy and associated special polynomials*. G Casale, B Malgrange and H Umemura managed to prove the foundational result of the equivalence of the two nonlinear differential Galois theories of Umemura and Malgrange, with surprising applications to the Picard solution of the sixth Painlevé equation. A Veselov, G Felder and M Feigin essentially completed the first draft of a paper on the geometry of V-systems describing logarithmic Frobenius structures. Veselov also intrigued many participants with the observation that an old mathematical recreation of Roger Penrose on iterated mappings was effectively a specialization of the discrete Painlevé equations. Overall, participants seem to have learnt a lot, had many useful interactions and universally expressed the wish that the programme had been longer.

The organisers would like to thank the ENIGMA Marie Curie Network for supporting the workshops and the Japanese Society for the Promotion of Science for support of Japanese participants.

Stochastic Computation in the Biological Sciences

23 October to 15 December 2006

Report from the Organisers:
S Brooks (Cambridge), A Doucet (UBC Vancouver), P Fearnhead (Lancaster), WR Gilks (Leeds) and S Tavaré (USC/Cambridge)

G Moore

S Brooks, WR Gilks, S Tavaré, P Fearnhead and A Doucet

Scientific Background

Many application areas within the biological sciences require sophisticated statistical techniques in order to deal with problems associated with large datasets, indirect measurements, complex underlying processes or any combination of these three. For example, in population genetics, genetic data from unrelated individuals contain information about the biological processes of inheritance which are closely intertwined with the demographic history of the populations from which the individuals were sampled. In many situations Monte Carlo methods offer the best (or even only) approach for analysing such data sets. Even so, many topical problems in the biological sciences now lie at or beyond the limit of what is practicable for current Monte Carlo methods on today's computers. Thus there is considerable interest in extending the power and range of applicability of Monte Carlo methods in order to meet the increasing demands of the applied research community. This has been an extremely active research area for many years, motivated in part by the computer revolution of the 1980s. However, different research communities have tended to develop their own Monte Carlo methodologies, with few interactions between them.

This programme brought together researchers from a range of communities and backgrounds in order to meet, interact and share knowledge. The focus of the programme was on the development and application of novel Monte Carlo methodology appropriate for the many challenging problems arising from the biological sciences.

Workshops

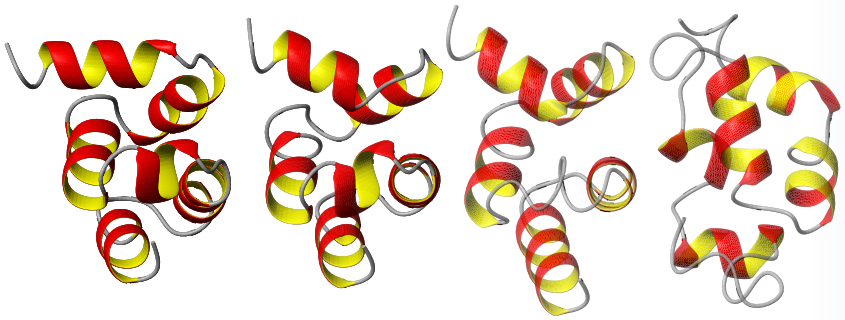
Recent Advances in Monte Carlo Based Inference

30 October–3 November 2006

Organisers: A Doucet and P Fearnhead

The first workshop was devoted to advances in methodology in stochastic computation. Monte Carlo methods, particularly Markov Chain Monte Carlo (MCMC), are often the methods of choice for making inferences about complex stochastic systems. Whilst MCMC dates back over 50 years, and there has been extensive research in Monte Carlo methods over the past 20 years, there are still many challenges that face researchers today. These include analysis of highly complicated stochastic models and large scientific data sets, and understanding the theoretical properties of some of the recent novel approaches.

Currently, Monte Carlo methods are used by researchers in numerous scientific fields, including statistics, physics, engineering, chemistry, genetics, econometrics, bioinformatics, and machine learning. This interdisciplinary workshop brought together researchers from a variety of such fields to discuss current and novel Monte Carlo methodology, and to cross-fertilise ideas across disciplines. The workshop had a broad focus, covering both recent advances in established methods such as MCMC and sequential Monte Carlo, together with more recent ideas that have had little exposure within the statistics community, such as variational methods, population



JM Carr and DJ Wales

Global optimisation results for an FF domain of the protein HYPA/FBP11 obtained using the basin-hopping approach

Monte Carlo, approximate Bayesian computation, quasi Monte Carlo, and indirect inference.

Stochastic Computation for the Analysis of Ecological and Epidemiological Data

20–24 November 2006

Organiser: S Brooks

The second workshop focussed on statistical issues arising in epidemiology and ecology. Both areas pose similar methodological problems for statisticians. Both require the analysis of large yet sparse datasets, often with both individual and environmental time-varying explanatory factors. Effective management is the key goal, in addition to developing understanding as to the processes underpinning the observed dynamics.

The workshop explored the cutting edge of scientific developments in these fields and discussed the statistical methodologies required to underpin future advances. In particular, the computational and statistical challenges involved in modelling animal population and disease dynamics at the individual level were discussed, and experts from a range of disciplines helped to outline future scientific and statistical developments.

Recent Advances in Statistical Genetics and Bioinformatics

11–15 December 2006

Organisers: WR Gilks and S Tavaré

Bioinformatics has grown up around the rapidly expanding databases of DNA sequence, molecular structure and interaction. Understanding the evolutionary and functional relationships between these biomolecules is perhaps the greatest challenge of 21st century science. Advanced statistical methods are becoming increasingly important in this endeavour. The arrival of dense genotyping arrays has provided huge amounts of SNP (single nucleotide polymorphism) data which have been used successfully to map genes associated with complex traits. Statistical methods for designing and analysing such whole genome scans are beginning to appear, but many open problems remain. The use of SNP data to estimate recombination rates across the genome, to detect evidence of selective sweeps and to infer demographic history have also provided challenges that were addressed in the workshop.

Highlights and Outcomes

Professor Elizabeth Thompson (Washington) was invited as the Rothschild Visiting Professor. She presented a special lecture entitled *Uncertainty and evidence in likelihoods for genetic linkage* on Monday 11 December 2006. The theme of the talk was the notion of fuzzy *p*-values, a topic the audience found most stimulating and provocative.

In addition to the workshops there was a very active group of resident scientists and mathematicians, numbering some 40 people over the course of the programme, who contributed to the lively environment in the Newton Institute. Interactions developed around weekly informal 'organisational' meetings in which topics of interest were discussed. Ongoing collaborations flourished, and several new ones developed from these interactions, including collaborations on efficient posterior simulation of large decomposable graphs (Peter Green and Alun Thomas), on statistical inference in the fossil record (Simon Tavaré and Bruce Rannala) and on the analysis copy number variation (Simon Myers and Matt Hurles), to name just three. Many of the visitors commented on the fact that the Newton Institute provides a great environment in which to focus on research without the distractions of regular university life.

Analysis on Graphs and its Applications

8 January to 29 June 2007

Report from the Organisers:
BM Brown (Cardiff), P Exner (Czech Academy of Sciences), P Kuchment (Texas A&M) and T Sunada (Meiji)

P Kuchment, BM Brown, P Exner and T Sunada

Scientific Background

In recent years, a lot of attention has been paid to analysis on graphs and graph-like low-dimensional structures. The main (albeit not the only) objects here are: the (usual) combinatorial graphs, in which case functions are defined on the set of vertices; 'quantum graphs', i.e., graphs considered as singular one-dimensional varieties (CW-complexes) with functions defined along the edges; and fractals (Sierpinski gasket and other self-similar objects). By 'analysis', we mean that in all these cases either objects with an analytic nature (discrete Laplace operators, quantum graph Hamiltonians, fractal Laplace operators, etc.) or problems with an analytic nature (the spectra of these operators, heat kernel asymptotics, quantum chaos, etc.) are considered. Thus, discrete and continuous methods blend, producing a uniquely interesting field.

Why should such objects be studied and why has there has been so much activity in this field lately? These kinds of structures and problems are starting to arise in a wide range of areas of mathematics, from number theory to discrete groups, spectral geometry and mathematical physics. Simultaneously, the burgeoning field of meso- and nano-scopic physics and technology strives to use graph models (and analogous two-dimensional 'open book' or mixed dimension models) to approximate low-dimensional objects such as circuits of quantum wires, thin photonic crystals and thin superconducting structures. Similar structures have also been used to model chemical compounds, such as electronic states in aromatic molecules or carbon nanotubes and recently discovered two-dimensional crystals (graphene). Analysis on fractals has been driven, at least partially, by real world applications: fractal multi-band (or wide-band) antennae are already commercially available.

Programme Structure

The programme assembled, essentially for the first time, a diverse group of researchers from various areas of physics, chemistry, computer science and mathematics (algebra, combinatorics, dynamical systems, graph theory, mathematical physics, number theory, operator theory, PDEs and probability) in order to create cross-pollination of ideas and methods. It involved 144 participants from 18 countries, plus more at the embedded workshops:

Analysis on Graphs and its Applications

10–15 January 2007 at Gregynog Hall, University of Wales

This LMS/EPSRC Short Course was devoted to introducing students and junior researchers, as well as a few more senior scientists interested in learning the subject, to the main structures and methods available. Lecture series were given on *Spectral geometry of discrete Laplacians*, *Quantum graphs and their applications* and *Analysis on fractals*.

Quantum Graphs, their Spectra and Applications

2–5 April 2007

This workshop was devoted to studying the so-called quantum graphs that have emerged

recently. These are graphs considered as one-dimensional CW-complexes equipped with differential operators, rather than the customary difference operators. These models have numerous applications in nanotechnology, microelectronics, quantum chemistry, superconductivity, optics (photonic crystals), waveguides, etc. Besides being in many cases useful low-dimensional models of complex systems, such graphs are also used as toy models for studying difficult issues such as Anderson localization and quantum chaos. The methods used or expected to be useful in analysis on quantum graphs come from a very wide range of mathematical areas: algebra, combinatorics, PDEs, spectral theory, micro-local and complex analysis, to name a few. Lecture topics included spectral theory, heat propagation and quantum chaos on quantum graphs; Bose–Einstein condensate models; control and inverse problems for quantum networks; and nodal properties of eigenfunctions of quantum graph Hamiltonians.

Graph Models of Mesoscopic Systems, Wave-Guides and Nano-Structures

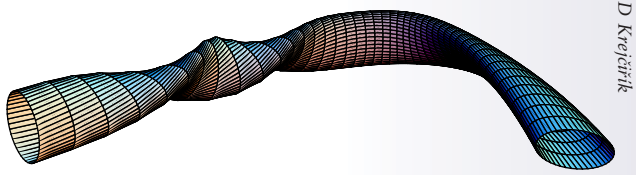
10–13 April 2007

This workshop was a logical continuation of the previous one, but with a more applied tilt. Topics included the modelling of newly discovered two-dimensional crystals (graphene), electronic transport in circuits of quantum wires, quantum graphs for quantum information transmission, quantum random walks, quantum chaos, graph models for spintronics (a fast developing application area), models for slowing down light, and many others. As in the previous workshop (and even to a higher degree), active and often cross-disciplinary communication among participants was triggered.

Analysis on Graphs and Fractals

29 May–2 June 2007 at Cardiff University

This LMS meeting took place at Cardiff, and unlike the previous two workshops was mostly devoted to analysis on purely discrete (combinatorial) graphs and fractals. In particular, new approaches were presented that link some classes of discrete groups (often of intermediate growth) with monodromy groups for rational mappings and spectral theory of fractals. It also included several applied talks, e.g., on Bose–Einstein condensate models and Anderson localization.



D Krejčiřík

The geometry of a curved quantum waveguide. The effects of twisting and bending are demonstrated at the left and right respectively.

Outcome and Achievements

The goals of the programme were two-fold: first and foremost, to build an interdisciplinary community of people working on problems of a similar nature and to share tools; and secondly, to make progress on some outstanding problems in the field such as analysis of Laplace operators on fractals, properties of various zeta-functions on graphs, localization phenomena on randomly perturbed graph systems, and the spectral properties of various classes of graphs (Schreier and Caley graphs, crystal lattice graphs, etc.).

The first goal was certainly achieved, with many new collaborations. One example was the intensive communication between the prominent physicist U Smilansky and leading number theorists H Stark and A Terras that led to his recent work on zeta-functions on graphs. Regarding the second goal, no-one could realistically expect that all the outstanding problems listed above would be resolved completely during the programme; yet progress in many of these directions was made by participants. Significant new developments were announced in workshop and seminar talks: for example, a breakthrough in the long standing problem of approximating spectra of Dirichlet Laplacians in thin branching domains was reported in talks by D Grieser and by B Vainberg.

A volume entitled *Analysis on Graphs and its Applications* (edited by P Exner, J Keating, P Kuchment, T Sunada and A Teplyaev) containing refereed papers is in preparation and will soon be published in the American Mathematical Society's *Proceedings of Symposia in Pure Mathematics* series.

A full report on this programme can be found at

www.newton.cam.ac.uk/reports/0607/aga.pdf

Highly Oscillatory Problems

15 January to 6 July 2007

Report from the Organisers:
B Engquist (Austin), T Fokas (Cambridge), E Hairer (Geneva) and A Iserles (Cambridge)

Background

High oscillation plays a crucial role in a wide range of phenomena in science and engineering, and it represents formidable mathematical and computational challenge. Its understanding calls for an extensive array of distinct mathematical techniques and numerical algorithms.

Traditionally, research into high oscillation was problem-oriented or technique-oriented. This led to an impressive, yet fairly disjoint, body of knowledge. The wish to create a shared space for different workers in this area motivated this Newton Institute programme, the first ever with the organising principle of high oscillation at its core. We brought together over 100 professionals (plus many more at the embedded workshops), mostly associated with the computation of high oscillation (e.g., multiresolution methods, homogenisation, geometric numerical integration, calculations in electromagnetics and acoustics, highly oscillatory quadrature, Riemann–Hilbert techniques, discretizations of the Schrödinger equation, exponential integrators), but also those working in the underlying theory (e.g., in asymptotics and in random matrix theory) and in application areas.

Three 'master problems' served as a useful focus in our deliberations, although the programme involved many more themes.

The Schrödinger equation: In its different settings, the Schrödinger equation is the basic model of wave phenomena, of cardinal importance in quantum and plasma physics and in chemistry. High oscillation is endemic, and it joins with a wide array of other phenomena that render analysis and computation so very challenging, including nonlinearity, large potentials, integrability, (de)focussing, and Hamiltonicity. No wonder that this equation has recently been approached with a very wide range of computational techniques: homogenisation, multiresolution, nonlinear optics approximation, symplectic and multisymplectic methods, Wigner measures, splitting methods and much more.

Electromagnetic and acoustic scattering: A major inverse problem, replete with applications, is to identify the shape of an object from waves (electromagnetic or acoustic) that it reflects and scatters. This can be reduced to the computation of the Helmholtz equation in an 'exterior' large domain and involves high oscillation, typically in a wide range of frequencies. It is exceedingly sensitive to the geometry of the underlying object. The state-of-the-art approach converts the Helmholtz equation to integral equations with highly oscillating kernels, defined on the boundary of the domain. This, in turn, is converted to quadrature of highly oscillating multivariate integrals.

Symplectic long-term integration: One of the great triumphs of geometric numerical integration has been the current generation of very sophisticated symplectic solvers for Hamiltonian problems, but the main remaining challenge (of critical importance in celestial mechanics and in accelerator physics) is their very long term behaviour and error accumulation. By 'long term' we mean the régime that involves a huge number of oscillations and it is essential that the qualitative properties of the underlying system remain true, at least in some ergodic sense. This has been treated with a measure of success using ideas from backward error analysis, modulated Fourier expansions, exponential integrators and mollifiers.

Programme Structure

The regular 'flow' of the programme included typically 3–5 seminar talks each week, of which one was suitable for a wider audience. Two workshops were organised at the Institute:

- *The Theory of Highly Oscillatory Problems*, 26–30 March

- *Effective Computational Methods for Highly Oscillatory Problems: the Interplay between Mathematical Theory and Applications*, 2–6 July

They were complemented by four satellite events:

- *The Future of Computational Acoustics*, Arup Acoustics, London, 22–23 February
- *Applying Geometric Integrators*, ICMS, Edinburgh, 24–27 April
- *Multi-resolution and High Oscillation for Evolutionary Problems: Blow-up and Hamiltonian Systems*, University of Bath, 11–12 June
- *High Frequency Wave Propagation and Scattering*, University of Reading, 24–26 July

There was also a one-day event on *Oscillatory Integrals and Integral Equations in High Frequency Scattering and Wave Propagation* on 19 June.

The two workshops at the Institute were devoted to a wide range of topics spanning the entire subject area of high oscillation, and they served the double purpose of reporting the latest advances to the experts while educating novices (who were often experts in other aspects of the subject). On the other hand, the satellite workshops were more focussed on particular research aspects of high oscillation.

This is the place to acknowledge the outstanding facilities of the Isaac Newton Institute and the exemplary helpfulness and competence of its staff.

Outcome and Achievements

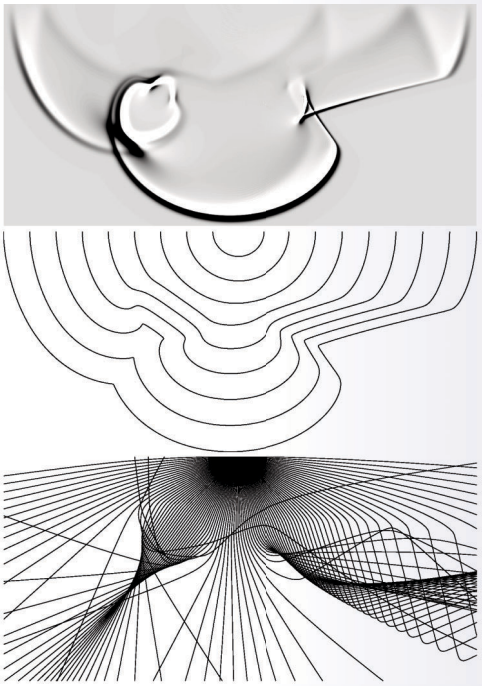
The massively interdisciplinary nature of this programme put the emphasis not on mathematical output *per se* but on collaborations across disciplines which have been initiated and have already produced useful results. Herewith, in no particular order, several such new collaborations:

Computation of Painlevé transcendents: F Bornemann and P Deift

Numerical methods for multiscale PDEs on perforated domains: A Abdulle and VH Hoang

Round-off error of implicit symplectic Runge–Kutta methods: E Hairer and RI McLachlan

Long-time analysis of analytical and numerical solutions of nonlinear wave equations: D Cohen, E Hairer and Ch Lubich



O Runborg

An initially circular wave propagating downwards through a heterogeneous medium. From top to bottom: numerical solution of the wave equation; solution of the eikonal equation; ray tracing solution.

Computation of highly oscillatory integral equations: H Brunner, A Iserles and SP Nørsett

Riemann–Hilbert techniques for spectral problems: P Deift and A Its

The generalised Dirichlet–Neumann map in polygonal domains: T Fokas and S Fulton

Spectra of travelling waves and the Evans function: V Ledoux, S Malham, J Niesen and V Thummler

Combination of modified Fourier expansion with polynomial subtraction and the hyperbolic cross: D Huybrechs, A Iserles and SP Nørsett

Highly oscillatory quadrature for acoustics and electromagnetics: OP Bruno, SN Chandler-Wilde, M Ganesh, I Graham, D Huybrechs and S Vandewalle

We are planning a volume in the Newton Institute series composed of survey papers highlighting different aspects of the programme. The programme also produced a large number of publications.

The programme established an enduring community under a new heading. We consider it vital for the programme to be the beginning of a considerably longer journey rather than a one-off event.

A full report on this programme can be found at

www.newton.cam.ac.uk/reports/0607/hop.pdf

Finances

Accounts for August 2006 to July 2007 (Institute Year 15)

	2005/06 Year 14 £'000	2006/07 Year 15 £'000
Income		
Grant Income – Revenue[1]	1,005	914
Grant Income – Workshop[2]	327	214
Grant from the University of Cambridge	226	233
NM Rothschild and Sons Trust Funds[3]	110	109
Investment Income	121	130
Donations, Reimbursements and Other Income[4]	44	47
Total Income	**1,833**	**1,648**
Expenditure		
Scientific Salaries[5]	399	353
Scientific Travel and Subsistence	456	362
Scientific Workshop Expenditure	215	202
Other Scientific Costs[6]	16	18
Staff Costs	370	388
Net Housing Costs[7]	31	79
Computing Costs	66	38
Library Costs	12	12
Building – Repair and Maintenance	14	10
Estates and Indirect Costs[8]	250	97
Consumables	20	20
Equipment – Capital	11	2
Equipment – Repair and Maintenance	2	8
Publicity	5	3
Recruitment Costs	3	2
Total Expenditure	**1,868**	**1,594**
Surplus / (Deficit)[9]	**(34)**	**55**

Notes to the Accounts

1. Grant Income – Revenue
The income breaks down as follows:

	2005/06 Year 14 £'000	2006/07 Year 15 £'000
EPSRC/PPARC Salaries	492	466
EPSRC/PPARC Travel and Subsistence	322	360
Trinity College (Isaac Newton Trust)	50	0
PF Charitable Trust	24	37
Leverhulme Trust	90	0
London Mathematical Society	25	25
Le Centre National de la Recherche Scientifique	0	24
Cambridge Philosophical Society	2	2
Total	**1,005**	**914**

2. Grant Income – Workshop
This figure for 2006/07 is not directly comparable to that for previous years as some workshop funding is now channeled through the Institute's main grant from EPSRC and therefore appears under "EPSRC/PPARC Travel and Subsistence" instead (see note 1 above).

3. NM Rothschild and Sons Trust Funds
The amounts received break down as follows:

Rothschild Visiting Professorships (drawdown)	31	25
Rothschild Mathematical Sciences (income)	79	84
Total	**110**	**109**

The income from the Rothschild Mathematical Sciences Fund supports the Professorship held by the Director of the Institute.

4. Donations, Reimbursements and Other Income
The figure for 2006/07 includes generous additional programme sponsorship received from the National Science Foundation (USA), the Royal Society, the John Templeton Foundation, the Wellcome Trust and the SPECT and ENIGMA European networks, as well as income received from publications and the sale of merchandise.

5. Scientific Salaries
This includes stipends paid to selected Visiting Fellows, Rothschild Visiting Professors, the Director and the Deputy Director.

6. Other Scientific Costs
This includes costs relating to meetings of the Institute's committees, Institute Correspondents' expenses, programme organisers' expenses and entertainment, as well as the travel expenses of overseas participants

for their visits to other UK institutions to give seminars (see page 13).

7. Net Housing Costs

These figures include the salary of the Housing Officer, and break down as follows:

	2005/06 Year 14 £'000	2006/07 Year 15 £'000
Income	313	294
Expenditure	344	372
Total	**(31)**	**(79)**

8. Estates and Indirect Costs

The figure for 2006/07 results from a new calculation carried out under the Full Economic Costs (FEC) régime. It is not comparable with figures for previous years since different elements are now included or excluded.

9. Surplus / (Deficit)

The surplus recorded for 2006/07 must be offset against accumulated past deficits, amounting at the end of 2005/06 to £416k.

Grants and Donations 2006/07

In addition to its substantial funding from the Engineering and Physical Sciences Research Council, the Institute is indebted for continuing funding to the Cambridge Philosophical Society, Le Centre Nationale de la Recherche Scientifique, the London Mathematical Society, the Particle Physics and Astronomy Research Council, PF Charitable Trust, NM Rothschild and Sons and the University of Cambridge. We are very grateful to the following organisations for their specific support during the year: the Biotechnology and Biological Sciences Research Council, the Boston Foundation, the ENIGMA, SOFTCOMP and SPECT European Networks, Microsoft Research Cambridge, the National Science Foundation (USA), the Royal Society, Schlumberger Cambridge Research, the John Templeton Foundation and the Wellcome Trust. Individuals also gave generously in support of our activities: Professor Roy and Mrs Ann Garstang, Dr Jonathan Hodgson, David Malcolm and David Wallace.

Cumulative Grants and Donations above £25,000

SERC/EPSRC/PPARC	£20,190k	over 22 years (to 2014)
Trinity College (Isaac Newton Trust)	£2,610k	over 14 years
NM Rothschild and Sons	£2,083k	over 10 years
European Union	£1,413k	over 15 years
Anonymous Donation	£1,065k	
Hewlett-Packard	£1,065k	over 10 years
Dill Faulkes Foundation	£1,000k	
Leverhulme Trust	£865k	over 12 years
St John's College	£750k	over 5 years
NATO	£728k	
Le Centre Nationale de la Recherche Scientifique	£459k	over 15 years
London Mathematical Society	£358k	over 15 years (to 2009)
Rosenbaum Foundation	£330k	over 7 years
PF Charitable Trust	£240k	over 3 years
Clay Mathematics Institute	£160k	
Gonville and Caius College	£100k	
Prudential Corporation plc	£100k	over 4 years
Microsoft Corporation	£90k	over 3 years (to 2008)
National Science Foundation	£74k	
Institute of Physics	£69k	over 14 years
Wellcome Trust	£65k	
British Meteorological Office	£64k	
Nuffield Foundation	£57k	
TSUNAMI	£40k	
John Templeton Foundation	£37k	
Daiwa Anglo-Japanese Foundation	£36k	over 4 years
BNP Paribas	£35k	
Cambridge Philosophical Society	£35k	over 20 years (to 2013)
American Friends (Hamish Maxwell): $50k	£32k	
American Friends (Anonymous Donation): $50k	£32k	
Office of Naval Research	£31k	
Emmanuel College	£30k	
Jesus College	£30k	over 6 years