UNIVERSITY OF CAMBRIDGE

Isaac Newton Institute for Mathematical Sciences

Annual Report for 1994-95

March 1996

ISAAC NEWTON INSTITUTE
FOR
MATHEMATICAL SCIENCES

Annual Report for 1994-95

Cover Photograph: J Austin

DIRECTOR'S REPORT

The Newton Institute is now an established and highly visible centre both nationally and internationally. Its reputation rests on the high quality of the participants that we attract, the opportunity provided for interacting with scientists of different backgrounds and the high standards of the facilities and services we provide.

The popularity of the Institute is reflected in the large growth in the number of visitors. In 1994/95 we had 360 long-stay visitors (average five weeks), representing an increase of 60% on the previous year. The total number of visitors, including participants at our many workshops (up to two weeks), was close to 1,000 and they came from more than 40 countries.

Our broad coverage of the mathematical sciences was emphasised this year by the programme on *Financial Mathematics*, a topical field which attracted the interest and support of many major banks, including the Bank of England.

The administration of the Institute has been greatly strengthened by the appointment this year of Sir Peter Swinnerton-Dyer as (honorary) Executive Director. This will help with the transitional arrangements until the new Director takes over in October 1996.

The Institute runs continuously at high pressure throughout the year, making extensive demands on the staff dealing with the logistic arrangements of our numerous visitors. I would like to pay tribute to the dedication of the staff in their demanding task, without which the science in the Institute could not flourish.

Sir Michael Atiyah, OM PRS

1. BRIEF HISTORY OF THE INSTITUTE

The Isaac Newton Institute for Mathematical Sciences was opened in July 1992, after four years of careful preparation. For a number of years and a variety of reasons, a need had been felt for a UK national institute in theoretical physics and mathematics. The realisation of this idea became possible with the availability of "pump-priming" financial support from Cambridge Colleges, notably St John's College and Trinity College (through the Isaac Newton Trust). St John's offered to provide a purpose-built building on land it owned in West Cambridge, promising to subvent the rent by £150,000*pa* for five years and Trinity offered £200,000*pa* towards running costs for the first five years.

Further support and endorsement came from the London Mathematical Society (LMS) at its retreat in May 1989 at the Isle of Thorns.

This was followed by negotiations with the Science and Engineering Research Council (SERC), since replaced by the Engineering and Physical Sciences Research Council (EPSRC), which invited proposals from universities wishing to develop a mathematics institute and, after consideration of proposals from Cambridge, Edinburgh (Edinburgh and Heriot-Watt Universities), London, Oxford and Warwick, recommended the funding of the Cambridge proposal and offered a 'rolling grant' of about £366,000*pa* for the first four years. This grant is reviewed every two years.

Sir Michael Atiyah was appointed Master of Trinity College in early 1990 and this cleared the way for him to become the first Director of the Institute.

Further funding was forthcoming from NM Rothschild and Sons and other generous contributions to setting-up costs came from Apple UK; Cambridge University Press; Princeton University Press; Springer-Verlag and other publishers; Christ's, Gonville and Caius, Emmanuel and Jesus Colleges; the Nuffield Foundation; Sun Microsystems and the University of Cambridge.

The Institute was formally established as part of the University of Cambridge on 2 November 1990, with a Management Committee and Scientific Steering Committee (see §3.1 and §4.3 below).

The Scientific Steering Committee met for the first time in 1990 and recommended the Director to select *Low Dimensional Topology and Quantum Field Theory* and *Dynamo Theory* as the first programmes to start in July 1992.

By the time the Institute opened on 3rd July 1992, the eight programmes for the first two years were at active stages of preparation, with invitations issued for nearly all of the first year and much of the second.

The official opening of the building had to wait until 30th October 1992 when the Chancellor of the University, HRH the Duke of Edinburgh, came to the Institute and met many of the visiting members.

2. NEW DEVELOPMENTS AND SUMMARY 1994 - 1995

Topological Defects and *Symplectic Geometry* were the programmes which ran from July to December 1994. They were followed by *Exponential Asymptotics* and *Financial Mathematics* which took place from January to June 1995.

2.1 Hewlett-Packard Inauguration: In October 1994 the Hewlett-Packard Basic Research Institute in the Mathematical Sciences (BRIMS) was inaugurated at the Newton Institute. This served to cement the Institute's special relationship with Hewlett-Packard who donated computer equipment worth £350,000 in July 1994 and later announced the establishment of a Hewlett-Packard Senior Research Fellowship based at the Newton Institute for a minimum of five years with full overhead. This generous support is worth at least £500,000, making a total gift of £850,000. The two Institutes will cooperate fully with each other, exchanging visitors and publicising each other's activities. Dr Colin Sparrow was appointed as the first Hewlett-Packard Senior Research Fellow in January 1995.

2.2 Leverhulme Trust: The Newton Institute also received its first year's support from the Leverhulme Trust in 1994/95. This money helped to support participants from Eastern Europe and the former Soviet Union on all four programmes, together with associated costs.

2.3 Gabriella and Paul Rosenbaum Foundation: The Gabriella and Paul Rosenbaum Foundation announced that it would extend its grant to the Newton Institute for a further two years (1995-1997).

2.4 Royal Society/Japan Society for the Promotion of Science/Kyoto Institute: Negotiations were completed in the latter half of 1994 between the Royal Society, the Japan Society for the Promotion of Science (JSPS), the Newton Institute and the Kyoto Institute in Japan. A scheme has been established whereby the JSPS pays the travel expenses of Japanese visitors coming to the UK in general and the Newton Institute in particular, and subsistence expenses for British visitors to Japan, and the Royal Society, through the Newton Institute, pays travel expenses for British scientists wishing to visit Japan, and the Kyoto Institute in particular, and also provides some subsistence support for Japanese visitors to the UK.

2.5 European Post-Doctoral Institute in Mathematics: Initial steps were taken in 1994/95 towards the establishment of a European Post-Doctoral Institute in Mathematics. This is a joint project with the Institut des Hautes Etudes Scientifiques (IHES) in Bures-sur-Yvette, France and the Max-Planck Institut für Mathematik in Bonn, Germany. Applications for funding were made to the European Union. The Institute will be formally established in the second half of 1995.

2.6 Corporate Sponsorship: A different kind of donation from industry was associated with the *Financial Mathematics* programme. Individual companies opted to become corporate members of the programme and, for a flat fee, were then able to send representatives to seminars and conferences. The scheme proved to be highly successful. It is expected that it will continue after the end of the programme itself in the shape of an annual one- or two-day meeting to be held at the Institute. In addition, the Bank of England donated £10,000 for a summer conference.

2.7 Programme Variations: There were discussions at both the Scientific Steering Committee and the Management Committee about possible variations in the usual Newton Institute programme format of two programmes running concurrently from January to June and two concurrently from July to December. The initial outcome of these discussions was that from July to December 1996 there will be one substantial programme *The Mathematics of Atmosphere and Ocean Dynamics* which will occupy all the space for the majority of the time, and two smaller six-week programmes,

one for six weeks in July and August, *The Mathematical Modelling of Plankton Population Dynamics*, and one for six weeks in November and December, *Four-Dimensional Geometry and Quantum Field Theory*. The Institute's committees will then assess the advantages and viability of future programme variations.

2.8 Fellowships: The Prudential Senior Visiting Fellows in 1994/95 were Professor S Pliska (*Financial Mathematics*) and Dr C Howls (*Exponential Asymptotics*). The Institute of Physics Fellow was Professor Sergei Slavyanov (*Exponential Asymptotics*). The Rosenbaum Fellows were Dr S Bates (*Symplectic Geometry*); Dr T Vachaspati (*Topological Defects*); Dr M Dunster (*Exponential Asymptotics*) and Dr A Cadenillas (*Financial Mathematics*).

2.9 Staff Changes: There were major staff changes during the course of 1994/95. Professor Peter Goddard left the Institute on 30th September 1994 and Professor John Wright became the new Deputy Director on 1st October 1994. Professor Goddard was elected Senior Fellow of the Institute by the Management Committee in October 1994. Dr Pelham Wilson resigned as Assistant Director with effect from 30th September 1994. Helen Strudwick, Computer Systems Manager since before the Institute opened, left at the beginning of November. Her Deputy, Mustapha Amrani, was promoted to Computer Systems Manager and Neil Dunbar was appointed in Mustapha's former role. Marjolein Allen, Librarian since before the Institute opened, left at the end of March 1995 and will be replaced by Andrea Le Core in September 1995. The Institute was very fortunate in being able to secure the services of Professor Sir Peter Swinnerton-Dyer as Executive Director from June 1995.

2.10 Management Committee: Members of the Management Committee reached the end of their initial terms of service on 31st December 1994. Most were reappointed but the Chairman, Professor PV Landshoff, who was instrumental in helping to set up the Institute, retired from the Committee as did Dr PMH Wilson. Professor Sir Martin Rees became the new Chairman and Dr N Linden replaced Dr Wilson. Dr G Reid, the appointee of St John's College was replaced by Professor G Segal. Dr GLI Richards became the EPSRC representative and Professor D Brannan replaced Professor JDM Wright as the LMS representative when the latter became Deputy Director.

2.11 Instructional Conferences for Young Scientists: Each programme during the year used the Institute's funding from the European Community to run a Euroconference, an instructional conference aimed at young people under the age of 35. The *Topological Defects* programme combined this with a NATO Advanced Study Institute (ASI) which is again targeted at young people. This conference was entitled *Formation and Interactions of Topological Defects* and was attended by over 80 young people. The Euroconference on the *Symplectic Geometry* programme was entitled *Floer Homology and Symplectic Geometry*; that on the *Financial Mathematics* programme, *Mathematical Finance* and that on the *Exponential Asymptotics* programme, simply *Exponential Asymptotics*. All were well-attended and well-received.

2.12 Talks Elsewhere: Visitors to the Newton Institute gave over 130 talks in other institutions. Universities visited included: Bristol; Dundee; Durham; Edinburgh; Glasgow; Heriot-Watt; Hewlett-Packard Basic Research Institute in Mathematical Sciences, Bristol; Hull; Imperial College; King's College, London; Lancaster; Liverpool; Manchester; National Physical Laboratory, Teddington; Newcastle; Oxford; Queen Mary and Westfield; Rutherford Appleton Laboratory; Sussex; University College, London; Warwick and York.

2.13 Building Security: Improvements were made both to the security of the building, following a number of thefts in other University departments, and to Seminar Room 2. The latter were made in response to questionnaire comments from participants and as a result the audio-visual system and blackout arrangements in Seminar Room 2 have been much improved.

2.14 Building Improvements: A new photocopying room was built underneath the staircase in the south west corner of the building to enable the photocopier to be moved out of the General Office. A new reception desk has also been built outside the General Office so that the Receptionist is more readily available to greet incoming visitors.

2.15 World Wide Web: The Institute set up its entry on the World Wide Web during the course of the year. Those seeking information through electronic means, on the Institute itself, its programmes, visitors and seminars can therefore now use WWW, ftp or gopher (see §5.5).

2.16 Cambridge University Press Publications: Further monographs in the series *Publications of the Newton Institute* were published by Cambridge University Press. These were *Lectures on solar and planetary dynamos*, edited by MRE Proctor and AD Gilbert; *Geometry of constrained dynamical systems*, edited by JM Charap and *Real-time computer vision*, edited by CM Brown and D Terzopoulous. Other volumes are still in production.

2.17 Princeton University Press Publications: Princeton University Press is planning a publication based on Professor Martin Kruskal's theory of Surreal Numbers to accompany other texts currently in preparation.

2.18 Visits from Anne Campbell, MP: The local MP, Anne Campbell, paid two visits to the Newton Institute in autumn 1994, the first to find out about the Institute itself and the second to attend the local mathematics teachers' colloquium.

Peter Goddard with Anne Campbell

3. MANAGEMENT AND STAFF

3.1 Management: The management of the Institute is the responsibility of the Management Committee. As stated above, the initial terms of office of all members of the Management Committee expired on 31st December 1994. Some were re-elected but the Chairman, Professor PV Landshoff retired from the committee and was replaced by Professor Sir Martin Rees, Dr PMH Wilson resigned and was replaced by Dr N Linden, Professor JDM Wright was succeeded as LMS representative by Professor D Brannan when the former became Deputy Director, Dr G Reid was succeeded as St John's College representative by Professor G Segal and Dr GLI Richards became the EPSRC representative in place of Mr J Farrow. The Committee consists of the Director, the Deputy Director, the Heads of the Department of Applied Mathematics and Theoretical Physics (DAMTP) and the Department of Pure Mathematics and Mathematical Statistics (DPMMS), five persons appointed by the General Board of the Faculties (of whom one is nominated by the Council of the School of Physical Sciences, one is nominated by the Faculty Board of Mathematics and one is nominated by the School of Technology), a Chairman appointed by the General Board, one person appointed by each of St John's College, Trinity College and the EPSRC and one additional person co-opted at the discretion of the committee.

The membership of the Management Committee at 30 June 1995 was:

Professor Sir Martin Rees, FRS	CSPS & General Board *Chairman*
Sir Michael Atiyah, OM, PRS	Director
Professor A Baker, FRS	Trinity College
Professor D Brannan	General Board
Professor JH Coates, FRS	Head DPMMS
Professor DG Crighton, FRS	Head DAMTP
Professor AP Dowling	School of Technology
Dr N Linden	Faculty of Mathematics
Professor FP Kelly, FRS	General Board
Dr GLI Richards	EPSRC
Professor G Segal, FRS	St John's College
Professor JDM Wright	Deputy Director
Professor Sir Christopher Zeeman, FRS	General Board

During the year 1994/95 the Management Committee met once during each University term (on 31st October, 6th March and 29th May). At these meetings it received reports on the Institute's finances, facilities, publicity, housing arrangements and fund-raising efforts. It approved the scientific programmes which the Director proposed to it on the advice of the Scientific Steering Committee and it received the minutes of that Committee. It was responsible for recommending to the General Board elections to Rothschild Visiting Professorships on the advice of the Director. It received regular detailed reports on the progress of planning for those programmes which had been approved and final reports on those programmes which had been completed.

3.2 Staff Sir Michael Atiyah remains Director of the Institute until the end of September 1996. During the course of 1994/95 procedures were initiated to appoint his successor.

Professor Peter Goddard left the Institute at the end of September 1994 when he became Master of St John's College. He was replaced as Deputy Director by Professor John Wright.

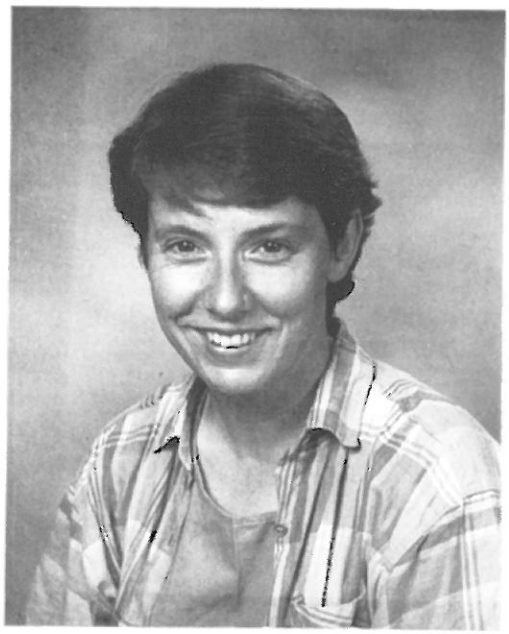
Helen Strudwick, Computer Systems Manager and one of the first members of the Institute's staff to be appointed, left at the beginning of November 1994. Dr Mustapha Amrani, who had been her Deputy since January 1994, was appointed as her successor. Neil Dunbar was appointed as the new Deputy Computer Systems Manager.

Marjolein Allen, Librarian and Information Officer and a very early employee of the Institute, left at the end of March 1995 and will be replaced by Andrea Le Core at the beginning of September 1995.

Florence Leroy spent the year at the Institute as Conference and Programme Secretary, a position previously filled by Jane Marsters. Michael Sekulla, who has worked at the Institute for quite some time in a temporary capacity, succeeded her.

Tracey Hibbitt was congratulated on her outstanding performance as Receptionist and upgraded to Secretary. Teresa Secker was upgraded from Catering Assistant to Receptionist.

As usual the Institute could not have run without the assistance of many other staff working as temporary or casual employees. In the year 1994/95 these have included: Elsie Batchelor; Louise Crascall; Ian Farquharson; Kate Gibbons; Michael Goddard; Ben Hardwick; Jane Hartwell; Penny Hunter; Wanda Lewcun; Carrie Marshall; Simone Marshall; Michael Sekulla; Peter Wren and Stephen Wren.



Helen Strudwick. Photo: Eaden Lilley Photography

Thanks are also due to those who assisted with the production of various Institute publications. These have included: Ian Farquharson; Matthias Gaberdiel; Daniel Scott; Paul Shah.

The present staff of the Institute consists of:

Director	Sir Michael Atiyah OM, PRS
Executive Director	Professor Sir Peter Swinnerton-Dyer FRS
Deputy Director	Professor J Wright
Institute Administrator	Ann Cartwright
Administrative Assistant	Lynne Stuart
Computer Systems Manager	Mustapha Amrani
Deputy Computer Systems Manager	Neil Dunbar
Librarian & Information Officer	Andrea Le Core
Housing Officer	Wendy Abbott
Accounts Clerk	Sarita Haggart
Conference & Programme Secretary	Michael Sekulla
Assistant to Administrator	Penny Hunter
Secretary	Tracey Hibbitt
Receptionist	Teresa Secker
Cleaner	Clive Dean

The Director, Executive Director and Deputy Director were supported in 1994/95 by two Assistant Directors, Dr Pelham Wilson (until 30th September 1994) and Dr Noah Linden.

3.3 Evaluation The Institute continues to collect information and monitor its performance and

achievements in various ways in order to seek means of improving its management and administrative procedures.

Biographical information on each visiting member is requested at the time of acceptance of invitation. At the time of departure, each visiting member is given a general questionnaire, requesting an evaluation of and comments on the Institute's facilities, staff support, financial provision and coffee, tea and lunch arrangements. Visiting members are also asked to fill out a housing questionnaire. Conference participants are asked to complete a questionnaire requesting evaluation and comments on conference organisation, scientific content, lunch arrangements and accommodation arrangements. The results of all these questionnaires are collated and discussed at regular staff meetings, together with suggestions for changes and problems which have emerged. Where possible, improvements have been made, for example recent improvements to Seminar Room 2 (see §5.1 below). This is seen as a continuing process.

The numbers of younger scientists attending lectures and seminars at the Institute are also monitored (although this relies upon them signing in at reception or being registered as affiliated participants). Numbers of women attending are recorded too. Each visiting member is required to write a report on his or her stay, giving details of work done and useful interactions during the visit and each fills in both a form indicating talks given in other academic institutions and one which indicates publications which are likely to arise out of the visit. These are followed up at regular intervals until publication details are received. On the whole the reports of visiting members have been positive and often very enthusiastic. A selection is quoted here (TOP = *Topological Defects*; SYG = *Symplectic Geometry*; EXP = *Exponential Asymptotics* and FIN = *Financial Mathematics*):

My sincere gratitude for excellent conditions for scientific work. I Bogulubsky, TOP

My visit to the Newton Institute was extremely stimulating. The program and the ASI led to a detailed exchange between particle physicists/cosmologists... and condensed matter theoreticians. I was persuaded that we (the particle physicists) must apply new methods... I feel that the program had had an important impact on current physics. R Brandenburger, TOP

The Isaac Newton Institute is a wonderful place to do science. T Kephart, TOP

It is also important to emphasize the unique contributions provided by the Isaac Newton Institute through its interdisciplinary nature. It is invaluable to learn and understand the jargon, approaches, and frameworks to problems which I already have an energizing attachment to. Such interactions are nearly impossible without day to day 'shoulder-rubbing', and are difficult without a gathering of the very best, and hence most articulate, researchers in their respective fields. I gather this is one of the goals of the INI, and I think it is achieved very well. A Rutenberg, TOP

The arrangements at the Institute are ideal for the exchange of ideas and for working long hours and weekends. T Vachaspati, TOP

This program has been a wonderful chance for me to learn new things ... It is the place where symplectic geometry was happening in the last six months - and I feel fortunate to have participated in it. D McDuff, SYG

By comparison (to other international institutes), the NI is quite extraordinary: the design and organization of the building and the functioning of a very supportive staff create an atmosphere that is remarkably conducive to interaction between visitors... I thank the staff for finding me comfortable living quarters and for giving me valuable assistance with the use of computers. My only regret is that I was unable to stay for a longer period of time. C Bender, EXP

Management and Staff

This experience at the Newton Institute has been by far the best one that I have had at any meeting devoted to a single subject or body of knowledge... the individuals present were a rather unique blend of pure and applied mathematicians together with mathematical physicists ...(which in my) experience... has not been brought together previously and invited to share a common program. D Lutz, EXP

My stay here at the Isaac Newton Institute is the best academic semester of my career. Especially the possibilities to concentrate purely on research, and to talk with other experts in the field at any time, will make this the most productive semester of my academic career. A Olde Daalhuis, EXP

I am very grateful to the staff of the Institute and the organizers of the Conference for invitation, assistance, financial support and creative atmosphere. To my mind the Isaac Newton gives excellent opportunities for scientists. S Slavyanov, EXP

(The Financial Mathematics programme) brings together top rated researchers as well as some leading industry practitioners by providing a continuous form over a six month period. I have personally benefited from this opportunity, and believe that this forum has significantly advanced our understanding of the financial systems around the world. There is no doubt in my mind that many ideas generated in the gathering will have profound impact on the discipline of Finance in both academic and practical dimensions. J Duan, FIN

The setting at the Sir Isaac Newton Institute is ideal for informal discussion and interaction. I Karatzas, FIN

I found my visit to the Institute extremely fruitful and invigorating. P Kopp, FIN

The Term Structure conference must rank as one of the most prestigious ever convened, since it has gathered together at one time and in one place so many academics that have made key breakthroughs in this area. J Steeley, FIN

The staff derive considerable satisfaction from such comments but they are far from complacent and are constantly striving to improve the Institute as a stimulating environment for research.

4. PROGRAMME STRUCTURE AND ORGANISATION

4.1 General The Institute adopted the pattern, for its early years at least, of having four research programmes per year, two running concurrently from January to June and two from July to December. This pattern was followed throughout 1994/95 when the programmes were *Topological Defects* and *Symplectic Geometry* (July to December 1994) and *Exponential Asymptotics* and *Financial Mathematics* (January to June 1995).

Each programme had an average of 17 to 24 visiting members in residence at any one time and the Institute had a total of 360 visiting members during the year. (The Institute classes those participants who stay for seven days or more as visiting members.) The total number of visiting members in a programme was between 73 and 103. The statistics for the four programmes which took place in 1994/95 are given in the following table:

Programme	*Visiting Members*	*Average Stay (days)*	*Average Occupancy*
Topological Defects	86	45	24
Symplectic Geometry	103	27	17
Exponential Asymptotics	73	39	19
Financial Mathematics	98	34	20

During its third year the Institute has seen a further increase in the overall number of visiting scientists. These have included 360 visiting members (almost one hundred and forty more than the previous year), each staying between one week and six months, just over five weeks on average. Both UK and overseas participation increased, the former from 56 to 64 and the latter from 169 to 296. Within the four programmes there have been a total of 32 workshops (an increase of 8 on the previous year). These were periods of more intense activity on specialised topics or pedagogical activities which involved an additional 507 participants, of whom 378 were from the UK. 61 of these were affiliated participants, young people who accompanied visiting members and stayed for periods ranging from several days to the full six months. In addition, the programmes themselves attracted a number of short-term visitors, including 107 who stayed for only a few days. Thus the Institute had a total of 974 recorded visitors in 1994/95 (and undoubtedly there were others who attended occasionally for lectures, workshops or Institute seminars).

The visiting members are listed in §9.1 and a chart showing the periods of their visits is given in §9.2. A breakdown of numbers by nationality is given in §9.3 and a graph showing the age distribution of visiting members is shown in §9.4. The median is 39 years with an interquartile range, 33 years to 49 years. For workshops and short stay visits the profile is younger. Detailed biographical records have not been compiled for all short stay participants but an age survey at a typical workshop indicated that the average age was 35.

4.2 Scientific Planning: The scientific planning for each programme is the responsibility of a team of three or four organisers. The choice of organisers is made so as to reflect the intended scope of the programme.

Programmes are selected about two years before they are scheduled to begin. The first task of the organisers is to identify leading workers who are willing to commit themselves to participating in the programme for an appreciable period. A wider group can then be approached in successive tranches. In the period between eighteen and six months before a programme starts the budgets for travel and subsistence are committed in this way. Six months before the programme starts budgets are

usually over-committed by between 5% and 10%. Naturally there will then be subsequent changes and withdrawals due to unforeseen circumstances, leaving flexibility in the budget to enable some invitations to be issued just before and during the programme.

A typical structure for a programme is to begin with some more pedagogical activity, to have two or three more specialised workshops towards the middle of the programme, focussing on particular aspects of the programme or closely related areas, and perhaps to end with some more general meeting summarising the state of the art. Such a model is not rigidly imposed and programmes vary quite considerably in their actual structure. Of those which took place in 1994/95, *Exponential Asymptotics* followed closely the pattern outlined above whilst *Financial Mathematics* because of the nature of its participants, particularly those from industry who were unable to absent themselves from their desks for long, deviated quite significantly from it.

In addition to the workshops which serve to widen UK participation in the programmes, the organisers are strongly encouraged to organise less formal special days, short meetings or intensive lecture series which can attract daily or short-term visitors, so further increasing the impact of the Institute on the UK mathematical community.

All of this is against the background of regular series of seminars in each programme. During the year 1994/95 there were over 740 lectures and seminars given in the Institute. A list of these seminars, which perhaps more than anything else illustrates the scope of the Institute and the intensity of its activities, is given in §9.5.

A list of publications produced by visiting members is also included in §9.6. This shows that the number of publications notified to the Institute in 1994/95 was 361, an increase of 32 on the previous year.

Visiting members of the Institute have also given over 130 seminars in departments outside Cambridge (an increase of 10 on the previous year). UK universities and other institutions at which visiting members have talked during 1994/95 include: Bristol; Dundee; Durham; Edinburgh; Glasgow; Heriot-Watt; Hewlett-Packard Basic Research Institute in Mathematical Sciences, Bristol; Hull; Imperial College; King's College, London; Lancaster; Liverpool; Manchester; National Physical Laboratory, Teddington; Newcastle; Oxford; Queen Mary and Westfield; Rutherford Appleton Laboratory; Sussex; University College, London; Warwick and York.

As mentioned above there has been much discussion in both Scientific Steering and Management Committee meetings about whether the original programme structure should be varied by having shorter or more substantial programmes or a mixture of both. Some topics, whilst not justifying a six-month programme might make excellent subjects for a two or three month one whilst others would justify spending a longer period of time or greater concentration of effort.

It has therefore been decided that from July to December 1996 there will be one substantial programme - *Mathematics of Atmosphere and Ocean Dynamics* - and two six-week programmes running alongside this. They will be *Mathematical Modelling of Plankton Population Dynamics* in July/August and *Four-Dimensional Geometry and Quantum Field Theory* in November/December. The basic programme structure will remain the standard but if this variation proves to be successful it will be repeated. A more diverse pattern could present greater logistical difficulties and, in the case of shorter programmes, some problems where Visiting Fellowships and Professorships were designed for participants staying for longer periods. There could also be too much overlap with the work of other British Institutes.

It has also been decided that there will be a slightly longer break between programmes in June/July in order to give staff time to complete administrative arrangements for the outgoing programmes

and to prepare properly for the new incoming programmes.

4.3 Scientific Steering Committee The Director is advised on the scientific work of the Institute and, in particular, on the selection of programmes by the Institute's Scientific Steering Committee. The scientists on this committee, with the exception of the Director, come from outside Cambridge. The Committee consists of the Director; three persons appointed by the General Board on the recommendation of the EPSRC; one person recommended by the General Board on the recommendation of the Particle Physics and Astronomy Research Council (PPARC); two persons appointed by the General Board on the recommendation of the LMS, six persons appointed by the General Board after consultation with the Councils of the Schools of the University and national scientific bodies (the Royal Society; the Royal Society of Edinburgh; the Royal Statistical Society; the Institute of Physics; the Royal Academy of Engineering; the Institute of Mathematics and its Applications and the Edinburgh Mathematical Society) and one additional person co-opted at the discretion of the Committee.

The membership of the Committee on 30 June 1995 was:

Professor Sir Christopher Zeeman, FRS	Oxford University	GB *Chairman*
Sir Michael Atiyah, OM, PRS	Newton Institute	Director
Professor JM Ball, FRS	Heriot-Watt	LMS
Professor MV Berry, FRS	Bristol	GB
Professor J-M Bismut	Orsay	GB
Professor M Cates	Edinburgh	GB
Professor S Donaldson, FRS	Oxford	EPSRC
Professor TWB Kibble, FRS	Imperial	PPARC
Professor J Moser	ETH Zürich	GB
Professor TJ Pedley, FRS	Leeds	GB
Professor BD Ripley	Oxford	EPSRC
Professor AFM Smith	Imperial College	EPSRC
Professor CTC Wall, FRS	Liverpool	LMS

Professor GA Gehring, and Professor JT Stuart, FRS, were also members of the Committee during 1994/95. The Committee is required to meet once per year but in practice meets twice per year, in Spring and Autumn.

4.4 Scientific Policy The Scientific Steering Committee perceives its role as involving both the consideration of proposals received and the stimulation of proposals in the areas of mathematical sciences which it considers to be potentially particularly suitable for the Institute. The Institute advertises its willingness to receive proposals in a variety of ways which have included the annual distribution of a poster containing a "Call for Proposals" to over 500 departments and institutions concerned with mathematical sciences in the UK and abroad, and publicity on ftp, gopher and World Wide Web (see §5.5). At meetings the Committee regularly considers in which areas it should stimulate proposals and the Director, Executive Director, Deputy Director or individual Committee members then assume responsibility for taking action in particular areas.

It is the intention of the Scientific Steering Committee that the Newton Institute should be devoted to the Mathematical Sciences in the broad sense. The range of sciences in which mathematics plays a significant part is, of course, too large for an Institute of modest size to cover adequately. 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 which are presented by departmental structures in Universities. In consequence, a main criterion in judging the "scientific merit" of a proposed research programme

is the extent to which it is "interdisciplinary". Usually this will involve bringing together research workers with very different backgrounds and expertise. There must, however, be a clear common ground on which all can focus and each programme has to have a substantial and significant mathematical content and a broad mathematical/scientific base. A further main criterion should be that the subject area is in the forefront of current development.

Because of the wide base of support for the Newton Institute in the research councils and elsewhere, the Institute's programmes should as far as possible represent an appropriate balance between the various mathematical fields. Such considerations, however, are secondary to the prime objective of having high quality programmes. If there are no exciting developments, actual or potential, in a particular field, it would be wrong to run a programme simply to maintain a balance.

4.5 Programmes The Institute began its scientific work in July 1992 with its first two programmes on *Low-dimensional Topology and Quantum Field Theory* and *Dynamo Theory*; since then ten further programmes on *L-functions and Arithmetic*; *Epidemic Models*; *Computer Vision*; *Random Spatial Processes*; *Geometry and Gravity*; *Cellular Automata, Aggregation and Growth*; *Topological Defects*; *Symplectic Geometry*; *Exponential Asymptotics* and *Financial Mathematics* have been completed. On the advice of the Scientific Steering Committee, the following programmes have now been selected for 1995-1997:

July to December 1995

Semantics of Computation

From Finite to Infinite Dimensional Dynamical Systems

January to June 1996

Dynamics of Complex Fluids

Computer Security, Cryptology and Coding Theory

July to December 1996

Mathematics of Atmosphere and Ocean Dynamics

Four-Dimensional Geometry and Quantum Field Theory

Mathematical Modelling of Plankton Population Dynamics

January to June 1997

Representation Theory of Algebraic Groups and related Finite Groups

Non-Perturbative Aspects of Quantum Field Theory

July to December 1997

Disordered Systems and Quantum Chaos

Neural Networks and Machine Learning

Details of programmes from July 1995 onwards are given below:

Semantics of Computation
Organisers: S Abramsky (Imperial), G Kahn (INRIA Sophia-Antipolis), JC Mitchell (Stanford), AM Pitts (Cambridge)
July to December 1995

Advances in hardware have enabled a huge expansion of the capabilities and uses of computer systems. The challenge of effectively engineering the software of these systems has led Computer Scientists to identify fundamental principles for structuring computational tasks, such as the use of *procedures* (i.e. breaking down large programming tasks into smaller blocks), and of *concurrency* (many tasks being performed simultaneously, possibly by separate units). These principles have been embodied in programming languages, and methods for reasoning about such constructs have

been developed. The attempt to provide rigorous foundations for these developments has resulted in a rich mathematical theory of the semantics of computation. While striking successes have been achieved, there are major challenges to refine the current framework for semantics in order to deal with the subtle issues which arise, for example, in combining concurrency and procedures. The programme will bring together mathematicians, theoretical computer scientists, language designers and software engineers, with the aim of enhancing the interactions between these overlapping communities, and thus furthering the interplay between foundational work and advanced language design and software technology.

From Finite to Infinite Dimensional Dynamical Systems

Organisers: P Constantin (Chicago), JD Gibbon (Imperial), J Hale (Georgia), CT Sparrow (Cambridge)
July to December 1995

The non-linear behaviour of dynamical systems is of great and continuing interest in mathematics and throughout the sciences. Although work in this area was originally stimulated by attempts to understand high dimensional systems such as the weather, much of the effort focussed on non-linearities in low dimensional systems for which the proofs and numerical experiments are much easier. More recently, progress has been made towards clarifying the relationship between low and high dimensional systems (including infinite dimensional ones). Some of these results show that infinite dimensional systems (PDEs for example) can be effectively finite dimensional, whilst others attempt to describe truly infinite dimensional behaviour. What these recent developments have in common is that they combine the topological approach, which has been so successfully applied to low dimensional systems, with classical analytic methods. The programme will bring together experts in both finite and infinite dimensional systems, and aims to make progress in such areas as spatio-temporal chaos, attractors in infinite dimensional systems, and others where experimental and numerical results suggest that both topological and analytic theories play important rôles.

Dynamics of Complex Fluids

Organisers: TCB McLeish (Leeds), JRA Pearson (Schlumberger Cambridge Research), K Walters (Aberystwyth)
January to June 1996

Many fluids of industrial, biological and environmental importance (eg molten plastics, salad dressings, whole blood, sinovial fluid, fluidised sediments) respond in a complicated fashion when deformed. The reasons for this complexity can be traced back to their molecular structure and to the hydrodynamic forces acting between molecules. The programme will bring together experts who seek to relate flow behaviour to structure and those who seek to predict flow fields of such fluids in complex geometries, with particular reference to polymer melts, polymer solutions, liquid crystals and colloidal suspensions. This involves modelling on a wide range of length (and associated time) scales, ie from molecular dynamics to large scale continuum mechanics. Most of the mathematical problems that arise involve non-linear differential, integro-differential or integral equations; a full range of analytical and numerical techniques has to be employed to obtain solutions.

Computer Security, Cryptology and Coding Theory

Organisers: RJ Anderson (Cambridge), PG Farrell (Manchester), P Landrock (Århus), RM Needham (Cambridge)
January to June 1996

Over the past twenty years, the quest for dependable computer systems has fuelled rapid advances in cryptology and coding theory. Cryptology is used to secure electronic transactions, while coding

theory has facilitated many recent advances in radio based communications. These techniques are central to designing distributed systems which will perform reliably despite the presence of noise and of malicious attacks, and there is a growing interaction between them at the theoretical level. Practical aspects are also important, and incorporating cryptographic and coding techniques into systems turns out to be much more complex than was first anticipated; this has led to interest in formal methods of verification and in robustness principles. By bringing together mathematicians, computer scientists and engineers working in these related fields, the programme aims to further both the theoretical and the engineering aspects of the art.

Mathematics of Atmosphere and Ocean Dynamics
Organisers: JCR Hunt (UK Met Office), ME McIntyre (Cambridge), J Norbury (Oxford), I Roulstone (UK Met Office)
July to December 1996

Weather forecasts are routinely computed for up to 10 days ahead, based on large quantities of wind, temperature and humidity data that are collected continuously and used to modify the computations. The data are of course insufficient to determine the exact state of the atmosphere. Since they are very expensive to obtain there is a premium on their optimal exploitation. Therefore it is of the highest importance for numerical weather prediction to identify the dominant processes and flow features that determine how the large scale weather patterns develop. By then ensuring that the continuous assimilation of data is consistent with these features the accuracy of the forecasts is greatly increased. Ocean modelling is beginning to develop similar data assimilation techniques. Recent exchanges of ideas between mathematicians and atmosphere-ocean dynamicists has brought a new geometric global viewpoint to these problems, in particular a new appreciation of how fluid-dynamical conservation laws, for example potential vorticity, connect with the symplectic geometric structure of the underlying equations of motion. A major challenge for the programme will be to bring ideas from geometry, analysis and the theory of dynamical systems to bear on the practical and urgent problems of weather forecasting, ocean and climate modelling.

Mathematical Modelling of Plankton Population Dynamics
Organisers: J Brindley (Leeds), M Fasham (Southampton), J McGlade (Warwick)
29 July to 06 September 1996

Plankton play a key role in ocean-atmosphere dynamics. Their effects range from alterations on a local scale of the structure of the sea-surface temperature and mixed layer depth, to ocean basin-wide emissions of potentially important climatological gases such as dimethyl sulphate, up to global fluxes of atmospheric carbon. These effects occur over a wide range of spatio-temporal scales and via a number of different biophysical processes. The programme will bring together mathematical and numerical modellers with biological oceanographers to review, improve and develop models, addressing particularly the needs to understand the spatio-temporal scale distribution of plankton behaviour and its relationship with the physical dynamics of the ocean-atmosphere system.

Within the six week programme will be embedded a specialist meeting attended by much larger number than the core participants, focussing on the effects of physical forcing on plankton populations and the consequences for fisheries.

Four-dimensional Geometry and Quantum Field Theory
Organisers: Sir Michael Atiyah, H Osborn (Cambridge)
04 November to 13 December 1996

This six-week programme will focus on the exciting recent developments centering around a remarkable duality in four-dimensional space-time. This formally interchanges Electricity and Magnetism

and works in certain non-abelian gauge theories. It has major implications for the understanding of strong interactions in physics and in four-dimensional geometry.

Representation Theory of Algebraic Groups and Related Finite Groups
Organisers: M Broué (Paris), RW Carter (Warwick), J Saxl (Cambridge)
January to June 1997

There is a famous theory due to Hermann Weyl for the characters of the finite dimensional irreducible representations of simple algebraic groups over the complex numbers. In finite characteristic no analogous formula has been proved, but there is a conjecture due to Lusztig which expresses the irreducible characters as linear combinations of the Weyl characters. This is related to certain characters of affine Kac-Moody algebras, and also to the representations of certain quantum groups - the latter being at the moment a rapidly developing branch of mathematics. Other related themes include subgroup structures of the corresponding groups of Lie type.

Non-Perturbative Aspects of Quantum Field Theory
Organisers: D Olive (Swansea), P Van Baal (Leiden), P West (King's College, London)
January to June 1997

Recent results of Sen, Seiberg and Witten have made increasingly plausible the idea of a quantum transformation between the weak and strong coupling regimes of certain spontaneously broken supersymmetric gauge theories in space-time of four dimensions. The relevant ideas encompass and unify many topics studied intensively over recent years by particle physicists including QCD and the theory of instantons, solitons and their quantisation, conformal field theory, Yang-Baxter equations, the s and t duality of string theory and the mirror symmetry of Calabi-Yau manifolds. The new results have also already had an impact on pure mathematics, for example in the understanding of the Donaldson classification of four manifolds. The aim of the programme is to explore the idea of electromagnetic duality, to gain new insights into fundamental physics (for example, the issue of confinement in QCD, and the improved formulation of unified string theories), and into pure mathematics.

Disordered Systems and Quantum Chaos
Organisers: J Keating (Bristol), DE Khmelnitskii (Cambridge), IV Lerner (Birmingham)
July to December 1997

The quantum properties of disordered systems have been the focus of considerable attention in many branches of physics, principally nuclear physics and condensed matter physics. Recently it has been recognised that many of the same phenomena also occur in deterministic systems which possess only a few degrees of freedom, but which are chaotic in the classical limit. Even more surprisingly, the theories developed in these areas also have natural counterparts in a number of topics in mathematics; for example, in the study of spectral properties of random operators and random matrices, in the theory of Fourier integral operators, in harmonic analysis (specifically in the theory of the Riemann zeta-function and related L-functions). In the past few years an extremely stimulating and productive cross-fertilisation between the above fields has slowly been developing. The aim of the programme is to accelerate the already significant rate of progress on some of the important common problems which occur, in different guises, in each area. The main topics upon which the programme will focus are localisation, fluctuation statistics, and trace formulae; with a particular emphasis on their role in the theory of mesoscopic systems.

Programme Structure and Organisation

Neural Networks and Machine Learning

Organisers: CM Bishop (Aston), D Haussler (UCSC), GE Hinton (Toronto), LG Valiant (Harvard), M Niranjan (Cambridge)
July to December 1997

Research into the problem of machine learning has grown significantly in recent years, stimulated in part by the emergence of a range of successful, large scale applications. At the same time there have been many impressive developments in the theoretical foundations of this field. These have arisen from several complimentary approaches including statistical pattern recognition, computational learning theory, statistics, information geometry and statistical mechanics. The principal aim of this programme is to promote greater inter-disciplinary collaboration between researchers from these different communities.

5. FACILITIES

5.1 Building: The Institute's building contains two seminar rooms with flexible seating (the larger, Seminar Room 1, holding between ninety-six and one hundred and fifty people and the smaller, Seminar Room 2, between thirty-six and fifty) a library, thirty offices (the majority double and some single occupancy), a General Office (for administration), offices for the Institute Administrator and the Deputy Director and common areas. For use in the seminar rooms, the Institute possesses four GBI 5000 overhead projectors, three Kodak Carousel 35mm slide projectors and a GEC CRT projector (mounted onto the ceiling in Seminar Room 1) which can project European and USA videos (in PAL, SECAM and NTSC formats) and the output, in monochrome or colour, from a SunSPARC station, an HP, a Macintosh Quadra or a PC. In each seminar room there are six chalk boards and two overhead projector screens. In Seminar Room 1 there is also a central screen which can be raised and lowered automatically from the lectern. It can be used for the CRT projector, one or two slide projectors (which can be controlled from the lectern) or an overhead projector.

The library, seminar rooms and administrative offices are grouped around a ground-floor common area. The scientists' offices which are on the mezzanine and galleried first and second floors, surround the mezzanine common area. Throughout the building there are places for discussion grouped around chalkboards. As with the rest of the Institute's facilities, the building has been designed with a view to quickness of assimilation, which is of prime importance given the relatively short average stay of participants compared with the members of a normal university department.

Improvements have been made to various aspects of the building in 1994/95. The audio-visual facilities in Seminar Room 2 have been substantially upgraded, with the addition of new tilting screens and a projector trolley. Curtains in Seminar Room 2 have been put on a pulley system so the room can be screened quickly and effectively.

A new Reception Desk has been built outside the General Office which accommodates two members of staff comfortably and three at particularly busy times. This means that new arrivals can be greeted at once and queries can be answered without the need to enter the office. The desk has proved to be particularly useful during conferences.

A staff photocopying room has been built underneath the stairs at the south west corner of the Institute. The photocopier previously in the office has been relocated as has the franking machine, leaving space for additional staff to work. The room is also used as a stationery store.

New cupboards have been built under the stairs at the north east corner of the building. These are used for storing coffee bar items.

Radiators in all offices throughout the building have been fitted with valves which enable them to be turned on and off by individual participants. This is important for the Newton Institute as visiting members come from so many different countries and climates. Air conditioning for both individual offices and the central space is currently being investigated.

Various measures have been taken to improve the security of the building, including additional security cameras and new locks and panic bars. Systems continue to be upgraded.

5.2 Computing: During the past year there have been several notable changes within the Computing Department at the Institute. At the beginning of October 1994 Helen Strudwick left the Institute to take up a new post at St John's College. She was replaced as Computer Systems Manager by Dr Mustapha Amrani.

In June 1995 the Department welcomed Neil Dunbar who joined the Institute as Deputy Computer Systems Manager. Although the Department is still stretched to provide an optimum service, this

appointment now means that many improvements to the system which have been delayed can now be implemented.

Hewlett Packard kindly donated ten new machines (1 HP 735 and 9 HP 715) which were set up and installed with the following software packages: TEX, LaTEX, Xdvi, Emacs, Perl, μemacs, Xemacs, Ghostview, xv, xmgr, Gnu gcc and g++ compilers, FORTRAN compiler and ANSI C compiler. These machines have filled a gap in the Institute's resources and their popularity with participants, particularly from the *Topological Defects* and the *Exponential Asymptotics* programmes, indicates that they are a valued addition to the system.

Several software packages were upgraded or added to UNIX in order to improve the existing provision. These include: Maple V version 3 on both Suns and HPs, Netscape (WWW browser) version 1.1N on all platforms (Suns, HPs, Macs and PCs), and Perl (Practical Extraction and Report Language) and Tcl/Tk on both Suns and HPs . In order to make the E-mail facilities at the Institute easier for novices, a new Pine mail system was installed.

The Isaac Newton Institute for Mathematical Sciences Wide World Web server was launched on 6th March 1995 (see §5.5). This Internet service provides information about the Institute including seminar information, lists of visitors, etc. According to the access figures, this is proving to be very popular and has increased the profile of the Institute in the international forum via the Internet. Seminar lists and phone lists are now generated in HTML to be incorporated in the WWW automatically on a weekly basis. The FTP archive and the gopher server were restructured to facilitate navigation. Every effort has been made to ensure that the information is up-to-date, this has been done by automating the periodic change of information such as the weekly seminar lists and weekly room and phone list. New messages are displayed at login or when the user changes to a particular directory.

On the administrative side, there have been several improvements to the existing databases and some new databases were added such as the Automatic Payment System and the Archiving System. The Novell System was installed with new versions of ODI drivers and VLM shells. Windows for workgroups 3.11 was also installed, along with the latest version of NCSA for most of the PCs. This should help to ensure that the administrative system of IBM compatibles and Macintosh machines is adequately equipped to cope with the intensive use it is subjected to. The existing Menu system was extended to allow access to all the current databases. In addition, access to telnet and ftp via the menu system was also provided. The system now offers the user a choice of seven machines including ipgate.

Due to incompatibility problems between the version of dBASE IV that was in use, and the newer NetWare VLM drivers (as opposed to the IPX driver), it was decided to upgrade the current databases to dBase IV version 5.0. DBase 5.0 was therefore purchased and installed on the Novell system. Updates of all existing dBase IV programs to the new version are underway, to take advantage of all the features of the new version. All PCs are being upgraded to 8Mg RAM in order to allow access to the World Wide Web and also the new dBase 5.0.

A series of workshops has been held for Institute administrative staff to help familiarise them with the potential of existing programs available and to answer any queries arising.

5.3 Library: The number of monographs currently held in the Library stands at 3570 and a catalogue of nearly all of these is available online via the University's Online Public Access Catalogue which can be accessed from the terminal in the library, in the offices of participants or remotely. In cataloguing the monographs thought has been given to the future developments for the library. The titles and holdings of serials are also on this system and can be accessed similarly.

Over the period 1994/95 nearly 550 loans were recorded. A commonly used rule of thumb states that for every loan transaction there are four other transactions taking place in the library, so that would make the transactions over the last year roughly 2200.

The library was heavily used by participants on the *Financial Mathematics* programme in particular and by affiliated participants on all four programmes.

The archives of publications of past participants is maintained in the library and is growing steadily. Copies of many of the papers have also been deposited. Details of papers are upgraded regularly and automatically sent to the Institute's File Transfer Protocol system.

Further Institute publications in the Cambridge University Press series appeared this year. These were *Lectures on solar and planetary dynamos*, edited by MRE Proctor and AD Gilbert; *Geometry of constrained dynamical systems*, edited by JM Charap and *Real-time computer vision*, edited by CM Brown and D Terzopoulous.

Marjolein Allen, the Institute's first Librarian left to join the staff of the University Library. She will be replaced in early September by Andrea Le Core.

Marjolein Allen, Librarian

5.4 Housing: The Institute provides housing for its participants in eleven flats (Mordell Court, Chesterton) and a listed building containing six study bedrooms (1 Chapel Street, Chesterton), both of which are rented from St Johns College, and an average of twelve privately owned houses and flats.

For a single person, prices vary from 15 to 18 pounds per night, with accommodation ranging from single study bedrooms to self-contained one-bedroom flats. For accompanied participants, prices range from 20 to 28 pounds per night - the price reflects the size of the property and the length of stay.

All the accommodation that the Institute has arranged is fully furnished and of good quality and the rent charged includes council tax, water rates, maintenance and standing charges for utilities. The prices reflect the fact that, in order to be able to guarantee accommodation for its relatively short stay members, the Institute often has to rent properties for periods when they will be unoccupied, therefore the rent charged to members must cover these voids. The rent charged must bear a sensible relation to the subsistence allowance paid by the Institute, currently 30 pounds per day. This allowance is primarily designed to cover the accommodation and basic food costs for a single person. It should also cover the cost of accommodation for a participant accompanied by his or her family, though not in this case the food costs as well.

Due to natural programme breaks and the fact that the visit period for participants varies considerably causing inevitable voids, it is difficult to get the average occupancy rate above 275 days per year. However, despite the foregoing and landlords imposing higher rents, the housing office is maintaining a healthy financial position with an annual turnover of 200,000 pounds. The housing office is also responsible for arranging accommodation for conferences which also contributes to the housing budget.

5.5 Publicity: The *Financial Mathematics* programme attracted much publicity for the Institute including articles in the *Financial Times* and *EPSRC News*.

The Institute has continued to publicise its own activities widely. NATO ASIs and Euroconferences each have their own specially targeted mailing lists which are used for each conference. Posters are

sent out well in advance of the conference date, inviting applications for funding.

All events are now also publicised on the Institute's own World Wide Web pages which contain information about all aspects of the Institute's activities. Those wishing to invite Institute participants to visit their own institutions can find out exact dates and direct line telephone contact numbers. Those wishing to attend the programmes or individual workshops and conferences can find all necessary details in addition to helpful ancillary information such as how to get here and a map of the institute's exact location. Information is constantly checked and upgraded and browsers can also find connections to other useful sources such as the programmes of the Hewlett-Packard Basic Research Institute in Mathematical Sciences in Bristol. The Newton Institute home page is:

http://www.newton.cam.ac.uk

Information is also available electronically via ftp and gopher and we encourage those seeking information on a regular basis to join either our email or standard mailing lists which can be either general or programme-specific.

The Scientific Steering Committee sends out a Call for Proposals on a regular basis to encourage new ideas and proposals for programmes. Weekly mailouts both through conventional and electronic means publicise programmes and seminars.

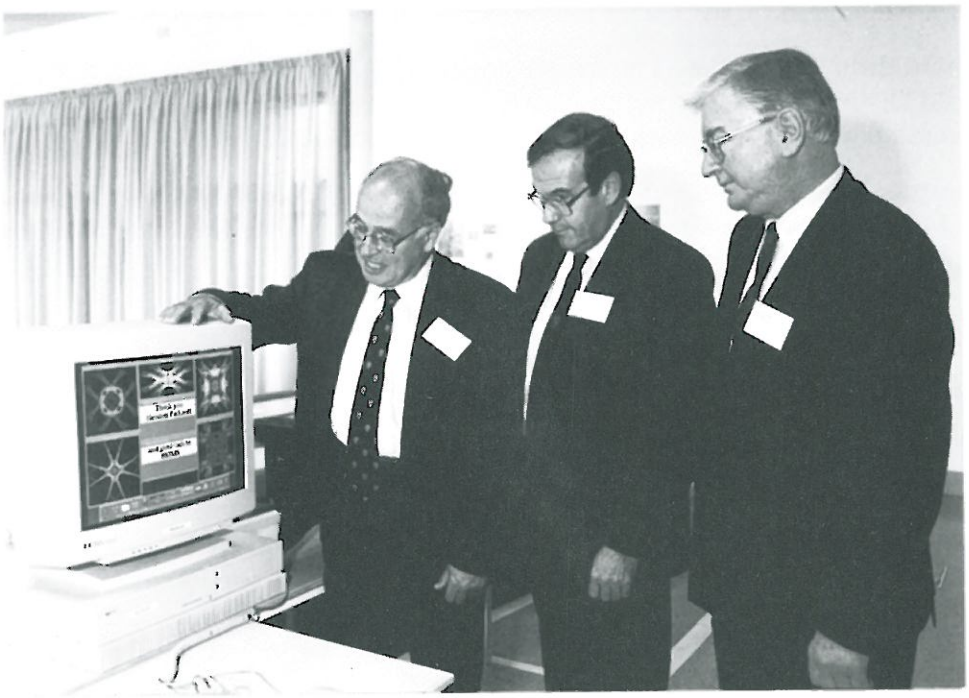
5.6 Merchandise: The Institute has continued to expand its list of available merchandise. Fermat's Last Theorem T-Shirts still sell well two years after Andrew Wiles' seminal lecture. In addition there have been programme-specific T-shirts for the *Topological Defects* and *Symplectic Geometry* programmes and a new generic Newton Institute T-shirt is now also on sale. Postcards of the Institute continue to be popular as do pens. More recently mugs and Christmas cards have been added to the range. Any profits from sales go to support the Institute's activities.

The Isaac Newton Institute Christmas card

6. FUND-RAISING AND GRANT AID

6.1 EPSRC: The Institute continues to receive rolling grants from the EPSRC for both scientific and administrative salaries and associated overheads, and for travel and subsistence for participants. These grants will next be reviewed in the autumn of 1995.

6.2 Hewlett-Packard: In addition to the donation of equipment worth £350,000, Hewlett-Packard are also funding a Hewlett-Packard Senior Research Fellow with full 100% overheads. The first Hewlett-Packard Senior Research Fellow is Dr Colin Sparrow. He was appointed from 1st January 1995 until 30th June 1996. The appointments procedure for his successor, who will be appointed for three years with the possibility of a further two, is now well under way.



Sir Michael Atiyah, Dr John Taylor and Professor Sir David Williams at the inauguration of the Hewlett-Packard Basic Research Institute in the Mathematical Sciences. Photo: Michael Manni Photographic

The inauguration of Hewlett-Packard's Basic Research Institute in the Mathematical Sciences took place at the Newton Institute on 11th October 1994. Talks were given by Professor Michael Berry on *Quantum Mechanics, Chaos and Prime Numbers* and Professor Frank Kelly on *Modelling Information Networks*, and Sir Michael Atiyah and Dr John Taylor, Director, Hewlett-Packard Laboratories, Europe, spoke about the relationship between the two institutes. Various distinguished persons, including the Vice Chancellor of the University of Cambridge, Professor Sir David Williams, attended the inauguration as well as senior members of the Hewlett-Packard organisation. The Rt Hon David Hunt, MP, Chancellor of the Duchy of Lancaster and Minister for Public Service and Science was unable to attend but sent the following statement about the inauguration:

> *I am delighted to welcome the establishment of the Basic Research Institute in the Mathematical Sciences (BRIMS). This joint undertaking will combine the complementary strengths of one of the world's leading mathematical research institutes, the Isaac Newton at the University of Cambridge, and part*

of Hewlett-Packard's mathematics research group in Bristol. This is an exciting initiative linking the private sector with a first class research institute and I congratulate the University of Cambridge in attracting this new institute to the United Kingdom. I wish BRIMS every success.

6.3 Isaac Newton Trust: The Isaac Newton Trust continued to provide the Institute with £200,000*pa* as a contribution to overheads for 1994/95. In addition, it made a contribution of £10,000 towards the salary of the Librarian and Information Officer. The Trust has announced that it will continue to support the Newton Institute beyond the period of its present grant, which ends in June 1997, and will do this by means of a loan or endowment.

6.4 St John's College: St John's College donated the sum of £150,000 to the Institute in 1994/95 being the third instalment (of five) of its funding to offset the rent of the Newton Institute building.

6.5 NM Rothschild and Sons: The money donated by NM Rothschild and Sons for the salary of a Rothschild Distinguished Visiting Professor was held over until 1995/96 as suitable candidates in 1994/95 were above the University's age limit for an established position.

6.6 Leverhulme Trust: The first instalment (of three) of £55,000 was paid by the Leverhulme Trust to the Institute to provide travel and subsistence for scientists from Eastern Europe and the former Soviet Union with associated costs.

6.7 Centre National de la Recherche Scientifique (CNRS): CNRS donated its third contribution of 400,000FF to the Institute towards subsistence and travel costs for French participants (in particular those from CNRS laboratories) and related costs.

6.8 Gabriella and Paul Rosenbaum Foundation: The Institute received the third instalment of a grant which has now been extended from three years to five years from the Gabriella and Paul Rosenbaum Foundation. The $70,000 given funds the salary of one young American scientist on each of the Institute's four programmes. The recipients in 1994/95 were Dr T Vachaspati (*Topological Defects*); Dr S Bates (*Symplectic Geometry*); Dr M Dunster (*Exponential Asymptotics*) and Dr A Cadenillas (*Financial Mathematics*). Dr Bates was awarded a National Science Foundation of America bursary for the second part of his stay at the Institute and so, with the permission of the Gabriella and Paul Rosenbaum Foundation, the latter three months of his grant was held over and will be awarded as an additional amount when there is an outstanding field for future programmes.

6.9 NATO Advanced Study Institutes (ASIs): An application was made to NATO by the organisers of the programme on *Topological Defects* for support to fund a conference under the NATO ASI programme. This conference was aimed at young scientists. The application was successful and the conference was awarded £49,962.

6.10 European Union: The Institute continued to use its funding from the European Union's Human Capital and Mobility Fund to fund one Euroconference per programme. Conferences on the *Topological Defects* and *Symplectic Geometry* programmes were funded from the 60,000 ecu given for Newton Institute Euroconferences Series One and conferences on the *Exponential Asymptotics* and *Financial Mathematics* programmes were funded from the 90,000 ecu awarded for the Newton Institute Euroconferences Series Two.

6.11 Corporate Membership of the Financial Mathematics Programme: Companies and financial institutions were invited to become corporate members of the *Financial Mathematics* programme. Each paid a fee of £2,000 or $3,000 and was then entitled to send as many representatives as it wished to workshops and conferences which formed part of the programme. The full list of corporate members was: Bank of England; BARRA; BZW; Chase International; Citibank; Deutsche

Bank; Deutsche Genossenschaftsbank; Equitable House Investments; Kleinwort Benson; Midland Global Markets (later HSBC Markets); Monis Software; Morgan Grenfell; NationsBanc; NatWest Markets; Prudential Corporation; Rothschild Asset Management; Salomon Brothers; Sanwa International; Societe Generale. The Prudential Corporation and Rothschild Asset Management were given complimentary membership because of their long-standing support for the Institute. The scheme was extremely successful and it is hoped that it will be extended beyond the programme with an annual *Financial Mathematics* meeting and circulation of general information.

6.12 Prudential Distinguished Fellowship: The year's instalment of £25,000 from the Prudential Corporation was the third of four, given to be spent on distinguished visiting fellows and associated costs. In 1994/95 the recipients were Professor S Pliska (*Financial Mathematics*) and Dr CJ Howls (*Exponential Asymptotics*).

6.13 LMS: LMS awarded the sum of £10,000 to the Institute in 1994/95. This was the third instalment (of four) given to fund the participation of short-term UK mathematicians. In addition, the Institute was also granted £900 for a conference for young people on the *Topological Defects* programme and support for Spitalfields Days on each of the four programmes.

6.14 Institute of Physics Fellowship: The Institute received the third £10,000 instalment (of five) of its grant from the Institute of Physics which is given to support a visiting physicist from Eastern Europe. The recipient of the fellowship was Professor Sergei Slavyanov from the Department of Computational Physics at St Petersburg University who attended the *Exponential Asymptotics* programme.

6.15 Jesus College: Jesus College contributed £5,000 towards running costs as it has pledged to do for the first five years of the Institute's operation.

6.16 Cambridge Philosophical Society: The Cambridge Philosophical Society funds four bursaries of £250 each per Institute year to enable young (under 35) scientists to attend the Institute's programmes. In 1994/95 the recipients of these awards were P Norbury (*Symplectic Geometry*), C Woodward (*Symplectic Geometry*), D Hobson (*Financial Mathematics*) and A Olde Daalhuis (*Exponential Asymptotics*).

7. FINANCIAL REPORT

Below is a complete list of major donations to the Newton Institute.

7.1 Major Donations in Cash

SERC/EPSRC	£3239k over 5 years
Isaac Newton Trust	£1050k over 5 years
St John's College	£750k over 5 years
Hewlett-Packard	£490k over 5 years
NM Rothschild & Sons	£333k over 5 years
NATO	£250k over 4 years
Rosenbaum Foundation	£225k over 5 years
Centre National de la Recherche Scientifique	£200k over 5 years
Leverhulme Trust	£165k over 3 years
Cambridge University	£121k
European Union	£107k over 4 years
Gonville and Caius College	£100k
Prudential Corporation plc	£100k over 4 years
London Mathematical Society	£70k over 5 years
Nuffield Foundation	£57k
Institute of Physics	£50k over 5 years
AFCU (Hamish Maxwell) $50,000	£32k
AFCU (Anonymous Donation) $50,000	£32k
Emmanuel College	£30k
Daiwa Anglo-Japanese Foundation	£26k over 2 years
Jesus College	£25k over 5 years
Corporate Members (FIN)	£32k
Bank of England	£12k
Applied Probability Trust	£10k over 3 years
Trinity College	£10k
Schlumberger UK	£9k
Cambridge Philosophical Society	£5k over 5 years
Christ's College	£5k
Harlequin Software	£5k
National Environment Research Council	£5k
Wellcome Trust	£5k

7.2 Donations in Kind

Computer equipment has been donated by Hewlett-Packard, Sun Microsystems and Apple UK (total value in excess of £670,000); software has been donated by NAG, Claris and Wolfram Research. Over 4000 books and journals have been donated by a large number of publishers and individual members of the mathematical community (estimated total value of gifts in kind is £927,000).

7.3 Summary Accounts for 1993/94 and 1994/95

Category	93/94	94/95
Expenditure		
Consumables	70,506	101,831
Computing	24,969	41,839
Library	27,467	23,538
Institute Rent	184,000	184,000
Scientific Costs	546,916	543,217
University Overheads	34,127	34,838
Staff Costs	211,836	296,834
Depreciation/Reprovision	80,000	140,000
Total	**1,179,821**	**1,366,096**
Income		
Grant Income	1,134,586	1,303,151
Workshops	30,337	38,874
General Income	10,924	32,982
Housing	9,325	2,833
Total	**1,185,172**	**1,377,839**
Income less Expenditure	5,351	11,743

Notes

[i] Consumables

The total figure for consumables is higher than in 1994/95. Some extraordinary items are listed below:

Building Costs: £20,987
Equipment Costs: £5,221
Recruitment Advertising: £5,408

[ii] Staff Costs

Staff costs are higher in 1994/95 than 1993/94 because we have had two computer officers for the whole year, we have employed a Hewlett-Packard Senior Research Fellow for half a year and we employed additional staff with NATO funding for a workshop.

In addition we have employed one extra member of staff because of the increased workload engendered by an increased number of participants and an increased number of conferences and workshops.

Financial Report

[iii] Grant Income

The following is a breakdown of grant income in 1993/94 and 1994/95:

	93/94	**94/95**
EPSRC	565,138	578,950
Newton Trust	210,000	210,000
St John's College	150,000	150,000
Hewlett-Packard		98,000
Leverhulme Trust		55,000
Rothschild	54,477	
Prudential	600	50,000
CNRS	47,243	46,474
Rosenbaum	46,789	38,768*
EC (Leibnitz)		21,479*
Daiwa	10,000	
LMS	10,000	10,000
Institute of Physics	10,000	10,000
Jesus College	5,000	5,000
American Friends	939	6,621
Royal Society		2,859*
Cambridge Philosophical Society	1,000	1,000
Interest	22,000	19,000
Other	1,400	
Total	**1,134,586**	**1,303,151**

* Indicates part of grant received carried over to be spent in forthcoming year - net figure shown here.

[iv] General Income

An increase in general income in 1994/95 reflects an increase in publications of the institute and higher interest rate and greater use of deposit accounts.

[v] Workshops

Corporate memberships for the *Financial Mathematics* programme were attributed to the workshops budget.

[vi] Housing

A decrease in housing income in 1994/95 reflects a higher number of short-stay visitors who came at the same time and were therefore accommodated in guest houses, reducing the occupancy of the Institute's accommodation at other times.

[vii] Depreciation/Reprovision

The Institute estimates that it needs at least £110,000*pa* to cover projected reprovision needs. As this target was not reached in 1993/94, a higher amount has been put aside in 1994/95.

8. PROGRAMME REPORTS

Programme 9: Topological Defects (July to December 1994)

Report from the Organisers:
AJ Bray (Manchester), TWB Kibble (Imperial), RS Ward (Durham)

Local Organisers: A-C Davis, NA Manton, EPS Shellard

Objectives: Topological defects appear in a vast array of physical situations, ranging from unified theories of elementary particles at the very highest energy scales to low-temperature laboratory phenomena near absolute zero. These defects exhibit remarkably similar behaviour, whether it be the reconnection of cosmic strings or of superfluid vortices, or the evolution of a defect network in a liquid crystal or in an expanding universe. Despite this very substantial overlap, there has hitherto been surprisingly little interaction between particle physicists, cosmologists and condensed-matter theorists. Indeed, it is not difficult to cite examples of closely related advances which were arrived at independently, a notable example being the simultaneous recognition of the relevance of homotopy theory for classifying topological defects.

The purpose of this programme was to bring together those working on Topological Defects from a wide range of different disciplines, in particular quantum field theory, topology, high-energy particle physics, cosmology and condensed-matter physics.

Organisation of the Programme: The organisation was undertaken by an organising committee of three — Professors Tom Kibble (Imperial College, Principal Organiser), Alan Bray (Manchester) and Richard Ward (Durham) — together with three local organisers — Drs Anne-Christine Davis, Nicholas Manton and Paul Shellard.

Throughout the six-month period, we ran three regular series of weekly seminars, a Topological Defects seminar on Tuesdays and two more informal lunch-time seminars on Wednesdays and Thursdays. The Wednesday seminars were intended to be particularly inter-disciplinary, while the Thursday programme was devoted mainly though not exclusively to defects in cosmology, the subject with the largest representation among our participants.

An important part of the programme was a NATO Advanced Study Institute on *Formation and Interactions of Topological Defects*, from 22 August to 2 September. The organising committee comprised Anne-Christine Davis (chair), Robert Brandenberger, Hans-Reiner Trebin and Gene Mazenko. The lecturers were:

- Maurice Kléman, Paris
- Ray Rivers, Imperial College
- Tom Kibble, Imperial College
- Gene Mazenko, Chicago
- Wojciech Zurek, Los Alamos
- Hagen Kleinert, Berlin
- Nigel Goldenfeld, Illinois at Urbana
- Neil Turok, Princeton
- Paul Shellard, DAMTP, Cambridge

- Alan Bray, Manchester
- Ruth Durrer, Zürich
- Martti Salomaa, Helsinki
- Bernard Yurke, Bell Labs, Murray Hill
- Nicholas Manton, DAMTP, Cambridge
- Brandon Carter, Observatoire de Paris, Meudon

We also ran several one- or two-day meetings:

14/15 July. *Topological Defects in Semiconductors, Superfluids and Liquid Crystals* (organiser: Alan Bray).

12/13 September. *Defects in First-Order Phase Transitions* (organisers: Anne-Christine Davis, Tom Kibble).

19 September (LMS Spitalfields Day). *Soliton Dynamics and Moduli Spaces* (organisers: Richard Ward, Nicholas Manton).

12–14 October. *Topological Defects: Numerical Approaches* (organiser: Paul Shellard).

16/17 November. *Topological Defects in Cosmology* (organisers: Tom Kibble, Anne-Christine Davis).

The London Mathematical Society supported not only the Spitalfields Day but also the final two-day meeting on Topological Defects in Cosmology.

Two of our participants gave Institute colloquia: Hans-Reiner Trebin on *Quasicrystals* and Tom Kibble on *Cosmic Strings in the Early Universe — and in the Laboratory?*.

Participation: The programme attracted about 90 participants (plus others who came for just one of the short meetings) for periods ranging from a week to six months, with an average of five to six weeks. There were also about a dozen students as affiliated participants. In addition, several Cambridge people came fairly regularly to our seminars and took an active part in more general discussions. We succeeded in maintaining an approximately constant number throughout the period. We attempted to ensure a reasonable balance between the different disciplines represented in the programme. In this we were only moderately successful. There were some periods when the cosmologists seriously outnumbered the others. Nevertheless, we were able to maintain a core representation from each camp.

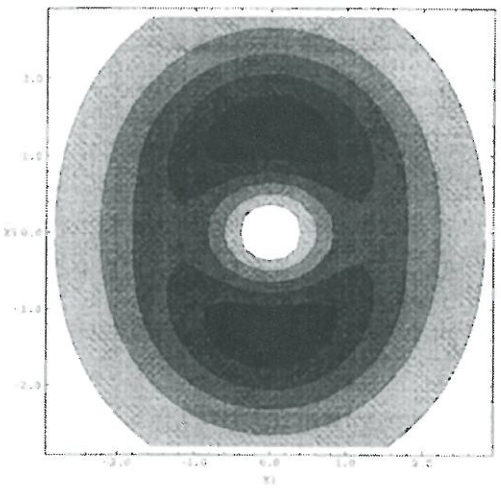
The ASI was attended by approximately 100 people, including about 45 long-term participants and over 50 others who came only for the two-week period. The other short meetings attracted somewhat smaller, but very satisfactory, numbers.

The reactions of participants were generally very positive. Several commented particularly on the successful interaction between different disciplines — a typical comment was 'truly successful, genuinely interdisciplinary'. Three or four made somewhat negative comments, mostly relating to the imbalance in numbers during certain periods, particularly a lack of condensed-matter physicists or of more formal mathematical physicists. The vast majority clearly saw the meeting as well organised, stimulating and worthwhile. One participant (Patricio Letelier) said it was 'the best I ever attended'! A notably large proportion praised the administration of the Isaac Newton Institute.

The questionnaire to participants at the ASI also gave excellent results: all respondents rated the organisation as excellent or good, and 32 out of 34 gave a similar rating to the scientific content.

Achievements: Overall this was a very successful programme, which has resulted in significant advances in several different areas.

The most notable feature, already mentioned above, was the successful interaction between different disciplines. We discovered several examples where people have been studying similar problems in the condensed-matter field and in cosmology but without knowing of each other's work.



Spatial probability distribution of nuclear matter for the deuteron, treated as a quantum bound state of two Skyrmions.

One of these concerns the topological classification of defects. The primary classification of defects in terms of the homotopy groups of the 'vacuum manifold' — the manifold of degenerate vacuum states or equilibrium states of the system — has been well understood for nearly twenty years. When a system with symmetry group G undergoes a phase transition in which the symmetry is broken spontaneously to the subgroup H, the vacuum manifold is the quotient space G/H. But there have been parallel developments by particle physicists and condensed-matter physicists, both largely ignorant of work in the other field: for example what are called 'composite defects' by particle physicists are 'semi-defects' in condensed matter.

More recently, it has been realised that the homotopy classification is in important ways incomplete. One of the most important discoveries of recent years was of 'embedded defects'. If G contains a subgroup G_1 which is broken to H_1, and if the relevant homotopy group of G_1/H_1 is non-trivial, one can embed the solution representing the G_1/H_1 defect in the larger theory. In some cases the embedded defect may be stable or at least metastable, even though it is not required by the homotopy of G/H. Such defects may for example play a rôle in the theory of baryogenesis — explaining the matter–antimatter asymmetry in the universe.

One of the very exciting ideas to emerge from the interdisciplinary discussions during our programme is that there may be similar structures in condensed-matter systems. A proposal has been made to search for them experimentally in liquid crystals. *Biaxial* nematics, which have recently been synthesised, provide the most promising candidate system.

Another example of cross-disciplinary fertilisation concerns what happens when two strings or vortices meet one another. In principle, they can either pass through one another without change or they can exchange partners — the process often known as 'intercommuting'. Particle physicists and cosmologists have come to believe that intercommuting *always* occurs. The evidence for this comes largely from quantum field theoretic arguments using the moduli space approach to defect dynamics, supplemented by numerical studies. Until now, condensed-matter physicists have generally been unaware of this work and have tended to assume that both outcomes are possible. The application to condensed matter may have considerable impact, for example on theories of high-temperature superconductivity.

In this context too, experiments with biaxial nematic liquid crystals would be of particular theoretical interest. This is because the fundamental group of the vacuum manifold is non-Abelian,

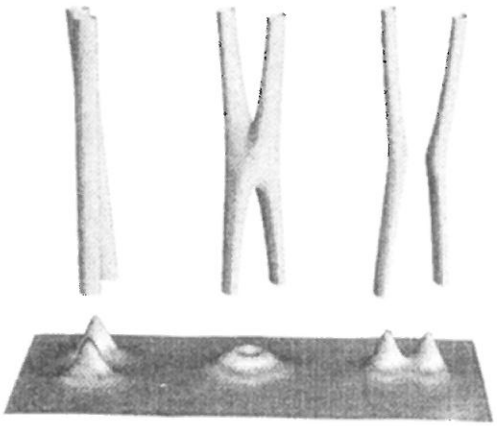
giving rise to very interesting possible dynamical effects.

One of main foci of debate throughout our programme has been on ways of estimating the defect density following a phase transition. People working on defects in cosmology have believed for many years that in the case of a second-order transition the basic length scale is set by the correlation length of the system at the so-called Ginzburg temperature. However comparison with work on transitions in condensed-matter systems has shown that this is incorrect: the length scale is determined by dynamical effects. This is a complicated issue that has occupied a lot of discussion time. A very much better understanding of the situation has now been reached. Several papers on it begun during the programme have now appeared.

There has also been important progress on the corresponding problem in the case of a first-order transition, though much still remains to be done. Some very promising collaborations have been started as a result of discussions at the programme.

Another area where there has been a valuable interchange of ideas is the study of the coarsening dynamics in the evolution of the systems of defects. This is a problem that has been extensively studied both in condensed-matter systems and in cosmology. There are obvious differences between the two cases — notably the fact that the dynamics is dominated by friction in the former case and by the expansion of the universe in the latter, but there are also striking similarities. In particular, in the early stages the two problems are very similar and lead to the same type of scaling behaviour. It has been very valuable to both communities to learn of the methods and approximations used in the other.

In the numerical field, there is the prospect that the sophisticated codes that have been constructed to study the evolution of cosmic strings in the early universe can be adapted to study flux tubes in superconductors and vortices in liquid helium. There may also be useful transfer of algorithms in the opposite direction.



The interaction of nearly parallel vortex strings. The two dimensional nature of the interaction is revealed by an energy density slice through the intersection where we observe the characteristic right-angled vortex scattering.

Several participants mentioned an unexpected synergy between the two parallel programmes, especially during the last few weeks. The last workshop in the Symplectic Geometry programme focussed on the new monopole equations found by Witten and Seiberg and their use in computing invariants of four-manifolds. The physical background of these equations lies in the $N = 2$ supersymmetric Yang–Mills theory, whose monopole solutions have been studied by several of the field theorists taking part in the Topological Defects programme.

Besides these interdisciplinary highlights, almost every participant reported progress on his or her own work. There has been notable progress for example in estimating the large-scale microwave background anisotropies induced by a network of cosmic strings, in theories of inflation and baryogenesis, in understanding quench experiments in liquid helium and in the isotropic–nematic transition, in extensions of the moduli-space approach to vortex dynamics, in numerical and analytic studies of coarsening dynamics, in the dynamics of two-dimensional Skyrmions, and on other topics too numerous to mention.

Conclusions: This was a successful programme. Even with the benefit of hindsight there are only a few things we would wish to change.

We should perhaps have made more strenuous efforts at an early stage to maintain a balance between the different disciplines. The problem arose partly because on the particle physics/cosmology interface there is a rather close-knit group of researchers working on topological defects, among whom news of an exciting event such as a Newton Institute Topological Defects programme spread rapidly, so that we had a lot of early applications. Had we fully appreciated the sociological differences between the communities, we would have made a bigger effort to ensure an equally rapid spread of information among the more diverse communities in condensed matter and field theory.

We were fortunate, however, that even during periods when there were relatively few condensed-matter representatives, those few proved to be extremely interactive, so that the interdisciplinary interaction could still continue very effectively.

Another area where we should have done better is in the representation of women. Our proportion of women was noticeably less than that of the parallel programme. Once again, this is something we should have addressed at an early stage. Only during the ASI did we have anything approaching a reasonably fraction.

Overall, however, the programme achieved more than many of us had hoped. The wide collaborations that have been set up will be of lasting benefit.

Finally, the Organisers wish to express their gratitude to the staff of the Isaac Newton Institute whose helpful and cooperative work did so much to make this programme memorable and rewarding.

TWB Kibble

Programme 10: Symplectic Geometry (July to December 1994)

Report from the Organisers:

S Donaldson (Oxford), D McDuff (Stony Brook), D Salamon (Warwick), CB Thomas (Cambridge)

The general aims of the programme were (1) to make progress on the existence and classification of symplectic structures, with special reference to dimension 4, (2) to study new algebraic invariants and their applications outside the area of symplectic geometry proper, and (3) exploit the parallelism between instanton and symplectic theories. In the course of the programme the last heading became extremely topical as a result of Witten's formulation of the monopole equations.

Overview of symplectic theory:

A symplectic structure on an even-dimensional smooth manifold is given by a closed 2-form ω of maximal rank. Such a form induces an almost-complex structure on the tangent bundle, which together with the real cohomology class of ω, form the most primitive topological invariants of the structure. Such manifolds arise naturally in classical mechanics, and ω can be thought of as a skew-symmetric analogue of a flat Riemannian metric. (Closure of the defining 2-form corresponds to the vanishing of the curvature tensor, which in both theories implies a unique local form for the 'metric'.) There is a sense in which symplectic theory carries the flavour of Kähler theory, and the most obvious examples of compact symplectic manifolds are projective algebraic varieties with the Fubini-Study metric. However, thanks to the efforts of R Gompf and others there are now numerous examples of non-Kähler symplectic manifolds, and more subtly of almost-complex structures which can be integrated symplectically but not holomorphically. This 'near-Kähler' nature can be illustrated by the following examples in dimension 4:

1. Direct calculation shows that the Seiberg-Witten invariant of a Kähler 4-manifold equals 1. By introducing a correction term into the Kähler argument, which is then deformed away C Taubes has shown (Autumn 1994) that, up to sign, the same holds for symplectic manifolds with $b_2^+ > 2$.

Taubes also shows that the connected sum of n copies of CP^2 with m copies of $\overline{CP}^2$ with the opposite orientation ($m \geq 0$, $n > 1$) has vanishing invariant and hence no symplectic structure compatible with the assigned orientation. This shadowing of a holomorphic argument in order to prove a symplectic result is also used by S Donaldson to prove a striking theorem on the existence of submanifolds.

2. Let V be a compact 4-dimensional symplectic manifold such that the cohomology class $[\omega]$ is integral. For sufficiently large values of k there exists a codimension two symplectic submanifold Z with $[Z]$ equal to the Poincaré dual of $k[\omega]$.

The second of these results figured prominently in the work of the programme. Donaldson himself gave lectures in three of the four workshops emphasising different aspects of his proof.

Another property which symplectic and complex manifolds seem to share is rigidity; again this can already be exhibited in dimension 4. For example D McDuff shows that if there is a positively immersed 2-sphere C in a minimal pair (V, ω) with $c_1(C) > 0$, then V is either a rational or a ruled surface. Such results are not entirely surprising given the general result that if two forms ω_1 and ω_0 on a compact manifold are connected by a smooth homotopy ω_t with constant cohomology class, then they are isotopic. And given the results of Donaldson and McDuff it becomes reasonable to ask about the uniqueness of the symplectic structure on CP^2, since the former guarantees the existence of some embedded symplectic surface.

On odd-dimensional manifolds the analagous structure is given by a contact 1-form α. Classically this is naturally defined on a surface of constant energy in a Hamiltonian system, and is again of

maximal rank, ie if the dimension of the underlying manifold M is $(2n+1)$, $\alpha \wedge d\alpha^n \neq 0$. Starting from the fact that all odd-dimensional spheres are contact, one can show that 'contact surgery' is possible. This implies that, without some restriction, contact structure is 'soft'. For example, provided that the structural group of the tangent bundle of the oriented manifold M reduces from $SO(2n+1)$ to $U(n)+(1)$ and M is sufficiently highly connected, M will admit a contact form. When $n=1$ one can even prove that the isotopy classification of contact structures *which satisfy the 'overtwisted' condition* coincides with the homotopy classification of the associated tangent plane fields $\xi = \{\alpha = 0\}$. Overtwisted means that there exists an embedded 2-disc on which ξ cuts a foliation with one closed leaf C and exactly one singular point in its interior. Eliminating such structures introduces rigidity — thus Y Eliashberg defines a contact structure to be 'tight' if there are no limit cycles cut on any embedded disc. He then proves

Theorem: A tight contact structure on the three sphere is isotopic to the standard contact structure associated with the Hopf fibration.

There are corresponding results for a few other manifolds, for example E Giroux has provided simple representatives for the isotopy classes of tight structures on the 3-torus, indexed by the integers $\mathbb{Z}$. More generally, in the course of the July workshop, Eliashberg sketched an argument to show how to perturb the tangent plane field of a codimension one foliation to a tight contact distribution. He also asks which compact 3-manifolds admit only finitely many isotopy classes of tight structures, the lens spaces being natural candidates.

Symplectic invariants and their applications:

Among the most powerful invariants in symplectic theory are the Floer homology groups, defined using an extension of Morse theory to suitable functions on special infinite-dimensional manifolds. So far two versions of the theory have proved their worth: the first (instanton theory) applies to 3- and 4-dimensional manifolds, the second (symplectic theory) to so-called *exact* symplectomorphisms with no restriction on the dimension. 'Exact' here means 'connected to the identity by means of a Hamiltonian flow', or equivalently 'belonging to the commutator subgroup of the group of all symplectomorphisms'. Under suitable restrictions, for example the vanishing of the second homotopy group of the underlying manifold V, the Floer groups can be used to show that the number of fixed points of an exact morphism is bounded below by the sum of the $\pmod 2$ Betti numbers of V, (Arnol'd Conjecture).

The instanton and symplectic theories are linked in an interesting way. Let $f: F \to F$ be a surface diffeomorphism with mapping torus $Y(f)$. $Y(f)$ is a 3-manifold for which the instanton Floer homology groups are defined; on the other hand let $M(F)$ be the moduli space of flat $SO(3)$-connections over F, identifiable with $\mathrm{Hom}(\pi_1(F), SO(3))$ modulo conjugation. $M(F)$ admits a natural symplectic structure which is compatible with the induced map $M(f)$; hence the symplectic Floer homology groups of $M(f)$ are defined. D Salamon and S Dostoglou have proved that the two families of Floer groups are isomorphic, and that even the ring structures are compatible. This result, explained at length during the second workshop, is particularly striking given that, although the symplectic Floer groups are additively isomorphic to the singular homology groups, the graded ring structures differ. This result, which one expects to extend to other classes of 3-manifold, beautifully illustrates the parallelism between symplectic and instanton theory to which I have already alluded. Furthermore M Callahan has used these techniques to show that symplectic Floer theory can distinguish between isotopy classes of symplectomorphisms.

Another class of symplectic invariants are 'capacities', which both behave like volumes and are essentially 2-dimensional. Their use has led to elegant proofs of many geometric properties of

symplectic manifolds, notably variants and refinements of the basic squeezing result. (This restricts the size of the symplectic camel in 4-space which can pass through a given 'eye' containing the origin.)

Spaces related to the moduli space $M(F)$ for a surface of genus g, with their natural symplectic structure, appear to have extremely interesting cohomology rings (either with the usual or the 'quantum' product). They received intensive study during the third workshop, which also concerned itself with Hamiltonian actions of compact Lie groups on symplectic manifolds, symplectic reduction, toric geometry and representation theory (via the orbit method).

Symplectic manifolds, instantons and algebraic geometry:

Since the 1960s there has been a sharp shift in the methods used to study 4-manifolds. Then the interest was in distinguishing between differentiable, PL and topological manifolds; now we are more interested in the fine structure of the first category. Thus projective algebraic varieties are Kähler, which are symplectic, which in turn are smooth manifolds with almost complex structures on their tangent bundles. One naturally asks which of these inclusions is proper, and remain so under the additional assumption of 1-connectedness, see the examples discussed above under the first heading. This analysis starts with the Donaldson invariants, combined by P Kronheimer and T Mrowka into a formal power series of the form

$$D(V) = (\exp Q/2) \sum_j a(j) \exp(K(j)),$$

where, under the assumption of 'simple type' the $K(j)$ are certain characteristic classes in $H^2(V)$. For certain manifolds such as elliptic surfaces usable formulae for D, involving hyperbolic functions, had (October 1994) been obtained, and the behaviour of D with respect to connected sums was well-understood. Then, quite suddenly, it became possible to include all these results in the properties of a totally new (Seiberg-Witten = SW) invariant, $SW: C \to \mathbb{Z}$, where C denotes the set of complex spin structures on the manifold V, and we assume that $b(+)(V) > 2$. A choice of spin structure determines a line bundle L with associated $U(2)$-bundles of positive and negative spinors, $S(+)$ and $S(-)(L)$. Seiberg and Witten then consider the space of solutions (A, ϕ) to the pair of equations

$$D_A(\phi) = 0,\ F_A^+ = (\phi, \bar{\phi})^+$$

specialise to the case when this space has dimension zero, ie is a finite union of points, and define SW = number of points. Building on their earlier work Kronheimer and Mrowka were then able to settle the following conjecture of R Thom:

Let g be the genus of a smooth surface representing the 2-dimensional homology class x in the 4-manifold V. Then g is bounded below by $(d-1)(d-2)/2$, where d is the degree of a complex algebraic curve representing the same class x.

What is particularly amazing about the SW-invariant is that it is motivated by physical theory which is as yet conjectural, and yet leads to hard proofs of mathematical results. Does this constitute experimental evidence?

The participants:

The list of participants demonstrates the interest aroused by the programme, particularly when one remembers that a similar long-term meeting had been held during the previous six months at the Institut Poincaré in Paris. The emphasis placed on different aspects of the subject at different times had the consequence that few of the participants stayed for more than a few weeks, but most of those who have contributed to the exciting developments sketched above visited Cambridge for some period during the six months. (The lower bound was achieved by M Gromov who came for the second week of the Euroconference.) The average stay was the two week duration of one of the four workshops, although several invitees participated in two or more.

Among the four organisers C Thomas was in residence for the full six months, D Salamon commuted regularly from the University of Warwick, D McDuff visited for July and August, and returned for the three later workshops, and besides being constantly on hand for advice. S Donaldson made a major contribution to the success of the second half of the programme. L Jeffrey was coopted as scientific adviser for the workshop on applications of symplectic methods, and by her enthusiasm contributed greatly to its success.

Sean Bates was the Rosenbaum Fellow and the EPSRC funded longterm stays by YG Oh (six months) and D Kotschick (two plus three months). We also profited from the presence of R Montgomery and A Schwarz, both of whom had originally considered themselves as participants in the parallel *Topological Defects* programme.

The mix of international participants varied with the activities. There was a heavy North American presence over the summer, and during the third workshop. We were very fortunate in that a grant from the Leverhulme Trust enabled us to invite a large number of mathematicians from the former East Bloc. These included not just the big names but several lesser known and younger mathematicians, who we hope will organise follow-up activities in their own countries. Throughout the six months there was close collaboration with other European countries, for example C Viterbo commuted from Paris throughout September, there were regular visits by a group of enthusiastic German research students, and we were seldom without a member of the thriving Swiss school of geometers.

The level of participation by British mathematicians was mixed with the largest number coming from Oxbridge and Warwick. This organiser at least was surprised that the programme did not make more appeal to native graduate students, particularly in the summer when important new developments in low-dimensional manifold theory were being explained. UK participation picked up during the Euroconference and was at its highest in December, when many students obviously made great efforts to come and hear lectures by E Witten, P Kronheimer, J Morgan and mathematicians of similar quality. We made a special effort to invite a number of researchers in 'affiliated' fields, such as algebraic topology, from English and Scottish universities. These short term visits were a success, and (we hope) help to raise the profile of the Institute.

Very few of those actually invited failed to show up. One particularly unhappy case was that of A Banyaga, who, having been refused a visa in July by the British authorities, was later detained in the United States by the immigration department! It was also unfortunate that C Taubes reneged on his original undertaking to attend the December workshop, and that H Hofer, having given some beautiful expository lectures in July and September, was prevented by illness from participating in the second half of the programme. There were also problems with inviting participants from Japan. We had hoped to profit from an exchange programme being negotiated between the Royal Society and the Japanese Mathematical Society, but the details of this were still incomplete at the end of the programme. The delay made it impossible for at least one mathematician to attend.

Affiliated students:

Besides the visitors from DAMTP and DPMMS there were a number of affiliated students either accompanying their supervisors, or participating as a result of encouragement by the latter. These included

A Canas da Silva (MIT) All four workshops
T Jarvis (Oxford) 25.9.–8.10. and 30.10.–12.11.
M Pozniak (Warwick) 25.9.–8.10.
H Ramanathan (Cambridge) 4.7.–17.12.
T Takieda (Princeton) 4.7.–17.12.
C Woodward (MIT) 30.10.–12.11.

T Jarvis should be read as representing a number of students accompanying Professor SK Donaldson.

Scientific activities:

These are outlined under various headings below. As with all programmes at the Institute the primary aim was to stimulate new research. As the partial list of publications illustrates, this was certainly achieved. Cooperation between various subdisciplines was good, and should lead to numerous joint papers, particularly in the area of overlap between symplectic and instanton theory.

1. Individual research.

This summary is culled from individual reports, and is in no way exhaustive. Furthermore, since so many of the leaders in the field participated in the programme, their work has already been covered in the initial survey. Defining the subject narrowly the two most important new results were Y Eliashberg's deformation theorem for 3-dimensional contact manifolds and S Donaldson's construction of symplectic submanifolds. An example of the probable impact of the former is provided by the work of H Geiges and J Gonzalo on the relation between contact forms and Thurston geometries. The notion of 'confoliation' provides a link between this work and earlier results on multifoliations. Another subject, which so far has been absent from this report is the geometry of Lagrangian submanifolds, which was intensively studied (at times in collaboration) by Y Chekanov, M Kazarian, YG Oh, K Ono, L Polterovich and T Takieda. For example, YG Oh has constructed a spectral sequence whose $E(2)$-level is given by the singular cohomology of the Lagrangian submanifolds of a symplectic manifold V, and which converges to the Floer cohomology of V. At the same time, and once more stimulated by the ideas of Y Eliashberg, R Ye and K Fukaya were working on problems associated with holomorphic discs. Although the subject of Poisson geometry did not figure prominently in the programme, we were lucky to catch A Weinstein on his way back to Berkeley from Paris, and to persuade him to lecture on "Flat connections and symplectic geometry". During his stay he also collaborated fruitfully with K Mackenzie from Sheffield; other researchers in this area included V Ginzburg, J Grabowski, M Karasev, JH Lu (Lie bialgebras and Lie algebra cohomology), P Xu and A Yoshioka. As has been indicated elsewhere the two variants of Floer (co)homology, and the relation between them were much studied during the programme. This was epitomised by D Salamon's lectures on the partial proof of the Atiyah-Floer conjecture, see above, but gained in significance when set beside the contributions of S Piuniukin (the equivalence of quantum and Floer ring structures), M Schwarz (pants-products in Floer theory), L Traynor and C Viterbo (generating functions). Various other individual contributions were made by A Givental (mirror symmetry), D McDuff (geodesics in the group of Hamiltonian symplectomorphisms, the

Hofer norm (both jointly with F Lalonde) and very useful expository work), H Konno (quantisation of moduli spaces), and M Shubin (semi-classical asymptotics and Morse inequalities). Finally A Schwarz took time off from the parallel programme to talk to many participants on a variety of topics. Outside the main workshops he also gave a talk on his work on "odd symplectic geometry".

2. Weekly seminars

Although the programme was built round the four workshops, a number of seminars and lectures were organised in between. These included a somewhat informal weekly colloquium, in which a participant would speak on some aspect of her/his research, two reading seminars on Carathéodory geometries (following M Gromov) and symplectic surgery (following R Gompf) respectively, and a short course by C Viterbo on his work on generating functions. In October and November SK Donaldson visited from Oxford and gave a course on the topology of moduli spaces, which it is hoped to write up for publication.

3. Workshops

Each of the four workshops described below were organised on the same pattern. The aim was four lectures of one hour each day, the morning lectures on M-T-Th-F being expository, and the afternoon lectures more specialised. Wednesday was kept for 'treats', and to provide slots for alterations in the programme. There was also a 'boot strap' seminar for graduate students in the middle of the day, which was also from time to time attended by one of the morning speakers to provide more explanation. This format worked well in July and September, but broke down during the third workshop in November, when so many invitees wanted (or needed?) to speak. Because of the excitement caused by E Witten's work this format also fell rather by the wayside in December. However the organisers would like to offer it as a model for future programmes at the Institute. Although each workshop is shown to run for two weeks, the formal scientific programme was organised on a Monday–Friday basis.

17.7.–30.7. *Instructional conference: 3-dimensional contact and 4-dimensional symplectic manifolds*

Great emphasis was placed on expository talks. All four organisers were involved in the choice of speakers and day to day arrangements.

Among the speakers were Y Eliashberg, E Giroux, R Gompf, H Hofer, D McDuff and A Weinstein.

25.9.–8.10. *Euroconference: Floer homology and symplectic invariants*

One of the aims of this meeting (organised by C Thomas and S Salamon) was to attract graduate students from as many members states as possible of the European Union. A separate report on this aspect has been prepared for DGXII of the Commission in Brussels.

Among the speakers were Y Chekanov, M Gromov, F Lalonde, D Salamon, M Schwarz, L Traynor and C Viterbo.

30.10.–12.11. *Applications of symplectic geometry*

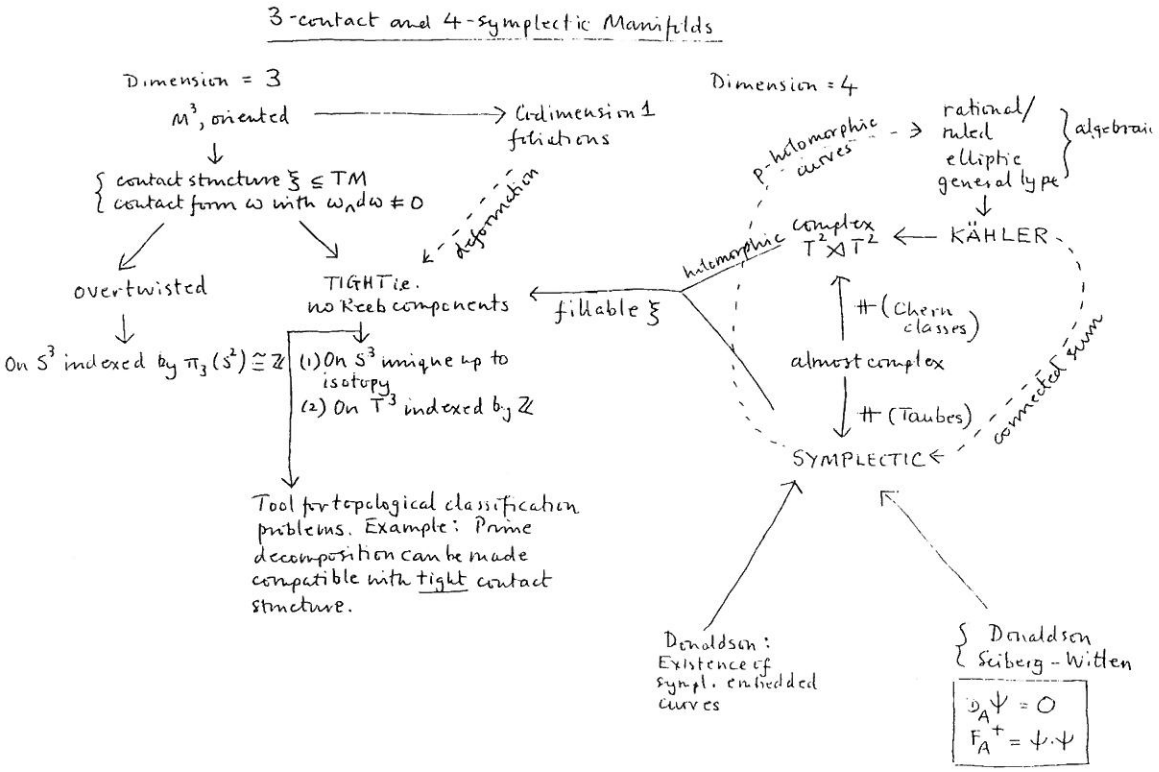
This workshop was very ably organised by L Jeffrey (Princeton/McGill) and included 42 formal lectures. The first week centred on the topology of moduli spaces, the second on group actions, representation theory and properties of the moment map.

4.12.–17.12. *Symplectic manifolds, instantons & algebraic geometry*

Programme Reports

The principal organiser of this meeting was SK Donaldson, and the programme was dominated by the recent work of E Witten, together with the geometric implications drawn by P Kronheimer, T Mrowka and C Taubes. A partial breakdown of the speakers gives:

4-manifolds: P Kronheimer, J Morgan, V Pidstagach and R Stern,
Algebraic geometry: F Catanese, M Manetti, U Persson,
Theoretical physics: R Dijkgraaf, D Olive,
Seiberg-Witten theory: E Witten (2 lectures).



The above chart illustrates some of the themes considered at the workshop on 3-dimensional contact and 4-dimensional symplectic manifolds, and the various connections between them. It is meant to emphasise the interdependance of 3- and 4-dimensional geometry, an aspect of the subject which has only increased in importance since December 1994.

4. Spitalfields Day

In conjunction with the London Mathematical Society the Institute played host to a Spitalfields Day on Wednesday, 7 December, which was advertised as widely as possible and open to all. Among the participants P Kronheimer and R Stern spoke; the remaining two talks were given by Sir Michael Atiyah and J Eells.

5. Talks elsewhere

As is so often the case many of our visitors were invited to give talks at other United Kingdom universities, notably Edinburgh, Oxford and Warwick. The overlap with the ICM in Zurich took several visitors to Switzerland in August — A Givental and S Salamon gave invited lectures. Several participants were also invited to visit Paris — these included S Bates, R Montgomery, A Schwarz, and L Traynor.

Summary:

The participants declared the programme to have been an outstanding success. Each of the four workshops had its own flavour. In July one had the feeling that much new work was being done, the Euroconference in September introduced a large number of young mathematicians to new homological methods, the third workshop might be compared to a nineteenth century sweatshop for its frenetic pace, and the fourth came at an ideal moment for publicising Seiberg-Witten theory on this side of the Atlantic Ocean. It is obvious that a great deal of new mathematics will come out of our activities, and in the short term we plan to publish two volumes of proceedings.

It would be churlish to conclude without thanking the administrative staff of the Institute. We owe much to their efforts, and their task was made all the harder by the need to handle so many visitors staying for short periods. The housing office in particular performed short notice miracles on more than one occasion!

CB Thomas

Programme Reports

Programme 11: Exponential Asymptotics (January to June 1995)

Report from the Organisers:
M Berry (Bristol); CJ Howls (Manchester); MD Kruskal (Rutgers); FWJ Olver(Maryland)

Introduction and Objectives: Although quantities which are exponentially small are important and arise frequently in physical applications, until recently the mathematical literature about them has been sparse. Reasons for this include the Poincaré definition of an asymptotic expansion which introduces rigour at the expense of exponentially small terms; the technical difficulty in computing high order terms in an expansion; the lack of appreciation, outside the communities of physicists and numerical analysts, of the role that exponentially small terms can play.

The theory of resurgence was developed in a simple form by Dingle in the 1950s, but independently formulated and extended by Ecalle in the 1980s, albeit in an abstract form. Among other things, the property of resurgence links the divergence of asymptotic expansions to the neglected small exponential contributions. It is also responsible for universalities in the asymptotic growth of high orders of asymptotic series. Resurgence consequently enables the divergent tails to be decoded (for example by resummation) to yield these exponentials. Repeated application of connection formulae linking different asymptotic solutions with the remainder terms of truncated expansions allows exponentially accurate analytic and numerical data to be extracted from divergent series.

Recent advances in computer algebra systems coupled with the rise of the theory of resurgence have encouraged investigations to exponential accuracy. New applications have been found in areas such as functional analysis, asymptotic matching, error bounds, eigenvalue asymptotics, chaos in classical and quantum mechanics, fluid dynamics, dendritic crystal growth, phase formation, and acoustics.

The aim of this programme was to bring together abstract mathematicians, applied mathematicians and physical scientists of all ages and with differing experiences to foster a common culture. In this respect at least the programme was a success with many new scientific contacts being forged across subject (and continental) divides.

Organisation: The planning was carried out by Dr Chris Howls (Manchester) with the oversight of Professors Michael Berry (Bristol), Martin Kruskal (Rutgers) and Frank Olver (Maryland). Most of the world leaders in asymptotic techniques attended the programme during the six months. Unlike some of the previous programmes at the Newton Institute, a less structured schedule of meetings and seminars was adopted. This format was designed to promote greater informal contact across disciplines and also to allow participants to take full advantage of the opportunity to carry out uninterrupted research. It was noted that this led to an increased number of informal discussions which, we believe, significantly enhanced the scientific work carried out during the six months. Some of the participants reported that they had not been able to write any papers yet, because of the faster pace of the research! The open and friendly structure of the Newton Institute greatly aided the work.

Topics which straddled subject boundaries were chosen for the main meetings so that these could act as points of contact for the differing groups.

A weekly seminar programme was implemented on Wednesday afternoons, although towards the end of the session the number of parallel informal presentations increased.

Two additional short lecture courses were run. MD Kruskal gave four lectures on surreal numbers (10-13 April) and AJ Guttmann (Melbourne) spoke on the applications of asymptotics to some problems in statistical mechanics (23-26May).

Programme Reports

In June six of the participants represented the Isaac Newton Institute at a meeting in Sligo, Ireland, organised under the auspices of the Royal Irish Academy, to commemorate the work of GG Stokes whose work on divergent series in the 1850s underpins the current vein of research.

The smooth running of this programme would not have been possible without the dedicated, efficient and seemingly tireless help given to the organisers by the administrative staff at the Institute. They play a significant role in facilitating the friendly and constructive atmosphere at the Institute.

Meetings:

Euroconference on Exponential Asymptotics (16-27 January) This meeting was aimed at younger researchers and attracted people from nine European countries. A series of instructional lectures in classical asymptotics was supplemented by some more advanced courses to give a flavour of the current thrusts of research. The areas covered included Stokes phenomena and resurgence, asymptotics and the Painlevé property, high order calculations of the Riemann-Siegel expansion of the zeta function, surreal numbers, Borel transforms, the evolution of shock layers and the implementation of computer algebra algorithms in asymptotics.

Hyperasymptotics (22 February)

This one day meeting started with talks outlining the genesis and development of the subject prior to this programme mainly through the works of Berry and Howls for integrals and Olde Daalhuis and Olver for ODEs. The afternoon talks revealed new (and long sought after) results obtained at the Newton Institute by Olde Daalhuis which enable the converging factors associated with hyperasymptotics to be practically and efficiently calculated. This has important consequences in highly accurate numerical calculations of solutions of differential equations and integrals

Connection Problems (14-17 March)

Japanese speakers formed a major part of this meeting (their participation being facilitated by the agreement between JSPS and the Royal Society). There was a healthy mix of connection topics presented, with the application of formally exact asymptotics to the nonlinear connection problems of Painlevé transcendents taking the lion's share.

Topics in Asymptotic Analysis (4-6 April)

The more general theme of this meeting gave rise to exponentially accurate asymptotic treatments of topics including the Riemann zeta function, eigenvalues, special functions, difference equations and viscosity. Nonlinear problems were again dealt with when Professor JB McLeod outlined the first rigorous but practical algorithm for solving the connection problems for all the Painlevé equations.

Resurgence and Non-standard Analysis (19-20 April)

Representatives of the French resurgence school presented their work. Subsequently, several revealing discussions on resurgence took place, dealing with the apparent differences in approach to exponentially accurate (and formally exact) asymptotics between the Anglo-American and French workers. The results were very beneficial to both parties. Direct collaborations have been established between the Nice school and UK participants, which have already led to publishable work on eigenvalue asymptotics and the calculation of multidimensional integrals.

Spitalfields Day (25 April)

Aimed at a wider mathematical audience, the Spitalfields Day was supported by the London Mathematical Society. The speakers concentrated on the use of exponential asymptotics in applied

physical problems with talks including Gaussian beams, viscous fluids, optical fibres and possible applications to stealth technology.

Spectral Theory (11 May)

The spectral day presented the different approaches of pure, applied and physical mathematicians to the subject of billiard eigenvalue asymptotics and nonlinear mappings. MV Berry outlined recent advances in the calculation of high orders of the Weyl series for certain smooth quantum billiards, which it is hoped will provide a stimulus for more rigorous work by pure mathematicians.

Final Meeting (19-22 June)

The final meeting was structured to allow both the long-term participants to present summaries of their work and for newer participants to give their talks. The main topics dealt with the significant advances made during the programme in the theory of exponential asymptotics for differential equations, linear and nonlinear, both by classical and novel methods and also applications to multidimensional integrals. Other topics included the asymptotics of polynomials, eigenvalues, random walks and wave propagation in inhomogeneous media.

Participation: The programme attracted seventy-three long term participants whose average stay was six weeks. Shorter term participants numbered sixteen. There were seven people present for the whole of the six months who provided a core of researchers across disciplines. Twenty of the participants could broadly be termed mathematical physicists or theoretical chemists. The remaining fifty or so mathematicians fell into several schools of differing interests and approaches to asymptotics. Twenty-two participants were from UK universities, fourteen each from France and the US. In all, sixteen countries were represented. Several of the foreign researchers gave series of seminars elsewhere in the UK during their stay.

Including the Euroconference, nine women participated in the programme. This small percentage largely reflects the lack of older women in the subject rather than any current inequality (seven were either postgraduate students or younger members of faculty).

The invitations were planned around the meetings so that, as far as external commitments allowed, groups working in similar areas but with different approaches could be present at the same time. This sometimes led to heated discussion, but enabled a very constructive exchange of ideas, most notably between the French school of Ecalle and the more numerically oriented Anglo-American applied mathematicians.

Achievements: Quite apart from the forging of new links and collaboration between the participants the main scientific achievements are summarised below.

The programme brought together active research groups from France, Japan, Russia, the UK and the US. To include all the ideas explored would produce a substantially longer report, so only certain highlights have been selected.

Unification of methods

A major achievement of the programme was to provide practical methods for numerically implementing some of the ideas of resurgence. This led to a greater appreciation of how the Borel transform can provide a unified approach to deriving exponentially accurate asymptotics, regardless of the source of the expansion, be it a linear or nonlinear ODE or multidimensional integral. Olde Daalhuis' discovery of a practical method to calculate the higher order converging factors (hyperterminants) for wide classes of divergent series has greatly facilitated this approach. In the short term, at least a dozen papers outlining significant advances in the field will result.

The Borel transform is effectively the inverse Laplace transform of a formal series expansion (or the progenitor function) with respect to the large (or small) parameter. On a formal basis it is a moment summation method and has the effect of killing the factorial growth of a wide class of divergent series. The consequence is that under certain growth restrictions on the parent function at infinity and assumptions about the completeness of the expansion, asymptotic formulae may be transformed into the Borel plane where they can be handled as convergent representations.

If the remainder term of the convergent series is represented by a Cauchy integral formula, the integration contour can be deformed to snag upon other singularities on adjacent Riemann sheets of the Borel plane. The nearest of these singularities determines the (finite) radius of convergence of the Borel transform, and hence the divergence of the asymptotic expansion in the original plane. The singularities are intimately linked to other asymptotic solutions of the particular problem being investigated. This technique automatically performs the book-keeping of exponentially small contributions, which appear at a Stokes phenomenon, as they migrate on to the relevant Riemann sheets of the Borel plane. Furthermore it allows exponentially accurate numerical studies, provided the coefficients of the asymptotic (or Borel) expansion are known and the analytic continuation in the Borel plane can be performed.

This programme has demonstrated the potential practical numerical and analytic advantages of this method in that the algorithm is similar, regardless of the origin of the series: a linear second order ODE produces one singularity in the Borel plane (another solution); higher order systems produce more singularities (one per solution); a saddlepoint integration of a well-behaved integrand (in any finite dimension) produces singularities which correspond to other saddles; a nonlinear ODE produces a convolution integral which propagates each basic singularity periodically to infinity. The latter situation corresponds to the generation of a one parameter family of solutions to the equation (Ecalle transseries), and allows for a numerical discrimination between exponentially close solutions of the system. Numerical results can be extracted hyperasymptotically in an identical way regardless of the system and using universal classes of hyperterminants.

It should be stressed that the singularities of a particular system are in principle recoverable from the defining differential equation or integral. Once the Borel transform is taken, at no point need divergent asymptotic expansions be introduced (together with the classical confusion associated with them).

While some of these results were already known in principle to the school of Ecalle, what was lacking in their approach was a practical scheme for calculation in the form of algorithms to determine high order terms and a numerical decoding of the divergent series associated with each Borel-singularity. Great steps along this road have been made during this programme, in the implementation of algebraic and numerical code (Dunster, Olde Daalhuis, Olver, Temme). One project carried out during the programme (Silverstone and Howls) has been the development of a computer package to compute hyperasymptotically accurate eigenvalues for an anharmonic oscillator, with arbitrary coupling constant and at arbitrary eigenlevel. Future projects will include the development of similar packages for linear ODES of arbitrary order and arbitrary rank and also to nonlinear systems. The systematic practical asymptotic development of equations involving parameters using Borel techniques is soon to be tackled.

Calculation of Stokes Multipliers

Many of the results of Ecalle can be derived (and some have been obtained during this programme by Olver and Olde Daalhuis) using existing techniques of classical analysis. Indeed, classical techniques often provide short-cuts in the Borel approach, or can eliminate the need for it. Stokes multipliers prefactoring the birth and death of exponentially small terms are in general difficult to calculate

but are essential to the classical or Borel-techniques. There are very few systems for which they can be calculated in closed form.

This programme has given rise to two new methods for calculating Stokes multipliers, one asymptotic, the other numerical. For example, by conjecturing that a connection formula exists between two or more asymptotic expansions, it is now possible to fold the higher order terms back on themselves to numerically calculate the Stokes multipliers to high (in principle arbitrary) accuracy.

Olver began a reworking of the classical asymptotic theory of nth order linear ordinary differential equations with a view to supplying direct numerical methods for the calculation of Stokes multipliers via boundary-value techniques.

Stokes multipliers play important physical roles, for example in the splitting of separatrices of perturbed nonlinear mappings and there is hope that the techniques developed here can be applied to discrete systems, for example to tracing chaotic trajectories.

Painlevé Analysis

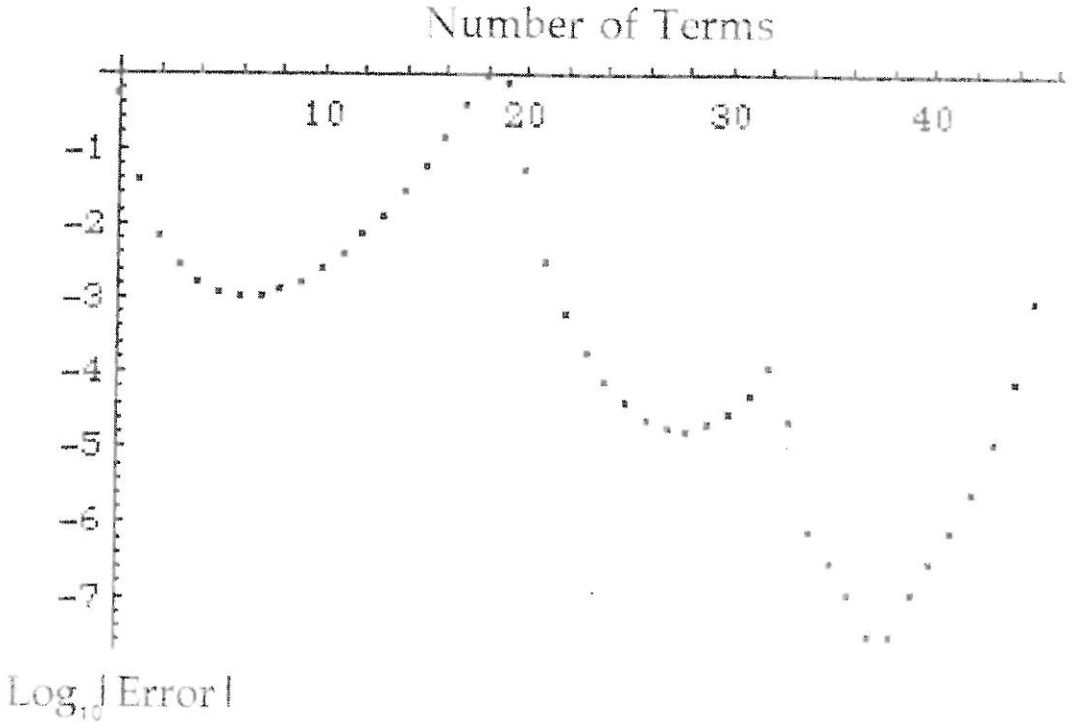
The application of exponential asymptotics to Painlevé-type equations was considered by differing schools. The Japanese school attack the problem using the theory of Voros and exact formal JWKB analysis. McLeod demonstrated the first practical uniform asymptotic algorithm for the solution of an arbitrary Painlevé connection problem. Kruskal and Joshi have considered the use of exponentially small terms in the local solutions of nonlinear differential equations with special reference to the Chazy equation and a fourth order equation to demonstrate the failure of the Painlevé property at higher orders in the expansion. Improved numerical techniques for solving the Painlevé-I equation have been developed, by introducing transformations to a fourth order system.

Other

The efficient calculation of the Riemann zeta function on the critical line received further attention from Berry, Keating, Dunster and Paris, including the presentation of realistic error bounds for existing formulae. Braaksma developed a Darboux-type theorem for slowly varying functions. After discussions with Olde Daalhuis and Howls, Majima derived a general theorem relating high orders of asymptotic coefficients in one complex sector to complete inverse factorial expansions involving coefficients in other sectors, irrespective of the precise origin of the series. Boyd produced a manuscript which allows exponentially dominant solutions of second order ODEs to be uniquely defined through careful use of integral representations. Dunster began research on providing rigorous error bounds for hyperasymptotic expansions. Some work on stochastic PDEswas carried out by van den Berg. Lochak continued his work in Hamiltonian perturbation theory. The Dieners generalised the concept of fleuves (exponentially attracted solutions of nonlinear systems) to PDEs with polynomial coefficients. Wood and his students intend to apply Ecalle's work to nth order linear ODEs. Voros gave several inspiring lectures and wrote a paper on exact quantisation conditions. We were very pleased to welcome Carl Bender during June, who interacted with and helped solve the problems of half-a-dozen participants.

On other mathematical matters, Kruskal investigated Hilbert's axiomatisation of Euclidean geometry and found it to be deficient. An affiliated participant (Gardiner-Garden) produced a paper on ocean dynamics near the coast of New South Wales.

CJ Howls



A major result of the exponential asymptotics programme was the practical development of the theory of resurgance. This has greatly widened the range of systems for which exponentially accurate analytic and numerical information can be derived from seemingly divergent asymptotic expansions. Here the lowest eigenvalue of a quartically perturbed anharmonic oscillator is calculated for a coupling constant of g=0.05. After two iterations (about 38 terms) the accuracy is increased to $O(10^{-7})$. *The best accuracy of the original expansion (6 terms) is only* $O(10^{-3})$. *Further iterations improve the accuracy as more of the analytic structure of the g plane is explored. Higher eigenvalues can be calculated with little extra effort. Other areas of application and development include multiple integrals, systems of ODEs, nonlinear equations and trace formulae.*

Programme 12: Financial Mathematics (January to June 1995)

Report from the Organisers:
M H A Davis (Imperial and Mitsubishi Finance), S D Hodges (Warwick), I Karatzas (Columbia), L C G Rogers (Bath)

Introduction: The aim of this meeting was to gather world leaders in all the major aspects of financial mathematics, to learn from them of the latest developments, and to pursue outstanding problems. At the same time, the organisers were keenly aware of the boundless interest in the subject outside Cambridge, outside mathematics and outside academia, and strove to make the programme as widely accessible as possible. The global and local were sometimes tugging in different directions; the more short-term visitors who came, the fewer the opportunities for longer-term study, but it appears that a satisfactory balance was achieved.

While the foundations of financial mathematics are now well established, there remains a great deal to be done at various levels. Practitioners are constantly searching for models and algorithms with desirable computational properties, and this search continues and will continue; not only are some of the most basic assets imperfectly understood (such as interest-rate derivatives), but each month brings new exotic options which need to be priced and hedged. The gradual realisation that the traditionally conservative world of actuaries and insurance can benefit from the financial market place in novel ways creates an entire new application area.

On the other hand, there are also major unresolved issues at a theoretical level; how to handle incomplete markets, transactions costs, taxation, and heterogeneous information are major theoretical challenges whose solution is still distant. Even very basic questions concerned with how prices form and change are far from being understood, and the simple question 'What is money?' will keep any good economist talking for at least an hour!

The abundance of data invites and defeats analysis, but in the end anyone who has an interest in this subject has to spend time looking at data. Any practitioner has also to be aware of regulatory constraints which academics safely ignore, and market anomalies and corporate structures can have effects which swamp those studied in idealised mathematical models.

The meeting did not attempt to cover the whole range of all possible disciplines and problems which impinge on the finance industry, but concentrated instead on those with a major mathematical component. The great figures of finance are of course well aware of all the dimensions of the problem, and it was extremely illuminating to have Bob Merton and Steve Ross visit us and give talks; in each case, a real problem was tackled with comparatively simple mathematical techniques which nevertheless gave a clear picture of the true nature of the problem, and how it was solved. Each talk was a beautiful piece of applied mathematics. People of this calibre understand the industry deeply by being immersed in it, and it was a considerable coup to draw them even briefly from their faxes and consulting.

The achievements of the programme so far are as diverse as the topics under discussion; it is impossible (and invidious) to single out any one or two results as the 'main' achievements of the six months, but in the section below on the scientific programme I detail those developments which I feel were most noteworthy. In a very real sense, the time to assess the programme is a year from now, when some of the seeds sown will have matured to bear fruit.

Participation: This programme involved far more people than any previous programme at the Newton Institute, confirming the widespread interest in the subject. The long-term members of the programme were Stewart Hodges and Chris Rogers from the organising committee, and Stan Pliska (Prudential Visiting Fellow) and Abel Cadenillas (Rosenbaum Fellow). Others who spent

long periods at the Institute and contributed fully to the programme were Philippe Artzner, Alan Brace, Michael Dempster, Steve Shreve, and Jim Steeley. The organisers are also very grateful to those who agreed to organise Special Emphases at various times during the programme, especially those who stepped in to take over from others who were unable to fulfil their initial commitments.

The list of those academics who were registered with the Institute is appended. In addition, there was a sizeable representation of major financial houses; the names of the Corporate Members follow.

Bank of England

BARRA International Ltd

BZW

Chase Investment Bank

Citibank N A

DG Bank

Deutsche Bank

Equitable House Investments Ltd

Kleinwort Benson Investment Management

Midland Global Markets

Monis Software

Morgan Grenfell & Co Ltd

NationsBanc

NatWest Markets

Prudential Corporation

Rothschild Asset Management Ltd

Salomon Brothers International Ltd

Sanwa International

Société Générale

After Easter, Mark Davis left for a position with Mitsubishi Finance International, which was a high-level defection from academia! The interest shown by City institutions was real and lasting; one of the most gratifying features of the programme was the fact that we saw many repeat visitors from our Corporate Members, indicating that they considered the proceedings worthwhile.

During the programme, we were particularly pleased to have Darrell Duffie, Bob Merton and Steve Ross visit us to give Institute Seminars; the attendance for these renowned speakers was exceptional even for the Newton Institute.

Timetable:

- January 4–10: Introductory Meeting: Mathematical Finance (organised by Stewart Hodges);
- February 8: LMS Spitalfields Day: Recent Developments in Financial Mathematics (organised by Chris Rogers);
- March 6–10: Relations Between Finance and Insurance (organised by Mark Davis, Paul Embrechts and Hélyette Geman);
- March 12–24: Optimal Portfolios Special Emphasis (organised by Ioannis Karatzas);
- March 25–31: Practitioners' Workshop (organised by Sam Howison and Paul Wilmott);
- April 10–14: Numerical Methods Special Emphasis (organised by Alain Bensoussan, Denis Talay, and Agnes Sulem);
- May 1–5: Financial Econometrics and Stochastic Volatility (organised by Andrew Harvey);
- May 8–13: World Wide Security Market Anomalies Special Emphasis (organised by Bill Ziemba);
- May 15–20: World Wide Asset Allocation Special Emphasis (organised by Bill Ziemba);
- May 21–June 3: Mathematics of Finance: Models, Theories and Computation (organised by Michael Dempster);
- June 6–9: Market Imperfections (organised by Stan Pliska);
- June 12–16: Term Structure of Interest Rates (organised by Darrell Duffie);

Scientific programme: Our opening week was a tutorial week, serving the purpose of introducing the main ideas and methods of financial mathematics to those working in other branches of mathematics, and to graduate students beginning their studies in this area. There were courses of lectures, given by Dempster, Hodges, Pliska and Rogers, and several other contributors.

Apart from the Spitalfields Day (Davis, Hodges, Pliska and Rogers) on February 8th, and seminar afternoons organised by Stan Pliska, the programme was quiet until March, allowing those present to get on with research: Bjork, Kabanov & Runggaldier developed further their model for interest rates in the HJM framework but with discrete shocks to the yield curve, Hodges and Rogers worked on fractional Brownian motion as a model of share prices (which has been extensively studied in recent years) and proved conclusively that the model is absurd.

March 6-10 saw a week on finance and insurance, organised by Paul Embrechts and Hélyette Geman. This was a fascinating week; not only are there good questions on insurance-linked derivatives (such as the catastrophe insurance futures contracts recently introduced), but one is forced to consider processes with jumps (large claims matter) and investment with stochastic interest rates, issues often ignored in traditional finance. Bühlmann found an intriguing example of a trinomial tree model which converges weakly to a diffusion model, and in which the optimal hedging portfolio (in terms of three instruments) collapses in the limit to a portfolio consisting of two instruments only. This is interesting in that the limiting process would in principle allow hedging with as many bonds as one wanted.

The optimal portfolios workshop (organised by Ioannis Karatzas) saw several exciting developments. Föllmer spoke on his work with Schweizer on the endogenous generation of prices in a market where agents' actions affect price; in particular, in a market with different agents, some of whom are acting as if the Black-Scholes assumptions are true, the effect feeds back into the volatility, and one ends up

with an interesting fixed-point problem. Karatzas spoke on continuing work with Cvitanič involving transactions costs; this is an interesting development of earlier work in the discrete time setting by Kusuoka, where the optimal hedging can be described in terms of two martingales corresponding to the marginal utilities of terminal holding of bond and stock for an appropriately-chosen utility. In some cases, partially explicit solutions can be obtained. Cover illuminated optimal portfolio choice problems from a very different perspective; it remains to be seen whether this viewpoint is compatible with the more conventional approaches. While in a different vein, the work of Delbaen, Monat, Schachermayer, Schweizer and Stricker on the L^2-closure of the space of attainable gains from trade closes an open problem of several years' standing, and represents an attractive piece of pure mathematics, of interest in its own right.

The numerical methods week just before Easter was a vibrant week with Gallic flair; Denis Talay had put together an excellent programme of speakers, who interacted well. The pricing of American options took centre stage. Particularly interesting was the work of Broadie and Glasserman, who obtain simulation bounds on the price of an American option, which appear to work reasonably well also for the case of American-style options on more than one asset; Carr and Faguet have also developed a hybrid discrete-continuous method for pricing the American put which give impressive combinations of speed and accuracy. There were talks on many other topics. Dumas reported on an important piece of work, concerned with the estimation of the volatility structure from option prices, as advocated by Dupire. This study showed considerable instability of the estimates, which calls the whole approach into question, and directs attention elsewhere in the hunt for a good model of stochastic volatility. Talay and Seumen-Tonou presented an attractive method for getting $o(h^2)$ estimates of $Ef(X_T)$, where X is a Markov process; such computations arise constantly in the pricing of derivatives. There will be a proceedings of the week, part of which will involve the establishment of certain benchmark problems relative to which to judge the quality of different algorithms.

The final part of the meeting began quietly in May with a week on econometrics; Andrew Harvey had brought together a group of colleagues who made excellent contributions on GARCH models, time-deformation, and long-range dependence in price processes, among other topics. Harvey, Ghysels, and Renault used the week to continue collaboration on stochastic volatility models, to be published in the *Handbook of Statistics*.

This was followed by two weeks organised by Bill Ziemba, the first on security market imperfections, the second on worldwide asset allocation. This fortnight was concerned with more specific practical issues, beyond the scope of the more conventional mathematical models studied elsewhere, and offered fascinating insights into the effects of different market practices.

The Bank of England ASI held in late May was organised by Mark Davis until he moved to Mitsubishi, and handed over to Michael Dempster later. This fortnight was essentially a full-scale conference in which many visitors from academia and the industry participated. While there were many excellent talks, and it is invidious to pick out the 'highlights', as a personal selection I particularly liked the work of Dybvig and Koo on the tax basis of a portfolio; this is a tough problem, but it was interesting to see someone attempting it. The work of Jeanblanc-Picqué and El Karoui on optimal investment with a non-negative wealth constraint was also very interesting. During the fortnight, there was an excursion to London to visit some of our Corporate Members. The day began at the Bank of England, continuing at Citibank and LIFFE, returning to Citibank in the evening. We had presentations from our hosts on some of the issues they were working on, and only regretted that we did not have longer to discuss them.

The market imperfections special emphasis, organised by Stan Pliska and Elias Jouini, was a low-key interlude before the final week, covering issues such as transactions costs and taxes. There

remains much to be done in each of these areas.

The final week of the programme, on interest rates, organised by Darrell Duffie, was a very busy week packed with excellent talks. As well as survey talks on stochastic partial differential equations, defaultable bonds, and econometric estimation of term-structure models, there were numerous talks on particular models of the Heath-Jarrow-Morton class, and other novel models. Perhaps the most noteworthy development here was the work on the Black model for pricing interest-rate caps; Miltersen, Sandmann & Sondermann as well as Brace, Gatarek & Musiela came up with essentially the same model which manages to guarantee the log-normality of the 3-month rate for all time, and thus fits the way that many practitioners have been pricing these things for a long time. The complete implications of the model are yet to be explored, but this was a very promising development.

Publications: In addition to numerous papers begun, continued or completed by the participants during their visits, there are four volumes being planned in conjunction with Cambridge University Press:

(i) World Wide Asset and Liability Modelling (edited by W T Ziemba and J M Mulvey);

(ii) Security Market Imperfections in World Wide Equity Markets (edited by W T Ziemba and D B Keim);

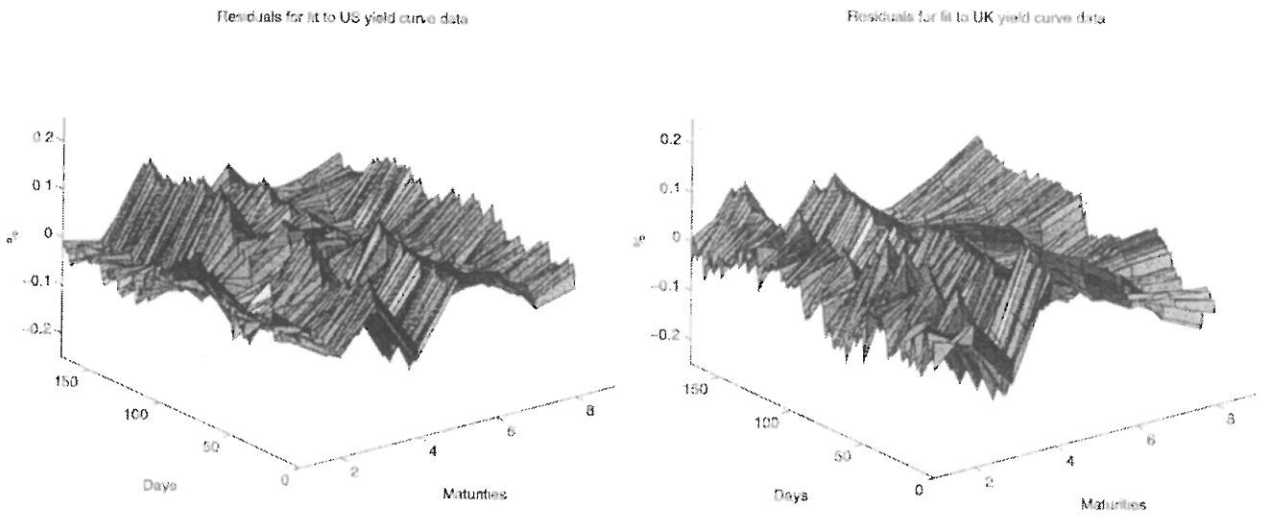
(iii) Numerical Methods in Mathematical Finance (edited by D Talay and L C G Rogers);

(iv) Methods and Examples of Mathematical Finance (edited by M A H Dempster and S R Pliska).

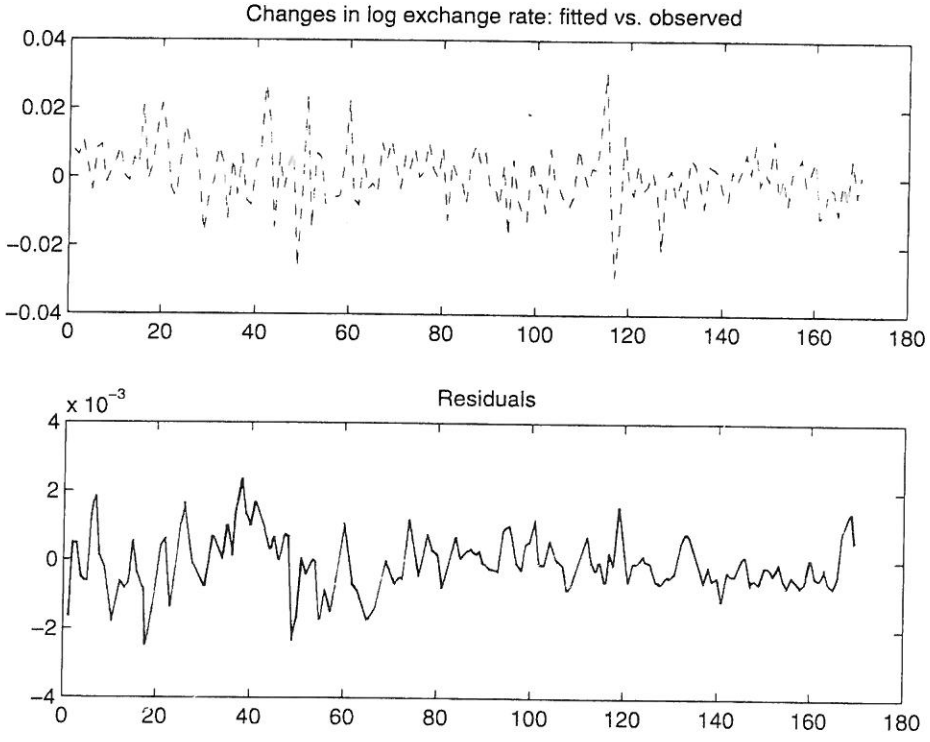
Continuation: It is intended to continue the link between the finance industry in Europe and the mathematical community via the Newton Institute; Michael Dempster, Stewart Hodges and Chris Rogers from the organisation, Frank Kelly and Doug Kennedy from Cambridge, and Simon Babbs and Mark Davis from City firms have already agreed to work together to maintain the connection, probably through an annual one- or two-day meeting presenting recent developments in the theory and practice of finance, to which a wide range of interested parties would be invited.

A further possibility would be to hold regular seminar afternoons at some convenient venue in Cambridge or in the City. Experience with such afternoons arranged in the past by Cambridge, and separately by Warwick, has been good.

LCG Rogers



Residuals from simultaneous fits of a 'potential' model to yield curves for the US and the UK, and the USD/GBP exchange rate. Pictured above are the residuals for the fits to the yield curves in the two countries. The basic ideas of these models were derived during the Newton Institute programme on Financial Mathematics.



Residuals from the same fitting procedure, this time for the fit to the observed changes in log exchange rate.

9. APPENDICES

9.1 NATIONALITIES AND COUNTRIES OF RESIDENCE OF VISITING MEMBERS

Please note that the term 'visiting members' applies to participants who stayed at the Institute for seven days or more.

Topological Defects

Participant	Nationality	Country of Residence	Home Institution	Visits
Achúcarro, A	Spain	Spain	Dept of Theoretical Physics, University Pais Vasco, Bilbao	1 Nov - 19 Nov, 21 Aug - 3 Sep, 4 Dec - 11 Dec
Albrecht, AJ	USA	UK	Blackett Laboratory, Imperial College	18 Jul - 31 Jul, 12 Oct - 14 Oct
Allen, B	USA	USA	Dept of Physics, University of Wisconsin	17 Sep - 16 Dec
Bhattacharjee, P	India	India	Indian Institute of Astrophysics, Bangalore	16 Aug - 20 Sep
Bibilashvili, T	Georgia	Georgia	Institute of Physics, Georgian Academy of Sciences	1 Dec - 15 Dec
Bogolubsky, IL	Russia	Russia	Institute of Nuclear Research, Moscow	21 Aug - 17 Sep
Borrill, J	UK	UK	Blackett Laboratory, Imperial College	14 Nov - 28 Nov, 18 Sep - 16 Oct, 21 Aug - 3 Sep
Brandenburger, R	USA	USA	Dept of Physics, Brown University	11 Jul - 5 Sep, 14 Nov - 6 Dec
Bray, AJ	UK	UK	Dept of Physics, University of Manchester	7 Jul - 17 Dec
Bucher, MA	USA	USA	Institute of Advanced Study, Princeton	4 Sep - 21 Sep
Caldwell, R	USA	USA	Theoretical Physics, Fermilab	15 Jul - 6 Aug, 1 Oct - 16 Dec
Carter, B	UK	France	Observatoire Paris-Meudon	21 Aug - 17 Sep, 14 Nov - 18 Nov
Chudnovsky, EM	USA	USA	Dept of Physics, City University, New York	1 Aug - 21 Aug
Copeland, EJ	UK	UK	School of Mathematics, University of Sussex	2 Oct - 16 Dec
Davis, AC	UK	UK	DAMTP, Cambridge	7 Jul - 16 Dec
De Vega, HJ	France	France	LPTHE, Université de Paris VII	7 Jul - 11 Jul, 25 Oct - 11 Nov
Dorsey, AT	USA	USA	Dept of Physics, University of Virginia	6 Jul - 4 Aug
Duff, M	UK	USA	Dept of Physics, Texas A & M University	30 Aug - 17 Dec
Durrer, R	Switzerland	Switzerland	Theoretical Physics, University of Zürich	24 Aug - 3 Sep
Everett, A	USA	USA	Dept of Physics, Tufts University	21 Aug - 3 Sep
Feigel'man, M	Russia	Russia	Landau Institute, Moscow	14 Aug - 28 Aug
Goldenfeld, N	UK	USA	Dept of Physics, Illinois at Urbana	4 Jul - 24 Jul
Goldstone, J	UK	USA	Massachusetts Institute of Technology	15 Jul - 15 Aug
Goldhaber, AS	USA	USA	Institute of Theoretical Physics, SUNY	1 Sep - 21 Sep
Gottlieb, DH	USA	USA	Dept of Maths, Purdue University	2 Nov - 26 Nov

Guilarte, JM	Spain	Spain	Dept of Physics, Salamanca	28 Aug - 24 Sep
Hindmarsh, MB	UK	UK	School of Maths and Physical Sciences, University of Sussex	30 Oct - 3 Dec
Holman, R	USA	USA	Dept of Physics, Carnegie Mellon University	22 Jul - 11 Aug
Ischenko, T	Russia	Russia	General Physics Institute of RAS, Moscow	21 Aug - 3 Sep
Jackiw, RW	USA	USA	Center for Theoretical Physics, MIT	21 Aug - 3 Sep
Karachevtseva, L	Russia	Ukraine	Institute for Physics of Semiconductors, Ukrainian Academy of Sciences	21 Aug - 3 Sep
Kephart, TW	USA	USA	Physics and Astronomy, Vanderbilt University	1 Oct - 30 Oct
Kibble, TWB	UK	UK	Blackett Laboratory, Imperial College	4 Jul - 17 Dec
Kléman, M	France	France	Université de Pierre et Marie Curie	4 Sep - 21 Sep, 20 Aug - 3 Sep
Kleinert, H	Germany	Germany	Theoretical Physics, Free University, Berlin	21 Aug - 3 Sep
Lavrentovich, OD	Ukraine	USA	Liquid Crystal Institute, Kent State University	9 Jul - 13 Aug
Lee, KM	Korea	USA	Dept of Physics, Columbia University	6 Jul - 30 Jul
Lee, CK	Korea	Korea	Dept of Physics, Seoul National University	14 Aug - 30 Aug
Leggett, AJ	UK	USA	Dept of Physics, University of Illinois	6 Jul - 30 Jul
Letelier, P	Chile	Brazil	Dept of Applied Maths, University of Campinas	2 Oct - 16 Dec
Liddle, AR	UK	UK	Astronomy Centre, University of Sussex	21 Aug - 3 Sep, 30 Oct - 19 Nov
Lyth, DH	UK	UK	Dept of Physics, University of Lancaster	6 Oct - 17 Dec
Maharana, J	India	India	Institute of Physics, Bhubaneswar	2 Oct - 28 Oct
Mazenko, GF	USA	USA	James Franck Institute, University of Chicago	16 Aug - 15 Sep
McLerran, LD	USA	USA	Dept of Physics, University of Minnesota	5 Sep - 28 Sep
Melker, A	Russia	Russia	St Petersburg State Technical University	21 Aug - 3 Sep
Misirpashaev, TS	Russia	Russia	Landau Institute, Moscow	1 Nov - 19 Nov
Montgomery, RW	USA	USA	Dept Maths, Univ California, Santa Cruz	15 Aug - 29 Sep, 13 Nov - 17 Dec
Monastyrsky, M	Russia	Russia	ITEP, Moscow	21 Aug - 19 Nov
Moraes, FJS	Brazil	Brazil	Dept of Physics, University of Federale Pernambuco	10 Oct - 27 Oct
Nattermann, T	Germany	Germany	Institute of Theoretical Physics, University of Köln	1 Aug - 14 Aug
Nunes, JLP	Portugal	USA	Dept of Physics, Brandeis University	17 Jul - 30 Jul
Peter, P	UK	France	Observatoire de Paris	1 Dec - 16 Dec
Pi, S-Y	USA	USA	Dept of Physics, University of Boston	21 Aug - 3 Sep
Popa, L	Romania	Romania	Institute of Gravity & Space Sciences	21 Aug - 3 Sep
Puri, S	India	India	Physical Sciences, J Nehru University	5 Sep - 2 Nov
Rey, S-J	Korea	Korea	Dept of Physics, Seoul National University	14 Jul - 31 Jul, 21 Aug - 2 Sep

Rivers, RJ	UK	UK	Blackett Laboratory, Imperial College	22 Aug - 30 Sep
Rivier, NY	Switzerland	France	Institute of Physics University of Strasbourg	22 Aug - 26 Aug, 5 Sep - 16 Sep
Roleder, K		Poland	Institute of Physics, University of Silesia	21 Aug - 3 Sep
Rutenberg, AD	UK	UK	Physics and Astronomy, University of Manchester	2 Oct - 18 Dec
Sakellariadou, M	France	France	LGCR, Université de Pierre et Marie Curie	21 Aug - 3 Sep
Salomaa, MM	Finland	Finland	Dept of Physics, University of Helsinki	21 Aug - 3 Sep, 12 Sep - 14 Sep
Saniga, M	Slovakia	Slovakia	Astronomical Institute, Slovak Academy of Sciences	21 Aug - 3 Sep
Sasaki, M	Japan	Japan	Dept of Physics, University of Kyoto	2 Oct - 29 Oct
Schwarz, A	Russia	USA	Dept of Maths, University of California at Davis	1 Jul - 17 Jul, 1 Aug - 23 Sep
Schroers, BJ	Germany	UK	Dept of Mathematical Science, University of Durham	27 Nov - 16 Dec, 5 Aug - 3 Sep
Shafi, Q	UK	USA	Bartol Research Institute, University of Delaware	27 Jul - 20 Aug
Shellard, EP	UK	UK	DAMTP, Cambridge	7 Jul - 16 Dec
Sikivie, PLMJ	Belgium	USA	Dept of Physics, University of Florida	14 Nov - 16 Dec
Sluckin, TJ	UK	UK	Mathematical Studies, University of Southampton	17 Oct - 11 Nov
Stebbins, A	USA	USA	Fermilab Astrophysics, Batavia	18 Jul - 14 Aug, 30 Aug - 14 Oct
Stewart, ED	UK	UK	Dept Physics and Materials, University of Lancaster	2 Oct - 19 Oct
Toner, J	USA	USA	IBM TJ Watson Research Center	5 Jul - 29 Jul
Toyoki, H	Japan	Japan	University of Yamanshi	12 Jul - 15 Sep
Trebin, H-R	Germany	Germany	Theoretical Physik, University of Stuttgart	26 Jul - 28 Oct
Turok, NG	UK	USA	Department of Physics, University of Princeton	22 Aug - 16 Dec
Vachaspati, T	India	USA	Dept of Physics, Case Western Reserve University	6 Jul - 16 Dec
Vilenkin, A	USA	USA	Department of Physics, Tufts University	2 Aug - 4 Sep
Volovik, G	Russia	Finland	Helsinki University of Technology	1 Nov - 21 Nov, 21 Aug - 3 Sep
Ward, RS	UK	UK	Dept of Mathematical Science, University of Durham	7 Jul - 17 Dec
Weinberg, EJ	USA	USA	Dept of Physics, Columbia University	7 Jul - 31 Jul
Yaremchuk, A	Ukraine	Russia	Acoustics Institute, Moscow	21 Aug - 3 Sep
Yurke, B		USA	AT & T Bell Laboratories	21 Aug - 3 Sep
Zakrzewski, WJM	UK	UK	Dept of Mathematical Science, University of Durham	1 Aug - 30 Sep, 11 Oct - 13 Oct
Zurek, WH	USA	USA	Los Alamos National Laboratory, New Mexico	11 Sep - 30 Sep, 20 Aug - 3 Sep

Symplectic Geometry

Participant	Nationality	Country of Residence	Home Institution	Visits
Alekseev, A	Sweden	Sweden	Institute of Theoretical Physics, Uppsala	31 Oct - 12 Nov
Audin, M	France	France	IRMA, Universite Louis Pasteur, Strasbourg	30 Oct - 10 Nov, 17 Jul - 30 Jul
Andersen, J	Denmark	USA	Dept of Mathematics, UC Berkeley	30 Oct - 12 Nov
Bates, SM	USA	USA	Dept of Mathematics, Columbia University	1 Jul - 17 Dec
Bialy, M	Israel	Israel	Dept of Math Sciences, University of Tel Aviv	14 Jul - 2 Aug
Braam, P	UK	UK	St Catherines College, Oxford	4 Dec - 11 Dec, 5 Oct - 6 Oct
Bradlow, SB	USA	USA	Dept of Mathematics, University of Illinois	30 Oct - 12 Nov
Buchdahl, N	Australia	Australia	Dept of Pure Mathematics, University of Adelaide	3 Dec - 17 Dec
Cappell, S	USA	USA	Courant Institute, New York University	7 Dec - 14 Dec
Catanese, F	Italy	Italy	Dept of Mathematics, University of Pisa	4 Dec - 11 Dec
Chekanov, Y	Russia	Russia	Institute of New Techs in Education, Moscow	18 Sep - 8 Oct
Cieliebak, K	Switzerland	Switzerland	ETH, Zürich	16 Jul - 31 Jul
Donaldson, SK	UK	UK	Mathematical Institute, Oxford	30 Oct - 12 Nov, 4 Dec - 17 Dec, 17 Jul - 30 Jul, 25 Sep - 8 Oct
Eliashberg, Y	USA	USA	Dept of Mathematics, Stanford University	16 Jul - 31 Jul
Fock, V	Russia	Sweden	Dept of Theoretical Physics, Uppsala University	30 Oct - 12 Nov
Fukaya, K	Japan	Japan	Dept of Maths, University of Tokyo	4 Jul - 31 Jul
Garcia-Prada, O	France	France	Dept Mathematique, Université de Paris Sud	30 Oct - 11 Nov
Ginzburg, V	Russia	USA	Dept of Mathematics, Stanford University	28 Oct - 12 Nov, 12 Jul - 14 Sep
Giroux, E	France	France	Dept of Pure Applied Maths, ENS Lyons	17 Jul - 1 Aug
Givental, AB	USA	USA	Dept of Maths, UC Berkeley	4 Jul - 3 Aug
Goldman, W	USA	USA	Dept of Mathematics, University of Maryland	10 Dec - 17 Dec
Gompf, RE	USA	USA	Dept of Mathematics, University of Texas	4 Jul - 3 Aug
Gonzalo, J	Spain	Spain	Dept of Maths, University of Autonoma, Madrid	4 Jul - 31 Jul
Grabowski, J	Poland	Poland	Institute of Maths, University of Warsaw	21 Nov - 1 Dec
Gromov, M	France	France	IHES, Bures-sur-Yvette	1 Oct - 7 Oct
Guillemin, V	USA	USA	Massachusetts Institute of Technology	29 Oct - 12 Nov
Guruprasad, K	India	Canada	Dept of Mathematics, McGill University	30 Oct - 5 Nov
Hambleton, I	UK	Germany	Max Planck Institut, Bonn	4 Dec - 16 Dec
Hausmann, J-C	Switzerland	Switzerland	Department of Mathematics, University of Geneva	4 Nov - 11 Nov

Hermann, D	France	France	Laboratoire de Topologie, Université de Paris Sud	1 Dec - 18 Dec
Hitchin, N	UK	UK	DPMMS, Cambridge	30 Oct - 12 Nov
Hofer, HHW	Germany	Switzerland	Department of Maths, ETH-Zentrum, Zürich	26 Sep - 7 Oct, 17 Jul - 29 Jul
Janushkevich, T	Poland	Poland	Stephen Banach International Centre, Warsaw	1 Dec - 14 Dec
Jeffrey, L	Canada	USA	Dept of Mathematics, University of Princeton	11 Dec - 17 Dec, 25 Oct - 20 Nov
Jones, JDS	UK	UK	Mathematics Institute, University of Warwick	30 Jul - 30 Jul, 5 Dec - 16 Dec
Kappos, E	UK	UK	University of Sheffield	27 Sep - 8 Oct
Karshon, Y	Israel	USA	Massachusetts Institute of Technology	6 Nov - 12 Nov, 17 Jul - 30 Jul
Karasev, M	Russia	Russia	Moscow Institute of Electronics and Mathematics	30 Oct - 12 Nov
Kazarian, ME	Russia	Russia	Steklov Mathematical Institute, Moscow	18 Sep - 8 Oct
King, A	UK	UK	Dept of Pure Mathematics, University of Liverpool	30 Oct - 4 Nov, 4 Dec - 17 Dec
Kirillov, A	Russia	USA	Dept of Mathematics, University of Pennsylvannia	30 Oct - 12 Nov
Konno, H	Japan	Japan	Dept of Mathematics, Tokyo Metropolitan University	26 Nov - 18 Dec
Kotschick, D	Germany	Switzerland	Mathematics Institute, University of Basel	25 Sep - 30 Dec, 7 Jul - 31 Jul
Kunzle, A	Switzerland	Germany	Max Planck Institute, Bonn	26 Sep - 9 Oct
Lalonde, F	Canada	Canada	Dept of Mathematics, University of Quebec	15 Jul - 31 Jul, 25 Sep - 8 Oct
Lerman, E	USA	USA	Massachusetts Institute of Technology	4 Nov - 12 Nov
Le, HV	Vietnam	Germany	Max Planck Institute, Bonn	25 Sep - 25 Nov
Lisca, P	Italy	Italy	Dipartamento di Matematica, Universita di Roma	12 Dec - 18 Dec
Li, W	USA	USA	MSRI, Berkeley	25 Sep - 8 Oct
Lizan, V	France	France	Dept of Mathematics, ENS Lyon	4 Dec - 17 Dec
Lu, J-H	China	USA	Dept of Mathematics, University of Arizona	4 Jul - 5 Aug
Mackenzie, KCH	Australia	UK	Dept of Maths and Stats, University of Sheffield	30 Oct - 13 Nov, 10 Jul - 24 Jul
Manetti, M	Italy	Italy	Dept of Mathematics, University of Pisa	4 Dec - 11 Dec
Matíc, G	USA	USA	Dept of Mathematics, University of Georgia	11 Dec - 18 Dec
McDuff, D	UK	USA	Dept of Maths, SUNY	4 Dec - 17 Dec, 25 Sep - 8 Oct, 18 Jul - 30 Aug, 3 Jul - 10 Jul, 30 Oct - 2 Nov
Mladenov, IM	Bulgaria	Bulgaria	Bulgarian Academy of Sciences	29 Oct - 12 Nov

Moatty, L	France	France	IHP, Paris	25 Sep - 8 Oct
Montgomery, RW	USA	USA	Dept of Mathematics, UCSC	30 Oct - 12 Nov
Morton, HR	UK	UK	Dept of Pure Maths, University of Liverpool	19 Nov - 26 Nov
Nakajima, H	Japan	Japan	Institute of Mathematics, Tohuku University	28 Oct - 12 Nov
Oh, Y-G	Korea	USA	Dept of Mathematics, University of Wisconsin	3 Jul - 23 Dec
Ono, K	Japan	Japan	Dept of Mathematics, University of Ochanomizu	15 Jul - 15 Oct
Persson, U	Sweden	Sweden	Dept of Mathematics, Chalmers University	11 Dec - 18 Dec
Pidstragach, V	Russia	Russia	Steklov Mathematical Institute, Moscow	3 Dec - 17 Dec
Piunikhin, S	Russia	USA	Massachusetts Institute of Technology	25 Sep - 9 Oct, 3 Dec - 18 Dec
Polterovich, L	Israel	Israel	Dept of Math Sciences, University of Tel Aviv	12 Jul - 23 Aug
Prato, E	France	France	ENS, Paris	30 Oct - 12 Nov
Rees, EG	UK	UK	Dept of Mathematics, University of Edinburgh	30 Oct - 12 Nov
Reid, M	UK	UK	Institute of Mathematics, University of Warwick	6 Dec - 17 Dec
Ruan, Y	USA	USA	Dept of Mathematics, University of Utah	4 Dec - 17 Dec
Salamon, DA	Germany	UK	Institute of Mathematics, University of Warwick	25 Aug - 25 Aug, 30 Oct - 12 Nov, 5 Dec - 9 Dec, 12 Dec - 16 Dec, 18 Jul - 29 Jul
Schwarz, A	Russia	USA	Dept of Maths, University of California at Davis	1 Jul - 17 Jul, 1 Aug - 23 Sep
Schwarz, M	Germany	Switzerland	ETH Zentrum, Zürich	25 Sep - 8 Oct
Semenov-T-Shansky, M	Russia	Russia	Steklov Mathematical Institute, St Petersburg	30 Oct - 12 Nov
Seredynska, M	Poland	Poland	Institute of Fundamental Tech Research, Warsaw	30 Oct - 12 Nov
Shubin, M	Russia	USA	Dept of Mathematics, Northeastern University	16 Jul - 30 Jul
Siebert, B	Germany	Germany	Mathematics Institut, University of Gottingen	4 Dec - 17 Dec
Sikorav, J-C	France	France	Topologie et Geometrie, Université Paul Sabatier	25 Sep - 8 Oct
Singer, SF	USA	USA	Massachusetts Institute of Technology	29 Oct - 4 Nov
Sjamaar, R	Netherlands	USA	Institute of Advanced Study, University of Princeton	3 Nov - 13 Nov
Stern, R	USA	USA	Department of Mathematics, UC Irvine	4 Dec - 17 Dec
Sudbery, A	UK	UK	Dept of Maths, University of York	30 Nov - 6 Dec
Szenes, A	USA	USA	Massachusetts Institute of Technology	8 Dec - 16 Dec
Thomas, CB	UK	UK	DPMMS, University of Cambridge	4 Jul - 17 Dec

Tian, G	USA	USA	Courant Institute, University of New York	7 Dec - 14 Dec
Tokieda, TF	Japan	USA	Dept of Maths, Princeton University	14 Jul - 16 Dec
Tolman, S	USA	USA	Massachusetts Institute of Technology	30 Oct - 12 Nov
Traynor, L	USA	USA	Dept of Mathematics, Bryn Mawr College	18 Sep - 17 Oct, 28 Oct - 18 Nov
Turaev, V	Russia	France	Dept of Maths, Université Louis Pasteur, Paris	1 Dec - 14 Dec
Tuynman, G	Belgium	France	Universite de Lille 1	6 Nov - 12 Nov
Tyurin, A	Russia	Russia	Steklov Mathematical Institute, Moscow	4 Dec - 17 Dec
Vanhaecke, P	Belgium	Belgium	Universite de Lille 1	30 Oct - 11 Nov
Vergne, M	France	France	ENS, Paris	1 Nov - 12 Nov
Viterbo, C	France	France	Dept of Mathematics, Université de Paris-Sud	5 Sep - 9 Sep, 12 Sep - 22 Sep, 27 Sep - 30 Sep
Weinstein, AD	USA	USA	Dept of Mathematics, UC Berkeley	1 Jul - 31 Jul
Weitsman, J	USA	USA	Dept of Mathematics, Columbia University	1 Nov - 12 Nov
Wolfson, JG	Canada	USA	Dept of Mathematics, Michigan State University	3 Jul - 31 Jul
Wu, S	USA	USA	Dept of Mathematics, Columbia University	2 Nov - 14 Nov
Wysocki, K	Switzerland	Switzerland	Departement Mathematik, ETH Zentrum, Zürich	23 Sep - 7 Oct
Xu, P	China	USA	Dept of Mathematics, University of Pennsylvannia	3 Jul - 1 Sep
Ye, R	China	USA	Dept of Mathematics, UCSB	17 Jul - 1 Aug
Yoshioka, A	Japan	Japan	Science University of Japan	26 Nov - 19 Dec
Zakalyukin, VM	Russia	Russia	Moscow Aviation Institute	1 Nov - 12 Nov

Exponential Asymptotics

Participant	Nationality	Country of Residence	Home Institution	Visits
Aoki, T	Japan	Japan	Dept of Mathematics, Kinki University	27 Feb - 25 Mar
Baesens, C	Belgium	France	CDSC, Université de Bourgogne	15 Jan - 28 Jan
Bender, CM	USA	USA	Dept of Physics, Washington University	5 Jun - 30 Jun
Berry, MV	UK	UK	HH Wills Physics Laboratory, Bristol	31 Mar - 9 Apr, 17 May - 19 May, 31 May - 4 Jun, 17 Apr - 25 Apr, 10 Mar - 18 Mar, 13 Jun - 25 Jun, 15 Jan - 28 Jan, 17 Feb - 23 Feb
Boyd, WGC	UK	UK	Dept of Mathematics, University of Bristol	20 Feb - 14 Apr, 19 Jun - 23 Jun
Braaksma, BLJ	Netherlands	Netherlands	Dept of Mathematics, University of Groningen	26 Feb - 18 Mar
Byatt-Smith, J		UK	Dept of Maths & Stats, University of Edinburgh	16 Jan - 27 Jan
Clarkson, PA	UK	UK	Institute of Maths & Stats, University of Kent	4 Apr - 6 Apr, 19 Jun - 22 Jun, 13 Mar - 17 Mar
Costin, O	Romania	USA	Dept of Mathematics, Rutgers University	27 Mar - 17 Apr, 14 Jan - 29 Jan
Costin, RD	Romania	USA	Dept of Mathematics, Rutgers University	4 May - 16 May
Delabaere, EJ-P	France	France	Université de Nice	20 Feb - 17 Mar
Diener, F	France	France	Université de Nice	22 Apr - 20 May
Diener, M	France	France	Université de Nice	9 Apr - 8 May
Dunster, TM	UK	USA	Dept of Math Science, San Diego State University	13 Jan - 30 Jun
Faucheux, I	France	France	ENS, Paris	17 Apr - 23 Apr
Fröman, PO	Sweden	Sweden	Institute of Theoretical Physics, University of Uppsala	6 Feb - 31 Mar
Fröman, NJ	Sweden	Sweden	Institute of Theoretical Physics, University of Uppsala	6 Feb - 31 Mar
Giller, SJ	Poland	Poland	Dept of Theoretical Physics, University of Lodz	29 May - 22 Jun
Goldhaber, A	USA	Israel	Weizmann Institute of Science, Rehovot	15 Mar - 30 Jun
Guttmann, AJ	Australia	Australia	Dept of Mathematics, University of Melbourne	14 May - 28 May
Hakim, V	France	France	Ecole Normale Superieure, Paris	16 Apr - 6 May
Howls, CJ	UK	UK	Dept of Mathematics, University of Manchester	2 Jan - 30 Jun
Hu, J	China	Hong Kong	Dept of Mathematics, HKUST	5 Jun - 30 Jun
Jaksic, V	Yugoslavia	USA	Institute for Mathematics, University of Minnesota	5 Feb - 25 Feb

Joshi, N	Australia	Australia	Dept of Mathematics, University of NSW	9 Jan - 30 Jun
Joye, A	Switzerland	France	Centre de Physique Théorique, CNRS Luminy	15 Jan - 28 Jan, 14 Mar - 19 Mar
Kawai, T	Japan	Japan	RIMS, University of Kyoto	27 Feb - 1 Apr
Keating, JP	UK	UK	Dept of Mathematics, University of Manchester	21 May - 9 Jun
King, J	UK	UK	Dept of Theoretical Mechanics, University of Nottingham	21 Feb - 22 Feb, 4 Apr - 7 Apr, 14 Mar - 16 Mar
Kitaev, A	Russia	Russia	Steklov Mathematical Institute, St Petersburg	18 Jun - 25 Jun
Kruskal, MD	USA	USA	Dept of Mathematics, Rutgers University	6 Jan - 30 Jun
Lamba, H	UK	UK	Dept of Mathematics, University of Strathclyde	15 Jan - 27 Jan
Lawless, F	Eire	UK	Dept of Mathematics, University of Abertay, Dundee	15 Jan - 27 Jan
Lochak, PA	France	France	Dept de Mathématiques, ENS, Paris	16 Apr - 5 May
Luke, C	UK	Eire	School of Mathematics, University of Dublin	17 Apr - 8 May
Lutz, DA	USA	USA	Dept of Mathematics, San Diego State University	8 Jan - 30 Jan
Majima, H	Japan	Japan	Dept of Mathematics, Ochanomizu University	27 Feb - 24 Mar, 31 Mar - 7 Apr
McLeod, JB	UK	UK	Dept of Maths and Stats, University of Pittsburgh	20 Feb - 24 Feb, 13 Mar - 17 Mar, 3 Apr - 7 Apr
Morgan, M	USA	UK	HH Wills Physics Laboratory, Bristol	16 Jan - 27 Jan
Murphy, BT	Eire	Eire	School of Applied Maths, Dublin City University	12 Jun - 23 Jun
Nikishov, AI	Russia	Russia	Dept of Theoretical Physics, Lebedev Institute	3 Apr - 26 May
Ohyama, Y	Japan	Japan	Dept of Mathematics, University of Osaka	26 Feb - 25 Mar
Olde Daalhuis, A	Netherlands	Netherlands	Institute of Physical Sciences & Technology, Oss	9 Jan - 30 Jun
Olver, FWJ	USA	USA	IPST, University of Maryland	11 Jan - 27 Jun
O'Malley, RE	USA	USA	Dept of Applied Maths, University of Washington	5 Jan - 30 Jun
Paris, RB	UK	UK	Maths and Computer Science, University of Abertay	27 Mar - 8 Apr, 17 Apr - 21 Apr, 18 Jun - 25 Jun
Pham, F	France	France	Laboratoire de Mathematiques, UNSA	16 Apr - 1 May, 4 Jun - 23 Jun
Ritus, VI	Russia	Russia	Dept of Theoretical Physics, Lebedev Institute	3 Apr - 26 May
Salvy, B	France	France	INRIA Roquencourt	19 Apr - 29 Apr, 2 Jan - 27 Jan
Sauzin, D	France	France	CNRS, Paris	17 Apr - 23 Apr

Shatalov, V	Russia	Russia	Computational Maths, Moscow State University	18 Apr - 1 Jun
Silverstone, HJ	USA	USA	Dept of Chemistry, Johns Hopkins University	5 Mar - 13 Apr
Slavyanov, SY	Russia	Russia	Institute of Physics, University of St Petersburg	15 Jan - 15 May
Solov'ev, E	Macedonia	Macedonia	Macedonian Academy of Sciences, Skopje	1 May - 30 Jun
Sternin, B	Russia	Russia	Computational Maths, Moscow State University	18 Apr - 1 Jun
Tajima, S	Japan	Japan	Dept of Information Engineering, Niigata University	26 Feb - 25 Mar
Takei, Y	Japan	Japan	RIMS, University of Kyoto	26 Feb - 25 Mar
Takasaki, K	Japan	Japan	Dept of Fundamental Sciences, University of Kyoto	20 Mar - 8 Apr
Tanveer, S	USA	USA	Dept of Mathematics, Ohio State University	24 Apr - 8 Jun
Temme, NM	Netherlands	Netherlands	CWI Amsterdam	19 Jun - 22 Jun, 3 Jan - 27 Jan
Tew, R	UK	UK	Dept of Theoretical Mechanics, University of Nottingham	21 Feb - 22 Feb, 14 Mar - 16 Mar, 4 Apr - 7 Apr
Tovbis, A	Israel	USA	Dept of Mathematics, University of West Virginia	3 Apr - 7 Apr, 28 May - 1 Jun
Uchiyama, K	Japan	Japan	Dept of Mathematics, Sophia University	4 Mar - 24 Mar
Van den Berg, IP	Netherlands	Netherlands	Dept of Econometrics, University of Groningen	17 Apr - 10 Jun
Voros, A	France	France	Service de Physique Théorique, Gif-sur-Yvette	14 Mar - 17 Mar, 27 Mar - 22 Apr, 10 May - 11 May, 18 Jan - 20 Jan
Wei, J	China	Italy	SISSA-ISAS, Trieste	1 Apr - 8 Apr
Weniger, EJ	Germany	Germany	Theoretische Chemie, Universität Regensberg	15 Jan - 27 Jan
Wickham, GR	UK	UK	Dept of Mathematics, University of Manchester	5 Jun - 30 Jun
Wong, R	Canada	Hong Kong	Dept of Mathematics, CUHK	18 Jun - 24 Jun
Wood, AD	UK	Eire	Mathematical Sciences, Dublin City University	17 Apr - 28 Apr, 5 Jun - 23 Jun
Xu, JJ	Canada	Canada	Dept of Mathematics, McGill University	5 Jun - 26 Jun
Yngve, S	Sweden	Sweden	Dept of Theoretical Physics, University of Uppsala	1 Jun - 30 Jun
Zinn-Justin, J	France	France	Service de Physique Théorique, CEA Saclay	26 Mar - 1 Apr

Financial Mathematics

Participant	Nationality	Country of Residence	Home Institution	Visits
Aase, KK	Norway	Norway	Institute of Finance and Management Sciences, Norges Handelshoyskole	6 Mar - 12 Mar
Ait-Sahlia, F	Algeria	USA	Operations Research, Stanford University	26 Mar - 15 Apr
Artzner, P	France	France	Dept of Mathematics, Université Louis Pasteur	5 Mar - 31 Mar, 16 May - 16 Jun
Avesani, RG	Italy	Italy	Universita degli Studi di Brescia	9 Apr - 15 Apr
Bertrand, P		France		8 Apr - 15 Apr
Bick, A	Israel	Canada	Dept of Business Admin, Simon Fraser University	9 Apr - 5 May
Bjork, T	Sweden	Sweden	Stockholm School of Ecomomics	1 Feb - 17 Feb
Brace, A	UK	Australia	Citibank, Sydney	17 Jan - 30 Jun
Brennan, MJ	UK	USA	Graduate School of Management, UCLA	1 May - 5 May
Broadie, M	USA	USA	Grad School of Business, Columbia University	8 Apr - 14 Apr
Bühlmann, H	Switzerland	Switzerland	Dept of Mathematics, ETH Zentrum, Zürich	19 Mar - 7 Apr
Cadenillas, A	Peru	Canada	Faculty of Management, University of Toronto	2 Jan - 30 Jun
Canestrelli, E	Italy	Italy	Dept of Mathematics, Università di Venezia	6 May - 14 May
Carassus, L	France	France	CREST Lab Finance	5 Jun - 9 Jun
Cover, TM	USA	USA	Information Systems Lab, Stanford University	18 Mar - 25 Mar
Cvitanic, J	Croatia	USA	Dept of Statistics, Columbia University, New York	21 May - 16 Jun
Dai, Q		USA	Graduate School of Business, Stanford University	8 Jun - 17 Jun
Dassios, A	Greece	UK	London School of Economics	21 May - 3 Jun, 6 Mar - 10 Mar, 8 May - 12 May
Davis, MHA	UK	UK	Dept Electrical Engineering, Imperial College	4 Jan - 31 Mar
De Koster, O	Netherlands	Netherlands	Technische Universiteit, Delft	22 May - 3 Jun
Delbaen, F	Belgium	Belgium	Dept für Mathematik, Zürich	2 Apr - 15 Apr, 12 Jun - 16 Jun
Dempster, MAH	UK	UK	Dept of Mathematics, University of Essex	13 May - 13 May, 16 May - 3 Jun, 1 Jan - 31 Mar
Detemple, J	France	USA	Faculty of Management, McGill University	10 Mar - 24 Mar
Duan, J-C	Canada	Canada	Faculty of Management, McGill University	20 Mar - 5 May
Dufresne, D	Canada	Canada	Dept of Maths and Stats, University of Montreal	5 Mar - 18 Mar
Dybvig, PH	USA	USA	Olin School of Management, Washington University	28 May - 12 Jun

Eberlein, EW	Germany	Germany	Institute of Maths, University of Freiburg	15 Mar - 29 Mar
El-Karoui, N		France	Laboratoire de Probabilités, Université de Paris	12 Apr - 14 Apr, 12 Jun - 16 Jun
Elliott, RJ	Canada	Canada	Dept of Statistics, University of Alberta	21 May - 3 Jun
Embrechts, P	Belgium	Switzerland	Dept of Mathematics, ETH Zentrum, Zürich	5 Mar - 25 Mar
Evstigneev, I	Russia	Russia	CEMI, Russia	23 May - 2 Jun
Foldes, LP	UK	UK	London School of Economics	20 Mar - 24 Mar, 21 May - 3 Jun
Föllmer, H	Germany	Germany	Institute of Maths, University of Bonn	12 Mar - 25 Mar
Frittelli, M	Italy	Italy	Facoltà di Economi, Università degli di Milano	22 May - 16 Jun
Geman, H	France	France	Dept Finance, ESSEC, Cergy-Pontoise	23 May - 1 Jun, 6 Mar - 8 Mar
Goffin, J-L	Belgium	Canada	Faculty of Management, McGill University	21 May - 3 Jun
Goodman, GS	USA	Italy	Department of Statistics, University of Florence	4 Jan - 11 Jan
Gottardi, P	Italy	Italy	Dipartimento di Scienze Economiche, Ca'Foscari	1 Feb - 23 Feb
Guerra, M-L	Italy	Italy	Istituto de Scienze Economiche, Università di Urbino	21 May - 3 Jun
Heath, D	USA	USA	Cornell University	1 Jun - 19 Jun, 19 Mar - 26 Mar
Hensel, CR	USA	USA	Frank Russell Co, Tacoma	6 May - 19 May
Hobson, DG	UK	UK	School of Mathematical Sciences, University of Bath	21 May - 24 Jun
Hodges, SD	UK	UK	Warwick Business School	3 Jan - 18 Jun
Howison, SD	UK	UK	Mathematical Institute, University of Oxford	25 Mar - 31 Mar
Jacka, SD	Australia	UK	Dept of Statistics, University of Warwick	20 Mar - 30 Mar, 23 May - 25 May
J-Piqué, M	France	France	Université d'Evry	24 May - 2 Jun
Kabanov, Y	Russia	Russia	Russian Academy of Sciences, Moscow	11 Feb - 19 Feb
Karatzas, I	USA	USA	Dept of Statistics, University of Columbia	14 Mar - 31 Mar
Kariya, T	Japan	Japan	Inst Econ Research, Hitotsubashi University	6 Apr - 27 Apr
Kennedy, DP	Eire	UK	Statistical Laboratory, University of Cambridge	1 Jan - 30 Jun
Koehl, P-F	France	France	ENSAE, Malakoff	4 Jun - 10 Jun
Koo, HK	Korea	USA	Olin School of Business, Washington University	4 Jun - 10 Jun
Kopp, PE	UK	UK	School of Mathematics, University of Hull	20 Mar - 8 Apr, 29 May - 30 May
Korn, R	Germany	Germany	Fachbereich Mathematik, Johannes Gutenburg University	12 Mar - 25 Mar
Kramkov, D	Russia	Russia	Steklov Mathematical Institute, Moscow	2 Jun - 27 Jun
Lacoste, V	France	France	Dept of Finance, Groupe ESSEC	30 May - 3 Jun, 12 Jun - 16 Jun

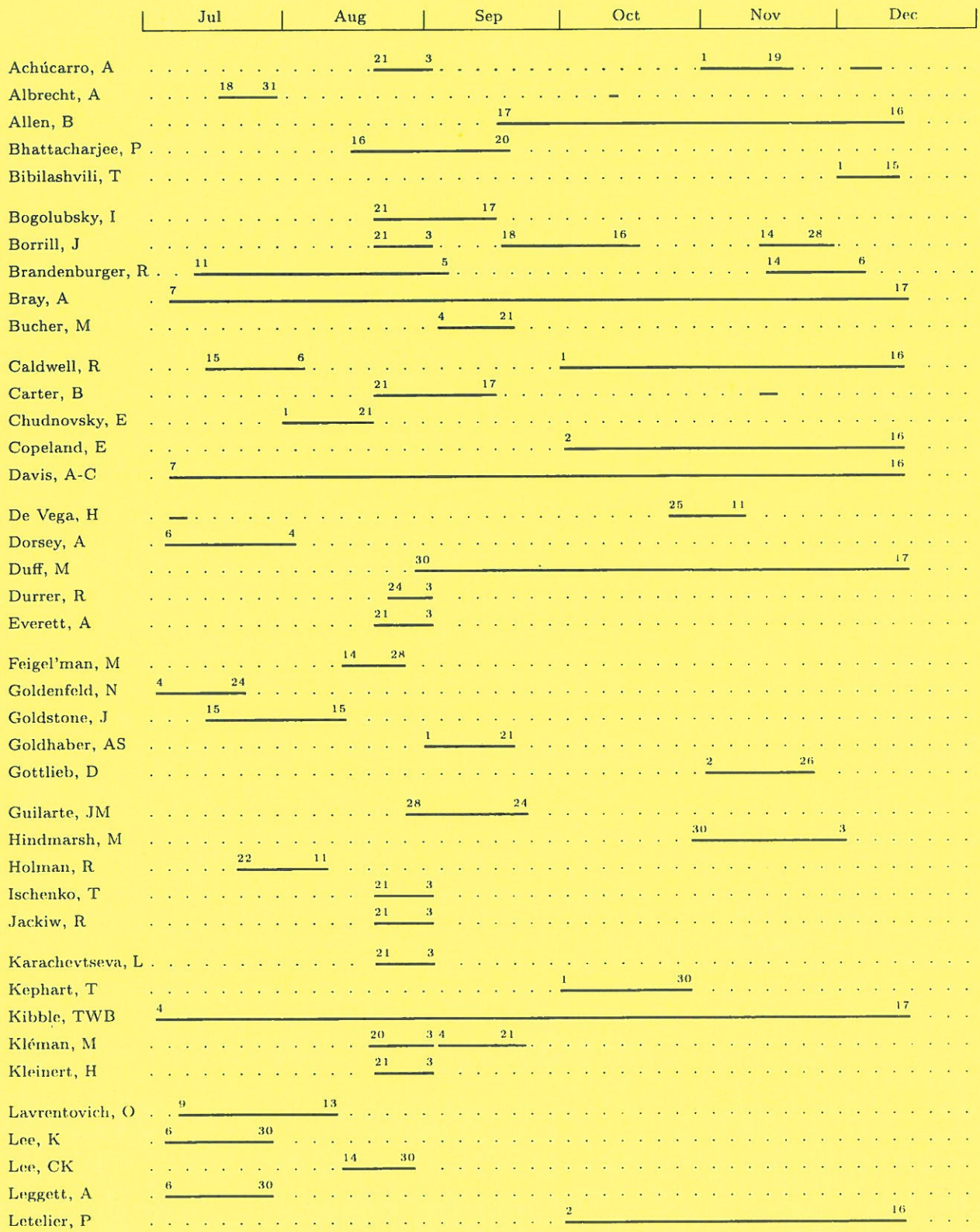
Lakner, P	Hungary	USA	Statistics and Operational Research Dept, NYU	29 May - 15 Jun
Lamberton, D	France	France	Université de Marne la Vallee, Noisy-le-Grand	14 May - 24 May, 9 Apr - 13 Apr
Lapeyre, B	France	France	CERMA-ENPC, Noisy-le-Grand	9 Apr - 14 Apr, 22 May - 4 Jun
Lehoczky, JP	USA	USA	Dept of Statistics, Carnegie-Mellon University	13 May - 5 Jun
Lovatt, DA	UK	UK	School of Information Systems, UEA	3 Jan - 10 Jan
Lyons, T	UK	UK	Department of Mathematics, Imperial College	10 Apr - 14 Apr, 16 Jun - 25 Jun
Madan, DB	USA	USA	College of Business and Management, University of Maryland	7 May - 5 Jun
Melnikov, AV	Russia	Russia	Steklov Mathematical Institute, Moscow	12 Jun - 21 Jun
Mercurio, F	Italy	Netherlands	Tinbergen Institute, Rotterdam	21 May - 2 Jun
Michaud, R	USA	USA	Acadian Asset Management, Boston	7 May - 21 May
Mulvey, J	USA	USA	Dept of Civil Engineering, University of Princeton	14 May - 23 May
Muradoglu, G	Turkey	Turkey	Faculty of Business Admin, Bilkent University	7 May - 14 May
Musiela, M	Australia	Australia	School of Mathematics, University of NSW	5 Jun - 16 Jun
Nielsen, JA	Denmark	Denmark	Dept of Operation Research, University of Aarhus	5 Mar - 12 Mar
Novikov, A	Russia	Russia	Steklov Mathematical Institute, Moscow	12 May - 11 Jun
Perraudin, W	UK	UK	Dept of Applied Economics, Cambridge	1 Jan - 1 Jun
Platen, E	Germany	Australia	Dept of Statistics, Australian National University	22 May - 16 Jun
Pliska, SR	USA	USA	Dept of Finance, University of Illinois	2 Jan - 30 Jun
Richardson, HR	USA	USA	Metron Inc, Reston, Virginia	5 Jan - 26 Jan
Roberts, G	UK	UK	Stats Laboratory, DPMMS, Cambridge	1 Jan - 30 Jun
Rogers, LCG	UK	UK	Dept of Mathematical Sciences, University of Bath	3 Jan - 30 Jun
Runggaldier, WJ	Italy	Italy	Dept of Mathematics, University of Padova	1 Feb - 18 Feb
Rutkowski, M	Poland	Poland	Institute of Mathematics, Politechnika Warszawska	4 Jun - 17 Jun
Satchell, SE	UK	UK	Trinity College, Cambridge	1 Apr - 30 Jun
Schachermayer, W	Austria	Austria	Institute of Statistics, University of Vienna	2 Apr - 21 Apr
Schweizer, M	Switzerland	Germany	Dept of Maths, Technical University of Berlin	5 Mar - 25 Mar
Scott, LO	USA	USA	Dept of Banking & Finance, University of Georgia	25 Mar - 1 Apr
Sevcik, P	Czech Republic	Czech Republic	Charles University, Prague	21 May - 3 Jun
Shirakawa, H	Japan	Japan	Tokyo Institute of Technology	12 Mar - 24 Mar, 21 May - 4 Jun
Shreve, SE	USA	USA	Dept of Mathematics, Carnegie-Mellon University	1 May - 12 Jun

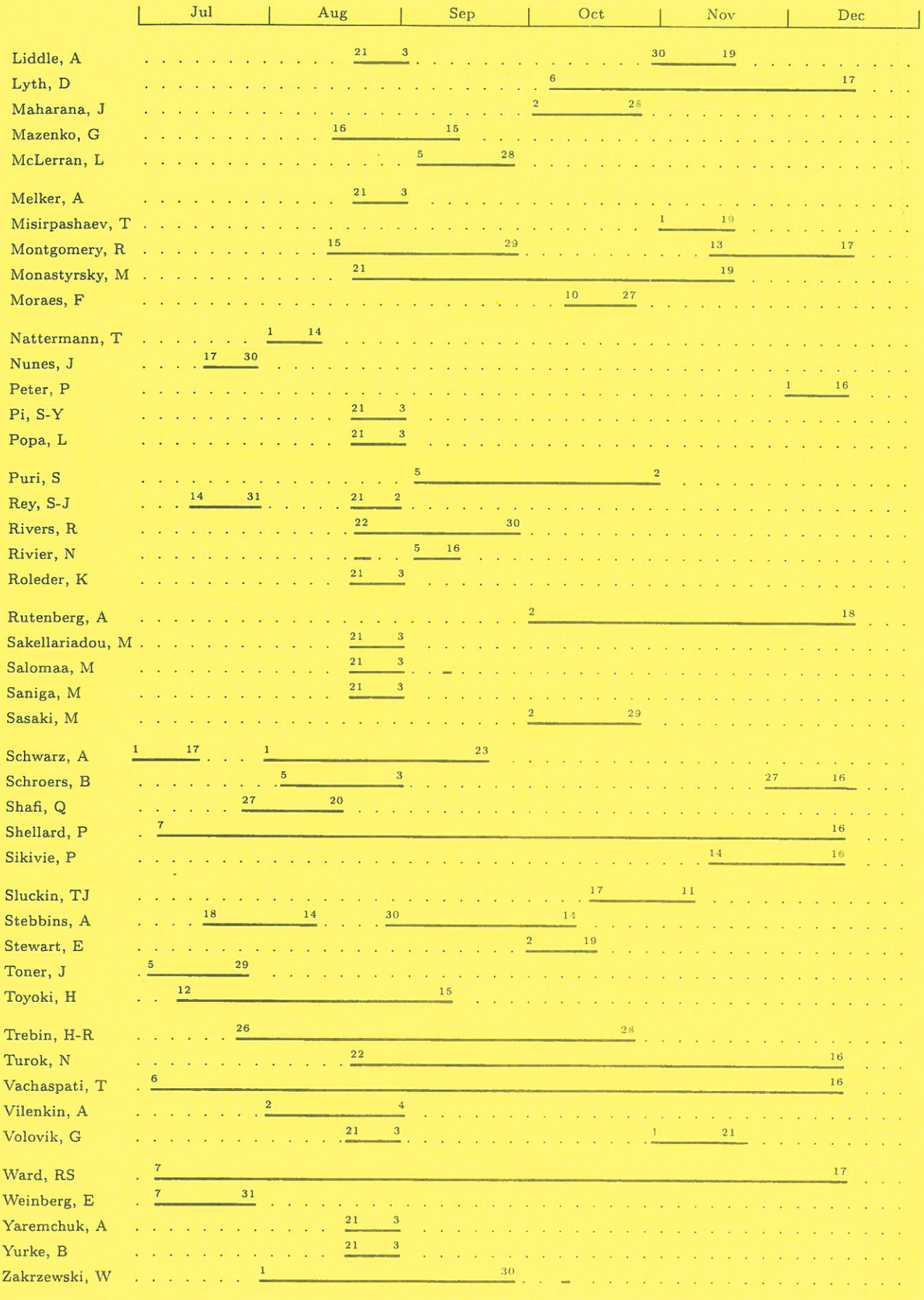
Skulimowski, A	Poland	Poland	Institutue of Automatics Control, Krakow	21 May - 3 Jun
Steeley, JM	UK	UK	Dept of Economics, University of Keele	1 May - 12 Jun
Stefanini, L	Italy	Italy	Istituto di Scienze Econ, Università di Urbino	21 May - 3 Jun
Stricker, C	France	France	Faculté de Sciences, Université de Besancon	21 May - 2 Jun
Sundaresan, SM	USA	USA	Graduate School of Business, Columbia University	6 Jun - 20 Jun
Tabakis, E	Germany	Germany	Mathematik VII, Universität Bayreuth	28 Feb - 22 Mar
Vecer, J	Czech Republic	Czech Republic		4 Jan - 10 Jan, 1 Jun - 6 Jun
Webber, N	UK	UK	Business School, University of Warwick	8 Feb - 28 Feb, 12 Jun - 16 Jun
Wilmott, P	UK	UK	Institute of Mathematics, Oxford	4 Jan - 30 Jun
Willinger, W	Austria	USA	Bell Communications Research, Morristown	18 Mar - 15 Apr
Zane, O	Italy	UK	School of Math Science, University of Bath	27 May - 19 Jun
Zariphopoulou, T	Greece	USA	Dept of Mathematics, University of Wisconsin	21 May - 3 Jun, 10 Apr - 14 Apr
Ziemba, WT	USA	Canada	University of British Columbia	7 May - 22 May

9.2 CHART OF VISITS 1994-95

Please note that the following charts include visiting members only, ie participants who stayed at the Institute for seven days or more.

Topological Defects




Jul
Aug
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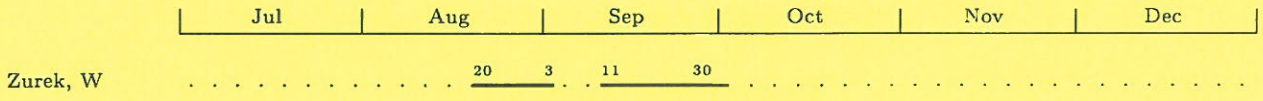
Liddle, A 21 3 30 19
Lyth, D 6 17
Maharana, J 2 28
Mazenko, G 16 15
McLerran, L 5 28
Melker, A 21 3
Misirpashaev, T 1 19
Montgomery, R 15 29 13 17
Monastyrsky, M 21 19
Moraes, F 10 27
Nattermann, T 1 14
Nunes, J 17 30
Peter, P 1 16
Pi, S-Y 21 3
Popa, L 21 3
Puri, S 5 2
Rey, S-J 14 31 21 2
Rivers, R 22 30
Rivier, N 5 16
Roleder, K 21 3
Rutenberg, A 2 18
Sakellariadou, M 21 3
Salomaa, M 21 3
Saniga, M 21 3
Sasaki, M 2 29
Schwarz, A 1 17 1 23
Schroers, B 5 3 27 16
Shafi, Q 27 20
Shellard, P 7 16
Sikivie, P 14 16
Sluckin, TJ 17 11
Stebbins, A 18 14 30 14
Stewart, E 2 19
Toner, J 5 29
Toyoki, H 12 15
Trebin, H-R 26 28
Turok, N 22 16
Vachaspati, T 6 16
Vilenkin, A 2 4
Volovik, G 21 3 1 21
Ward, RS 7 17
Weinberg, E 7 31
Yaremchuk, A 21 3
Yurke, B 21 3
Zakrzewski, W 1 30


Jul
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Zurek, W
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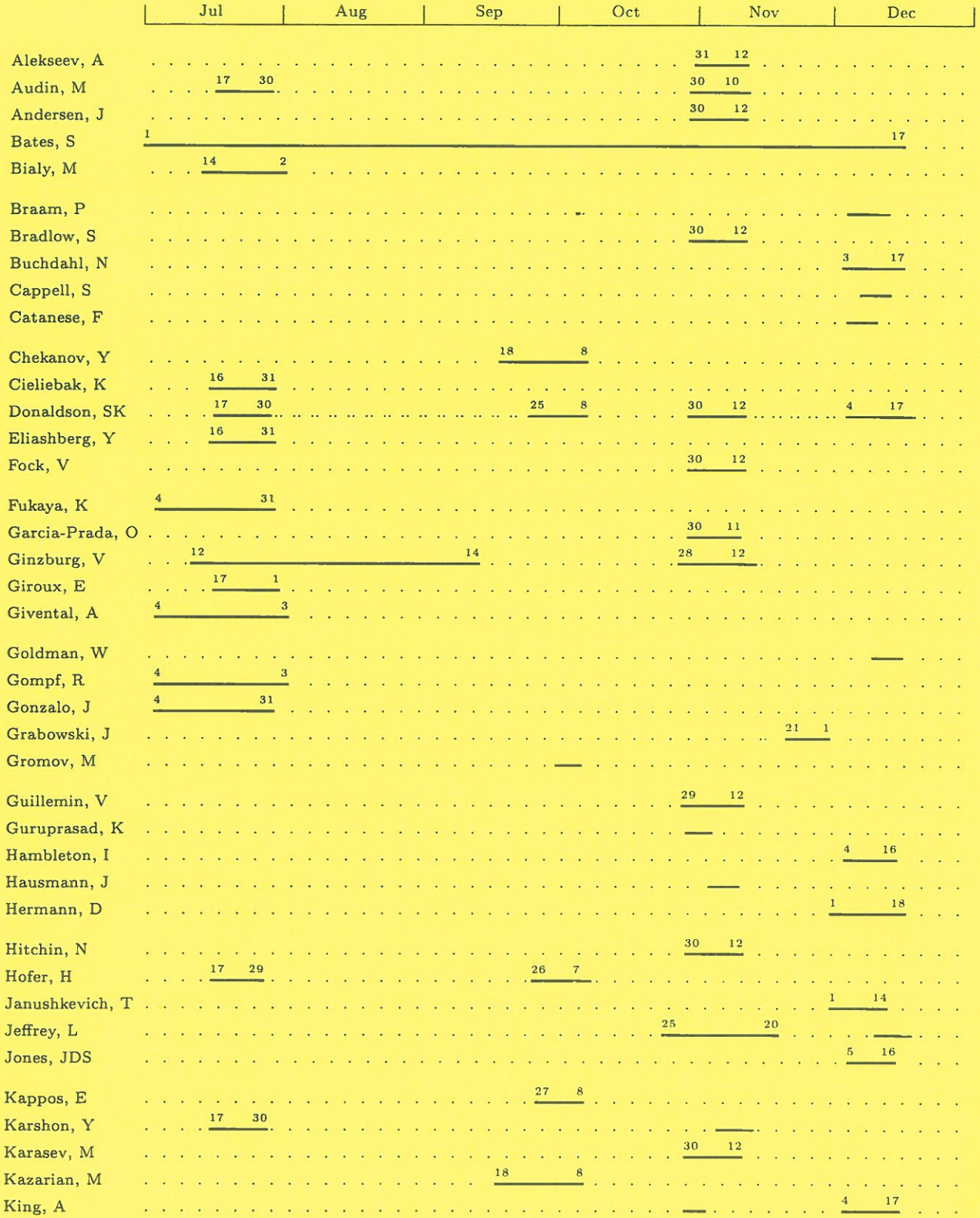
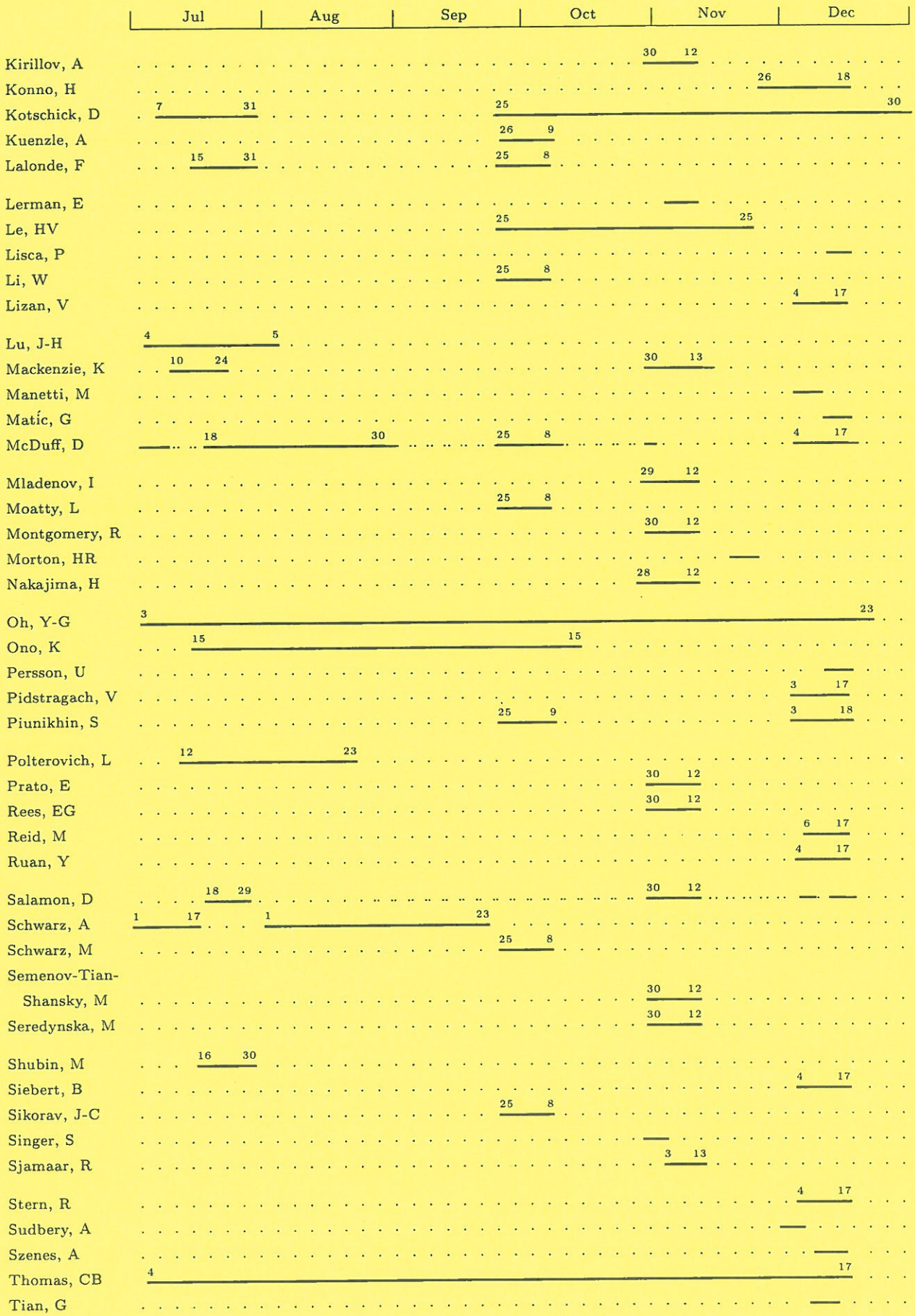
9.2 CHART OF VISITS 1994-95

Symplectic Geometry




Jul
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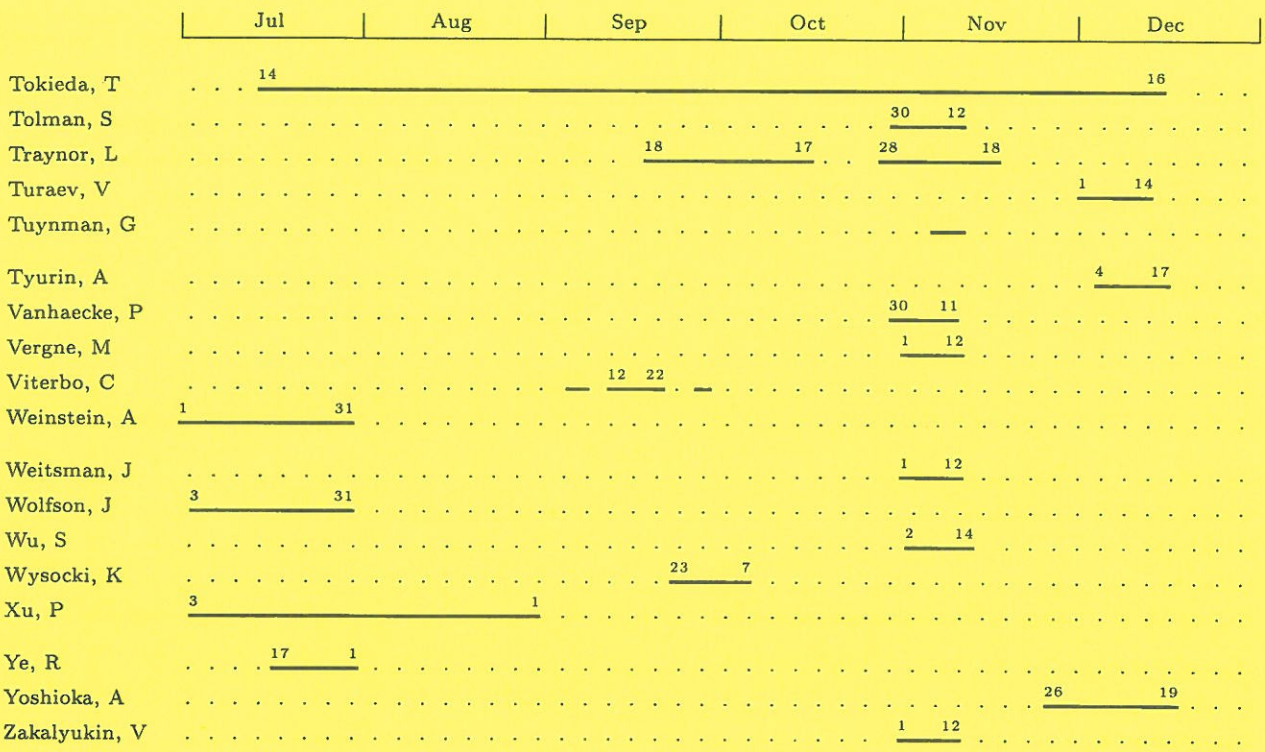
Kirillov, A 30 12
Konno, H 26 18
Kotschick, D 7 31 25 30
Kuenzle, A 26 9
Lalonde, F 15 31 25 8
Lerman, E
Le, HV 25 25
Lisca, P
Li, W 25 8
Lizan, V 4 17
Lu, J-H 4 5
Mackenzie, K 10 24 30 13
Manetti, M
Matić, G
McDuff, D 18 30 25 8 4 17
Mladenov, I 29 12
Moatty, L 25 8
Montgomery, R 30 12
Morton, HR
Nakajima, H 28 12
Oh, Y-G 3 23
Ono, K 15 15
Persson, U
Pidstragach, V 3 17
Piunikhin, S 25 9 3 18
Polterovich, L 12 23
Prato, E 30 12
Rees, EG 30 12
Reid, M 6 17
Ruan, Y 4 17
Salamon, D 18 29 30 12
Schwarz, A 1 17 1 23
Schwarz, M 25 8
Semenov-Tian-Shansky, M 30 12
Seredynska, M 30 12
Shubin, M 16 30
Siebert, B 4 17
Sikorav, J-C 25 8
Singer, S
Sjamaar, R 3 13
Stern, R 4 17
Sudbery, A
Szenes, A
Thomas, CB 4 17
Tian, G


Jul
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Tokieda, T
14
16
Tolman, S
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12
Traynor, L
18
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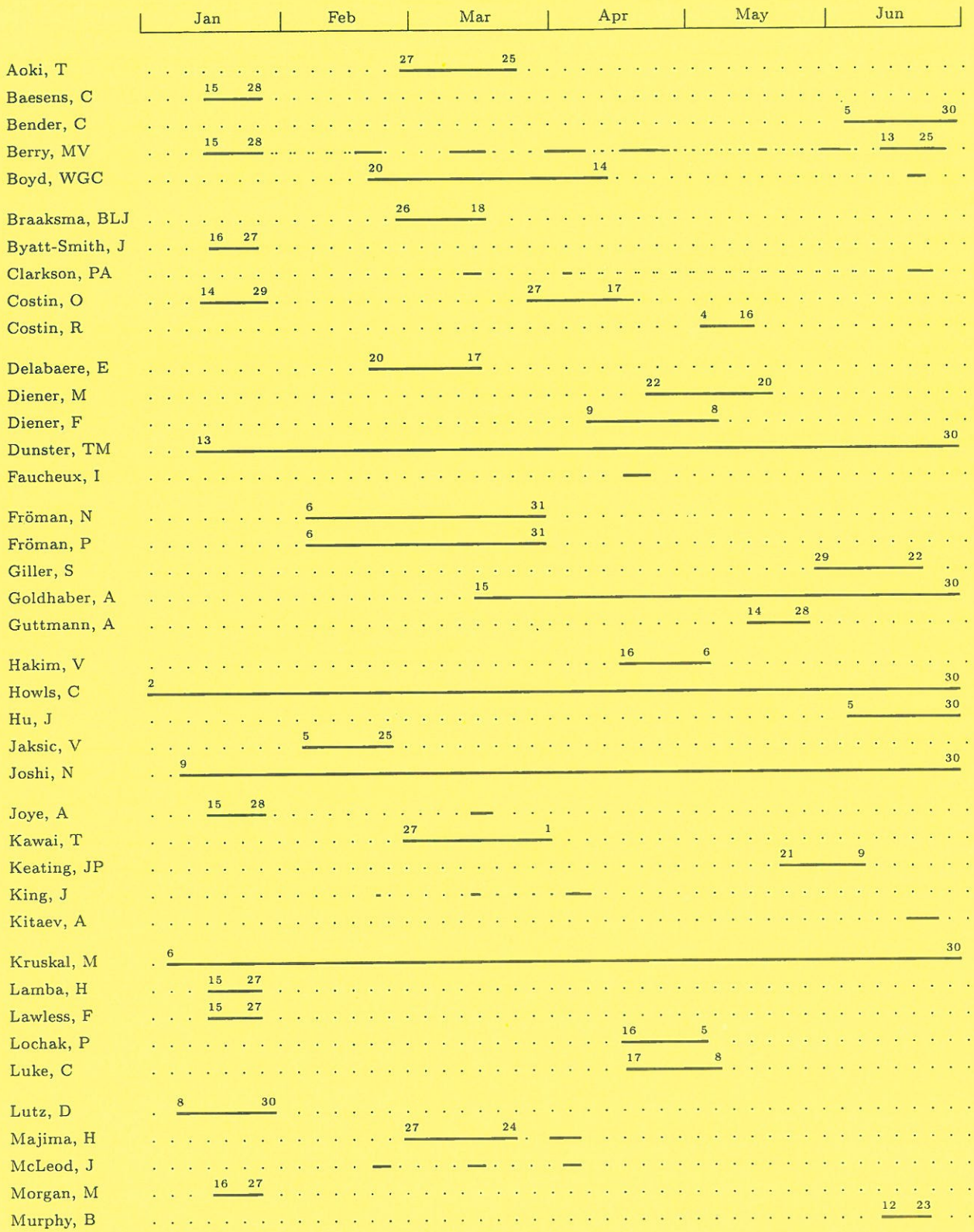
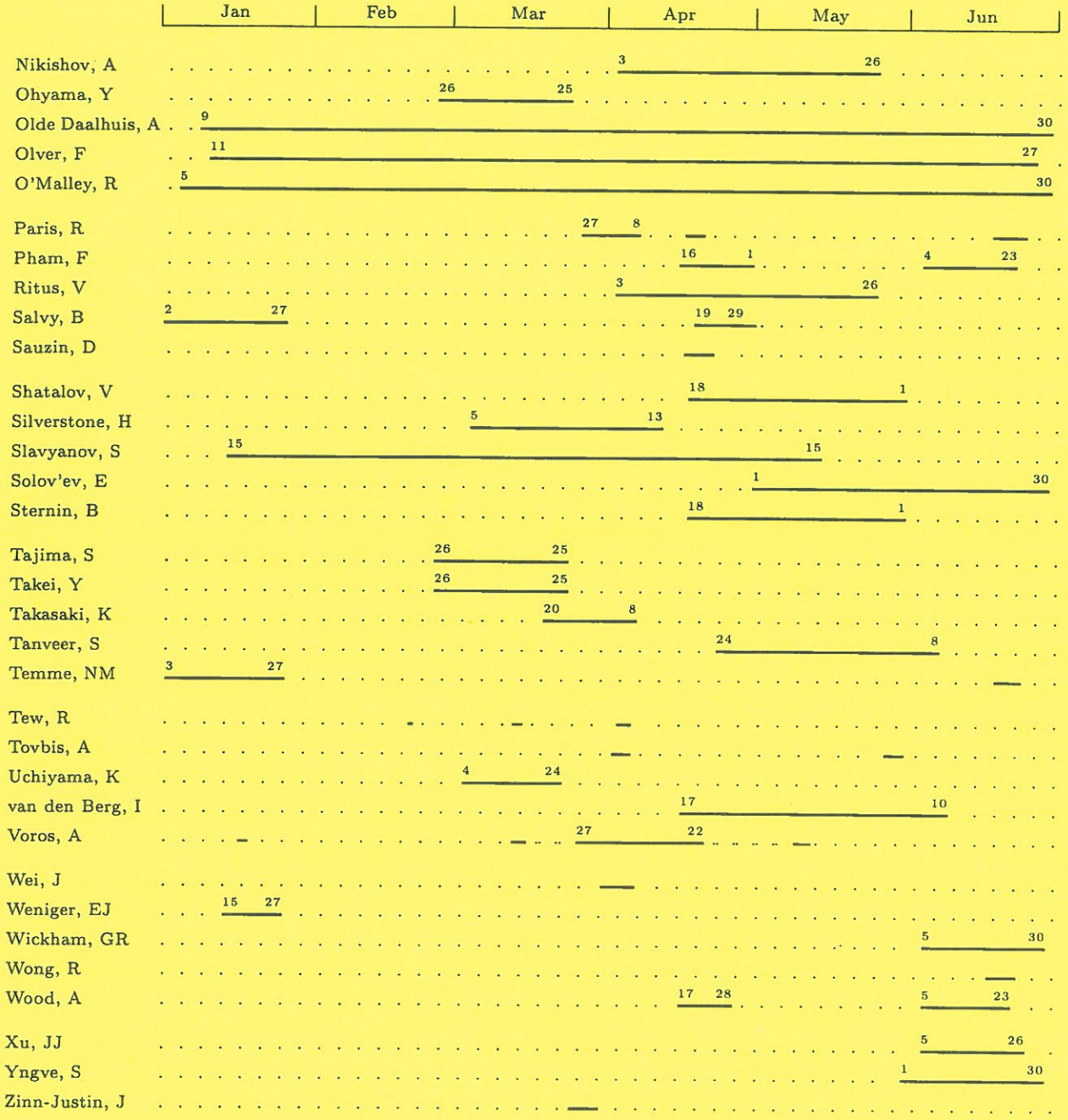
28
18
Turaev, V
1
14
Tuynman, G
Tyurin, A
4
17
Vanhaecke, P
30
11
Vergne, M
1
12
Viterbo, C
12
22
Weinstein, A
1
31
Weitsman, J
1
12
Wolfson, J
3
31
Wu, S
2
14
Wysocki, K
23
7
Xu, P
3
1
Ye, R
17
1
Yoshioka, A
26
19
Zakalyukin, V
1
12

9.2 CHART OF VISITS 1994-95

Exponential Asymptotics




Jan
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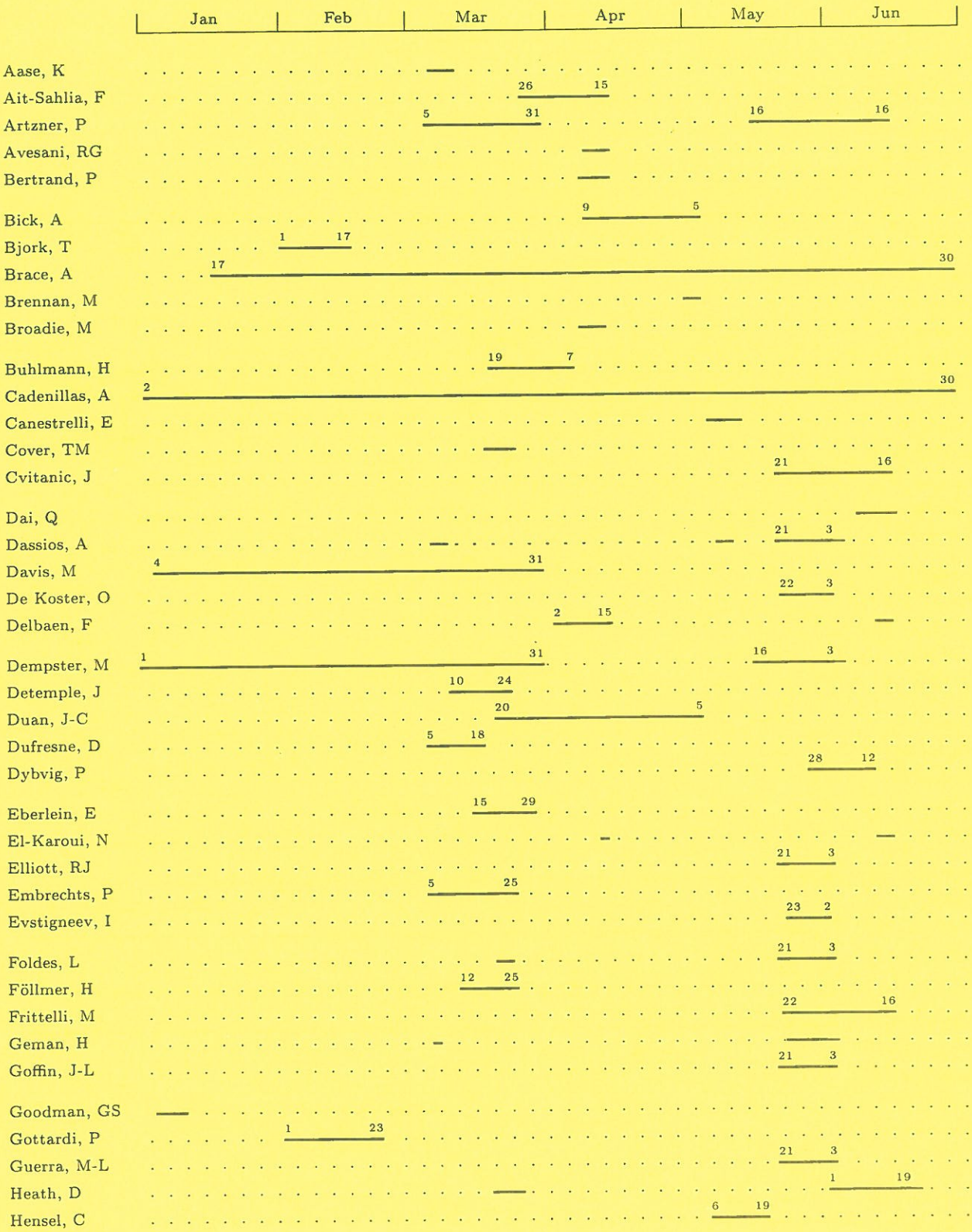
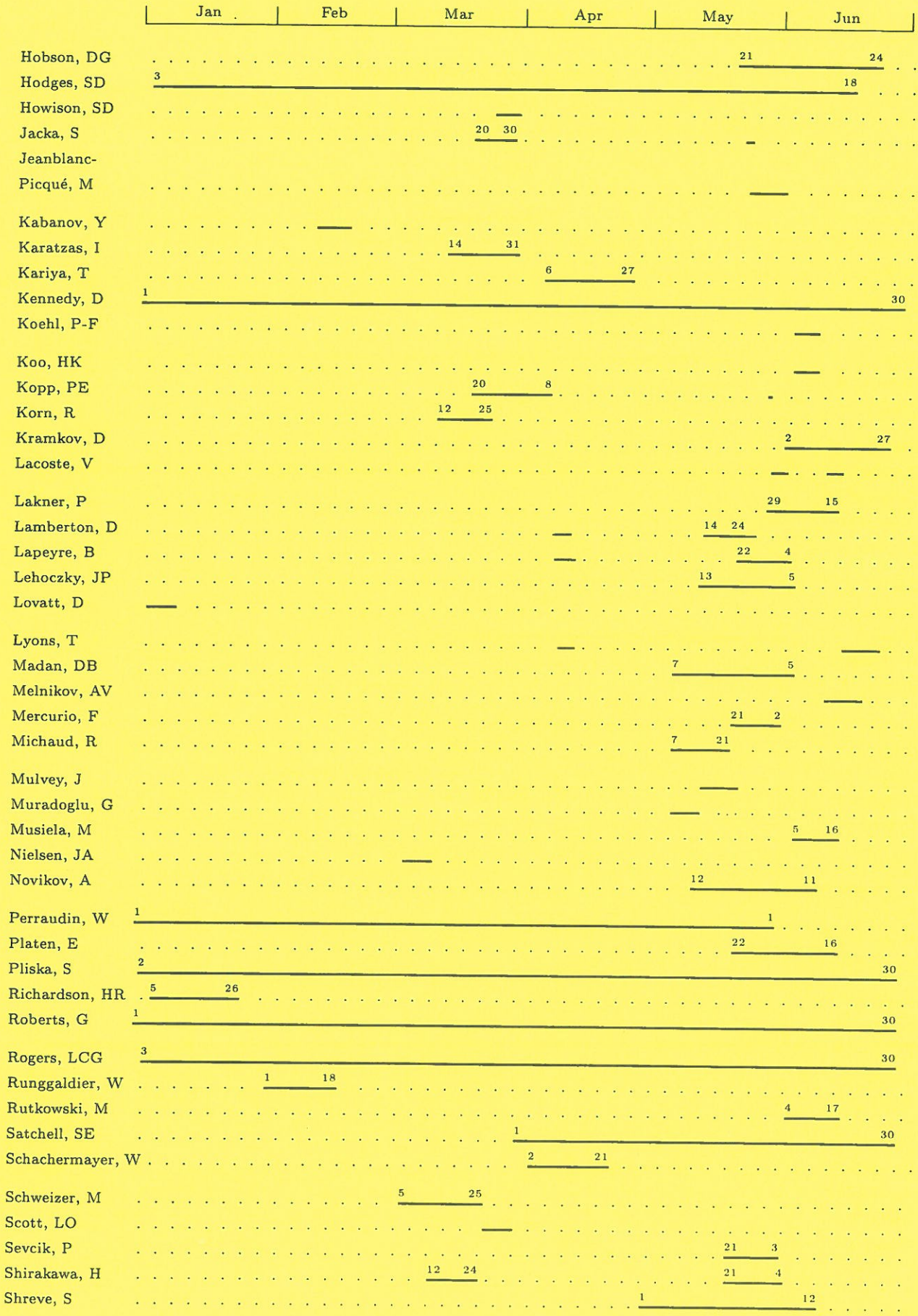
Nikishov, A 3 26
Ohyama, Y 26 25
Olde Daalhuis, A 9 30
Olver, F 11 27
O'Malley, R 5 30
Paris, R 27 8
Pham, F 16 1 4 23
Ritus, V 3 26
Salvy, B 2 27 19 29
Sauzin, D
Shatalov, V 18 1
Silverstone, H 5 13
Slavyanov, S 15 15
Solov'ev, E 1 30
Sternin, B 18 1
Tajima, S 26 25
Takei, Y 26 25
Takasaki, K 20 8
Tanveer, S 24 8
Temme, NM 3 27
Tew, R
Tovbis, A
Uchiyama, K 4 24
van den Berg, I 17 10
Voros, A 27 22
Wei, J
Weniger, EJ 15 27
Wickham, GR 5 30
Wong, R
Wood, A 17 28 5 23
Xu, JJ 5 26
Yngve, S 1 30
Zinn-Justin, J

9.2 CHART OF VISITS 1994-95

Financial Mathematics




Jan
Feb
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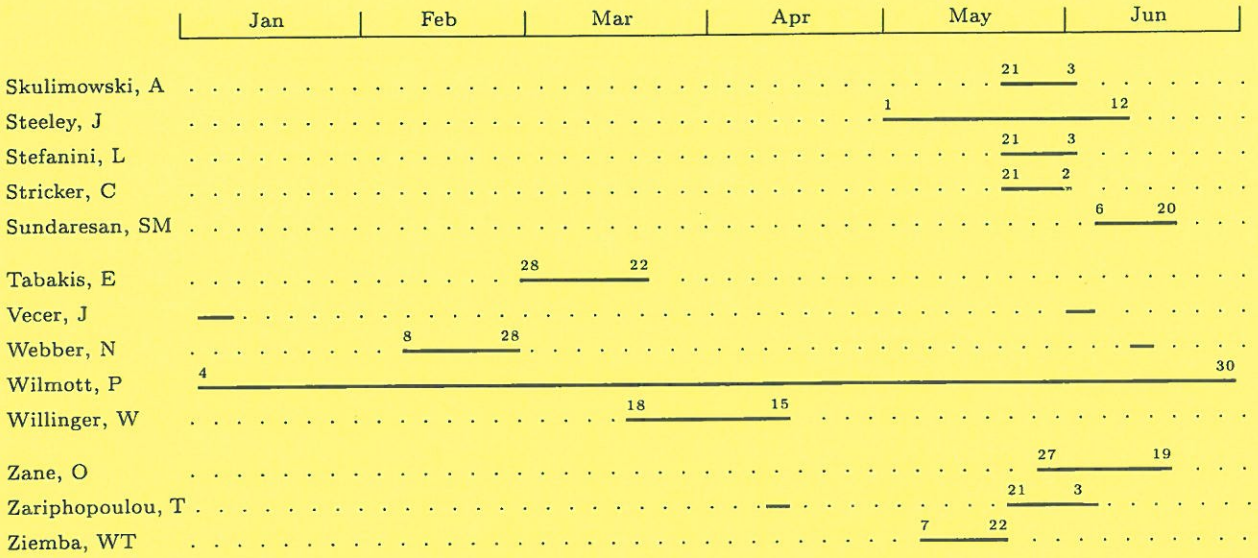
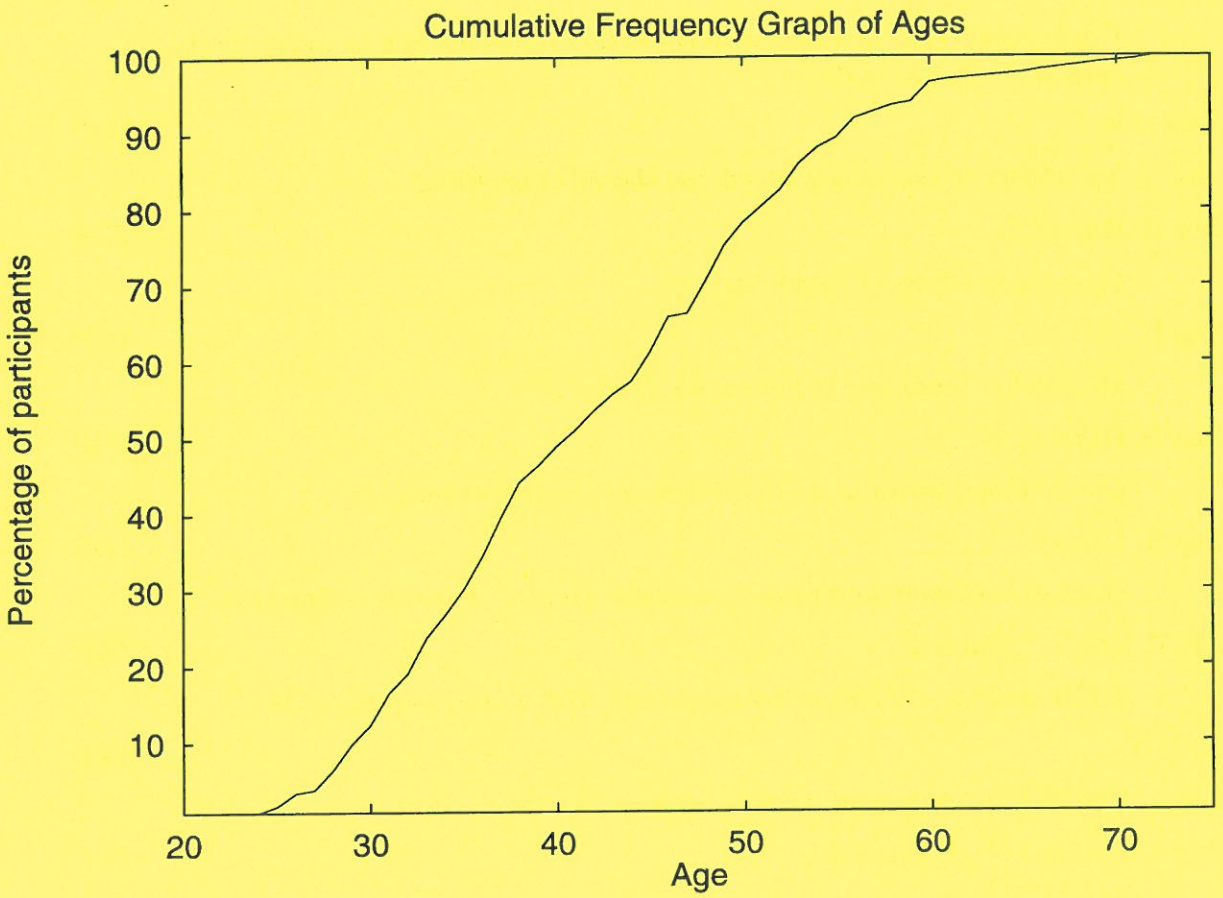
Jun
Hobson, DG 21 24
Hodges, SD 3 18
Howison, SD
Jacka, S 20 30
Jeanblanc-
Picqué, M
Kabanov, Y
Karatzas, I 14 31
Kariya, T 6 27
Kennedy, D 1 30
Koehl, P-F
Koo, HK
Kopp, PE 20 8
Korn, R 12 25
Kramkov, D 2 27
Lacoste, V
Lakner, P 29 15
Lamberton, D 14 24
Lapeyre, B 22 4
Lehoczky, JP 13 5
Lovatt, D
Lyons, T
Madan, DB 7 5
Melnikov, AV
Mercurio, F 21 2
Michaud, R 7 21
Mulvey, J
Muradoglu, G
Musiela, M 5 16
Nielsen, JA
Novikov, A 12 11
Perraudin, W 1 1
Platen, E 22 16
Pliska, S 2 30
Richardson, HR 5 26
Roberts, G 1 30
Rogers, LCG 3 30
Runggaldier, W 1 18
Rutkowski, M 4 17
Satchell, SE 1 30
Schachermayer, W 2 21
Schweizer, M 5 25
Scott, LO
Sevcik, P 21 3
Shirakawa, H 12 24 21 4
Shreve, S 1 12


Jan
Feb
Mar
Apr
May
Jun
Skulimowski, A 21 3
Steeley, J 1 12
Stefanini, L 21 3
Stricker, C 21 2
Sundaresan, SM 6 20
Tabakis, E 28 22
Vecer, J
Webber, N 8 28
Wilmott, P 4 30
Willinger, W 18 15
Zane, O 27 19
Zariphopoulou, T 21 3
Ziemba, WT 7 22

9.3 NATIONALITY AND COUNTRY OF RESIDENCE

Country	Visiting Members		Others*
	Residents	Nationals	Residents
Algeria	0	1	0
Australia	6	6	1
Austria	1	2	0
Belgium	2	7	2
Brazil	2	1	1
Bulgaria	1	1	0
Canada	10	8	4
Chile	0	1	0
China	0	5	1
Croatia	0	1	0
Czech Republic	2	2	1
Denmark	1	2	4
Eire	3	3	6
Finland	2	1	1
France	42	34	34
Georgia	1	1	0
Germany	13	15	37
Greece	0	2	1
Hong Kong	2	0	0
Hungary	0	1	0
India	3	5	0
Israel	3	5	0
Italy	12	12	15
Japan	17	18	4
Korea	2	5	0
Macedonia	1	1	0
Netherlands	6	6	13
Norway	1	1	5
Peru	0	1	0
Poland	7	6	2
Portugal	0	1	1
Romania	1	3	0
Russia	25	34	2
Slovakia	1	1	0
Spain	3	3	4
Sweden	7	6	4
Switzerland	9	9	10
Turkey	1	1	2
UK	64	69	378
Ukraine	1	2	0
USA	108	70	73
Vietnam	0	1	0
Yugoslavia	0	1	0
Unknown	0	5	7
Total	360	360	614

* *Workshop and Short Stay Participants*


Cumulative Frequency Graph of Ages
Percentage of participants
100
90
80
70
60
50
40
30
20
10
20
30
40
50
60
70
Age

9.5 PAPERS PRODUCED BY PARTICIPANTS

Programmes within which papers were produced are indicated by codes as follows: CAG=*Cellular Automata, Aggregation and Growth*; CVI=*Computer Vision*; DYN=*Dynamo Theory*; EPI=*Epidemic Models*; EXP=*Exponential Asymptotics*; FIN=*Financial Mathematics*; RSP = *Random Spatial Processes*; SYG=*Symplectic Geometry*; TOP=*Topological Defects.*

Abraham DB, Fontes L, Newman CM *et al* — RSP

Surface deconstruction and roughening in the multi-ziggurat model of wetting

Ait-Sahlia F, Lai T-L, Tao Y-C — FIN

Weak convergence methods with correction terms for free boundary problems in stochastic control

Albrecht A — TOP

The theory of everything versus the theory of anything

Allen B, Kay AOB — TOP

Long-range effects of cosmic strings

Allen B — TOP

Maximally-symmetric bi-tensors on S^3 and H^3

Allen B, Caldwell R — TOP

Gravitational waves in spatially-open inflationary cosmology

Allen B, Casper P — TOP

Gravitational-radiation rates for realistic families of cosmic-string loops

Aoki T, Kawai T, Takei Y — EXP

WKB analysis of Painlevé transcendents with a large parameter II

Arnold V — DYN

The Vassiliev theory of discriminants and knots

Astrom K, Cipolla R, Giblin PJ — CVI

Motion from the frontier of curved surfaces

Austin D, Copeland E, Kibble TWB — TOP

Characteristics of cosmic string scaling configurations

Baker A — SYG

Some calculations with Milnot hypersurfaces and an application to Ginzburg's symplectic bordism ring

Barlow M, Pemantle R, Perkins EA — RSP

Diffusion limited aggregation on the binary tree

Barlow M, Kigami J — RSP

Localized eigenfunctions of the Laplacian on pcf self-similar sets

9.5 Papers Produced by Participants

Bates S, Norton A — SYG

On sets of critical values in the real line

Bates S, Weinstein A — SYG

Lectures on the geometry of quantization

Bates S — SYG

A capacity representation theorem for some nonconvex domains

Bates S, Montgomery R — SYG

Carnot-Caratheodory geometries

Bender CM, Tovbis A — EXP

Solution of boundary layer problems using lattice perturbation theory

Benfatto G, Marinari E, Olivieri E — RSP

Some numerical results on the block spin transformation for the 2D Ising model at the critical point

Benjamini I, Ferrari P A, Landim C — RSP

Asymmetric conservative processes with random rates

Bhattacharjee P, Sigl G — TOP

Monopole annihilation and highest energy cosmic rays

Bibilashvili TM — TOP

Quantum field theory in the media with varying chemical potential

Bibilashvili TM — TOP

The problem of the double time-ordered operator product calculation in the nonequilibrium quantum field theory

Bick A — FIN

Futures pricing via futures strategies

Björk T, Kabanov Y, Runggaldier WJ — FIN

A general approach to bond markets ....

Bogolubsky I — TOP

String-like solitons in gauged models of anisotropic antiferromagnet

Bogolubsky I — TOP

Soliton analogs of Abrikosov-Nielsen-Olesen strings

Borrill J, Kibble T, Vachaspati T *et al* — TOP

Defect production by sub-luminal bubbles

Borrill J, Kibble T, Vachaspati T *et al* — TOP

Defect production in slow first order phase transitions

Bouchau J-P, Sornette D — FIN

Option pricing in the presence of strong fluctuations

9.5 Papers Produced by Participants

Boyd, WGC — EXP

Integral representations of steepest descents type of solution of linear second order differential equations

Braaksma B, Stark D — EXP

A Darboux type theorem for slowly varying functions

Brace A, Musiela M — FIN

Mathematical finance

Brandenberger R, Davis A-C, Prokopec T *et al* — TOP

Local and nonlocal defect-mediated electroweak baryogenesis

Brandenberger R, Davis A-C, Rees M — TOP

Nucleosynthesis constraints on defect-mediated electroweak baryogenesis

Brandenberger R, Davis A-C, Trodden M — TOP

Particle physics models, topological defects and electroweak baryogenesis

Brandenburg A — DYN

Solar dynamos: computational background

Brandenburg A, Donner KJ, Thomasson M — DYN

Galactic dynamos and dynamics

Brandenburg A, Moss D — DYN

The excitation of nonaxisymmetric magnetic fields in galaxies

Bray AJ, Derrida B — TOP

Exact exponent λ of the autocorrelation function for a soluble model of coarsening

Bray AJ — TOP

Theory of phase ordering kinetics

Bray AJ, Puri S, Rojas, F — TOP

Ordering kinetics of conserved XY models

Brown C, Terzopoulos D — CVI

Real time computer vision

Brygdes D, Slade G — RSP

A collapse transition for self-attracting walks

Buchdahl NP — SYG

Sequences of stable bundles over compact complex surfaces

Bucher M, Goldhaber A, Turok N — TOP

An open universe from inflation

Bühlmann, H — FIN

Crosshedging in insurance

9.5 Papers Produced by Participants

Carter B, Gregory R — TOP

Curvature corrections to dynamics of domain walls

Carter B — TOP

Transonic elastic model for wiggly Goto Nambu string

Carter B, Peter P — TOP

Supersonic string model for Witten vortices

Carter B, Davis A-C, Brandenburger R — TOP

Dynamics of cosmic strings and other brane models

Chate H, Grinstein G, Tang Lei-Han — CAG

Long-range correlations in systems with coherent (quasi)periodic oscillations

Chekanov Y — SYG

Hofer's symplectic energy and Lagrangian intersections

Chudnovsky EM, Vilenkin A — TOP

Vortex pairs in two dimensional superconductors

Cipolla R, Fletcher G, Giblin PJ — CVI

Surface geometry from cusps of apparent contours

Cooper DB, Subrahmonia J, Keren D — CVI

Practical reliable Bayesian recognition of 2D and 3D objects using implicit polynomials and algebraic invariants

Copeland E, Lahiri A, Wands D — TOP

String cosmology with a time-dependent antisymmetric tensor potential

Copeland E, Vasquez A, De Vega H — TOP

Quantum string backreaction

Costin O — EXP

Exponential asymptotics, trans-series

Cvitanic J, Cvoco D — FIN

Optimal consumption with policy dependent titles

Davis A-C, Jeannerot R — TOP

Scattering off an $SO(10)$ cosmic string

Davis A-C, Brandenberger R — TOP

Formations and interactions of topological defects

Davis A-C, Jeannerot R — TOP

Constraining supersymmetric $SO(10)$ models

Dawson D, Greven A — RSP

Multiple time scale analysis for interacting branching models

9.5 Papers Produced by Participants

De Vega HJ, Larsen AL, Sanchez N — TOP

Circular strings and multi-strings in de Sitter and anti de Sitter spacetimes

De Vega HJ, Giannakis I, Nicolaidis A — TOP

String quantization in curved spacetimes: null string approach

Derrida B, Hakim V, Pasquier V — CAG

Exact first-passage exponent of 1D domain growth: relation to a reaction-diffusion model

Derrida B, Evans MR, Mallick K — CAG

Exact diffusion constant of a one dimensional asymmetric exclusion model with open boundaries

Diener F — EXP

Fleuves complexes

Diener M — EXP

Rivers of PDE

Dorsey A — TOP

Linear response of thin superconductors in perpendicular magnetic fields: an asymptotic analysis

Duan J-C — FIN

Fitting the "smile family" - a GARCH approach

Duan J-C, Yu M-T — FIN

Fixed rate deposit insurance coverage - a GARCH pricing approach

Dudarev S, Vvedensky D, Whelan M — CAG

Statistical treatment of dynamical electron diffraction from growing surfaces

Dudarev S, Vvedensky D, Whelan M — CAG

Dynamical electron scattering from growing surfaces

Dudarev S, Whelan M, Rez P — CAG

Theory of electron backscattering from crystals

Dudarev S, Peng L-M, Whelan M — CAG

On the Doyle-Turner representation of the optical potential for RHEED calculations

Dudarev S, Whelan M — CAG

Interference between resonance and potential scattering of high energy electrons from crystal surfaces

Dudarev S, Whelan M — CAG

On the origin of the resonance phenomenon in RHEED

Duff M J, Ferrara S, Khuri R R *et al* TOP

Supersymmetry and dual string solitons

Duff MJ TOP

Kaluza-Klein theory in perspective (long version)

Duff MJ TOP

Classical/quantum duality

Duff MJ, Khuri RR, Lu JX TOP

String solitons

Duff MJ, Minasian R TOP

Dual string Kac Moody algebra from fivebrane Mickelsson-Fadeev algebra

Duff MJ TOP

Strong/weak coupling duality from the dual string

Duff MJ TOP

Kaluza-Klein theory in perspective (short version)

Dufresne D FIN

Three properties of gamma variables

Dunster TM EXP

Error bounds for exponentially improved asymptotic solutions of ODES

Dunster TM EXP

Uniform asymptotic expansions for the generalised exponential integral

Durrer R TOP

Global field dynamics and cosmological structure formation

Durrer R, Gangui A, Sakellariadou M TOP

Doppler peaks in the angular power spectrum of the cosmic microwave background form global topological defects

Eisenberg LK FIN

Connectivity and financial network shutdown

Embrechts P, Klueppelberg M FIN

Modelling extremal events in insurance and finance

Emmrich C, Weinstein A SYG

Geometry of the transport equation in multi-component WKB approximations

Felipe, JAN, Bray, AJ, Puri, S TOP

Phase-ordering kinetics with external fields and biased initial conditions

Ferrari PA RSP

Shocks in one-dimensional processes with drift

9.5 Papers Produced by Participants

Ferrari PA, Maes C — RSP

Brazil nuts

Ferrari PA, Frigessi A *et al* — RSP

Fast approximation MAP restoration of multicolor images

Flyvbjerg H, Fygenson D K, Sneppen K *et al* — CAG

Spontaneous nucleation of microtubules

Fuertes WG, Guilarte JM — TOP

Semilocal Chern-Simons defects

Fukaya K — SYG

Morse homotopy and Chern-Simons perturbation theory

Fukaya K, Oh Y — SYG

Genus zero open string on the cotangent bundle and Morse homotopy

Gama S, Vergassola M, Frisch U — DYN

Negative eddy-viscosity in isotropically forced two dimensional flow: linear and non-linear dynamics

Gama S, Vergassola M, Frisch U — DYN

Two-dimensional isotropic negative eddy viscosity: a common phenomena

Giblin P, Weiss RS — CVI

Skeletonisation using an extended Euclidean distance transform

Giblin PJ, Weiss RS — CVI

Epipolar curves on surfaces

Gill AJ, Rivers RJ — TOP

The dynamics of vortex and monopole production by quench induced phase separation

Gill AJ, Kibble TWB — TOP

Vortices in superfluid helium

Giller S — EXP

Topological expansion for exponential asymptotics

Givental A — SYG

Homological geometry and mirror symmetry

Givental A — SYG

Homological geometry II: Integral representations

Godreche C, Luck J, Evans M *et al* — CAG

Spontaneous symmetry breaking; exact results for a biased random walk model of an exclusion process

Goldman WM — SYG

An ergodic action of mapping class group

Gompf R — SYG

The homeomorphism classification of Stein surfaces

Gompf R — SYG

Symplectic manifolds and Lefschetz fibrations

Gonzalo J — SYG

Contact circles on 3-manifolds

Gottardi P — FIN

The survival assumption and existence of competitive equilibria when asset markers are incomplete

Grabowski J — SYG

Poisson brackets and deformational quantization

Grabowski J, Urbanski P — SYG

Tangent lifts of Poisson and related structures

Grenfell BT, Kleczkowski A, Ellner A *et al* — EPI

Non-linear forecasting and chaos in ecology and epidemiology: measles as a case study

Guilarte JM — TOP

Semi-local Chern-Simons defects

Guilarte JM — TOP

On the scattering of Chern-Simons solitons

Hakim V — CAG

Non-linear Schroedinger flow past an obstacle

Handcock M, Nychka D, Meier K — EPI

Kriging and Splines: an empirical comparison of their predictive performance

Haran S — LFN

The mysteries of the prime at infinity

Harvey A, Ghysels E, Renault E — FIN

Stochastic volatility

Heesterbeek J, Roberts M — EPI

Threshold quantities for infectious diseases in periodic environments

Hindmarsh MB, Kibble TWB — TOP

Cosmic strings

Hindmarsh MB — TOP

Where are the hedgehogs in quenched nematics?

Hobson D — FIN

Bounds on the price of a lookback

Hofer H, Wysocki K, Zehnder E — SYG

A characterisation of the tight three sphere

Hofer H, Wysocki K, Zehnder E — SYG

Properties of pseudoholomorphic curves in symplectisations II: embedding controls and algebraic invariance

Hollerbach R, Galloway D, Proctor M — DYN

Numerical evidence of fast dynamo action in a spherical shell

Isham CJ, N Linden — GGR

Continuous histories and the history group in generalised quantum theory

Jaksic V, Pillet C-A — EXP

Spin-Boson system and return to equilibrium

Jeanblanc Picqué M, El Karoui N, Shreve S — FIN

Robustness of Black and Scholes formulae

Jeffrey L, Kirwan F — SYG

Localization and the quantization conjecture

Jeffrey L, Kirwan F — SYG

Intersection pairings in moduli spaces of holomorphic bundles of arbitrary rank on a Riemann surface

Jeffrey L, Kirwan F — SYG

On localization and Riemann-Roch numbers for symplectic quotients

Jeffrey L, Guruprasad K, Huebschmann J *et al* — SYG

Group systems, groupoids and moduli spaces of parabolic bundles

Joyce M, Prokopec T, Turok N — TOP

Non-local electroweak baryogenesis, part 1: thin wall regime

Joyce M, Prokopec T, Turok N — TOP

Non-local electroweak baryogenesis, part 2: the classical regime

Kar S, Maharana J — TOP

Planckian scattering on non-Abelian gauge particles

Kardar M, Stella AL, Sartoni G *et al* — CAG

The unusual universality of branching interfaces in random media

Kariya T, Kamizono K — FIN

A self-consistency test for spote rate model

Karshon Y — SYG

Equivariant index and the moment map for completely integrable focus actions

Kazarian M — SYG

Characteristic classes of singularities

Kennedy DP — FIN

Characterizing and filtering Gaussian models of the term structure of interest rates

Kibble TWB, Vilenkin A — TOP

Density of strings formed at a second-order cosmological phase transition

Kibble TWB, Vilenkin A — TOP

Phase equilibrium following bubble collision

Kirillov A — LDT

Variations on the triangular theme

Kirillov A, Melnikov A — LDT

On some remarkable sequences of polynomials

Kleman M — TOP

Classification of topological defects

Kopp PE, Willinger W, Cutland NJ *et al* — FIN

Convergence of Snell envelopes and critical prices in the American PUT

Kotschick D, Lisca P — SYG

Instanton invariants of CP^2 via topology

Kotschick D — SYG

Non-trivial harmonic spinors on generic algebraic surfaces

Kotschick D — SYG

Gauge theory is dead - Long live gauge theory

Kramkov D — FIN

On new hedging parameters for market imperfections

Lavrentovich OD, Terentjev EM — TOP

Topological point defects, loops and divergence elasticity of a nematic liquid crystal

Lavrentovich OD — TOP

Droplets of liquid crystals

Lee C — TOP

Dyonic extension of supersymmetric self-gravitating solitons

Lee C — TOP

The Bogomol'nyi bound of Lee-Weinberg magnetic monopoles

Lee K — TOP

Spin of magnetic flux vortex in superconductors

Lee K — TOP

Rotating Q-balls

Lee K — TOP

Vortices and sound waves in superfluids

Leese RA, Manton NS, Schroers BJ — TOP

Attractive channel skyrmions and the deuteron

Leggett T — TOP

On the limits of semiclassical description for superfluid systems

Letelier P — TOP

Spinning strings as torsion line spacetime defects

Letelier P — TOP

Spacetime defects: open and closed shells

Letelier P, Holvorceau PR, Wang A — TOP

The interaction of outgoing and ingoing spherically symmetric null fluids

Levendorskii, SZ, Sudbery, A — SYG

Yangian construction of the Virasoro algebra

Liddle A, Roberts D, Lyth D — TOP

False vacuum inflation with a quartic potential

Liggett TM — RSP

Survival of discrete time growth models, with applications to oriented percolation

Liggett TM — RSP

Multiple transition points for the contact on the binary tree

Liu Z-J, Wienstein A, Xu P — SYG

Manin triples for Lie bi-algebroids

Lizan V — SYG

Some remarks about singularities of J-curves in 4-dimensional almost-complex manifolds

Lu H — SYG

Lie bi-algebras and Lie algebra cohomology

Lutz DA — EXP

Ordinary differential equations and the complex domain

Lyth D, Woszczyna A — TOP

Large scale perturbations in the open universe

Mackenzie K, Xu P — SYG

Classical lifting processes and multiplicative vector fields

Maharana J — TOP

Four dimensional string-string solutions and symmetries of string effective action

Majima, H, Howls, C, Boyd, W *et al* — EXP

Vanishing theorem in asymptotic analysis IV

Makhlin Yu G, Misirpashaev T Sh — TOP

Topology of vortex-soliton intersection: invariants and torus homotopy

Martin A, Davis A-C — TOP

Evolution of fields in a second order phase transition

Martinelli F, Olivieri E — RSP

Instability of renormalization-group pathologies under decimation

Martinelli F, Cesi F — RSP

On the layering transition of an SOS surface interacting with a wall

McDuff D, Lalonde F — SYG

Local non-squeezing theorems and stability

McDuff D, Lalonde F — SYG

Hofer's L^∞-geometry: energy and stability of Hamiltonian flows, parts I and II

McDuff D, Lalonde F — SYG

Homotopy properties of stable positive paths and bifurcation of eigenvalues

McDuff D — SYG

Rational and ruled symplectic four-manifolds revisited

McKane A, Blum T — CAG

Improved perturbation theory for the Kardar-Zhang equation

McKane A, Zia RKP — CAG

Distributions of absolute central moments for random walk surfaces

McLeod JB — EXP

Application of uniform asymptotic to Painlevé equation

McLerran L — TOP

Really computing real time correlation functions

Monastyrsky M, Natanzon SM — TOP

The moduli space of instantons on $N = 2$ supersymmetrical σ-models

Monastyrsky M — TOP

Modern mathematics in the light of Fields medals

Montgomery R — TOP

Smoothness of sub-Riemannian Hausdorff measures

Montgomery R, Shapiro B — TOP

Characteristic classes for the degenerations of two-plane fields in four dimensions

Murty R — LFN

Selburg's conjectures and Artin L-functions

Murty R, Fouvry E — LFN

Supersingular primes common to two elliptic curves

Nattermann T, Kierfeld J, Hwa T — TOP

Vortex glass phases in layered superconductors

Novikov A — FIN

Pricing contingent claims for a class of term structure models

Nychka D — EPI

Epidemics: models and data

Oh Y-G — SYG

Floer cohomology, spectral sequences and the Maslov class of Lagrangian embeddings in $\mathbb{C}$

Oh Y-G — SYG

On the Fredholm-regularity of holomorphic trajectories (with addendum to "Floer cohomology of Lagrangian intersection etc")

Ohyama, Y — EXP

Nonlinear equations related to second order linear equations

Olivieri E, Scoppola E — RSP

Markov chains with exponentially small transition probabilities: the first exit problem from a general domain. II. The general case.

Olver F, Sapiro G, Tannenbaum A — CVI

Differential invariant signatures and flows in computer vision: a symmetry approach

Ono K — SYG

Lagrangian intersection under legendrian deformations

Paris RB — EXP

An asymptotic expansion for the Riemann zeta function

Paris RB — EXP

The behaviour of the late terms in the uniform asymptotic expansion of the incomplete gamma function

9.5 Papers Produced by Participants

Peter P — TOP

Surface current-carrying domain walls

Pham F — EXP

Confluence of turning points in exact WKB analysis

Piette BMAG, Schroers BJ, Zakrzewski WJ — TOP

Dynamics of baby Skyrmions

Pliska S — FIN

Introduction to mathematical finance: discrete time models

Pliska S, Atkinson, Wilmott — FIN

Portfolio management with transaction costs

Pliska S, Cadenillas A — FIN

Optimal trading with taxes and transaction costs

Polterovich L, Eliashberg Y — SYG

Lagrangian intersections in contact geometry

Polterovich L, Eliashberg Y — SYG

Local Lagrangian knots are trivial

Priest ER, Titov VS, Rickard GK — DYN

The formation of magnetic singularities by nonlinear time-dependent collapse of an x-type magnetic field

Priest ER, Titov VS, Veckstien GE *et al* — DYN

Steady linear x-point magnetic reconnection

Proctor M, Moffatt HK — DYN

Summary of the NATO ASI in Cambridge, Sept 92

Proctor M, Fearn DR, Sellar CC — DYN

Nonlinear magnetoconvection in a rapidly rotating sphere and Taylor's constraint

Proctor M, Galloway DJ, Hollerbach R — DYN

Fine structure and magnetoconvection in a rapidly rotating sphere

Proctor M, Gilbert AD — DYN

Convection and magnetoconvection in a rapidly rotating sphere

Proctor M, Hollerbach R — DYN

Nonaxisymmetric shear layers in a rotating spherical shell

Richardson HR — FIN

Real time optimization of commodity trading

Ritus VI, Nikishov AI — EXP

Similarity of quantum radiations of accelerated mirror in 1+1 space-time and accelerated scalar change in 3+1 space-time

Rivier N, Pieranski P, Rothen F — TOP

Conformal crystals and their defects

Rivier N — TOP

Defects in quasicrystals, in systems with deterministic disorder and in amorphous materials

Rivier N — TOP

Odd rings and tunnelling modes in glasses

Rivier N, Dubertet B — TOP

Why does skin stay smooth? The dynamics of tissues in statistical equilibrium

Rivier N — TOP

Discrete geometry in nature: grain boundaries in flowers and metals

Roberts, M — EPI

A pocket guide to host-parasite models

Ruan Y, Tian G — SYG

Bott-type symplectic Floer cohomology and its multiplication structures

Runggaldier WJ, Bjork T, Kabanov Yu — FIN

Bond markets where prices are driven by a general marked point process

Rutenberg AD, Bray AJ — TOP

Unwinding scaling violations in phase ordering

Rutenberg AD — TOP

Comment on "Theory of spinoidal decomposition"

Rutenberg AD, Bray AJ — TOP

Phase ordering of two-dimensional XY systems below T_{KT}

Rutenberg AD — TOP

Two-dimensional textures: scaling violations in phase-ordering systems

Rutenberg AD — TOP

Scaling violations with textures in two-dimensional phase-ordering

Rutenberg, AD, Bray, AJ — TOP

The energy-scaling approach to phase-ordering growth laws

Salamon D — SYG

Symplectic Floer-Donaldson theory and quantum cohomology

Salamon D — SYG

Lagrangian intersections, 3-manifolds with boundary and the Atiyah-Floer conjecture

9.5 Papers Produced by Participants

Salamon D — SYG

Spin geometry and Seiberg-Witten invariants

Salamon D, Hofer H — SYG

Transversality in elliptic Morse theory and the symplectic action

Salamon D, Eliashberg Y, Hofer H — SYG

Lagrangian intersections in contact geometry

Salvy B, Slavyanov SY — EXP

A combinatorial problem in the classification of 2nd order linear ODEs

Sasaki M, Tanaka T, Yamamoto K — TOP

Euclidean vacuum mode functions for a scalar field

Saveliev M, Gervais J-L — LDT

Lotka-Volterra type equations and their explicit integration

Saveliev M — LDT

On some integrabel generalisations of the continuous Toda system

Saveliev M, Gervais J-L — LDT

Higher grading generalisations of the Toda systems

Schachermayer U, Delbaen F — FIN

The variance-optimal Martingale measure for continuous processes

Schwarz A, Prukova M — SYG

A-algebras and the cohomology of moduli spaces

Schwarz A, Fuchs D — SYG

Matrix Vieta theorem

Schwarz A, Zabovonsky O — SYG

On exactness of semiclassical approximation

Schwarz A — SYG

Application of quantum field theory to contact geometry

Schwarz A, Alexandrov M, Kontsevich M — SYG

The geometry of the master equation and topological quantum field theory

Schwarz M, Salamon D, Piunikhin S — SYG

Symplectic Floer-Donaldson theory and quantum cohomology

Shellard EPS, Battye RA — TOP

Axion string constraints

Shellard EPS, Allen B, Caldwell RR *et al* — TOP

Cosmic strings confront COBE

Shellard EPS, Battye RA — TOP

String radiative backreaction

Shellard EPS, Avelino PP — TOP

Dynamical friction on cosmic string motion and magnetic field generation

Shellard EPS — TOP

String network evolution

Shellard EPS — TOP

Vortex reconnection

Shellard EPS — TOP

Topological defects in cosmology

Shirakawa H, Konno H — FIN

Mathematical finance

Shreve S, Karatzas I, Jeanblanc Pique M — FIN

Methods of mathematical finance

Shubin M — SYG

Remarks in topology of Hilbert Grassmanian

Shubin M — SYG

Semiclassical asymptotics and Morse inequalities

Shubin M — SYG

Novikov inequalities for vector fields

Siemens XA, Kibble TWB — TOP

High-harmonic configurations of cosmic strings: an analysis of self-intersections

Sikivie P, D'Hoker E, Kanev Y — TOP

Casimir forces between beads on strings and membranes

Sikivie P, Tkachev I, Wang Y — TOP

The spectrum of cold dark matter on earth

Sikivie P — TOP

Sources and distributions of dark matter

Silverstone, H, Howls, C — EXP

Hyperasymptotics of the anharmonic oscillator

Slavyanov S, Salvy B — EXP

A combinatorial problem in the classification of second-order PDE with polynomial coefficients

Slavyanov S, Komarov I, Ponomarev LI — EXP

Spheroidal and Coulomb spheroidal functions

Slavyanov SY, Veshev NA — EXP

Structure of avoided crossings for eigenvalues related to equations of Heun's class

Slavyanov SY — EXP

Comparative study of confluence for hypergeometric and Painlevé classes of equations

Slavyanov SY, Lay W, Seeger A — EXP

A generalization of the Riemann scheme for equations of the hypergeometric class

Sluckin TJ — TOP

The random anistropy nematic spin model

Solov'ev E A — EXP

Theory of low energy ion-atom collisions

Solov'ev E A, Janev R K, Jakimovski D — EXP

The mechanism of double ionization of helium by slow antiprotons

Spohn H — CAG

Fluctuations of a flux driven interface

Stebbins A, Caldwell R — TOP

No very large scale structure in an open universe

Stebbins A, Allen B, Caldwell R *et al* — TOP

Cosmic microwave background radiation anistropy induced by cosmic strings

Steeley J, Hodges S — FIN

Cointegration and market efficiency revisited

Stern RJ, Fintushel R — SYG

Immersed spheres in 4-manifolds and the immersed Thom conjecture

Sternin B, Shatalov V — EXP

Complex rays method and resurgent analysis

Sternin B, Shatalov V — EXP

Collision problem in atomic physics and resurgent analysis

Stricker C, Choulli T — FIN

Deux applications de la decomposition de Galtchouk -Kunita-Watanabe

Strominger A, Polchinski J — GGR

Possible resolution of the black hole information puzzle

Sudbery T, Levendorskii SZ — SYG

Quantum lie algebras of type A_n

Tabachnikov S — SYG

Asymptotic dynamics of the dual billiard transformation

Tabachnikov S — SYG

Introducing projective billiards

Tabachnikov S — SYG

The four-vertex theorem revisited: two variations on an old theme

Tabakis E — FIN

Computational aspects of trimmed single-hole clustering

Tabakis E — FIN

Trivial pursuit: looking for uninteresting subsets

Tajima, S — EXP

On the Stark-Wannier quantized state

Tajima, S — EXP

Direct image of the Rham system and the rational double points

Tanveer S — EXP

Asymptotic calculation of three dimensional thin film effects on unsteady Hele-Shaw fingering

Tanveer S, Conley S, Baker G *et al* — EXP

An asymptotic description of the formation of a Moore singularity in a vortex sheet

Temme NM — EXP

Contour integrals and uniform expansions

Thomas CB, Baker A — SYG

Elliptic cohomology - a guide for the perplexed

Thomas CB, Glover H — SYG

Yagita invariant of general linear groups

Thomas CB — SYG

Almost linear actions by $SL(2,p)$ on $S^p - 2$

Thomas CB — SYG

Three-manifolds and PD^3 groups

Thomas CB, Geiges HJ — SYG

Confoliations and three-dimensional geometries

Tod P — GGR

Scalar-flat Kähler and hyper Kähler metrics from Painlevé-III

Tod P — GGR

More on supercovariantly constant spinors

Toner J — TOP

Anomalous elasticity of polymer cholesterics

Toom A — CAG

On convergence of some series associated with random walks

Toom A — CAG

Tails in harnesses. Part I: convergence and power decay

Toom A — CAG

Tails in harnesses. Part II: Exponential decay

Tovbis A — EXP

The Stokes phenomenon for nonlinear ODEs

Toyoki H — TOP

Formation and dynamics of boujums in the thin layers of nematics and hybrid boundary conditions

Traynor L — SYG

Symplectic isotopics of chopped polydiscs

Traynor L — SYG

Legendrian helix links

Trebin H-R, Kutka R — TOP

Relations between defects in the bulk and on the surface of an ordered medium: a topological investigation

Turaev VG — LDT

Quantum invariants of three-manifolds

Turok N — TOP

Electroweak baryogenesis

Turok N, Nasser S — TOP

Z condensation and electroweak baryogenesis

Turok N, Ferreira P — TOP

A flat spacetime model for cosmic string scaling

Turok N — TOP

Matter from motion: baryogenesis at the electroweak phase transition

Turok N — TOP

Pi in the sky? Microwave anisotropics from cosmic defects

Turok N, Crittenden R, Coulson D — TOP

Temperature-polarization correlations from tensor fluctuations

Turok N, Bucher M — TOP

Microwave anisotropics in an open inflationary universe

Uchiyama, K — EXP

L/2-theory of singular perturbation of hyperbolic equation III

Vachaspati T — TOP

Zero modes on linked strings

Vachaspati T, Kephart T — TOP

Topological incarnations of electroweak defects

Van Le, H — SYG

Note on embeddedness of holomorphic spheres and minimal disks

Vergassola M, Dubrulle B, Frisch U *et al* — DYN

Burger's equation, devil's staircases and the mas distribution for large-scale structures

Volovik G, Vachaspati T — TOP

Aspects of ^3He and the standard electroweak model

Voros A — EXP

Exact quantization conditions

Ward RS — TOP

Stable topological skyrmions on the two-dimensional lattice

Weinstein A — SYG

Multicomponent wave equations

Weinstein A — SYG

Lie algebroids, connections and deformation quantization

Weinstein A — SYG

Poisson modules

West P — LDT

W_3 string scattering

West P — LDT

The low-level spectrum of the W_3 string

Wolf D, Moser K — CAG

Vectorized and parallel simulations of the Kardar-Parisi-Zhang equation in 3+1 dimensions

Wolf D, Droz M, McKane J *et al* — CAG

Scale invariance, interfaces and non-equilibrium dynamics

Wood A — EXP

George Gabriel Stokes: an Irish mathematical physicist

Wood A — EXP

Stokes phenomenon for high order differential equations

Wood A — EXP

GG Stokes - industrial and applied mathematician

Xu P — SYG

Flux homomorphism on symplectic groupoids

Xu P, Mackenzie K — SYG

Integrability of Lie bialgebroids

Ye R — SYG

Filling by holomorphic disks in symplectic 4-manifolds

Yui N, Gouvea FQ — LFN

Arithmetic of diagonal hypersurfaces over finite fields

Zakrzewski WJ — TOP

A modified discrete sine-Gordon model

Zariphopoulou T, Constaninides G — FIN

Universal option bounds with proportional transaction costs

Zariphopoulou T, Constantinides G — FIN

Option prices with power utilities

Zheligovsky V, Galloway DJ — DYN

On a class of non-axisymmetric flux rope solutions to the electromagnetic induction equation.

Ziemba WT, Mulvey JM — FIN

World wide asset and liability modeling

Ziemba WT, Keim DB — FIN

Security market imperfections in world wide equity markets

Zisserman A, Mundy JL, Forsyth DA *et al* — CVI

Class-based grouping in perspective images

Zurek W — TOP

Cosmological experiments in superfluids and superconductors

van den Berg, San T — EXP

From the discrete to the continuous: shoboscopy extended

van den Berg IP, Kondjeti F — EXP

From discrete random walks to partial differential equations

9.6 SEMINARS AND LECTURES

July 1994 – June 1995

Programmes within which seminars took place are indicated by codes as follows: EXP=*Exponential Asymptotics*; FIN=*Financial Mathematics*; SYG=*Symplectic Geometry*; TOP=*Topological Defects*. INS denotes an Institute seminar. An asterisk indicates that the seminar took place within a workshop.

K Lee	*Relativistic treatment of vortices in a superconductor*	12/07/94	TOP
T Leggett	*Topological defects in ^3He-A: are they relevant to the nucleation of the B phase?*	14/07/94	TOP*
P McClintock	*Generation of defects in superfluid ^4He as an analogue of the formation of cosmic strings*	14/07/94	TOP*
M Moore	*Non-local resistivity and the energy barriers against flux-line crossing*	14/07/94	TOP*
J Toner	*Lattice gauge theory of topological defects in liquid crystals*	15/07/94	TOP*
H Toyoki	*Kinetics of topological defects in the phase ordering of nematics*	15/07/94	TOP*
A Dorsey	*Interfacial pattern formation in type-I superconductors*	15/07/94	TOP*
P Shah	*The scattering and statistical mechanics of vortices*	15/07/94	TOP*
D McDuff	*4-dimensional symplectic manifolds I*	18/07/94	SYG*
Y Eliashberg	*3-dimensional contact manifolds I*	18/07/94	SYG*
HJ Geiges	*Contact manifolds and complex surfaces*	18/07/94	SYG*
A Weinstein	*Flat connections & symplectic geometry I*	18/07/94	SYG*
D McDuff	*4-dimensional symplectic manifolds II*	19/07/94	SYG*
Y Eliashberg	*3-dimensional contact manifolds II*	19/07/94	SYG*
M Audin	*Algebraic Liouville tori*	19/07/94	SYG*
T Vachaspati	*Embedded defects*	19/07/94	TOP
A Weinstein	*Flat connections & symplectic geometry II*	19/07/94	SYG*
F Lalonde	*Hofer's geometry*	20/07/94	SYG*
D Kotschick	*Instantons and Symplectic 4-manifolds*	20/07/94	SYG*
R Brandenberger	*Topological defect formation*	20/07/94	TOP
V Ginzburg	*Existence and non-existence of closed trajectories for some Hamiltonian flows*	20/07/94	SYG*
J Wolfson	*Symplectic gluing along hypersurfaces and resolution of singularities*	20/07/94	SYG*
D McDuff	*4-dimensional symplectic manifolds III*	21/07/94	SYG*
Y Eliashberg	*3-dimensional contact manifolds III*	21/07/94	SYG*
Y Karshon	*Periodic Hamiltonian flows in dimension 4*	21/07/94	SYG*
A Weinstein	*Flat connections & symplectic geometry III*	21/07/94	SYG*
D McDuff	*4-dimensional symplectic manifolds IV*	22/07/94	SYG*
Y Eliashberg	*3-dimensional contact manifolds*	22/07/94	SYG*
M Bialy	*Integrable classical Hamiltonian systems in low dimensions*	22/07/94	SYG*
A Weinstein	*Flat connections & symplectic geometry IV*	22/07/94	SYG*
R Gompf	*Cutting & pasting symplectic manifolds*	25/07/94	SYG*

9.6 Seminars and Lectures

J Gonzalo	*Topology & analysis of contact circles*	25/07/94	SYG*
E Giroux	*Torsion of contact structures in dimension 3*	25/07/94	SYG*
H Hofer	*Holomorphic curves & global questions in contact geometry*	26/07/94	SYG*
R Gompf	*Cutting & pasting symplectic manifolds*	26/07/94	SYG*
Y-G Oh	*Fredholm theory of holomorphic discs under perturbation of boundary conditions*	26/07/94	SYG*
E Weinberg	*Bubble nucleation in theories with symmetry breaking by radiative corrections*	26/07/94	TOP
K Ono	*Arnold's conjecture for low-dimensional symplectic manifolds*	26/07/94	SYG*
M Shubin	*Semiclassical asymptotics & Morse inequalities*	27/07/94	SYG*
M Fukaya	*Gauge theory on 4-manifolds with corners*	27/07/94	SYG*
R Ye	*Filling by holomorphic discs in symplectic 4-manifolds*	27/07/94	SYG*
SK Donaldson	*Existence of symplectic submanifolds*	27/07/94	SYG*
H Hofer	*Holomorphic curves & global questions in contact geometry*	28/07/94	SYG*
R Gompf	*Cutting & pasting symplectic manifolds*	28/07/94	SYG*
K Cieliebak	*Pseudoholomorphic curves and Bernoulli shifts*	28/07/94	SYG*
H Hofer	*Holomorphic curves & global questions in contact geometry*	29/07/94	SYG*
R Gompf	*Cutting & pasting symplectic manifolds*	29/07/94	SYG*
A Givental	*Introduction to mirror symmetry*	29/07/94	SYG*
L Polterovich	*Around the problem of Lagrangian knots*	29/07/94	SYG*
L Polterovich	*Lagrangian tori in R^4*	02/08/94	SYG
OD Lavrentovich	*Topological defects in confined liquid crystals*	02/08/94	TOP
A Vilenkin	*Topological inflation*	09/08/94	TOP
R Holman	*Dissipation in field theories*	10/08/94	TOP
R Nattermann	*Vortex glass phases*	11/08/94	TOP
W Zakrzewski	*Soliton-like objects in 2+1 dimensions*	15/08/94	TOP
B Schroers	*Multisolitons and soliton dynamics in a 2-dimensional Skyrme model*	15/08/94	TOP
S Bates	*Entropy dimension of action spectra*	16/08/94	SYG
R Ward	*Exact topological defects on the one-dimensional lattice*	16/08/94	TOP
E Chudnovsky	*Solitons & instantons in magnets and superconductors*	17/08/94	TOP
Q Shafi	*SUSY, inflation & topological defects*	18/08/94	TOP
Y-G Oh	*Floer cohomology and the Maslov class of Langrangian embeddings in $\mathbb{C}$*	18/08/94	SYG
M Kléman	*Classification of topological defects*	22/08/94	TOP*
R Rivers	*Finite temperature field theory and defect mediated phase transitions*	22/08/94	TOP*
T Kibble	*Phase transitions in the early universe and defect formation*	22/08/94	TOP*
G Mazenko	*Dynamics of first order phase transitions*	22/08/94	TOP*
M Kléman	*Classification of topological defects*	23/08/94	TOP*
R Rivers	*Finite temperature field theory and defect mediated phase transitions*	23/08/94	TOP*
T Kibble	*Phase transitions in the early universe and defect formation*	23/08/94	TOP*
G Mazenko	*Dynamics of first order phase transitions*	23/08/94	TOP*

9.6 Seminars and Lectures

M Kléman	*Classification of topological defects*	24/08/94	TOP*
W Zurek	*Cosmological experiments in superfluid helium*	24/08/94	TOP*
T Kibble	*Phase transitions in the early universe and defect formation*	24/08/94	TOP*
G Mazenko	*Dynamics of first order phase transitions*	24/08/94	TOP*
H Kleinert	*Phase transitions and disorder field theory of vortices and defect lines*	25/08/94	TOP*
N Goldenfeld	*Kinetics of ordering in systems with non-scaling order parameters*	25/08/94	TOP*
N Turok	*Dynamics of the electroweak phase transitions and baryogenesis*	25/08/94	TOP*
H Kleinert	*Phase transitions and disorder field theory of vortices and defect lines*	26/08/94	TOP*
N Goldenfeld	*Kinetics of ordering in systems with non-scaling order parameters*	26/08/94	TOP*
N Turok	*Dynamics of the electroweak phase transitions and baryogenesis*	26/08/94	TOP*
EPS Shellard	*Evolution of cosmic string networks*	27/08/94	TOP*
A Bray	*Topological defects and phase ordering dynamics*	27/08/94	TOP*
R Durrer	*Global field dynamics and cosmological structure formation*	29/08/94	TOP*
K Ono	*Lagrangian immersions, contact geometry and Floer homology*	29/08/94	SYG
A Bray	*Topological defects and phase ordering dynamics*	29/08/94	TOP*
M Salomaa	*Defects in superfluid ^3He*	29/08/94	TOP*
D Salamon	*Quantum cohomology, Lagrangian intersections and the Atiyah-Floer conjecture*	29/08/94	SYG
R Durrer	*Global field dynamics and cosmological structure formation*	30/08/94	TOP*
M Salomaa	*Defects in superfluid ^3He*	30/08/94	TOP*
B Yurke	*Coarsening dynamics in liquid crystal systems*	30/08/94	TOP*
B Yurke	*Coarsening dynamics in liquid crystal systems*	31/08/94	TOP*
M Salomaa	*Defects in superfluid ^3He*	31/08/94	TOP*
W Zurek	*Cosmological dynamics in superconductors*	31/08/94	TOP*
N Manton	*The geometry of defect scattering*	01/09/94	TOP*
B Carter	*Dynamics of cosmic strings*	01/09/94	TOP*
R Rivers	*Finite temperature field theory and defect mediated phase transitions*	01/09/94	TOP*
R Gaylord	*Doing science with Mathematica: programming in Mathematica*	01/09/94	INS
N Manton	*The geometry of defect scattering*	02/09/94	TOP*
B Carter	*Dynamics of cosmic strings*	02/09/94	TOP*
D Salamon	*Quantum cohomology and the Atiyah-Floer conjecture*	06/09/94	SYG*
H Hofer	*Symplectic homology*	06/09/94	SYG*
R Montgomery	*Gromov's paper on Carnot-Caratheodory geometry*	06/09/94	SYG
J Burzlaff	*Existence theorems for 90° vortex-vortex scattering*	06/09/94	TOP
M Gromov	*A new area-like capacity for symplectic manifolds*	06/09/94	SYG*
D Salamon	*Quantum cohomology and the Atiyah-Floer conjecture*	07/09/94	SYG*

9.6 Seminars and Lectures

H Hofer	*Symplectic homology*	07/09/94	SYG*
H-R Trebin	*Topological theory of semidefects*	07/09/94	TOP
P Bhattacharjee	*Ultra-high energy cosmic rays from topological defects*	08/09/94	TOP
C Thomas	*Free actions by finite groups on S^3*	09/09/94	SYG
V Ginzburg	*Momentum mappings and the rigidity of Poisson actions*	09/09/94	SYG
C Viterbo	*Generating functions in symplectic topology*	09/09/94	SYG
N Turok	*First-order phenomena at the electroweak phase transition*	12/09/94	TOP*
L McLerran	*Curing the ultraviolet problem in numerical simulations of sphaleron transitions in gauge theories*	12/09/94	TOP*
R Rivers	*First-order transitions?*	12/09/94	TOP*
G Mazenko	*Post-Gaussian approximations in phase-ordering kinetics*	13/09/94	TOP*
M Salomaa	*Vortices and monopoles at the superfluid ^3He A-B interface*	13/09/94	TOP*
M Kléman	*Phase transitions in swollen surfactants*	13/09/94	TOP*
R Montgomery	*Carnot-Caratheodory Geometries: Nilpotentization and sublaplacians*	13/09/94	SYG
N Rivier	*Topological defects and the glass transition*	13/09/94	TOP*
T Kibble	*Defect formation by bubble collisions (discussion)*	13/09/94	TOP*
F Goldhaber	*Aharonov-Berry construction and the kinematics of the fractional quantum Hall effect*	14/09/94	TOP*
B Allen	*CMBR pertubations from gravitational waves in spatially open, flat and closed inflation*	15/09/94	TOP*
A Schwarz	*Odd symplectic geometry and quantum field theory*	16/09/94	SYG
C Viterbo	*Generating functions in symplectic topology*	16/09/94	SYG
N Hitchin	*Dynamics of monopoles*	19/09/94	
G Gibbons	*Self-gravitating solitons*	19/09/94	
R Montgomery	*On periodic solutions to the Lorentzian Yang-Mills-Higgs equations*	19/09/94	
A Schwarz	*Instantons, Chern-Simons Lagrangians and related topics*	19/09/94	
S Bates	*Carnot-Carathéodory geometries*	20/09/94	SYG
M Bucher	*An open universe from a defect*	20/09/94	TOP*
C Thomas	*Introduction to symplectic capacities*	21/09/94	SYG
	Phases in superfluid liquids and topological charges	21/09/94	TOP*
P Peter	*Current-carrying cosmic strings*	22/09/94	TOP*
L Traynor	*Generating functions in symplectic topology*	26/09/94	SYG*
S Bates	*A new representations theorem for Ekeland-Hofer capacity*	26/09/94	SYG*
F Lalonde	*Length minimising paths in Hofer's geometry, and a generalised non-squeezing theorem*	26/09/94	SYG*
M Schwarz	*Introduction to Floer homology I*	26/09/94	SYG*
M Schwarz	*Introduction to Floer homology II*	27/09/94	SYG*
L Traynor	*Generating functions in symplectic topology*	27/09/94	SYG*
Y Chekanov	*Hofer's symplectic energy and Lagrangian intersections*	27/09/94	SYG*
PK Townsend	*Anomalies and axion defects*	27/09/94	TOP
M Kazarian	*Characteristic classes of Langrangian singularities*	27/09/94	SYG*
D McDuff	*Local non-squeezing and stability*	28/09/94	SYG*
C Viterbo	*Generating functions in symplectic topology*	28/09/94	SYG*

9.6 Seminars and Lectures

PM Sutcliffe	*Solitons from instantons*	28/09/94	TOP
Y-G Oh	*Floer homology and the Maslov class of Lagrangian embeddings in $\mathbb{C}^n$*	28/09/94	SYG*
M Schwarz	*Introduction to Floer homology*	29/09/94	SYG*
C Viterbo	*Generating functions in symplectic topology*	29/09/94	SYG*
PS Letelier	*Strings in general relativity*	29/09/94	TOP
K Ono	*Lagrangian intersections under Legendrian deformations*	29/09/94	SYG*
M Schwarz	*Cup products in Floer homology*	30/09/94	SYG*
S Martin	*Cohomology rings of symplectic quotients*	30/09/94	SYG*
H Van Le	*Cup length estimates for symplectic fixed points*	30/09/94	SYG*
K Wysocki	*Characterisation of the tight 3-sphere*	30/09/94	SYG*
D Salamon	*Quantum cohomology and the Atiyah-Floer conjecture*	03/10/94	SYG*
H Hofer	*Symplectic homology*	03/10/94	SYG*
M Pozniak	*Floer homology for clean Lagrangian intersections*	03/10/94	SYG*
D Kotschick	*Instanton invariants of CP^2*	03/10/94	SYG*
D Salamon	*Quantum cohomology and the Atiyah-Floer conjecture*	04/10/94	SYG*
H Hofer	*Symplectic homology*	04/10/94	SYG*
W Li	*Floer homology of Lagrangian intersections and instantons*	04/10/94	SYG*
A Bray	*Defect dynamics in the kinetics of ordering*	04/10/94	TOP
D Kotschick	*Instanton invariants of CP^2*	04/10/94	SYG*
JC Sikorov	*Local singularitics of p-holomorphic curves (after M Micallef & B White)*	05/10/94	SYG*
M Callahan	*Floer homology of moduli spaces of flat connections of a Riemann surface*	05/10/94	SYG*
R Jones	*Surface effects on demiscing in thin mixed polymers*	05/10/94	TOP
P Braam	*Floer homology and instanton invariants*	05/10/94	SYG*
M Gromov	*Positive scalar curvature and almost flat bundles*	05/10/94	SYG*
D Salamon	*Quantum cohomology and the Atiyah-Floer conjecture*	06/10/94	SYG*
H Hofer	*Symplectic homology*	06/10/94	SYG*
P Braam	*Floer homology and instanton invariants*	06/10/94	SYG*
M Gromov	*Positive scalar curvature and almost flat bundles*	06/10/94	SYG*
D Salamon	*Quantum cohomology and the Atiyah-Floer conjecture*	07/10/94	SYG*
H Hofer	*Symplectic homology*	07/10/94	SYG*
R Montgomery	*Carnot-Carathéodory geometries: on sublaplacians*	11/10/94	SYG
BMA Piette	*Finite difference methods for the two-dimensional o-model*	12/10/94	TOP*
WJ Zakrzewski	*Topological discretization of sine-Gordon-like models*	12/10/94	TOP*
S Puri	*Cell dynamical systems*	12/10/94	TOP*
N Turok	*Phase ordering and scaling in an expanding universe*	12/10/94	TOP*
W Janke	*Defect mediated two-step melting*	12/10/94	TOP*
A Martin	*Evolution of fields in a second-order phase transition*	12/10/94	TOP*
K Strobl	*Configurational statistics and percolation properties of line defects*	12/10/94	TOP*
RA Leese	*Implementing the moduli space approach to soliton interactions*	13/10/94	TOP*
E Myers	*Lattice gauge theory approach to string interactions*	13/10/94	TOP*

9.6 Seminars and Lectures

WK Baskerville	*Skyrme crystals and nucleons*	13/10/94	TOP*
J Borrill	*Texture evolution: approaches and approximations*	13/10/94	TOP*
K Schwarz	*Simulating superfluid vortex-line tangles (etc) on a supercomputer*	13/10/94	TOP*
EPS Shellard	*High resolution simulations of string networks*	13/10/94	TOP*
B Allen	*Segment-joining for wide dynamic range in cosmic string simulations*	13/10/94	TOP*
P Ferreira	*String simulations with the Smith-Vilenkin algorithm*	13/10/94	TOP*
D Nicole	*Achieving high performance on a parallel supercomputer*	13/10/94	TOP*
WJ Zakrzewski	*Using the connection machine*	13/10/94	TOP*
J Borrill	*A parallel application on the Fujitsu AP1000*	13/10/94	TOP*
A Stebbins	*An overview of graphics packages*	13/10/94	TOP*
B Allen	*Video animations of a string network*	13/10/94	TOP*
NJ Zabusky	*The visiometric and modelling approach to 2D and 3D vortex dynamics*	13/10/94	TOP*
BJC Baxter	*Overview of numerical approaches*	14/10/94	TOP*
E Myers	*Multigrid methods*	14/10/94	TOP*
RA Battye	*Absorbing boundary conditions*	14/10/94	TOP*
P Sutcliffe	*Pseudospectral methods for defects*	14/10/94	TOP*
JM Stewart	*Berger-Oliger adaptive mesh algorithms*	14/10/94	TOP*
A Stebbins	*Gravitational effects of topological defects*	14/10/94	TOP*
RR Caldwell	*Cosmic strings and the cosmic microwave background*	14/10/94	TOP*
J Borrill	*Textures and the microwave background*	14/10/94	TOP*
PP Avelino	*Linearized gravity, the Zeldovich approximation and strings*	14/10/94	TOP*
AT Sornberger	*Structure formation with strings and baryons*	14/10/94	TOP*
H Trebin	*Quasi-crystals*	17/10/94	INS*
S Donaldson	*Symplectic geometry and the topology of moduli spaces*	18/10/94	SYG
	Carnot-Carathéodory geometries	18/10/94	SYG
M Duff	*String/string duality in four dimensions*	18/10/94	TOP
P Casper	*Gravitational radiation from cosmic string loops*	19/10/94	TOP
T Korner	*The ubiquitous Fourier transform*	24/10/94	INS*
S Donaldson	*Symplectic geometry and the topology of moduli spaces*	25/10/94	SYG
H Geiges	*Convex integration and Engel structures, Carnot-Carathéodory geometries*	25/10/94	SYG
A Rutenberg	*Nonsingular topological textures in one-dimensional phase ordering*	25/10/94	TOP
S Puri	*Phase ordering kinetics*	26/10/94	TOP
O Garcia-Prada	*Moment maps and symplectic quotients in gauge theory: some new developments I*	31/10/94	SYG*
J Huebschmann	*Extended moduli spaces*	31/10/94	SYG*
L Jeffrey	*De Rham representatives for the cohomology of moduli spaces*	31/10/94	SYG*
A King	*Cohomology of rank 2 vector bundles over Riemann surfaces*	31/10/94	SYG*
N Hitchin	*The symplectic geometry of moduli spaces of connections on surfaces*	01/11/94	SYG*

9.6 Seminars and Lectures

S Bradlow	*Moment maps and symplectic quotients in gauge theory: some new developments II*	01/11/94	SYG*
K Mackenzie	*Poisson groups and Lie algebroids*	01/11/94	SYG*
M Karasev	*Quantization of Poisson manifolds*	01/11/94	SYG*
T Sluckin	*Aspects of defects in liquid crystals*	01/11/94	TOP
M Semenov	*Graph connections, configuration of complex lines, and related quantum algebras*	01/11/94	SYG*
N Hitchin	*The geometry of the Painlevé equation*	02/11/94	SYG*
S Singer	*The full Toda lattice*	02/11/94	SYG*
H De Vega	*Exact string solutions in inflationary and FRW spacetimes and self-consistent string cosmology*	02/11/94	TOP*
VM Zakalyukin	*Lagrangian and Legendre symmetric singularities*	02/11/94	ySYG*
V Fock	*Combinatorial description of projective structures and higher generalisations*	02/11/94	SYG*
A Kirillov	*Combinatorial and statistical aspects of the orbit method*	03/11/94	SYG*
J Weitsman	*Geometry of the intersection ring of the moduli space of flat connections and the conjectures of Newstead and Witten*	03/11/94	SYG*
K Guruprasad	*Geometric invariants and the symplectic structure on the parabolic moduli space*	03/11/94	SYG*
H Nakajima	*Affine Lie algebras and instantons on ALE spaces*	03/11/94	SYG*
A Kirillov	*Combinatorial and statistical aspects of the orbit method for some finite groups II*	04/11/94	SYG*
V Ginzburg	*Momentum mappings for Poisson manifolds*	04/11/94	SYG*
A Alekseev	*Commuting variables on the moduli space of flat SU(n) connections on a Riemann surface*	04/11/94	SYG*
J Andersen	*The Poisson structure on the moduli space of flat connections and chord diagrams*	04/11/94	SYG*
M Audin	*Eigenvectors of Lax matrices*	07/11/94	SYG*
M Vergne	*Geometric quantization and equivariant cohomology*	07/11/94	SYG*
P Vanhaecke	*Integrable systems and their morphisms*	07/11/94	SYG*
V Guillemin	*The Jeffrey-Kirwan localisation theorem*	07/11/94	SYG*
N Hitchin	*The geometry of the Painlevé equation*	07/11/94	INS*
L Jeffrey	*Localization for non-Abelian group actions*	08/11/94	SYG*
M Vergne	*The equivariant index of transversally elliptic operators*	08/11/94	SYG*
S Wu	*Symplectic cuts and Duistermaat-Heckman measure*	08/11/94	SYG*
G Tuynman	*Universal models for symplectic and cosymplectic manifolds*	08/11/94	SYG*
E Terentjev	*Confined defect structures in liquid crystals: Topological charge conservation in real life*	08/11/94	TOP
E Lerman	*Symplectic blow-ups in slow motion*	08/11/94	SYG*
V Guillemin	*Multiplicities as Riemann-Roch numbers of reduced spaces*	09/11/94	SYG*
Y Karshon	*Equivariant index and the moment map*	09/11/94	SYG*
GE Volovik	*Observation of π_3 topological objects in ^{3}He: Intersection of π_1 and π_2 solitons*	09/11/94	TOP
E Prato	*Remarks on Hamiltonian torus actions on symplectic orbifolds*	09/11/94	SYG*
J-M Kantor	*Counting points in polytopes*	09/11/94	SYG*

9.6 Seminars and Lectures

S Tolman	*Symplectic toric manifolds*	09/11/94	SYG*
S Martin	*Non-Abelian localisation*	10/11/94	SYG*
F Kirwan	*Non-Abelian localisation with singularities*	10/11/94	SYG*
L Jeffrey	*Informal discussion on non-Abelian localisation*	10/11/94	SYG
G Mangano	*SO(10) grand unified models: Neutrino masses and baryogenesis*	10/11/94	TOP
E Meinrenken	*Geometric quantization of torus actions and multiplicities*	10/11/94	SYG*
R Sjamaar	*Convexity properties of the moment mapping reexamined*	10/11/94	SYG*
V Guillemin	*Multiplicities as alternating sums of partition functions*	11/11/94	SYG*
F Kirwan	*Residue formula for pairings on moduli spaces of bundles on compact Riemann surfaces*	11/11/94	SYG*
M Vergne	*Multiplicities and transversally elliptic operators*	11/11/94	SYG*
C Woodward	*Multiplicity-free actions of non-Abelian groups*	11/11/94	SYG*
S Donaldson	*Symplectic geometry and the topology of moduli spaces*	15/11/94	SYG
R Montgomery	*Carnot-Carathéodory geometries: isoperimetric problems*	15/11/94	SYG
G Volovik	*Quantum field theory in ^3He: fermions, bosons, topological defects, chiral anomoly, etc*	15/11/94	TOP
P Sikivie	*Physics on a string*	16/11/94	TOP*
P Shellard	*String radiation constraints*	16/11/94	TOP*
D Lyth	*Particle physics model building and cosmic strings*	16/11/94	TOP*
R Gregory	*Curvature corrections to the dynamics of domain walls*	16/11/94	TOP*
A Achúcarro	*Semi-local strings in condensed matter?*	16/11/94	TOP*
T Prokopec	*Electroweak baryogenesis from a classical force*	16/11/94	TOP*
M Trodden	*Defect mediated electroweak baryogenesis*	16/11/94	TOP*
W Perkins	*Baryon non-conservation on string backgrounds*	16/11/94	TOP*
A-C Davis	*Inhomogeneous baryogenesis and nucleosynthesis*	16/11/94	TOP*
J Magueijo	*The last texture*	16/11/94	TOP*
N Tetradis	*Cosmological phase transitions and the renormalisation group*	16/11/94	TOP*
O Philipsen	*B+L violation in the symmetric phase of the standard model*	16/11/94	TOP*
T Evans	*Winding number fluctuations in gauge theories*	16/11/94	TOP*
A Gill	*Defect formation*	17/11/94	TOP*
R Battye	*String radiative back-reaction*	17/11/94	TOP*
L Bettencourt	*Winding number fluctuations in gauge theory*	17/11/94	TOP*
R Jeannerot	*Topological defects and supersymmetric SO (10)*	17/11/94	vTOP*
X Martin	*Cosmic string dynamics*	17/11/94	TOP*
K Strobl	*Self-interacting walks*	17/11/94	TOP*
N Lepora	*Embedded defects*	17/11/94	TOP*
M Goodband	*Perturbations around strings*	17/11/94	TOP*
T Vachaspati	*Zero modes on linked strings*	17/11/94	TOP*
R Brandenburger	*New statistics for topological defects in cosmology*	17/11/94	TOP*
E Copeland	*String scaling solutions*	17/11/94	TOP*
M Hindmarsh	*Perturbations from cosmic strings*	17/11/94	TOP*
A Liddle	*Inflation and topological defects*	17/11/94	TOP*

9.6 Seminars and Lectures

A Albrecht	*Inflation without perturbations*	17/11/94	TOP*
M Levitt	*Self-recognition in the folding of protein molecules*	18/11/94	*
R Penrose	*Mathematical logic, quantum theory, and mental phenomena*	21/11/94	INS*
S Donaldson	*Symplectic geometry and the topology of moduli spaces*	22/11/94	SYG
S Tabachnikov	*Carnot-Carathéodory geometries*	22/11/94	SYG*
D Gottlieb	*The index of vector fields and topological defects*	22/11/94	TOP
C Yeung	*The decay of autocorrelations in phase ordering dynamics*	23/11/94	TOP
N Turok	*Z-condensation and electroweak baryogenesis*	24/11/94	TOP*
T Kibble	*Cosmic strings in the early universe and in the laboratory*	28/11/94	INS*
S Donaldson	*Symplectic geometry and the topology of moduli spaces*	29/11/94	SYG
M Hindmarsh	*Hedgehogs in nematics*	29/11/94	TOP
A Rutenberg	*2D textures: scaling violations in phase ordering*	30/11/94	TOP
S Donaldson	*The interaction between symplectic and 4-dimensional geometry*	05/12/94	SYG*
F Catanese	*Classification of algebraic surfaces: biregular, topological and differentiable points of view*	05/12/94	SYG*
R Stern	*4-manifolds: some of the old and some of the new*	06/12/94	SYG*
E Witten	*Monopoles and 4-manifolds*	06/12/94	SYG*
M Manetti	*Iterated branched covers and components of moduli spaces*	06/12/94	SYG*
B Schroers	*Instantons, Skyrmions and the deuteron*	06/12/94	TOP
M Atiyah	*The impact of quantum field theory on geometry*	07/12/94	SYG*
P Kronheimer	*Problems in 4-dimensional topology*	07/12/94	SYG*
R Stern	*4-dimensional manifolds and their Donaldson-Witten invariants*	07/12/94	SYG*
J Eells	*Geometric problems obstructing the wide screen*	07/12/94	SYG*
P Kronheimer	*Applications of the Seiberg-Witten equations*	08/12/94	SYG*
S Cappell	*Lattice sums and characteristics classes*	08/12/94	SYG*
P Sikivie	*Galactic halo formation*	08/12/94	TOP
E Witten	*$N = 2$ supersymmetric Yang-Mills theory*	08/12/94	SYG*
M Callahan	*Floer homology and the mapping class group, I*	09/12/94	SYG*
V Pidstragach	*From Kronheimer-Mrowka to Seiberg-Witten*	09/12/94	SYG*
G Tian	*Rational curves in Calabi-Yau manifolds*	09/12/94	SYG*
M Callahan	*Floer homology and the mapping class group, II*	12/12/94	SYG*
Y Ruan	*Bott-type Floer homology ring and rational quantum homotopy*	12/12/94	SYG*
S Donaldson	*Symplectic submanifolds*	12/12/94	SYG*
A Tyurin	*Applications of Donaldson theory of algebraic geometry and number theory*	12/12/94	SYG*
D Olive	*Electromagnetic duality*	13/12/94	SYG*
R Dijkgraaf	*Elliptic curves, mirror symmetry and conformal field theory*	13/12/94	SYG*
U Persson	*Constructing smooth surfaces by deformation of normal crossings*	13/12/94	SYG*
J Wheatley	*Vortex lattice melting in the frustrated 2D XY model*	13/12/94	TOP
J Morgan	*A product formula for Sieberg-Witten invariants and the genus minimising principle for holomorphic curves*	14/12/94	SYG*

Y Ruan	*Sigma model coupled with gravity and deformation type of symplectic manifolds*	14/12/94	SYG*
T Bibilashvili	*Thermal perturbations in QFT at finite temperatures*	14/12/94	TOP
A Stipsicz	*Donaldson series and (-1)-tori*	14/12/94	SYG*
J Morgan	*Ruminations on the case* $b_2^+ = 1$	15/12/94	SYG*
L Lisca	*SO(3) invariants of* CP^2 *via topology*	15/12/94	SYG*
T Vachaspati	*Electroweak strings and baryon number*	15/12/94	TOP
J Jones	*Floer homotopy type*	15/12/94	SYG*
A King	*The cohomology ring of the moduli space of rank 2 bundles on a Riemann surface*	16/12/94	SYG*
W Goldman	*Ergodic theory on moduli spaces*	16/12/94	SYG*
G Segal	*N = 2 supersymmetry in two dimensions*	16/12/94	SYG*
S Hodges	*Role of markets, state preference no-arbitrage and E[U] paradigm*	04/01/95	FIN*
S Hodges	*How the literature developed: efficient markets, mean variance, derivatives, term structure, etc*	04/01/95	FIN*
S Pliska	*Multiperiod securities market models*	04/01/95	FIN*
S Pliska	*Options futures and derivatives*	05/01/95	FIN*
C Rogers	*Discrete-time martingales*	05/01/95	FIN*
C Rogers	*Brownian motion, etc*	05/01/95	FIN*
C Rogers	*Itô's formula and SDEs*	05/01/95	FIN*
S Pliska	*Options, futures and derivatives*	06/01/95	FIN*
S Pliska	*More about continuous time valuation*	06/01/95	FIN*
S Hodges	*Other derivative instruments*	06/01/95	FIN*
S Pliska	*Optimal consumption and investment*	06/01/95	FIN*
L Foldes	*Semi-martingales*	07/01/95	FIN*
L Foldes	*Optimal consumption and investment revisited*	07/01/95	FIN*
C Rogers	*Markov methods*	09/01/95	FIN*
M Dempster	*Dynamic stochastic programming models*	09/01/95	FIN*
M Dempster	*Solution techniques and computational results*	09/01/95	FIN*
M Dempster	*Dynamic portfolio management: (introduction) static models, dynamic control models*	09/01/95	FIN*
S Pliska	*Term structure research*	10/01/95	FIN*
S Hodges	*Other processes*	10/01/95	FIN*
S Hodges	*Other topics*	10/01/95	FIN*
S Gandhi	*Valuation of American options: perturbation expansions*	13/01/95	FIN*
A Cadenillas	*The consumption-investment problem and the stochastic maximum principle*	13/01/95	FIN*
A Olde Daalhuis	*Introductory lectures on asymptotics I*	16/01/95	EXP*
A Olde Daalhuis	*Introductory lectures on asymptotics II*	16/01/95	EXP*
MV Berry	*The Riemann-Siegel expansion: a case study in asymptotics I*	16/01/95	EXP*
D Lutz	*Borel associated functions and their applications to differential equations I*	16/01/95	EXP*
A Olde Daalhuis	*Introductory lectures on asymptotics III*	17/01/95	EXP*

9.6 Seminars and Lectures

A Olde Daalhuis	*Introductory lectures on asymptotics IV*	17/01/95	EXP*
MV Berry	*The Riemann-Siegel expansion: a case study in asymptotics II*	17/01/95	EXP*
A O'Malley	*Exponentially long time evolution of shock layers I*	17/01/95	EXP*
D Lutz	*Borel associated functions and their applications to differential equations II*	17/01/95	EXP*
A Olde Daalhuis	*Introductory lectures on asymptotics V*	18/01/95	EXP*
A Olde Daalhuis	*Introductory lectures on asymptotics VI*	18/01/95	EXP*
MV Berry	*The Riemann-Siegel expansion: a case study in asymptotics III*	18/01/95	EXP*
R O'Malley	*Exponentially long time evolution of shock layers II*	18/01/95	EXP*
D Lutz	*Borel associated functions and their applications to differential equations III*	18/01/95	EXP*
F Olver	*Introductory lectures on asymptotics I*	19/01/95	EXP*
F Olver	*Introductory lectures on asymptotics II*	19/01/95	EXP*
MV Berry	*The Riemann-Siegel expansion: a case study in asymptotics IV*	19/01/95	EXP*
R O'Malley	*Exponentially long time evolution of shock layers III*	19/01/95	EXP*
D Lutz	*Borel associated functions and their applications to differential equations IV*	19/01/95	EXP*
F Olver	*Introductory lectures on asymptotics III*	20/01/95	EXP*
F Olver	*Introductory lectures on asymptotics IV*	20/01/95	EXP*
M Berry	*The Riemann-Siegel expansion: a case study in asymptotics V*	20/01/95	EXP*
D Lutz	*Borel associated functions and their applications to differential equations V*	20/01/95	EXP*
O Costin	*Rigorous asymptotics beyond all orders for ODEs*	23/01/95	EXP*
N Joshi	*Asymptotics and the Painlevé property I*	23/01/95	EXP*
M Kruskal	*Surreal numbers with applications to exponential asymptotics I*	23/01/95	EXP*
B Salvy	*Computer algebra and asymptotics I*	23/01/95	EXP*
B Salvy	*Computer algebra and asymptotics II*	23/01/95	EXP*
F Olver	*Introductory lectures on asymptotics V*	24/01/95	EXP*
F Olver	*Introductory lectures in asymptotics VI*	24/01/95	EXP*
M Kruskal	*Surreal numbers with applications to exponential asymptotics II*	24/01/95	EXP*
H Richardson	*A modeling framework for optimal currency trading*	24/01/95	FIN*
N Joshi	*Asymptotics and the Painlevé property II*	24/01/95	EXP*
B Salvy	*Computer algebra and asymptotics III*	24/01/95	EXP*
N Temme	*Introductory lectures on asymptotics I*	25/01/95	EXP*
N Temme	*Introductory lectures on asymptotics II*	25/01/95	EXP*
M Kruskal	*Surreal numbers with applications to exponential asymptotics III*	25/01/95	EXP*
N Joshi	*Asymptotics and the Painlevé property III*	25/01/95	EXP*
B Salvy	*Computer algebra and asymptotics IV*	25/01/95	EXP*
N Temme	*Introductory lectures on asymptotics III*	26/01/95	EXP*

9.6 Seminars and Lectures

N Temme	*Introductory lectures on asymptotics IV*	26/01/95	EXP*
M Kruskal	*Surreal numbers with applications to exponential asymptotics IV*	26/01/95	EXP*
N Joshi	*Asymptotics and the Painlevé property IV*	26/01/95	EXP*
B Salvy	*Computer algebra and asymptotics V*	26/01/95	EXP*
N Temme	*Introductory lectures on asymptotics V*	27/01/95	EXP*
N Temme	*Introductory lectures on asymptotics VI*	27/01/95	EXP*
M Kruskal	*Surreal numbers with applications to exponential asymptotics V*	27/01/95	EXP*
S Slavyanov	*Classification and asymptotic properties of confluent Fushian second-order ODEs*	27/01/95	EXP*
B Flesaker	*Dynamic models for yield curve evolution: theory and practice*	27/01/95	FIN*
D Kennedy	*Gaussian random field models for interest rates*	27/01/95	FIN*
M Kruskal	*New numbers (yes genuinely new, genuine numbers): the surreality of Cantabrigian John Conway*	30/01/95	INS
B O'Malley	*Singular perturbations, stability and exponential asymptotics*	06/02/95	INS
L Rogers	*Asymptotic turnpike results in optimal portfolio theory*	08/02/95	FIN*
S Hodges	*Economic equilibria which support Black-Scholes option prices*	08/02/95	FIN*
M Davis	*Modelling and pricing health insurance*	08/02/95	FIN*
S Pliska	*Portfolio management with fixed transaction costs: a free boundary problem*	08/02/95	FIN*
J-P Bourguignon	*From Euclidean spaces to manifolds*	13/02/95	INS
Y Kabanov	*Portfolios with a continuum of bonds*	15/02/95	FIN
S Blyth	*Introduction to the correlation curve and financial markets*	17/02/95	FIN*
D Duffie	*The valuation of credit-risk within models of the term structure of interest rates*	17/02/95	INS
N Trudinger	*Isoperimetric inequalities and Monge-Ampere equations*	20/02/95	INS
M Berry	*Resurgence and hyperasymptotics for integrals with saddles*	22/02/95	EXP*
WGC Boyd	*Error bounds for the method of steepest descents*	22/02/95	EXP*
F Olver	*Hyperasymptotics for ODEs with irregular singularities*	22/02/95	EXP*
A Olde Daalhuis	*Improving Poincaré*	22/02/95	EXP*
V Jaksic	*Return to equilibrium*	24/02/95	EXP
S Tezuka	*Pricing options by using low-discrepancy sequences*	24/02/95	FIN*
P Dybvig	*Pricing long bonds: pitfalls and opportunities*	24/02/95	FIN*
R Worcester	*Survey research: the marriage of the art of asking questions and the science of sampling*	27/02/95	INS
P Fröman	*The history of the so-called WKB-method from 1817 to 1926*	01/03/95	EXP*
P Collins	*Risk and reward: Mathematics in banking*	06/03/95	INS
B Braaksma	*Borel transforms*	07/03/95	EXP
H Majima	*Asymptotics expansions in several variables*	07/03/95	EXP
N Fröman	*Phase integral formulae for quantal expectation values in matrix elements not involving wave functions*	08/03/95	EXP*

9.6 Seminars and Lectures

P Embrechts	*Extreme events in insurance and finance*	09/03/95	FIN*
K Aase	*An equilibrium model of catastrophe futures*	09/03/95	FIN*
C Klüppelberg	*Modelling delay in claim settlement*	09/03/95	FIN*
R Norberg	*A continuous-time Markov chain interest model with applications to insurance*	09/03/95	FIN*
H Föllmer	*Martingale measures (or microeconomic foundations)*	13/03/95	FIN*
I Karatzas	*Pricing under constraints/costs*	13/03/95	FIN*
C Zeeman	*Controversies in mathematics: vibrating strings and catastrophe theory*	13/03/95	INS
N Joshi	*The Painlevé connection problem*	14/03/95	EXP*
A Olde Daalhuis	*Calculation of Stokes multipliers*	14/03/95	EXP*
R Korn	*Impulse control stategies in continuous trading*	14/03/95	FIN*
BLJ Braaksma	*Multisummability and the Stokes phenomenon*	14/03/95	EXP*
MV Berry	*Superadiabatic renormalisation for Stokes constants and quantum transition prefactors*	14/03/95	EXP*
M-CQuenez	*Backwards stochastic differential equations in finance*	14/03/95	FIN*
T Kawai	*WKB analysis of Painlevé transcendents I*	15/03/95	EXP*
A Joye	*Semiclassical asymptotics beyond all orders for simple scattering systems*	15/03/95	EXP*
A Voros	*A survey of the quartic oscillator problem*	15/03/95	EXP*
I Karatzas	*Some results in transaction costs*	15/03/95	FIN*
M Schweizer	*L_2-problems in finance*	15/03/95	FIN*
E Delabaere	*Exact semi-classical expansions for one dimensional quantum oscillators*	15/03/95	EXP*
C Rogers	*Arbitrage with fractional Brownian motions*	15/03/95	FIN*
T Aoki	*WKB analysis of Painlevé transcendents II*	16/03/95	EXP*
PA Clarkson	*Bäcklund transformations and hierarchies of exact solutions for continuous and discrete fourth Painlevé equations*	16/03/95	EXP*
H Föllmer	*A generalised Itô formula*	16/03/95	FIN*
H Majima	*On the flatness of the sheaf of asymptotically developable functions*	16/03/95	EXP*
P Artzner	*Some remarks on a paper by P Dybvig*	16/03/95	FIN*
HJ Silverstone	*Connection problems and Borel summation*	16/03/95	EXP*
M Dempster	*Fast numerical valuation of American, exotic and complex options*	16/03/95	FIN*
Y Takei	*WKB analysis of Painlevé transcendents III*	17/03/95	EXP*
Y Ohyama	*Halphen-type equation for level three modular forms*	17/03/95	EXP*
PO Fröman	*Phase-integral approximation, Stokes phenomenon and connection problems*	17/03/95	EXP*
M Fritelli	*Dominated families of martingale - and supermartingale - measures*	17/03/95	FIN*
E Eberlein	*Hyperbolic option prices*	17/03/95	FIN*
N Fröman	*Exponential asymptotics associated with a simple turning point*	17/03/95	EXP*
S Pliska	*Optimisation with unknown parameters*	17/03/95	FIN*
I Karatzas	*A deterministic approach to optimal stopping*	20/03/95	FIN*

9.6 Seminars and Lectures

J Detemple	*Asset pricing in intertemporal, noisy, rational expectation equilibrium*	20/03/95	FIN*
Y Takei	*WKB analysis of Painlevé transcendents; in more detail*	21/03/95	EXP
H Föllmer	*On micro-ecomomic foundations of financial markets*	21/03/95	FIN*
T Cover	*Minimax regret portfolios with side-information*	21/03/95	FIN*
T Fokas	*2-D quantum gravity Painlévé & WKB*	21/03/95	EXP
H Bühlmann	*Continuous limit of discrete-time models for the term-structure*	21/03/95	FIN*
R Korn	*Value-preserving portfolio strategies*	21/03/95	FIN*
F Jamshidian	*Universal and asymptotic portfolios*	21/03/95	FIN*
D Heath	*Maximising the probability of reaching a goal in finite time*	22/03/95	FIN*
H Shirakawa	*Optimal portfolio selection with proportional transaction costs*	22/03/95	FIN*
TM Dunster	*Error bounds for the Stokes smoothing of the generalised exponential integral*	22/03/95	EXP*
K Uchiyama	*Graphical illustration of new Stokes line for integrals with saddles*	22/03/95	EXP
R Pinch	*Fermat's last theorem*	22/03/95	
S Hodges	*Gamma hedging under transactions costs in an incomplete market*	23/03/95	FIN*
W Willinger	*More on FBM asset pricing models*	23/03/95	FIN*
H Föllmer	*Information theory and optimal portfolios*	23/03/95	FIN*
T Cover	*Information theory and optimal portfolios*	23/03/95	FIN*
D Heath	*Model choice and validation*	23/03/95	FIN*
H Shirakawa	*Clark's formula for Poisson processes*	24/03/95	FIN*
PE Kopp	*Convergence of discrete models*	24/03/95	FIN*
S Pliska	*Optimal trading of co-integrated prices*	24/03/95	FIN*
J Billingham	*Wear in mud pumps*	27/03/95	*
R Mitchell	*Dried ink plugs & nozzle closure*	27/03/95	*
J Morgan	*Gas jets in cross flows*	27/03/95	*
J Beumée	*Bond sweeteners*	27/03/95	*
R Baston	*Embedding maps*	27/03/95	*
P Nesvadba	*Microwaving frozen food*	27/03/95	*
S Halvorsen	*Anthracite cooking*	27/03/95	*
	Review of progress at OCIAM on some problems for Pilkingtons	28/03/95	*
	Review of progress on Stealth plane problems of British Aerospace (involves exponentially small asymptotics)	29/03/95	*
L Scott	*Multifactor term structure models*	30/03/95	FIN*
J Zinn-Justin	*Multi-instanton methods*	30/03/95	EXP*
K Takasaki	*Voros coefficients and the JWKB connection problem*	03/04/95	EXP*
F Olver	*General connection formulae for Liouville-Green (or JWKB) approximations*	03/04/95	EXP*
SJ Chapman	*Stokes surfaces and complex ray theory*	04/04/95	EXP*
TM Dunster	*Rigorous exponentially-improved asymptotic solutions of second order ODEs*	04/04/95	EXP*

9.6 Seminars and Lectures

R Paris	*New asymptotic formulae for the Riemann zeta function*	04/04/95	EXP*
WGC Boyd	*Gamma function asymptotics by an extension of the method of steepest descents*	04/04/95	EXP*
B Oksendal	*Optimal switching in an economic activity under uncertainty*	04/04/95	FIN
JB McLeod	*Uniform asymptotics and connections for the Painlevé equations*	05/04/95	EXP*
O Costin	*Generalized Borel summation and complete asymptotic expansions for nonlinear systems of differential equations*	05/04/95	EXP*
AI Nikishov	*Natural width of Stokes lines*	05/04/95	EXP*
H Buhlmann	*Explicit results on diffusion approximations for interest rate models*	05/04/95	FIN
HJ Silverstone	*Exponentially small high-order expansions for eigenvalues: nuts and bolts*	05/04/95	EXP*
A Tovbis	*Exponential asymptotics & applications: chaos integrability transition in perturbed integrable systems*	05/04/95	EXP*
S Slavyanov	*Exponential asymptotic phenomena for special functions of Heun class*	06/04/95	EXP*
CJ Howls	*Doubly uniform asymptotics for integrals with coalescing saddlepoints*	06/04/95	EXP*
R Spigler	*WKB and similar asymptotics for differential, difference and abstract equations*	06/04/95	EXP*
J Wei	*Viscosity approach in a singularly perturbed problem*	06/04/95	EXP*
W Willinger	*A fractional version of the Black-Scholes model*	07/04/95	FIN*
A Mbanefo	*Pricing options on futures spreads*	07/04/95	FIN*
F Delbaen	*Spline interpolation of forward rate curves*	07/04/95	FIN*
M Broadie	*Valuation formulae for American options on multiple assets*	10/04/95	FIN*
M Kruskal	*Bigger, better, bolder, yet more basic! I*	10/04/95	EXP*
P Carr	*Fast accurate valuations of American options*	10/04/95	FIN*
D Lamberton	*On the approximation of American options prices*	10/04/95	FIN*
X Zhang	*Numerical methods for American options in a jump-diffusion model*	10/04/95	FIN*
M Crouhy	*Stochastic volatility option pricing model: overview*	11/04/95	FIN*
R Avesani	*Alternative ideas about volatility*	11/04/95	FIN*
M Kruskal	*Bigger, better, bolder, yet more basic! II*	11/04/95	EXP*
B Dumas	*Implied volatility trees and the empirical process for the price of the underlying asset: the case of SP500 options*	11/04/95	FIN*
P Bossaerts	*Local parametric analysis of derivatives pricing*	11/04/95	FIN*
P Bertrand	*Estimation of the volatility of a process: comparison of different estimators when the volatility has abrupt changes*	11/04/95	FIN*
G Barles	*Convergence of numerical schemes for parabolic equations arising in finance theory*	12/04/95	FIN*
F Ait-Sahlia	*Corrected random walk approximations for contingent claim problems*	12/04/95	FIN*
M Kruskal	*Bigger, better, bolder, yet more basic! III*	12/04/95	EXP*

9.6 Seminars and Lectures

B Lapeyre	*Deterministic numerical methods and Monte Carlo methods for exotic options*	12/04/95	FIN*
P Seumen Tonou	*Approximation of diffusion processes and path-dependent options*	12/04/95	FIN*
A Bensoussan	*Computations of options for non observable assets*	13/04/95	FIN*
F de Varenne	*A valuation model for corporate debt*	13/04/95	FIN*
M Kruskal	*Bigger, better, bolder, yet more basic! IV*	13/04/95	EXP*
N Pistre	*Pricing the generalized convex option price*	13/04/95	FIN*
N El Karoui	*Backward stochastic differential equations in finance*	13/04/95	FIN*
D Chevance	*Discretisation of backward stochastic differential equations*	13/04/95	FIN*
A Sulem-Bialobroda	*Numerical analysis of variational inequalities in portfolio management*	14/04/95	FIN*
T Zariphopoulou	*Numerical schemes for portfolio models with singular transactions*	14/04/95	FIN*
T Kariya	*An implementation of the HJM models with Japanese data*	18/04/95	FIN
A Bick	*Futures pricing via futures strategies*	18/04/95	FIN
A Voros	*Quantum resurgence*	19/04/95	EXP*
JP Ramis	*Gevrey separation of fast and slow variables*	19/04/95	EXP*
F Diener	*The canards of singular perturbed equations in 2 or 3 dimensions*	19/04/95	EXP*
I van den Berg	*Exponential approximation by diverging series of Euler type*	19/04/95	EXP*
F Pham	*Complex Lagrangian manifolds and resurgent functions*	20/04/95	EXP*
V Shatalov	*On the existence of resurgent solutions to ordinary differential equations*	20/04/95	EXP*
P Lochak	*Long time stability of nearly integrable Hamiltonian systems: from small divisors to resurgence*	20/04/95	EXP*
Sauzin	*Exponential smallness of the splitting of the separatrices of the rapidly forced pendulum and parametric resurgence*	20/04/95	EXP*
S Slavyanov	*The structure of avoided crossings for Heun's class of special functions*	21/04/95	EXP
B Sternin	*On the existence of resurgent solutions to ordinary differential equations*	24/04/95	EXP*
MV Berry	*Superoscillations, evanescent waves and Gaussian beams*	25/04/95	EXP*
S Chapman	*Stokes surfaces and complex ray theory*	25/04/95	EXP*
S Tanveer	*Exponential asymptotics in viscous fingering*	25/04/95	EXP*
A Wood	*Exponential asymptotics and spectral theory for curved optical waveguides*	25/04/95	EXP*
V Babich	*Exponential asymptotics for total internal reflection*	26/04/95	EXP*
R Elliott	*Markov term structure*	01/05/95	FIN*
A Brace	*An analytically tractable log-normal interest rate model within the HJM framework that jointly fits the cap and swaption markets*	01/05/95	FIN*
S Taylor	*Analysis of volatility of ultra high frequency exchange rate*	01/05/95	FIN*
S Hodges	*Co-integration and pricing spread options*	02/05/95	FIN*
N Shephard	*Estimating stochastic volatility models*	02/05/95	FIN*

9.6 Seminars and Lectures

J-C Duan	*Option pricing under stochastic volatility and conditional fat-tailed distributions*	03/05/95	FIN*
B Sternin	*Saddle point method and the resurgence functions theory*	03/05/95	EXP*
C Rogers	*Long memory in asset prices?*	04/05/95	FIN*
E Renault	*Long memory in continuous time stochastic volatility models*	04/05/95	FIN*
W Ziemba	*The January small firm effect in US markets*	08/05/95	FIN*
E Dimson	*The HG1000 index: returns from small and other asset categories in the UK*	08/05/95	FIN*
C Hensel	*1. The January barometer: US and worldwide results*	08/05/95	FIN*
C Hensel	*2: US investment returns during Democratic and Republican administrations, 1928 - 1995*	08/05/95	FIN*
P Oppenheimer	*Should Europe have a single currency?*	08/05/95	INS*
J Berk	*Does size really matter?*	09/05/95	FIN*
S Slavyanov	*Asymptotic solutions of Fedholm type integral equations with rapidly oscillating kernals*	09/05/95	EXP
R Michaud	*Examining multi-country market anomalies for global stock selection*	09/05/95	FIN*
C Hensel	*A long term examination of the turn-of-the-month effect*	09/05/95	FIN*
J Shackell	*Orders of infinity*	10/05/95	EXP*
E Canestrelli	*Calendar anomalies in the Italian stock market*	10/05/95	FIN*
G Muradoglu	*Turkish stock market anomalies*	10/05/95	FIN*
W Ziemba	*Japanese seasonal anomalies*	10/05/95	FIN*
Y Safarov	*Nonclassical two-term spectral asymptotics*	11/05/95	EXP*
W DeBondt	*Survey of behavioural finance*	11/05/95	FIN*
A Voros	*Normal modes of quantum billiards portrayed in a reduced stellar representation*	11/05/95	EXP*
J Shanken	*Problems in measuring portfolio performance: an application to contrarian investment strategies*	11/05/95	EXP*
J Keating	*Exponential semiclassical asymptotics for perturbed cat maps*	11/05/95	EXP*
D Keim	*Execution costs and investment performance: an analysis of institutional equity trades*	11/05/95	FIN*
T Martikainen	*Small markets-big profits: Finnish experience*	12/05/95	FIN*
D Keim	*The predictability of stock returns: a synthesis of the cross sectional evidence*	12/05/95	FIN*
J Shanken	*The cross section of expected stock returns*	12/05/95	FIN*
R Haugen	*Predicting stock returns in global markets*	12/05/95	FIN*
R Haugen	*Predicting stock returns in global markets*	13/05/95	FIN*
R Michaud	*Multiple forecast factors for global stock selection*	13/05/95	FIN*
W Ziemba	*The January effect in US markets*	13/05/95	FIN*
E Dimson	*The small firm effect in the UK*	13/05/95	FIN*
J Berk	*Measuring the risk of small cap stocks*	13/05/95	FIN*
W DeBondt	*The winner-loser effect*	13/05/95	FIN*
D Keim	*Value v growth in international investing*	13/05/95	FIN*
J Shanken	*Book to market, dividend yield and expected market returns*	13/05/95	FIN*

9.6 Seminars and Lectures

A Fokas	*Spectral theory, integrability and chaos*	15/05/95	EXP
C Hensel	*1: The importance of the asset allocation decision*	15/05/95	FIN*
C Hensel	*2: Mean-variance optimization: pitfalls and remedies*	15/05/95	FIN*
C Series	*Circle packing designs and bending Kleinian groups*	15/05/95	INS*
W Ziemba	*Development of asset-liability management models and the Russell-Yasuda model*	16/05/95	FIN*
M Diener	*Fleuves of ODE & 1st order quasi-linear equations*	16/05/95	EXP*
M Dempster	*The CALM asset-liability*	16/05/95	FIN*
R Michaud	*Mean-variance analysis and asset-liability modelling*	17/05/95	FIN*
A Rudd	*Persistence of mutual fund performance*	17/05/95	FIN*
B Sternin	*Complex ray method and resurgent analysis*	17/05/95	EXP*
JM Mulvey	*The Towers Perrin asset-liability allocation model*	17/05/95	FIN*
F Molinari	*SSB utility theory*	18/05/95	FIN*
N Hakannson	*Dynamic asset allocation*	18/05/95	FIN*
E Solov'ev	*Adiabatic approach to atomic collision theory*	18/05/95	EXP*
M Brennan	*Strategic asset allocation*	18/05/95	FIN*
T Marsh	*International investing in partially segmented markets*	19/05/95	FIN*
H Zimmerman	*An algorithm for international portfolio selection and optimal currency hedging*	19/05/95	FIN*
G Connor	*The comparative performance of global versus international models of equity market risk*	20/05/95	FIN*
T Marsh	*International investing in partially segmented markets*	20/05/95	FIN*
R Michaud	*Advances in global asset allocation*	20/05/95	FIN*
N Hakansson	*Dynamic asset allocation*	20/05/95	FIN*
JM Mulvey	*The Towers Perrin asset-liability allocation model*	20/05/95	FIN*
M Brennan	*Strategic asset allocation*	20/05/95	FIN*
M Dempster	*The CALM asset-allocation model*	20/05/95	FIN*
W Ziemba	*The Russell-Yasuda asset allocation model*	20/05/95	FIN*
H Zimmerman	*An algorithm for international portfolio selection and optimal currency hedging*	20/05/95	FIN*
GT Rüttimann	*The lattice of tripotents in a JBW* - Triple*	21/05/95	*
R Hudson	*Existence theorems via higher order Itô product formulas*	21/05/95	*
M Lindsay	*Non-commutative Dirichlet forms*	21/05/95	*
K Ylinen	*Fourier transforms of instruments in the setting of noncommutative locally compact groups*	21/05/95	*
G Vincent-Smith	*Itô formula for quantum semi-martingales*	21/05/95	*
L Bunce	*Velocity maps*	21/05/95	*
KR Parthasarathy	*What is a quantum Markov process*	21/05/95	INS*
S Hodges	*Ex-post evaluation of dynamic portfolio strategies (or how to tell whether a million dollars has been thrown away)*	22/05/95	FIN*
J Mulvey	*Dynamic portfolio management by stochastic control*	22/05/95	FIN*
D Madan	*Pricing the risks of defaults*	22/05/95	FIN*
M King	*Messages from the markets; inferring expectations from the prices of cash and derivative instruments applications to economic policy*	22/05/95	INS*

9.6 Seminars and Lectures

D Hobson	*A complete model with stochastic volatility*	23/05/95	FIN*
A Guttmann	*Series analysis*	23/05/95	EXP*
J Rebholz	*Lookback and barrier options with one and two underlying assets*	23/05/95	FIN*
F Delbaen	*The space of attainable claims under the original measure*	23/05/95	FIN*
C Stricker	*Closedness of a space of stochastic integrals*	23/05/95	FIN*
J-P Bouchaud	*Levy distributions and option theory in the presence of extreme fluctuations*	23/05/95	FIN*
S Jacka	*Optimally investing for several beneficiaries*	24/05/95	FIN*
A Guttmann	*Series analysis*	24/05/95	EXP*
B Dupire	*A unified theory of volatility*	24/05/95	FIN*
J Traub	*New methodologies for valuing derivatives*	24/05/95	FIN*
H Kushner	*Numerical methods for solving optimal control problems with diffusion models*	24/05/95	FIN*
J-L Goffin	*Analytic center cutting plane methods for pseudomonotone variational inequalities*	24/05/95	FIN*
D Helson	*Derivatives risk: an exchange perspective*	25/05/95	FIN*
A Guttmann	*Series analysis*	25/05/95	EXP*
T Vorst	*Exotic options and the observation frequency*	25/05/95	FIN*
L Hughston	*Interest rate and foreign exchange processes*	25/05/95	FIN*
H Geman	*Cross-currency options and correlation risk management*	25/05/95	FIN*
M Dempster	*Numerical valuation of cross-currency swaps and swaptions*	25/05/95	FIN*
D Madan	*Filtering derivative security valuations from market prices*	26/05/95	FIN*
A Guttmann	*Series analysis*	26/05/95	EXP*
J Cvitanic	*Hedging and optimization with policy dependent prices*	26/05/95	FIN*
A Skulimowski	*Multicriteria decision support for multistage portfolio optimization based on dynamic reference points*	26/05/95	FIN*
A Cadenillas	*Consumption-investment problem with subsistency consumption, bankruptcy, and random market coefficients*	26/05/95	FIN*
M Jeanblanc-Picqué	*Optimization of consumption-investment under a postitive wealth constraint with labour income*	26/05/95	FIN*
A Mbanefo	*Trading options on future spreads*	29/05/95	FIN*
N Christofides	*Tax structures for multinational companies*	29/05/95	FIN*
I Evstigneev	*Robust insurance mechanisms and the shadow price of information*	29/05/95	FIN*
M Brennan	*Information, trade and derivative securities*	29/05/95	FIN*
R Merton	*A model of contract guarantees for credit-sensitive, opaque financial intermediaries*	29/05/95	INS*
H Shirakawa	*Evaluation of investment opportunities by option pricing theory*	30/05/95	FIN*
E Kopp	*Hyperfinite market models and convergence of critical prices*	30/05/95	FIN*
V Lacoste	*Wiener chaos decomposition - applications to option hedging*	30/05/95	FIN*
M Jeanblanc-Picqué	*Parisian options*	30/05/95	FIN*
J Lehoczky	*Simulation methods for computing option prices*	30/05/95	FIN*
E Platen	*A multi-factor interest rate term structure model*	01/06/95	FIN*

9.6 Seminars and Lectures

R Elliott	*Markov term structure*	01/06/95	FIN*
A Brace	*An analytically tractable log-normal interest rate model within the HJM framework that jointly fits the cap and swaption markets*	01/06/95	FIN*
W Perraudin	*Yield curves with jump short rates*	01/06/95	FIN*
S Tanveer	*Viscous fingering*	01/06/95	EXP
N Webber	*Modeling European term structures*	01/06/95	FIN*
F Mercurio	*Option pricing and hedging in discrete time with transaction costs and incomplete markets*	02/06/95	FIN*
T Zariphopoulou	*Pricing derivative securities in markets with frictions*	02/06/95	FIN*
S Shreve	*There is no nontrivial hedging portfolio for option pricing with transaction coats*	02/06/95	FIN*
S Tanveer	*Viscous fingering*	02/06/95	EXP
D Sullivan	*The Dirac operator and the notion of a differentiable structure in dimension four*	05/06/95	INS*
A Tovbis	*Exponential asymptotics and approximation of the splitting of stable and unstable manifolds for the Henon map*	06/06/95	EXP
S Pliska	*Topics on portfolio optimisation and taxes*	06/06/95	FIN*
E Jouini	*Efficient portfolio strategies with market frictions*	06/06/95	FIN*
D Kramkov	*Optimal decomposition of supermartingales and hedging in incomplete markets*	07/06/95	FIN*
J Cvitanic	*Topics in hedging, portfolio optimisation and transaction costs*	07/06/95	FIN*
I van den Berg	*Binomial coefficients & the heat equation*	07/06/95	EXP
HK Koo	*Consumption and portfolio optimisation under labour income*	07/06/95	FIN*
S Ross	*Heading long run commitments: exercises in incomplete market prices*	07/06/95	INS
PF Koehl	*Incomplete markets, transactions costs, and liquidity*	08/06/95	FIN*
L Carassus	*Arbitrage opportunities and investment opportunities*	08/06/95	FIN*
D Kramkov	*On parameters for hedging portfolios accounting for market imperfections*	08/06/95	FIN*
SM Sundaresan	*Design and valuation of corporate securities with strategic debt service and asymmetric information*	08/06/95	FIN*
A Brace	*Duration and convexity in HJM framework*	08/06/95	FIN*
M Rutkowski	*Topics on interest rates models*	09/06/95	FIN*
SM Sundaresan	*Term structure and default spreads in corporate securities*	09/06/95	FIN*
P Dybvig	*Long forward and zero-coupon rates can never fall*	12/06/95	FIN*
A Carverhill	*Efficient and flexible bond option valuation in the Heath Jarrow Morton framework*	12/06/95	FIN*
E Pardoux	*A short course on stochastic PDEs, Part I*	12/06/95	FIN*
E Pardoux	*A short course on stochastic PDEs, Part II*	12/06/95	FIN*
M Musiela	*General topic review: term structure as solutions of stochastic PDEs, Part I*	13/06/95	FIN*
M Musiela	*General topic review; term structure as solutions of stochastic PDEs, Part II*	13/06/95	FIN*

9.6 Seminars and Lectures

D Kennedy	*Characterizing and filtering Gaussian models of the term structure of interest rates*	13/06/95	FIN*
A Tovbis	*An introduction to the Borel-Laplace method for nonlinear ODEs*	13/06/95	EXP
Y Ait-Sahlia	*General topic review: econometric estimation of term structure models, Part I*	13/06/95	FIN*
Y Ait-Sahlia	*General topic review: econometric estimation of term structure models, Part II*	13/06/95	FIN*
J-J Xu	*Generalised needle solutions, interfacial instabilities and pattern formations*	14/06/95	EXP
F Pham	*Analytic structure of the energy levels of the anharmonic oscillator*	14/06/95	EXP
D Lando	*General topic review: modelling term structures of defaultable bonds, Part I*	15/06/95	FIN*
D Lando	*General topic review: modelling term structures of defaultable bonds, Part II*	15/06/95	FIN*
F Jamshidian	*Term structure modelling the pitfalls of theory and some practical approaches*	15/06/95	FIN*
F Pham	*An introduction to Voros resurgence: computing the Stokes structure of one-dimensional polynomial oscillators*	15/06/95	EXP
K Miltersen	*Closed form solutions for term structure derivatives with log normal interest rate*	15/06/95	FIN*
D Heath	*Contingent claim valuation using trees*	15/06/95	FIN*
S Schaefer	*Term structure dynamics*	16/06/95	FIN*
C Rogers	*Term structure modelling: where next?*	16/06/95	FIN*
A Olde Daalhuis	*Hyperasymptotics and Stokes phenomena for nonlinear ODEs*	19/06/95	EXP*
TM Dunster	*Improved uniform asymptotics for the generalised exponential integral*	19/06/95	EXP*
C Bender	*Random walks in D-dimensions*	19/06/95	EXP*
F Olver	*Computation of Stokes multipliers for linear differential equations of high order*	19/06/95	EXP*
N Joshi	*The initial value problem for the KdV equation; an asymptotic approach*	20/06/95	EXP*
PA Clarkson	*Symmetry and the Chazy equation*	20/06/95	EXP*
A Tovbis	*The Stokes phenomenon for nonlinear equations and applications*	20/06/95	EXP*
J Hu	*Computation of the adiabatic invariant for nonlinear oscillators*	20/06/95	EXP*
R Wong	*Asymptotics of some orthogonal polynomials*	21/06/95	EXP*
N Temme	*Asymptotics of Hermite-Padé polynomials associated with the exponential function*	21/06/95	EXP*
WGC Boyd	*The asymptotics of Bi(z)-type solutions of linear second order differential equations*	21/06/95	EXP*
R Bullough	*Closed forms for the eigenvalues of the Mathieu equation: summation of the Dingle-Müller asymptotics*	21/06/95	EXP*

9.6 Seminars and Lectures

G Wickham	*Some problems in wave propagation in inhomogeneous media*	22/06/95	EXP*
CJ Howls	*Hyperasymptotic generalisations and pitfalls*	22/06/95	EXP*
MV Berry	*Chaos and classical limits*	22/06/95	EXP*
M Kruskal	*Remarks on exponential asymptotics*	22/06/95	EXP*
L Fishman	*An exact well-posed, one-way reformulation of the Helmholz equation with application to direct and inverse wave propagation modelling*	27/06/95	EXP

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