Report of the Review Panel

for the

Erwin Schrödinger International Institute for Mathematical Physics

April 2008

1. The Institute and its Mission.

The Erwin Schrödinger International Institute for Mathematical Physics (ESI) was founded in Vienna in 1992, becoming fully operational in 1993, housed in the building in Pasteurgasse where Erwin Schrödinger spent his last years. The Institute soon out grew this first home and it moved to its present accommodation in Boltzmanngasse in 1996.

The mission of the Institute is:

> to advance research in mathematics and physics at the highest international level through fruitful interactions between scientists from these disciplines;
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> to support research at the surrounding universities and to stimulate the scientific environment in Austria; and
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> through its geographical location in the centre of Europe, to stimulate exchange between scientists from Central and Eastern Europe and the rest of the world.

The Institute pursues its mission in a number of ways: primarily, by running four to six thematic programmes each year, selected about two years in advance on the basis of the advice of the Institute's International Scientific Advisory Committee; also by organizing workshops, conferences and summer schools at shorter notice; by a programme of Senior Visitor Fellows (SRF), who give lecture courses at the Institute; a programme of Junior Research Fellows (JRF), who are graduate students or postdoctoral fellows; and by inviting individual scientists who collaborate with members of the local scientific community.

Formally, the ESI is run by the Erwin Schrödinger International Institute for Mathematical Physics Society, which was established for this sole purpose. Most of the members of the Society are mathematicians and physicists from the University of Vienna and the Vienna University of Technology. The ESI reports twice a year to the Society, through its Managing Board (Vorstand) and the Society reports in turn annually to the Austrian Ministry of Science and Research (BMWF), from which it receives the core of the funding required to run the ESI.

The Society appoints the Scientific Directorate of the ESI, which comprises a President and two Scientific Directors. At present, these are: Klaus Schmidt, Professor of Mathematics, University of Vienna (since 1994), President (since 2003, Scientific Director 1995-2003); Joachim Schwermer, Professor of Mathematics, University of Vienna (since 2001), Scientific Director (since 2003); and Jakob Yngvason, Professor of Physics, University of Vienna (since 1996), Scientific Director (since 2003, President 1998-2003). The past members of the Scientific Directorate are Walter Thirring (President 1993-1997) and Peter Michor (Scientific Director 1993-2002).

The President and Scientific Directors do not receive stipends or an entitlement to a reduction in teaching duties in their home institution as compensation for their administrative work for the Institute but they do receive a 'Director's Share', that is the resources to invite scientific visitors to the ESI for a total of 300 days each year. [Because each visitor receives an allowance of €90 per diem, a Director's Share corresponds to a resource allocation of €27,000.]

2. The Review Panel and its Procedures.

As part of its review of Austrian scientific institutions, the Austrian Ministry of Science and Research has commissioned a review of the ESI by a panel consisting of Jean-Michel Bismut (Orsay); Robbert Dijkgraaf (Amsterdam); Peter Goddard (IAS, Princeton, Chair); Felix Otto (Bonn); and Scott Sheffield (Courant Institute, NYU). The remit assigned to the Panel is "to evaluate the quality and performance of the scientific activities of the ESI and to make any recommendations for the Institute's future development it will find appropriate".

A review of the ESI, similarly commissioned, had been conducted at the end of 2002 with Professor Nigel Hitchin as chair. This review assessed the work of the Institute over the period from the start of its operations in 1993. The present review is therefore concerned primarily with the five-year period 2003-2007.

The Panel conferred together by telephone on April 3, 2008, to discuss its proposed procedures and the information provided to the Panel by the ESI. Following this discussion, the Chair of the Panel consulted a number of former members of the International Scientific Advisory Committee of the ESI and others with experience of the ESI and received written comments were received from the following: Jean-Pierre Bourguignon (IHES, Paris); Luis Caffarelli (Texas); Giovanni Gallavotti (Rome); Elliott Lieb (Princeton); Harald Niederreiter (Singapore); Bálint Tóth (Budapest); and Anatoly Vershik (Steklov Institute, St Petersburg).

The Panel received documents on the following from the Scientific Directorate of the ESI:

Activities 1993-2007 (data on conferences, programmes and visitors);
ESI Junior Research Fellowships 2008-09: call for applications;
ESI Mission Statement;
Future Development of the ESI;
Implementation of the Recommendations of the 2002 Evaluation of the ESI;
List of ESI Junior Research Fellows 2004, 2005, 2006 and 2007;
List of Main Programmes and Workshops of the ESI 1992-2008;
List of Members of the Erwin Schrödinger International Institute for Mathematical Physics Society
List of Members of the International Scientific Advisory Committee 1993-2008;
Organizers of ESI Programmes and Workshops 2005-2007 (indicating members of the local scientific community);
Report of the Review Panel on the Erwin Schrödinger International Institute for Mathematical Physics 2002;
Self-Assessment of the ESI: Strong and Weak Points;
Senior Research Fellow Lecture Courses 2002-2008;
Scientific Reports of the ESI for each of the years 2002 to 2007.

The Panel visited the ESI from 18 April to 20 April 2008. On arrival the Panel was given a tour of the ESI accommodation and facilities followed by an overview of the Institute's history, structure, operation and funding and discussion of its scientific strategy and activities with the Scientific Directorate. The Panel continued its discussions over dinner alone. On the morning of 19 April, the Panel met with Maria Windhager of the Institute's administration to discuss the administrative arrangements, the Scientific Directorate for further discussion, and some programme organizers, JRFs and SRFs. These include a number of scientists who had joined the faculties of Universities in Vienna in recent years. The discussions continued over lunch. There were further discussions with the Scientific Directorate and private discussions of the Panel in the afternoon and in the morning of Sunday, April 20. The panel concluded its visit by outlining and discussing its provisional conclusions with the Scientific Directorate at the end of the morning. [Robbert Dijkgraaf was prevented by illness from attending in person but received the documents listed above and participated by telephone in a conference to review conclusions on 20 April.]

During its visit to the ESI, the Panel met with the following scientists in addition to the Scientific Directorate: Werner Ballmann (SRF 2004, 2005), Professor of Mathematics, University of Bonn, Director MPIM, Bonn; Christoph Dellago§*, Professor of Physics, University of Vienna; Harald Grobner (JRF, January – June 2007; PhD Vienna 2007); Karlheinz Gröchenig§*, Professor of Mathematics, University of Vienna; Harald Grosse*, Professor of Physics, University of Vienna; Joachim Hermisson§*, Professor of Mathematics and Biosciences, University of Vienna; Christian Krattenhaler*, Professor of Mathematics; Bianca Mladek (JRF, May – October 2004; PhD Vienna 2008); Radoslav Rashkov (SRF 2007-08), Professor Physics, Sofia University; Domokos Szász, Professor of Mathematics, University of Budapest; and Frank Verstraete§*, Professor of Physics, University of Vienna [§ recent appointment in Vienna; * present or recent programme organizer].

3. The Institute's Physical Environment and Resources.

The ESI is very attractively housed in accommodation on part of the upper floor of a two hundred-year-old Catholic seminary at Boltzmanngasse 9 to which it moved in 1996. The conversion of the space was performed in a way that creates a distinctive and sympathetic environment for the Institute, which is one of its major assets. The ESI is well located close to the departments of mathematics and physics of the University of Vienna. The seminary building provides an environment that is both quiet and relatively secluded inside but still close to the centre of Vienna with all that it has to offer culturally.

In 2004, the ESI expanded its facilities within the seminary by adapting additional space and a large lecture room, the Boltzmann Lecture Hall. In addition to a common room and lecture rooms, the ESI has 14 offices of varying sizes with desks for 54. The success of the ESI depends on a number of factors but crucial among them is its beautiful and well located quarters, elegantly and effectively adapted for its purpose. Recently, a wireless internet access has been established throughout the Institute. In the intensely competitive environment of international research institutes in the mathematical sciences, having an attractive and convenient environment is essential for success in attracting leading scientists.

The ESI does not have its own library but visitors have access to libraries in the University of Vienna. This arrangement works well except for some aspects of electronic access from

computers in the ESI to electronic journals, which is limited in some respects. It would be very desirable to improve these arrangements if possible.

The financial resources of the ESI over the last five years are set out in the following table. Indexed to 2007 values using the Austrian VPI, the average annual BMWF grant for the period five-year period 2003-2007 was €913k, the average total income was €1,000k and the average expenditure €933k. Although the funds provided by the BMWF to the ESI have been increased to provide for the SRF and JRF programmes, in 2003 and 2004, respectively, basic funding has not increased and, in fact, the BMWF funding has decreased by 30% in real terms from 2005 to 2007.

ESI Income and Expenditure 2003 - 2007

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	2003	2004	2005	2006	2007	Average
BMWF funding	670,876	861,880	1,062,880	957,880	845,000	879,703
Other funding	0	30,662	72,980	59,980	269,252	86,575
Total funding	670,876	892,542	1,135,860	1,017,860	1,114,252	966,278
Infrastructure	334,931	463,621	424,598	399,239	380,307	400,539
Scientific Costs	366,203	443,982	516,566	528,470	638,839	498,812
Total Costs	701,134	907,603	941,164	927,709	1,019,146	899,351
Surplus (Deficit)	-30,258	-15,061	194,696	90,151	95,106	66,927

In addition to BMWF funding, the ESI has secured support for specific programmes and workshops from the EU, the ESF and, occasionally, the NSF, but such support is not guaranteed and is difficult to take advantage of in the planning process. Private support for basic research, which forms a major part of the income of some comparable scientific institutes in other countries, is not available on any scale in Austria at present.

Planning for the future programmes at the ESI has to stretch three years into the future but the horizon to which funding is guaranteed is effectively the end of the financial year. This is a precarious arrangement because commitments, albeit qualified, have to be entered into which extend up to two years into the future. It would be preferable if this situation could be regularized.

4. The Development and Work of the Institute 2002-2007.

The central activities of the Institute remain the typically four to six large programmes run each year. Planning for these begins typically two years in advance, which is the normal practice for such programmatic activity in institutes. However, about a quarter of the scientific budget is set aside for activities, such as smaller programmes, workshops and visits by individual scientists, arranged at much shorter notice, enabling the ESI to respond quickly and easily to emerging scientific developments. [Two thirds of this provision, of about €120k, corresponds to the Directors' Shares, which total about €80k.]

Programme organizers are encouraged to include series of introductory lectures for the benefit of graduate students and others but the response has not been uniform. In recent

years, the ESI has also run a number of very successful instructional workshops, with both introductory and more advanced lecture courses aimed at junior researchers.

Funding provided by the BMWF enabled the establishment of a *Junior Research Fellowship Programme* from 2004 to provided support for PhD students and young postdoctoral fellows, normally lasting between two and six months, to enable them to participate in the scientific activities of the Institute and to interact with member of the local scientific community. Two competitions are held each year, attracting about 75 applicants with a 30% success rate, leading to the award of about 75 person months of support at present.

ESI Activities 1993-2007

Year	Programmes	Conferences	Visitors	Nationalities	Preprints
1993	3	1	103	18	67
1994	5	2	185	33	119
1995	6	3	217	34	108
1996	4	4	259	31	120
1997	5	2	242	34	105
1998	6	3	333	39	133
1999	5	2	409	42	168
2000	5	3	408	51	157
2001	5	3	460	41	137
2002	6	2	334	48	109
2003	5	5	422	50	167
2004	5	9	424	42	132
2005	5	8	520	47	219
2006	7	11	557	46	125
2007	6	11	586	49	101
Total	78	69	5459		1967
Average	5.2	4.6	364	40	131

The Institute initiated a *Senior Research Fellowship Programme* in 2000 in order to increase its impact on the local scientific community, by bringing to Vienna leading scientists, who would interact with graduate students and postdoctoral fellows in the surrounding universities in particular, by giving graduate courses. The ESI Review of 2002 advocated that the Programme be given the flexibility to include some leading scientists who were not necessarily required to give graduate courses. Extra resources have been allocated to achieve this and the ESI now has both 'teaching' SRFs, who typically give about 36 hours of teaching over a period of about three months, and 'non-teaching' SRFs, who may act as programme organizers, as focal points for the JRF Programme and other members of the scientific community, particularly the younger ones.

The ESI was founded with a particular mission to stimulate exchange between scientists from Central and Eastern Europe and the rest of the world, which it retains. Since it was first conceived in 1989, the political and scientific landscapes have evolved considerably and new research institutions have been established in both Eastern and Western Europe. In its

first ten years of operation, from 1993 to 2002, the percentage of participants coming from Eastern Europe fell from more than 40% to about 20%. In the last five years this percentage has remained approximately constant, at about 21%, whilst the overall numbers have increased by over 40%. The tables below give figures for the geographical distribution of the country of origin of visitors to the ESI for the last five years and also figures for the participation for each country with an average of more than 10 participants *per annum*. Percentage averages are given and, for comparison, the corresponding percentage averages for the Isaac Newton Institute for Mathematical Sciences in Cambridge are given (where the average is taken over the three years 2004-05 to 2006-07). The increased participation at the ESI from Eastern Europe (21% rather than 5%) is necessarily mainly at the expense of smaller levels of participation from Western Europe (55% rather than 68%) and North America (13% rather than 19%).

Geographical Distribution of Visitors by Region

	2003	2004	2005	2006	2007	Average	NI Av
W Europe	230	249	264	367	394	54.9%	68.1%
E Europe	106	97	117	107	143	20.8%	4.8%
Middle East	9	8	33	10	10	2.6%	2.3%
Africa	4	1	3	5	4	0.6%	0.4%
Asia	25	23	30	30	29	5.0%	3.6%
Australasia	8	12	7	8	8	1.6%	1.1%
N America	76	62	86	70	67	13.2%	19.2%
C & S America	6	9	8	7	9	1.4%	0.5%

[The column labelled 'NI Av' gives the average for the Newton Institute for 2004-07.]

Geographical Distribution of Visitors by Country

	2003	2004	2005	2006	2007	Average	NI Av
Austria	29	22	28	39	53	6.2%	1.0%
France	43	24	32	64	62	8.2%	8.8%
Germany	71	92	88	99	115	17.0%	8.4%
Italy	21	39	31	70	55	7.9%	2.9%
Switzerland	7	9	8	15	12	1.9%	1.0%
UK	15	28	16	18	30	3.9%	36.6%
Czech Rep.	3	15	17	7	17	2.2%	0.6%
Hungary	11	13	11	27	10	2.6%	0.4%
Poland	21	16	26	13	16	3.4%	2.1%
Russia	38	29	27	27	51	6.3%	1.2%
Israel	6	8	29	6	7	2.0%	1.8%
Japan	12	17	23	19	14	3.1%	2.3%
Canada	12	7	13	9	11	1.9%	3.0%
USA	64	55	73	61	56	11.3%	16.2%
Other	111	87	126	130	155	22.2%	13.8%

[The column labelled 'NI Av' gives the average for the Newton Institute for 2004-07.]

By virtue of its geographical location and its now well established contacts, ESI continues to play a significant role in promoting and facilitating contacts between Central and Eastern Europe and the rest of the world. It also plays an active role in the European Postdoctoral Institute for the Mathematical Sciences (EPDI) and the committee of the European Research Centres on Mathematics (ERCOM).

In common with other research institutes in the mathematical sciences, the ESI has to work to ensure that the average length of visits does not decrease markedly. The number of long-term visitors (more than a month) as a percentage of the total of medium and long-term visitors (two weeks or more) decreased from 45% to 60% in the first years of the ESI to 25% to 30% in the few years before the 2002 Review. This percentage has fluctuated somewhat in the last five years but it has averaged about 32%.

The Review Panel was impressed with the quality of the programmes that had taken place over the last five years. It noted that over the years the ESI had widened the range of its programmes from being originally more narrowly focused within the area of mathematical physics. The Scientific Directorate has gently and wisely increased the scope of the programmes mounted by the Institute in recent years, into areas of pure mathematics more remote at present from theoretical physics, and into areas of physics and biology beyond the areas usually characterized as mathematical physics. This is a process that the Panel thinks should be continued in the same judicious fashion. However, it means that the name of the Institute, characterizing its scope as mathematical physics, is no longer so accurate. This is probably not a problem within the mathematical community but it may not be optimal where communication with the physicists and other scientists is concerned.

All of the scientists whom the Panel met testified to the high quality of their experience at the ESI.

5. Scientific Management

Perhaps the most striking features of the ESI are the minimal arrangements that provide for the scientific direction and administration of the Institute. In fact, at first sight it seems quite implausible that an institute as active as the ESI can be run in such minimalist fashion. The President and two Scientific Directors are Professors at the University of Vienna with regular teaching duties. They receive no financial compensation or concessions for the heavy burden in terms of time and commitment that the scientific direction of the ESI imposes (other than their Director's "Shares").

The administrative staff of three is also extremely lean but clearly very efficient and highly appreciated. The combination of the simplicity and the effectiveness of the administrative arrangements – everyone gets the same allowance of €90 *per diem* and no travel support – is a very attractive feature of the Institute in the eyes of many of the programme participants and visitors. However, the limited resources available for administration mean that these are insufficient to support other than very minimal public relations activities and the computing support is provided on a informal basis by scientists from the University of Vienna.

The lightness of the administrative arrangements aid ESI's ability to respond quickly to suggestions for scientists to invite at short notice from members of the Austrian scientific community. In terms of funding, and also in terms of office and lecture hall accommodation, the ESI has much greater flexibility than the local university departments and for this reason

it frequently houses scientific events organized by, or jointly organized with, university departments.

The International Scientific Advisory Committee meets annually, usually in April. It reviews the scientific work of the ESI, reviews proposals submitted for programmes at the Institute and provides advice on their selection, which takes place about two years in advance. At each meeting, the Committee elects its own chair for the part of the meeting concerned with the review of programme proposals. The 2002 Review Panel commented on the desirability of turn over on the Scientific Advisory Committee and now all of its external members are new to that Panel reported. If they are not already there, provisions should be put in place to ensure that the membership of the Committee turns over completely on a timescale of five to six years.

6. Fulfilling the Mission

The 2002 Review Panel concluded that the ESI had established its position as one of the leading research centres in mathematics and theoretical physics in Europe. It had done this on the basis of much smaller resources financially and particularly in terms of human resources than other comparable institutes. This position has been consolidated and enhanced during the last five years.

Any international institute such as the ESI faces some tension between its fundamental purposes of fostering research at the highest possible levels on the one hand and supporting and stimulating research in the local scientific community, in the case of ESI in Vienna, in Austria, and in nearby countries, particularly to the east. In a scientifically developed environment, such as that in which the ESI was established, there is little real conflict between these requirements, because the best way of benefiting the local community is to ensure that the ESI functions at the highest levels internationally and so attracts the world's leading mathematical scientists to Vienna, where their presence will enhance and stimulate activity further.

This has clearly been the approach successfully followed by the ESI. It needs to be supplemented by processes to ensure that information about the activities of the Institute are widely visible in institutions beyond the ESI and the University of Vienna. It is possible that more could be done to this end and also to enable graduate students and young researchers from nearby universities in countries to the east to participate in seminars and lecture courses. Both of these developments would require extra resources given the lack of spare room in the budget for additional scientific activity and the minimal provision for administrative and secretarial support.

From discussions with Professors recently appointed at the University of Vienna and others, it was clear that the ESI has been an important factor in attracting outstanding scientists to posts in Vienna, as the 2002 Review Panel had advocated.

7. Securing the Future

The achievements of the ESI, now clearly established as a leading international centre for research in the mathematical sciences have been quite remarkable, and all this has been achieved with the minimal deployment of resources, financial and human, certainly when compared with similar institutes in other countries. This minimal structure has resulted in

informality and flexibility of style and practice, which gives a distinctive character to the Institute that is highly appreciated by participants in its programmes. It helps create an ethos that is very conducive to research.

However this minimalism of approach and informality of arrangements may create vulnerabilities in a time of change. Over the fifteen years of its existence only a handful of scientists have been centrally involved in its development. The present lean and effective organization depends very heavily on the talents, self-sacrifice and good nature of the President and two Scientific Directors. Two of these three, the President and one of the Scientific Directors, are scheduled to retire from their university posts within the next five years. The continued success of the ESI at the highest level will depend on the ability to appoint comparably talented and selfless successors.

The Panel takes the view that it is not wise or reasonable to depend on future Scientific Directors and Presidents being as willing to undertake the duties of these offices with no compensation or concessions. In order to help secure the future, they should be given benefits beyond their "Shares". For example, the resources should be provided to enable each Director to reduce his or her load of teaching and administration in the university to no more than half the normal stint. This is the minimum provision made in most comparable institutes elsewhere.

The Panel gave extensive consideration to ways in which the ESI arrangements might be made more robust as it goes into this period of change. Simply generally strengthening the administration by the addition of more staff, or making the procedures more stable by codifying them more precisely and formally, runs the risk of damaging the present light, friendly and efficient administrative arrangements, which is now part of the essential character of the ESI and is so much appreciated by participants. However one step that could probably be taken without disturbing the present arrangements would be to appoint an executive assistant to the President, who could assist with the writing of scientific and other reports and other higher-level administrative tasks, and also outreach and the publicizing of ESI activities. This should reduce the pressures on the President and, perhaps also on the Scientific Directors, and so make the recruitment of these officers easier.

Another step which might help safeguard the prevailing high standards of quality and probity in the scientific leadership of the ESI, through the impending period of change, would be to appoint the Chairman of the Scientific Advisory Committee for a period of three years, rather than only within the context of a single meeting, and to give him or her the standing to make representations to the Vorstand on matters relating to the scientific work of the Institute, if he or she felt it appropriate. The Chairman could also be given a role in advising on the selection of the President and the Scientific Directors.

The Panel also considered other ways in which the ESI could be strengthened by widening the group of those involved at any particular time on a long-term basis in the scientific life of the Institute. Such a broadening of its scientific base really needed to ensure the stability of the ESI's achievements and to enable it to develop into new scientific areas. The Panel considered arguments put forward for establishing ESI Professorships, which would have a two to five-year tenure and might be attractive both to established active senior scientists and to promising young scientists at an early stage of their careers. However, the Panel did not feel sufficiently confident that this format of appointment, for which, given the absence

of any real prospect of tenure, there are few if any parallels elsewhere, would attract an appropriately strong field of applicants.

The Panel took the view that it would be better to follow two well-established models for the appointment of outstanding scientists, who would spend some years at the Institute and extend the human resources available to provide scientific leadership and planning: two-year postdoctoral fellows (PDF) and half-year or one-year appointments for senior scientists. Because of the competition resulting from the continuing rapid growth internationally of research institutes, and particularly in light of the impending retirements, steps, such as these need to be taken to preserve the important benefits for Austrian science which have been secured by the remarkable success of the ESI.

Resources should be made available to enable the appointments of two two-year PDFs each year (so that there would be four present at any one time). These fellows would further enhance the scientific life of the institute, providing continuity, particularly in relation to the Junior Research Fellow (JRF) programme and contributing to the organization of seminar series and workshops. The administrative load on each of the PDFs would be moderate but, taken together, they would provide a substantial contribution to the running of the ESI. The gross cost of this would be about 4 x €60k = €240k *p.a.*

The strength and diversity of the activity of the Institute could be enhanced further by having the resources for the appointment of senior scientists, typically on leave from posts in universities, for one-year or half-year periods, to compliment and extend the expertise of the Scientific Directorate. If there were two such senior visitors in residence at any one time, the gross cost of this would be about 2 x €150k = €300k *p.a.*

Important though such additional posts would be for the future of the ESI, they should not be made at expense of the core programme. Indeed it is necessary to correct for the real decline in recent years of the resources available to the Institute. This would require an increase in the budget of about €200k *p.a.*

8. Summary of Conclusions

1. The ESI maintains a high standard in its research activities, comparable with the leading institutions internationally, which almost all operate on a larger scale.

2. It does this at minimal cost in terms of financial cost and human effort, in an informal and flexible fashion.

3. The attractive, well-adapted and conveniently located accommodation of the ESI has made a crucial contribution to the success of the Institute.

4. The participants in the ESI are nearly all delighted with the facilities and the informal ethos of ESI.

5. Over its lifetime, the ESI has had a great impact on the standing of Vienna as a centre on the world stage for mathematics and theoretical physics, through its activity in areas of mathematics and physics where important developments are happening or seem imminent,

and through the contribution it has made to attracting excellent mathematicians and physicists to permanent positions in Viennese universities.

6. In the last five years the international standing of the ESI has been consolidated and enhanced.

7. These important benefits and achievements may be vulnerable because the President and one of the two Scientific Directors are scheduled to retire within the next five years.

8. The present lean and effective organization depends very heavily on the talents, self-sacrifice and good nature of the President and two Scientific Directors.

9. The Directors have gently and wisely increased the scope of ESI over recent years and this process should be continued in a similar fashion.

10. Originally, the work of the ESI was rather more narrowly focused within the area of mathematical physics and the desirable broadening that has taken place perhaps presents some issues of "branding". Its involvement in physics outside of what is usually now termed "mathematical physics" may not be as well known as it might be in the relevant communities.

11. The graduate courses provided by the Senior Research Fellows (SRF) at the ESI provided a significant and valuable contribution to the graduate courses available at the universities in Vienna.

12. Whilst the contribution made by the ESI to facilitating connections between Eastern Europe and the Rest of the World in mathematics and physics has changed over the years since its inception, it still makes a valuable contribution in this context.

13. Greater benefit could be derived from the courses given by SRFs at the ESI if resources were available to facilitate the attendance of graduate students and other young researchers from outside Vienna, perhaps particularly from Eastern Europe.

14. The ESI is an important and stimulating resource for Austrian mathematics and physics generally but most particularly in relation to the University of Vienna. The publicity it gives to its activities is good but could be strengthened further.

9. Summary of Recommendations.

1. Resources should be made available to ESI to facilitate the attendance at graduate courses and seminars of graduate students and other young researchers from outside Vienna, perhaps particularly from Eastern Europe.

2. The publicity ESI gives to its activities should be strengthened further particularly to improve communication with centres beyond the University of Vienna.

3. Consideration should be given to amending the name slightly by broadening the term "Mathematical Physics" in the title of the Institute.

4. Provisions should be put in place, if they are not already there, to ensure that the membership of the International Scientific Advisory Committee turns over on a timescale of five to six years.

5. In order to help secure the future, the Directors should be given benefits beyond their "Shares". For example, the resources should be provided to enable each Director to reduce his or her load of teaching and administration in the university to no more than half the normal stint.

5. Consideration should be given to appointing an executive assistant to the President, who could assist with the writing of scientific and other reports and other higher-level administrative tasks, and help with outreach and the publicizing of ESI activities, whilst leaving in place the present light, friendly and efficient general administrative structure.

6. Consideration should be given to appointing the Chairman of the Scientific Advisory Committee for a period of three years and giving him or her the standing to make representations to the Vorstand on matters relating to the scientific work of the Institute, if he or she felt it appropriate. The Chairman could also be given a role in advising on the selection of the President and the Scientific Directors.

7. Resources should be made available to enable the appointments of two two-year postdoctoral fellows each year (so that there would be four present at any one time). The gross cost of this would be about 4 x €60k = €240k *p.a.*

8. Resources should also be provided for the appointment of senior scientists, typically on leave from posts in universities, for one-year or half-year periods, to compliment and extend the expertise of the Directors. If there were two such senior visitors in residence at any one time, the gross cost of this would be about 2 x €150k = €300k *p.a.*

9. In addition to providing additional resources for Recommendations 7. and 8., the basic resources available for programmes be increased in real terms by about €200k *p.a.* to compensate for the decline in value in recent years.

Jean-Michel Bismut
Robbert Dijkgraaf
Peter Goddard (*Chair*)
Felix Otto
Scott Sheffield