The Erwin Schrödinger International Institute for Mathematical Physics

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ESI NEWS

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Contents

Editorial

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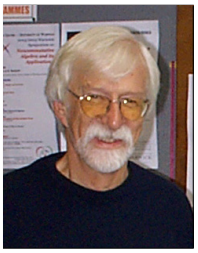


Turning fifteen is not usually a major event in an individual's life, but for a scientific institution this anniversary is an occasion for reflection: unlike individuals, research institutes have to evaluate on a regular basis the impact of their activities both on the local scientific communities and the relevant scientific disciplines.

When the ESI was opened 15 years ago as a result of a fortunate combination of political events in Europe and a bold initiative by a small group of mathematicians and physicists (notably Walter Thirring and Peter Michor) and the (then) Minister of Science Erhard Busek, it quickly made an enormous difference to the scope, quality and international orientation of research in mathematics and mathematical physics in this country. Before 1992 Vienna — and Austria — was the home of some outstanding individual scientists of international status, but it had no internationally visible research center in the mathematical sciences which could serve as a focal point for scientific activities and contribute to putting the country back on the international map after the terrible intellectual losses of the Nazi era. After the ESI had come into existence it began to offer scientific activities at the highest international level in a wide range of topics in mathematics and mathematical physics, many of which had been represented insufficiently in this country. It has attracted, and continues to attract, many of the world's top researchers to work here in Vienna, and it has been instrumental in filling faculty positions at the surrounding universities with top quality applicants.

A considerable part of this issue of ESI NEWS is devoted to a review of the activities of the Institute during the past 15 years. However, the historical perspective of this issue is not centered exclusively on the Institute, its location and its programmes. It also focuses on the exodus from Austria in 1938 of some of its most creative scientific minds (many of them at a very tender age), and on Hermann Minkowski and the early days of relativity theory. Current and future scientific developments and activities will, of course, regain their rightful place in the next issues of ESI NEWS.

Where Mathematics meets Physics – the ESI celebrates its 15th Anniversary

Wolfgang L. Reiter and Klaus Schmidt

On April 14, 2008, the ESI celebrated its 15th anniversary with a series of lectures by distinguished scientists on topics ranging from ultra cold atoms (Rudolf Grimm, Innsbruck), supergravity (Thibault Damour, IHES, Bures-sur-Yvette), quantum ideas in number theory (Don Zagier, MPIM, Bonn and College de France, Paris), to the Langlands programme and mirror symmetry (Ed Frenkel, Berkeley), and mathematical biology (Steven N. Evans, Berkeley and Peter Schuster, Vienna). The last of these lectures also opened a subsequent Workshop on "Frontiers in Mathematical Biology". This list of topics reflects the wide spectrum of the Institutes current scientific activities.

A window of opportunity: setting up an Institute for Mathematical Physics

In August of 1990 Alexander Vinogradov, Moscow, sent a letter to Peter Michor, Vienna, with the proposal to set up an institute devoted to mathematics and physics in Vienna. This proposal had been preceded by discussions between Vinogradov and Michor on the preservation of the scientific community in the Eastern European countries in the aftermath of the fall of the communist governments in these countries. At that time the entire region was threatened with a huge brain drain involving many of these countries' best scientists.

Setting up an institution on the interface between mathematics and physics in Vienna was seen as a potentially valuable contribution at that time of crisis: based on the cultural and scientific tradition in Vienna — from Ludwig Boltzmann to Erwin Schrödinger and Walter Thirring, especially in the field of mathematical physics, a new institute based in Vienna could provide a focal point for both Eastern and Western science and an international platform at the highest level of research in the field of mathematical physics.

This initiative was warmly welcomed

by Thirring. In a letter to the Minister of Science and Research, Erhard Busek, dated October 18, 1990, Thirring proposed to establish an international research institute in Vienna, devoted to mathematical physics with the name "The Erwin Schrödinger International Institute for Mathematical Physics" (ESI). Thirring's proposal immediately won the support of eminent scientists all over the world, and Busek favourably responded in December 1990. A non-profit society was founded according to Austrian law, which formally runs the Institute and receives its basic funding from the Austrian Federal Ministry for Science and Research.

The Institute became fully operational in January 1993 under the directorship of Walter Thirring and Peter Michor in the very building in Pasteurgasse in Vienna's 9th district where Erwin Schrödinger had spent his last years.

With the growth of the Institute its original accommodation in Pasteurgasse soon became too small, and in summer 1996 the Institute moved into its new premises next to the Institutes of Mathematics and Physics of the University of Vienna in Boltzmanngasse 9.

Mission of the ESI

From the very beginning the Institute's mission was to advance research in mathematics and physics at the highest international level through fruitful interactions between leading scientists from these disciplines. With its scientific activities and international contacts the Institute aims to support research at the surrounding universities and to stimulate the scientific environment in Austria and beyond.

When the Institute was founded in 1993 it had a second important mission: through its geographical location in the centre of Europe the Institute aimed to stimulate intellectual exchange between scientists from Central and Eastern Europe and the Western world. With the subsequent changes in post-Communist Europe this second mission became less important. Nevertheless, the role of the ESI as a scientific meeting place of these European regions remains as strong as ever.

The Institute's scientific activities are centred around four to six larger thematic programmes per year on the basis of applications submitted two years in advance and evaluated by an International Scientific Advisory Committee. In addition, workshops, conferences and summer schools are organized at shorter notice, as well as visits of individual scientists who collaborate with members from the local scientific community.

In order to increase the impact of the Institute's activities on the graduate and post-doc programmes of the surrounding universities the ESI started in 2000 to offer several Senior Research Fellowships with the aim of attracting top quality scholars to Vienna for longer (and repeated) periods.

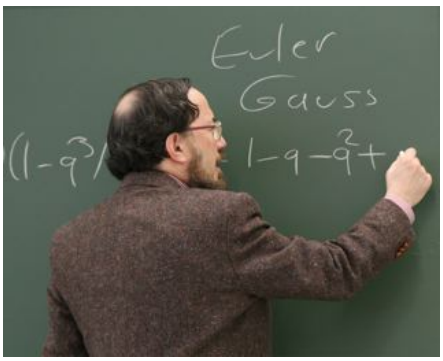
The most important subsequent development was the creation of the Junior Research Fellows Programme in 2004. The purpose of that programme is to enable post-docs and PhD-students to participate in the activities of the Institute, to strengthen their contacts with the Austrian and international research communities, and to work with individual visitors and Austrian scientists.

The presence of the Junior Research Fellows at the Institute has a very positive impact on its scientific atmosphere through their interaction with the regular thematic programmes and the Senior Research Fellows. The Junior Research Fellows Programme is part of the Institute's long term policy of vertical integration of research and scientific education at highest international levels. Gender mainstreaming is especially taken care of with this programme: since its beginning the rate of female participants is about 25 % of the participants of this programme, a number slightly above similar ratings in the US. To achieve this goal the ESI was supported by extra funding from the Austrian Federal Ministry for Science and Research.

To date the Institute has organized 78 thematic programmes, almost 4000 scientists have visited the Institute (among them the majority of leading reasearchers in mathematics and mathematical physics). The ESI preprint server offers about 2000 ESI preprints, almost all of them directly related to research originating from scientific activities at the Institute.

Some pictures from the Anniversary Celebration

AUDIENCE AT THE OPENING CEREMONY



DON ZAGIER

RUDI GRIMM

THIBAULT DAMOUR

ED FRENKEL

STEVEN N. EVANS

PETER SCHUSTER

JAKOB YNGVASON, PETER MICHOR AND WALTER THIRRING
KLAUS SCHMIDT THANKING THE SPEAKERS
CONVERSATION AMONG SPEAKERS AND REKTOR GEORG WINCKLER WITH PETER AICHELBURG

ESI at Boltzmanngasse 9 – A Site of History

Annelise Schmidt

In 1996 the ESI moved from its original location at the bottom of the *Strudlhofstiege* to a large building complex in Boltzmanngasse in Vienna's 9th district next to the buildings of the physics and chemistry institutes of the University of Vienna. This quarter has a very distinct character today as it had in the past. Visitors to the ESI have often asked about the history of the building in which the institute is located and commented on its monastic atmosphere. Here we give a short history of this building.

The Spanish Hospital

Under Emperor Charles VI the relationship of the Austrian court to the Spanish monarchy brought to Vienna a great number of Spaniards, as well as people from Milano, Naples, Sicily and the Netherlands. It proved difficult to look after them properly if they fell on hard times and became sick, since they were seldom capable of speaking German and very much adhered to the traditional way of life of their native country. In order to redress this state of affairs Emperor Charles VI decided to establish a hospital for people from these countries, as well as for young Germans who had married women from those countries and subsequently lived in Vienna, but who were not able to seek medical help in case of illness. He chose two superintendents of the Spanish and Dutch councils in Vienna to set up such an establishment similar to those existing in Spain and to administer them in the same manner.

In a personal letter of August 25, 1718, to the Secretary of State Marquis de Rialp, the Emperor established various sources of funding for the establishment and running of this 'Spanish Hospital'.

As building grounds for the hospital three vineyards in what is now called Boltzmanngasse were acquired on September 27, 1717, by the imperial valet Paul Pruny (Boltzmanngasse was originally called Carlgasse and thereafter Waisengasse/Orphans Lane) in the district of Alsergrund (then called Schottenberg or Ochsenberg). In these grounds the building of the hospital began on the day of the feast of saint Eulalia (December 10). The church was built at the same time.

As the space proved insufficient, on November 13, 1725, one and a half additional neighbouring vineyards were bought from the widow of the Royal Baker, Eva Höfer, in order to enlarge the hospital. After this expansion the hospital was able to offer 90 beds for patients.

After the death of Emperor Karl VI, Empress Maria Theresia enlarged the building in 1741 by having an additional floor built on top of the existing building. From this time onward sick soldiers of any nationality were also cared for at the hospital.

Due to a decrease in funding, administrative inefficiency and the large number of unnecessary persons supported out of hospital funds the hospital could accommodate only 105 patients (68 soldiers, 17 nationals, 7 women and 13 mentally ill - the latter in separate cells), although officially funding was provided for 202 patients. For this reason the administrative structure of the hospital was changed in 1753, and in 1754, by order of Empress Maria Theresia, the Trinity Hospital of the Alser suburb was joined

with and moved to the Spanish Hospital. In this combined hospital both civilians and soldiers were treated, irrespective of the nationality, birth or gender.

In 1759 the Strudlhof (a 'Pestspital' for victims of the bubonic plague, after which Strudlhofgasse is named) was also taken over by the Spanish Hospital and used as for treating victims of syphilis and later as an orphanage and foundling home.

The Royal Orphanage

The orphanage in Rennweg (in what is now the 3rd district of Vienna) was moved to the Spanish Hospital in 1785; the Rennweg foundling home was accommodated in the Strudlhof. A plaque mounted in the inner yard of the building has the following inscription: *Orphanis Alendis et Erudiendis Josephus II Anno MDCCLXXXV* (To Nurture and Educate the Orphans this Building has been Dedicated by Josef II in 1785). In 1786 the orphaned girls were also moved from the Spanish Hospital to Strudlhof. In 1788 the foundling home was moved to the so-called Möltzer Gardens in Alsergasse in 1788 by orders of Emperor Joseph II; the orphanage remained at the Spanish Hospital until the early 20th century.

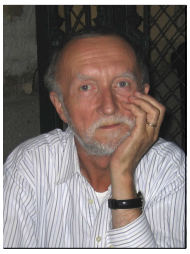
The Priests Seminary

On January 21, 1913, the Orphanage (i.e., the former Spanish Hospital) changed ownership at the cost of 1.846.000,– crowns (Kronen) and became a priests' seminary. After the sale the outhouses to the left of the church were demolished, while the main building to the right of the church was adapted for the purposes of the seminary. To the left of the church a new building was added, the present alumni rooms. On July 17, 1914, the city of Vienna gave permission for the official opening of the building. The seminary started its operation on August 10, 1914; the library in that building had already been in use slightly earlier.

FRONT VIEW OF THE BUILDING AT BOLTZMANNGASSE 7 AND 9
PLAQUE AT THE ORPHANAGE
REAR VIEW OF THE BUILDING AT BOLTZMANNGASSE 9

The Exodus of Physicists and Mathematicians from Austria in the Year 1938

Wolfgang L. Reiter



Austria's recent history is marked by a preference for years ending with the number 8. Dramatic historical events of political significance in Austria accidentally follow this pattern. None of the "8"-events characterise the *beginning* of an *aetas aurea*. The year 1848 is marked by a failed bourgeoise revolution followed by the neo-absolutist regime of Francis Joseph I which ended with the collapse of the Austrian-Hungarian Empire in 1918 and, subsequently, the proclamation of the democratic Republic of *Deutsch-Österreich*, as the country was named. This naming already signalled a lack of confidence in its feasibility as a politically self contained entity. The politically split republic between what was then called "Red Vienna" and a conservative countryside, was governed since 1934 by an authoritarian semi-fascist regime eclipsed in spring of 1938. *Springtime for Hitler and Germany!* (Mel Brooks).

On March 12, 1938 troops of Nazi Germany crossed the Austrian border and received a warm welcome by a good part of the population. From one day to the next the political and human scenario changed dramatically. Already during the night prior to the annexation formerly amicable neighbours turned into voracious robbers of Jewish tenants or shopkeepers next door.[1] During the days following the annexation the new masters seized power at all levels, most actively supported by a dedicated Nazi minority of about 25% of the Austrian population.

Citizens which the Nazis considered as enemies were immediately endangered, especially the Austrians of Jewish decent. It took only one month's time that all Jewish pupils were expelled from their schools and concentrated into so-called *Judenschulen*, a first step towards the ghettoisation of the Jewish population. The Viennese born physicist and historian of science, Gerald Holton, and Walter Kohn, Nobel laureate of chemistry in 1998, have been among the many children victimised by the Nazis. Gerald Holton and Gerhard Sonnert recently published an enlightening analysis of the lives and careers of émigré children forced to flee from Central Europe. Among these often traumatized young people there are many who most successfully contributed to the scientific culture of the country of save haven, the United States.[2] Ironically, this may be called Hitler's gift.[3] Walter Kohn once remarked: *"I think this emigration, from a broader point of view, should be viewed as a great blessing, since it enabled the emigrants to make some highly significant contributions to the world of scholarship."*[4] (See the Annex for lists of mathematicians and physicists who emigrated from Austria during their early childhood.)

The universities — a stronghold of German nationalism and Nazism during the twenties and thirties of the last century — figured among the highest ranking targets of the Nazi's prosecution. What took the Nazis in Germany, the so-called *Altreich*,

six years, to cleanse public life according to their racist, political and religious delusions, was accomplished in Austria, the *Ostmark*, in the time span of months. To give an example: the number of students inscribed at the University of Vienna decreased by 42% during the winter semester of 1938/39, since Jewish and politically undesirable students (the latter two groups amounted to 23% of the decrease in numbers of students; 19% left the university out of other reasons) had been relegated from university studies.[5] The purge of faculty members of the University of Vienna started forty eight hours after the invasion and was finalized within two months after the annexation of Austria. It ranged between roughly 50% (Medical Faculty) and 30% (Philosophical Faculty, including the sciences).[6] The speed and criminal energy of the Austrian Nazis puzzled even their German masters. [7]

To illustrate the enormous loss which the sciences suffered after Austria as a country had disappeared off the map and the whole population had come under Nazi legislation and the rules of the 1935 Nuremberg Laws, enacted in Austria on May 20 1938, I give a few examples of mathematicians and physicist who fled Europe to save their lives.

Kurt Gödel left Vienna at the beginning of 1940 and was invited to take a position at the Institute for Advanced Study in Princeton. Viennese born Richard von Mises was expelled from his position in Berlin immediately after the Nazi seized power and accepted a chair for pure and applied mathematics at the University of Istanbul, as did his later wife, the mathematician Hilde Polaczek-Geiringer. Both emigrated to the United States in 1939. Karl Menger left Austria already in 1937 for the United States, followed by his pupil Abraham Wald in 1938. Franz Alt, one of the early pioneers of computer programming and collaborator of John von Neumann, Eduard Helly and Olga Taussky-Todd were forced to leave and finally were lucky enough to get academic positions in the United States. Alfred Tauber died in the Theresienstadt concentration camp. And many more had to save their lives by fleeing from the empire of evil: Walter Mayer, Albert Einstein's assistent for many years, Gustav Bergmann, Eugen Lukacs. It has to be noted that the influence of refugees from Austria in the United States — besides mathematical logic (Gödel) and topology (Menger) — was especially significant in the field of applied mathematics with Helly, Wald, Lukacs, Hilda Geiringer-Mises and Richard Mises.[8]

The Physics Institutes of the University of Vienna lost one third of their faculty members in March 1938. At the Institute for Theoretical Physics Hans Thirring was dismissed for political reasons; Friedrich Kottler, David Kurt Konstantinovsky and Johann Friedrich Ludloff shared the fate of being of Jewish descent with the pioneers of radioactivity research, Stefan Meyer and Karl Przibram. The experimentalist Felix Ehrenhaft, (in)famous for his struggle with Millikan on the charge of the electron and his claims about the discovery of magnetic monopoles, could leave the country for England and the United States. Erwin Schrödinger escaped via Italy and Switzerland to Ireland, where he spent the whole war period at the Institute for Advanced Studies in Dublin until his late return to Austria in 1956, when finally the country got its sovereignty by the *State Treaty of Vienna* in 1955.

This short account of the consequences of the annexation in March 1938 for science in Austria has to be complemented by a quick look at the measures the Austrian political authorities took after the liberation of the country and the end of World War II. On the official political level little to nothing was done to invite refugees from Austria to return to the country and to participate in the new start of a democratic society. Only a small number of emigrees came back to the country of their birth or childhood.[9]

Victor Weisskopf once told me that he got a call for a chair in West Germany during the early years after the end of World War II. With bitterness in his voice he remarked that he had heard nothing like this from his former homeland Austria. Certainly, he said, he would not have had the intention to accept such an offer, but an invitation to return would have been highly significant symbolic act signifying a new spirit transcending the dark seven years of Nazi terror. This didn't happen. What happened for three decades after 1945 was the self-provincialisation of academic life in Austria.

In the German language the word *"Anschluß"* has different meanings: *"Anschluß" = annexation*, was the euphemism popular in 1938 and later, but *"Anschluß" = contact* with the world of international science was a hard lesson to learn for the scientific community in Austria after 1945. The destruction of the cultural and intellectual life in Austria in 1938 left its marks until long after the end of World War II. The end of the Cold War in 1989 changed the landscape in Central and Eastern Europe not only in politics. The initiative which lead to the foundation of the ESI in 1992/93 was — among others — an indirect consequence of the fall of the Iron Curtain and a reaction to the deteriorating conditions for the mathematical sciences in the Soviet Union during the first years after 1990. Since then the ESI, which in 2008 celebrates its 15th anniversary, successfully contributes to bringing the country back into the international theatre of scholarship in the mathematical sciences.

It probably takes more than one life span to enable a society deeply involved in crimes — as perpetrators or "passive" observers — to actively and publicly react, to talk about the involvement of parents and grandparents in criminal and murderous actions. At least, the political myth that Austria was "the first victim of Nazi barbarism" has lost its popular effectiveness in recent years.

After 70 years the history of the Nazi past is on the verge of becoming a collection of merely historical events and is no longer influenced and interpreted by any contemporary memories. The historization of the Nazi period is — among others — a function of the biological cycle. Without eye witnesses still living, the past becomes historical and the task of present-day (academic and political) understanding. Understanding the enormity of the cultural break represented by Nazism will remain crucial for coping with the dangers and problems affecting our (modern) society for generations to come.

Appendix

Little known is the fact how many of the younger generation of refugees from Austria had successful carriers in mathematics or physics in the countries they got shelter. Many of the children had been rescued by a so-called *Kindertransport* (Children's Transport) to Great Britain. Below I list the names of mathematicians born after 1920 who had to leave Austria in 1938:

John (Hans) Markus Blatt (1921-1990), Hermann Bondi (1919-2005), Peter Georg Braunfeld (1930-), Gertrude Ehrlich (1923-), Herbert Federer (1920-), Walter Frederick Freiberger (1924-), Lisl Nowak Gaal (1924-), Felix Haas (1921-), Walter S. Helly (1930-), Harry Hochstadt (1925-), Walter Kochen (1928-), Kurt Kreith (1932-), Hans Kronberger (1920-), Walter Littmann (1929-), Friedrich Ignaz Mautner (1921-1996), Hans Offenberger (1920-1988), Edgar Reich (1927-), Hans Reiter (1921-1992), Walter Rudin (1921-), Juan

Jorge Schaeffer (1927-), Alfred Marcel Schneider (1925-), Hans Schneider (1927-), Biyamin Schwarz (1919-2000), Josef Silberstein (1920-), Frank Spitzer (1926-1992), Theodor David Sterling (1923-), Erwin Trebitsch (1920-), Hans Felix Weinberger (1928-) und John (Hans) Wermer (1927-).

The following names belong to young Austrians born after 1920 who were expelled from their home country and got their academic training as physicists in Great Britain or the United States:

Fred Peter Adler (1925-), Erika Rivka Bauminger (1927-), Arthur Biermann (1925-), Frank Joachim Blatt (1924-), Henry Victor Bohm (1929-), Frederic de Hoffmann (1924-1989), Harold Paul Furth (1930-), Thomas Gold (1920-2004), Robert Gomer (1924-), Kurt Gottfried (1929-), Leopold E. Halpern (1925-2007), Erich Martin Hardt (1919-), Charles Maria Herfeld (1925-), Arvid Herzenberg (1925-), Charles M. Herzfeld (1925-), Walter F. Hitschfeld (1922-), Frederic Gerald Holton (1922-), Robert Karplus (1927-), Walter Kohn (1924-), Noémie Koller (1933-), Alfred Leitner (1921-), Peter Lindenfeld (1921-), Ernest M. Loebl (1923-), Georg M. Low (1926-1984), William Zeev Low (1922-), Harry Lustig (1925-), Hans Michael Mark (1929-), Peter Arnold Moldauer (1923-1985), Peter Wolfgang Neurath (1923-), Paul Michael Pfalzner (1923-), Dan Porat (1922-), Kurt Reibel (1926-), Frederic Reif (1927-), Wolfgang Rindler (1924-), Fritz Rohrlich (1921-), Norbert Rosenzweig (1925-), Baruch Rosner (1931-), John Ross (1926-), Edwin E. Salpeter (1924-), Erwin Robert Schmerling (1928-), Siegfried Fred Singer (1924-), Joseph Sucher (1930-), Robert Stratton (1928-), Gerald Erich Tauber (1922-), George Maxime Temmer (1922-1997), Kurt Toman (1921-), Arye Leo Weinreb (1921-), Werner Paul Wolf (1930-), Paul Zilsel (1923-2006).

These two lists of mathematicians and physicists impressively demonstrate the loss of intellectual potential Austria suffered in the aftermath of the year 1938.

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Hermann Minkowski and the Scandal of Spacetime

Scott Walter

When Hermann Minkowski's first paper on relativity theory[1] appeared in April 1908, it was met with an immediate, largely critical response. His paper purported to extend the reach of the principle of relativity to the electrodynamics of moving media, but one of the founders of relativity theory, the young Albert Einstein, along with his coauthor Jakob Laub, found Minkowski's theory to be wanting on physical and formal grounds alike. The lesson in physics delivered by his two former students did not merit a rejoinder, but their summary dismissal of his sophisticated four-dimensional formalism for physics appears to have given Minkowski pause.

The necessity of such a formalism for physics was stressed by Minkowski in a lecture entitled "Raum und Zeit," delivered at the annual meeting of the German Association for Natural Scientists and Physicians in Cologne, on 21 September 1908. Minkowski argued famously in Cologne that certain circumstances required scientists to discard the view of physical space as a Euclidean three-space, in favour of a four-dimensional world with a geometry characterized by the invariance of a certain quadratic form. Delivered in grand style, Minkowski's lecture appears to have struck a chord, generating a reaction that was phenomenal in terms of sheer publication numbers and disciplinary breadth.

Historians have naturally sought to explain this burst of interest in relativity theory. According to one current of thought, Minkowski added nothing of substance to Einstein's theory of relativity, but expressed relativist ideas more forcefully and memorably than Einstein.[2] . It has also been suggested that Minkowski supplied a mathematical imprimatur to relativity theory, thereby reassuring those who had doubted its internal coherence.[3] A third explanation claims that Minkowski's explicit appeal to "pre-established harmony" between pure mathematics and physics resonated with Wilhelmine scientists and philosophers, just when such Leibnizian ideas were undergoing a revival in philosophical circles.[4]

The lack of historical consensus on the reasons for the sharp post-1908 upswing in the fortunes of special relativity reflects, to a certain extent, the varied, conflicting accounts provided by the historical actors themselves.[5] A focus on the disciplinary reception of Minkowski's theory, however, shows a common concern over the adequacy of Euclidean geometry for the foundations of physics. Much of the excitement generated by Minkowski's Cologne lecture among scientists and philosophers arose from an idea that was scandalous when announced on September 21, 1908, but which was soon assimilated, first by theorists and then by the scientific community at large: Euclidean geometry was no longer adequate to the task of describing physical reality, and had to be replaced by the geometry of a four-dimensional space Minkowski named the "world" (*Welt*).

The scandalous nature of spacetime is brought into focus first by examining the situation of physical geometry at the time of Minkowski's first lecture on relativity in 1907, and then by following the evolution of his definition of the "world" in his writings on relativity. For the sake of concision, these preliminary observations are omitted here, in favour of a few examples of the reaction sustained by Minkowski's radical world view on the part of a few of his most capable readers in physics.[6]

The published version of "Raum und Zeit" sparked an explosion of publications in relativity theory, with the number of papers on relativity tripling between 1908 (32 papers) and 1910 (95 papers).[7] This sudden upswing in the interest is clearly a complex historical phenomenon requiring careful study, for the theory of relativity carried different meaning for different observers.[8] While Minkowski's spacetime theory is conceptually and formally distinct from Einstein's special relativity theory and the Lorentz-Poincaré relativity theory, the history of its reception is similarly polysemous. For example, a disciplinary analysis of the reception of Minkowski's Cologne lecture reveals a overwhelmingly positive response on the part of mathematicians, and a decidedly mixed reaction on the part of physicists.[9] A close examination of the physicists' response to Minkowski's lecture shows that what they objected to above all in Minkowski's view was the idea that Euclidean space was no longer adequate for understanding physical phenomena. The range of response among physicists to Minkowski's attack on Euclidean space, we will see here, went fairly smoothly from cognitive shock and outright denial, on one end, to unreserved enthusiasm and collaborative extension on the other end.

Among the physicists shocked by Minkowski's spacetime theory was Danzig's Max Wien, an experimental physicist. In a letter to the Munich theoretical physicist Arnold Sommerfeld, Max Wien described his experience reading Minkowski's Cologne lecture as provoking "a slight brain-shiver, now space and time appear conglomerated together in a gray, miserable chaos".[10] His cousin Willy Wien, director of the Würzburg Physical Institute and co-editor of *Annalen der Physik*, was shocked, too, but it wasn't the loss of Euclidean space that bothered him so much as Minkowski's claim that circumstances forced spacetime geometry on physicists. The entire Minkowskian system, Wien said in a 1909 lecture, "evokes the conviction that the facts would have to join it as a fully internal consequence." Wien would have none of this, as he felt that the touchstone of physics was experiment, not abstract mathematical deduction. "For the physicist," Wien concluded his lecture, "Nature alone must make the final decision".[11]

On the opposite end of the spectrum of response to Minkowski's attack on Euclidean space, Max Born and Arnold Sommerfeld saw in Minkowski spacetime the future of theoretical physics. Both men had close ties to Minkowski, and upon the latter's untimely death on 12 January 1909, each took up the cause of promoting a spacetime approach to physics. In a crucial contribution to Minkowski's program, Sommerfeld transformed Minkowski's unorthodox matrix calculus into a four-dimensional vector algebra and analysis,[12] based on the notational conventions he had introduced in 1904 as editor of the physics volumes of Felix Klein's monumental *Encyclopedia of Mathematical Sciences Including Applications*. Sommerfeld's streamlined spacetime formalism was taken over and extended by Max Laue, then working in Sommerfeld's institute in Munich, for use in the first German textbook on relativity theory.[13] Laue's textbook was hugely successful, and effectively established the Sommerfeld-Laue formalism as the standard for research in relativity physics.

Sommerfeld insisted upon the simplification afforded to calculation by the adoption of a spacetime approach, and left aside Minkowski's philosophical interpretation of spacetime, with one exception. In the introduction to his 1910 reformulation of Minkowski's matrix calculus, Sommerfeld echoed Minkowski's belief that absolute space should vanish from physics, to be replaced by the "absolute world" of Minkowski spacetime.[14] This exchange of absolutes, Euclidean 3-space for Minkowski spacetime, was clearly designed to calm physicists shocked by Minkowski's high-handed dismissal of Euclidean space as the frame adequate for understanding physical phenomena.

Between the extremes represented by the responses of Max Wien and Arnold Sommerfeld emerged the mainstream response to Minkowski's interpretation. The latter is well represented by remarks expressed by Max Laue in his influential relativity textbook, mentioned above. Laue considered Minkowski spacetime as an "almost indispensable resource" for precise mathematical operations in relativity.[15] He expressed reservations, however, about Minkowski's philosophy, in that the geometrical interpretation (or "analogy") of the Lorentz transformation called upon a space of four dimensions. One could avail oneself of the new four-dimensional formalism, Laue assured his readers, even if one was not blessed with Minkowski's spacetime-intuition, and without committing oneself to the existence of Minkowski's four-dimensional world.

By disengaging Minkowski's spacetime ontology from the Sommerfeld-Laue spacetime calculus, Laue cleared the way for the acceptance by physicists of his tensor calculus, and of spacetime geometry in general. A detailed study of the reception of Minkowski's ideas on relativity has yet to be realized, but anecdotal evidence points to a change in attitudes toward Minkowski's spacetime view in the 1950s. For example, in the sixth edition of Laue's textbook, celebrating the fiftieth anniversary of relativity theory, and marking the end of Einstein's life, its author still felt the need to warn physicists away from Minkowski's scandalous claim in Cologne that space and time form a unity. As if in defiance of Laue, this particular view of Minkowski's ("Von Stund' an …") was soon cited (in the original German) on the title page of a rival textbook on special relativity.[16] In Laue's opinion, however, Minkowski's most famous phrase remained an "exaggeration".[17]

Minkowski's carefully-crafted Cologne lecture shocked scientists' sensibilities, in sharp contrast to all previous writings on relativity, including his own. The author of "Raum and Zeit" famously characterized his intuitions (*Anschauungen*) of space and time as grounded in experimental physics, and radical in nature. Predictably, his lecture created a scandal for physicists in its day, but unlike most scandals, it did not fade away with the next provocation. Instead, Minkowski focused attention on how mathematics structures our understanding of the physical universe, in a way no other writer had done since Riemann, or has managed to do since, paving the way for acceptance of even more visually-unintuitive theories to come in the early twentieth century, including general relativity and quantum mechanics. Minkowski's provocation of physicists in Cologne, his rejection of existing referents of time, space, and geometry, and his appeal to subjective intuition to describe external reality may certainly be detached from Minkowski geometry, as Laue and others wished, but not if we want to understand the explosion of interest in relativity theory in 1909.

Notes

[1]Hermann Minkowski, 'Die Grundgleichungen für die electromagnetischen Vorgänge in bewegten Körpern.' *Nachrichten von der Königlichen Gesellschaft der Wissenschaften zu Göttingen*, pp. 53

– 111, 1908.

[2]Gerald Holton, 'The metaphor of space-time events in science.' *Eranos Jahrbuch*, 34: 33 – 78, 1965.
Tetu Hirosige, 'Theory of relativity and the ether.' *Japanese Studies in the History of Science*, 7: 37 – 53, 1968.

[3]József Illy, 'Revolutions in a revolution.' *Studies in History and Philosophy of Science*, 12: 173 – 210, 1981.

[4]Lewis Pyenson, *The Young Einstein: The Advent of Relativity*. Adam Hilger, Bristol, 1985.

[5]Richard Staley, 'On the histories of relativity: propagation and elaboration of relativity theory in participant histories in Germany, 1905–1911.' *Isis*, 89:263–299, 1998.

[6]For an expanded version of this narrative see: Scott Walter, 'Minkowski's modern world.' In Vesselin Petkov, editor, *Minkowski Spacetime: A Hundred Years Later*. Springer, Berlin, in press.

[7]Scott Walter, 'Minkowski, mathematicians, and the mathematical theory of relativity.' In Hubert Goenner, Jürgen Renn, Tilman Sauer, and Jim Ritter, editors, *The Expanding Worlds of General Relativity*, volume 7 of *Einstein Studies*, pp. 45 – 86. Birkhäuser, Boston/Basel, 1999.

[8]Klaus Hentschel, *Interpretationen und Fehlinterpretationen der speziellen und der allgemeinen Relativitätstheorie durch Zeitgenossen Albert Einsteins*. Birkhäuser, Basel, 1990.

[9]Scott Walter, 'Minkowski, mathematicians, and the mathematical theory of relativity.' In Hubert Goenner, Jürgen Renn, Tilman Sauer, and Jim Ritter, editors, *The Expanding Worlds of General Relativity*, volume 7 of *Einstein Studies*, pp. 45 – 86. Birkhäuser, Boston/Basel, 1999.

[10]Ulrich Benz, *Arnold Sommerfeld: Lehrer und Forscher an der Schwelle zum Atomzeitalter, 1868–1951*. Wissenschaftliche Verlagsgesellschaft, Stuttgart, 1975, p. 71

[11]Scott Walter, 'The non-Euclidean style of Minkowskian relativity.' In Jeremy Gray, editor, *The Symbolic Universe: Geometry and Physics, 1890–1930*, pp. 91 – 127. Oxford University Press, Oxford, 1999.

[12]Arnold Sommerfeld, 'Zur Relativitätstheorie, I: Vierdimensionale Vektoralgebra.' *Annalen der Physik*, 32: 749 – 776, 1910,
Arnold Sommerfeld, 'Zur Relativitätstheorie, II: Vierdimensionale Vektoranalysis.' *Annalen der Physik*, 33:649–689, 1910.

[13]Max von Laue, *Das Relativitätsprinzip*. Vieweg, Braunschweig, 1911.

[14]Arnold Sommerfeld, 'Zur Relativitätstheorie, I: Vierdimensionale Vektoralgebra.' *Annalen der Physik*, 32:749–776, 1910, p. 749

[15]Max von Laue, *Das Relativitätsprinzip*. Vieweg, Braunschweig, 1911, p. 46

[16]John Lighton Synge, *Relativity: The Special Theory*. North-Holland, Amsterdam, 1956.

[17]Max von Laue, *Die Relativitätstheorie: die spezielle Relativitätstheorie*. Vieweg, Braunschweig, 6th edition, 1955, p. 60

Hyperbolic Dynamical Systems at the ESI in 2008

Domokos Szász

Depending on their fundamental behaviours, dynamical systems can be classified as 'stable' or 'unstable'. Basic examples of stable systems are the mathematical pendulum or the solar system with periodic or quasi-periodic motions (cf. KAM-theory). Unstable behaviour is strongly connected to non-vanishing of Lyapunov exponents, to sensitivity to initial conditions, and to stochastic or chaotic behaviour. Basic examples of unstable systems are particle systems (e. g. those of hard balls) giving rise to statistical mechanics, or hydrodynamic equations giving rise to turbulence.

Technically speaking, for the map which describes the transition of the system from time zero to time one, hyperbolicity means that the spectrum of the linearized map has no eigenvalue on the unit circle. Hyperbolicity is most easily detected if this condition also holds for all iterates of the map, i.e., for the transitions of the system from time zero to time n for every $n \geq 1$.

In 1996, Philippe Choquard, Carlangelo Liverani, Harald Posch and myself organized the semester *Hyperbolic Systems with Singularities* at the ESI. Though billiard systems, hard ball systems, etc. were among our top interests, the name of the semester was different and chosen with the following idea back in our minds. We intended to go beyond billiard-like systems, we wanted to understand them primarily as examples of hyperbolic systems with singularities. The hope was that this wider framework would help to better understand billiard-like systems. The semester was most successful, with many exciting results in the seminars, discussions and in subsequent preprints.

Let me point out here only one result, Lai Sang Young's tower construction, for two reasons. Firstly, the title of her paper — probably accidentally — was *Statistical Properties of Hyperbolic Systems with Singularities* thus containing the same 'terminus technicus' as the name of the semester. (Her paper was ESI preprint No. 445 and appeared in 1998 in Annals of Mathematics). The second reason is that the — in my view — most sensational result of that paper, the exponential decay of correlations for planar finite horizon Sinai billiards, was proved exactly by using the advantage of considering billiards from this broader perspective, as hyperbolic systems with singularities. In this way, part of her tools and ideas were borrowed from methods worked out for the Hénon map, for unimodal maps of the interval, etc. Since then billiard methods are getting better and better embedded into the theory of hyperbolic dynamical systems. It is worth pointing out that before Young's work, for the same class of billiards, stretched exponential decay had already been known (Bunimovich-Sinai, 1981, Bunimovich-Chernov-Sinai, 1991) and this weaker property was still sufficient to establish the CLT (central limit theorem), for instance. However, for the derivation of finer stochastic properties (e. g. the local version of CLT, Szász-Varjú, 2004) this weaker property was not sufficient and for obtaining them it seems to have been necessary to go down to the tower construction itself.

This time the name of the programme is not very original: *Hyperbolic Systems with Singularities*, organized by Harald Posch, Lai Sang Young and myself. The fact that physicists have been among the organizers (Harald Posch both times and Philippe Choquard in 1996) reflects the fact that the topic is central to both mathematics and physics. Furthermore the composition of a mixed audience has the absolute advantage that both mathematical and physical theories can gain a lot from the interaction of the communities involved.

The duration of the programme is rather short: six weeks altogether. By using the abbreviation $Wn, n = 1, 2, ..., 6$ for the 6 weeks of the programme, the structure of the semester is the following. W2 - W5 are the central parts of the program. During W2 and W5 there will be two workshops. W2 (June 2-6) will be focused on nonequilibrium systems and was organized essentially by Harald Posch with the assistance of the co-organizers. The talks and the discussions will concentrate on four major topics:

- Hamiltonian systems: low-dimensional particle systems
- Hamiltonian systems: anharmonic chains and coupled maps
- Stochastic systems
- Open quantum systems

In the last decade these problems have been in the focus of attention equally of mathematicians and physicists. To mention just one fundamental problem, to which the

community of mathematical physicists has been returning regularly: Fourier's law of heat conduction. The aim is to describe it for more and more realistic physical systems from possibly purely microscopic, Newtonian assumptions on the dynamics. Now there is a hope that we can make a big step toward this goal. The list of the speakers in W2 is impressive: Benettin, Eckmann, Gaspard, Jacquet, Jona-Lasinio, Mukamel, Pillet, Politi, Presutti, Rey-Bellet, Rondoni, Ruelle, Sanders, Schlein, Vulpiani, Young. It is not a great risk to bet that the lectures (in average three talks a day) and the discussions of that week will provide new insight into this mainstream area.

W3 and W4 will have a special structure. During each of them we organize 3 minicourses consisting three one-hour lectures each. Thus there will be 6 minicourses altogether. As mentioned before, Young's tower construction proved to be a powerful and widely applicable method for treating stochastic properties of hyperbolic systems both with and without singularities. Since 1998, other concurrent methods have also appeared. The principle for the selection of the topics and the speakers of 5 minicourses by Baladi, Bálint-Tóth, Chernov, Dolgopyat and Liverani was that the audience should be able to see and compare the concurrent methods side by side. In the last years Baladi and Liverani (and also Keller, see W5) have been perhaps the main protagonists in Banach-space/transfer-operator methods. On the other hand Chernov and Dolgopyat have developed and applied in various contexts most successfully the, I would call, geometric tools, like growth lemmas, coupling lemmas, etc. In my understanding an advantage of their approach is that it is robust (I can, of course, imagine that after the other minicourse series we will see that the other methods also have this feature).

Finally, Bálint and Tóth could extend Young's tower construction to the multidimensional case (admittedly under a geometric assumption ensuring the fulfilment of Young's complexity condition; it is expected to hold for typical multidimensional finite horizon Sinai billiards, at least) and they will report about this exciting development. The odd (wo)man out is the minicourse given by Amie Wilkinson. Her topic is stable ergodicity, a bit, but not very far, away from the subject of the previous talks. The methods are often related, and more importantly, many galvanizing results have been reached in the last decade in this area.

During W3 (June 9-13) and W4 (June 16-20) the days of minicourse lecture series will be Monday, Wednesday and Friday. On Tuesdays and Thursdays there will be a limited number of seminar talks (60 minutes) and reports (30 minutes). The programme is in preparation, therefore here I only list the names of the planned speakers:

W3 Gilbert, Haydn, Hu, Kifer, Lenci, Pesin;
W4 de Simoi, Wright.

In 1996 during our semester the first general result for hard ball systems was under preparation: a hard ball system consisting of an arbitrary number of particles in arbitrary dimension is hyperbolic for typical collection of masses and radii (the corresponding paper of Simányi and Szász appeared in Annals of Mathematics in 1999, ESI preprint No. 436). Since then Simányi has got closer and closer to establishing the Boltzmann-Sinai ergodic hypothesis. This is very recent: he has a manuscript completing the proof of this celebrated conjecture. During W4 two seminars will be devoted to the methods of his recent remarkable work.

The topic of the W5 (June 23-27) workshop is general: hyperbolic dynamical systems. Again, four speakers were requested to deliver two lectures each: Keller will talk about *Banach space methods for coupled map lattices*, Li about his recent results, joint with Yasha Sinai, on the *Navier-Stokes equation*, Marklof about his recent results, joint with Strombergsson, on the *Boltzmann-Grad limit for the periodic 2-D Lorentz gas*, and Lanford on a topic not yet specified. Other speakers during W5 will be: Alves, Bachurin, van Beijeren, Bunimovich, Demers, Gentile, Gorodetsky, Gouezel, Kaloshin, Klages, Koiller, Ledrappier, Markarian, Melbourne, Ott, Pene, Pollicott, Stoyanov, Torok, Varjú, Wojtkowski, Yarmola.

The programmes of W1 (May 26-30) and W6 (June 30-July 4) will be organized spontaneously, on the spot. For completeness, let me list the names of those participants not mentioned above: Barra, Bonetto, Bufetov, Collet, Giulietti, Howard, Khanin, Kupiainen, Lin, Mihalescu, Stenlund, Tsujii, Zaslavsky, Zhang. From this list it is evident that for these 'more modest' weeks we will also have excellent people for discussions and seminars.

In 1996 an important component of the success of our semester was the excellent place and atmosphere provided by ESI (and the city of Vienna) for our activity. With more space and the enhanced infrastructure in mind we can be sure that this will happen the same way this year, too. In the name of the organizers I want to express our sincere gratitude a) to the directorate and administration of ESI for solving all technical problems, in particular those occurring due to the fact that the European Soccer Cup will take place in Vienna during our semester, b) to Inge Posch designing the original home page of the semester; c) and — last but not the least — to Péter Bálint and Imre Péter Tóth for helping them in organizing the scientific programme (and regularly keeping the home page updated).

Scientific activities at the ESI since 1992/93

2008

Main Programmes

Combinatorics and Statistical Physics (M. Drmota, C. Krattenthaler, B. Nienhuis, M. Bousquet-Mélou), February 1 - June 15, 2008

Metastability and Rare Events in Complex Systems (C. Dellago, P. Bolhuis, E. Vanden Eijnden), February 1 - April 30, 2008

Hyperbolic Dynamical Systems (L.-S. Young, H. Posch, D. Szasz), May 25 - July 5, 2008

Operator Algebras and Conformal Field Theory (Y. Kawahigashi, R. Longo, K.-H. Rehren, J. Yngvason), August 25 - December 14, 2008

Workshops organized outside the Main Programmes

28th Winter school in geometry and physics, Srni (Czech Republic), January 12 - 19, 2008 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings will appear in Arch. Math. (Brno)

Workshop "Tensor network methods and entanglement in quantum many-body systems (F. Verstraete, G. Vidal, M. Wolf), January 16-18, 2008

Workshop on "Intermetallics" (J. Hafner), January 23 - January 24, 2008

ESI - 15th Anniversary Celebration (W. L. Reiter, K. Schmidt, J. Schwermer, J. Yngvason), April 14, 2008

Frontiers in Mathematical Biology (R. Bürger, J. Hermisson), April 14 - April 18, 2008

Symposium on the 65th birthday of Hans Lischka (A. Aquino, K. Wolschann), July 3 - July 4, 2008

Summer School on "Combinatorics and Statistical Physics" (M. Drmota, C. Krattenthaler, B. Nienhuis, M. Bousquet-Mélou), July 7 - July 18, 2008

Topics in Mathematical Physics (C. Hainzl, R. Seiringer, J. Yngvason), July 21 - July 31, 2008 (R. Beig), August 20 - August 21, 2008

Mathematical Challenges in String Phenomenology (R. Blumenhagen, M. Douglas, M. Kreuzer, E. Scheidegger), October 5 - October 19, 2008

Structural Probability (V. Kaimanovich, K. Schmidt), November 2 - November 16, 2008

Profinite Groups (F. Grunewald, W. Herfort, P.A. Zalesski), December 7 - December 20, 2008

2007

Main Programmes

Langlands Duality and Physics (E. Frenkel, N. Hitchin, J. Schwermer, K. Vilonen), January 9 - January 20, 2007

Automorphic Forms, Geometry and Arithmetic (S.S. Kudla, M. Rapoport, J. Schwermer), February 11 - February 24, 2007

Amenability (A. Erschler, V. Kaimanovich, K. Schmidt), February 26 - July 31, 2007

Mathematical and Physical Aspects of Perturbative Approaches to Quantum Field Theory (R. Brunetti, K. Fredenhagen, D. Kreimer, J. Yngvason), March 1 - April 30, 2007

Poisson Sigma Models, Lie Algebroids, Deformations, and Higher Analogues (H. Bursztyn, H. Grosse, T. Strobl), August 1 - September 20, 2007

Applications of the Renormalization Group (H. Grosse, G. Gentile, G. Huisken, V. Mastropietro), October 15 - November 23, 2007

Workshops organized outside the Main Programmes

27th Winter school in geometry and physics, Srni (Czech Republic), January 13 - 20, 2007 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings will appear in Arch. Math. (Brno), 43, No. 5 (2007)

Lieb-Robinson Bounds and Applications (F. Verstraete, J. Yngvason), February 20 - February 24, 2007

Deterministic Dynamics meets Stochastic Dynamics (C. Dellago, P. Hänggi, H. Kauffmann, H. Posch), April 18 - April 20, 2007

Thirringfest (W.L. Reiter, K. Schmidt, J. Schwermer, J. Yngvason), May 15, 2007

Theory meets Industry (J. Hafner), June 11 - June 14, 2007

Central European Joint Programme of Doctoral Studies in Theoretical Physics (H. Grosse, H. Hüffel, J. Yngvason), September 24 - 28, 2007

Spectra of arithmetic groups (J. Schwermer), October 7 - October 13, 2007

ESF workshop on Noncommutative Quantum Field Theory (H. Grosse), November 26 - November 30, 2007

4th Vienna Central European Seminar on Particle Physics and Quantum Field Theory (H. Hüffel), November 30 - December 2, 2007

Miniworkshop on Ergodic Theory and von Neumann Algebras (K. Schmidt), December 3-14, 2007

Spectral Theory and Schrödinger Operators (T. Hoffmann-Ostenhof, A. Laptev), December 10-21, 2007

Ergodic Theory, Limit Theorems and Dimensions (F. Hofbauer, R. Zweimüller), December 17-21, 2007

2006

Main Programmes

Arithmetic Algebraic Geometry (S.S. Kudla, M. Rapoport, J. Schwermer), January 2 - February 18, 2006

Diophantine Approximation and Heights (D. Masser, H.P. Schlickewei), February 27 - May 12, 2006

Rigidity and Flexibility (V. Alexandrov, I. Sabitov, H. Stachel), April 23 - May 6, 2006

Gerbes, Groupoids, and Quantum Field Theory (P. Aschieri, H. Grosse, B. Jurco, J. Mickelsson, P. Xu), May 8 - July 31, 2006

Complex Quantum and Classical Systems and Effective Equations (E. Carlen, L. Erdős, M. Loss), May 15 - August 15, 2006

Homological Mirror Symmetry (A. Kapustin, M. Kreuzer, A. Polishchuk, K.-G. Schlesinger), June 12 - June 28, 2006

Global Optimization, Integrating Convexity, Optimization, Logic Programming, and Computational Algebraic Geometry (F. Benhamou, I. Bomze, I. Emiris, C. Floudas, A. Neumaier, L. Wolsey), October 1 - December 23, 2006

Workshops organized outside the Main Programmes

26th Winter school in geometry and physics, Srni (Czech Republic), January 14 - 21, 2006 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Arch. Math. (Brno), 42 Suppl. 1-327.

Aspects of Spectral Theory (M. Baake, W. Kirsch, and K. Schmidt), January 15 - January 19, 2006

Meeting of the EU-Network "Analysis of Large Quantum Systems" (J. Yngvason), March 4 - March 5, 2006

RDSES - Educational Workshop on Discrete Probability (V. Kaimanovich, K. Schmidt, W. Woess), March 12 - March 25, 2006

International Symposium on Boltzmann's Legacy (G. Gallavotti, A. Kupiainen, W.L. Reiter, K. Schmidt, J. Schwermer, J. Yngvason), June 7 - June 9, 2006

Complex Analysis, Operator Theory and Applications to Mathematical Physics (F. Haslinger, E. Straube, H. Upmeier), October 1 - October 15, 2006 and November 6 - November 17, 2006

Seminar Sophus Lie (D. Burde, P.W. Michor, W.A.F. Ruppert), November 3 - November 4, 2006

Modern Methods of Time-Frequency Analysis (H.G. Feichtinger and K. Gröchenig), November 20 - November 24, 2006

Quantum Statistics (K. Audenaert, F. Verstraete and M. Wolf), November 27 - December 1, 2006

3rd Vienna Central European Seminar on Particle Physics and Quantum Field Theory (H. Hüffel), December 1 - December 3, 2006

Causes of Ecological and Genetic Diversity (R. Bürger, U. Dieckmann), December 11 - December 16, 2006

2005

Main Programmes

Open Quantum Systems (J. Derezinski, G.M. Graf, J. Yngvason), January 20 - March 31, 2005

Modern Methods of Time-Frequency Analysis (J.J. Benedetto, H.G. Feichtinger, K. Gröchenig), April 4 - July 8, 2005

Geometric Methods in Analysis and Probability (J. Cooper, P.W. Jones, V. Milman, P. Müller, A. Pajor, D. Preiss, C. Schütt, C. Stegall), May 25 - August 5, 2005

Complex Analysis, Operator Theory and Applications to Mathematical Physics (F. Haslinger, E. Straube, H. Upmeier), September 5 - November 11, 2005

Geometry of Pseudo-Riemannian Manifolds with Applications in Physics (D. Alekseevsky, H. Baum, J. Konderak), September 1 - December 31, 2005

Workshops organized outside the Main Programmes

25th Winter school in geometry and physics, Srni (Czech Republic), January 15 - 22, 2005 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 79 (2006) 1-192.

Singularity Formation in Non-linear Evolution Equations (P. Bizon, P.C. Aichelburg), May 9 - May 22, 2005

Summer School on "Vertex Algebras and Related Topics" (E. Frenkel, V. Kac, J. Schwermer), June 12 - July 2, 2005

The Interaction of Mathematics and Physics at the Turn of the Twentieth Century (D. D. Fenster, J. Schwermer), February 10 - June 30, 2005

Geometric Aspects of Spectral Theory (M. van den Berg, L. Friedlander, T. Hoffmann-Ostenhof), Matrei, July 2 - July 12, 2005

String Theory in Curved backgrounds and Boundary Conformal Field Theory (H. Grosse, A. Recknagel, V. Schomerus), November 3 - November 10, 2005

2nd Vienna Central European Seminar on Particle Physics and Quantum Field Theory (H. Hüffel), November 25 - November 27, 2005

Bose-Einstein Condensation and Quantum Information (H. Grosse, E.H. Lieb, W. Thirring, P. Zoller), December 17 - December 20, 2005

2004

Main Programmes

Geometric and analytic problems related to Cartan connections (T. Branson, A. Cap, J. Slovak), January 2 - April 20, 2004

String Theory in Curved Backgrounds and Boundary Conformal Field Theory (H. Grosse, A. Recknagel, V. Schomerus), March 1 - June 30, 2004

Tensor categories in Mathematics and Physics (J. Fuchs, Y.-Z. Huang, A. Kirillov, M. Kreuzer, J. Lepowsky, C. Schweigert), May 31 - July 9, 2004

Singularity Formation in Non-linear Evolution Equations (P.C. Aichelburg, P. Bizon), July 7 - August 15, 2004

Many-Body Quantum Theory (M. Salmhofer, J. Yngvason), September 1 - December 31, 2004

Workshops organized outside the Main Programmes

Seminar Sophus Lie (P.W. Michor, W.A.F. Ruppert), January 9 - January 10, 2004

24nd Winter school in geometry and physics, Srni (Czech Republic), January 17 - January 24, 2004 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser.75 (2005), 1-356

Ludwig Faddeev Conference (A. Alekseev, N. Reshetikhin), March 22 - March 26, 2004

Summer School on "Nonlinear Wave Equations" (Y. Brenier, S. Klainerman, N. Mauser, A. Selberg), July 7 - July 14, 2004

Workshop on Penrose Inequalities (R. Beig, P. Chrusciel, W. Simon), July 26 - August 7, 2004

Workshop on Stochastic and Deterministic Dynamics in Equilibrium and Nonequilibrium Systems (C. Dellago, H. Posch), August 25 - August 28, 2004

Workshop on Stochastic processes from physics and biology (A. Wakolbinger), November 26 - November 27, 2004

1st Vienna Central European Seminar on Particle Physics and Quantum Field Theory (H. Hüffel), November 26 - November 28, 2004

Workshop on Automorphic Representations (J. Schwermer), December 6 - December 9, 2004

2003

Main Programmes

Mathematical population genetics and statistical physics (E. Baake, M. Baake and R. Bürger), December 1, 2002 - February 28, 2003

Kakeya-related problems in analysis (A. Iosevich, I. Laba, D. Müller), February 15 - April 15, 2003

Penrose inequalities (R. Beig, P. Chrusciel, W. Simon), June 2 - July 29, 2003

Poisson Geometry and Moment Maps (A. Alekseev, T. Ratiu, H. Haller, P.W. Michor), August 1 - October 15, 2003

Gravity in Two Dimensions (W. Kummer, H. Nicolai, D.V. Vassilevich), September 8 - October 31, 2003

Workshops organized outside the Main Programmes

23nd Winter school in geometry and physics, Srni (Czech Republic), January 18 - January 25, 2003 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 72 (2004)

Idempotent Mathematics and Mathematical Physics (G. Litvinov, V. Maslov), February 2 - February 10, 2003

Entanglement and Decoherence of Complex Quantum Systems (M. Arndt, G. Kurizki, S. Stenholm, A. Zeilinger), September 5 - September 7, 2003

Conference on Diophantine Approximation in celebration of Wolfgang Schmidt's 70th birthday (H.P. Schlickewei, K. Schmidt, R. Tichy), October 6 - October 10, 2003

Mathematical Analysis of Large Quantum Systems (J. Yngvason), December 6 - December 7, 2003

2002

Main Programmes

Developed turbulence (K. Gawedzki, A. Kupiainen, M. Vergassola), May 15 - July 14, 2002

Arithmetic, automata, and asymptotics (R. Tichy, P. Grabner), spring 2002

Quantum field theory on curved space time (K. Fredenhagen, R. Wald, J. Yngvason), July 1 - August 31, 2002

Aspects of foliation theory in geometry, topology and physics (J. Glazebrook, F. Kamber, K. Richardson), July 15 - December 31, 2002

Noncommutative geometry and quantum field theory, Feynman diagrams in mathematics and physics (H. Grosse, J. Madore, D. Kreimer, J. Mickelsson, I. Todorov), August 26 - November 22, 2002

Workshops organized outside the Main Programmes

22nd Winter school in geometry and physics, Srni (Czech Republic), January 12 - January 19, 2002 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 71 (2003), 3–207

Arithmetic Groups and Automorphic Forms (J. Schwermer), January 27 - February 2, 2002

Stability Matters (T. Hoffmann-Ostenhof, H. Grosse, H. Narnhofer, K. Schmidt, W. Thirring, J. Yngvason), July 28 - August 2, 2002

2001

Main Programmes

Scattering Theory (V. Petkov,A. Vasy,M. Zworski), March 1 - July 31, 2001

Random Walks (V. Kaimanovich, K. Schmidt, W. Woess), February 15 - July 15, 2001

Mathematical Cosmology (P.C. Aichelburg, G.F.R. Ellis, V. Moncrief, J. Wainwright), June 15 - August 15, 2001

Mathematical Aspects of String Theory (M. Blau, J. Figueroa O'Farrill, A. Schwarz), September 3 - November 16, 2001

Nonlinear Schrödinger and Quantum Boltzmann Equations (P. Gerard, P. Markowich, N.J. Mauser, G. Papanicolau), fall 2001

Workshops organized outside the Main Programmes

21st Winter school in geometry and physics, Srni (Czech Republic), January 13 - January 20, 2001 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 69 (2002) 3-254.

75 Jahre Schrödinger-Gleichung (W.L. Reiter, J. Yngvason), March 28, May 9, May 10, 2001

2000

Main Programmes

Duality, String Theory and M-Theory (H. Grosse, M. Kreuzer, S. Theisen), March 15 - July 15, 2000

Representation Theory (V. Kac, A. Kirillov), April 1 - July 31, 2000

Confinement (W. Lucha, A. Martin, F. Schöberl), May 1 - June 30, 2000

Algebraic Groups, Invariant Theory, and Applications (B. Kostant, P.W. Michor, F. Pauer, V. Popov), August 1 - December 29, 2000

Quantum Measurement and Information (A. Zeilinger, A. Eckert, P. Zoller), September 1 - December 20, 2000

Workshops organized outside the Main Programmes

20th Winter school in geometry and physics, Srni (Czech Republic), January 14 - January 21, 2000 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 66 (2001) 7-218

Wolfgang Pauli und die Physik des 20. Jahrhunderts (W.L. Reiter, A. Zeilinger), April 12 - April 13, 2000

1999

Main Programmes

Functional Analysis (J.B. Cooper), January 1 - July 31, 1999

Nonequilibrium Statistical Mechanics (G. Gallavotti, H. Posch, H. Spohn), February 1 - March 31, 1999

Holonomy Groups in Differential Geometry (D. Alekseevsky, K. Galicki, C. LeBrun), fall 1999

Complex Analysis (F. Haslinger, H. Upmeier), August 1 - November 15, 1999

Applications of Integrability (A. Alekseev, L. Faddeev, H. Grosse), August 15 - October 31, 1999

Workshops organized outside the Main Programmes

19th Winter school in geometry and physics, Srni (Czech Republic), January 9 - January 16, 1999 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 63 (2000) 7-196

Workshop "Geometrical aspects of scattering theory (T. Hoffmann-Ostenhof), Matrei, July 5 - July 12, 1999

1998

Main Programmes

Spectral Geometry and its Applications (L. Friedlander, V. Guillemin), February 1 - June 30, 1998

Schrödinger Operators with magnetic Fields (I. Herbst, T. Hofmann-Ostenhof, J. Yngvason), March 1 - June 30, 1998

Number Theory and physics I. Convexity (P.M. Gruber), September - December, 1998

Number Theory and Physics II. Quantum Field Theory and the Statistical Distribution of Prime Numbers (I. Todorov), September 1 - November 30, 1998

Quantization, generalized BRS Cohomology and Anomalies (R.A. Bertlmann, M. Kreuzer, W. Kummer, A. Rebhan, M. Schweda), September 28 - December 31, 1998

Charged Particle Kinetics (C. Schmeisser, P. Markowich), October 5, 1998 - January 31, 1999

Workshops organized outside the Main Programmes

18th Winter school in geometry and physics, Srni (Czech Republic), January 10 - January 17, 1998 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 59 (2000) 7-228

Epistemological and Experimental Perspectives on Quantum Physics (D. Greenberger, W.L. Reiter, A. Zeilinger), September 3 - September 6, 1998

Classification of Filtrations of Stochastic Processes (W. Schachermayer, K. Schmidt), November 30 - December 4, 1998

1997

Main Programmes

Ergodic Theory and Dynamical Systems (A. Katok, K. Schmidt, G. Margulis), January 1 - August 30, 1997

Mathematic Relativity (R. Beig), January 1 - June 30, 1997

Spaces of Geodesics and Complex Structures in General Relativity and Differential Geometry (L. Mason, P. Nurwoski, H. Urbantke), March 1 - July 31, 1997

Nonlinear Therory of Generalized Functions (M. Oberguggenberger, M. Kunzinger, M. Grosser), September 29 - October 4, 1997

Local Quantum Physics (D. Buchholz, H. Narnhofer, J. Yngvason), September 29 - October 4, 1997

Workshops organized outside the Main Programmes

17th Winter school in geometry and physics, Srni (Czech Republic), January 11 - January 18, 1997 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 54 (1998) 13-124

Formal power series and algebraic combinatorics 97 (C. Krattenthaler), July 14 - 18, 1997

1996

Main Programmes

Condensed Matter Physics - Dynamics, Geometry and Spectral Theory (V. Bach, R. Seiler), August 6, 1995 - February 24, 1996

Topological, conformal and integrable Field Theory (K. Gawedzki, H. Grosse), February 15 - May 14, 1996

Representation Theory with Applications to Mathematical Physics (I. Penkov, J.A. Wolf), April 1 - June 30, 1996

Mathematical Problems of Quantum Gravity (A. Ashtekhar, P. Aichelburg), July 1 - August 31, 1996

Hyperbolic Dynamical Systems with Singularities (D. Szasz), September 1 - December 31, 1996

Workshops organized outside the Main Programmes

16th Winter school in geometry and physics, Srni (Czech Republic), January 14 - January 21, 1996 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 46 (1997) 9-176

Aspects of Spectral Theory (M. Hoffmann-Ostenhof, T. Hoffmann-Ostenhof, H. Langer, R. Mennicken), July 15 - July 18, 1996, Satellite conference of the European Mathematical Congress

Statistical mechanics as a branch of probability theory September 16 - 20, 1996

The changing Metaphysics of Science organized jointly with the "Internationales Institut für Kulturwissenschaften in Wien"

1995

Main Programmes

Complex Analysis (F. Haslinger), January 1 - March 31, 1995

Noncommutative Differential Geometry (A. Connes, M. Dubois-Voilette, P.W. Michor), spring 1995

Field Theory and Differential Geometry (G. Marmo, P.W. Michor), May 15 - July 31, 1995

Geometry of Nonlinear Partial differential Equations (A. Vinogradov), spring 1995

Gibbs Random Fields and Phase Transitions (R. Dobrushin, R. Kozecky), fall 1995

Reaction-Diffusion Equations in Biological Context (K. Sigmund, R. Bürger, J. Hofbauer), September 1 - November 15, 1995

Condensed Matter Physics - Dynamics, Geometry and Spectral Theory (V. Bach, R. Seiler), August 6, 1995 - February 24, 1996

Workshops organized outside the Main Programmes

15th Winter school in geometry and physics, Srni (Czech Republic), January 14 - January 21, 1995 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 43 (1996) 9-228

Semi-Classical Limits and Kinetic Equations (C. Schmeiser), November 27 - November 28, 1995

1994

Main Programmes

Ergodicity in Non-Commutative Algebras (H. Narnhofer), spring 1994

Mathematical Relativity (P. Aichelburg, R. Beig), July 1 - September 15, 1994

Gibbsian Random Fields (R. Dobrushin), August 1 - December 31, 1994

Quanternionic and Hyper-Kähler Manifolds (D. Alekseevsky, S. Salamon), September 1 - December 31, 1994

Spinors, Twistors and Conformal Invariants (A. Trautman, V. Soucek, H. Urbantke), September 1 - October 31, 1994

Workshops organized outside the Main Programmes

14th Winter school in geometry and physics, Srni (Czech Republic), January 15 - January 22, 1994 Organized jointly with the Czech Union of Mathematicians and Physicists Proceedings have appeared in Suppl. Rend. Circ. Mat. Palermo, II. Ser. 39 (1996) 9-148.

International Symposium in Honour of Boltzmann's 150th Birthday (W. Thirring et al.), February 23 - February 26, 1994

1993

Main Programmes

Two Dimensional Quantum Field Theory (H. Grosse), spring 1993

Schrödinger Operators (T. Hofmann-Ostenhof), 1993

Differential Geometry (P.W. Michor), 1993

1992

Interfaces between Mathematics and Physics (P.W. Michor, H. Narnhofer, W. Thirring), March 2 - March 6, 1992

75 years of Radon transform (S. Gindikin, P.W. Michor), August 31 - September 4, 1992

ESI Senior Research Fellow Lecture Courses since 2002

2007/08

Christos N. Likos (Universität Düsseldorf), fall term 2007: *Introduction to Theoretical Soft Matter Physics.*

Radoslav Rashkov (Sofia University), fall term 2007: *Dualities between gauge theories and strings.*

John Barrett (University of Nottingham) and **Richard Szabo** (University of Edinburgh), fall term 2007: *Two short courses on theoretical physics.*

2006/07

Ioan Badulescu (Université de Poitiers), fall term 2006: *Representation Theory of the General Linear Group over a Division Algebra.*

Thomas Mohaupt (University of Liverpool), fall term 2006: *Black holes, supersymmetry and strings.*

Miroslav Englis (Academy of Sciences, Prague), fall term 2006: *Analysis on Complex Symmetric Spaces.*

Miroslav Englis (Academy of Sciences, Prague), spring term 2007: *Analysis on Complex Symmetric Spaces*, continuation of the fall term 2006 lecture course

Vadim Kaimanovich (Internationale Universität Bremen), spring term 2007: *Boundaries of groups: geometric and probabilistic aspects.*

Thomas Mohaupt (University of Liverpool), spring term 2007: *Black holes, supersymmetry and strings, continuation of the fall term 2006 lecture course.*

2005/06

Emil Straube (Texas A&M University), fall term 2005: *The L^2-Sobolev theory of the d-bar-Neumann problem, continuation of the spring term lecture course.*

Bernard Helffer (Université Paris Sud-Orsay), fall term 2005: *Introduction to the spectral theory for Schrödinger operators with magnetic fields and application.*

David Masser (Universität Basel), spring term 2006: *Heights in diophantine geometry.*

Mathai Varghese (University of Adelaide), spring term 2006: *K-theory applied to physics.*

2004/05

Manfred Salmhofer (Universität Leipzig), fall term 2004: *Renormalization Theory - Analysis and Applications.*

Anton Wakolbinger (Universität Frankfurt), fall term 2004: *Stochastische Prozesse aus der Populationsgenetik.*

Vlatko Vedral (Imperial College, London), fall term 2004: *Foundations of Quantum Information.*

Boban Velickovic (Jussieu, Paris), fall term 2004: *Introduction to Descriptive Set Theory.*

Werner Ballmann (Universität Bonn), spring term 2005: *Kählergeometrie.*

Jan Derezinski (Warsaw University), spring term 2005: *Operator algebras and their applications in physics.*

Anatoly Vershik (Steklov Institute, St. Petersburg), spring term 2005: *Representation theory of symmetric groups, graphs, universality.*

Emil Straube (Texas A&M University), spring term 2005: *The L^2-Sobolev theory of the d-bar-Neumann problem.*

2003/04

Vladimir Mazya (Linköping University, Sweden), fall term 2003: *Sobolev spaces with applications to PDE.*

Jürgen Rohlfs (Kath. Universität Eichstätt), fall term 2003: *Algebraic Groups over number fields and related geometric questions.*

Peter van Nieuwenhuizen (C.N. Yang Institute for Theoretical Physics, Stony Brook), fall term 2003: *N=1 and N=2 Supersymmetry and Supergravity*, continuation of the spring term lecture course

Werner Ballmann (Universität Bonn), spring term 2004: *Über die Geometrie der Gebäude.*

Jürgen Fuchs (Karlstad University), spring term 2004: *Conformal Field Theory.*

2002/03

Arkadi Onishchik (Yaroslavl State University), fall term 2002: *Real representation theory of Lie algebras and Lie groups.*

Anatoly Vershik (Steklov Institute, St. Petersburg), fall term 2002: *Measure theoretic constructions and their applications in ergodic theory, asymptotics, combinatorics, and geometry.*

Michael Lacey (Georgia Institute of Technology, Atlanta), spring term 2003: *Recent trends in Fourier analysis.*

Peter van Nieuwenhuizen (C.N. Yang Institute for Theoretical Physics, Stony Brook), spring term 2003: *N=1 and N=2 Supersymmetry and Supergravity.*

ESI News

International Scientific Advisory Commitee of the ESI:

We welcome **John Cardy** (Oxford) as a new member from 2008.

The ESI is deeply indepted to **Giovanni Gallavotti** who served as member of the International Scientific Advisory Commitee for 10 years. Many thanks to Giovanni for his great support!

New Members of the ESI Society:

Markus Arndt (Faculty of Physics, University of Vienna)
Reinhard Bürger (Faculty of Mathematics, University of Vienna)
Joachim Hermisson (Faculty of Mathematics, University of Vienna)

Wolfgang L. Reiter, one of the co-founders and Vice Presidents of the ESI was appointed Honorary Professor for History of Science at the Faculty of Historical and Cultural Studies of the University of Vienna.

News from the Administration:

Irene Alozie has left the administrative staff of the ESI at the end of 2007. Thanks to Irene for all her service.

A warm welcome to **Beatrix Wolf** who has joined the administrative staff of the ESI in May 2008.

New ESI Lectures in Mathematics and Physics

Recent Developments in Pseudo–Riemannian Geometry.
Dimitri Alekseevsky and Helga Baum (eds.)

In the fall 2005 a thematic programme, entitled *Geometry of Pseudo-Riemannian Manifolds with Applications in Physics*, was held at the Erwin Schödinger Institute. In Riemannian geometry one studies the local and global properties of smooth manifolds equipped with a smooth metric tensor which is positive definite, and over the last thirty years or so important progress has been made in understanding this class of manifolds. If a smooth manifold is endowed with a metric tensor of indefinite signature one refers to this object as a pseudo-Riemannian manifold. The main source for problems in this realm was the theory of general relativity which deals with 4-dimensional Lorentzian manifolds, that is, the signature is $(1, 3)$. However, recent developments in theoretical physics require a thorough analysis of the general case in arbitrary dimensions. It turned out that the two theories differ considerably in their methodological approach as well in their results. As an outcome of this programme at the ESI its organizers Dimitri Alekseevsky and Helga Baum edited a volume *Recent Developments in Pseudo-Riemannian Geometry* which is published in June 2008 by the European Mathematical Society Publishing House in the book series ESI LECTURES IN MATHEMATICS AND PHYSICS. It is a reader of 549 pages in which one finds a detailed description of the present state of the art in this very active field of research. The topics covered range from *Classification of pseudo-Riemannian symmetric spaces* over the *Geometry and dynamics of the Einstein universe* to *Generalized geometries in supergravity*.

Current and future activities of the ESI

Thematic Programmes 2008

Combinatorics and Statistical Physics, February 1 – June 15, 2008
Organisers: M. Bousquet-Melou, M. Drmota, C. Krattenthaler, B. Nienhuis
Workshop, May 25 – June 7, 2008
Summer School, July 7 – July 18, 2008

Metastability and Rare Events in Complex Systems, February 1 – April 30, 2008
Organizers: P.G. Bolhuis, C. Dellago, E. van den Eijnden
Workshop, February 17 – February 23, 2008

Hyberbolic Dynamical Systems, May 12 – July 5, 2008
Organisers: H. Posch, D. Szasz, L.-S. Young
Workshop, June 15 – June 29, 2008

Operator Algebras and Conformal Field Theory, August 25 – December 15, 2008
Organisers: Y. Kawahigashi, R. Longo, K.-H. Rehren, J. Yngvason

Thematic Programmes 2009

Representation theory of reductive groups — local and global aspects, January 2 – February 28, 2009
Organizers: G. Henniart, G. Muic and J. Schwermer

Number theory and physics, March 1 - April 18, 2009
Organizers: A. Carey, H. Grosse, D. Kreimer, S. Paycha, S. Rosenberg and N. Yui

Selected topics in spectral theory, May 4 – July 25, 2009
Organizers: B. Helffer, T. Hoffmann-Ostenhof and A. Laptev

Large cardinals and descriptive set theory, 2 weeks in June – July 2009
Organizers: S. Friedman, M. Goldstern, R. Jensen, A. Kechris and W.H. Woodin

Entanglement and correlations in many-body quantum mechanics, August 18 – October 17, 2009
Organizers: B. Nachtergaele, F. Verstraete and R. Werner

Other Scientific Activities in 2008

Tensor network methods and entanglement in quantum many-body systems, January 16 – January 18, 2008
Organizers: F. Verstraete, G. Vidal and M. Wolf

Ab-initio density-functional studies of intermetallic compounds, January 23 – January 25, 2008
Organizer: J. Hafner

15th Anniversary of the ESI, April 14, 2008
Organizers: W.L. Reiter, K. Schmidt, J. Schwermer and J. Yngvason

Frontiers in Mathematical Biology: Mathematical population genetics, April 14 – April 18, 2008
Organizers: R. Bürger and J. Hermisson

Topics in Mathematical Physics, July 21 – July 31, 2008
Organizers: C. Hainzl, R. Seiringer and J. Yngvason

Profinite Groups, December 7 – December 20, 2008
Organizers: K. Auinger, F. Grunewald, W. Herfort and P.A. Zalesski

Editors: Wolfgang L. Reiter, Klaus Schmidt, Joachim Schwermer, Jakob Yngvason

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Zweck der Publikation: Information der Mitglieder des Vereins Erwin Schrödinger Institut und der Öffentlichkeit in wissenschaftlichen und organisatorischen Belangen. Förderung der Kenntnisse über die mathematischen Wissenschaften und deren kultureller und gesellschaftlicher Relevanz.