ESI **The Erwin Schrödinger International Institute for Mathematical Physics**

Boltzmanngasse 9/2
A-1090 Vienna, Austria

Scientific Report for 2003

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A preface by the President

The Erwin Schrödinger International Institute for Mathematical Physics (ESI) was officially opened in April 1983 and is now in its 11th year of operation. Within these eleven years the ESI has established itself as a research centre of international excellence in the mathematical sciences. To date well over 2400 scientists have visited the Institute, many of them repeatedly, and most of the leading researchers in mathematics and mathematical physics have worked here at some stage during this period. The research activities of the ESI are documented in almost 1500 ESI preprints, the overwhelming majority of which were subsequently published in leading international journals.

Far from having been a routine year for the Institute, 2003 saw some important developments and changes at the ESI. The first and most alarming of these was a significant cut in the basic funding of ESI (and of practically all comparable Austrian research institutions) by the Ministry of Science: in June 2003 we were notified of a 14.3% reduction in our recurrent grant for 2003. Since our recurring costs are fairly constant, this meant an effective reduction of our scientific budget by well over 25%. Although this forced us to take quite harsh emergency measures we were able to maintain all our scientific activities, albeit at a somewhat reduced level, by using reserves.

However, not all financial news were bad. Based on a promise by the Minister of Science, Mrs. Elisabeth Gehrer, in 2002, to fund our Senior Research Fellows program at the rate of €94.000 p.a. starting from 2003, we expanded that program in line with our long-term policy of vertical integration of research and scientific education at highest international levels. Details of this program can be found in the scientific report for 2003. In addition to the Senior Research Fellows program we applied in 2003 for a *Junior Research Fellows Program* to complement the Senior Research Fellows Program by enabling us to fund outstanding graduate students and post-docs to participate in the scientific activities of ESI. This application was successful and were promised €150.000 p.a. for the years 2004–2006 to initiate this program.

Another important change in 2003 was the retirement of Peter Michor as Scientific Director of the ESI after more than 11 years of invaluable service to the Institute. As a result of this we had to re-organize the management of the Institute, and the Managing Board (Vorstand) of the society running the Erwin Schrödinger Institute elected with effect from November 4, 2003, Joachim Schwermer and the former President Jakob Yngvason as Scientific Directors and Klaus Schmidt (as former Scientific Director) as President of the Institute. Joachim Schwermer had already been deeply involved in the Institute's activities by organizing the Senior Research Fellows Program of the ESI since the beginning of 2003.

The end of 2003 saw yet another development with considerable impact on the ESI. In December 2003 the Mathematics Department of the University of Vienna moved to new premises nearby, forcing us to take over not only the ESI Lecture Hall (which we had previously shared with the Mathematics Department), but also a large lecture room and several offices along the corridor providing access to the ESI. Although this space will be needed urgently for the beginning Junior Research Fellows and the expanded Senior Research Fellows Programs in 2004, the decision to increase our financial commitments at a time of increased financial stringency was not taken lightly.

In spite of these financial concerns affecting institutions like the ESI world-wide, the Institute has had a very successful 11th year with important research programs and conferences, and with two major new scientific initiatives (the Senior and Junior Research Fellows Programs).

Klaus Schmidt
President

General remarks

Management of the Institute

Honorary President: Walter Thirring
President: Klaus Schmidt
Directors: Joachim Schwermer and Jakob Yngvason
Administration: Maria Windhager, Isabella Miedl, Ursula Sagmeister
Computers: Andreas Čap, Gerald Teschl, Hermann Schichl

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Budget and visitors: The budget of ESI for 2003 was € 670.876,– from the Austrian Federal Ministry for Education, Science and Culture, € 22.000,– from the University of Vienna and € 9.450,– from various external sources. € 370.740,– were spent on scientific activities and € 334.782,– on administration and infrastructure. Visitors supported from other (mainly non-Austrian) sources contributed the equivalent of a further € 18.235,–.
The number of scientists visiting the Erwin Schrödinger Institute in 2003 was 422, and the number of preprints was 169.

Programs in 2003

Mathematical population genetics and statistical physics

Organizers: E. Baake, M. Baake, and R. Bürger

Budget: ESI € 37.605,–, external sources € 7.575,–

Dates: December 1, 2002 - February 28, 2003; and follow-up workshop December 8 - 19, 2003

Preprints contributed: [1247], [1250], [1255], [1257],[1260], [1261], [1265], [1274], [1275], [1277], [1279], [1281], [1283], [1287], [1291], [1304], [1305], [1318], [1322], [1324], [1329], [1330], [1333], [1334], [1336], [1337], [1348], [1382], [1393], [1406], [1410], [1426], [1433].

Report on the program

This program, with its inclination towards mathematical biology, was a (relative) novelty at the Erwin Schrödinger Institute. Its major goal was the transfer of methods from mathematical physics, probability theory, and dynamical systems, to problems related to biological evolution. Consequently, researchers from the various disciplines were invited who would not have met otherwise. This resulted in a productive interplay that greatly profited from the communication-friendly environment at ESI. Several lasting collaborations were initiated of which we can only guess the future impact.

Organisation of the program: The program consisted of two workshops (Dec. 16-20, 2002, and Feb. 17-21, 2003) embedded into a three-month program (Dec. 2002 – Feb. 2003) with a loose series of talks and plenty of time for research, as well as a follow-up (and summing-up) workshop (Dec. 8-19, 2003).
Rather than aiming at a complete list of topics, we would like to emphasize a few highlights with a bias towards collaborations that were initiated during the course of the program.

1. Particle systems, genetic drift and genetic draft: The stochastic genetic processes that govern finite populations can nowadays be formulated in terms of interacting particle systems and their relatives. This makes powerful modern methods available for population biology. D. Dawson gave a wonderful overview talk pointing out the many connections between the stochastic processes in population genetics and mathematical physics; several related talks (A. Greven, I. Zähle, M. Möhle, R. Griffiths, P. Slade) could hook into it.
A particularly challenging problem concerns the interplay between selection and genetic drift (i.e., random fluctuations of the genetic composition of a population). Here, J. Gillespie put forth a rather radical hypothesis that explains a large body of genetic evidence by a new process called genetic draft – and A. Wakolbinger did a great job in translating this into the language of interacting particle systems, which might lead the way towards a better understanding of the properties of this novel process.

2. Recombination: In the course of sexual reproduction, maternal and paternal genes are 'mixed' to produce the genotype of the offspring. The dynamics of this process was addressed from various points of view during the program: From the point of view of dynamical systems and discrete mathematics by Y. Lyubich, K. Dawson [1406], O. Redner [1281] and M. Baake, and as a stochastic (coalescent) process by N. Barton and A. Etheridge [1318], A. Sturm, S. Lessard, and W. Stephan [1322]. In applications, recombination is important for mapping the locations of disease genes, as laid out by R. Hudson and T. Johnson. In fact, these two had not met before and learned at ESI that they work on related problems. Indeed, after hearing Hudson's talk, Johnson worked day and night to compare the performance of their methods, and came up with this comparison worked out in his own talk three days later [1433] !

3. Mutation-selection models: Here, one is mainly interested in the asymptotic properties of a population under the influence of selection and mutation as opposing forces (selection favouring the 'fittest' types, mutation tending to 'randomize' the population). For a certain class of examples, some progress has been made in recent years with methods well-known in mathematical physics: The asymptotic properties are accessible through a variational principle, and large numbers of types can be handled through a thermodynamic limit. The phase structure was worked out in detail by T. Garske and U. Grimm [1291] during the program, a connection with the so-called continuum-of-alleles model was presented by O. Redner [1261], and a connection with multitype branching processes was further investigated by H.-O. Georgii and E. Baake [1277]. A generalization of the (thermodynamic) limiting procedure from the particular collection of examples to a large class of models was achieved by E. Baake, M. Baake, A. Bovier and M. Klein [1410]. (This collaboration was initiated over the Christmas days of 2002 at ESI, the work was completed in fall 2003, and the results presented at the December 2003 follow-up meeting at the ESI.)

4. Multilocus population genetics: Many traits of evolutionary interest are quantitative, i.e., can be measured on a continuous scale. Simple examples are body height or brain weight. Such traits are typically determined by many gene loci, are subject to selection, and show considerable genetic variation. Because genetic variation is essential for all evolutionary processes, a fundamental problem is to understand the structure and amount of genetic variation of such traits maintained by the interplay of various ecological and genetic mechanisms.
During this ESI program, substantial progress has been made in this direction, most notably by M. Turelli and N.H. Barton [1324], [1426]. In the first paper, a very general multilocus model of a quantitative trait was analyzed and the pattern and amount of genetic variation maintained by various forms of balancing selection (caused by pleiotropy, or sex-dependent effects, or genotype-environment interaction) could be determined. In their second paper, a very general analysis is performed of changes in the mean and variance components of a polygenic trait caused by changes in allele frequencies. The relation between genotype and phenotype as well as the number of diallelic loci is arbitrary in this work. Both papers advance the subject substantially and greatly generalize previous work. R. Bürger and A. Gimelfarb [1348] studied another model of balancing selection, namely frequency- and density-dependent selection on a quantitative trait, in particular the potential of frequency-dependent selection in maintaining genetic variation. Such models are important for understanding the processes that lead to character divergence within a population and, eventually, to speciation. The analysis of Bürger and Gimelfarb heavily relies on extensive numerical calculations. Bürger (in preparation) was able to use the results of Turelli and

Barton to provide a complete mathematical analysis for the weak-selection limit of the Bürger-Gimelfarb model. Talks by U. Dieckmann, S. Gavrilets, and C. Matessi dealt with multilocus models of speciation and led to a sparkling debate. A number of other topics on multilocus population genetics were discussed during the workshop. We refer to the ESI preprints of R. Haygood [1382], V. Kirzhner et al. [1334], V. Passekov [1329], and M. Willensdorfer and R. Bürger [1274], as well as topic 2 above, recombination.

The **follow-up meeting** in December 2003 was the final highlight of the program. Here, some of the most active participants of the previous long-term program could be brought together again, and the progress of various collaborations that had been initiated the winter before was reported on. The loose format with two talks per day was judged ideal by all participants. It left enough time to continue joint work in an intense way: Most blackboards were full every night.

Invited scientists: N. Barton, M. Benaim, R. Bialowons, M. Birkner, A. Bovier, D. Dawson, K. Dawson, A. Etheridge, W. Ewens, U. Dieckmann, T. Garske, S. Gavrilets, J. Geiger, H.-O. Georgii, J. Gillespie, A. Gimelfarb, A. Greven, R. Griffiths, U. Grimm, S. Grossmann, A. v. Haeseler, R. Haygood, J. Hermisson, I. Hildebrandt, R. Hudson, V. Hutson, L. Imhof, P. Jagers, T. Johnson, G. Kersting, M. Klein, V. Kirzhner, A. Klenke, S. Lessard, Y. Lyubich, C. Matessi, D. Metzler, M. Möhle, M. Notohara, V. Passekov, L. Peliti, P. Pfaffelhuber, O. Redner, C. Richard, P. Slade, W. Stephan, A. Sturm, F. Tria, M. Turelli, A. Wakolbinger, A. Wagner, G. Wagner, B. Yakir, I. Zähle, X.-S. Zhang, L. Zhivotovsky, N. Zint.

Kakeya-related problems in analysis

Organizers: A. Iosevich, I. Laba, and D. Müller

Budget: ESI €34.553,– , external sources €675,–

Dates: February 15 - April 15, 2003

Preprints contributed: [1286], [1292], [1296], [1299], [1300], [1301], [1302], [1303], [1306], [1311], [1312], [1316], [1319], [1338], [1356], [1397], [1398], [1399], [1400], [1401], [1434], [1435], [1445], [1455], [1456].

Report on the program

The aim of the program was to bring together experts from several different areas of mathematics for the purpose of stimulating collaborative research and achieving progress on the Kakeya-related problems.

The work produced by the workshop participants is extremely diverse,but several explicit directions and lines of synthesis can be identified. Perhaps the largest group represented at the workshop is composed of people working on convergence of Fourier type expansions in one and several variables. This area of analysis has received an important boost in recent years due to efforts of people like Lacey, Thiele and others. This theme is represented by ESI preprints [1286], [1296], [1306], [1316], [1356], [1397], [1398], and, to some extent, [1399] and [1400], listed above. While the preprints [1286],[1299], [1397], and [1398] deal with classical analytic aspects of convergence of Fourier series, preprints [1296], [1306], [1316], [1356] provide a beautiful illustration of interaction of analytic and number theoretic methods, particularly continued fraction expansions and discrete restriction estimates (preprint [1296]). We note that preprint [1356] applies a combination of analytic and number theoretic methods to the study of the Schrödinger operator. This interaction with partial differential equations, while not the main theme of the workshop, was a very welcome byproduct.
Another large group represented at the workshop worked on analytic, combinatorial, and number theoretic problems where convexity and related geometric methods play an important role. This theme is represented by preprints [1299], [1300], [1301], [1302], [1303], [1311] and [1312]. Preprints [1300] and [1303] deal with tiling and the existence and non-existence of orthogonal exponential bases. These questions are organized around the celebrated Fuglede conjecture which says that $L(D)$, D a bounded domain, has an orthogonal basis of exponentials if and only if D tiles by translation. While this conjecture, in its most general form, was recently disproved by T. Tao, it is still believed to be true in the context of convex sets.

Moreover, the issue of connections between tiling and spectral properties of domains very much warrant further investigation, particularly since the connections are more complicated than originally believed. Recent work on the Fuglede conjecture led to a number of interesting developments in the theory of distance sets and decay properties of the Fourier transform. These efforts are represented by preprints [1292], [1299], [1301], [1302] and [1311]. The results pertaining to distance sets should be particularly emphasized due to their connections with the Kakeya needle problem. One of the most important side-effects of the workshop is a series of on-going collaborations between the mathematicians involved in various aspects of the Fuglede conjecture and those involved in the study of classical properties of convex bodies using Fourier methods, particularly A. Koldobsky. Preprint [1312] is a beautiful illustration of the work of the latter group.
It is interesting to note that the two groups described above interacted very closely, and results will become apparent in the months and years to come. For example, Konyagin and Iosevich are collaborating on Falconer type problems for polygonal distances, a result involving both analytic and number theoretic aspects. In a similar way, Wang solved a problem in additive number theory, posed by Nathanson. Both papers mentioned are work in preparation. This type of synthesis permeated the workshop in ways the organizers could not have predicted.

Concluding remarks: As we indicated in the opening paragraph, the main goals of the program were achieved. Unlike a typical workshop or a conference where researchers who are already well-acquainted with one another interact in a familiar environment, this program created new interactions and new collaborations which will bear fruit for many years to come. Some of these collaborations have led to work in progress.
An especially fruitful line of research stimulated by the program is the study of distance sets and related topics. As a result of intense discussions involving Hofmann, Iosevich, Konyagin, Laba, Solymosi, and others, several interesting ideas arose. We believe that a small focused follow-up workshop at the ESI dedicated to the Erdős Distance Conjecture and the Falconer Distance Conjecture in Fall 2004 would help to further crystalize these ideas and bring about further progress.
The synthesis and collaborations resulting from this workshop are still on-going. Due to the diverse nature of the participants and projects involved, the full extent of the influence of the workshop may not be fully apparent until the underlying ideas and connections had time to develop. We are nevertheless convinced that this workshop achieved its main goal of disseminating important ideas of analysis related to the Kakeya conjecture and bringing together researchers with the ability and the desire to make progress on these problems in the near future.

Invited scientists: Georgyi Arutyunyants, Imre Barany, Jong-Guk Bak, Dimitry Bylik,Luca Brandolini, Tony Carbery, Leonardo Colzani, Joe Conlon, Michael Gnewuch, Antonio Cordoba, Loukas Grafakos, Ben Green, Sinan Gunturk, Derrick Hart, Steve Hofmann, Alex Iosevich, Philippe Jamming, Norbert Kaiblinger, Michael Kempe, Alexander Koldobsky, Mihalis Kolountzakis, Oleg Kovrizhkin, Sergei Konyagin, Elliot Krop,Izabella Laba, Michael Lacey, Akos Magyar, William McClain, Gerd Mockenhaupt, Detlef Müller, Camil Muscalu, Melvyn Nathanson, Konstantin Oskolkov, Malibika Pramanik, Imre Ruzsa, Andreas Seeger, Per Sjoelin, Jozsef Solymosi, Fernando Soria, Christoph Thiele, Luis Vega, Yang Wang, Jim Wright, Marisa Zymonopoulou.

Penrose inequalities

Organizers: R. Beig, W. Simon, P.T. Chruściel

Budget: ESI € 42.745,–,City of Vienna € 2.000,– , external sources € 1.960,–

Dates: June 2 - July 29, 2003

Preprints contributed: [1340], [1342], [1343], [1345], [1347], [1353], [1354], [1390], [1451], [1461].

Report on the program

The Penrose inequality is a strengthened form of the positive energy theorem in general relativity. Originally it grew out of an attempt by Penrose to find evidence against his cosmic censorship hypothesis, according to which singularities evolving from asymptotically flat initial data for the Einstein equations should be hidden behind an event horizon. Penrose argued that any violation of the Penrose inequality leads to a counterexample to cosmic censorship. One version of the Penrose inequality is the following: The total mass M of appropriately regular asymptotically flat initial data of the vacuum Einstein equations satisfies

$$M \geq \sqrt{\frac{A(S)}{16\pi}}, \tag{1}$$

where $A(S)$ is the area of an outermost trapped surface. If equality holds in Eq.(1), the initial data should be one for the Schwarzschild space-time.
Proofs of various special cases have been obtained by various authors, most of whom participated in the workshop; this has been described in detail in our workshop proposal. As also pointed out in that proposal, the aim of the workshop was to bring those people together, as well as other physicists and mathematicians involved in topics revolving around that inequality, in order to make progress towards a proof of a full conjecture, as well as to explore its applications.
We have succeeded in doing this, and we believe the workshop to have been quite successful. The highlights of the workshop were the following:

1. A series of lectures by Lohkamp, who announced the proof of the Riemannian positive energy theorem for asymptotically flat Riemannian manifolds in all space dimensions, without the hypothesis that the manifold is spin. In this context one should note the lecture by Galloway, who showed how to generalise a previous argument of Lohkamp to obtain the positive mass theorem for asymptotically hyperbolic manifolds. We have been informed by Lohkamp that he thinks that his argument in the asymptotically flat case will carry over to the asymptotically hyperbolic one, and he is planning to work on this once the writing of the asymptotically flat case is completed.

2. A series of lectures by Bray, who described his various attempts of obtaining the proof in the general case, the difficulties that arise, and some open avenues. In one of these lectures, and in his contribution at the "discussion session", Bray outlined strategies for a proof of the inequality under fairly general conditions (in particular for "weak" flows). Some such strategies have been worked out during the discussions at the workshop, mainly between Andersson, Bray, Hayward, Ilmanen, Mars and Simon. These researchers are currently working on those approaches. Bray also presented results on quasilocal masses defined via inverse mean curvature flow.

3. A series of lectures by Ilmanen, summarising his work with Huisken, describing in detail those key elements of the proof which are bound to play a role in attempts to generalise their approach, and describing some recent results which lead to simplifications of the original argument.

Several other significant seminars were presented. A series of talks by Hayward, Malec, Mars, Simon presented in detail a proposal for a space-time flow which could give a solution to the problem at hand. As already mentioned in point 2. above, that approach inspired quite a lot of scientific activity during the workshop, with high expectations concerning the final result.
One should also mention a lecture by Ashtekar on his results on "dynamical horizons" obtained with B. Krishnan, and related to Hayward's concept of "trapping horizons". (There appeared in the July issue of the journal "Bild der Wissenschaft" an article on this development, mentioning our ESI program; such public outreach is certainly positive for the Institute).
For the remaining talks we refer to the list of seminars together with abstracts.
Several collaborations have started during the workshop, and it would be useful to have some follow-up visits to Vienna, and perhaps also to organise a smaller follow-up meeting sometimes in summer 2004.
As of today four preprints have been submitted, but we have been informed of further ones which will be submitted to the Institute server in a near future.

Invited Scientists: Mark Aarons, Michael Anderson, Abhay Ashtekar, Robert Bartnik, Göran Bergqvist, Hubert Bray, Ulrich Christ, Sergio Dain, Erwann Delay, Felix Finster, Greg Galloway, Sean Hayward, Marc Herzlich, Tom Ilmanen, Jacek Jezierski, Jerzy Kijowski, Margarita Kraus, Badri Krishnan, Szymon Leski, Jerzy Lewandowsky, Joachim Lohkamp, Edward Malec, Marc Mars, Daniel Maerten, Niall O'Murchadha, Tomasz Pawlowski, Istvan Racz, K. Roszkowski, Rich Schoen, Laszlo Szabados, Paul Tod, Robert Wald, Gilbert Weinstein, G. Wylezek.

Poisson Geometry and Moment Maps

Organizers: A. Alekseev and T. Ratiu, S. Haller and P. Michor (local organization)

Budget: ESI €77.690,– , external sources €9.750,–

Dates: August 1 - October 15, 2003

Preprints contributed: [1349], [1350], [1351], [1352], [1363], [1367], [1368], [1370], [1371], [1372], [1374], [1375], [1376], [1378], [1379], [1380], [1383], [1385], [1389], [1408], [1409], [1411], [1460], [1465].

Report on the program

The program *Poisson Geometry and Moment Maps* centered around two conferences.

AlanFest conference. This conference was in honor of the 60th birthday of Prof. Weinstein (UC Berkeley). Weinstein is an outstanding scientist and a founder of Poisson geometry. Most of the leading world experts in Poisson geometry contributed talks to this meeting. Below we list some of the most important and interesting contributions:

- Prof. B. Kostant (MIT) explained how the nilpotent orbits of exceptional simple Lie groups can be obtained as symplectizations of prequantum line bundles over nilpotent orbits of classical Lie groups.
- Prof. J.J. Duistermaat (Utrecht) described a stochastical model of the dynamics of the magnetic axis of the earth. This model is directly compared to the geological data.
- Prof. J. Marsden (Caltech) discussed applications of Dirac structures in applied mechanics, including the celestial mechanics of asteroids.
- Prof. M. Crainic (Utrecht) presented a new proof of the linearization theorem for Poisson brackets based on the recent theory of integration of Lie algebroids to Lie groupoids.

The conference took place in the period August 4-8, 2003. The number of participants was around 100. Most of them came with their own means, only the 22 invited speakers were supported by the ESI.

Symplectic Geometry and Moment Maps. This conference was focused on equivariant symplectic geometry. The main topics covered by the meeting were: equivariant cohomology and moment maps, quantization commutes with reduction paradigm, group valued moment maps, stacks and orbifolds. Below we list the most important contributions:

- Prof. V. Guillemin (MIT) explained his approach to the *signature quantization* in connection with the Guillemin-Sternberg 'quantization commutes with reduction' conjecture.
- Prof. L. Jeffrey (Toronto) presented her recent results on the structure of moduli spaces of flat connections on non-orientable Riemann surfaces.
- Prof. E. Meinrenken (Toronto) discussed new localization formulas for *higher classes* in the context of Lie group valued moment maps.
- Prof. R. Sjamaar (Cornell) gave a new family of examples of spaces with group valued moment maps obtained by symplectic implosion.

The conference took place on August 11-15, 2003. It involved around 40 participants, among them a number of graduate students and young postdocs working in the field of moment maps. This conference was the most important meeting in moment map theory this summer.

After the two meetings the program consisted of several smaller scale activities in working groups:

1) A. Alekseev, M. Duflo, A. Szenes, M. Vergne were working on applications of higher residue formulas and on Maurer-Cartan calculus.

2) H. Flaschka, A. Odzijewicz and T. Ratiu worked on various aspects of infinite dimensional Poisson geometry including Banach Lie-Poisson spaces, random matrix theory and geometry of diffeomorphism groups.

3) P. Boalch, A. Kotov, H. Flaschka, M. Puta, T. Ratiu, A. Rosly, V. Roubtsov were discussing various aspects of complete integrability.

A. Alekseev, P. Boalch, H. Flaschka, P.Michor, and T. Ratiu were long term visitors of the program (the duration of the visit $\geq$ 1 month). They contributed to organizing the seminar series and to creating a research atmosphere of the program.

Invited Scientists: Yilmaz Akyldiz, Anton Alekseev, Momo Bangoura, Mohamed Barakat, Sean Bates, Pierre Bieliavsky, Phil Boalch, Louis Boutet de Monvel, Henrique Bursztyn, Ana Cannas da Silva, River Chiang, Marius Crainic, Liana David, Ben Davis, Michel Duflo, Hans Duistermaat, August Egilsson, Rui Loja Fernandes, Hermman Flaschka, Philip Foth, Paul Gauduchon, Victor Ginzburg, Rebecca Goldin, Janusz Grabowski, Alfonso Gracia-Saz, Victor Guillemin, Simone Gutt, Mark Hamilton, Megumi Harada, JeanClaude Hausmann, Andre Henriques, Nan-Kuo Ho, Helmut Hofer, Tara Holm, Stefan Jansen Lisa Jeffrey, Yael Karshon, Vinay Kathotia, Michael Kinyon, Jair Koiller, Yvette Kosmann-Schwarzbach, Bertram Kostant, Alexei Kotov, Eugene Lerman, Jiang-Hua Lu, Zhang-Ju Liu, Shahn Majid, Charles-Michel Marle, Guiseppe Marmo, Jerry Marsden, Rajan Mehta, Eckhard Meinrenken, David Metzler, Peter Michor, Kentaro Mikami, Nobutada Nakanishi, Anatol Odzijewicz, Yong-Geun Oh, Hideki Omori, Liviu Ornea, Juan-Pablo Ortega, Paul-Emile Paradan, Fani Petalidou, Enrique Planchart, Jean Pradines, Mircea Puta, Tudor Ratiu, Anders Reiter- Skovborg, Jean Renault, Konstanze Rietsch, Claude Roger, Alexei Rosly, Volodya Roubtsov, Dmitry Roytenberg, Pavol Severa, Reyer Sjamaar, Jim Stasheff, Robert Stanton, Haruo Suzuki, Andras Szenes, Xiang Tang, Susan Tolman, Barbara Tumpach, Gijs Tuynman, Michele Vergne, Cornelia Vizman, San Vu Ngoc, Aissa Wade, Stefan Waldmann, Alan Weinstein, Jonathan Weitsmann, Joseph Wolf, Ping Xu, Milen Yakimov, Hiroaki Yoshimura, Marco Zambon, Eduard Zehnder, Steve Zelditch, Chenchang Zhu.

Gravity in Two Dimensions

Organizers: W. Kummer, H. Nicolai, D.V. Vassilevich (coordinators); D. Grumiller, W. Kummer (local organization)

Budget: ESI €44.480,–

Dates: September 8 - October 31, 2003

Preprints contributed: [1358], [1369], [1377], [1381], [1384], [1386], [1387], [1388], [1392], [1394], [1402], [1403], [1404], [1413], [1414], [1416], [1417], [1418], [1421], [1423], [1427], [1428], [1430], [1431], [1436], [1444], [1461], [1462].

Report on the program

In the physical context two dimensional gravity theories appear from dimensional reduction of higher dimensional gravity theories and from string models. Being considerably simpler than their parent theories the 2D gravity models nevertheless retain many of the important features of the theories from which they

have been derived. The geometric part of all 2D gravities is integrable at the classical level. Subsequently the formulation of 2D gravity as a Poisson-Sigma model with nonvanishing torsion allowed even deeper insight. Now, further progress is expected solving partially or completely some other twodimensional models among which not only spherical but also more general reductions of multidimensional gravities play a special role. Several groups are working presently on supersymmetric extensions of the dilaton models which are of particular relevance due to their relation to superstrings. Another interesting issue is the connection of the dilatonic formulation of 2D gravity (or, more generally, the Poisson-Sigma models) to other integrable gravity models, as e.g. matrix models.

This was the scientific motivation for the workshop which attracted the attention of experts in classical general relativity, string theory, Black Hole physics, integrable models, spectral geometry and other fields of theoretical and mathematical physics. In view of the large variety of methods used in twodimensional gravity, the interaction between researchers was of particular importance. To maximize the overlap almost all participants were present either in the last week of September or the first week of October, with a handful of exceptions (6 people, mostly string theoreticians, stayed about a week each in the period end of October until mid of December).

Overview lectures were given by Jackiw (Chern-Simons gravities),Kummer (dilaton gravities in two dimensions), and Nicolai (gauged supergravities in 3 dimensions).

Dimensional reduction and quantization were the main theoretical topics of the workshop. General aspects were addressed in the talks by Cadoni, Hajicek, Mann, Navarro-Salas, Niedermaier. Gitman gave a lecture on the symmetries of generic constrained systems. Many closely related talks referred to applications to particular systems. As we expected the main physical system considered during the workshop was the black hole, and the main physical effect was the Hawking radiation (lectures by Fabbri, Filippov, Frolov, Fursaev, Grumiller, Kuchar, Zaslavskii). A rather unconventional approach to the Unruh-Hawking effect was presented by Belinski and Narozhny which caused heated discussions after and during the talks.

Barvinsky, Galtsov, Moskaliuk, Shapiro and Zelnikov gave talks on cosmological applications thus making contact to modern astrophysical data.

Classical and quantum integrability of two-dimensional gravity theories can be best explored with the help of the Poisson sigma models (PSMs). Many talks were devoted to various extensions and generalizations of PSMs. Bergamin considered graded PSMs and their relation to supergravity. Bojowald described classical solutions for PSMs on Riemann surfaces. Ikeda and Strobl reported on higher-dimensional extensions of PSM. Samtleben talked about non-local charges in d=2 gravity with matter couplings and a canonical realization of the Geroch group. Hirshfeld gave an overview of relations between PSMs and deformation quantization. Closely related to this last topic were the talks by Buric, Radovanovic and Vassilevich who considered non-commutative gravity, non-commutative Yang-Mills, and non-commutative heat trace asymptotics respectively. Non-commutative field theories are of continuing traditional interest in Vienna and in the ESI.

Since the inclusion of matter degrees of freedom typically destroys integrability for such systems numerical simulations can produce new insights, as witnessed by the seminal work of Choptuik on critical collapse a decade ago. Kunstatter presented in his talk a (somewhat surprising) generalizationof Choptuik's results to arbitrary dimensions; Fodor discussed the dynamics of spherically symmetric magnetic monopoles.

Alternative formulations of two-dimensional gravity theories were presented by Bojowald and Mikovic (loop gravity and spin foam models). Mignemi considered deformations of two dimensional gravity. Metric-affine gravities in 2D were analyzed by Obukhov. Talks by Hehl and Katanaev dealt with relations between gravitation and electrodynamics and with solid state physics. Kazakov and Kostov talked on the matrix model approach to two-dimensional gravity. Related talks by string theoreticians were given in the period November-December, for instance the series of lectures by Sharpe on D-branes on Calabi-Yau manifolds.

The stimulating atmosphere of the workshop resulted in several new collaborations and interactions between participants of the workshop, local physicists and mathematicians, and even a few participants of parallel workshops (e.g. Anton Alekseev and John Madore).

Invited Scientists: Igor Bandos, Andrei Barvinsky, Vladimir Belinski, Luzi Bergamin, Christian Böhmer, Martin Bojowald, Maja Buric, Mariano Cadoni, Christian van Enckevort, Alessandro Fabbri, Alexandre Filippov, Peter Fischer, Gyula Fodor, Valeri Frolov, Dimitrij Fursaev, Dmitri Gal'tsov, Jack Gegenberg, Dimitry Gitman, Petr Hajicek, Friedrich Hehl, Allan Hirshfeld, Noriaki Ikeda, Yakov Itin, Roman Jackiw, Michael Katanaev, Vladimir Kazakov, Ivan Kostov, Karel Kuchar, Gabor Kunstatter, Karl Landsteiner, Robert Mann, Salvatore Mignemi, Aleksandar Mikovic, Peter Minkowski, Stepan Moskaliuk, N.B. Narozhny, Jose Navarro-Salas, Max Niedermaier, Yuri Obukhov, Voja Radovanovic, Henning Samtleben, Ilya Shapiro, Eric Sharpe, Thomas Strobl, Stefan Vandoren, Oleg Zaslavskii, Andrej Zelnikov

Workshops organized outside the main programs

Winter school in geometry and physics

Organizers: P. Michor, J. Slovak, V. Souček

Budget: Budget contribution by the ESI € 1.000,–

This traditional conference has taken place each January since 1980 for one week in a picturesque village in the Czech part of the Bohemian mountains. Since 1994 it has been a joint enterprise of the Czech society of mathematicians and physicists and the Erwin Schrödinger Institute for Mathematical Physics. The proceedings of this meeting will be published as a supplement of the 'Rendiconti Matematici di Palermo'.

Idempotent Mathematics and Mathematical Physics

Organizers: G.L. Litvinov and V.P. Maslov.

Budget: ESI € 15.736,–, external sources € 8.075,–

Dates: February 2 - February 10, 2003

Preprints contributed: [1307], [1323], [1339], [1341], [1420], [1422], [1437], [1438], [1439], [1440], [1441], [1442], [1443], [1446], [1447], [1448], [1449].

Report on the program

The main objective of the workshop was to enhance collaboration between different scientific groups in the world working on the methods of Idempotent Mathematics and their applications in different areas including Mathematical Physics, Differential Equations, Algebraic Geometry, Optimization, Analysis and Numerical Analysis, stochastic problems, computer applications.

The workshop was concerned with Idempotent Mathematics (or Idempotent Analysis, or Idempotent Calculus) and its applications, especially in Mathematical Physics. Idempotent Mathematics is a new mathematical area. It is based on replacing the usual arithmetic operations by a new set of basic operations (such as maximum or minimum). There is a lot of such new arithmetics, which are associated with sufficiently rich algebraic structures called idempotent semirings (i.e. semirings with idempotent addition; this means that $x + x = x$). One of the most important examples is the well-known max-plus algebra.
In a sense, the traditional Mathematics over numerical fields can be treated as a quantum theory, while the Idempotent Mathematics can be treated as a 'classical shadow (or counterpart)' of the traditional one. There exists the corresponding procedure of an idempotent dequantization. This dequantization is based on the so-called logarithmic transform used by E. Schrödinger (1926) and E. Hopf (1950). In the case of idempotent dequantization the parameter of the dequantization coincides with the Planck constant taking pure imaginary values. A similar idea (a passage to the imaginary time) is used in the Euclidean quantum field theory (there is the well-known duality between energy and time).

There exists a correspondence between interesting, useful and important constructions and results in the traditional Mathematics and similar constructions and results in Idempotent Mathematics. This heuristic correspondence can be formulated in the spirit of the well-known N. Bohr's correspondence principle in Quantum Mechanics; in fact, the two principles are intimately connected. For example, the Hamilton–Jacobi equation is an idempotent version of the Schrödinger equation, the variational principles of Classical Mechanics can be treated as an idempotent version of the Feynman path integral approach to Quantum Mechanics. The representation of solutions to the Schrödinger equation in terms of the Feynman integral corresponds to the Lax–Oleinik representation of solutions to the Hamilton–Jacobi equation. The Legendre transform turns out to be an idempotent version of the Fourier transform etc. A systematic and consistent application of the idempotent correspondence principle leads to a variety of results, often quite unexpected.
The abstract theory is well advanced and includes, in particular, a new integration theory, linear algebra and spectral theory, idempotent functional and harmonic analysis etc. Its applications include important problems in Mathematical Physics, Differential Equations, and Algebraic Geometry, various optimization problems such as multi-criteria decision making, optimization on graphs, discrete optimization with a large parameter (asymptotic problems), optimal design of computer systems and computer media, optimal organization of parallel data processing, dynamic programming, applications to numerical analysis, discrete event systems, computer science, discrete mathematics, mathematical logic, etc.
Invited scientists presented 35 talks; the corresponding abstracts, schedule and the list of participants were published in the form of an ESI Preprint and distributed; 20 ESI preprints are prepared.

Invited Scientists: Marianne Akian, Irina Andreeva, Francois Baccelli, Ali Baklouti, Peter Butkovic, Vittorio Cafagna, Guy Cohen, Antonio DI Nola, Stephane Gaubert, Michel Gondran, Oleg Gulinsky, Zuzana Hucki, Issai Kantor, Konstantin Khanin, Vassili Kolokoltsov, Grigori Litvinov, Paola Loreti, Gianfranco Mascari, David MCCaffrey, Grigory Mikhalkin, Geert Jan Olsder, Endre Pap, Mikael Passare, Marco Pedicini, Jean-Pierre Quadrat, Ilya Roublev, Grigori Shpiz, Ivan Singer, Andrei Sobolevskii, August Tsikh, Oleg Viro, Cormac Walsh, Edouard Wagneur, Karel Zimmermann

Conference on Diophantine Approximation in celebration of Wolfgang Schmidt's 70th birthday

Organizers: H.P. Schlickewei, K. Schmidt, R. Tichy

Budget: ESI €6.498,–, external sources €9.450,–

Dates: October 6 – 10, 2003

During a mathematical career spanning almost 50 years Wolfgang Schmidt has made fundamental contributions to many key areas of number theory, among them

- Normal numbers,
- Uniform distribution,
- Aproximation of algebraic numbers,
- Transcendental numbers,
- The Hardy-Littlewood method,
- Diophantine equations,
- Nonlinear diophantine approximation,
- The Riemann conjecture for the congruence-zeta-function.

This conference was funded jointly by the Erwin Schrödinger Institute, the Austrian Ministry of Science, the City of Vienna and an FWF Research Project of Robert Tichy (Graz), and was devoted to the impact of Wolfgang Schmidt's wide-ranging work on Diophantine approximation on present-day number theory. The proceedings of this workshop will be published in a special volume by deGruyter.

Program:

David Masser: Counting points of bounded height.
Dale Brownawell: Sharp Liouville-Lojasiewicz inequality.
Tanguy Rivoal: Basic hypergeometric series and arithmetic consequences.
Jeff Thunder: Wolfgang Schmidt's influence on the study of Thue equations, Thue inequalities, and generalizations.
Clemens Fuchs: Some applications of the Subspace Theorem.
Viktor Losert: Two equations for linear recurrence.
Preda Mihailescu: On Catalan's conjecture.
Yuri Bilu: Divisibility of class numbers.
Damien Roy: Diophantine approximation in bounded degree.
Michel Waldschmidt: Dependence of logarithms on commutative algebraic groups.
Yann Bugeaud: On Mahler's and Koksma's classifications of numbers.
Jan-Hendrik Evertse: On the number of equivalence classes of binary forms of given degree and discriminant.
Kalman Győry: Index form equations and their applications.
Robert Tijdeman: Lattices and discrete uniform distribution.
Vasili Bernik: Works of Wolfgang Schmidt on Diophantine Approximation, new results and problems.
Walter Philipp: Metric theorems for pseudo-random measures.
Francesco Amoroso: Lower bounds for the heights on a power of the multiplicative group.
Patrice Philippon: Normalized height of monomial varieties.
Serguei Stepanov: Orbit sums on vector modular invariants.
Alain Lasjaunias: Continued Fractions for a class of algebraic power series over a finite field.
Umberto Zannier: Some diophantine equations in several variables.
Pietro Corvaja: Diophantine equations with linear recurrences.
Gael Rémond: Intersection of subvarieties and subgroups on abelian varieties.
Joseph Beck: Wolfgang Schmidt and combinatorics.
Maxim Skriganov: Harmonic analysis on totally disconnected groups and irregularities of point distributions.
William Chen: Orthogonality in the classical discrepancy problem.
Johannes Schoißengeier: The distribution (mod 1) of the multiples of an irrational number.
Christoph Baxa: Calculation of improper integrals using $(n\alpha)$-sequences.
Hans Hejtmanek: Diophantos, Arithmetica.
Scott Ahlgren: Arithmetic of sigular moduli and class equations.
Fritz Schweiger: Diophantine properties of multi-dimensional continued fractions.
Roger Baker: Diophantine inequalities.
Hans Peter Schlickewei: The mathematical work of Wolfgang Schmidt.
Edmund Hlawka: Persönliche Worte über Wolfgang Schmidt.
Robert Tichy: Closing words.

Participants: S. Ahlgren, F. Amoroso, R. Baker, C. Baxa, J. Beck, V. Beresnevich, V. Bernik, F. Beukers, Y. Bilu, D. Brownawell, Y. Bugeaud, W. Chen, P. Corvaja, J. Evertse, C. Fuchs, P. Gruber, K. Gyoery, J. Hejtmanek, E. Hlawka, A. Lasjaunias, V. Losert, D. Masser, P. Mihailescu, W. Philipp, P. Philippon, G. Remond, H. Rindler, T. Rivoal, D. Roy, A. Schinzel, H. Schlickewei, L. Schmetterer, K. Schmidt, W. Schmidt, J. Schoissengeier, , F. Schweiger, M. Skriganov, S. Stepanov, C. Stewart, L. Summerer, R. Tichy, R. Tijdeman, J. Thunder, C. Viola, M. Waldschmidt, E. Wirsing, K. Yu, U. Zannier.

Entanglement and Decoherence of Complex Quantum Systems

Organizers: M. Arndt, G. Kurizki, S. Stenholm, A. Zeilinger

Budget: entirely funded by the RTN Network,*Quantum Complex Systems*

Dates: September 5 – 7, 2003

Workshop of the RTN Network, Quantum Complex Systems (QUACS), financed by the European Union.

Program:

Wojciech Zurek, Los Alamos: Environment - Assisted Invariance, Ignorance, and Information in Quantum Physics.
Gershon Kurizki, Weizmann: Controlled entanglement of complex systems.
Vladimir M. Akulin and Pierre Pillet, Orsay: Control and Coherence Protection in Quantum Systems: an Example of Rydberg AtomsOrsay.
Ruth Garcia Fernandez, Kaiserslautern: Creation and Measurement of a Coherent superposition of Quantum States.
Michael Fleischhauer, Kaiserslautern: Quasi-decoherence free subspaces in quantum memories for photons: suppressing decoherence using collective excitations.

Claus Kiefer, Köln: Decoherence - Concepts and Examples.
Ferdinand Schmidt-Kaler, Innsbruck:
Markus Arndt, Vienna: Quantum interference and decoherence of complex molecules.
Stig Stenholm, Stockholm: Time reversal in dynamic quantum systems.
Erik B. Karlsson, Uppsala: Quantum coherence and decoherence seen in ultrafast neutron scattering experiments on protons in condensed matter.
C. Aris Chatzidimitriou-Dreismann, Berlin: Entanglement and decoherence of protons in condensed matter - Subfemtosecond neutron scattering results and theoretical considerations.
Gershon Kurizki, Anton Zeilinger,Round table discussion: Coherence and Entanglement of complex systems: bold dreams and realistic goals.
Jean-Michel Raimond, Paris: Atom/mesoscopic field entanglement: a new insight into Rabi oscillation.
Christoph Simon, Santa Barbara: Towards Quantum Superpositions of a Mirror.
Antonio Barone, Naples: More on the Josephson Effect as a probe of the order parameter symmetry.
Miriam Blaauboer, Delft: QUACS at Delft: from August 2002 to today and beyond.

Participants: V.M. Akulin, M. Arndt, A. Barone, M. Blaauboer, C.A. Chatzidimitriou-Dreismann, M. Fleischhauer, R. Garcia Fernandez, E.B. Karlsson, C. Kiefer, G. Kurizki, P. Pillet, J-M. Raimond, F. Schmidt-Kaler, C. Simon, S. Stenholm, J. Yngvason, A. Zeilinger, W. Zurek.

Mathematical Analysis of Large Quantum Systems

Organizer: J. Yngvason

Budget: External sources €2.835,–

Dates: December 6 – 7, 2003

Meeting of the Post Doctoral Training Network HPRN-CT-2002-00277, financed by the European Union. The network incorporates teams from Munich, Copenhagen, Haifa, Mainz, Paris, Vienna, Warsaw and Zurich.

Program:
Michael Loss, Atlanta: Existence of atoms in non-relativistic quantum electrodynamics.
Jean-Marie Barbaroux, Munich: Some connections between Dirac-Fock theory and electron/positron field energy.
Christian Hainzl, Paris: On the Vacuum Polarization Density caused by an External Field.
Mathieu Lewin, Paris: A self-consistent model of the polarized vacuum.
Jan Derezinski, Warsaw: Van Hove Hamiltonians as models for the infrared and ultraviolet problem.
Alessandro Pizzo, Zuerich: Ground state in non-relativistic Q.E.D. and S-matrix elements for Rayleigh scattering: expansion in the coupling constant.
Soeren Fournais, Paris: On confinement to lowest Landau band for large atoms in strong magnetic fields.
Christian Jaekel, Munich: Nelson Symmetry for thermal Bosons.
Matthias Mueck, Mainz: Thermal Relaxation to a Stationary State for Particle Systems in Interaction with Several Bosonic Heat Reservoirs.
Laurent Bruneau, Warsaw: On a Hamiltonian model for friction.
Joaquim Puig, Barcelona: The Ten Martini Problem.
Christoph Buchendorfer, Zuerich: Scattering of Edge States in a Strong Magnetic Field.
Jacob Schach Moeller, Mainz: The massive translation invariant Nelson model.
Kai Schnee, Vienna: Dimensional reduction of trapped Bose gases.
Thomas Ostergaard Soerensen, Munich: Optimal regularity results for many-electron wave functions.
Oliver Matte, Mainz: On the spectrum of semi-classical Witten-Laplacians and Schroedinger operators in large dimension.
Rafal Fruboes, Warsaw: Level Shift Operator and 2nd order perturbation theory.
Brice Camus, Munich: Spectral estimates at a degenerate critical energy level for Schrdinger operators. Case of a minimum of the potential.
Takeyuki Nagao, Munich: Analysis of zero energy resonances by finite rank perturbations.
Rupert Frank, Munich: On the Laplacian on the halfplane with a periodic boundary condition.

Participants: Andrew Antonets, J. Avron, Volker Bach, Jean-Marie Barbaroux, Laurent Bruneau, Christoph Buchendorfer, Brice Camus, Isabelle Catto, Jan Derezinski, Laszlo Erdos, Maria Esteban, Soeren Fournais, Rupert Frank, Rafal Fruboes, Gian Michele Graf, Bernard Helffer, Christian Hainzl, Thomas Hoffmann-Ostenhof, Jens Hoppe, Doris Jakubassa, Christian Jaekel, Frederic Klopp, Alexey Kononenko, Mathieu Lewin, Michael Loss, Oliver Matte, Juergen Mayr, Matthias Mueck, Takeyuki

Nagao, Thomas Ostergaard, Alessandro Pizzo, Joaquim Puig, Jacob Schach Moller, Kai Schnee, Eric Sere, Heinz Siedentop, Edgardo Stockmeyer, Markus Walser, Jacek Wojtkiewicz, Semjon Wugalter, Jakob Yngvason, Heribert Zenk

Senior Research Fellows Program

To stimulate the interaction with the local scientific community the ESI offered lecture courses on an advanced graduate level. These courses were taught by Senior Research Fellows of the ESI whose stays in Vienna were financed by the Austrian Ministry of Education, Science and Culture, the University of Vienna and the Vienna University of Technology. The coordinator of this program was Joachim Schwermer.

This year's program concentrated on the following lecture courses:

Michael Lacey (Georgia Institute of Technology), Summer 2003, on:
Recent trends in Fourier analysis

Peter van Nieuwenhuizen (SUNY at Stony Brook), Summer 2003/January 2004, on:
$N = 1$ *and* $N = 2$ *supersymmetry and supergravity*

Vladimir Maz'ya (Linköping University), Fall 2003, on:
Soboloev spaces with applications to PDE

Jürgen Rohlfs (University Eichstätt), Winter 2003/January 2004, on:
Algebraic groups over number fields and related geometric questions

There were many informal meetings between the lecturers and the participants of the courses in which they discussed and elaborated on the ideas and results presented in the lectures. Some of the courses are going to appear in an extended form in the ESI book series "ESI Lectures in Mathematics and Physics" published by the European Mathematical Society. The first volume in this series is going to be the course "Lectures on Real Semisimple Lie Algebras and Their Representations" by Arkady Onishchik given in 2002 at the ESI, forthcoming February 2004.

A planned course by **Julius Wess** on *Quantenfeldtheorie auf nichtkommutativen Räumen* unfortunately had to be cancelled due to a sudden serious illness of the speaker.

We include descriptions of the content of the lecture courses followed by a short report covering the research activities of the Senior Research Fellow in question.

Michael Lacey: Recent trends in Fourier analysis

Course: A fundamental result of Lennart Carleson on the pointwise convergence of Fourier series, from 1965, is related to the analysis of singular integrals that have symmetries with respect to modulation. These connections have only become apparent in the last few years, and the subject has grown quite a bit since the connection came to light. This course investigated some parts of this area.

1. Convolution and discrete approximations - Introduced a notion of tiles, (closely related to frames) and operators formed from sums of tiles. Averaging, in appropriate ways, over tiles, generates convolution operators. Special attention was paid to the Hilbert transform. Outline a connection between Littlewood—Paley theory, wavelets, BMO spaces, and singlular integrals.

2. Singular Integrals with Modulation - Carleson's Theorem on the convergence of Fourier series. [Complete proof of the pointwise convergence of square integrable Fourier series. Outline how this proof should be modified to prove the convergence of Fourier series of L^p functions, $p > 1$.] Bilinear Hilbert Transform. Complements and Extensions [including work of Lacey, Thiele, Muscalu, Tao, Grafakos, Nahmod, Gilbert, Li and Terwilliger, et al.]

3. Dyadic Models, $T1$ and Tb theorems - The dyadic models that are used in recent works of Lacey and Thiele and coauthors, as well as those of Nazarov, Treil, Volberg and coauthors, give a useful insight into the $T1$ theorem of David and Journe. The Tb theorem has recently been revisited, through the solution of the Kato Square Root Problem, of Auscher, Hofmann, Lacey, McIntosh, and Tchmaitchin.

4. Weak-type Orthogonality and Littlewood-Paley inequalities - We stated a weak L^2 orthogonality principle, which arises from the proof of Carleson's theorem. The connection to Littlewood-Paley inequalities is interesting, especailly those variants suggested by Rubio de Francia's inequality. Some of these inequalities are proved in a situation governed by BMO in product domains.

5. Commutator Estimates, Weak Factorization in H^1 of product domains - It is a classical fact that an H^1 function can be factored into a product of functions in H^2. A recent result of Ferguson and Lacey, building on a prior result of Ferguson and Sadosky, establishes a weak factorization result for functions in H^1 of product domain. This fact entails significant difficulties not present in the classical case.

6. Recent thoughts on Hilbert transform on vector fields - A well known problem concerns the boundedness of a Hilbert transform, or Maximal function, computed in a unit line segment in the plane, whose direction varies in a smooth fashion. A positive answer to this question would depend upon a very delicate extension of Carleson' theorem to a higher dimensional setting.

The lectures for the course were attended by various members of the Department, post-Docs and students at the NuHAG.

In the last week, the course was additionally attended by other short term visitors to the ESI, including by Dr. Nenad Teofanov (Univ. Novi Sad, Serbia),Ursula Molter, Carlos Cabrelli (both of the University of Buenos Aires), and Prof. V. Madych and Karlheinz Gröchning (both of Univ. of Conneticut, Storrs) In addition, I gave a colloquium in Vienna, and a plenary lecture at the Sampling Theory and Time Frequency Analysis 2003 conference in Strobl (cf. http://www.univie.ac.at/NuHAG/SampTA03).

Research: The lectures at the Institute offered me the opportunity to reflect some on issues that have occupied my mind over the past several years.

The most significant accomplishment was the very great advances made on a new result that is joint with Xiaochun Li (UCLA). In it we establish norm inequalities for a Hilbert transform on smooth families of lines. This line of investigation was first proposed by A. Zygmund, and amplified much later by E.M. Stein. Our result will be the first that imposes only smooth conditions on the families of lines, with prior results of Stein and J. Bourgain imposing analyticity and real analyticity respectively.

I significantly advanced two survey articles.One of these concerns developments on the Littlewood Paley inequalities. A second concerns the Carleson theorem, and a host of related topics. Both papers were significantly improved by the presentation of the lectures.

Additional scientific interactions took place with a number of visitors to the Institute, especially those that participated in the workshop on Combinatorial and Number-Theoretic Methods in Harmonic Analysis. These visitors included Professors James Wright, Andreas Seeger, Detlev Müller, Konstantin Oskolkov, and Christiph Thiele. As well, I had several discussions with the students William McClain and Derrick Hart. At the conclusion of my stay, Ursula Molter, Carlos Cabrelli and myself had some discussions about a Lemma of J.-L. Journé that is central to the product theory of BMO spaces. These discussions will likely lead to a short paper on the subject.

Professor James Campbell (Univ. Memphis), who held the associated short term position, and myself had extended conversations about a question in ergodic theory that has connections to a classical result of N. Wintner and A. Wintner and the theorem of Carleson on Fourier series. This question requires a particular refinement of the proof of Carleson's theorem.

Again, the time spent in Vienna was a fruitful time scientifically.

Preprints contributed: [1397], [1398], [1399], [1400].

Peter van Nieuwenhuizen: $N = 1$ and $N = 2$ supersymmetry and supergravity

Course: This course was embedded in the Seminar for Theoretical Physics at the Vienna University for Technology. During March/April the participants laid the foundations for supersymmetric quantum field theories by using lecture notes of Philip Argyres, University of Cincinnati. The lectures by van Nieuwenhuizen started with an introduction to simple $N = 1$ supergravity from scratch. This covered the historical development as well as the basic implementation of a local $N = 1$ supersymmetry with Noether's method. In the following the main focus was on various aspects of $N = 1$ and $N = 2$ superspace theories as, e.g., the use of supermultiplets resp. the coset approach which led to a systematic construction of superspace. A discussion of the $N = 1$ superspace approach to supergravity and matter-coupled Yang-Mills theories concluded the lectures. These were followed by a talk of Dr. Luzi Bergamin presenting results on specific aspects of super-Yang-Mills theories and supersymmetry anomalies.

Part II of the ESI course on $N = 1$ and $N = 2$ Supersymmetry and Supergravity by Prof. Peter van Nieuwenhuizen (C.N. Yang Institute for Theoretical Physics, Stony Brook) begun on Thursday, January 8th, 2004 and continued on the following Tuesdays until January 27th, with 2-hour lectures each. In this second part, Prof. van Nieuwenhuizen discussed in detail the derivation of anomalies in $D = 10, N = 1$ and $N = 2B$ supergravity from quantum mechanical path integrals. As a preparation for this lecture series, the students participating in this year's seminar studied anomalies in general (using the textbook by Prof. Aichelburg (University of Vienna)). In his lectures, Prof. van Nieuwenhuizen started by developing the techniques of deriving one-loop gravitational anomalies in quantum field theories with arbitrary spin and external gravity and Yang-Mills gauge fields from quantum mechanical path integrals. This in particular involved a careful discussion of operator-ordering issues, the usage of coherent states for fermions, and subtleties in the continuum limit to unambiguously derive equal-time contractions and Feynman rules. With these techniques, the gravitational anomalies were then computed in any (even) dimension. Finally, these formulas were applied to the ten-dimensional case. For $N = 2B$ supergravity the anomalies cancel by themselves, but for $N = 1$ supergravity the anomalies are cancelled by a counter term which was derived from descent equations, and this is only possible if the gauge group is $SO(32)$ of $\mathrm{E}_8 \times \mathrm{E}_8$. Besides the participants of the regular seminar, a number of students and senior researchers from the University of Vienna took part, so that the attendance was as good as in part I (the seminar room was usually filled completely).

Research: In the first part of his Senior Research Fellowship, Prof. Peter van Nieuwenhuizen collaborated with Dr. F. Bastianelli (Bologna) on the subject of anomalies from quantum mechanical path integrals, and good progress was made in the project of writing a joint textbook on this matter. He furthermore begun a research collaboration with Ao. Univ. Prof. Anton Rebhan and Dipl.-Ing. Robert Wimmer from the Institute for Theoretical Physics of the Vienna University of Technology on the quantization of $N = 2$ supersymmetric vortices in $2 + 1$ dimensions. Previous work on this issue by other authors had led to the conclusion that standard multiplet shortening arguments in favour of BPS saturation at the quantum level would not apply, while direct calculations of the quantum mass led to nonzero corrections. In this new research a direct calculation of the quantum corrections to the central charge could be achieved, which demonstrated BPS saturation at the quantum level. In follow-up work during the summer it could then be established that the previous arguments against multiplet shortening were faulty, as proper analysis of the zero modes in the vortex background revealed. This research led to the publicaton of ESI preprint [1344], which has by now been published in Nucl. Phys. B679 (2004) pp. 382-394. Besides this collaboration, Prof. van Nieuwenhuizen has also interacted intensively with Prof. W. Kummer, Drs. L. Bergamin and D. Grumiller (TU Wien) on the subject of two-dimensional supergravity models.

During the second part of the Senior Schrödinger Fellowship (January 2004), Dr. Robert Wimmer (now University of Hannover) and Ao.Univ.Prof. Anton Rebhan (TU Wien) resumed the collaboration on the quantization of higher-dimensional solitons begun the previous year. As a follow-up of the collaboration on supersymmetric vortices, a joint article was prepared which summarized the previous findings (ESI preprint [1452]) on supersymmetric kinks and vortices and which is to appear in a volume on Quantum Field Theory under the Influence of External Conditions edited by Prof. Kim Milton (Univ. of Oklahoma,

Norman). New research was begun on the quantization of $N = 2$ supersymmetric monopoles in $3 + 1$ dimensions, which led to surprising new results, namely the discovery of previously unnoticed anomaly in the central charge of these extended objects that play a central role in nonperturbative studies of supersymmetric Yang-Mills theories (Seibert-Witten theory). The effect of this anomaly is to give rise to BPS-saturation-preserving but nontrivial quantum corrections to mass and central charge of supersymmetric monopoles, which previous direct calculations have missed, but which are crucial for consistency with the newer results from Seibert-Witten theory. These results have been published as ESI preprint [1453] and submitted for publication to Physics Letters B. Further joint research on this topic is planned, and a diploma student (Robert Schöfbeck from the TU Vienna) has joined into these efforts.

Prof. van Nieuwenhuizen has also spent much time on continuing discussions with Prof. W. Kummer, Drs. L. Bergamin and D. Grumiller on the ongoing research on two-dimensional supergravity models. He has moreover worked intensively with Sebastian Guttenberg (doctoral student of Ao.Univ.Prof.M. Kreuzer, TU Vienna), who is studying covariant quantization of the Green-Schwarz superstring along the methods presented by Prof. van Nieuwenhuizen previously.

Preprints contributed: [1344], [1452], [1453].

Vladimir Maz'ya: Sobolev spaces with applications to PDE

Course: Sobolev spaces play an outstanding role in modern analysis, in particular,in the theory of partial differential equations and its applications in mathematical physics. They form an indispensable tool in approximation theory, spectral theory, differential geometry etc... Needless to say the theory of these spaces is of interest in itself being a beautiful domain of analysis.

The course included the basics on Sobolev spaces, approximation and extension theorems, imbeddings and compactness theorems, their connection with isoperimetric inequalities, capacities with applications to Sobolev spaces, Besov spaces, boundary traces of Sobolev functions, pointwise inequalities for derivatives, Gagliardo-Nirenberg inequalities, pointwise multipliers, variational approach to elliptic equations, inequalities for general differential operators. Some open problems were formulated as well.

Research: During his stay V. Maz'ya worked on various sets of problems, in particular, on different aspects of the theory of Schrödinger operators. Together with I. Verbitsky he obtained in [1357] criteria for the form boundedness of the relativistic Schrödinger operator. He completed his joint work with Kondriatiev and Shubin on discreteness criteria for the spectrum of the magnetic Schrödinger operator [1359] resp. his joint work with Shubin [1360] on an improvement of the classical Molchanov criterion. V. Maz'ya collaborated with the visitors G. Schmidt (Berlin), F. Lanzara (Rome)and J. Rossmann (Rostock) invited on his behalf to the ESI. The results obtained pertain to a numerically efficient algorithm for scattering problems for the Schrödinger operator based on the so called approximate approximation[1412] resp. weighted estimates for the Stokes system in an arbitrary polyhedron.

Preprints contributed: [1357], [1359], [1360], [1412], [1419].

Jürgen Rohlfs: Algebraic groups over number fields and related geometric questions

Course: The course started off with a survey over the basic elements in algebraic number theory needed in the lectures. Rings of integers, completions of fields, adeles, ideles of number fields and the idele class group were discussed in detail. This was followed by a comprehensive treatment of the cohomology of finite groups and the duality result of Tate-Nakayama. Following Langlands' approach the lecturer presented the abelian classfield theory of tori, the main focus of this course. Finally, the concept of Tamagawa numbers was discussed. The result due to Ono on the Tamagawa number of tori in which an explicit formula is given was proved at the end of the lectures. There will be notes taken by participants and elaborated upon available in due time.

Research: During my stay I had T.N. Venkataramana (Tata Institute for Fundamental Research, Bombay, 14 days), Laurent Clozel (Orsay, Paris, 4 days) and S.S. Kudla (University of Maryland, USA, 7 days in 2004) as visitors at the ESI. All three mathematicians gave a lecture in the mathematics colloquium of the University of Vienna and one in the research seminar of J. Schwermer.

Together with Venkataramana I studied the infinite dimensional $\mathbb{Q}$-rational Steinberg representation of the rational points of a reductive algebraic $\mathbb{Q}$-group. We could obtain some results on the irreducibility of this representation. Schwermer and I discussed intersection numbers of special cycles in arithmetically defined locally symmetric spaces. Based on some general results obtained in earlier work we could prove some new non-vanishing theorems for the cohomology of arithmetic groups. These encode some interesting number theoretical information.
Currently I am working on a problem in the cohomology of arithmetic groups in which the cohomology of tori as discussed in my course plays a fundamental role but dealt with from a different point of view.

Visitors outside the main programs

Visitors to ESI not associated with any of the main programs and workshops in 2003, but related to previous ones, have so far contributed the preprints [1262], [1289], [1294], [1308], [1310], [1315], [1317], [1325], [1328], [1331], [1335], [1344], [1346], [1357], [1359], [1360], [1361], [1362], [1366], [1373], [1391], [1397], [1398], [1399], [1400], [1405], [1407], [1412], [1415], [1419], [1425], [1429], [1450], [1452], [1453], [1454], [1458], [1463].

This list includes preprints contributed by the Senior Research Fellows and their collaborators.
ESI spent €31.305,– with external contributions amounting to €4.785,–. These figures do not include the invitations issued by the Senior Research Fellows which are budgeted separately.

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Lanzara Flavia, Univ. La Sapienza; 03.11.2003 - 23.11.2003, SFS;
Lasjaunias Alain, IMB; 05.10.2003 - 08.10.2003, WMS;
Lenz Daniel, Fakultaet f. Mathematik, TU Chmenitz ; 25.01.2003 - 29.01.2003, BBB;
Leski Szymon, Center for Theoretical Physics, Polish Academy of Sciences; 01.07.2003 - 15.07.2003, BSC;
Lerman Eugene, Univ. of Illinois, Urbana-Champaign; 03.08.2003 - 17.08.2003, ALF;
Lewandowski Jerzy, Warsaw University, Dept. of Physics, Institute of Theoretical Physics; 15.07.2003 - 29.07.2003, BSC;
Lewin Mathieu, Ceremade; 06.12.2003 - 07.12.2003, YNG;
Lieb Elliott, University of Princeton; 12.03.2003 - 15.03.2003, ACM;
Litvinov Grigori, Independent University of Moscow; 31.01.2003 - 11.02.2003, LM;
Loreti Paola, Universita di Roma, La Sapienza; 07.02.2003 - 09.02.2003, LM;
Losert Viktor, Uni Wien; 06.10.2003 - 10.10.2003, WMS;
Losik Mark V. , Saratov State University, Department of Mathematics ; 20.10.2003 - 19.12.2003, MI;
Loss Michael, Georgia Tech. School of Mathematics; 04.12.2003 - 10.12.2003, YNG;
Lu Jiang-Hua, University of Arizona; 02.08.2003 - 19.08.2003, ALF;
Madore John, Université de Paris Sud, Laboratoire de Physique Theorique , et Hautes Energies; 26.09.2003 - 09.10.2003, MTK;
Maeda Yoshiaki, Keio University 3-14-1, Department of Mathematics, Faculty of Science and Technology; 30.07.2003 - 18.08.2003, ALF;
Magyar Akos, University of Georgia, Department of Mathematics; 25.02.2003 - 06.03.2003, LIM;
Majid Shahn, School of Math. Science, Queen Mary and Westfield College; 01.08.2003 - 05.08.2003, ALF;
Malec Edward, Jagiellonian University, Institute of Physics; 12.06.2003 - 19.07.2003, BSC;
Mann Robert, University of Waterloo; 30.09.2003 - 11.10.2003, KNV;
Marmo Giuseppe, Universitá Frederico II Napoli, Dipartimento di Scienze Fisiche; 31.07.2003 - 12.08.2003, ALF;

Mars Marc, Faculty of Physics, University of Salamanca; 06.07.2003 - 02.08.2003, BSC;
Marsden J.E., Caltech, CD5 107-81; 04.08.2003 - 14.08.2003, ALF;
Martin Isbeliz, Univ. Simon Bolivar; 05.08.2003 - 08.08.2003, ALF;
Mascari Giovanni Francesco, National Research Council; 05.02.2003 - 09.02.2003, LM;
Masser David, Universität Basel, Mathematisches Institut; 05.10.2003 - 10.10.2003, WMS;
Matte Oliver, Johannes Gutenbert Universität; 06.12.2003 - 07.12.2003, YNG;
Mayr Jürgen, LMU-München; 06.12.2003 - 07.12.2003, YNG;
Mazya Vladimir, Linköping University; 01.09.2003 - 30.11.2003, SF;
McCaffrey David, Shell Global Solutions; 06.02.2003 - 09.02.2003, LM;
McClain William, Georgia Institute of Technology ; 26.02.2003 - 09.03.2003, LIM;
Mehta Rajan, University of California; 01.08.2003 - 08.08.2003, ALF;
Mermin N. David, Cornell University; 22.10.2003 - 19.11.2003, YNG;
Metzler David, University of Florida; 04.08.2003 - 15.08.2003, ALF;
Metzler Dirk, Goethe-Universität Frankfurt, Fachbereich Biologie u. Informatik ; 18.02.2003 - 21.02.2003, BBB;
Mickelsson Jouko, Royal Institute of Technology, Theoretical Physics; 12.10.2003 - 27.10.2003, MTK;
Mignemi Salvatore, Universita di Cagliari; 22.09.2003 - 04.10.2003, KNV;
Mikami Kentaro, Akita University; 04.08.2003 - 10.08.2003, ALF;
Mikovic Aleksandar, Universidade de Lusofona; 26.09.2003 - 03.10.2003, KNV;
Mikhalkin Grigory, University of Utha, Department of Mathematics ; 03.02.2003 - 05.02.2003, LM;
Minkowski Peter, Uni Bern; 02.11.2003 - 15.11.2003, KNV;
Mockenhaupt Gerd, Georgia Tech; 24.02.2003 - 05.03.2003, LIM;
Moller Jacob Schach, Universität Mainz; 06.12.2003 - 07.12.2003, YNG;
Morimoto Tohru, Nara Women's University; 11.03.2003 - 18.03.2003, CAP;
Moskaliuk Stepan, National Academy of Sciences of Ukraine, Bogoljubov Institute for Theoretical Physics; 05.09.2003 - 27.09.2003, KNV; 06.10.2003 - 12.10.2003, KNV;
Möhle Martin, University of Tübingen, Mathematics Institute; 18.02.2003 - 21.02.2003, BBB; 15.12.2003 - 20.12.2003, BBB;
Mück Matthias, Wissenschafl. Mitarbeiter; 05.12.2003 - 08.12.2003, YNG;
Müller Detlef, C.A.-Universität Kiel, Mathem. Seminar; 24.02.2003 - 15.03.2003, LIM;
Mumford David, Brown University; 19.11.2003 - 23.11.2003, MI;
Muscalu Camil, UCLA, Department of Mathematics; 20.03.2003 - 31.03.2003, LIM;
Nagao Takeyuki, University of Tokyo; 05.12.2003 - 07.12.2003, YNG;
Nakanishi Nobutada, Gibu-Keizai University; 04.08.2003 - 08.08.2003, ALF;
Narozhny Nikolay, Moscow Engineering Physics Institute; 05.10.2003 - 10.10.2003, KNV;
Nathanson Melvyn, City University of New York , Lehmann College, Department of Mathematics; 24.02.2003 - 02.03.2003, LIM;
Navarro-Salas Jose, University of Valencia; 21.09.2003 - 28.09.2003, KNV;
Nicolai Hermann, Max-Planck-Institut für Gravitationsphysik; 29.09.2003 - 05.10.2003, KNV;
Niedermaier Max, CNRS, Uni. Tours; 25.09.2003 - 05.10.2003, KNV;
Notohara Morihiro, Nagoya-City University, Graduate School of Natural Science; 07.02.2003 - 22.02.2003, BBB;
Obukhov Yuri, Inst. fuer Theor. Physik; 26.09.2003 - 04.10.2003, KNV;
Odzijewicz Anatol, University of Bialystoic, Institute of Theoretical Physics; 01.08.2003 - 15.08.2003, ALF; 05.09.2003 - 21.09.2003, ALF;
Oh Yong-Geun, University of Wisconsin; 03.08.2003 - 09.08.2003, ALF;
Olsder Geert Jan, Delft University of Technology, Faculty Information Technology and Systems; 03.02.2003 - 09.02.2003, LM;
Omori Hideki, Science Univ Tokyo; 04.08.2003 - 09.08.2003, ALF;
/'O Murchadha Niall, University College Cork, Physics Department; 03.06.2003 - 31.07.2003, BSC;
Ornea Liviu, University of Bucharest, Faculty of Mathematics; 01.08.2003 - 01.09.2003, ALF;
Ortega Juan-Pablo, Institut Non Lineaire de Nice; 02.08.2003 - 09.08.2003, ALF;
Oskolkov Konstantin, University of South Carolina, Department of Mathematics; 16.02.2003 - 15.03.2003, LIM;

Pap Andre, Department of Mathematics; 03.02.2003 - 09.02.2003, LM;
Papadopoulos Athanase, Universite Louis Pasteur; 23.09.2003 - 28.09.2003, SCH;
Paradan Paul-Emile, Institute Fourier; 02.08.2003 - 15.08.2003, ALF;
Passare Mikael, Stockholm University, Department of Mathematics; 06.02.2003 - 09.02.2003, LM;
Pawlowski Tomasz, Theoretical Physics Institute, Warsaw University ; 14.07.2003 - 27.07.2003, BSC;
Pedicini Marco, Instituto per le , Applicazioni del Calcolo; 07.02.2003 - 09.02.2003, LM;
Petalidou Fani, Universite Pierre et, Marie Curie; 04.08.2003 - 08.08.2003, ALF;
Petrosyan David, Inst. of Electronic Structure; 04.09.2003 - 06.09.2003, YNG;
Pfaffelhuber Peter, Universität Erlangen, Mathematisches Institut; 17.02.2003 - 21.02.2003, BBB;
Philipp Walter, University of Illinois, Department of Statistics; 06.10.2003 - 10.10.2003, WMS;
Philippon Patrice, CNRS; 05.10.2003 - 11.10.2003, WMS;
Piccinini Renzo, Universita di Milano; 07.05.2003 - 08.05.2003, MI;
Pizzo Alessandro, Inst. f. Theoretische Physik; 06.12.2003 - 07.12.2003, YNG;
Planchart Enrique, Univ. Simon Bolivar; 04.08.2003 - 08.08.2003, ALF;
Pradines Jean, Universite Paul-Sabatier; 03.08.2003 - 09.08.2003, ALF;
Pramanik Malabika, University of Wisconsin-Madison ; 30.03.2003 - 07.04.2003, LIM;
Prvanović Slobodan, Ministry of Science and Technology; 18.12.2003 - 28.12.2003, YNG;
Puig Joaquim, Universitat de Barcelona; 06.12.2003 - 08.12.2003, YNG;
Puta Mircea, University of Timisoara; 04.08.2003 - 18.08.2003, ALF; 17.09.2003 - 29.09.2003, ALF;
Quadrat Jean-Pierre, INRIA Domane de Volucean; 03.02.2003 - 09.02.2003, LM;
Rácz István, MTA-KFKI , Research Institute for Particle and Nuclear Physics; 23.06.2003 - 11.07.2003, BSC;
Radovanović Voja, Faculty of Physics; 20.09.2003 - 05.10.2003, KNV;
Ratiu Tudor S., Ecole Polytechnique Federalede Lausanne; 01.08.2003 - 15.10.2003, ALF;
Remond Gael, Institut Fourier; 06.10.2003 - 12.10.2003, WMS;
Renault Jean, Univ. of Orleans; 03.08.2003 - 09.08.2003, ALF;
Repovs Dusan, University of Ljubljana; 12.11.2003 - 13.11.2003, MI;
Rivoal Tunguy, LMNO; 06.10.2003 - 11.10.2003, WMS;
Rietsch Konstanze, King's College, University of London; 26.01.2003 - 30.01.2003, MI; 01.08.2003 - 15.08.2003, ALF;
Roger Claude, Universite Lyon 1; 14.09.2003 - 30.09.2003, ALF;
Rosly Alexei, Institute of Theoretical and , Experimental Physics (ITEP); 16.09.2003 - 01.10.2003, ALF;
Rossmann Jürgen, University of Rostock; 19.11.2003 - 23.11.2003, SFS;
Roublev Ilia, Moscow Lomonosov State University; 04.02.2003 - 10.02.2003, LM;
Roubtsov Vladimir, Université d'Angers, Département de Mathématiques ; 18.09.2003 - 28.09.2003, KNV;
Roy Damien, University of Ottawa; 05.10.2003 - 11.10.2003, WMS;
Roytenberg Dmitry, Utrecht University; 03.08.2003 - 08.08.2003, ALF;
Rusza Imre, Reńyi Institute; 17.03.2003 - 07.04.2003, LIM;
Samtleben Henning, Utrecht University , Spinoza Institute; 28.09.2003 - 08.10.2003, KNV;
Schach M/oller Jacob, Universität Mainz; 06.12.2003 - 07.12.2003, YNG;
Schinzel Andrzej, Institute of Mathematics, Polish Academy of Sciences; 06.10.2003 - 10.10.2003, WMS;
Schlickewei Hans Peter, Philipps-Universität, Fachbereich Mathematik und Informatik ; 05.10.2003 - 11.10.2003, WMS;
Schmidt Gunther, Weierstrass Institut für, angewandte Analysis; 03.11.2003 - 08.11.2003, SFS;
Schmidt Wolfgang, University of Colorado; 06.10.2003 - 17.10.2003, WMS;
Schoissengeier Johannes, Uni Klagenfurt; 06.10.2003 - 10.10.2003, WMS;
Schroer Bert, CBPF Rio de Janeiro; 26.08.2003 - 12.09.2003, YNG;
Seeger Andreas, University of , Wisconsin-Madison; 01.03.2003 - 09.03.2003, LIM;
Séré Eric, University of Paris-Dauphine; 06.12.2003 - 07.12.2003, YNG;
Ševera Pavol, Comenius University, Faculty of Mathematics and Physics, Department of Theoretical Physics; 04.08.2003 - 11.08.2003, ALF;
Shapiro Ilya, Juiz de Fora; 15.09.2003 - 05.10.2003, KNV;
Sharpe Eric, University of Illinois; 24.11.2003 - 26.11.2003, KNV;
Shub Michael Ira, IBM; 21.10.2003 - 23.10.2003, SCH;

Siedentop Heinz, Universität München; 06.12.2003 - 08.12.2003, YNG;
Simon Christoph, Dept. of Physics; 04.09.2003 - 08.09.2003, YNG;
Singer Ivan, Institute of Mathematics; 04.02.2003 - 10.02.2003, LM;
Sipe John, University of Toronto; 14.08.2003 - 24.08.2003, YNG;
Sjamaar Reyer, Cornell University; 01.08.2003 - 16.08.2003, ALF;
Sjoelin Per, Royal Insitute of, Technology; 19.02.2003 - 01.03.2003, LIM;
Skovborg Anders, Aarhus University; 03.08.2003 - 09.08.2003, ALF;
Skriganov Maxim, Steklov Institute of Mathematics St.Petersburg Branch; 05.10.2003 - 12.10.2003, WMS;
Slade Paul, University of Minnesota; 10.02.2003 - 22.02.2003, BBB;
Sobolevskiy Andrey, Moscow State University, Physics Department, Quantum Statsitics and Field Theory Division; 05.02.2003 - 10.02.2003, LM;
Solymosi Jozsef, University of California ; 24.02.2003 - 03.03.2003, LIM;
Soria Fernando, Universidad Autonoma de Madrid; 20.03.2003 - 29.03.2003, LIM;
Oestergaard Soerensen Thomas, University of Copenhagen, Department of Mathematik; 26.03.2003 - 01.04.2003, HO; 09.06.2003 - 15.06.2003, YNG; 02.12.2003 - 07.12.2003, YNG;
Souček Vladimir, Charles University, Faculty of Mathematics and Physics, Mathematical Institute; 24.06.2003 - 25.06.2003, CAP; 30.09.2003 - 01.10.2003, CAP;
Stanton Robert J., Ohio State University; 07.08.2003 - 09.08.2003, ALF;
Stasheff James, University of North Carolina; 03.08.2003 - 09.08.2003, ALF;
Steinacker Harold, Ludwig-Maximiliansuniversität München, Institut f. Theoretische Physik; 23.03.2003 - 30.03.2003, MTK; 29.09.2003 - 05.10.2003, MTK;
Stenholm Stig, Royal Institut of Technology (KTH), Physics Department ; 02.09.2003 - 10.09.2003, YNG;
Stepanov Sergey A., Steklov Mathematical Institute; 05.10.2003 - 10.10.2003, WMS;
Stephan Wolfgang, Universität München, Department Biologie II; 11.02.2003 - 21.02.2003, BBB;
Stockmeyer Edgardo, Uni München; 06.12.2003 - 07.12.2003, YNG;
Strobl Thomas, TPI Jena, ; 11.08.2003 - 16.08.2003, ALF; 21.09.2003 - 12.10.2003, KNV;
Sturm Anja, WIAS; 19.02.2003 - 21.02.2003, BBB;
Summerer Leonhard, Uni Wien; 06.10.2003 - 10.10.2003, WMS;
Suzuki Haruo, Hokkaido University; 04.08.2003 - 08.08.2003, ALF;
Szabados László, Benő, Research Inst. for Particle and Nuclear Physics, Hungarian Academy of Sciences; 26.06.2003 - 16.07.2003, BSC;
Szenes Andras, BME Institute of Mathematics, Department of Geometry; 23.08.2003 - 07.09.2003, ALF;
Tang Xiang, UC Berkeley; 04.08.2003 - 09.08.2003, ALF;
Thiele Christoph, UCLA; 02.03.2003 - 18.03.2003, LIM;
Thunder Jeff, Northern Illinois University; 06.10.2003 - 10.10.2003, WMS;
Tijdeman Robert, University Leiden; 05.10.2003 - 12.10.2003, WMS;
Todorov Ivan, Bulgarian Academy of Sciences, Institute for Nuclear Research and Nuclear Energy; 02.11.2003 - 16.11.2003, MTK;
Tolman Susan, University of Illinois; 03.08.2003 - 16.08.2003, ALF;
Toth Arpad, Eotvos University; 04.12.2003 - 05.12.2003, SCH;
Tsikh August, Krasnoyarsk State University; 06.02.2003 - 09.02.2003, LM;
Tumpach Barbara, Ecole Polytechnique; 04.08.2003 - 15.08.2003, ALF;
Turelli Michael, University of California, Section of Evolution and Ecology; 08.12.2003 - 22.12.2003, BBB;
Tuynman Gijs, Universite de Lille I; 04.08.2003 - 08.08.2003, ALF;
Van Enckevort Christian, Johannes Gutenberg Universität ; 24.11.2003 - 05.12.2003, KNV;
Van Nieuwenhuizen Peter, State University of New York; 16.05.2003 - 15.06.2003, SF;
Vandoren Stefan, Spinoza Institute; 06.12.2003 - 10.12.2003, KNV;
Vassilevich Dmitri, Leipzig University; 07.09.2003 - 12.10.2003, KNV; 10.12.2003 - 31.12.2003, KNV;
Vega Luis, Universidad Del Pais Uasco, Departemento De Matematicas; 24.02.2003 - 01.03.2003, LIM;
Venkataramana Tyakal, Tata Institute, School of Math.; 13.10.2003 - 31.10.2003, SFS;
Vergne Michéle, CNRS, Centre de Mathematique, Ecole Polytechnique; 25.08.2003 - 18.09.2003, ALF;
Viola Carlo, Universita di Pisa; 05.10.2003 - 11.10.2003, WMS;
Viro Oleg, Uppsala univeristat, Matematiska institutionen; 03.02.2003 - 09.02.2003, LM;

Vizman Cornelia, West University of Timisoara, Insitute of Mathematics; 18.01.2003 - 16.02.2003, MI; 03.08.2003 - 16.08.2003, ALF; 29.09.2003 - 12.10.2003, ALF;
Vu Ngoc San, Institut Fourier; 03.08.2003 - 10.08.2003, ALF;
Wade Aissa, Penn State University; 04.08.2003 - 16.08.2003, ALF;
Wagner Andreas, University of New Mexico, Department of Biology ; 08.01.2003 - 17.01.2003, BBB;
Wagneur Edouard, IRCCYN; 03.02.2003 - 10.02.2003, LM;
Wakolbinger Anton, Universität Frankfurt, FB Mathematik; 27.12.2003 - 10.01.2003, BBB; 17.02.2003 - 26.02.2003, BBB; 10.12.2003 - 18.12.2003, BBB;
Wald Robert, University of Chicago, Enrico Fermi Insitute; 14.07.2003 - 25.07.2003, BSC;
Waldmann Stefan, Fakultät f. Mathematik und Physik; 03.08.2003 - 09.08.2003, ALF;
Waldschmidt Michel, Université M. Curie, Institut de Mathématiques; 06.10.2003 - 11.10.2003, WMS;
Walser Markus, Uni Mainz; 06.12.2003 - 07.12.2003, YNG;
Wang Yang, Georgia Institute of Technology; 24.02.2003 - 04.03.2003, LIM;
Weinstein Alan, University of California; 02.08.2003 - 10.08.2003, ALF;
Weinstein Gilbert, University of Alabama at Birmingham; 14.07.2003 - 22.07.2003, BSC;
Weitsman Jonathan, UC Santa Cruz; 04.08.2003 - 19.08.2003, ALF;
Wess Julius, Universität München; 13.03.2003 - 19.03.2003, MTK; 15.10.2003 - 15.12.2003, SF;
Wohlgenannt Michael, Universiät München, Institut für Theoretische Physik; 22.01.2003 - 25.01.2003, MTK;
Wojtkiewicz Jacek, Dept. for Mathematical Methods in Physics; 06.12.2003 - 07.12.2003, YNG;
Wolf Joseph A., University of California; 03.08.2003 - 08.08.2003, ALF; 14.08.2003 - 23.08.2003, ALF;
Wulkenhaar Raimar, Max-Planck-Institute for Mathematics in the, Sciences; 24.02.2003 - 02.03.2003, MTK; 30.03.2003 - 04.04.2003, MTK; 04.10.2003 - 16.10.2003, MTK; 27.10.2003 - 02.11.2003, MTK;
Wright James, University of Edingburgh; 01.03.2003 - 11.03.2003, LIM;
Wugalter , Math. Institut; 06.12.2003 - 07.12.2003, YNG;
Yajima Kenji, University of Tokyo, Department of Mathematical Sciences; 11.03.2003 - 16.03.2003, YNG;
Yakimov Milen, University of California; 20.08.2003 - 31.08.2003, ALF;
Yoshimura Hiroaki, Waseda University; 04.08.2003 - 13.08.2003, ALF;
Yu Kunrui, Hong Kong University; 06.10.2003 - 10.10.2003, WMS;
Zagier Don, MPI für Mathematik; 13.01.2003 - 15.01.2003;
Zambon Marco, UC Berkeley; 03.08.2003 - 10.08.2003, ALF;
Zannier Umberto, Istituto Universitario d'Architettura (I.U.A.V.); 05.10.2003 - 10.10.2003, WMS;
Zaslavskiy Oleg, Kharkov National University; 21.09.2003 - 14.10.2003, KNV;
Zehnder Eduard, ETH-Zentrum; 04.08.2003 - 08.08.2003, ALF;
Zelnikov Andrei, University of Alberta; 21.09.2003 - 12.10.2003, KNV;
Zenk Heribert, LMU München; 05.12.2003 - 08.12.2003, YNG;
Zhang Xu-Sheng, Institute of Cell, Animal, Population Biology ; 17.02.2003 - 22.02.2003, BBB;
Zhu Chenchang, UC Berkeley; 03.08.2003 - 10.08.2003, ALF;
Zimmermann Karel, Charles University, Faculty of Mathematics and Physics; 04.02.2003 - 08.02.2003, LM;
Zint Natali, Uni Greifswald; 06.12.2003 - 13.12.2003, BBB;
Zurek Woscilech, MSB288T-6 Theoretical Astrophysics; 02.09.2003 - 07.09.2003, YNG;
Zukowski Marek, Uniwersytet Gdanski, Instytut Fizyki Teoretycznej 1; 24.10.2003 - 05.11.2003, YNG;
Zymonopoulou Maria-Isabelle, University of Missouri, Department of Mathematics; 22.02.2003 - 02.03.2003, LIM;

List of seminars and colloquia outside the conferences

2003 01 13 , A. Wagner: "The structure of genetic networks: design, history, or (mere) chemistry?"
2003 01 20 , J. Hofbauer: "Unequal crossover dynamics"
2003 01 21 , A. von Haeseler: "Testing substitution models within a phylogenetic tree"
2003 01 27 , D. Lenz: "Measure dynamical systems with pure point spectrum"
2003 01 28 , V. Hutson: "Reaction Diffusion Equations with non-local Dispersal"
2003 01 29 , K. Rietsch: "The Peterson variety and total positivity"
2003 02 03 , S. Grossmann: "Statistics of optimal sequence alignments"
2003 02 04 , B. Yakir: "Large deviations for smooth processes"
2003 02 06 , B. Griffiths: "Diffusion processes, reversibility, frequency spectrum and the age of a mutation"
2003 02 11 , P. Slade: "Modeling resistance evolution in a genetically modified plant-herbivore interaction "
2003 02 12 , C. Vizman: "Coadjoint orbits of the group of Hamiltonian diffeomorphisms and Prequantization"
2003 02 13 , J. Geiger: "Growing conditioned trees"
2003 02 14 , M. Notohara: "The stepping stone model with a generalized diffusion term"
2003 02 17 , B. Griffiths: "Importance sampling on evolutionary histories of samples of genes "
2003 02 17 , J. Gillespie: "Is the population size of a species relevant to its evolution? "
2003 02 17 , P. Slade: "Non-neutral genealogical structure "
2003 02 17 , W. & Y. Kim: "Selective sweeps in the presence of interference among partially linked loci "
2003 02 18 , A. Etheridge: "The distribution of surviving blocks of ancestral genomes "
2003 02 18 , G. Kersting: "Path decompositions for Markov chains "
2003 02 18 , M. Möhle: "Forward and backward diffusion processes in exchangeable population models "
2003 02 18 , M. Notohara: "Effects of population structure on the genealogy and DNA polymorphism for sampled genes "
2003 02 19 , D. Metzler: "Statistical alignment based on fragment insertion and deletion models "
2003 02 19 , M. Benaim: "Self interacting diffusion "
2003 02 19 , X. Zhang: "Pleiotropic mutations,selection and genetic variation in quantitative traits"
2003 02 20 , A. Sturm: "A coalescent incorporating mutation and selection "
2003 02 20 , H. Georgii: "Multitype Galton-Watson processes: the ancestral types of typical individuals "
2003 02 20 , J. Geiger: "The shape of large Galton-Watson trees"
2003 02 20 , P. Pfaffelhuber: "The finite system scheme for state-dependent multitype branching processes "
2003 02 21, A. Wakolbinger: "Hierarchical equilibria of branching populations "
2003 02 21 , P. Jagers: "Branching processes in random, near critical environments "
2003 02 21 , W. Angerer: "Realistic models of cell proliferation in fluctuation analysis "
2003 02 24 , A. Cordoba: "Fractal Fourier Series "
2003 02 24 , G. Mockenhaupt: "On the Hardy-Littlewood majorant problem"
2003 02 24 , P. Sjoelin: "A theorem of Antonov on convergence of Fourier series"
2003 02 24 , S. Konyagin: "Rearrangement of trigonometric Fourier series"
2003 02 25 , I. Barany: "On the randomized integer convex hull"
2003 02 25 , K. Oskolkov: "t.b.a"
2003 02 25 , M. Nathanson: "A functional equation arising from multiplication of quantum integers"
2003 02 25, M. Nathanson: "Representation functions of additive bases for the integers"
2003 02 25 , Y. Wang: "Bernoulli convolution associated with certain non-Pisot numbers"
2003 02 26 , S. Hofmann: "Falconer conjecture for random metrics "
2003 02 26 , W. Ewens: "Challenges for Mathematics in Genetics - a Personal View"
2003 02 27 , A. Magyar: "t.b.a"
2003 02 27 , L. Vega: "t.b.a"
2003 02 27 , M. Kempe: "Boundedness of maximal operators associated to quasi-homogeneous hypersur-

faces"
2003 02 27 , S. Gunturk: "One-Bit Quantization: 0-1 sequences with prescribed moving averages"
2003 02 28 , J. Bak: "A restriction theorem for a 2-dimensional surface in R"
2003 02 28 , J. Solymosi: "On sums and products of complex numbers"
2003 02 28 , L. Grafakos: "Sublevel set estimates for the Carleson-Hunt operator"
2003 02 28 , O. Kovrizhkin: "Periodizations over integer lattices"
2003 03 06 , D. Müller: "More on the Kakeya-Problem and the wave-equation"
2003 03 12 , T. Morimoto: "Nilpotent geometry and the curvatures of a subriemannian structure"
2003 03 13 , G. Gallavotti: "Statistical equivalence in fluid mechanics models"
2003 03 13 , H. Narnhofer: "Non-commutative Ergodic Theory"
2003 03 13 , V. Jones: "Surprises from Subfactors"
2003 03 14, E. Lieb: "The Dilute, Cold Bose Gas: A Truly Quantum-Mechanical Many-body Problem"
2003 03 14, H. van Beijeren: "The Uphill Turtle Race: Short Time Behavior of Nucleation Probabilities"
2003 03 14, J. Fröhlich: "Dissipative Transport (recent results)"
2003 03 14 , K. Oskolkov: "Schrödinger Equation and Oscillatory Hilbert Transforms"
2003 03 17, G. Harder: "A congruence between a Siegel modular form and a classical one"
2003 03 19 , A. Cap: "A remarkable class of overdetermined systems of PDEs"
2003 03 25 , C. Muscalu: "On multi-linear singular integral operators"
2003 03 25 , L. Colzani: "Summability of Fourier expansions"
2003 03 26 , A. Koldobsky: "Projections of convex bodies and the Fourier transform"
2003 03 26 , D. Burde: "Über Multiplizitäten im Längenspektrum Riemannscher Flächen"
2003 03 26 , F. Soria: "On certain weigthed inequalities for fractional integrals "
2003 03 26 , I. Laba: "t.b.a"
2003 03 26 , J. Conlon: "Combinatorial problems in PDEs"
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2003 03 28 , A. Iosevich: "Analysis and combinatorics of distance sets"
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2003 03 28 , M. Kolountzakis: "t.b.a"
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and their applications"
2003 06 26, H. Bray: "the Penrose inequality I"
2003 06 27, H. Bray: "the Penrose inequality II"
2003 06 30 , H. Bray: "the Penrose inequality III"
2003 07 01 , H. Bray: "the Penrose inequality IV"
2003 07 01 , J. Lohkamp: "Positive Scalar Curvature I"
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2003 07 03 , M. Aarons: "Mean curvature flow of spacelike hypersurfaces"
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2003 07 11 , T. Ilmanen: "Topology, Infinity, etc."
2003 07 14 , S. Hayward: "Penrose and other inequalities for black holes in or near spherical symmetry"
2003 07 15 , M. Mars: "On the monotonicity of the Hawking mass"
2003 07 15 , M. Mars: "the monotonicity of the Hawking mass "
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2003 08 12 , P. Paradan: "K-multiplicities and moment maps"
2003 08 12, V. Guillemin: "Symplectic toric spaces with isolated singularities"
2003 08 12 , Y. Karshon: "Geometric quantization and spin c structures"
2003 08 13 , E. Meinrenken: "A proof of Witten's formulas for moduli spaces of flat connections "
2003 08 13, H. Bursztyn: "Dirac structures and group-valued moment maps"
2003 08 13 , R. Sjamaar: "Quasi-Hamiltonian implosion"
2003 08 13, S. Tolman: "The homology of quasi-Hamiltonian reductions: an index formula"
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2003 08 14, J. Weitsman: "The Euler Maclaurin formula with remainder for simple polytopes"
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2003 09 04 , A. Szenes: "The Mirror Toric Residue Conjecture"
2003 09 04 , M. Vergne: "An integration formula for toric reductions"
2003 09 08 , A. Alekseev: "Invariant differential operators on symmetric spaces and the Duflo-Rouviere map"
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2003 09 19 , A. Filippov: "Integrable two dimensional theories describing higher dimensional branes, black holes and cosmologies"
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2003 09 22, J. Navarro-Salas: "Stress Tensor and Anomalies in Dilaton Coupled Theories"
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2003 09 22 , W. Kummer: "2D gravity - "Vianna style""
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2003 09 23 , M. Bojowald: "Two-dimensional models in loop quantum gravity"
2003 09 23 , M. Katanaev: "Two-dimensional gravity and the problem of energy"
2003 09 24 , D. Grumiller: "Quantum Dilaton Gravity - Virtual Black Holes an the S-Matrix"
2003 09 24 , O. Zaslavskii: "Black hole and cosmological solutions in exactly solvable models of 2D dilaton gravity"
2003 09 24 , R. Jackiw: "Two lectures on two-dimensional gravity"
2003 09 24 , V. Frolov: "Non-Minimally Coupled Massive Scalar Field in a 2D Black Hole: Exactly Solvable Model"
2003 09 25 , D. Gal'tsov: "Algebra Virasoro on the horizon of rotating dilaton black hole and the problem

of the entropy of extremal black holes"
2003 09 25 , L. Bergamin: "gPSM approach to 2D(quantum) dilaton supergravity"
2003 09 25 , R. Jackiw: "Two lectures on two-dimensional gravity"
2003 09 26 , A. Barvinsky: "Nonperturbative heat kernel and the cosmological constant problem"
2003 09 26 , A. Filippov: "Summary of talk I and II"
2003 09 26 , F. Hehl: "Summary of talk I"
2003 09 26 , I. Shapiro: "Summary of talk I and II"
2003 09 26 , M. Niedermaier: "Dimensionally reduced gravity theories are asymptotically safe"
2003 09 26 , Y. Itin: "Einstein and Cartan in chains: The two dimensional case"
2003 09 29 , D. Vassilevich: "Non-commutative heat kernel"
2003 09 29 , M. Buric: "2D noncommutative gravity (an example)"
2003 09 29 , R. Mann: "Chaos in 2D Relativistic Self-Gravitating Systems"
2003 09 29 , V. Radovanovic: "The one loop effective action for theta expanding noncommutative SU(2) YM theory"
2003 09 30 , A. Hirshfeld: "The Poisson-Sigma model and deformation quantization"
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2003 09 30 , S. Mignemi: "Deformations of Poincare algebra and two-dimensional gravity"
2003 09 30 , T. Strobl: "Topological gravity models in d spacetime dimensions"
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2003 10 01 , G. Fodor: "Dynamical magnetic monopoles"
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2003 10 02, M. Cadoni: "Entropy of the 3-brane from a two-dimensional perspective"
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2003 10 03, I. Kostov: "Boundary correlations in 2D Quantum Gravity"
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2003 10 06 , J. Thunder: "Wolfgang Schmidt's influence on the study of Thue equations, Thue inequalities, and generalizations"
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2003 10 06, T. Rivoal: "Basic hypergeometric series and arithmetic consequences"
2003 10 06 , V. Belinski: "The Quantum Field Theory behind the Hawking Effect in two dimensional spacetime"
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2003 10 07 , D. Roy: "Diophantine approximation in bounded degree"
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2003 10 08 , J. Gegenberg: "Stringy Gravity and the Thurston Geometrization Conjecture"
2003 10 08 , M. Laurent: "Totally real integral points on a plane algebraic curve"
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2003 10 09 , G. Remond: "Intersection of subvarieties and subgroups on abelian varieties"
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2003 10 09 , J. Schoissengeier: "The distribution (mod 1) of the multiples of an irrational number"
2003 10 09 , M. Bojowald: "Classical Solutions for Poisson Sigma Models on a Riemann surface"
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2003 10 09 , P. Corvaja: "Diophantine equations with linear recurrences"
2003 10 09 , S. Moskaliuk: "On the Polarization Effects of CMB in the Anisotropic Bianchi-I Cosmological Model"
2003 10 09 , U. Zannier: "Some diophantine equations in several variables"
2003 10 09 , W. Chen: "Orthogonality in the classical discrepancy problem"
2003 10 10 , E. Hlawka: "Persoenliche Worte ueber Wolfgang Schmidt"
2003 10 10 , H. Hejtmanek: "Diophantos, Arithmetica"
2003 10 10 , H. Schlickewei: "The mathematical work of Wolfgang Schmidt"
2003 10 10 , R. Baker: "Diophantine inequalities"
2003 10 10 , R. Tichy: "Closing words"
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2003 10 10 , S. Stepanov: "Orbit sums on vector modular invariants"
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2003 10 16 , T. Venkataramana: "the first Betti number of arithmetic hyperbolic manifolds"
2003 10 20 , D. Anosov: "Three lectures on Spectra of Ergodic Transformations"
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2003 10 21, H. Araki: "Equilibrium statistical mechanics of Fermion lattice systems"
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2003 10 27 , A. Papadopoulos: "Transversely affine foliations on surfaces"
2003 10 29 , I. Bandos: "Lagrangian description of supergravity interacting with super-p-brane objects and super-Higgs effect in such interacting systems"
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2003 11 05 , A. Cap: "Automorphism groups of parabolic geometries"
2003 11 11 , P. Minkowski: "Supersymmetric Yang-Mills theories and spontaneous parameters"
2003 11 12 , D. Repovs: "On the Hilbert-Smith conjecture and related problems"
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2003 12 17 , E. Baake: "An asymptotic maximum principle for essentially linear evolution models"
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