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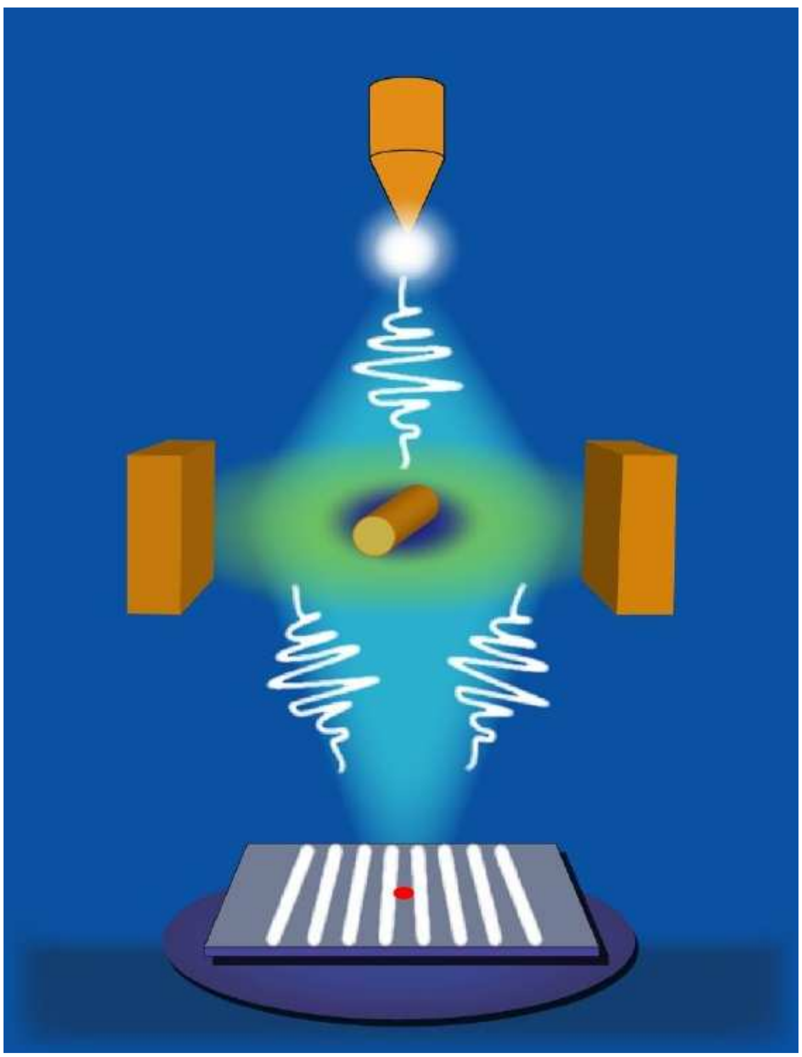

International Association of Mathematical Physics News Bulletin, April 2010

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Cover photo (courtesy of Professor A.Tonomura): From double-slit experiment to the Aharonov-Bohm effect. See a comment at the end of the page 7.

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Reflections on the IAMP Geography

by Pavel Exner (IAMP President)

The topic of today's meditation was inspired by complaints of American colleagues about the shaky position our discipline enjoys in the U.S. True, such woes are ubiquitous since competition for resources in science was and will always be tough. Nevertheless some of them give you the feeling that the problem may be serious. It is thus useful to look how different mathematical physics communities around the world are doing.

The two main IAMP buttresses are traditionally Europe and North America which together account for some eighty percent of the membership. Looking at the numbers, one finds a remarkable stability, with the ratio two-to-one in favour of Europe. This is true not only relatively: after we rechecked the membership list recently, we found only slightly more members than we had in 1980, when the Association was just a few years old, and the numbers then and now look very similar.

The said ratio need not mean that the European situation is better, after all it corresponds to the population ratio of the two geographical areas. It seems, nevertheless, that the Old Continent is not doing badly. Let me restrict myself to one example. Three years ago the EU started its project of supporting basic research through the European Research Council, conceived to be a counterpart to the NSF, JSPS, and similar agencies worldwide. Of its 950 prestigious — and substantial — grants awarded so far in all science fields a full *fourteen* went to IAMP members, of which 12 were awarded through mathematics panels and two through physics.

Not a bad score for a society of our size! Since we are proud of our successful colleagues, it is appropriate to name them here. In the "starting" category, up to ten years after PhD, they are, alphabetically: *Massimiliano Berti, Mihalis Dafermos, Søren Fournais, Alessandro Giuliani, Benjamin Schlein, Frank Verstraete*, and *Katrin Wendland*; in the "advanced" category without age limitations: *Demetrios Christodolou, Antti Kupiainen, Carlangelo Liverani, Roberto Longo, Fabio Martinelli, Giorgio Parisi*, and *Stanislav Smirnov*. We wish them success with their projects, and we hope they will not remain alone and that they will soon find followers.

The situation across the Atlantic looks much less satisfactory, and the complaints I quoted in the introduction often concerned difficulties with obtaining an NSF support for a mathematical-physics project. Since none can have doubts about the wealth of talent in the New World, the only plausible explanation is that the activities of our colleagues there are drifting to other areas, often probably to the territory of "pure" mathematics.

We do not have data which would allow us to gauge this spreading process, but it is instructive to look at the distribution of about 140 conferences and schools posted at the IAMP website during roughly the last decade, without distinguishing whether a meeting was supported by the IAMP or not — it is a plausible assumption that this is a representative list of mathematical-physics gatherings around the world, or more exactly, those which their organizers label as such. Now in this sample the Europe vs. North America ratio is about *four-to-one*, and worse than that, the imbalance has grown rapidly with time. It is probably no accident that, despite repeated efforts, the IAMP has not managed to hold one of its congresses on North American territory for almost three decades.

This is certainly a worrisome tendency — a structure becomes unstable when one of its legs seriously weakens — and we have to discuss what can be done. Naturally, we are most interested in hearing opinions of our American colleagues on this issue, and the pages of the News Bulletin are the most appropriate place to express them.

To conclude, let me add that the transatlantic balance is not the only information one can read from our database, and a closer look reveals other interesting facts. Some regional communities are strong and stable, while on the other hand, there are surprisingly weak ones at places where mathematical physics have a solid tradition. This goes beyond this editorial frame, however, it gives the Executive Committee food for thought.

Aharonov-Bohm & Berry Phase Anniversaries 50/25

by Masao Hirokawa (Okayama, Japan)

The 50th anniversary of the discovery of the Aharonov-Bohm effect and the 25th anniversary of that of the Berry phase passed brilliantly last year. An international meeting (ABB 50/25) was held on the 14th and 15th of December 2009 at the University of Bristol, from which the famous papers [AB, C, B] came out, organized by Prof. Sandu Popescu, Prof. Mark Dennis, and Prof. Bob Evans [PV]. Many mathematicians as well as theoretical and experimental physicists were on hand to celebrate these two anniversaries.

M. Peshkin (left), Y. Aharonov (center), and M. Berry (right)

Before Y. Aharonov and D. Bohm published their sensational paper [AB], the vector potential was believed to be merely a mathematical tool to help solve several electromagnetic problems easily, but, it had not been at all regarded as a real field. Now, however, it has been established that the Aharonov-Bohm effect is due to the vector potential as a quantum-mechanical phenomenon, and thus, the vector potential is indeed a real field, in the sense of a gauge field, and a foundation of gauge field theory. Assume that a magnetic field $\vec{B}$ is confined to a region Ω perfectly, so that $\vec{B} = \vec{0}$ outside Ω. The vector potential is given by the electromagnetic potential $\vec{A}$, with $\vec{A} \neq \vec{0}$ outside Ω. Then, Y. Aharonov and D. Bohm asserted that an electron would be affected by the vector potential even if the electron lives outside Ω, and thus, never touches the magnetic field: To see this amazing phenomenon of the Aharonov-Bohm effect simply and shortly, we employ the path-integral description for the electron propagating from the point x to the point y, and calculate the distribution of the electron at y. Consider two paths P_1 and P_2 of the electron outside Ω such that both paths have the starting point x and the end point y, such that the loop (i.e., the closed curve $P = P_1 - P_2$ made by connecting P_1 and P_2) encircles Ω. Then we can find a contribution from P_1 and P_2, thanks to Stokes' theorem, as

$$\left(e^{ie\int_{P_1}\vec{A}\cdot d\vec{x}}\right)\left(e^{ie\int_{P_2}\vec{A}\cdot d\vec{x}}\right)^{*} = e^{ie\oint_P \vec{A}\cdot d\vec{x}} = e^{ie\int \vec{B}\cdot d\vec{S}}, \qquad \hbar = c = 1,$$

in the interference pattern. Namely, we have obtained the flux $\int \vec{B} \cdot d\vec{S}$ enclosed by P as a phase shift, known as the Aharonov-Bohm phase [R, A, H], even though the wave function of the electron passes around Ω without touching the magnetic field! In the early stage of the history of the Aharonov-Bohm effect, as is well known, it was not recognized by many authorities in physics other than R. P. Feynman and a few other physicists. R. G. Chambers was the first to tackle the problem of its experimental demonstration [C], which was performed shortly after Aharonov and Bohm's paper was published. G. Möllenstedt and W. Bayh [MB] and other groups followed him. Opponents of the Aharonov-Bohm effect claimed that there was leakage of magnetic field from Ω with finite size for their experiments, and thus, that the electron touches the magnetic field that leaks out. Here we recall that Y. Aharonov and D. Bohm employed an infinitely long solenoid as Ω. Thus, whether the Aharonov-Bohm effect is a physical reality was at the center of a controversy in physics. It had seemed to be hardly demonstrated with a perfect experiment until about twenty-five years ago, when A. Tonomura and his collaborators settled the physical controversy with their series of experiments using holography electron microscopes [O, T1, PT]. The cover photo is a schematic illustration of a holography electron microscope [T2], provided by Prof. Akira Tonomura with his kind permission. *We are preparing an article on the interview with Prof. Tonomura for the next issue of the IAMP News Bulletin.*

The Berry phase is, roughly speaking, a generalization of the Aharonov-Bohm phase, and it is the realization of holonomy in quantum mechanics, namely, the Berry phase corresponds to the holonomy group of a fiber bundle. For further details, please read Refs.[B, S]

At ABB 50/25 the great mathematician Prof. Michael Atiyah and our IAMP colleague Prof. Joseph Avron were among the invited speakers. The titles of their talks were respectively "Topology and Quantum Physics" (by Prof. Atiyah) and "Swimming in Curved Space: the Baron, the Sir and the Cat" (by Prof. Avron). As for titles of all invited speakers, please visit the home page of the ABB 50/25 (http://abb.iopconfs.org/). In some of their talks they came up with the stories about experimental demonstrations of the Aharonov-Bohm effect, the Aharonov-Casher effect, and the Berry phase. Every speech was unique and fascinating. The audience sometimes roared with laughter at amusing stories and sometimes had to strain their brains to answer questions. In particular, Prof. Yakir Aharonov had a lecture on some paradoxes in physics (see Ref.[AR]).

M. Atiyah (right)

J. Avron

Prof. Tonomura gave a talk with the title “Observation of Gauge Fields by Electron Waves” there, too. In an interview to appear in the next bulletin, he says the Aharonov-Bohm effect is an essence in physics, and it is so magnetic that many scientists in several fields have been studying it. Also, he says his heart leaps for joy at the result of the experiment by using our familiar tools. Actually, before his talk, Prof. Andre Geim had a talk entitled “Of Flying Frogs, Berry Phases and Other Stuff.” As everyone knows, they succeeded in levitating a frog with magnets and delighting our scientific mind.

Y. Aharonov (left) and A. Tonomura (right)

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* * *

Professor Akira Tonomura group (HARL) experiment, see figure on the cover page:

> *In this experiment, electrons shot individually at a certain interval travel through a device called an electron bi-prism before reaching a detector, where they are recorded as individual particles. At first, it appears that electrons reach the detector at random, but as the number of electrons increases, a pattern (interference fringes) begins to emerge. The Aharonov-Bohm effect can be observed as a shift of the interference pattern.*

The 25th anniversary of the founding of HARL

by Masao Hirokawa (Okayama, Japan)

A ceremony celebrating the 25th anniversary of the founding of Hitachi Advanced Research Laboratory (HARL) was held on the 1st of this April. It is one of research institutes of Japanese company, Hitachi Ltd, where researchers have been mainly engaging in fundamental physics and human science. This reporter was once a member of HARL, and so, took part in the ceremony. HARL was founded in 1985 in memory of the 75th anniversary of the founding of Hitachi Ltd. At the ceremony Dr. Haruo Takeda, the present Director of HARL, had a celebration speech first, and briefly described the recent activity of HARL. After him, Dr. Eiichi Maruyama, who was the first Director of HARL, gave a speech, and talked about the history of HARL and the current condition of the Japanese economy in the business world of technology. According to his talk, HARL started its activities inside the campus of Hitachi Central Research Laboratory (HCRL). In 1990 HARL was settled in the new site from HCRL so that electron microscopes of Tonomura's group would be protected from troubles such as vibration and magnetic field caused by, for example, electric trains. Thus it is located in suburban area of Saitama prefecture, Japan. Dr. Akira Tonomura is one of the Hitachi Fellows, also, a group director of RIKEN (http://www.riken.go.jp/engn/index.html), and he was a professor of Okinawa Institute of Science and Technology until February of this year. Almost all of his experiments, such as the experiment for demonstration of the Aharonov-Bohm effect and the double-slit experiment with electrons for the demonstration of particle-wave duality, have been performed in HCRL and HARL, his home grounds. We can find photos of their experimental results in several textbooks of physics and enlightening books such as "Warped Passages" by Prof. Lisa Randall. In particular, the latter, the double-slit experiment, was selected as "the most beautiful experiment in the history of science" in a 2002 polls of readers of IOP journal, Physics World. We can also enjoy their experiments on the web page (http://www.hitachi.com/rd/research/em/movie.html); their experimental technology knows no bound. They are always exploring new frontiers in quantum measurement, and thus, their cutting-edge technology often gives reality to mathematical theory. *We will report them in the next IAMP News Bulletin. An article containing an interview with Dr. Tonomura is in preparation.*

Physicists in HARL have studied quantum measurement and material science in the light of fundamental physics not only to launch new enterprises in Hitachi but also to make progress in physics. Dr. Shojiro Asai, who was the second Director of HARL, often said that mathematicians connected with physics in HARL should learn real physics in the contact of experiments there as well as theory so that they would share a common language with physicists. So, for instance, they are required to develop their sense of units and the ability to analyse experimental data, etc. As one of contributions to physics by

HARL, there is the International Symposium on Foundations of Quantum Mechanics in the Light of Technology (ISQM) (cf. http://www.hqrd.hitachi.co.jp/isqm/). It has been held every three years since 1983. The first four ISQMs met at HCRL. After that, all ISQMs have been held at HARL under the auspices of the Physical Society of Japan, the Japan Society of Applied Physics, and Hitachi Ltd. Many great physicists have been members of the advisory committee and the organizing committee, and/or attended each ISQM: Y. Aharonov, A. Aspect, L. Esaki, H. Ezawa, K. Fujikawa, P. G. de Gennes, Y. Imry, H. J. Kimble, S. Kobayashi, R. Kubo, R. Landauer, A. J. Leggett, J. E. Mooij, S. Nakajima, Y. Nambu, M. Namiki, M. Peshkin, I. Prigogine, G. 't Hooft, R. A. Webb, J. A. Wheeler, Y. Yamamoto, C. N. Yang, A. Zee, A. Zeilinger, and others. Some of them were already a Nobel Prize Laureates, and some were awarded the Nobel Prize afterwards. They frequently gave pointed advice to HARL researchers. The reporter remembers the question that he was often asked by the advisors, especially, by Prof. Chen-Ning Yang: "What is your contribution to physics?" In a sense this question represents HARL's spirit required even of mathematicians, because HARL is an institute within a private company and thus mathematical physics has to be a 'physical' and 'practical' science there. Dr. Tonomura received an item representing "$M \cap \Phi$ in HARL" from Prof. Yang. It is a Chinese picture drawn by Mr. Fan Zeng. In the picture the great theoretical physicist Chen-Ning Yang and the great mathematician Shiing-Shen Chern sit face to face with each other. Prof. Chern was once a student of Prof. Yang's father, Prof. Ko-Chuen Yang. HARL is a wonderland where mathematicians and both theoretical and experimental physicists want to gather and to talk with each other. At the end of this report, we recall some of the IAMP members who have visited HARL: Prof. Huzihiro Araki, Prof. Hiroshi Ezawa, Prof. Nobuaki Obata, and Prof. Taku Matsui.

The main building of HARL

IAMP Editorial Board would like to thank HARL for providing some materials about ISQM, and the photo of HARL's main building with their kind permission.

Professor Huzihiro Araki about the IAMP

Professor Huzihiro Araki has made phenomenal contributions to statistical physics and quantum field theory. He has made great progress in the theory of factors in von Neumann algebras and fundamental results on C-algebras. In 2003 Professor Araki was awarded the Henry Poincaré Prize 2003 for his lifetime contributions to the foundations of quantum field theory, quantum statistical mechanics, and the theory of operator algebras. Professor Araki was the second IAMP president and the one who drafted its Statutes. We are thankful to Professor Araki that he shares with the News Bulletin some of his thoughts about IAMP.*

Bulletin: *You are both a mathematician and a physicist. What was your way to this combination, which IAMP expresses as* $\mathrm{M} \cap \Phi$*?*

Araki: I will describe how I became both a mathematician and a physicist step by step. In primary school I did not learn any English (it was during the war), but I knew two English characters P and C as mathematical symbols for permutation and combination. At the age of junior high school, I absorbed various branches of mathematics such as group theory, higher algebra, analytic function theory, Lebesgue measure theory, theory of Hilbert spaces and so on (in Japanese texts). As my father is a theoretical physicist working on both quantum theory of atoms and molecules, and the theory of nuclei and mesons, there were a lot of books on these subjects as well as on quantum theory. So I also learned about quantum theory, which I used to tell one of class-mates on our way home from school. (I happened to be in a special class for science education consisting of about 30 students each year, selected from middle schools all over so-called Kansai Area including Kyoto, Osaka, Kobe and so on. In particular, at the final stage of the entrance examination for this class, we had an oral examination of three Kyoto University Professors on Physics, Chemistry and Biological Sciences, including Professor Yukawa.) While in senior high school, I learned German (in an unofficial club in my high school) and as an exercise on this language, I read the book of von Neumann on the mathematical foundation of quantum mechanics, which happened to be in my father's bookshelf. This is the first book I read on mathematical physics, but it was easy as I knew already quantum mechanics and Hilbert space theory. When I was in the third year of Kyoto University (Department of Physics), the Research Institute for Fundamental Physics with Professor Yukawa as its Director was created in Kyoto University (as a national center for joint research on theoretical physics), and the first big international conference after the war was held there (and in two other buildings). On the first day of the conference, as I was at the entrance of one of the buildings for the conference as an assistant interpreter, the first bus with foreign participants arrived and one young person who rushed in from the bus asked me where is the men's room? I pointed to the nearby toilet. This person is the first foreign scientists I ever talked to and he happened to be Professor C.N.Yang. Later, I had a chance to exchange a few words with Professor Wigner, but it was difficult to understand his accented English. This is the beginning of how I became a mathematical physicist. I should note that at that time, there was a high barrier between mathematicians and physicists in Japan. Mathematicians considered physicists' arguments unacceptable, while physicists considered mathematicians' arguments not useful. I could understand both sides and tried to be an interpreter. After obtaining a Master Degree under Professor Yukawa, I went to Princeton University with a Fulbright Fellowship. There I met with Professor Rudolf Haag who just arrived from Europe as a guest

Professor, and I immediately started discussions with him. (Professor Arthur Wightman came back from Europe half a year later.) Although I already knew a lot of mathematics and physics, it was Professor Haag who taught me how to obtain a significant insight in mathematical physics. While I was in U.S., for three years, I saw mathematical physics growing. There was a conference on mathematical physics in Shelter Island (at the tip of Long Island) organized by Friedrichs. I went there in a car with Professors Wightman, Haag, and Bargman. It is the first conference I attended outside of Japan and the first conference on mathematical physics. I saw Professor Wiener and Professor Van der Waerden. I remember Friedrichs was complaining about Van der Waerden taking a taxi from New York Airport to the conference site, which he had to pay. With respect to this happening, I had a different reaction, that the scientific contact between U.S. and Europe is quite close despite of the distance. Back in Princeton, when I obtained some general results about generalized retarded functions within the Wightman axioms for quantum fields, I was immediately told (either from Wightman or Haag) that the same work is being done by Ruelle and by Steinmann. About two years later, when I arrived in Zurich from Japan, the person who greeted me at the airport happened to be David Ruelle and his wife. I felt that the world of mathematical physicists is a close community.

Bulletin: *You participated in almost all ICMP, since the first one in Moscow 1972 initiated by N.N.Bogoliubov. The evolution of these Congresses reflects the evolution of Mathematical Physics and our Association. How do you view this evolution? In your opinion what are the important points in the IAMP history?*

Araki: Here I will tell you only about ICMP and I will write about the beginning of IAMP separately. If my memory is correct, ICMP (although this name was not used at the beginning) in the past were held in the following cities and years: 1.Moscow (1972), 2.Warsaw (1974), 3.Kyoto(1975), 4.Rome (1977), 5.Lausanne (1979), 6.Berlin (1981), 7.Boulder (1983), 8.Marseille (1986), 9.Swansea (1988), 10.Leipzig (1991), 11.Paris (1994) 12.Brisbane (1997), 13.London (2000), 14.Lisbon (2003), 15.Rio de Janeiro (2006), 16.Praha (2009). I attended all these conferences except the second one in Warsaw because I did not know about it. I organized the third one following suggestions given to me by some Russians at the first conference, without knowing anything about the one in Warsaw. Before the establishment of IAMP, there was no organization to decide on the next IAMP. Now the EC (Executive Committee) of IAMP decides the next site of ICMP after closely examining applications. In case no application seems forthcoming, the IAMP EC members try to drum up candidates to choose from. Financial support by some international organization came about gradually in the history of IAMP. At the Kyoto ICMP, one foreign participant happened to be an EC member of IMU (International Mathematical Union), who later became its President. Probably, he observed the mathematical nature of the ICMP. We are now getting financial support from IMU except in the years when IMU organizes its own ICM (International Congress of Mathematicians). Note that the terms of Officers as well as ICM are with period 4, while ICMP is held with period of 3 more recently, so that every 12 years we have both ICM and ICMP in the same year. The other important Union is IUPAP (International Union of Pure and Applied Physics). At an early stage, I proposed in the capacity of the President of IAMP to IUPAP to create a new Commission on Mathematical Physics in IUPAP. This proposal was approved (along with creation of a few other Commissions) and the Commission on Mathematical Physics was created in IUPAP as C18 (Commission 18). The first chairman was Arthur Wightman. It provides financial support for conferences on mathematical physics if funding is applied for and approved by the Commission. In particular, ICMP is treated as the major conference that this Commission supports. UNESCO has provided support of participation of scientists from developing countries to scientific conferences. At the time of the Berlin ICMP, I learned about this and found out how to obtain support for participants of ICMP. So I asked the German organizers of that ICMP to contact the German representatives in UNESCO to make application for such funding from UNESCO to Berlin ICMP. At the same time, I contacted UNESCO and made IAMP eligible for such a support for its major conference, i.e. ICMP. This went through and UNESCO support was obtained. I believe that now such a support is obtained automatically through IUPAP. A comment about the interval of successive ICMP conferences. The terms of Officers of IUPAP as well as the interval of successive major IUPAP related conferences are 3 years. Thus, ICMP as a major conference under C18 of IUPAP is held every 3 years, and I believe that ICMP so far established a solid tradition. But it is important to watch out for healthy growth. The EC of IAMP and the Commission C18 of IUPAP have a possibility of giving major influences on ICMP and election or appointment of devoted persons with balanced views to these positions is very important. Also participation of influential members of IUPAP and IMU to ICMP is important to obtain the understanding of these two organizations.

As final comments, I add brief descriptions of some of the happenings at ICMP. At the time of Lausanne ICMP, we had an EC meeting of IAMP on one evening and it ended near midnight. Then we realized that we were locked in the building and had no way to contact someone with keys. Fortunately, Piron, who was a student in the university where we had the EC meeting, was there and he led us through some narrow underground corridor through some buildings until we came out into the open air! On the occasion of the Berlin ICMP, myself, Elliott Lieb and two local organizers Schrader and Ruedi Seiler made a final list of session organizers and invited speakers by telephoning various people, taking one whole day. The next day Ruedi Seiler and I went to the office of the University and tried to write invitation letters to session organizers and invited speakers. It was a weekend and there was no secretary. So I typed on a German typewriter (for the first time), minimizing the amount of typing by decomposing letters into parts which are common to many people, and Professor Seiler made invitation letters by combining different typed parts. We succeeded in making all the invitation letters, to which I signed by the end of the day. Then we went to a restaurant for a dinner. At this Berlin ICMP, professor Bogoliubov took all the Soviet delegates in one train from Moscow to Berlin. At the Boulder ICMP, we had made the organizing committee decision of session organizers and main invited speakers by telephone conference with myself as the chairman and Professor Walter Wyss and some other local organizers on Boulder end of the telephone and Professor Elliott Lieb and some other members of the organizing committee on Princeton end of the telephone.

Bulletin: *How is mathematical physics developing? Are you optimistic or pessimistic, given recently few traditional centers of Mathematical Physics (e.g. EPF Lausanne, UC Dublin) almost disappeared.*

Araki: The disappearance of some traditional centers of mathematical physics can happen at any time. It can be compensated to some extent if a new center or two of mathematical physics are created, when young powerful mathematical physicists show up. In the past, we had the following happening. A chair at the university of Göttingen was about to disappear when Borchers retired. Mathematical physicists world wide wrote letters to top people in the state and university, emphasizing the brilliant tradition in Göttingen and deploring the administrative decision of terminating this important chair. Probably this had an effect and the chair remained. Göttingen remains a center of mathematical physics.

Bulletin: *But it sounds like mathematical physics is merging into applied mathematics? Do you agree with a thesis by Professor Takashi Ichinose that mathematical physics serves as a negotiator between physics and mathematics?*

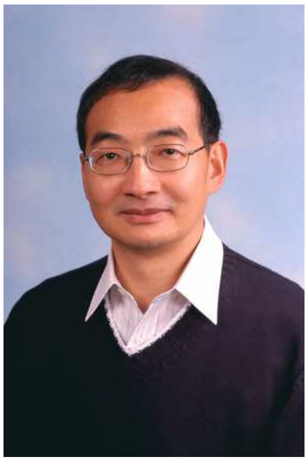
Araki: I do not understand any problem unless you show some concrete example of something wrong. Any piece of work can be evaluated from mathematical point of view and physical point of view. If one such evaluation makes a good point, it is a good work. I have written many papers in which I use known results in physics to create interesting new mathematics, and have also used some mathematics for physics. Both are mathematical physics, I believe. When I visit some countries and attend meetings of a society (either mathematics or physics), I may find that not all talks are interesting, as they deal with minor matters. However, there can be an excellent piece of work either in applied mathematics or applied physics. More concretely, I have to see a concrete example of mathematical physics approaching applied mathematics before making any comments about it.

The interview was taken by
Valentin Zagrebnov (Marseille, France)

Professor Huzihiro Araki (Kyoto) in Dubna,
International Bogolyubov Conference - August 2009

Shing-Tung Yau the Wolf Prize laureate 2010 in Mathematics

by Horng-Tzer Yau (Harvard University, USA)



In January 2010, Professor Shing-Tung Yau was awarded the Wolf Prize in Mathematics with the citation that "Shing-Tung Yau has linked partial differential equations, geometry, and mathematical physics in a fundamentally new way, decisively shaping the field of geometric analysis." Shing-Tung Yau was born in Guangdong Province, China in 1949 and moved to Hong Kong at the age of five. In 1966, he entered the newly established Chinese University of Hong Kong and by 1969 , he was admitted to UC Berkeley on a fellowship from IBM. He received his Ph.D. degree two years later under the supervision of S.-S.Chern. At the same time, Yau studied non-linear differential equations with C.Morrey and the integration of these two subjects has become his life time career goal.

After spending a year as a member of IAS, Princeton, and two years at SUNY Stonybrook, Yau went to Stanford. Yau has very fond memories of this period at Stanford; he said that "I met my very good friend Leon Simon and my former student Richard Schoen. Together we developed the subject of nonlinear analysis in geometry." From 1979 to 1984, Yau was a permanent member of IAS, Princeton. A particularly influential event during this period was the special year in differential geometry at IAS, organized by him in 1979 at the invitation of Armand Borel. Yau wrote "practically all geometers came. We set a good direction for geometry. I proposed one hundred interesting problems for the field of geometry. Some of them were solved and some of them were not. The 1970's have been one of the most fruitful eras of geometry." "Together with my friends Schoen, Simon, Cheng, Meeks, Uhlenbeck, Hamilton, and later by Donaldson, Taubes and Huisken, and others, nonlinear analysis in geometry has been established as a rich subject. Its importance in understanding beauty of nature can never be underestimated. The most recent developments show their importance in physics and in applied science." In 1984, Yau moved to UC San Diego. Since 1987, he has been a faculty member at Harvard University.

Yau received the Fields medal in 1983 for his work on the Calabi conjecture in complex geometry. Commenting on Yau's work for the Fields medal, Nirenberg said that Yau "uses these (minimal) surfaces in the way, previously, people had used geodesics", and Yau is "an analyst's geometer (or geometer's analyst) with remarkable power and insight." In 1994, in recognition of his pioneering work, Yau received the Crafoord Prize established by the Royal Swedish Academy of Sciences in areas not overlapped with the Nobel Prizes. In 1997, he received the National Medal of Science, the United States' highest honor for contributions to science.

The impact of Yau's work on mathematics is described by S.Donaldson as "Yau is a towering figure in modern differential geometry. His characteristic approach, blending geometry with PDE theory, has set the tone for vast parts of the subject over the past quarter century.” Besides his work in mathematics, he has also contributed greatly to physics. Yau’s interests in and impact on physics are summarized by E.Witten, an eminent physicist and a Fields medalist at IAS, Princeton: “Yau has been tirelessly interested for all these years in theoretical physics and especially in areas of theoretical physics that are related to differential geometry and can be understood by differential equations. I am always amazed at the breadth of his interests, and all the areas of which he is in the forefront. A lot of things in string theory nowadays depend on Yau’s work, whether through applications to physics that Yau made himself, or ways that other people found to apply Yau’s mathematical ideas and results to physics. And Yau’s enthusiasm is so infectious; he always makes other people excited that there are so many wonderful new things to be found.”

A very good summary of Yau’s achievement up to now was given in the citation of the Wolf Prize awarded to him in 2010: “He has developed new analytical tools to solve several difficult nonlinear partial differential equations, particularly those of the Monge-Ampere type, critical to progress in Riemannian, Kahler and algebraic geometry and in algebraic topology, that radically transformed these fields.” The Calabi-Yau manifolds, as these are known, a particular class of Kähler manifolds, have become a cornerstone of string theory aimed at understanding how the action of physical forces in a high-dimensional space might ultimately lead to our four-dimensional world of space and time. Prof. Yau’s work on T-duality is an important ingredient for mirror symmetry, a fundamental problem at the interface of string theory and algebraic and symplectic geometry. While settling the positive mass and energy conjectures in general relativity, he also created powerful analytical tools, which have broad applications in the investigation of the global geometry of space-time.

Prof. Yau’s eigenvalue and heat kernel estimates on Riemannian manifolds, count among the most profound achievements of analysis on manifolds. He studied minimal surfaces, solving several classical problems, and then used his results, to create a novel approach to geometric topology. Prof. Yau has been exceptionally productive over several decades, with results radiating onto many areas of pure and applied mathematics and theoretical physics. In addition to his diverse and fundamental mathematical achievements, which have inspired generations of mathematicians, Prof. Yau has also had an enormous impact, worldwide, on mathematical research, through training an extraordinary number of graduate students and establishing several active mathematical research centers.”

In the following, we list some of the major contributions by Yau.

I. Major conjectures solved.

I.1. *Calabi Conjecture.*

The most famous conjecture solved by Yau may be the Calabi conjecture concerning the existence of Kähler-Einstein metrics. According to Yau, “When I arrived at Stanford, there was a big conference in geometry. A physicist was invited to give a talk on general relativity.

Although I did not understand physics well, I immediately fell in love with the geometry problem associated with general relativity. It is fascinating to give physical meaning of space that we saw and vice versa. The problem was too difficult to solve at that time. But I kept it in mind.

During the conference, I thought I found a way to disprove the proposal of Prof. Calabi. I was asked to give a presentation of my thoughts. It all sounded good. Nobody objected. So everyone was happy that the general expectation was true: the Calabi conjecture is wrong after all. After two months, Prof. Calabi wrote me for clarification of my thoughts. I found a serious gap in my reasoning. It was the most painful period of my research life. I could not sleep.

However, the pain of going through each single detail of the problem convinced me that the opposite direction should be right. The argument to give the counterexample to the Calabi Conjecture was that if it were true, something must happen. Hence a few years later, when I settled this problem, I knew many natural consequences of it.

After I decided that it must be true, I worked towards the right direction. Many preparatory works were done to prepare for the final proof. I worked with Cheng on understanding my questions related to Monge-Ampere equations, affine geometry, maximal surfaces and many related problems. Schoen, Simon and I worked on minimal surfaces. In a matter of two years, we understood a great deal of nonlinear analysis related to geometry."

The trials with the Calabi conjecture are echoed by B.Lawson: "One very funny aspect of Yau's early career is that he produced a constant stream of *counterexamples* to the Calabi Conjecture. Of course they never reached print. He would explain them in private, or give an informal talk at a meeting, and eventually a flaw would be found in his (usually very clever) construction. After a while the counterexamples stopped, and with a few years of intense work Yau come up with a complete proof of the conjecture".

The solution of the Calabi conjecture has far reaching consequences. The existence of such a canonical unique metric allows one to give explicit representatives of characteristic classes. The Calabi-Yau manifolds are the vacuum in the string theory. Andrew Strominger, a physicist at Harvard University explained Yau's contribution in physics by saying "The work of Prof. S.-T.Yau transcends pure mathematics and has had a deep and lasting impact on physics. To cite two important examples, his proof of the positive energy theorem in general relativity finally demonstrated - sixty years after its discovery - that Einstein's theory is consistent and stable. His proof of the Calabi conjecture allowed physicists - using Calabi-Yau compactification - to show that string theory is a viable candidate for a unified theory of nature."

In algebraic geometry, the proof of the Calabi conjecture implies the famous Miyaoka-Yau inequality on Chern numbers of surfaces, a characterization of the complex projective plane and quotients of the two dimensional complex unit ball, an important class of Shimura varieties. As D.Gieseker, an eminent algebraic geometer at UCLA, explains:

"The impact of Yau's work on algebraic geometry is not solely from the interaction with physics. Important conjectures of Severi and Bombieri were also established as corollaries of the Calabi conjecture, which by the way was proved at UCLA during a visit by Yau. Yau also made the most important contribution in the case that $c_1 > 0$ and conjectured about its relation to the stability in the sense of geometric invariant theory in algebraic geometry. This has motivated the important work of Donaldson on scalar curvature and stability. Another important result of Donaldson-Uhlenbeck-Yau is that a holomorphic vector bundle is stable in the sense of Mumford if and only if there exists an Hermitian-Yang-Mills metric on it. This has many important consequences in algebraic geometry, for example, the characterization of certain symmetric spaces, Chern number inequalities for stable bundles, and the restriction of the fundamental groups of a Kähler manifold."

I.2. *Positive mass conjecture and existence of black holes.*

Yau pioneered the method of using minimal surfaces to study geometry and topology. By a deep analysis of how minimal surfaces behave in the space-time, Schoen and Yau proved the long standing conjecture that the total mass in the Einstein's general relativity is positive. This theorem implies that the Einstein equation of gravity is stable, a fundamental issue for the theory of general relativity. Schoen and Yau continued their work on manifolds with positive scalar curvature, which led to Schoen's solution of the celebrated Yamabe problem. Most recently, Yau and his former student Mu-Tao Wang gave the correct definition of quasi-local mass, a delicate and important problem studied by many people.

I.3. *Smith conjecture.*

Meeks and Yau solved the well-known question, whether the Douglas solution (for which Douglas received the Fields medal) of a minimal disk bounded by an extremal Jordan curve is always embedded in the three dimensional space. Meeks and Yau then went on to prove that these embedded minimal surfaces are equivariant for finite group actions. Combining this with a result of Thurston, they proved the famous Smith conjecture: for any cyclic group acting on a sphere, the set of fixed points is not a knotted curve.

I.4. *Hermitian Yang-Mills connection and stable vector bundles.*

Uhlenbeck and Yau proved the existence and uniqueness of Hermitian-Einstein metrics (or equivalently Hermitian Yang-Mills connections) for stable bundles on any compact Kähler manifolds, extending an earlier result of Donaldson for projective algebraic surfaces and Narasimhan and Seshadri for algebraic curves. Both the results and methods of this paper have been influential in many many parts of both algebraic geometry and string theory. This important result is now usually called the Donaldson-Uhlenbeck-Yau Theorem.

I.5. *Frenkel conjecture.*

Siu and Yau proved the Frenkel conjecture, made in 1961, in complex geometry that any compact positively curved Kähler manifold is biholomorphic to the complex projective space. An independent proof was given by S.Mori, a Fields medalist, using methods of algebraic geometry in positive characteristic.

I.6. *Mirror conjecture.*

With Lian and Liu, Yau proved the mirror formulas conjectured by string theorists. These formulas give the explicit numbers of rational curves of all degrees in a large class of Calabi-Yau manifolds in terms of the Picard-Fuchs equations of the corresponding mirror manifolds.

II. New methods and concepts initiated.

II.1. *Gradient estimates and Harnack inequalities.*

While studying the question of bounded harmonic functions on manifolds of positive Ricci curvature, Yau developed the method of gradient estimates for Harnack inequalities. This method has been used and refined by him and other people to attack many outstanding problems, for example, bounds on the heat kernel.

There have been many spectacular applications. For example, R.Hamilton extended this method to the Ricci flow, which led to the canonical decomposition of a three-dimensional manifold into pieces, each of which has a geometric structure, in the Thurston program. The recent solution of the Poincaré conjecture and breakthrough on the Thurston program by Perelman also used this method in an important way.

The gradient estimates were also used crucially in Yau's joint work with S.Y.Cheng to give a complete proof of the higher dimensional Minkowski problem and the Dirichlet problem for the real Monge-Ampére equations, and other results on Kähler-Einstein metric of bounded pseudoconvex domains.

II.2 *Uniformization of complex manifold.*

When Yau was a graduate student, he started to generalize the uniformization of Riemann surfaces to higher dimensional complex Kähler manifolds.

When the manifold is compact with positive bisectional curvature, the Frenkel conjecture proved by Siu-Yau and independently by Mori shows that it is the complex projective space. Yau proposed a series of conjectures when the manifold is noncompact and made fundamental contributions towards their solutions. For example, when the bisectional curvature is positive, it must be biholomorphic to $\mathbf{C}^n$.

II.3 *Harmonic maps and rigidity.*

Siu and Yau had pioneered the method of using harmonic maps to prove rigidity of complex structure. The Siu-Yau method, was extended to prove strong and super rigidities of many locally symmetric spaces.

II.4 *Minimal submanifolds.*

Minimal submanifolds have been used by Yau in the solutions of the positive mass conjecture, the Smith conjecture, the Frenkel conjecture etc. Many people have since used minimal surfaces for other problems. The power of minimal surfaces in Yau's work also motivated Gromov's introduction of psudo-holomorphic curves in symplectic geometry, which have revolutionized the field.

III. Open problems.

Many open problems proposed by Yau have been very influential. As S.Donaldson pointed out, "Apart from his own renowned research results, he has also done a huge amount to foster the development of the subject in a whole variety of ways. On a personal level, I recall as a graduate student gaining a large part of my orientation in the field from his Princeton Seminar volume, and particularly from his masterful concluding survey. At the same time, I remember studying in awe his proof of the Calabi conjecture and trying to understand it. Now, 23 years later, I am still trying to understand it!"

Peter Li expressed similar feeling about the impact of these open problems: "Other than the obvious fact that Yau is a top-notch mathematician, his impact in mathematics has gone beyond his theorems. He has been very generous in supervising graduate students and mentoring postdoctoral fellows, in terms of his time, his energy, and more importantly his insights in the subject. One example is his famous set of open problems in geometry. Many mathematicians are unwilling to share their insights with the public because they would rather save it for their own use and for the use of their students and protégés. Yau's problem set is a counter-example to this phenomenon. As far as I know, his problem set is still extremely influential and continues to generate a lot of interesting mathematics."

III.1 *Harmonic functions with controlled growth.*

One of Yau's problems is about bounded harmonic functions and harmonic functions on noncompact manifolds of polynomial growth. It is typical of Yau to never be satisfied with only one aspect of problems. After proving non-existence of bounded harmonic functions on manifolds with positive curvatures, he turned around and proposed the Dirichlet problem at infinity for bounded harmonic functions on negatively curved manifolds, and then proceeded to harmonic functions of polynomial growths.

The following story by Dennis Sullivan, a versatile topologist, on the Dirichlet problem for bounded harmonic functions shows Yau's strong geometric intuition and conviction:

"Once when Yau was a professor at the IAS (Princeton) and I was visiting there I mentioned to him how awkward it was to write papers using Brownian motion and Riemannian geometry because there was not a convenient reference connecting the two cultures. I was remembering Yau's result that a p-summable harmonic function on a large Riemannian manifold has to be zero for p larger than one, and the fact due to Lucy Garnett that the same result follows for p equal to one in an intuitively obvious way using Brownian motion in a dynamical argument. Yau answered that he had tried to use random path arguments to construct bounded holomorphic functions on large negatively curved complex manifolds and the method did not seem to lead anywhere, and so the lack of references might be justified. He particularly mentioned the problem of finding bounded harmonic functions on large real manifolds of negative curvature.

Thinking about this later that night it seemed intuitively obvious using random paths that such bounded harmonic functions should exist abundantly in Yau's problem. However it was not easy the next day to describe the argument because of the kind of difficulty already mentioned about references and different math cultures. Milnor was listening and he suggested I try to write a formal argument. This was possible and about a year later I was happy to present the rigorous argument to Yau. Yau's response was unyielding: "If one could do it that way one could also do it by geometry!" he insisted. In fact, Yau was right because Michael Anderson about the same time independently found the same result about bounded harmonic functions on simply connected negatively curved manifolds using a geometrically natural convexity construction.

The moral of the story seems to be that having a definite perspective and sticking to it is an effective asset in doing and stimulating research whether or not in a given instance one is right or one is wrong or one is both right and wrong."

III.2 *Rank rigidity of nonpositively curved manifolds.*

Motivated by Mostow's Strong Rigidity theorem for locally symmetric spaces, Yau called for a notion of rank for general manifolds extending the one for locally symmetric spaces and asked for rigidity properties for higher rank metrics. This was achieved by Ballmann, Brin and Eberlein in their pioneering work on non-positive curved manifolds, Gromov's and Eberlein's metric rigidity theorems for higher rank locally symmetric spaces and the classification of closed higher rank manifolds of non-positive curvature by Ballmann and Burns-Spatzier. Thus rank 1 manifolds of non-positive curvature are now the focus of research on manifolds of non-positive curvature. They behave much more like manifolds of negative curvature, but remain poorly understood in many regards.

III.3 *Kähler-Einstein metrics and stability of manifolds.*

It is known that if a complex manifold has a Kähler-Einstein metric, then its tangent bundle is stable. Yau realized early in 1980s that the existence of special metrics on Kähler manifolds is equivalent to the stability of the manifolds. Various people such as S.Donaldson, a Fields medalist, have made progress to understand such a relation.

III.4 *Mirror symmetry.*

Yau has been the driving force for the interactions of string theory and mathematics. He not only collaborates with several leading string theorists like Strominger, Vafa and Witten, but he also has had many post-doctors from theoretical physics like B.Greene, E.Zaslow and A.Klemm who have since become leading figures in string theory. The famous Strominger-Yau-Zaslow program to explicitly construct mirror manifolds is one of the most active directions in mathematical physics, as well as in algebraic and symplectic geometry. Indeed, as D.Giesekser observed, "The past few decades have seen the reemergence of a remarkably fruitful interaction between mathematics and physics, in particular between string theory and algebraic geometry. This impact by physics arose from physical arguments suggesting that certain unexpected and mysterious mathematical relationships exist that are not evident from a standard mathematical view point, the mirror conjecture being a prime example of such a relation. Yau has been the epicenter of this interaction. It is impossible to overstate the importance of Yau's proof of the Calabi conjecture, as it is the absolutely essential bridge between string theory and algebraic geometry. This development has flowered in many directions, in particular the proof of the mirror conjecture, the SYZ program and the Yau-Zaslow conjecture."

Professor Shing-Tung Yau has integrated geometry, analysis, topology, algebraic geometry, mathematical physics and general relativity into a deep rich subject of mathematics. Besides pure mathematics, his work has inspired many applications in applied mathematics, computer graphics and spectral graph theory. From differential geometry, non-linear partial differential equations and general relativity to algebraic geometry and string theory, there is hardly a research direction in modern geometric analysis which does not make essential use of Yau's work, or is not deeply influenced by a research program which he has laid out. The diversity of mathematics disciplines which have been fundamentally reshaped by his work is astonishing. Yau will surely be counted among the greatest figures in the long history of mathematics. We are certain that we have only witnessed the beginning of the influence from Yau's deep insight in mathematics.

Professor Shing-Tung Yau (Harvard University), the Wolf Prize laureate 2010

News from the IAMP Executive Committee

New individual members

IAMP welcomes the following new members

1. Davids Agboola, Department of Pure and Applied Mathematics, Ladoke Akintola University of Technology, Nigeria
2. Chanchal Bedi, Department of Theoretical Physics, Guru Nanak Dev University, Amritsar, India
3. Massimiliano Berti, Dipartimento di Matematica e Applicazioni "R. Caccioppoli", Universita degli Studi di Napoli, Federico II, Napoli, Italy
4. Jonathan Breuer, Department of Mathematics Hebrew University of Jerusalem, Jerusalem, Israel
5. Mihalis Dafermos, University of Cambridge, Cambridge, UK
6. Danilo Eduardo Diaz Vázquez, Departamento de Ciencias Fisicas, Universidad Andrés Bello, Santiago, Chile
7. Bertrand Duplantier, Institut de Physique Théorique, Saclay, Gif-sur-Yvette, France
8. Sergiu Klainerman, Department of Mathematics, Princeton University, Princeton, USA
9. Israel Klich, Department of Physics, University of Virginia, Charlottesville, USA
10. Igor Krichever, Department of Mathematics, Columbia University, New York, USA
11. Demeter Krupka, Department of Theoretical Physics and Astrophysics, Masaryk University, Brno, Czech Republic
12. Olga Krupkova, Department of Mathematics, The University of Ostrava, Ostrava, Czech Republic
13. Gandalf Lechner, Faculty of Physics University of Vienna, Vienna, Austria
14. Dan Mangoubi, Einstein Institute of Mathematics, Hebrew University, Jerusalem, Israel
15. Patrick Moylan, Department of Physics, The Pennsylavania State University, Abington College, Abington, USA
16. Giorgio Parisi, Department of Physics, Universita di Roma La Sapienza, Rome Italy
17. Yehuda Pinchover, Department of Mathematics, Technion, Haifa, Israel

18. Radu Purice, Simion Stoilow Institute of Mathematics of the Romanian Academy, Bucharest, Romania

19. Renato Renner, Institute for Theoretical Physics, ETH Zürich, Switzerland

20. Vered Rom-Kedar, Department of Computer science and applied mathematics, The Weizmann Institute, Rehovot, Israel

21. Zeev Rudnick, Department of Mathematics, Tel Aviv University, Tel Aviv, Israel

22. Marta Sanz-Solé, Facultat de Matematiques, Universitat de Barcelona, Spain

23. Walter D. Suijlekom, Department of Mathematics, Radboud University, Nijmegen, Netherlands

24. Mouhcine Tilioua, Department of Mathematics, Hassan I University, Khouribga, Morocco

25. Frank Verstraete, Faculty of Physics, University of Vienna, Vienna, Austria

26. Katrin Wendland, Department of Mathematics, University of Augsburg, Augsburg, Germany

New associate members

IAMP welcomes two new associate members:

- Cambridge University Press
  Link: http://www.cambridge.org/uk/

- The Pacific Institute for the Mathematical Sciences (PIMS)
  Link: http://www.pims.math.ca/
  See page 26 for more information

Open positions

- Deadline May 10, 2010: A postdoc position for two years is available for a project on nematic phase transitions for hard-rod lattice models, starting on September or October 1st, with A.C.D. van Enter (Groningen) and R. Fernandez (Utrecht). We are looking for someone with a PhD in the areas of probability or mathematical (statistical) physics. The position is funded by the STAR (stochastics) cluster of the Dutch Science Foundation NWO. The candidate is expected to spend half the time in Groningen and half the time in Utrecht. The salary is attractive, following NWO rules. Employment is on the basis of a 38-hour week, and includes the standard package of social benefits (retirement fund, possible participation in the university health insurance scheme etc). If you are interested, or require further information, please send letters (or email) before May 10th to

Prof. Dr A.C.D. van Enter,
Email: aenter@phys.rug.nl
Address: Johann Bernoulli Institute of Mathematics and Computer Science,
University of Groningen,
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Telephone: +31 (0)50 36 33939 (secretary)
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or to

Prof. Dr. R.Fernandez,
Email: r.fernandez1@uu.nl
Address: Department of Mathematics,
Utrecht University,
P.O. Box 80010,
3508 TA Utrecht,
The Netherlands
PH: +31 (0)30 2531430

- Deadline May 31, Ph.D. position at the Mathematical Physics group of the Radboud University Nijmegen.
  Link: `http://www.ru.nl/vacaturedetails?recid=499349`

Recent conference announcements

With support from IAMP:

- Aug 30– Sep 4, 2010
  Link: `http://www.mat.uniroma3.it/users/giuliani/public_html/cime/index.html`
  C.I.M.E. Summer Course on Quantum Many Body Systems, Cetraro (Cosenza), Italy

Other announcements:

- Sep 6-10, 2010
  Link: `http://qmath11.uhk.cz/index.htm`
  QMath11 Mathematical Results in Quantum Physics, Hradec Kralove, Czechia

- Aug 2 – 27, 2010
  Link: `http://www.thphys.uni-heidelberg.de/~joerg/leshouches2010`
  Quantum theory from small to large scales, Summer School at Les Houches, France

- Jul 26 – 31, 2010 Link: `http://www.imf.au.dk/events/ssctmp2010`
  Summer School on Current Topics in Mathematical Physics, Aarhus, Denmark

- Jul 11–16, 2010
  Link: http://sites.google.com/site/pathintegrals2010/home
  Path Integrals - 2010, Howard University's Blackburn Center, Washington DC, USA

- Jun 21 – 24, 2010
  Link: http://www.u-cergy.fr/agm/QED2010
  Mathematical Aspects of Quantum Electrodynamics, Institut Henri Poincare, Paris, France

- Jun 16–Jul 2, 2010
  Link: http://www.gursey.gov.tr/new/mathphys10
  "Feza Gürsey" International Summer School in Mathematical Physics II: Probability, Statistical Mechanics and Renormalisation Group, Istanbul, Turkey

- Jun 7 – Jun 25, 2010,
  Link: http://math.bu.edu/people/dkreimer/houches/houches.html
  Summer school on structures in local quantum field theory, Les Houches, France

Jan Philip Solovej (IAMP Secretary)

Pacific Institute for the Mathematical Sciences

The Pacific Institute for the Mathematical Sciences (PIMS) is a consortium established by the eight main research universities in Western Canada and in the State of Washington, USA: the University of Alberta, the University of Calgary, the University of British Columbia, Simon Fraser University, the University of Victoria, the University of Washington, the University of Regina and the University of Saskatchewan. The Banff International Research Station (BIRS) was created by PIMS but now functions as a completely independent entity. Funding for PIMS comes mainly from the Canadian Federal government (NSERC), the provincial governments as well as the member universities.

The geographical separation of our eight members makes PIMS an unusual organisation in which each member has a "site" office, while the Institute as a whole functions as a cooperative enterprise whose mandate includes

- promoting research in and applications of the mathematical sciences
- facilitating the training of highly-qualified personnel at the graduate and postdoctoral level
- creating mathematical partnerships with similar organizations in other countries, with a particular focus on Latin America and the Pacific Rim
- educational initiatives.

A large part of our activity is generated in response to *Collaborative Research Group* (CRG) proposals submitted by member sites. These typically consist of an enhanced postdoctoral program, workshops, summer schools, thematic programs and support for visitors, particularly in the Distinguished Chair program. These are visitors who are in residence at one or more sites for typical periods of two weeks and longer. IAMP members who are interested in participating in our activities should begin with informal enquiries to acquaintances at our member institutions.

Much more information including our current CRG's and thematic programs may be found by following links at http://www.pims.math.ca/.

Communicated by
Alejandro Adem
Director of PIMS