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Cover picture: The Association of Women in Mathematical Physics is presented in this issue of the IAMP Bulletin

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Contents

Reminiscences of the founding of the IAMP

collected by IAN JAUSLIN

The International Association of Mathematical Physics formally came into existence on July 1, 1977 with a message in the Bulletin from Walter Thirring, first president of the association, stating [Bu77]:

> *The outcome of the votes for the statutes is as follows: Yes – 242, No – 2, Abstain – 15. Therefore the statutes have been approved by a sufficient majority and AMP starts to exist legally in July 77.*

By then, the statutes (the rules and bylaws of the association) had been written, mostly by Huzihiro Araki, and voted upon by the members between April 1 and May 31, 1977 [Bu77]. But the idea for the IAMP (the 'I' was added in 1979, with the accession of Araki to the presidency [Bu79]) has its roots back in 1974, at a congress in Warsaw, where a group of mathematicians and physicists sat around a dinner table, discussing the future of the field. In the fifty years that followed, the IAMP has organized congresses, published the Bulletin (initially with preprints and conference announcements and later with original articles), negotiated discounts with scientific publishers, awarded prizes, funded conferences, organized online seminars, and generally buttressed the development of the field of mathematical physics.

To mark the occasion of the fiftieth anniversary of the conception of the IAMP, I have collected some thoughts and reminiscences from some of the people involved in the early years of the association. Specifically, I have individually interviewed **Arthur Jaffe**, **Elliott Lieb**, **David Ruelle**, and **Daniel Sternheimer**, and was sent a written statement by **Heide Narnhofer**. In the following pages, I will transcribe quotes from these interviews, collected together thematically, interspersed with comments and quotations from written sources. As much as possible, I have attempted to reproduce the quotes verbatim, with minor corrections for grammar and clarity. (My interview with Sternheimer was conducted in French, which I am taking the liberty to translate.) For the sake of precision, I will use brackets '[]' to indicate that I have made a change to improve readability, and '[...]' to indicate that I am skipping parts of the quote. For the sake of clarity, the quotes will be colored: blue for Jaffe, green for Lieb, purple for Ruelle, red for Sternheimer, and orange for Narnhofer (the colors are not required to comprehend the article).

1 The conception of the IAMP

Let us start from the very beginning, with the inception of the idea for the IAMP. Lieb began:

> *The idea was originated by [Moshe] Flato and [Daniel] Sternheimer, whose idea was a European IAMP. Except it wouldn't be 'I', but rather 'EAMP'. But [some] thought that, if we're going to do anything like this, it should be international.*

Sternheimer confirmed:

> *Around the beginning of the 1970's, the European Physical Society was created. [...] The EPS worked [...] as a federation of national societies. But, I was a member of the*

> *American Physical Society as an individual, so I figured that, because we are trying to develop Europe, why don't we create a European society of mathematical physics [...], and in which anyone could be a member. I spoke to Moshe [Flato] about the idea and he immediately jumped on board. We presented the idea at the congress in Warsaw in 1974, and Elliott [Lieb] and [Huzihiro] Araki objected: 'why should it be European'? So we happily agreed to make it international. But the main idea was that members should be individuals.*

Lieb also pointed out this specificity of the IAMP:

> *The idea was novel [...] because there are not many international associations in which the members are [individual] people. Usually, they are associations of societies. But in this case, the members were going to be [individual] people [...], and one had to make sure that the statutes were written in such a way that nobody could [...] control things. If it had to be [individual] people, it had to be for sure democratic.*

Indeed, the possibility of individuals controlling the association was a concern at the time of its inception. Jaffe recalled:

> *I think I first learned about the plans for the association in the meeting in Warsaw in 1974. Richard Raczka [...] had a dinner one evening, which was devoted to a discussion of potentially having an association for mathematical physics. [...] [Flato] was proposing this association. While I very much liked the idea, after returning to Paris where I was on sabbatical, I heard that some people [...] were upset, because they thought Flato was trying to create the association and then control it.*

Sternheimer added:

> *A big fear [of Rudolf Haag] was that [Flato] wanted to take over mathematical physics. But, Haag eventually convinced himself this was not the case, and had never been the case.*

Haag wrote about these discussions in an article published in The European Physics Journal H [Ha10]:

> *We met in Geneva. On one side there was Flato and [Constantin] Piron, on the other side [Klaus] Hepp and myself and, if I remember correctly, [Hans-Jürgen] Borchers as a neutral witness. In the course of the discussion Flato succeeded in convincing me that he was not a bad guy and we ultimately agreed that the organization should be created, that the first president should be Walter Thirring and that in the executive board there should be no person who had played any role in the previous controversy.*

(Since this meeting is reported to have taken place in Geneva, it is presumably a followup of the dinner discussions that happened in Warsaw.) Lieb remarked on the question:

> *There were only, shall we say, potential problems. There were no actual problems, it all went very smoothly. The idea came from Flato and Sternheimer, but they never interfered. They took an interest, but they never [interfered].*

2 Setting the wheels in motion

With these initial worries resolved, the association was created. There was much work to be done! Jaffe told me:

> *Eventually a committee was formed to draft bylaws. [Ray] Streater, [David] Ruelle, [Huzihiro] Araki, and [Constantin] Piron were on it. As far as I know, Araki did most of the work, and came up with the plan for the association.*

Lieb added:

> *Araki was such a highly regarded person. He made up statutes, which are still used. [...] [Araki] was not afraid of work: [...] if something needed to be written out he would write it out, in a very clear way. Writing theorems, or whatever, he was always extremely clear.*

While the statutes were being written, the association needed to be run. Narnhofer wrote:

> *[Flato, Piron, Haag, and Hepp] asked Walter Thirring whether he would be willing to serve as president for this organization. He was understood to be the appropriate choice due to his broad interest in various areas of mathematical physics and even more for his ability to harmonize and collaborate in all directions.*

Lieb commented on Thirring's appointment:

> *Everybody understood that Thirring was somebody that everybody could agree about.*

which Sternheimer confirmed:

> *It was decided by Flato and Haag that neither of them would lead the association [...] and that Thirring would become president. Thirring was someone who was neutral and honest.*

Thirring was appointed president in 1975 or 1976 (I have heard both dates, and written records are scant). Soon after taking office, Thirring started sending out a news bulletin, the first of which was sent on March 12, 1976, and is still available on the IAMP website [Bu76]. Narnhofer recalled:

> *We understood it as our first task to encourage researchers to inform us about their interest to participate in this organization. As a consequence they [would] send us their articles and we would provide them with the list of the articles that arrived in Vienna. Then [anybody] could [ask for] a preprint [directly] from the author. [...] In addition information about conferences were added [to] the list.*

In fact, the early bulletins are all available on the IAMP website, and consist of a few short paragraphs written by Thirring on recent developments, followed by a list of preprints, conference announcements, and a membership list. They remain one of the few contemporary written sources on the early history of the IAMP. In particular, they report the results of votes that were held, such as the vote on confirming the statutes in the spring of 1977, mentioned at the beginning of this article.

Once the statutes were ratified, the IAMP officially came into existence as a formal organization. (It was even formally recognized by UNESCO in 1980 [Bu80].) The executive committee voted in 1977 to confirm Thirring as president [Bu77], and in 1978 to confirm Araki as vice president, Ruelle as secretary, and Piron as treasurer [Bu78]. But the statutes specified that the association should be run democratically, and so the first general elections were held in 1978. The first elected executive committee consisted of Araki, Borchers, Faddeev, Hunziker, Lieb, Penrose, Piron, Raczka, Sternheimer, Streater, Streit, and Wightman [Bu78]. Araki succeeded Thirring as president in January 1979 [Bu79]. Thirring signed off his last news bulletin:

> *Since this is the last bulletin issued from me I would like to take the opportunity to thank all people who have helped me with their effort to make AMP a useful undertak[ing]. Having done my job as a midwife, I remain with best wishes.*

3 The role of the IAMP in the early days

And so the association was created, incorporated, and started to work for the community. Asked about how he viewed the purpose of the IAMP at the time of its creation, Jaffe told me:

> *I was all for it! Because I thought it would be good for the young people in mathematical physics to have an association. And it would be good for mathematical physics to be recognized as a subject of its own, rather than as a part of particle physics.*

Asked the same question, Lieb responded:

> *[The purpose of the IAMP] was to make visible that which we always assumed to exist, but nobody knew about. [...] This thing called 'Mathematical Physics' did not have the old fashioned meaning. In the old days, [...] it meant a lot of solving Lagrange equations, or [...] turbulence; [...] things which might be called 'applied math'. The idea of mathematical physics as writing papers that contain good physics and good mathematics at the same time [...] was started by people just doing it. Walter Thirring was one of these.*

Narnhofer commented:

> *In these early days we were not interested in the legal foundation and the statutes of such an organization. We concentrated on its task, namely to support common research in mathematical physics to the best of our abilities.*

4 The Congresses

One of the missions of the IAMP has been to organize the Congresses in Mathematical Physics, starting with one in Lausanne in 1979 [Bu78, Bu79]. These were in the continuation of a sequence of conferences that had been organized before the creation of the IAMP. Sternheimer recalled:

> *In December 1972, we [...] went to Moscow, where Bogolyubov organized '$M \cap \Phi$' [...], which became the first congress on mathematical physics, a posteriori. [...] It was a great occasion to meet people from Eastern Europe who could not travel easily. [...] In 1974, there was another conference in Warsaw. [...] That was, a posteriori, the second congress on mathematical physics. [...] After that, there were congresses that were really organized by the IAMP. The early ones were retroactively co-opted.*

Jaffe recalled:

> *It wasn't called a congress: there was a meeting organized by the Russians in 1972, there was a meeting organized by people in Poland in 1974, and a meeting organized by people in Rome in 1977. [...] The meeting organized in Lausanne was [under the auspice of the IAMP].*

Lieb spoke on the meeting in Moscow:

> *The idea of the mathematical physics meeting [comes from] the Russian group. They were the ones who invented the logo $M \cap \Phi$, I am told. [...] And we just took over the logo. [...] They should be credited with the original idea.*

The meeting in Moscow and the logo $M \cap \Phi$ were the subject of an article in this bulletin from October 2022 [Bu22-10]. Lieb added, speaking about the meeting in Rome in 1977:

> *The purpose of that meeting was not to create IAMP. [...] It was a legitimate scientific meeting. [One] might say that IAMP was created during the [general assembly].*

In addition to these, there was a meeting in Kyoto in 1975, which Ruelle recalled:

> *I remember one meeting that took place in Japan. It was a normal lecture room: [...] it was a small meeting. I was interested in rigorous results in statistical mechanics and all the people in the audience [...] were interested in related questions. [...] Everybody knew everybody.*

Beginning with Lausanne 1979, the IAMP took over the organization of the Congresses in Mathematical Physics. Thirring wrote in the Bulletin from July 1977:

> *At the Rome conference there was a general discussion on the function of AMP for coordinating conferences on mathematical physics. The majority felt that there should be a general conference on mathematical physics every two years continuing the series of the Rome conference. This conference should be sponsored by AMP in the active sense that AMP is involved in the Program Committee and furthermore the place of the conference should be decided by a general vote of AMP members. So the selection procedure would be that the various possibilities are published by AMP and members inform us about their priority. For the next conference there is not enough time for this procedure and so the Executive Committee of AMP will make the selection.*

Lausanne was selected and announced the following year [Bu78]. The conference would be organized by Philippe Choquard. For the following congress, in 1981, there were three bids: one by N.N. Bogoliubov in the USSR, one by R. Schrader, B. Schroer, R. Seiler, and D.A.

Uhlenbrock in West Berlin, and one by M.E. Mayer in California. A vote was held in late 1978, and it was decided the congress for 1981 would be held in Berlin [Bu78]. The congress was officially named 'VIth International Conference on Mathematical Physics' (the first five being understood to be Moscow 1972, Warsaw 1974, Kyoto 1975, Rome 1977, and Lausanne 1979), and announced by Araki in the October 1979 bulletin [Bu79]. The topics listed in the announcement were impressively broad:

> *Statistical Mechanics, Quantum Field Theory, Gravitation, Gauge Theory, Non-Linear Systems, Dynamical Systems, Turbulence and Chaos, Critical Phenomena, Foundations of Quantum Mechanics, Non-Relativistic Quantum Mechanics, C^*-Algebra Approach, Group Theory, Probabilistic Methods, Geometrical and Deformation Approach.*

For the following meeting in 1983, Araki wrote that a location in North America would be 'desirable', to ensure geographical diversity, and an adequate representation of the 'large population of mathematical physicists in North America' [Bu79]. Boulder, Colorado, in the USA, ended up being selected [Bu80].

Whereas much has been lost to the sands of time, it is possible to catch a glimpse of the atmosphere at these early ICMP's by reading the minutes of the General Assembly held in Lausanne in 1979, which were published in the October 1979 Bulletin [Bu79], and are available on the IAMP website.

5 Musings on the state of IAMP and mathematical physics

In my interview with Jaffe, the conversation naturally shifted towards the state of mathematical physics: he told me:

> *I think that mathematical physics still hasn't become regarded as what I think it should be, namely the union of mathematics and physics. I always objected to the symbol $M \cap \Phi$; I thought it should be $M \cup \Phi$. I thought that being inclusive was much more important than being exclusive. And I think that efforts to be inclusive have only been partially successful. There has been tremendous interaction over the lifetime of IAMP between mathematics and physics, but that's not always recognized as 'mathematical physics'. And that is, from my point of view, a big problem. [...] If you go to a math department and talk about mathematical physics they might say it's physics, and if you go to a physics department they might say it's mathematics, and that's not a good sign. I hope we will eventually reach the point where physics and mathematics are just two parts of the same subject: mathematical physics.*

Ruelle had some comments on how mathematical physics has changed:

> *It is interesting that things have changed quite a bit. First, the number of people doing [...] rigorous results in theoretical physics has increased enormously. In fact, I was astonished to hear that people consider that a career. And [that] research [is] a normal thing to do. They [are] not looking for the answer to any specific problem, they just [want] to make a career of research. [...] The first people who were interested in doing*

research in mathematical physics were in fact interested in specific problems, and it was a small number of people; not a general congregation of many people.

6 A final word

And so the IAMP came to be. It started out as an idea in the mind of Sternheimer, pushed forward by Flato, through much resistance, partially motivated by personal and professional animosities, birthed into the dutiful and deft hands of Thirring, Araki, and others, who gave it a life of its own. The success of this enterprise was far from obvious, and we owe an enormous debt to those mentioned in this article, who worked very hard to build and stabilize the association. The fact that it has remained strong, relevant, and central in the mathematical physics community over the past 50 years is a consequential achievement.

In closing, I would like to include one more quote from Lieb:

Everything was done by lifting bootstraps. It's a question like 'how did life get started?' Nobody knows, but it did. [...] I'm really happy that [...] people are taking this history seriously. You have to realize that this is something that comes out of nowhere. From left field, as they say. And I'm really happy about it.

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Presentation of the Association of Women in Mathematical Physics

by SERENA CENATIEMPO, ANA ROS-CAMANCHO, HANNE VAN DEN BOSCH

The Association for Women in Mathematical Physics was born in 2023 to promote and support women and gender minorities in our field. We are very grateful for this opportunity to reach out to the IAMP members to present our association.

This initiative began as informal (online) meetings to create a network of female researchers in our field. We felt how empowering it could be to connect and share experiences. From here, we started looking for a more structured way to support gender diversity and inclusion in Mathematical Physics. After a long reflection, founding an association seemed the best way to sustain this kind of initiative in the long run. Then came the hard work of designing an organisation, writing the statutes, and doing the necessary paperwork to become an official association, which saw the light at the end of 2023.

Simultaneously, during all this time, we have been exploring several specific topics in working groups. A reading group about research on gender gap, participation of women and minorities in academia and the job market meets on a regular basis to present in turn and discuss articles or books. Diversity and gender equality are subtle issues and we need to base our understanding and actions on solid grounds. That is why we are interested in scientific research about gender gap, participation of women and minorities in academia and the job market.

Another group promotes ways to enlarge the participation in mathematical physics events for women researchers and people with health issues, both through specific measures, such as special travel and childcare grants, and the planning of hybrid events. If organisers allow for remote participation, this allows you to showcase your work even if care responsibilities, health issues, or the budget do not allow you to attend in person.

A third group focuses on mentoring events to support career development. In the past months, the first two mentoring sessions geared towards early career researchers took place: applying for the ERC starter grant and explaining the academic job market in France. At the last ICMP conference in Strasbourg, members of the association organised an inspiring panel discussion and also took the opportunity to have an in-person lunch meeting with those who could attend.

For the forthcoming years, we plan to continue in this fashion and secure funding to have more impact. Our hope is to be a valuable complement to the work of IAMP, that promotes Research in Mathematical Physics as a whole. As AWMP, we promote gender diversity in this field, to ensure that researchers from diverse backgrounds can thrive in this global community and contribute to the subject we are all passionate about.

If this short text has made you curious or enthusiastic, you are kindly invited to check out www.awmp-mathphys.org for more information and to consider joining our association. Any person can join as a supporting member, researchers in mathematical physics who identify as female, non-binary or belonging to a gender minority can become ordinary members. For the moment, membership is free, and we are entirely supported by donations and pro-bono

work. Please feel free to write to econtact@awmp-mathphys.org if you have any questions, comments, or suggestions.

The 8th AQFTUK meeting, York, 2024

by CHRISTOPHER J. FEWSTER and DAAN W. JANSSEN

AQFTUK (Algebraic Quantum Field Theory in the UK) is a network of UK based researchers in AQFT – an approach to QFT that places primary focus on the algebra of observables. It has been supported by the London Mathematical Society since 2020, and is coordinated by Pieter Naaijkens (Cardiff), Robin Hillier (Lancaster), Alexander Schenkel (Nottingham) and Chris Fewster (York).

The 8th AQFTUK meeting was held on 26–28 June 2024 as a satellite meeting for ICMP2024 and was the largest meeting of the AQFTUK yet, with 50 participants coming from the UK and Argentina, Austria, France, Germany, Italy, Japan, Mexico, Norway, Poland, and Spain. This event was organised by Chris Fewster and Daan Janssen (York). Additional financial support from the IAMP, the London Mathematical Society, the Institute of Physics and the Department of Mathematics at the University of York, was gratefully received and essential for AQFTUK 8 to proceed. Some speakers were also supported by an EPSRC grant EP/Y000099/1 to the University of York.

The meeting was held in the King's Manor, a historic complex of buildings in the city centre of York, and featured 22 talks on subjects spanning operator algebraic techniques in quantum field theory and quantum information, quantum fields on curved spacetimes and semi-classical gravity, AQFT on backgrounds with boundaries and corners, homological and category theoretical techniques in quantum field theory, and relativistic quantum measurement theory and quantum reference frames.

In particular, invited talks were given by

- Victor Carmona (MPI-MiS Leipzig) 'Additivity and descent of factorization algebras'
- Tiziano Gaudio (Lancaster University) 'On the unitarity and the strong graded locality of some VOSA models',
- Christiane Klein (Université Grenoble Alpes) 'Exploring quantum fields on rotating black holes',

- Eleni-Alexandra Kontou (King's College London) 'Non-minimal coupling, negative null energy, and effective field theory',
- Leon Deryck Loveridge (Universitetet i Sørøst-Norge) 'Operational quantum reference frames and some applications',
- Pieter Naaijkens (Cardiff University) 'Bulk/boundary à la DHR in topologically ordered models',
- Michele Schiavina (Università di Pavia) 'Classical superselection sectors from Hamiltonian reduction',
- Rainer Verch (Universität Leipzig) 'Moving away from equilibrium',
- Elizabeth Winstanley (University of Sheffield) 'Charged quantum scalar field theory on a charged black hole'.

University of York/Alex Holland

The IAMP was advertised during the meeting in a short presentation by the current President, Kasia Rejzner (York).

Three of the invited talks and 11 of the contributed talks were given by early career researchers, in line with the tradition of the AQFTUK series. Lively scientific discussions continued beyond the confines of the conference day in many of the locations available for such purposes in the city of York.

In conclusion, the meeting demonstrated the vigour of AQFT and related subjects across the UK and beyond. The AQFTUK meetings will continue during 2024-25 – please see our website https://sites.google.com/view/aqftuk for details.

Final call for bids to organise the next EMS-IAMP Summer School in Mathematical Physics

by KASIA REJZNER and JAN PHILIP SOLOVEJ

The call is open to submit bids for the next summer school in mathematical physics organized with support from EMS and IAMP. The last one took place in 2022 and we would like to have the next one in 2025. The school should be one–week long and intended for PhD students, postdocs, and young researchers. It should include 2–4 advanced graduate–level courses that will introduce some important techniques relevant for modern mathematical physics. If you are interested in hosting the school, please submit a single PDF file (1–2 pages) by the 15th of November 2024, containing the following information:

- a description of the planned event and of its scientific scope,
- provisional dates and location of the event,
- scientific committee (if there is one) and local organising committee,
- a (provisional) list of courses and who will give them,
- the expected number of participants,
- a financial plan, detailing other sources of support and expected expenses.

Applications should be sent to Kasia Rejzner (president@iamp.org) and Jan Philip Solovej (vicepresident@iamp.org).

Dimitri Rauelevich Yafaev (1948–2024)

by GRIGORI ROZENBLUM and TATJANA SUSLINA

On June 16, 2024, Dimitri Rauelevich (Dima) Yafaev, an outstanding Soviet, Russian and French mathematician, specialist in mathematical physics, functional analysis and spectral theory of operators, passed away.

Dima was born in Ufa on January 2, 1948, but soon the family moved to Leningrad. Dima's father, Rauel Khasan'yanovich Yafaev, was a prominent scientist in the field of epidemiology, professor at the Military Medical Academy and the Leningrad Sanitary and Hygienic Institute, and academician of the Russian Academy of Natural Sciences; his mother, Serafima Petrovna Yafaeva, was a specialist in metallurgy. Dima began his scientific career in Leningrad, successfully, when at school, participating in city Olympiads in mathematics and physics. In 1965, he entered the School of Physics of Leningrad State University (LSU), where at the Department of Higher Mathematics and Mathematical Physics his mentor was Professor M.Sh. Birman, a leader in the field of spectral theory of operators. Dima's scientific youth was spent in the remarkable environment of the Leningrad school of mathematical physics and analysis, created by V.I. Smirnov and L.V. Kantorovich, their followers and students, including O.A. Ladyzhenskaya, L.D. Faddeev, V.M. Babich, M.Z. Solomyak and others. During this early period, in graduate school, D.R. made significant progress in spectral theory and quantum scattering theory for many-particle problems, in particular, with long-range potentials. He discovered a number of new effects, in particular, in the description of the discrete spectrum in the Efimov effect and additional channels in the long-range scattering theory.

Having defended his PhD thesis on this topic in 1973, D.R. worked at the School of Physics of Leningrad State University until 1977, and then, until 1990, at the Leningrad Branch of the V.A. Steklov Mathematical Institute of the USSR Academy of Sciences (LOMI). In 1975, he received the university prize for young researchers. In 1982, he defended his Doctor of Science thesis on the topic of "Spectral effects at the edge of the continuous spectrum and scattering theory". D.R.'s further professional activity is associated with France. In 1990-1992, he worked as an associate professor at the University of Nantes, and then, until his retirement in 2016, at the University of Rennes, where after a series of promotions, he became a Professor of the First Class. While working in France, D.R. maintained close ties with his home university, where he held the position of a leading research fellow, and then a professor, participating in scientific life, implementing scientific grant programs, attending seminars, and giving reports on his results. He also developed and taught a new course based on his own results, "Mathematical Theory of Scattering" for M.Sc. students of the Department of Higher Mathematics and Mathematical Physics at St. Petersburg State University. These remarkable lectures in video format continued to be used online in teaching students, even when the traditional method of teaching became impossible due to the pandemic and for other reasons.

D.R.'s scientific activity lasted more than 50 years. He has published over 170 articles in leading mathematical journals. His three books on quantum scattering theory represent the most comprehensive systematic exposition of the subject and serve as a source of knowledge for hundreds of researchers.

Problems related to the scattering theory, as well as related problems of spectral theory and analysis, were at the center of D.R.'s interests throughout his scientific life. Here, D.R.'s contribution was comprehensive. He developed methods for analyzing multiparticle systems, including systems with long-range and non-stationary interactions. In doing so, new effects were discovered, in particular, conditions of appearance of new scattering channels were found, and cases of the absence of completeness of wave operators were investigated. For a wide class of long-range repulsive potentials, it was established that a scattered wave with low energy decreases exponentially with time. Simultaneously, D.R. developed a number of new methods for studying multiparticle and non-stationary systems with long-range potentials, of which new versions of the principle of limiting absorption and asymptotic estimates for the evolutionary unitary group that refine this property should be noted.

A significant place in the works of D.R. is occupied by the study of quantitative characteristics of scattering, in particular, their quasi-classical and high-energy asymptotic properties in various situations. In particular, the asymptotic high-energy behavior of the scattering cross-section, scattering phases was found, and estimates of the number of bound states in the Efimov effect were established. Using a specially adapted technique of pseudodifferential operators, the asymptotic formulas for eigenvalues of the scattering matrix were proved.

Estimates for the scattering operator and the scattering matrix in various quasi-normalized classes were obtained jointly with D.R.'s best student, Alexander V. Sobolev, who became later an advanced mathematician and now works in London, at the University College.

In late 1990s – early 2000s, D.R. turned to the study of problems related to magnetic fields. The results obtained here turned out to be quite unexpected and even counterintuitive in places. In particular, having found the scattering characteristics of a magnetic field of the Aharonov-Bohm type in the classical two-dimensional situation, he established that in the three-dimensional situation the Aharonov-Bohm type effect is absent since the singularity of the magnetic field can be eliminated using an ingenious gauge transformation. Other unexpected results are related to the analysis of classical and quantum three-dimensional systems with a magnetic field of the Biot-Savart-Laplace type, that is, a field in the 3D space, generated by an infinite rectilinear conductor. In traditional understaning, such a field should not induce a motion of a charged particle in the direction of the conductor. D.R. discovered that in fact such a motion, very complex, possesses an averaged drift in the direction of the current; it is present in both the classical and quantum formulations. D.R. described the characteristics of such a motion.

A large number (about 20) of works from the 2000s – 2010s, partially written jointly with A. Pushnitski, are devoted to the study of various properties of Hankel operators. These integral operators on the half-axis with a kernel depending on the sum of arguments have been the subject of research since the end of the 19th century and have found numerous applications in the theory of functions and operators, approximation theory, the theory of random processes and in various applied issues. The series of works under discussion began with the observation that even for a very weak perturbation of a self-adjoint operator, the perturbation of the spectral projection at a point of the absolutely continuous spectrum can be very strong, non-trace-class, and its properties are expressed through a Hankel-type operator. In the works of this period, Hankel operators were extensively studied from the point of view of spectral theory and scat-

tering theory. New functional representations of such operators were discovered, conditions for boundedness and belonging to Schatten classes were found, the question how the properties of a discrete spectrum depend on the nature of kernel discontinuities was clarified, conditions for the closedness and closability of the operator in the case where the boundedness condition is violated were found, and the formulas of asymptotics of eigenvalues and singular values for operators with piecewise continuous symbols were established. It turned out later that a scattering theory parallel to the classical scattering theory for differential operators can be developed for Hankel operators, and a number of new effects were found.

Dimitry Rauelevich continued his active scientific work after his retirement in France in 2016. And he did not leave his work at his *Alma Mater* St. Petersburg University until the end of his days.

During this period, he published more than 25 scientific articles. He discovered new areas of research. This includes a new approach to constructing the asymptotics of solutions and eigenfunctions for Sturm-Liouville equations and Jacobi matrices with coefficients growing at infinity; this created a new understanding of asymptotic and spectral properties of operators in limit-circle class. In particular, a scattering theory for the Laguerre operator was developed, and new results on the asymptotics of general orthogonal polynomials were obtained along this path. Together with A.V. Sobolev, the development of a scattering theory for Toeplitz operators was started. D.R. was working on his last article several days before his death, despite a serious illness, and left it in a state close to completion.

Dimitri Rauelevich was a beautiful lecturer. He did not like modern methods of computer presentation, but his artistic performances at the blackboard contained a surprisingly large amount of material with wonderfully clear presentation.

D.R. enjoyed great authority in the scientific community. He was invited to give sectional talks at the International Congress of Mathematicians in Berlin in 1998 and twice at the International Congresses on Mathematical Physics, in 1981 and 1988. He participated as an invited speaker at many international conferences, in mathematical schools, where he gave advanced courses, and in research programs at international scientific centers. He was among the organizers of many conferences; of particular importance was the annual St. Petersburg Conference on Spectral Theory, dedicated to the memory of M.Sh. Birman, Dimitri Rauelevich's teacher.

D.R. was a member of the editorial boards and editorial councils of several influential mathematical journals, including the editorial board of "Journal of Spectral Theory" and the council of the journal "Functional Analysis and Its Applications".

D.R. had a wonderful family. His wife Natasha supported him throughout their long life together. Of the two sons, Ivan successfully works as a sales representative, and Andrei became a mathematician, a famous specialist in algebraic geometry; he works in London, at the University College.

Those who knew Dimitri Rauelevich will remember his constant goodwill, unfailing smile, and willingness to help.

Memories of Giuseppe (Giosi) Benfatto 1944-2024

by GIOVANNI GALLAVOTTI

I met Giosi in the mid-seventies when he turned to Statistical Mechanics, after a brief experience mainly on high energy physics. He immediately devoted his energies to contribute to the project of understanding aspects of the renormalization group method in quantum field theory. The project started involving a rather large number of collaborators: Giosi was the real driving force. He was always first in attempting new ideas to overcome the numerous difficulties met. He never stopped even though the number of collaborators dwindled and in the end, about two years later only Giosi, Francesco Nicolò and I were left: I have no doubts that it was the merit of Giosi that the project did not stop on the way. I continued to collaborate with Giosi: it was clear to me that without the support of his formidable skill and force/patience in performing demanding calculations and looking for new ideas I would have found insurmountable difficulty: the result on the vanishing beta function in Fermionic systems and the quasi particles theory of the Fermi surface has been largely his contribution. I also had the experience of co-authoring a book: his strict attention to small details was of great help.

Afterwards, after about 20 years of strict collaboration I only followed and admired his work. He continued to animate the research in our group while dedicating himself to other subjects of theoretical Physics attracted by the problems that were interesting for our group: so he worked on statistical mechanics, on continua, on KAM stability in classical mechanics, on simulations (he was an expert on codes, for which he kept strong interest always keeping enough distance so that simulations at no time became anywhere close to disturb his research). He continued to devote attention, mainly to renormalization problems, first with Vieri Mastropietro, then with Alessandro Giuliani, Pierluigi Falco, Marcello Porta, ... achieving a remarkable series of results employed towards the analysis of low temperature properties of Fermi systems and proving well known conjectures on exact cancellations necessary to give a meaning to perturbative predictions. I will remember his continuous moral example, his personal kindness, his availability to discuss any scientific problem with whomever asked his opinion or advice, never declining to help by performing even detailed computations.

Giovanni Gallavotti

September, 2024

G. Benfatto's publications list can be found at

https://www.mat.uniroma2.it/∼benfatto/pubblicazioni.html

Henri Epstein (1932-2024)

by JEAN-PIERRE ECKMANN and UGO MOSCHELLA

I was very happy to have crossed Henri's life through many phases of my career. When I was still a graduate student, Henri came regularly over from CERN, to attend the mathematical physics seminar at the department of theoretical physics at the University of Geneva.

I will describe below, some of the papers which I liked best, and which impressed me most (excluding of course most of the 12 papers which we wrote together, and with others). Ugo will describe in his contribution the long collaboration with J. Bros and Henri.

At that time, Henri was quite involved in explaining with Y. Glaser the interplay of localization in energy and causality for quantum filed theory. There are many papers of this period, also with J. Bros, of which "The role of locality in perturbation theory" relates locality and renormalizability.

This was quite new to me, since I had missed, due to my military service, the introduction to the theory of analytic functions. Here, the Brandeis Lectures of Henri opened my eyes on the "correct" way to think about analytic functions in several variables, namely that their domains of analyticity are in no way arbitrary as in 1 variable, but are bigger either by the "edge-of-the-wedge" theorem, or by the notion of "domain of holomorphy". As I started to visit regularly the IHES, we also started to publish together. The first papers were on Time-Ordered-Products in quantum field theory (together with Juerg Fröhlich), and Borel summability of the mass and the S-matrix in Φ^4 models, where he taught me finally to play with analytic functions.

There are many beautiful papers by him, and they all excel by their simplicity, and the originality of his approach, usually using some unexpected properties of analytic functions. A typical example which I like is the paper "Remarks on two theorems of E. Lieb" in which he studied the convexity of functions of the type

$$f(A) = \mathrm{Tr}\exp(B + \log A), \qquad \text{or } g(A) = \mathrm{Tr}(e^{B/(2n}A^{1/n}e^{B/(2n)}) \,,$$

with $B = B^*$ and A arbitrary in the set of complex $N \times N$ matrices (or in a von Neumann algebra with a finite trace). Then he shows that $F(z) \equiv f(A_2 + zA_1)$ resp. $g(A_2 + zA_1)$ with $A_1 = A_1*$ and $A_2 = A_2^* > 0$ satisfies

$$\frac{\mathrm{d}^{2m}F(t)}{\mathrm{d}t^{2m}} \leq 0 \text{ for all integer } m \geq 1 \,.$$

The trick in all these inequalities (there are many more in the paper) is the representation

$$f(A) = \frac{1}{2\pi i}\int_{\mathcal{C}} f(z)(z - A)^{-1}\mathrm{d}z \,,$$

and similar formulas, which show that these functions have the Herglotz property (see below).

In the early 1980's under the influence of Feigenbaum's work, Henri studied several variants of this problem. In particular, using the theory of Herglotz (Pick) functions (functions which map the upper half-plane to itself) Henri provided the first, elegant, proof of the existence of Feigenbaum's function without the need of a computer.

Another, far-reaching piece of work is his paper with Lascoux, in which they studied the global structure of the Feigenbaum function g in the complex plane: This function has a natural domain D of holomorphy. It has the intriguing property that $\lambda^{-1}\partial D \subset \partial D$ while $\lambda D \subset D$, where g is the Feigenbaum fixed point, and λ the corresponding scaling. (The study uses the inverse function(s) of g.)

The domain is a union of an infinite family of "patches". (This result actually anticipates Yoccoz' work on the so-called "Yoccoz puzzle".)

Finally, to show that Henri was not only interested in analytic functions, I might mention the paper "A Global attracting set for the Kuramoto-Sivashinsky equation" with P. Collet and J. Stubbe, which uses just classical analysis, and was part of a still on-going challenge, to prove or disprove, extensivity of the Kuramoto-Sivashinsky equation.

Let me end with some personal remarks: Henri and I spent a lot of time together, mostly at IHES, but also in Geneva. We both loved to play with the "computer" which was bought, probably by Oscar Lanford's insistence at the IHES, and we experimented many important and mostly unimportant ideas on it (with its old pen-plotter). With the advent of personal computers and printers, the computer room was converted, to our amusement, to a toilet.

Another important pastime were our visits to Paris: A mixture of restaurants ("le Hangar", "Le Balzac"), sweets (following the guide "Paris sucré"), checking antique books at Blanchard. And the weekly challenge: at the FNAC Montparnasse, buying Classical CD's and trying to avoid buying the same CD twice in a row.

All these times with Henri, David Ruelle, and Oscar Lanford, remind me of the kindness, and constant scientific help I received at IHES. I will keep Henri in a good souvenir.

Jean-Pierre Eckmann

I met Henri Epstein towards the end of his career. I was a postdoc at the IHES in the mid-nineties and Henri was close to his retirement. Despite this apparent major obstacle, a scientific collaboration and, most importantly, a close friendship began at that time which were to last until the end of Henri's days. In fact, friendship and collaboration were between the three of us, the third person being Jacques Bros.

After my return to Italy, Henri and Jacques regularly came to see me on the Como lake where my University is located, a place that had become so familiar to them that their habits and personal relationships in Como even became independent of mine.

And the three of us loved so much to travel to Vienna at the Schrödinger Institute, in the glorious epoch when Walter Thirring was there. We spent so many happy hours in Vienna, discussing, laughing and filling the blackboards in the monumental corridors of the institute with many many small chalk marks - that was the specialty of Jacques - discussions interrupted only by escapes to Demel's or to the Musikverein.

At the Musikverein Henri and I attended one evening the most beautiful concert of our life: in the Brahms-Saal Christine Schäfer sang Schubert's Winterreise in such a sublime way that at the end nobody dared even to breathe and silence went on for many endless moments before the final standing ovation. Those were the days...

So, after his official retirement, Henri went on and devoted himself mainly to the study of quantum fields on the de Sitter universes, collaborating with me and Jacques Bros, and occasionally also with Michel Gaudin and Vincent Pasquier.

De Sitter's models are solutions of Einstein's cosmological equations without matter; a positive cosmological constant gives rise to the de Sitter universe while a negative cosmological constant corresponds to the anti-de Sitter universe. Both of them play a central role in contemporary theoretical physics: understanding quantum field theory on the de Sitter universes is of great importance for physical cosmology at one end and for string theory at the other end.

Despite some similarities among them, the de Sitter and anti-de Sitter manifolds present different kinds of difficulties to quantum field theory. From a geometrical point of view, they are analytic Lorentzian manifolds particularly well suited to be explored with the methods of the theory of analytic functions of several complex variables; as Jean-Pierre was recalling above, of this theory Henri was the last surviving master of a glorious era. His knowledge, gone away with him, was one of the pillars sustaining our collaboration.

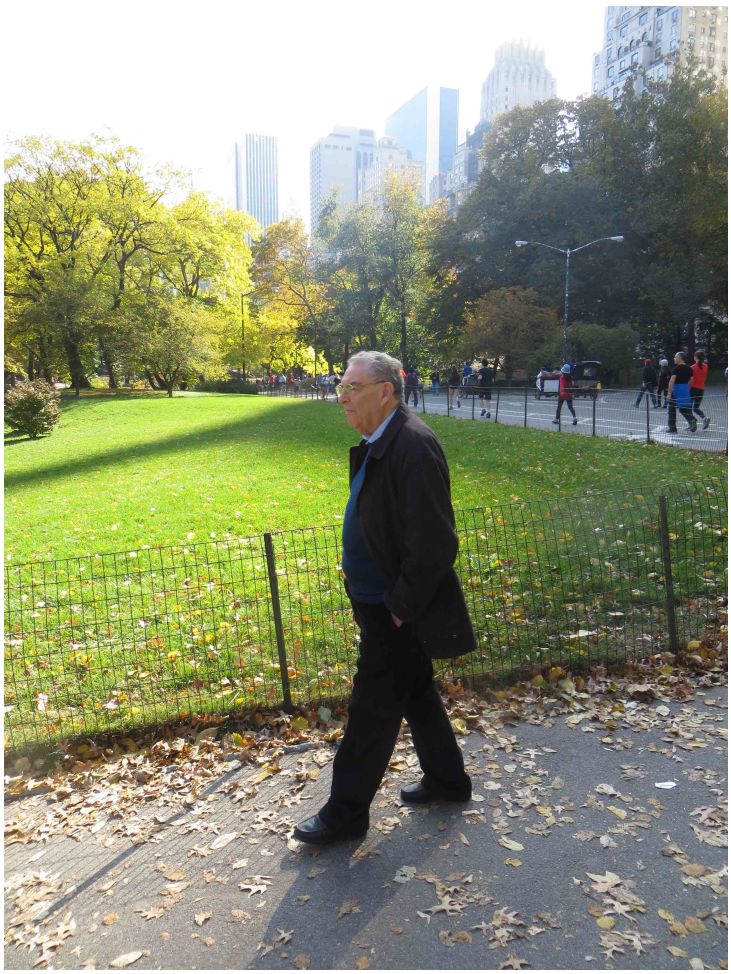
The results obtained over 30 years range from general structural properties of de Sitterian quantum field theories to the calculation of very concrete formulae such as the two Kallen-Lehmann formulae; these are non-trivial exact formulae which have surprising consequences for the stability of particles and the existence of bound states in de Sitter quantum field theory.

Two years ago, Henri was invited by Slava Rychkov to give his last talk at the IHES; with his usual sense of humour he gave the title "Archeological Remarks on Analyticity Properties in Momentum Space in QFT". The subject of the seminar was the crossing symmetry; his old results are nowadays studied and used in the so called bootstrap program and young generations of theoretical physicists are learning about Henri's work and can also profit from an explanation directly from his lips (https://youtu.be/_0YZFxzM2XQ).

Henri worked until the last days of his life, as long he could. He was still working hard the last days of May; a strange destiny wanted that the final paper signed by Henri was published on the very day of his death, August 15, 2024.

He loved beauty and elegance in his research and all things of life; he loved literature and music. His sense of humor and clarity of mind made working with him a pleasure, a joy. Until the end, he remained young in spirit, enthusiastic, sincere, and generous. Mozart and Schubert whom he loved so much, accompanied him on his last journey.

Ugo Moschella



Time's Arrow

Scientific anniversaries

70 years ago, A.N. Kolmogorov published his paper *On Conservation of Conditionally Periodic Motions for a Small Change in Hamilton's Function* (Dokl. Akad. Nauk SSSR 98, 527–530, 1954), the beginning of KAM theory.

In the same year, C.N. Yang and R. Mills published their work on a local $SU(2)$ gauge theory of isospin. Their paper *Conservation of Isotopic Spin and Isotopic Gauge Invariance* appeared on October 1, 1954 (Physical Review 96, 191–195).

Again, in the same year, Fred Hoyle published his work on stellar nucleosynthesis in his paper *On Nuclear Reactions Occurring in Very Hot Stars. I. the Synthesis of Elements from Carbon to Nickel* (The Astrophysical Journal Supplement Series. 1: 121–146).

50 years ago, F. Wegner published foundational work on the general structure of Wilson's renormalization group in his paper *Some Invariance Properties of the Renormalization Group* (J. Phys. C: Solid State Phys. 7, 2098 (1974)).

Personal Celebrations

Jean-Pierre Eckmann turned 80 on January 27, 2024

Lost luminaries

Giosi Benfatto (1944-2024)

Henri Epstein (1932-2024)

John Klauder(1932-2024)

Readers are encouraged to send items for "Time's Arrow" to salmhofer@uni-heidelberg.de.

News from the IAMP Executive Committee

New individual members

IAMP welcomes the following new members

1. Stefano Galanda, University of Genoa, Italy
2. Jakob Geisler, TU Braunschweig, Germany
3. Dr. Sylvain Lavau, RuđerBošković Institute, Croatia
4. Aldo Riello, Perimeter Institute for Theoretical Physics, Canada
5. Dr. Elke Rosenberger, University of Potsdam, Germany
6. Dr. Muhammad Roshanzamir, Shahrekord University, Iran
7. Gabriel Schmid, University of Genoa, Italy
8. Dr. Markus Schröfl, Friedrich Schiller Universität Jena, Germany
9. Dr. Luuk Stehouwer, Dalhousie University, Canada
10. Prof. Raffaele Vitolo, University of Salento, Italy

Recent conference announcements

XX Brunel-Bielefeld Workshop on Random Matrix Theory and Applications

December 13-14, 2024; London, UK.

Mathematical Challenges in Quantum Mechanics, School & Workshop"

February 10-14, 2025; GSSI, L'Aquila, Italy.

Random Matrices and Integrability in Complex and Quantum Systems, Research Workshop of the Israel Science Foundation

April 23 - 28, 2025; Yad Hashmona, Judean Hills, Israel.

Open positions

For an updated list of academic job announcements in mathematical physics and related fields visit

http://www.iamp.org/page.php?page=page_positions

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