C18 - Mathematical Physics

Report to the Council & Committee Chairs (Fall 2018)

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1 Summary

The main periodic IUPAP sponsored event associated with the Commission on Mathematical Physics (C18) is the triannual International Congress on Mathematical Physics (ICMP). The 2018 ICMP took place this summer in Montreal, Canada. The International Scientific Committee of the congress invited an impressive slate of speakers for the plenary and public talks and broad representation of organizers of the thematic sessions. In the course of its deliberations, the International Scientific Committee kept itself well aware of the continuing underrepresentation of women in the field of mathematical physics and has tried hard to make progress on this issue. With the 2018 program ICMP is approaching the 20% mark for women plenary speakers and session organizers at this years congress. See https://icmp2018.org for details of the program. A detailed report is given in a separate section of this report.

At the ICMP in Montreal, through C18, three researchers were recognized by a IUPAP Young Scientist Prize. A subcommittee of the previous commission, chaired by Manfred Salmhofer, reviewed the nominations, solicited the input of outside reviewers, and selected three winners. The selection was approved through an email vote by the current membership of the commission. The three winners of the 2018 Young Scientist Prize are Wei-Kuo Chen (University of Minnesota, USA), Phan Thanh Nam (Ludwig-Maximilian University, Germany), and Vadim Gorin (MIT, USA). A brief bio and description of their work appears in a separate section of this report.

One member of the Commission, Olga Rossi, resigned for personal reasons. We are currently considering candidates to nominate for her replacement.

2 2018 Conference support

The International Congress of Mathematical Physics (ICMP), on its three year cycle, is the most important conference of the International Association of Mathematical Physics. The XIXth ICMP was held in Montreal, July 23-28, 2018. This was the first time since 1983 that the Congress is being held in North America (in 1983 the Congress was held in Boulder, Colorado). Following a tradition started in London

in 2000, the ICMP 2018 was preceded by the Young Researchers Symposium (July 20 and 21, 2018). Seven satellite meetings have been organized in Banff, Toronto, Montreal, and Perimeter Institute either a week before or a week after the ICMP 2018.

The ICMP was attended by 574 registered participants, out of which 95 are women. The organization of the ICMP followed the traditional route, with sixteen plenary speakers and twelve topical session. Three plenary speakers are woman. Each topical session had six speakers, selected by two organizers, who themselves were selected by the International Scientific Committee of the ICMP. Four session organizers and ten session speakers are women. In addition, ten prize lectures were presented at the ICMP. There were no women among prize lectures.

The distribution of the registered participants per country was: AE: 3, AT: 17, AU: 7, BE: 6, BR: 2, CA: 114, CH: 19, CL: 4, CN: 3, CO: 2, CR: 1, CZ: 6, DE: 58, DK: 18, DZ: 1, ES: 2, FI: 3, FR: 64, GB: 21, IE: 1, IL: 7, IN: 8, IR:1, IS:1, IT: 26, JP:17, KR:5, KZ:1, LB:1, LR:1, MA:2, ML:1, MX:2, MY:1, NL:2, NZ:1, OM:1, PL:4, PT:3, RU:1, SA:2, SE:5, US:129.

One novelty of the ICMP 2018 were two highly successful public lectures. The first was given by Rainer Weiss (MIT, Nobel Prize in Physics 2017) on Gravitational Wave Astronomy and Ligo's experimental discovery of gravitational waves. The second one was given by Elliott Lieb (Princeton University) on the topic of entropy. Many members of Montreal?s scientific community attended these two lectures.

Another novel aspect of the ICMP 2018 was a large number of contributed talks (119), which were given in ten parallel evening sessions on July 24 and 27. Combined with Young Researchers Symposium, where 66 talks were given by junior participants, the total number, variety, and quality of contributed talks significantly added to the success of the ICMP.

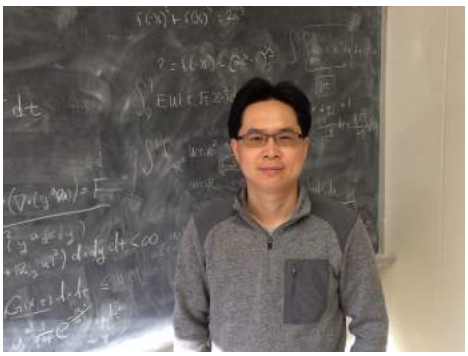
The organizational aspects of the ICMP were very successfully handled by the Canadian Mathematical Society (CMS).

The ICMP 2018 was a considerable international success. This success has reflected very positively on Montreal's and Canada's mathematical physics community, the CMS organizational capacities, and the entire Canada Mathematical Institutes system (these three institutes were major sponsors of the ICMP and its satellites).

The XXth ICMP will be held in Geneva, Switzerland, in August 2021.

3 2018 Young Scientist Prize winners: Wei-Kuo Chen, Phan Thanh Nam, and Vadim Gorin

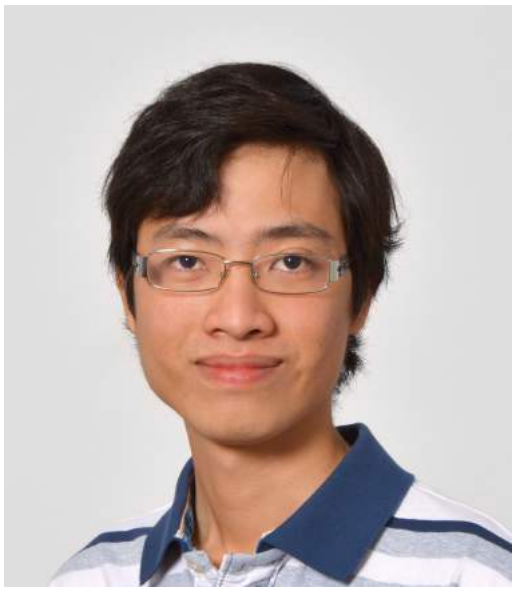
Wei-Kuo Chen earned his B.Sc. and M.Sc. in Math from Taiwan. In 2009, he received his Ph.D. degree in math at the University of California, Irvine. From 2012 to 2015, he was a L.E. Dickson instructor in the department of mathematics at the University of Chicago. Since then, he has been serving as an assistant professor in the school of mathematics at the University of Minnesota.



Dr. Chen's research interest generally lies on the probability theory and its applications with a special focus on the field of spin glass models. They are disordered spin systems introduced by theoretical physicists in order to understand some strange magnetic behavior of certain alloys. Mathematically, spin glass models exhibit several crucial features, such as quenched disorder and frustration, that are commonly shared in various disordered systems with high complexity.

Dr. Chen's work has been focused on establishing mathematically rigorous results for the famous Sherrington-Kirkpatrick (SK) model as well as its generalization, the mixed p-spin model, following the groundbreaking works of G. Parisi in late ?70. By adopting stochastic optimal control methods, Chen solved a number of fundamental problems in the mixed p-spin model. In particular, he (jointly with Antonio Auffinger) established the uniqueness of the functional order parameter in the Parisi formula for the thermodynamic limit of the free energy and additionally he (jointly with Antonio Auffinger and Qiang Zeng) showed that that the SK model exhibits the full-step replica symmetry breaking solution at zero temperature. Lately Dr. Chen?s research interest has been extended to some emerging applications involving randomized combinatorial optimization problems arising from computer and data sciences by means of spin glass methodologies including the positive semi-definite programming and signal detection and recovery problems.

Phan Thanh Nam was born in 1985 in Phu Yen, Vietnam. He graduated from Vietnam National University at Ho Chi Minh City in 2007 and obtained his PhD in Mathematics from University of Copenhagen in 2011. Afterwards, he was a Post-doc at CNRS and University of Cergy-Pontoise until 2013, a Post-doc at IST Austria until 2016, and an Assistant Professor at Masaryk University until 2017. Currently, he is a Professor of Mathematics at LMU Munich. Nam?s work concerns the mathematical treatment of many-body quantum systems from first principles. In this research line, the general difficulty lies on Schrdinger?s equation for many particles, which is easy to write down but very difficult to analyze.



A large portion of Nam's work is devoted to the theory of interacting Bose gases, which has been a hot topic since the first realization of the Bose-Einstein condensation in 1995. He has derived a novel approach to prove the condensation by means of quantum de Finetti theorems (joint with M. Lewin and N. Rougerie), and a general strategy to justify Bogoloiubov's approximation for the excitation spectrum (joint with M. Lewin, S. Serfaty and J.P. Solovej). Some tools developed in these works have become standard in current studies.

Another favorite problem in his research is the ionization conjecture. Despite convincing experimental evidence that a neutral atom can bind at most one or two extra electrons, justifying this fact rigorously from quantum mechanics is notoriously difficult. In his PhD thesis, Nam proved a universal bound for the excess charge, which remains the best known up to now. Then he successfully proved the ionization conjecture in Thomas-Fermi-Dirac-von Weizscker theory (joint with R. Frank and H. Van Den Bosch), an approximation used widely in computational quantum physics and chemistry but poorly understood mathematically for a long time.

Vadim Gorin was born in Moscow, Russia. He became a candidate of sciences in mathematics at Moscow State University in 2011, and at the same year he earned his PhD in mathematics from the Utrecht University. Vadim spent the Spring of 2012 at Mathematical Sciences Research Institute at Berkeley and then joined the mathematics department of the Massachusetts Institute of Technology. He has been working at MIT since that time: first as a CLE Moore Instructor and currently as an assistant professor.

Vadim Gorin works on asymptotic representation theory, studying various properties of representations of groups linked into series (such as unitary groups, orthogonal groups, or symmetric groups) as the rank tends to infinity. In a related work on mathematical statistical mechanics, Gorin focuses on 2-D lattice models, random matrices, and interacting particle systems.

The central tool of his research is the use of symmetric functions of representation-theoretic origin for the delicate asymptotic analysis of large stochastic systems of particles. Among the main results is the analysis of the macroscopic fluctuations for a class of discrete random stepped surface models leading to the Gaussian Free Field. In another direction, Vadim (with several collaborators) discovered a surprising appearance of random matrix distributions in the local limits of statistical mechanics systems such as the six-vertex model and random sorting networks.