Research Networking Programmes

Science Meeting – Scientific Report

Stochastics and Interactions
Budapest, 21-24 July 2015

Proposal Title: Stochastics and Interactions
Application Reference N°: 5756

1) Summary (up to one page)

The conference was centered around research interests of Bálint Tóth who celebrates his 60^{th} birthday this year. As Bálint is an exceptional researcher with an excellent professional network and a broad range of world-class contributions in leading areas of probability theory, our invited speakers reported on advances in frontier-line research of many topics. One of the striking features of developments was how much seemingly different topics within probability theory interlace and support one another. We therefore judge the meeting extremely successful in promoting discussions and further cooperations between these research areas. Below we try to summarise the main topics of the conference but for the above reason it is very difficult to make a clear distinction between single categories.

- We have heard about current frontiers of percolation theory;
- we have seen various aspects of the rich interplay between probability theory and that of partial differential equations;
- we have learned about recent investigations on mathematical aspects of statistical physics;
- we have heard about interesting probabilistic questions originating in various problems in other disciplines such as supersymmetric methods from physics, number theory, and computer science;
- very interesting questions of non-reversible stochastic dynamics, and their unique, tricky methods of solutions were explained;
- we have seen how new results from the theory of deterministic dynamics bring us closer and closer to the true origin of randomness in nature.

Besides our invited speakers, many local and a few international top researchers, as well as local and international postgraduate students and early-career research fellows followed the talks and engaged in discussions.

2) Description of the scientific content and of discussions at the event (up to four pages)

We detail the points of the introduction below.

- We have heard about frontiers of percolation theory: the construction of frozen percolation processes (Jacob van den Berg (CWI, Amsterdam. NL)), an improvement of the celebrated Burton-Keane argument for non-iid. percolation models (Dmitry Ioffe (Technion, Haifa, IL)), and reconstruction of certain events in percolation and other spin systems from limited information (Gábor Pete (Rényi Inst./TU Budapest, HU)).

- There is a rich interplay between probability theory and that of partial differential equations. Heat flows and Brownian motion are strongly connected, now we have learned about such connections on Riemannian manifolds (Michiel van den Berg (University of Bristol, UK)). There are various types of scaling limits where stochastic processes scale to (stochastic) (system of) PDE's. Examples included a two-species exclusion model (József Fritz (TU Budapest, HU)), directed polymers (Konstantin Khanin (University of Toronto, CA)), and a chain of interacting oscillators with a certain type of added noise (Stefano Olla (Ceremade, Paris, FR)).

- Investigations on mathematical aspects of statistical physics are as active as ever. The meeting featured the extreme point process associated to the Discrete Gaussian Free Field (Marek Biskup (UCLA, California, US)), spin glass models in connection with neural networks (Erwin Bolthausen (Universität Zürich, CH / Kyoto University, JP)), random interchange and random loop models that arise from quantum spin systems (Roman Kotecký (University of Warwick, UK / Center for Theoretical Study, Prague, CZ) and Daniel Ueltschi (University of Warwick, UK)), and discrete weighted graph-valued Markov chains the stationary distributions of which have strong connections to critical models of statistical physics (Wendelin Werner (ETH Zürich, CH)).

- We have heard about interesting probabilistic questions originating in various other problems of physics or mathematics, such as eigenvalue-distributions of random matrices using supersymmetric methods from theoretical particle physics (László Erdős (IST Vienna, AT)), very interesting scaling of certain dependent process of exponential sums that are of central interest in number theory (Jens Marklof (University of Bristol, UK)), and asymptotics of random sorting networks of computer science (Bálint Virág (University of Toronto, CA / Rényi Inst., Budapest, HU)).

- Dynamics of non-reversible stochastic systems is always hard and investigations often involve unique, tricky methods. One model that described condensation of vapour featured metastable behaviour (Frank den Hollander (Universiteit Leiden,

NL)), we learned about the physicist's approach to phenomena seen in new interacting processes on graphs (János Kertész (Central European University/TU Budapest, HU)), fascinating results and new connections to other fields of probability were explained in the world of random walks in random environment (Gady Kozma (Weizmann Institute, Rehovot, IL)) and reinforced random walks (Pierre Tarrès (Ceremade, Paris, FR)). We have also seen breakthrough results for last passage percolation-type models with a slow bond (Vladas Sidoravicius (IMPA, Rio de Janeiro, BR)).

- New results from the theory of deterministic dynamics bring us closer and closer to the true origin of randomness in nature. A billiard model with rare interactions was explained, where a Markov jump process results from pure hard-core collisions (Domokos Szász (Hungarian Academy of Sciences / TU Budapest, HU)). We have also been shown effective handling of the symbolic dynamics of substitutions (Michael Keane (Delft, NL / Leiden, NL / Wesleyan, US)).

There were several questions after almost all lectures, often a vivid discussion started from those. These were helped by the carefully chosen chairmen for each morning and afternoon session of the meeting.

The programme was intentionally planned to give plenty of opportunities for interactions. We had coffee breaks in a common foyer, lunches with most participants going together to the same place, a wine reception on the first evening, and a conference dinner. We have seen lots of interactions on these occasions, and in one morning even a spontaneous mini-lecture formed on percolation-related topics with Jacob van den Berg, Edward Crane, Nic Freeman, and Balázs Ráth among the participants.

3) Assessment of the results and impact of the event on the future directions of the field (up to two pages)

Seeing all these interactions we are confident that the meeting greatly helped young participants and promoted exchange of ideas. The research interests of the participants were on one hand much diverse and the topics of the talks covered a very significant part of modern probability theory. On the other hand participants spoke a common language in the sense that talks were accessible to pretty much all of the audience. This can of course also be attributed to the experience and excellence of our speakers.

Cross references that arose (e.g., between Gaussian Free Field and particle systems or Liouville Quantum Gravity; neural networks and spin glass models; percolation models and dependent spin systems; combinatorial aspects of loop models and statistical physics, number theory and classical probability; dynamical systems and Markov processes; reinforced random walks and Schrödinger operators) make it very likely that this meeting will have a significant positive influence on future methodology in modern probability theory.

Annexe 4a): Programme of the meeting to be found on the next page.

Stochi **Mon Jul 20 – Sun Jul 26, 2015 (Budapest)**

	Mon 7/20	Tue 7/21	Wed 7/22	Thu 7/23	Fri 7/24	Sat 7/25	Sun 7/26
9am							
		Opening 9:20am -					
10am		D. Szász 9:30am - 10:20am	J. v.d.Berg 9:30am - 10:20am	D. Ueltschi 9:30am - 10:20am	J. Fritz 9:30am - 10:20am		
		J. Marklof 10:20am - 11:10am	D. Ioffe 10:20am - 11:10am	R. Kotecký 10:20am - 11:10am	G. Kozma 10:20am - 11:10am		
11am		Coffee 11:10am - 11:40am	Coffee 11:10am - 11:40am	Coffee 11:10am - 11:40am	Coffee 11:10am - 11:40am		
		M. v.d.Berg 11:40am - 12:30pm	G. Pete 11:40am - 12:30pm	F. d.Hollander 11:40am - 12:30pm	L. Erdős 11:40am - 12:30pm		
12pm		Lunch (XO bistro; ticket required) @ Budapest, Rákóczi út 5., 1088 12:30pm - 2:30pm	Lunch (XO bistro; ticket required) @ Budapest, Rákóczi út 5., 1088 12:30pm - 2:30pm	Lunch (XO bistro; ticket required) @ Budapest, Rákóczi út 5., 1088 12:30pm - 2:30pm	Lunch (XO bistro; ticket required) @ Budapest, Rákóczi út 5., 1088 12:30pm - 2:30pm		
1pm							
2pm		J. Kertész 2:30pm - 3:20pm	M. Biskup 2:30pm - 3:20pm	K. Khanin 2:30pm - 3:20pm			
3pm		Coffee 3:20pm - 3:50pm	Coffee 3:20pm - 3:50pm	Coffee 3:20pm - 3:50pm			
4pm		W. Werner 3:50pm - 4:40pm	P. Tarrès 3:50pm - 4:40pm	E. Bolthausen 3:50pm - 4:40pm			
5pm		B. Virág 4:40pm - 5:30pm	V. Sidoravicius 4:40pm - 5:30pm	S. Olla 4:40pm - 5:30pm			
6pm		M. Keane 5:45pm - 6:35pm					
7pm		Wine reception 7pm - 8pm		Conference dinner (Sipos Halászkert) @ 1036 Budapest, Lajos utca 46. 7pm - 9pm			
8pm							

Annexe 4b): List of speakers and participants who benefited from this ESF funding

Speakers:

Jacob van den Berg	(CWI, Amsterdam. NL)
Michiel van den Berg	(University of Bristol, UK)
Marek Biskup	(UCLA, California, US)
Erwin Bolthausen	(Universität Zürich, CH / Kyoto University, JP)
László Erdős	(IST Vienna, AT)
József Fritz	(TU Budapest, HU)
Frank den Hollander	(Universiteit Leiden, NL)
Dmitry Ioffe	(Technion, Haifa, IL)
Michael Keane	(Delft, NL / Leiden, NL / Wesleyan, US)
János Kertész	(Central European University / TU Budapest, HU)
Konstantin Khanin	(University of Toronto, CA)
Roman Kotecký	(Univ. of Warwick, UK / ÚTIA, Prague, CZ)
Gady Kozma	(Weizmann Institute, Rehovot, IL)
Jens Marklof	(University of Bristol, UK)
Stefano Olla	(Ceremade, Paris, FR)
Gábor Pete	(Rényi Inst. / TU Budapest, HU)
Vladas Sidoravicius	(IMPA, Rio de Janeiro, BR)
Domokos Szász	(Hungarian Academy of Sciences / TU Budapest, HU)
Pierre Tarrès	(Ceremade, Paris, FR)
Daniel Ueltschi	(University of Warwick, UK)
Bálint Virág	(University of Toronto, CA / Rényi Inst., Budapest, HU)
Wendelin Werner	(ETH Zürich, CH)

Further participants:

Bálint Tóth	(University of Bristol, UK / Rényi Inst. / TU Budapest, HU)
Lucian Beznea	(IMAR Bucharest, RO)
Nic Freeman	(University of Bristol, UK)
Matija Vidmar	(University of Ljubljana, SI)