

Random Walks and Random Media

April 30, 2012 to May 4, 2012

MSRI, Berkeley, CA, USA

Organizers:

Noam Berger (The Hebrew University of Jerusalem)

Nina Gantert (Technical University, Munich)

Andrea Montanari (Stanford University)

Alain-Sol Sznitman (Swiss Federal Institute of Technology)

Ofer Zeitouni* (University of Minnesota/Weizmann Institute)

Random walks and Random Media

Report

The field of random media has been the object of intensive mathematical research over the last thirty years. It covers a variety of models, mainly from condensed matter physics, physical chemistry, and geology, where one is interested in materials which have defects or inhomogeneities. These features are taken into account by letting the medium be random. It has been found that this randomness can cause very unexpected effects in the large scale behavior of these models; on occasion these run contrary to the prevailing intuition. A feature of this area, which it has in common with other areas of statistical physics, is that what was initially thought to be just a simple toy model has turned out to be a major mathematical challenge.

The workshop on random walks and random media was designed to bring together a group of researchers working on different aspects of random walks interacting with an environment, which might be random (and fixed) or random because it is related to the past trajectory of the walker or of other walkers. The schedule left time for interactions between researchers (including one afternoon, Wednesday, free) and many discussions and exchanges of ideas occurred throughout the week.

The workshop opened on Monday morning with a review talk by A. Ramirez (Santiago, Chile) who first reviewed conditions, due to Sznitman, for ballisticity for random walks in i.i.d. random environments, and then described recent advance (obtained in collaborations with Berger and Drewitz, and with Campos) on their understanding. In particular, using a local CLT type argument (originally due to Berger) and an appropriate renormalization argument, one reduces checking Sznitman's condition (which involves a stretched exponential rate of decay of certain exit probabilities) to checking polynomial rates of decay for exit probabilities. This was followed by a talk of C. Sabot (Lyon) who described recent advance (due to him and P. Tarres) in the study of edge reinforced random walks (an example of a walk in a random environment which is determined by the past trajectory of the walk, introduced by Diaconis and Coppersmith); he showed how the ERRW can be represented as a mixture of vertex reinforced jump processes, where the mixing measure is related to the so-called SUSY sigma model of Disertori, Spencer and Zirnbauer. This allowed them to deduce strong recurrence for strong reinforcement, a problem that had been open open for some time. (See below the description of the talk by Omer Angel for another approach to the resolution of that problem.)

Monday afternoon featured talks by D. Dolgopyat (U. Maryland) who discussed a dynamical approach towards central limit theorems for random walks in dynamically changing random environments, and for weakly reinforced walks; by M. Biskup (UCLA), who described joint work with Salvi and Wolff on the fluctuations of the effective conductance for walks on resistance networks; and by A. Fribergh (NYU), who described recent joint work with BenArous and Sidoravicius that settled the conjectured monotonicity of the velocity of (biased) random walks on a Galton-Watson tree, in the regime of high speed, using an appropriate coupling with biased simple random walk, and regeneration times.

The morning session on Tuesday was dedicated to polymer models. There were two speakers, T. Seppäläinen and I. Corwin. Seppäläinen gave a 90 minute review where he started from the very basics and reached current results, whereas Corwin gave a talk on some state-of-the-art results in the field.

In the beginning of his talk Seppäläinen defined the model of a directed polymer. He explained the motivation behind the definition, as well as the physical significance of this model. He then proceeded to discuss its behavior, and proved many of the early results in the field, in particular establishing phase transition and concluding basic facts on the behavior in each phase. He then continued with more advanced results, particularly regarding polymers in $1 + 1$ dimensions (i.e. one spatial dimension and one temporal dimension), discussed its explicit solution and the fact that it belongs to the KPZ (Kardar-Parisi-Zhang) universality class.

In his talk Corwin defined the MacDonal process, which is a new type of stochastic process, based on the Macdonald symmetric functions. He then used the Macdonald process to understand the limiting behavior of several different growth processes, particle systems, and directed polymers in random media. He then showed that this leads to the KPZ equation for those processes.

The afternoon talks on Tuesday were given by D. Wilson (Microsoft Research) who described his joint work with Kenyon concerning the computation of certain probabilities related to uniform random spanning trees on graph determined by surfaces; by V. Sidoravicius, who described work concerning interacting particles that model a particular greedy server in a network; and by K. Alexander (USC) who discussed concentration estimates and rate of convergence for directed polymers.

Wednesday had only morning talks, the afternoon being devoted to free discussions between participants. Two of the talks were devoted to the topic of random interacements, which provide a model for the microscopic structure left at suitable time scales by random walks on large recurrent graphs which locally look like a transient graph. The third talk was concerned with random walks among random conductances.

A. Teixeira (IMPA, Rio de Janeiro) gave a longer review talk on the topic of random interacements where he described some of the results which have been obtained, as well as a list of open questions in particular concerning the investigation of the near critical regime for the percolation of the vacant set of random interacements. Then J. Cerný (University of Vienna) presented recent results obtained jointly with Popov concerning a shape theorem for the chemical distance on the occupied set of random interacements on Z^d , d at least 3, and their application to controls of the distance on the trace of a random walk trajectory on a large d -dimensional torus.

The third talk was given by S. Popov (State University of Campinas) who presented results obtained with several collaborators pertaining to the quenched limit law under diffusive scaling of a random walk among random conductances conditioned to have its first coordinate positive.

The first morning talk on Thursday was delivered by Y. Peres (Microsoft Research), who discussed joint work with Berger concerning the statistical hypothesis testing problem of detecting the trail of a random walker who modifies the environment at sites that were visited; he also introduced a riddle (and its solution) concerning the surprise points of (general, not necessarily reversible) random walks on graphs. This was followed by O.

Angel (UBC), who described his recent proof (with Kozma and Crawford) of recurrence for edge-reinforced random walks on Z^d ; unlike the Sabot-Tarres work, their proof does not appeal to the relation with the SUSY model. The morning session was closed by E. Bolthausen (U. Zurich), who reviewed his recent work with den-Hollander and Opoku concerning the critical line of localization-delocalization of the random copolymer, that used abstract large deviations statements to investigate long-standing questions concerning the slope of the line at the origin. The afternoon was devoted to several talks. First, P. Sousi (Cambridge, England) presented joint work with Peres and Popov on random walks that are martingales and interact with their past through an agent who can only choose from finitely many possible steps. Results concerning transience/recurrence (as a function of the number of allowed steps and the dimension) were presented. A. Levit (UBC) then presented results concerning mean field models that possess a jump-process representation, and B. Toth (Budapest) discussed his work with Tarres and others concerning scaling limits for self-interacting random walks and diffusions.

The last day of the conference was opened by P. Diaconis (Stanford), who gave an inspiring talk on the cutoff phenomenon for typical birth and death chains, where he explained the cutoff phenomenon and pointed out connections with combinatorics. The “random media” aspect came in by considering a “typical” birth and death Markov chain whose stationary law is uniform, by choosing a certain random tri-diagonal doubly stochastic matrix as transition matrix. Then, J. Peterson (Purdue) talked about his new result on large deviations and slowdown probabilities for excited random walks in one dimension. He explained similarities and differences of his results with the corresponding statements for random walk in random environment. The last speaker of the morning session, E. Kosygina (CUNY), gave a survey talk on excited random walks, pointing out open problems for excited random walks in the multi-dimensional case and describing new results for the one-dimensional case. The afternoon was devoted to talks by two junior researchers: J. Ding and N. Sun (both from Stanford). Ding exposed recent work on the maximum of the two-dimensional discrete Gaussian free field. It has long been known that this quantity satisfies a law of large numbers on the scale $\log N$, with N the grid size; recently the fluctuations had been proved to be at scale of order 1. Ding presented a number of new ideas that lead to the proof that the law of the maximum, properly centered, has indeed exponential tails on the scale $O(1)$. Sun presented research about statistical mechanics models on sparse graph sequences. With Z_n the partition functions associated with the family of graphs, the question considered by Sun is whether the sequence $(1/n) \log Z_n$ converges and to compute the limit. Novel results were presented for sequences of graphs that converge locally to unimodular tree, when the weight on edges corresponds either to the Potts model or to the independent set model from statistical physics.

Organizers

First Name	Last Name	Institute
Noam	Berger	Hebrew University of Jerusalem
Nina	Gantert	Technische Universität München
Andrea	Montanari	Stanford University
Alain-Sol	Sznitman	ETH Zürich
Ofer	Zeitouni	Weizmann Institute of Science

Speakers

First Name	Last Name	Institute
Kenneth	Alexander	University of Southern California
Omer	Angel	University of British Columbia
Marek	Biskup	University of California
Erwin	Bolthausen	Universität Zürich
Jiri	Cerny	ETH Zürich
Ivan	Corwin	Massachusetts Institute of Technology
Jian	Ding	Stanford University
Dmitry	Dolgopyat	University of Maryland
Alexander	Fribergh	New York University, Courant Institute
Elena	Kosygina	Bernard M. Baruch College, CUNY
Anna	Levit	MSRI - Mathematical Sciences Research Institute
Vlada	Limic	Université d'Aix-Marseille I (Université de Provence)
Andrea	Montanari	Stanford University
Jonathon	Peterson	Purdue University
Serguei	Popov	State University of Campinas (UNICAMP)
Alejandro	Ramirez	Pontificia Universidad Catolica de Chile
Christophe	Sabot	Université Claude-Bernard (Lyon I)
Timo	Seppalainen	University of Wisconsin
Vladas	Sidoravicius	Mathematical Sciences Research Institute
PERLA	SOUSI	University of Cambridge
Nike	Sun	Stanford University
Augusto	Teixeira	Institute of Pure and Applied Mathematics (IMPA)
Balint	Toth	Budapest University of Technology and Economics

Random Walks and Random Media

April 30, 2012 to May 4, 2012

Schedule

Monday, April 30, 2012			
8:50AM - 9:00AM	Simons Auditorium	Welcome	
9:00AM - 10:30AM	Simons Auditorium	Alejandro Ramirez	Criteria for Ballistic Behavior of Random Walks in Random Environment
10:30AM - 11:00AM	Atrium	Tea	
11:00AM - 12:00PM	Simons Auditorium	Christophe sabot	Edge reinforced random walks, Vertex reinforced jump process, and the SuSy hyperbolic sigma model
12:00PM - 1:30PM	Atrium	Lunch	
1:30PM - 2:30PM	Simons Auditorium	Dmitry Dolgopyat	Dynamical point of view on some random walk models
2:30PM - 3:30PM	Simons Auditorium	Marek Biskup	A central limit theorem for the effective conductance and resistance
3:30PM - 4:00PM	Atrium	Tea	
4:00PM - 5:00PM	Simons Auditorium	Alexander Fribergh	On the monotonicity of the speed of biased random walk on a Galton-Watson tree without leaves

Tuesday, May 01, 2012			
9:00AM - 10:30AM	Simons Auditorium	Timo Seppalainen	Directed polymers and KPZ universality
10:30AM - 11:00AM	Atrium	Tea	
11:00AM - 12:00PM	Simons Auditorium	Ivan Corwin	Directed random polymers and Macdonald processes
12:00PM - 2:00PM	Atrium	Lunch	
2:00PM - 3:00PM	Simons Auditorium	David Wilson	Spanning trees of graphs on surfaces and the intensity of loop-erased random walk on Z^2
3:00PM - 3:30PM	Atrium	Tea	
3:30PM - 4:30PM	Simons Auditorium	Vladas Sidoravicius	Stability of the greedy server: Proof of the Coffman-Gilbert conjecture on the unit circle
4:30PM - 5:30PM	Simons Auditorium	Kenneth Alexander	Subgaussian rates of convergence of means in
5:30PM - 7:00PM	Atrium	Reception	

Wednesday, May 02, 2012			
9:00AM - 10:30AM	Simons Auditorium	Augusto Teixeira	Random walks on finite graphs and random interlacements
10:30AM - 11:00AM	Atrium	Tea	
11:00AM - 12:00PM	Simons Auditorium	Jiri Cerny	Chemical Distance on Random Interlacements
12:00PM - 1:00PM	Simons Auditorium	Serguei Popov	Conditional quenched CLTs for random walks among random conductances.

Thursday, May 03, 2012			
9:00AM - 10:00AM	Simons Auditorium	Yuval Peres	Detecting the trail of the random walker
10:00AM - 10:30AM	Atrium	Tea	
10:30AM - 11:30AM	Simons Auditorium	Omer Angel	Linearly reinforced random walks
11:30AM - 12:30PM	Simons Auditorium	Erwin Bolthausen	On the localization-delocalization critical line for the random copolymer
12:30PM - 2:00PM	Atrium	Lunch	
2:00PM - 3:00PM	Simons Auditorium	Perla Sousi	Self-interacting random walks
3:00PM - 3:30PM	Atrium	Tea	
3:30PM - 4:30PM	Simons Auditorium	Anna Levit	Stochastic Representation of the Ground States for the Mean Field
4:30PM - 5:30PM	Simons Auditorium	Balint Toth	Scaling limits for self-interacting random walks and diffusions

Friday, May 04, 2012			
9:00AM - 10:00AM	Simons Auditorium	Persi Diaconis	The Cutoff Phenomenon for Typical Birth and Death Chains
10:00AM - 10:30AM	Atrium	Tea	
10:30AM - 11:30AM	Simons Auditorium	Jonathon Peterson	Large deviations and slowdown asymptotics for excited random walks
11:30AM - 12:30PM	Simons Auditorium	Elena Kosygina	Excited random walks on \mathbb{Z}^d
12:30PM - 2:00PM	Atrium	Lunch	
2:00PM - 3:00PM	Simons Auditorium	Jian Ding	Maxima of two-dimensional discrete Gaussian free field
3:00PM - 3:30PM	Atrium	Tea	
3:30PM - 4:30PM	Simons Auditorium	Nike Sun	Potts and independent set models on d -regular graphs

Participants

First Name	Last Name	Institute
Daniel	Ahlberg	MSRI - Mathematical Sciences Research Institute
Tom	Alberts	University of Toronto
David	Aldous	University of California
Kenneth	Alexander	University of Southern California
Hamed	Amini	École Polytechnique Fédérale de Lausanne (EPFL)
Sebastian	Andres	Rheinische Friedrich-Wilhelms-Universität Bonn
omer	angel	University of British Columbia
Tonci	Antunovic	University of California
Luca	Avena	Universität Zürich
Marco	Aymone	Institute of Pure and Applied Mathematics (IMPA)
Arvind	Ayyer	University of California
Francois	Bacelli	École Normale Supérieure
Anirban	Basak	Stanford University
Noam	Berger	Hebrew University
Jeremie	Bettinelli	Université de Paris XI (Paris-Sud)
Prateek	Bhakta	Georgia Institute of Technology
Marek	Biskup	University of California
Erwin	Bolthausen	Universität Zürich
Jiri	Cerny	ETH Zürich
Sunil	Chhita	MSRI - Mathematical Sciences Research Institute
Moran	Cohen	Hebrew University
Ivan	Corwin	Massachusetts Institute of Technology
Jan	Czajkowski	University of Wrocław
Amir	Dembo	Stanford University
Jean-Dominique	Deuschel	TU Berlin
Jian	Ding	Stanford University
Dmitry	Dolgopyat	University of Maryland
Renato	dos Santos	Universiteit Leiden
Alexander	Drewitz	ETH Zürich
Ming	Fang	MSRI - Mathematical Sciences Research Institute
Sergey	Foss	Heriot-Watt University
Alexander	Fribergh	New York University, Courant Institute
Nina	Gantert	Technische Universität München
Nicos	Georgiou	University of Utah
Ilya	Goldsheid	Queen Mary and Westfield College
Vadim	Gorin	MSRI - Mathematical Sciences Research Institute
Nadine	Guillotini-Plantard	Institut Camille Jordan
Xiaoqin	Guo	University of Minnesota Twin Cities
Zachary	Hamaker	Dartmouth College
Christopher	Hoffman	University of Washington
Alexander	Holroyd	Microsoft Research
Yueyun	Hu	University Paris 13
Adrien	Kassel	École Normale Supérieure
pamela	kbb	KITOMAVO COMUNIDADES
Tom	Kennedy	University of Arizona
Richard	Kenyon	Brown University
Elena	Kosygina	Bernard M. Baruch College, CUNY
Michael	Kozdron	University of Regina
Greg	Lawler	Princeton University
Eunghyun	Lee	University of Helsinki
Anna	Levit	MSRI - Mathematical Sciences Research Institute
Junchi	Li	Duke University
Lingyun	Li	University of California
Vlada	Limic	Université d'Aix-Marseille I (Université de Provence)
Svante	Linusson	Royal Institute of Technology (KTH)
James	Martin	University of Oxford
Curtis	McMullen	Harvard University
Peter	Mester	MSRI - Mathematical Sciences Research Institute

Participants

First Name	Last Name	Institute
Sevak	Mkrtchyan	MSRI - Mathematical Sciences Research Institute
Andrea	Montanari	Stanford University
Elchanan	Mossel	UC Berkeley Math Faculty
Joe	Neeman	University of California, Berkeley
Mina	Ossiander	Oregon State University
Greta	Panova	University of California
Yuval	Peres	Microsoft Research
Jonathon	Peterson	Purdue University
Serguei	Popov	State University of Campinas (UNICAMP)
Lea	Popovic	Concordia University
Eviatar	Procaccia	Weizmann Institute of Science
James	Propp	University of Massachusetts
Chuan	Qin	University of California
Anthony	Quas	University of Victoria
Miklos	Racz	University of California, Berkeley
Ali	Rajaei	Tarbiat Modares University
Sanjay	Ramassamy	École Normale Supérieure
Alejandro	Ramirez	Pontificia Universidad Católica de Chile
Firas	Rassoul-Agha	University of Utah
David	Renfrew	University of California
Steffen	Rohde	University of Washington
Ron	Rosenthal	Hebrew University
Christophe	sabot	Université Claude-Bernard (Lyon I)
Michele	Salvi	TU Berlin
bruno	schapira	Université de Paris XI (Paris-Sud)
Timo	Seppalainen	University of Wisconsin
Gregory	Shinault	University of California
Mykhaylo	Shkolnikov	MSRI - Mathematical Sciences Research Institute
Vladas	Sidoravicius	MSRI - Mathematical Sciences Research Institute
Allan	Sly	University of California, Berkeley
Florian	Sobieczky	University of Colorado
Alexander	Soshnikov	University of California
PERLA	SOUSI	University of Cambridge
Suresh	Srinivasamurthy	Kansas State University
Alexandre	Stauffer	Microsoft Research
Nike	Sun	Stanford University
Alain-Sol	Sznitman	ETH Zürich
Pierre	Tarres	University of Oxford
martin	tassy	Brown University
Augusto	Teixeira	Institute of Pure and Applied Mathematics (IMPA)
Balint	Toth	Budapest University of Technology and Economics
Laurent	Tournier	Université de Paris XIII (Paris-Nord)
Huy	Tran	University of Washington
Nick	Travers	University of California
Nikolay	Tropin	St. Petersburg State University
Stanislav	Volkov	Lund University
Vladislav	Vysotsky	Arizona State University
Cassie	walther	University of North Florida
Xiaoming	Wang	Florida State University
Brent	Werness	University of Chicago
David	Wilson	Microsoft Research
Peter	Winkler	MSRI - Mathematical Sciences Research Institute
Tilman	Wolff	Weierstraß-Institut für Angewandte Analysis und Stochastik (WIAS)
Benjamin	Young	Royal Institute of Technology (KTH)
Ofer	Zeitouni	Weizmann Institute of Science

Officially Registered Participant Information

Participants		113
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Gender		113
Male	76.11%	86
Female	10.62%	12
Declined to state	13.27%	15

Ethnicity*		113
White	56.64%	64
Asian	12.39%	14
Hispanic	1.77%	2
Pacific Islander	0.00%	0
Black	0.88%	1
Native American	0.00%	0
Mixed	0.00%	0
Declined to state	28.32%	32

* ethnicity specifications are not exclusive

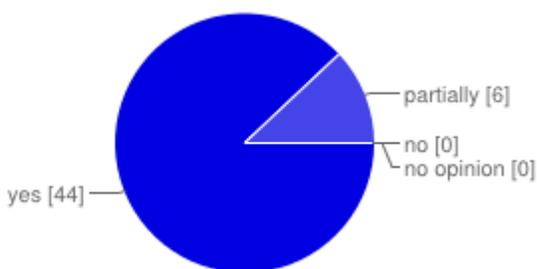
50 [responses](#)

Summary [See complete responses](#)

50 responses out of 113 participants: 44% of total participants

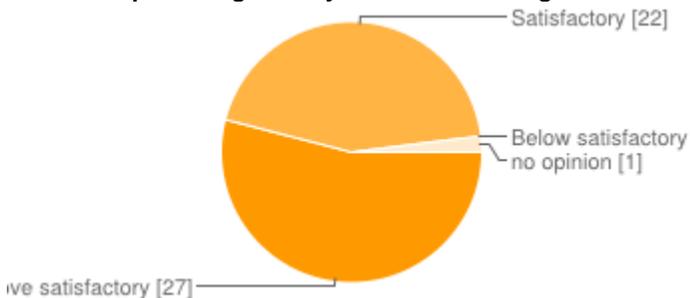
Topic presentation and organization

Did the various topics within the workshop integrate into a coherent picture?



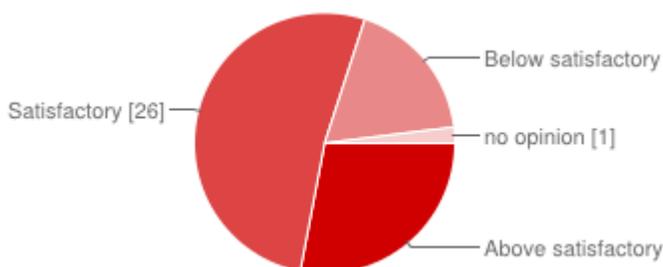
yes	44	88%
partially	6	12%
no	0	0%
no opinion	0	0%

Were the speakers generally clear and well organized in their presentation?



Above satisfactory	27	54%
Satisfactory	22	44%
Below satisfactory	0	0%
no opinion	1	2%

Was there adequate time between lectures for discussion?



Above satisfactory	14	28%
Satisfactory	26	52%
Below satisfactory	9	18%
no opinion	1	2%

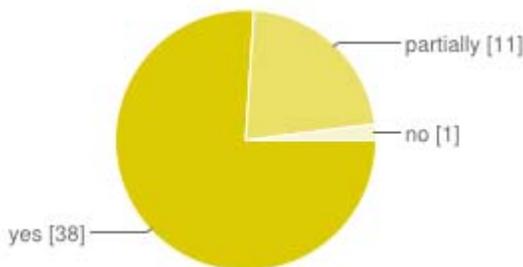
Additional comments on the topic presentation and organization

I prefer a 2 hour lunch
 talks and more discussion time.
 Although I realize it is sometimes hard to predict ahead of ti ...

I would have appreciated having fewer
 A number of talks could have been shorter.

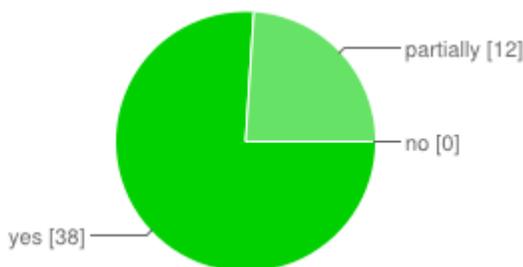
Personal assessment

Was your background adequate to access a reasonable portion of the material?



yes	38	76%
partially	11	22%
no	1	2%

Did the workshop increase your interest in the subject?



yes	38	76%
partially	12	24%
no	0	0%

Was the workshop worth your time and effort?



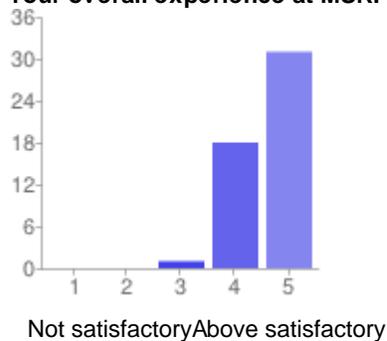
yes	44	88%
partially	6	12%
no	0	0%

Additional comments on your personal assessment

My area of expertise only slightly overlapped the research foci of this workshop. The workshop provided a clear picture of the field and techniques used to explore it. This was very valuable. I w ...

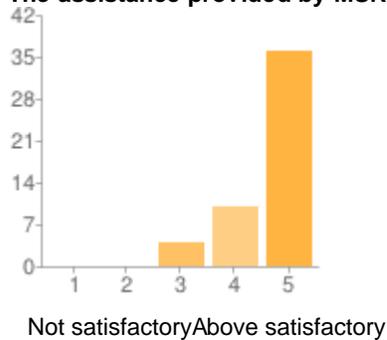
Venue

Your overall experience at MSRI



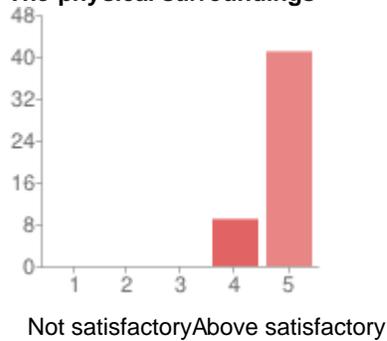
1 -Not satisfactory	0	0%
2	0	0%
3	1	2%
4	18	36%
5 -Above satisfactory	31	62%

The assistance provided by MSRI staff

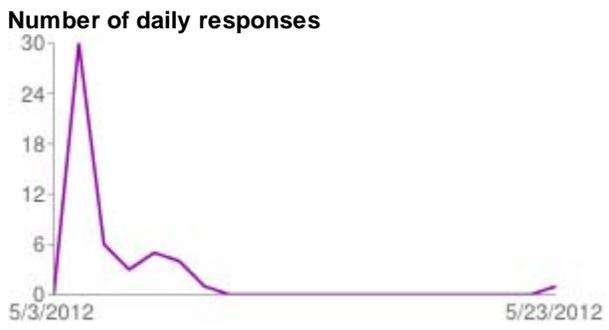


1 -Not satisfactory	0	0%
2	0	0%
3	4	8%
4	10	20%
5 -Above satisfactory	36	72%

The physical surroundings



1 -Not satisfactory	0	0%
2	0	0%
3	0	0%
4	9	18%
5 -Above satisfactory	41	82%



Workshop: Random Walks and Random Media

Apr. 30 – May 4, 2012

Additional Survey Responses

Additional comments on the topic presentation and organization

- I prefer a 2 hour lunch
- I would have appreciated having fewer talks and more discussion time.
- A number of talks could have been shorter. Although I realize it is sometimes hard to predict ahead of time which speakers should have a full hour or more, and which should not! I was happy with the 90 min talks, but some of the hour speakers overstayed their welcome.
- I appreciated the three 90 min lectures that were meant to be reviews.
- fewer talks would be better
- The conference would have benefitted from shorter talks (30-40 minutes) with long breaks for people to talk and work together.
- Very well selected group of speakers

Additional comments on your personal assessment

- My area of expertise only slightly overlapped the research foci of this workshop. The workshop provided a clear picture of the field and techniques used to explore it.
- This was very valuable. I would have wished for more time to develop research collaborations.
- excellent and enjoyable
- I had many very important (to me) discussions between talks.

Additional comments on the venue

- the shuttle was once full and some people had to arrive with the next shuttle, after the beginning of the first talk
- AS before, the refreshments and lunch are a little disappointing. Fortunately Berkeley has great restaurants for dinner and coffee shops for math work, but this doesn't help when one is trapped up the hill for lunch. Also, the air conditioning is ridiculous. Why is it so hard to have comfortable temperature in the lecture hall?
- air conditioning way way too much
- One of the days they ran out of food
- The air was very stuffy. It would be better to be able to open the windows and also to seat on the balconies after 5pm
- The 8:40 shuttle was overfull every day; adding another one at that time could be profitable.
- problem with air conditioning: too cold

We welcome any additional comments or suggestions you may have to improve the overall experience for future participants

- I think a very good job of having similar talks on the same day was done. I appreciate this.
- We have been told that when going to Bank of America with the reimbursement cheque, we would not incur any cost. However, they did charge us a 5\$ fee.
- Shuttle bus from Rose Garden Inn would be great.
- Many thanks for making hot tea and coffee available at all times