Mathematical Sciences Research Institute

Introductory Workshop:
Lattice Models and Combinatorics

Jan. 16, 2012 to Jan. 20, 2012

MSRI, Berkeley, CA, USA

Organizers:

Cédric Boutillier (Université Pierre et Marie Curie),

Tony Guttmann* (University of Melbourne),

Christian Krattenthaler (University of Vienna),

Nicolai Reshetikhin (University of California, Berkeley)

David Wilson (Microsoft Research)

Report on the MSRI workshop "Lattice Models and Combinatorics"

1 Organizers

- Cédric Boutillier (Université Pierre et Marie Curie),
- Tony Guttmann (University of Melbourne),
- Christian Krattenthaler (University of Vienna),
- Nicolai Reshetikhin (University of California, Berkeley),
- David B. Wilson (Microsoft Research)

2 Scientific description

Research at the interface of lattice statistical mechanics and combinatorial problems of "large sets" has been an exciting and fruitful field in the last decade or so. In this workshop the speakers described and discussed a variety of methods and applications, spanning the spectrum from theoretical developments to the numerical end. These covered the behaviour of lattice models at a macroscopic level (scaling limits at criticality and their connection with SLE) and also at a microscopic level (combinatorial and algebraic structures), as well as discussions of efficient numerical algorithms to generate and study these objects.

3 Highlights of the presentations

The workshop, dedicated to the memory of Philippe Flajolet, started with a presentation by Mireille Bousquet-Mélou of his contribution to analytic combinatorics, and some of the general ideas which governed his research.

The speakers presented results in various interesting directions about integrable systems and exactly solvable models on lattices. Archetypical integrable models are the XXZ quantum spin chain, and its classical counterpart, the 6-vertex model.

Francesco Colomo described progress in describing the limit shape of the 6-vertex model with domain wall boundary conditions, generalizing the arctic circle theorem for tilings of the Aztec diamond with dominos. Jean-Michel Maillet explained how to compute correlation functions and form factors in the framework of the algebraic Bethe ansatz.

Luigi Cantini explained how to compute the finite size emptiness formation probability for the XXZ spin chain at $\Delta = -\frac{1}{2}$ and made connections with combinatorics of plane partitions in some special cases. Andrea Sportiello presented the proof obtained in collaboration with Luigi Cantini of a refinement of the Razumov–Stroganov conjecture. Paul Zinn-Justin showed several computations for the six-vertex and the eight-vertex models on their combinatorial lines.

Another well-known integrable model on the lattice is the Ising model. Clément Hongler studied in collaboration with Konstantin Izyurov and Stas Smirnov the conformal invariance property of energy density and spin correlations in the Ising model at criticality. Richard Kenyon presented joint work with Robin Pemantle about limit shapes for the Ising model, inspired by the arctic circle theorem for groves by Petersen and Speyer.

Using dimer techniques, much can be said on the Ising model via the Fisher correspondence. Zhongyang Li gave an exact characterization of the critical temperature for the layered Ising model. Béatrice de Tilière showed an explicit correspondence between Ising configurations at criticality and spanning trees on isoradial graphs, yielding a better understanding of the relation between the free energies of these models.

Mihai Ciucu gave an overview and presented new results about the link between the asymptotic behavior for correlation functions for holes and defects in dimer configurations and electrostatics.

Lauren Williams gave a presentation of several combinatorial aspects of the Asymmetric Simple Exclusion Process (ASEP) on a finite lattice with open boundary conditions, and explained how to compute the probability of a configuration in the steady state using bijections with (marked) staircase tableaux. Another Simple Exclusion Process arose in Dan Romik's talk, but in that case the dynamics were driven by the *jeu de taquin* moves on infinite Young tableaux.

A couple of talks were dedicated to random lattices, namely planar maps. Olivier Bernardi presented joint work with Nicolas Curien and Grégory Miermont on site and edge percolation on finite planar triangulations. They determined the critical probability for the appearance of long interfaces between clusters. Grégory Miermont presented his proof of the convergence of random planar quadrangulations to the

Brownian map.

Several other exactly solvable models and aspects of the theory of integrable systems were also presented: Philippe Di Francesco gave an introduction to the relationship between the combinatorics of some integrable systems and cluster algebras. Jesper Jacobsen showed formulae for the corner free energy, i.e. the constant order term in the expansion of the logarithm of the partition function for a large class of models as an infinite product with interesting periodicity properties.

Alexei Borodin described the class of Macdonald processes, that are integrable, from the representation theory viewpoint. This is a much larger class than, for example, processes occurring in tilings, and they occur in the study of random directed polymers. Gordon Slade showed the result obtained jointly with David Brydges for the quadratic decay of the two-point function for weakly self-avoiding walk on $\mathbf{Z}^4$. The proof uses the identification of this two-point function with that of a supersymmetric field theory, which is then analyzed using renormalization group methods.

David Wilson chaired a Software Demonstration session, where eight participants presented software related to the topics of the conference that they wrote or (in one case) simply use. This type of session is quite unusual, but aroused considerable interest, and participants were impressed by the quality and the quantity of software presented.

4 Interactions

The participants were generally impressed with the quality of the talks and were happy with the format of four talks per day, with several people commenting that this was "the right number". The breaks between the talks were filled with lively mathematical discussions, and the meeting earned its title of "workshop". A few participants indicated that they would have liked an open problems session, but other participants were quite happy not to have one, preferring instead to have the time with which to talk with colleagues.

Organizers		
First Name	**Last Name**	**Institution**
Cédric	Boutillier	Université de Paris VI (Pierre et Marie Curie)
Tony	Guttmann	University of Melbourne
Christian	Krattenthaler	University of Vienna
Nicolai	Reshetikhin	University of California, Berkeley
David	Wilson	Microsoft Research

Speakers		
First Name	**Last Name**	**Institution**
Olivier	Bernardi	Massachusetts Institute of Technology
Alexei	Borodin	Massachusetts Institute of Technology
Mireille	Bousquet-Melou	Universite Bordeaux 1
Luigi	Cantini	Université de Cergy-Pontoise
Mihai	Ciucu	Indiana University
Filippo	Colomo	Universita di Firenze
Beatrice	de Tiliere	Université de Paris VI (Pierre et Marie Curie)
Philippe	Di Francesco	Commissariat à l'Énergie Atomique (CEA)
Clément	Hongler	Columbia University
Jesper	Jacobsen	École Normale Supérieure
Richard	Kenyon	Brown University
Jean Michel	Maillet	ENS Lyon and CNRS
Grégory	Miermont	Université de Paris XI (Paris-Sud)
Dan	Romik	University of California
Gordon	Slade	University of British Columbia
Andrea	Sportiello	Università di Milano --- Milano, Italy
Lauren	Williams	UC Berkeley Math Faculty
Paul	ZINN-JUSTIN	Universite Pierre et Marie Curie - Paris 6

Introductory Workshop: Lattice Models and Combinatorics

January 16, 2012 to January 20, 2012

Schedule

Monday, January 16, 2012			
8:55AM - 9:15AM	Simons Auditorium	Welcome	
9:15AM - 10:15AM	Simons Auditorium	Mireille Bousquet-Melou	Philippe Flajolet, founder of Analytic Combinatorics
10:15AM - 10:45AM	Atrium	Tea	
10:45AM - 11:45AM	Simons Auditorium	Dan Romik	Second class particles in exclusion processes and "jeu de taquin" on infinite Young tableaux
11:45AM - 1:45PM	Atrium	Lunch	
1:45PM - 2:45PM	Simons Auditorium	Paul Zinn-Justin	Six-vertex and eight-vertex models on their combinatorial line
2:45PM - 3:15PM	Atrium	Tea	
3:15PM - 4:15PM	Simons Auditorium	Jesper Jacobsen	Exact corner free energies for two-dimensional integrable lattice models
Tuesday, January 17, 2012			
9:30AM - 10:30AM	Simons Auditorium	Philippe di Francesco	Discrete Integrable Systems and Cluster Algebras
10:30AM - 11:00AM	Atrium	Tea	
11:00AM - 12:00PM	Simons Auditorium	Andrea Sportiello	6-Vertex and O(1) Dense Loop Model: Correspondences of Razumov-Stroganov type
12:00PM - 2:00PM	Atrium	Lunch	
2:00PM - 3:00PM	Simons Auditorium	Alexei Borodin	Macdonald processes and random directed polymers
3:00PM - 3:30PM	Atrium	Tea	
3:30PM - 4:30PM	Simons Auditorium	Luigi Cantini	Finite size Emptiness Formation probability for the XXZ spin chain at $Delta=-1/2$
4:30PM - 5:30PM	Simons Auditorium	David Wilson	Software Demos

Wednesday, January 18, 2012			
9:00AM - 10:00AM	Simons Auditorium	Lauren Williams	Combinatorics of the asymmetric simple exclusion process
10:00AM - 10:30AM	Atrium	Tea	
10:30AM - 11:30AM	Simons Auditorium	Olivier Bernardi	A nested loop approach to percolation on random triangulations
11:30AM - 12:30PM	Simons Auditorium	Grégory Miermont	The scaling limit of random plane quadrangulations
Thursday, January 19, 2012			
9:30AM - 10:30AM	Simons Auditorium	Jean-Michel Maillet	The form factor approach to correlation functions in critical integrable models
10:30AM - 11:00AM	Atrium	Tea	
11:00AM - 12:00PM	Simons Auditorium	Filippo Colomo	Arctic curves of the six-vertex model
12:00PM - 2:00PM	Atrium	Lunch	
2:00PM - 3:00PM	Simons Auditorium	Mihai Ciucu	The interaction of diagonal defects in a dimer system on the square lattice
3:00PM - 3:30PM	Atrium	Tea	
3:30PM - 4:30PM	Simons Auditorium	Beatrice de Tiliere	Combinatorics of critical Ising model via dimers
Friday, January 20, 2012			
9:30AM - 10:30AM	Simons Auditorium	Clément Hongler	Conformal Invariance of Ising Model Correlations
10:30AM - 11:00AM	Atrium	Tea	
11:00AM - 12:00PM	Simons Auditorium	Gordon Slade	A renormalisation group analysis of the 4-dimensional weakly self-avoiding walk
12:00PM - 2:00PM	Atrium	Lunch	
2:00PM - 3:00PM	Simons Auditorium	Zhongyang Li	Critical temperature of ferromagnetic layered Ising models
3:00PM - 3:30PM	Atrium	Tea	
3:30PM - 4:30PM	Simons Auditorium	Richard Kenyon	Banded states and limit shapes in the Ising model

Confirmed Participants		
First Name	**Last Name**	**Institution**
Daniel	Ahlberg	MSRI - Mathematical Sciences Research Institute
David	Aldous	University of California
Hamed	Amini	École Polytechnique Fédérale de Lausanne (EPFL)
Timothy	Andersen	Rensselaer Polytechnic Institute
Paul	Anderson	Berkeley City College
Tonci	Antunovic	University of California
Arvind	Ayyer	University of California
Anirban	Basak	Stanford University
Riddhipratim	Basu	University of California
Nicholas	Beaton	University of Melbourne
Matthias	Beck	San Francisco State University
Olivier	Bernardi	Massachusetts Institute of Technology
Dan	Betea	California Institute of Technology
Jeremie	Bettinelli	Université de Paris XI (Paris-Sud)
Prateek	Bhakta	Georgia Institute of Technology
Nayantara	Bhatnagar	University of California, Berkeley
Alexei	Borodin	Massachusetts Institute of Technology
Mireille	Bousquet-Melou	Universite Bordeaux 1
Cédric	Boutillier	Université de Paris VI (Pierre et Marie Curie)
Milan	Bradonjic	Bell Laboratories, Alcatel-Lucent
Eric	Brattain	University of California
Anna	Bykhovskaya	Moscow State University
Luigi	Cantini	Université de Cergy-Pontoise
Oliver	Cheng	Brown University
Sunil	Chhita	MSRI - Mathematical Sciences Research Institute
Mihai	Ciucu	Indiana University
Steven	Collazos	San Francisco State University
Filippo	Colomo	Universita di Firenze
Thomas	Creighton	Northwestern University
Beatrice	de Tiliere	Université de Paris VI (Pierre et Marie Curie)
Amir	Dembo	Stanford University
Philippe	Di Francesco	Commissariat à l'Énergie Atomique (CEA)
Shawn	Drenning	MSRI - Mathematical Sciences Research Institute
Pierluigi	Falco	California State University
Ming	Fang	MSRI - Mathematical Sciences Research Institute
Laura	Florescu	Los Alamos National Laboratory
zhengyuan	Gao	University of Amsterdam
Vadim	Gorin	MSRI - Mathematical Sciences Research Institute
Tony	Guttmann	University of Melbourne
Shahrzad	Haddadan	Dartmouth College
Zachary	Hamaker	Dartmouth College
Alexander	Holroyd	Microsoft Research
Clément	Hongler	Columbia University
Jesper	Jacobsen	École Normale Supérieure

Confirmed Participants		
First Name	**Last Name**	**Institution**
Samuel	Johnson	Simon Fraser University
Vladislav	Kargin	Cambridge University
Dave	Kaspar	University of California
Adrien	Kassel	École Normale Supérieure
Tom	Kennedy	University of Arizona
Richard	Kenyon	Brown University
Noureen	Khan	University of North Texas
Natasha	Komarov	Dartmouth College
Michael	Kozdron	University of Regina
Christian	Krattenthaler	University of Vienna
viacheslav	Krivokolesko	Siberian Federal University
Ricky	Kwok	University of California
Lionel	Levine	Cornell University
Anna	Levit	MSRI - Mathematical Sciences Research Institute
Aihua	Li	Montclair State University
Svante	Linusson	Royal Institute of Technology (KTH)
Jean Michel	Maillet	ENS Lyon and CNRS
John	McSweeney	MSRI - Mathematical Sciences Research Institute
Peter	Mester	Indiana University, Bloomington
Anthony	Metcalfe	Royal Institute of Technology (KTH)
Grégory	Miermont	Université de Paris XI (Paris-Sud)
Jason	Miller	Microsoft Research
Sarah	Miracle	Georgia Institute of Technology
Sevak	Mkrtchyan	MSRI - Mathematical Sciences Research Institute
Fatemeh	Mohammadi	MSRI - Mathematical Sciences Research Institute
Fumihiko	Nakano	Gakushuin University
Eric	Nordenstam	University of Vienna
Lea	Popovic	Concordia University
James	Propp	University of Massachusetts
Miklos	Racz	University of California, Berkeley
Nicolai	Reshetikhin	University of California, Berkeley
Steffen	Rohde	TU Berlin
Dan	Romik	University of California
Ernest	Ruet d'Auteuil	The Institute of Combinatorics and Its Applications
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Robert	Russell	unafilliated
Gus	Schrader	UC Berkeley Math Faculty
Travis	Scrimshaw	University of California
Chris	Scullard	Lawrence Livermore National Laboratory
Mykhaylo	Shkolnikov	MSRI - Mathematical Sciences Research Institute
Gordon	Slade	University of British Columbia
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Alexander	Soshnikov	University of California
Christine	Soteros	University of Saskatchewan

Confirmed Participants		
First Name	**Last Name**	**Institution**
PERLA	SOUSI	University of Cambridge
Andrea	Sportiello	Università di Milano --- Milano, Italy
Amanda	Streib	Georgia Institute of Technology
Jessica	Striker	University of Minnesota Twin Cities
Nike	Sun	Stanford University
Kelli	Talaska	University of California
martin	tassy	Brown University
Marie	Théret	Université de Paris VII (Denis Diderot)
Creighton	Thomas	Northwestern University
Craig	Tracy	University of California
Maria	Tsarenko	University of Melbourne
Maria	Vares	Brazilian Center for Physics Research (CBPF/CNPq)
Mirko	Visontai	University of Pennsylvania
Mirjana	Vuletic	Brown University
Samuel	Watson	Massachusetts Institute of Technology
Lauren	Williams	UC Berkeley Math Faculty
Nathan	Williams	University of Minnesota Twin Cities
David	Wilson	Microsoft Research
Peter	Winkler	Dartmouth College
Rich	Wong Kew	University of California, Berkeley
hao	wu	Université de Paris XI (Paris-Sud)
Kyung	Yi	University of Texas at Dallas
Benjamin	Young	Royal Institute of Technology (KTH)
Kim	Younjin	MSRI - Mathematical Sciences Research Institute
Zafeirakis	Zafeirakopoulos	Johannes Kepler Universität Linz
Alex	Zhai	Harvard University
Paul	ZINN-JUSTIN	Universite Pierre et Marie Curie - Paris 6

Officially Registered Participant Information

Participants		**115**

Gender		**115**
Male	66.96%	77
Female	20.00%	23
Declined to state	13.04%	15

Ethnicity*		**115**
White	66.96%	77
Asian	13.04%	15
Hispanic	0.87%	1
Pacific Islander	0.00%	0
Black	0.00%	0
Native American	0.00%	0
Mixed	0.00%	0
Declined to state	19.13%	22

* ethnicity specifications are not exclusive

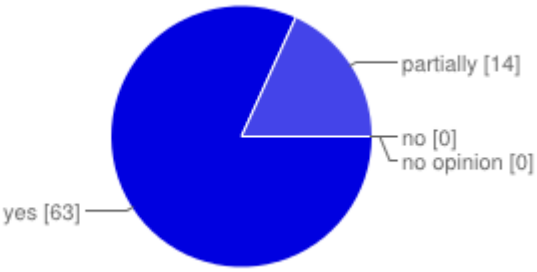
77 responses

Summary See complete responses

77 responses out of 115 participants: 67% of total participants.

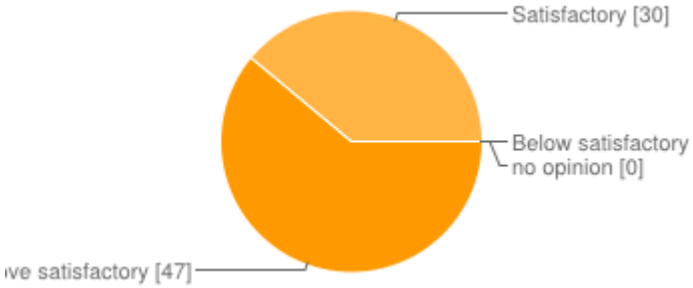
Topic presentation and organization

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



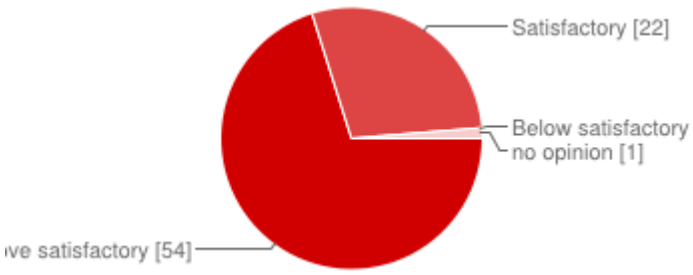
yes	**63**	82%
partially	**14**	18%
no	**0**	0%
no opinion	**0**	0%

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



Above satisfactory	**47**	61%
Satisfactory	**30**	39%
Below satisfactory	**0**	0%
no opinion	**0**	0%

Was there adequate time between lectures for discussion?



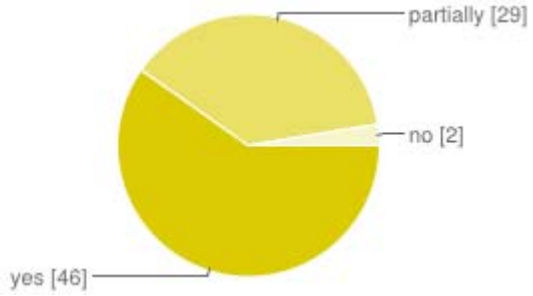
Above satisfactory	**54**	70%
Satisfactory	**22**	29%
Below satisfactory	**0**	0%
no opinion	**1**	1%

Additional comments on the topic presentation and organization

This workshop was outstanding by any standards Very satisfied with entire workshop, and look

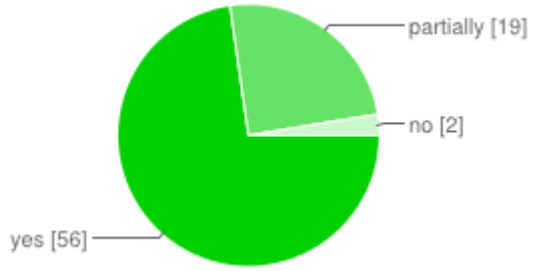
Personal assessment

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



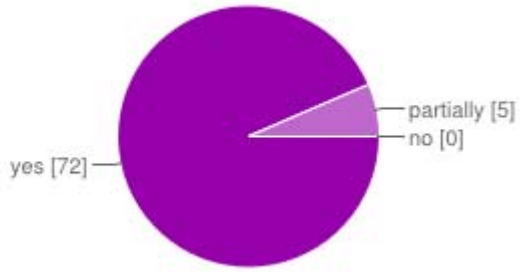
yes	**46**	60%
partially	**29**	38%
no	**2**	3%

Did the workshop increase your interest in the subject?



yes	**56**	73%
partially	**19**	25%
no	**2**	3%

Was the workshop worth your time and effort?

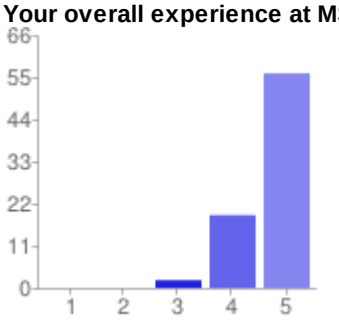


yes	**72**	94%
partially	**5**	6%
no	**0**	0%

Additional comments on your personal assessment

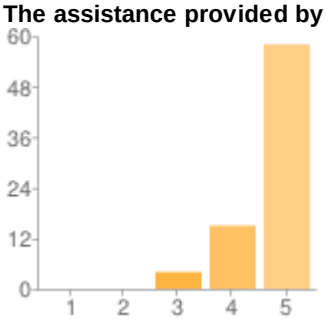
I was unable to follow in detail many of the talks, but usually I could still get some big-picture understanding out of them. Небыло обзорных докладов Thank you for the fantastic experience! As a gra ...

Your overall experience at MSRI



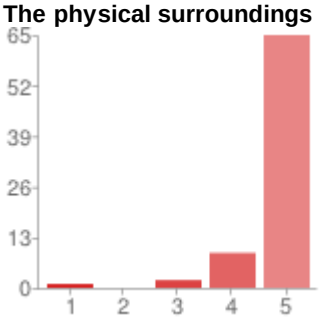
1 -	Not satisfactory	**0**	0%
2		**0**	0%
3		**2**	3%
4		**19**	25%
5 -	Above satisfactory	**56**	73%

The assistance provided by MSRI staff



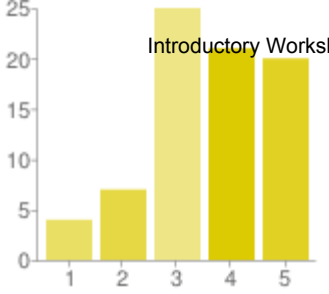
1 -	Not satisfactory	**0**	0%
2		**0**	0%
3		**4**	5%
4		**15**	19%
5 -	Above satisfactory	**58**	75%

The physical surroundings



1 -	Not satisfactory	**1**	1%
2		**0**	0%
3		**2**	3%
4		**9**	12%
5 -	Above satisfactory	**65**	84%

The food provided during the workshop



Not satisfactoryAbove satisfactory

1 -	Not satisfactory	**4**	5%
2		**7**	9%
3		**25**	32%
4		**21**	27%
5 -	Above satisfactory	**20**	26%

Additional comments on the venue

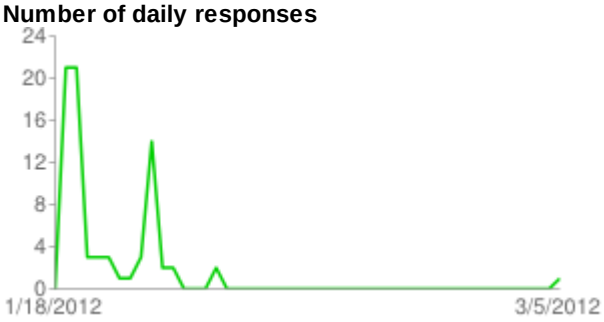
The wifi kept quitting when I was working in the library. The food and environment was generally excellent. Place a remarkable The MSRI building is very nice and functional, and the surroundings are be ...

Thank you for completing this survey

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

I think it may have been useful to have one or two sessions at the beginning of the workshop devoted to establishing some basic definitions/facts/etc. about certain topics (e.g. XXZ spin chain, domi ...

Number of daily responses



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Additional Survey Responses

Additional comments on the topic presentation and organization

- This workshop was outstanding by any standards
- Very satisfied with entire workshop, and look forward to more in the future.
- The mix of probabilists, combinatorists and theoretical physicists was great. It was good to have long talks and enough time for discussion between each of them.
- Some of the talks were not introductory enough for an introductory workshop, but otherwise it was great to see the interplay between combinatorics, physics, and probability.
- Best workshop yet.
- Great Job. Thank you for organizing the workshop.
- This is one of the best workshops I have attended and in a great place that favor contacts and discussions. Excellent!
- I liked the arrangement of talks and discussion breaks. Many conferences try to squeeze in too many talks, but here I felt there was a good balance.
- not "introductory"
- Some of the speakers did a superb job, and did a true effort to be understandable to combinatorists and probabilists as well. Some forgot that in the audience not everyone was a combinatorist.
- I would have preferred more shorter talks

Additional comments on your personal assessment

- I was unable to follow in detail many of the talks, but usually I could still get some big-picture understanding out of them.
- Небыло обзорных докладов
- Thank you for the fantastic experience! As a graduate student with a combinatorial grasp of lattice models, it was deeply instructive to hear about other perspectives. The problems that physicists are interested in--as well as the techniques that they use to tackle those problems--were well worth learning about.
- The most valuable conference I've been to! I am going home with many new ideas and possible collaborations. I'm planning on working on at least 2 new papers as a result of conversations I've had here.
- As someone not in the field, I learned a lot.
- I benefited greatly of several discussions
- It was worth it even though I had to spend three hours commuting every day.

Additional comments on the venue

- The wifi kept quitting when I was working in the library.
- The food and environment was generally excellent.
- Place a remarkable
- The MSRI building is very nice and functional, and the surroundings are beautiful
- Beautiful facilities, attentive staff, and a unparalleled view of the bay.
- Beautiful and inspiring
- I love MSRI,
- That's a great place for such workshops. Really nice.
- The food at lunchtime was truly subpar (out of politeness I will not use stronger words). Maybe some people don't care but for me this really detracted from the otherwise wonderful experience. I would strongly recommend replacing your caterer. If more than one food option could be

arranged, that would be even better (after all, people come to MSRI from all over the world and don't have uniform food preferences).
- I found the food reasonable, but expensive for what it is.
- The food itself was good, but I did not like long lines during the lunch and reception
- Although the surroundings of MSRI are great, the constraints imposed by the shuttle schedule and the fact tht the door closes early is a minus. The absence of a proper place for lunch in MSRI is another issue (rather than the quality of the food itself, which is fine).)
- coffee could be better
- Very limited vegetarian options on some days
- Fabulous spot. Only possible improvement is in the food quality, but it was OK, just not particularly good.
- The room was much too cold. And it is barbaric to have a math conference in which participants are not allowed to bring coffee into the lecture room.

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

- I think it may have been useful to have one or two sessions at the beginning of the workshop devoted to establishing some basic definitions/facts/etc. about certain topics (e.g. XXZ spin chain, domino tilings) to help people better understand the talks.
- Захотелось больше узнать об истории университетов и институтов Беркли и особенно об истории математиских проблем решаемых в Берклиинституов р
- Please get speakers to repeat questions loudly for audience.
- More time for discussion
- Arranging visits of various lengths (like short ones of two or three weeks) would be useful
- I had a great time, thanks!
- Mathematicians are machines for converting coffee into theorems, but its hard to produce good theorems if there is no possibility of getting good coffee.
- why cooling was on in the seminar room, in january!?