

Scientific Report

Summary

The Summer School “Fundamental Problems in Statistical Physics XIII” took place in Leuven in June 16-29, 2013. The Summer school is part of a series of Schools with a long tradition, dating back to 1961 when the first edition was organized. Over the years the School has been very influential in forming several generations of Statistical Physicists and hopefully it will continue to do so for the coming years. The aim of the school is to provide a broad perspective in topics of current interest in Statistical Physics by means of a series of pedagogical lectures given by leading experts in the field, accompanied by evening seminars and poster session.

Description of the scientific content

With the help of an international advisory board¹ the following 10 lecturers were selected:

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| Gerard Barkema (Utrecht) | <i>Monte Carlo simulations</i> |
| Abhishek Dhar (Bangalore) | <i>Heat conduction in disordered harmonic crystals</i> |
| Yariv Kafri (Technion) | <i>Energy fluctuations in driven systems</i> |
| Jorge Kurchan (Paris) | <i>Large Deviations, metastability and selection</i> |
| Kirone Mallick (Paris) | <i>The exclusion process, a paradigm for non-equilibrium behaviour</i> |
| Davide Marenduzzo (Edinburgh) | <i>Nonequilibrium phase transitions in active matter</i> |
| John Marko (Northwestern) | <i>Biophysics of protein-DNA interactions and chromosome organization</i> |
| Roland Netz (Berlin) | <i>Solvation effects and hydration interactions</i> |
| Christian Van den Broeck (Hasselt) | <i>Stochastic thermodynamics: a first introduction</i> |
| Angelo Vulpiani (Rome) | <i>Chaos and coarse graining in Statistical Mechanics</i> |

These lecturers gave two series of lectures of 2 hours each. The typical daily program consisted in two hours lecture in the morning, two hours in the afternoon and an evening seminar of one hour (the full program is appended at the end of this document).

¹ The advisory board members are: H. van Beijeren (Utrecht), E. Frey (Munich), P. Gaspard (Brussels), P. Grassberger (Calgary), J. Indekeu (Leuven), J. Krug (Köln), S. Majumdar (Paris), B. Nienhuis (Amsterdam), G. Schütz (Jülich), C. Vanderzande (Hasselt).

As seen from the lecture titles a broad area of Statistical Physics was covered during the School. The foundations of Statistical Mechanics and its connections with Chaos theory were discussed by Vulpiani. The lectures of Van den Broeck discussed some recent advances on the Thermodynamics of Small Systems which are out of equilibrium. The lecture of Mallick covered various aspects of the exclusion process, a paradigmatic and central model for non-equilibrium systems, while Dhar gave an overview of the current state of the art concerning heat transport in harmonic systems. The lectures by Kurchan discussed the connection between metastability and large deviation functionals, while Kafri reported about some recent results on fluctuations in driven systems. Biological and soft matter have become increasingly important fields of research in Statistical Physics, therefore these topics have also played a central role in the school program. The lectures of Marko were focused on discussing the statistical mechanics of protein-DNA interactions. Netz discussed the role of water in mediating interaction between proteins and surfaces or other molecules. Marenduzzo reported about some of the most important and recent results in the field of “Active matter”, a new emerging field in Statistical Physics. An increasing number of problems in Statistical Physics require advanced numerical techniques: some of these aspects were covered by Barkema’s lectures which provided a pedagogical introduction to the Monte Carlo method and discussed some advanced algorithms and open issues.

These lectures were accompanied by evening seminars, discussing some specific topics in some more details. Here below the list of seminar speakers and the topics covered.

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| Tapio Ala-Nissila (Helsinki) | <i>Why is it so difficult to understand and model "simple" boiling of a liquid?</i> |
| Klaus Kroy (Leipzig) | <i>Hot Brownian Motion</i> |
| Jesper Jacobsen (Paris) | <i>Logarithmic correlation functions in geometrical critical phenomena</i> |
| Ignacio Pagonabarraga (Barcelona) | <i>Collective behavior and emergent patterns in active matter</i> |
| Jan Sengers (Maryland) | <i>50 years of nonequilibrium statistical physics: A history of surprises</i> |
| Flavio Seno (Padova) | <i>A physics approach to the protein problem</i> |
| Andrzej Stasiak (Lausanne) | <i>Conservation of complex knotting and slipknotting patterns in proteins</i> |

In the present edition we had the pleasure of welcoming as a special guest Prof. Eddie Cohen (the founder of the school and active organizer of the first few editions). Prof. Cohen had the chance to meet the participants and to deliver a sharp and vivid speech about the role of the School and about his first experiences as a researcher.

Two poster presentations and sessions were organized on the first and second week of the school. The poster remained hanged for a full week, therefore ample time was available for

discussions also outside the official poster sessions.

Assessment of the results and impact of the event on the future direction of the field

We received very positive feedback from the participants and lecturers and are personally very pleased overall about the school. In particular we were positively surprised by the enthusiasm shown by the participants. At the beginning of the school we asked for active participation and encouraged the participants to ask questions; we could not be more pleased by the outcome. The lectures turned out to be very stimulating and well-suited for the level of the audience. The first part of each series of lectures was dedicated to providing basic information, while the second part was more focused on open issues, which stimulated several discussions which often continued after the lecture hours. The choice of topics, which was not too narrow, was very much appreciated by the participants. There are nowadays many “more specialized” summer schools, but the FPSP has developed over the years its own purpose and style. The aim is to expose the participants to a broad choice of topics of modern interest in Statistical Physics in order to broaden their horizons in this stimulating and still very active field of research. We are currently editing some lecture notes which are expected to appear in about one year after the end of the school.

List of participants

We received 119 applications to the Summer School, of these 85 participants were selected on the basis of their CVs, background and motivations; here is the full list

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| 1. Natasa Adzic | 2. Avraham Aminov | 3. Guillaume Attuel |
| 4. Arash Azari | 5. Urna Basu | 6. Thijs Becker |
| 7. Fabrizio Benedetti | 8. Soham Biswas | 9. Stefano Bo |
| 10. Giovanni Brandani | 11. Jakob T. Bullerjahn | 12. Vicente Buzón |
| 13. Luca Ciandrini | 14. Catrin Ciemer | 15. Julien Cividini |
| 16. Karmen Condic-Jurkic | 17. Rahul Dandekar | 18. Olivier Dauloudet |
| 19. Diana David-Rus | 20. Eleonora De Leonardis | 21. Andreas Dechant |
| 22. Christoph Erlenkamper | 23. Gianmaria Falasco | 24. Anna Frishman |
| 25. Ivan Golushko | 26. Torsten Groß | 27. Carlo Guardiani |
| 28. Yosi Hammer | 29. Chaitra Hegde | 30. Ehsan Irani |
| 31. Zakieh Izadi | 32. Ishutesh Jain | 33. Julian Kappler |
| 34. Steffen Karalus | 35. Ville Kauppila | 36. Gert Knoops |
| 37. Olga Konevtsova | 38. Nitin Kumar | 39. Aki Kutvonen |

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| 40. Tanguy Laffargue | 41. Bruno Lannoo | 42. Abhrajit Laskar |
| 43. Demian Levis | 44. Chang You Lin | 45. Luis G. Lopez |
| 46. Matteo Lulli | 47. Paolo Margaretti | 48. Alessia Marruzzo |
| 49. Christian Matek | 50. Daniel A. Matoz-Fernandez | 51. Araks Matrirosyan |
| 52. Harri Mökkönen | 53. Johannes Neidhart | 54. Izaak Neri |
| 55. Armita Nourmohammad | 56. Stefan Nowak | 57. Winny O`Kelly de Galway |
| 58. Fabien Paillusson | 59. Arnab Pal | 60. Jan Plagge |
| 61. Adrien Poncelet | 62. Lorenzo Pucci | 63. Markus Quade |
| 64. Marcela Reale | 65. Mélanie Rolles | 66. Himani Sachdeva |
| 67. Sina Sadeghi | 68. Guglielmo Saggiorato | 69. Alberto Salazar Martinez |
| 70. Francesco Santamaria | 71. Raoul Schram | 72. Maria Schwarzl |
| 73. Hamid Seyed-Allaei | 74. Kamran Shayanfard | 75. Priyanka Singh |
| 76. Alexandre Solon | 77. Juraj Szavits Nossan | 78. Rafael Tapia-Rojo |
| 79. Rafal Topolnicki | 80. Kiamars Vafayi | 81. Hans Vandebroek |
| 82. Sasidevan Vijayakumar | 83. Jean-C. Walter | 84. Justin Whitehouse |
| 85. Stefano Zamuner | | |

Subdivided according the following 20 different nationalities: Argentina (3), Armenia (1), Belgium (7), Croatia (2), Finland (3), France (8), Germany (13), India (11), Iran (8), Israel (3), Italy (14), Mexico (1), Netherlands (1), Poland (1), Romania (1), Russia (2), Serbia (1), Spain (3), Taiwan (1), United Kingdom (1)

Programme

Sunday, June 16

15.00/. - Arrivals to La Foresta/Registrations

18.30/20.00 - Dinner

Monday, June 17

8.00 - Breakfast

9.00/11.20 - *Christian Van den Broeck*

12.15 - Lunch

14.00/16.20 - *Kirone Mallick*

18.00 - Dinner

19.30/20.30 - *Tapio Ala-Nissila*

Tuesday, June 18

8.00 - Breakfast

9.00/11.20 - *Kirone Mallick*

12.15 - Lunch
14.00/16.20 - *Christian Van den Broeck*
18.00 - Dinner
19.30/21.00 - *Poster presentations*

Wednesday, June 19

8.00 - Breakfast
9.00/11.20 - *Abhishek Dhar*
12.15 - Lunch
14.00/15.20 - *Poster Session*
18.00 - Dinner
19.30/20.30 - *Ignacio Pagonabarraga*

Thursday, June 20

8.00 - Breakfast
9.00/11.20 - *Abhishek Dhar*
12.15 - Lunch
14.00/16.20 - *Davide Marenduzzo*
18.00 - Dinner
19.30/20.30 - *Jesper Jacobsen*

Friday, June 21

8.00 - Breakfast
9.00/11.20 - *Davide Marenduzzo*
12.15 - Lunch
14.00/16.20 - *Gerard Barkema*
18.00 - Dinner
19.30/20.30 - *Flavio Seno*

Saturday, June 22

8.00 - Breakfast
9.00/11.20 - *Gerard Barkema*
12.15 - Lunch
18.00/22.00 - Barbecue

Sunday, June 23

8.00 - Breakfast
9.00/18.00 - Excursion to Antwerp
18.30 - Dinner

Monday, June 24

8.00 - Breakfast
9.00/11.20 - *Angelo Vulpiani*
12.15 - Lunch
13.45/15.45 - *Roland Netz*
16.00/17:30 - Poster presentations
18.00 - Dinner
19.30/21.00 - Poster session

Tuesday, June 25

8.00 - Breakfast
9.00/11.20 - *Roland Netz*
12.15 - Lunch
14.00/16.20 - *John Marko*
17.00/18.00 - *Eddie Cohen*
18.00 - Dinner
19.30/20.30 - *Klaus Kroy*

Wednesday, June 26

8.00 - Breakfast
9.00/11.20 - *Angelo Vulpiani*
12.15 - Lunch
14.00/16.20 - *John Marko*
18.00 - Dinner
19.30/20.30 - *Andrzej Stasiak*

Thursday, June 27

8.00 - Breakfast
9.00/11.20 - *Yariv Kafri*
12.15 - Lunch
14.00/16.20 - *Jorge Kurchan*
18.00 - Dinner
19.30/20.30 - *Jan Sengers*

Friday, June 28

8.00 - Breakfast
9.00/11.20 - *Jorge Kurchan*
12.15 - Lunch
14.00/16.20 - *Yariv Kafri*
19.00 - Dinner

Saturday, June 29

8.00 - Breakfast

9.00/ - Departures...

We wish to thank all our sponsors for their generous support to the school!

Enrico Carlon, Marco Baiesi and Andrea Parmeggiani
Organizers of FPSPXIII