

DPG Physics School on Computational Physics of Complex and Disordered Systems

Organized by Alexander K. Hartmann (University of Oldenburg)
and A. Peter Young (University of California Santa Cruz)

21. - 25. September 2015, Physik Zentrum Bad Honnef, Germany

Subject of the school

Ordered and regular systems, such as crystals or simple gases, can be well described by analytical theories. Real systems, however, are often non-ideal, non-regular or disordered. Examples are metallic alloys, glasses, cell membranes, polymer mixtures, or even trans-physics problems such as optimization problems or social networks.

The existence of disorder often leads to behavior which is different from, and more complex than, that of ordered systems. As a result, disordered and glassy systems have been active fields of research for several decades because of their intrinsic interest. Unfortunately, the inclusion of disorder often makes analytic methods impossibly difficult. Hence, most of these problems can only be treated numerically by using efficient algorithms and high-performance computers.

Computer simulations play an ever increasing role in physics research. For example, more than 20% of all publications in Physical Review Letters are concerned, at least partially, with numerical methods. The reason for this success is that, with the widespread availability of powerful computing facilities, computer simulations allow to us study systems which are intractable analytically, to measure “arbitrary” quantities which are out of reach of experiments, and to study a wide range of models, some of which are very close to experiment while others are very artificial but contain an important piece of physics.

This school will provide an introduction to the field, algorithmic techniques, and selected up-to-date research topics. In particular, an introduction to the different types of disordered systems will be given. Furthermore, Monte Carlo, Molecular dynamics, network analysis approaches, as well as some combinatorial optimization problems and algorithms will be explained. The lectures will be accompanied by extensive hands-on numerical exercises (students will be required to bring their own laptops). Finally, some modern applications will be presented, including, for example, glasses, spin glasses, phase transitions in optimization problems, and non-equilibrium (ageing) phenomena.

The school addresses students which have a physics background and basic knowledge in a high-level programming language like Pascal, C/C++, or Fortran. Furthermore the participants should have some knowledge in Statistical Mechanics on undergraduate level. Experience with Computational Physics is not required but advantageous.

All participants will receive a free copy of the textbook “Big Practical Guide to Computer Simulations” (author: A.K. Hartmann, World Scientific, Singapore, 2015).

Lecturers/ Organizers

- Baruch Barzel
Bar-Ilan University, Ramat-Gan, Israel
- Daniele Coslovich
Université Montpellier, France
- Alexander K. Hartmann
University of Oldenburg, Germany
- Helmut G. Katzgraber
Texas A&M University, College Station, USA
- Walter Kob
Université Montpellier, France
- Werner Krauth
Ecole Normale Supérieure Paris, France
- Andrew J. Ochoa
Texas A&M University, College Station, USA
- Roberta Sinatra
Northeastern University, Boston, USA
- A. Peter Young
University of California, Santa Cruz, USA
- Zheng Zhu
Texas A&M University, College Station, USA

Schedule (L: lecture, E: hands-on computer exercise, P: poster session)

Lectures are 75 min. without break, or 90 min. including 15 min. break.

- Sunday 20. September 2015

Arrival

18:30-19:30 *dinner*

- Monday 21. September 2015

9:00-10:15	(L) Monte Carlo Methods (Katzgraber)
	<i>coffee break</i>
11:00-12:15	(L) Spin Glasses (Katzgraber)
12:30	<i>lunch</i>
14:30-15:45	(E) Monte Carlo/Spin Glasses I (Katzgraber,Ochoa,Zhu)
	<i>coffee break</i>
16:30-18:00	(E) Monte Carlo /Spin Glasses I (Katzgraber,Ochoa,Zhu)
18:30-19:30	<i>dinner</i>
20:00-	(P) Poster session of participants

- Tuesday 22. September 2015

9:00-10:15	(L) Introduction to Glasses (Kob)
	<i>coffee break</i>
11:00-12:15	(L) Molecular Dynamics/ Glasses: recent results (Kob)
12:30	<i>lunch</i>
14:30-15:45	(E) Molecular Dynamics / Glasses I (Kob, Coslovich)
	<i>coffee break</i>
16:30-18:00	(E) Molecular Dynamics / Glasses II (Kob, Coslovich)
18:30-19:30	<i>dinner</i>
	(E) continuation exercises

- Wednesday 23. September 2015

9:00-10:15	(L) Cluster Algorithms I (Krauth)
	<i>coffee break</i>
11:00-12:15	(L) Cluster Algorithms II (Krauth)
12:30	<i>lunch</i>
14:00-19:00	<i>excursion</i>
18:30-19:30	<i>dinner</i>

- Thursday 24. September 2015

9:00-10:15	(E) Cluster Algorithms I (Krauth)
	<i>coffee break</i>
11:00-12:15	(E) Cluster Algorithms II (Krauth)
12:30	<i>lunch</i>
14:30-15:45	(L) Networks I (Barzel,Sinatra)
	<i>coffee break</i>
16:30-18:00	(E) Networks I (Barzel,Sinatra)
18:30- ...	<i>conference dinner</i>

- Friday 25. September 2015

9:00-10:15	(L) Networks II (Barzel,Sinatra)
	<i>coffee break</i>
11:00-12:15	(E) Networks II (Barzel,Sinatra)
12:30	<i>lunch</i>
15:00	<i>departure</i>