Classical and Quantum particle systems, 7.5 hp

Course period:
January 23-May 15, 2017

Last day for application:
January 25

Course leaders / Address for applications:
Jakob Björnberg and Jules Lamers
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Course description (Advertisement for Ph.D. students):
The first part of this course is an introduction to probabilistic models for phase transitions, including percolation, the classical Ising model, and the second part of the course complements this with an introduction to quantum integrability for such models. The subject is at the intersection of probability theory and statistical physics.

We will meet once a week for approx. 14 weeks. There will be some homework exercises and an oral exam at the end of the course. The exact schedule will be determined before the course starts.

Responsible department and other participation departments/organisations:
Mathematics Department

Teachers:
Jakob Björnberg (main contact) and Jules Lamers

Examiner:
Jakob Björnberg

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1. Confirmation
The syllabus was confirmed by the Head of the Department of Mathematical Sciences 20XX-XX-XX.

Disciplinary domain: Science
Department in charge: Department of Mathematical Sciences
Main field of study: Mathematics and Mathematical statistics

2. Position in the educational system
Elective course; third-cycle education

3. Entry requirements
The student should have a reasonably good background in probability theory and linear algebra.

4. Course content
The aim of this course is to give an introduction to probabilistic and quantum-integrable aspects of models for phase transitions. The subject is at the intersection of probability theory and statistical physics, and the second part of the course has some ties with (quantum) algebra and complex analysis.

Models that will be discussed include percolation, classical models for magnetic phase transitions such as Ising and Potts, the six-vertex model for ice, as well as quantum-mechanical models such as the ferromagnetic and antiferromagnetic Heisenberg spin systems.

Topics covered will include the existence and basic properties of phase transitions, stochastic domination and correlation inequalities, probabilistic representations of quantum spin systems, the (coordinate and algebraic) Bethe ansatz, transfer matrices and the Yang–Baxter equation. No background in physics will be assumed.

5. Outcomes

After completion of the course the Ph.D. student is expected to be able to:

- Understand the central parts of particle systems and phase transitions in a classical and quantum setting.

6. Required reading
The main sources will be (a) the book *Probability on Graphs* by Geoffrey Grimmett, a version of which is available on the author's homepage, and (b) the notes *A pedagogical introduction to quantum integrability* by Jules Lamers, see `arXiv:1501.06805`.

7. Assessment
Passing grade requires a passing grade on the homework and the final oral exam.

A Ph.D. student who has failed a test twice has the right to change examiners, if it is possible. A written application should be sent to the Department.

In cases where a course has been discontinued or major changes have been made a Ph.D. should be guaranteed at least three examination occasions (including the ordinary examination occasion) during a time of at least one year from the last time the course was given.

8. Grading scale

The grading scale comprises Fail, (U), Pass (G)

9. Course Evaluation

The course evaluation is carried out together with the Ph.D. students at the end of the course, and is followed by an individual, anonymous survey. The results and possible changes in the course will be shared with the students who participated in the evaluation and to those who are beginning the course.

10. Language of instruction

The language of instruction is English.