SFT-2016
Lectures on Statistical Field Theories
Galileo Galilei Institute
Florence, 8-19 February 2016

Program of lectures

Paul Fendley
Lattice models and topological order (10h)

I will describe how topological order arises in lattice models in one and two spatial dimensions. A particular focus will be on the role of zero modes. I will start the Ising/Majorana/Kitaev chains, describe the effect of interactions, and then move onto parafermionic systems. Time permitting, I will describe analogous behaviour in two dimensions; which models will be decided by audience vote.

Robert Konik
Studying perturbed conformal and integrable field theories using the Truncated Spectrum Approach: overview and applications to low dimensional strongly correlated systems (6h)

The program of lectures is the following:

- Overview of TCSA and its applications to perturbed conformal field theories;
- The use of numerical and analytical renormalization groups with the TCSA;
- Combining the TCSA with matrix product states to study 2+1 dimensional systems realized as coupled arrays of chains.

Frank Pollmann
Characterization of topological orders starting from microscopic Hamiltonians (6h)

I will show that numerical investigations of a many-body ground state wavefunction using the density matrix renormalization group (DMRG) method can yield a remarkably complete characterization of different types of topological orders. A central tool is the entanglement which encodes many of the essential features.
The first lecture will provide a brief introduction to entanglement in quantum many-body systems and the area law. Based on the latter, an efficient representation in terms of matrix-product states (MPS) is introduced. The space of MPS can then be used to variationally find an approximation of ground states using the density-matrix renormalization group method.
The second lecture will focus on the class of symmetry protected topological (SPT) phases in one-dimensonal systems. After introducing the basic concept of SPT phases and their classification, I will demonstrate how to detect these phases in numerical simulations.
The third lecture will discuss some basics of intrinsic topological orders and emergent anyonic excitations. I will then show how to extract characterizing properties of topological orders directly from ground-state wavefunctions.
Some notes are available at http://theory.fi.infn.it/SFTschool/LectureNotes/

Slava Rychkov
Conformal Field Theory methods and applications in D>2 (10h)

Lecture will address the following topics:

- constraints from conformal kinematics
- radial quantization and OPE
- conformal blocks
- conformal bootstrap

See http://xxx.arxiv.org/abs/1601.05000 for lecture notes on these topics.

Ettore Vicari
Renormalization-group theory of thermal and quantum critical phenomena (6h)

The first few lectures are dedicated to an overview of the main ideas of the theory of critical phenomena at classical and quantum transitions. Applications and some theoretical and experimental results are discussed.
In the other four lectures some issues are considered in more details, providing the theoretical bases to the study of critical phenomena. In particular, we discuss:

- the quantum-to-classical mapping which connects D-dimensional quantum critical behaviours with classical (D+1)-dimensional theories;
- the Wilson renormalization-group theory;
- the computation of renormalization-group flows using field-theoretical approaches;
- typical quantum transitions in cold atom experiments.