Introduction to statistical mechanics

The aim of statistical mechanics is to understand the macroscopic behavior of a physical system by using a probabilistic model containing the informations provided by the microscopic interactions. The goal of this course is to give an introduction to this broad subject, which lies at the intersection of many areas of mathematics: probability, graph theory, combinatorics, and sometimes even algebraic geometry.
In the first part of the course we will introduce the key notion of equilibrium statistical mechanics. In particular we will study the phase diagram for the following models: percolation (flow of liquids in porous materials), dimer models (crystal surfaces) and Ising model (ferromagnetism). In the second part we will introduce interacting particle systems, a large class Markov processes used to model phenomena arising in physics (e.g. the kinetically constrained models for glasses) as well in other disciplines such as biology (e.g. the contact model for the spread of infections) and social sciences (e.g. the voter model for the dynamics of opinions).