Prof. Quentin Berger (Sorbonne University)

Ph.D. course
"Statistical mechanics and disordered systems"

20 hours

- In the first part of the course course, I will review some models of **statistical mechanics** and discuss a central question in the study of disordered systems, the so-called **disorder relevance**. This question is quite broad and mainly consists in determining whether the properties of a system are stable under small (random) perturbations or whether they are affected by the presence of a small noise.

- For the rest of the course I will develop at length an example: the **Directed Polymer Model**.

  The Directed Polymer Model is based on a Simple Random Walk interacting with a random environment, and it has seen an incredible activity (and important progress) over the past decade. In fact, even though the model is very simply defined (it is a disordered version of the simple random walk), it exhibits a wide range of behaviours and in particular it undergoes a **phase transition** as the intensity of disorder varies.

  I will first describe important features of this model, for instance showing the presence of a phase transition and discussing the role of the dimension in the question of disorder relevance. I will then present very recent result on several fronts:

  - the recent characterization of the **phase transition in dimension d≥3**,
  - the construction of a disordered scaling limit and its relation to the **Stochastic Heat Equation**,
  - the case of the **critical dimension d=2**.