Cours de Physique
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An introduction to the non-perturbative renormalization group

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Ce cours, composé de sept séances, a pour but de donner une introduction pédagogique aux méthodes modernes de renormalisation non perturbative à la Wilson. Très peu de connaissances préalables de théorie (quantique ou statistique) des champs seront nécessaires pour le suivre, mis à part l'intégration fonctionnelle et les rudiments de ce qu'est une transition de phase du second ordre. Il se déroulera ou non en anglais suivant l'assistance.

We provide an introduction to the Wilson renormalization group and its modern non-perturbative implementations (NPRG). The scalar O(N) models will be our favourite playground.
We start by introducing the conceptual and technical framework used throughout these lectures: Wetterich's version of the Wilson RG. The exact RG equation is derived showing how and why Kadanoff's block-spin idea is conveniently implemented on the Gibbs free energy (the generating functional of one-particle-irreducible correlation functions). We then derive the two main nonperturbative approximation schemes: the derivative expansion (DE) on one hand and the Blaizot-Mendez-Wschebor (BMW) scheme on the other hand. We show how the DE truncated at its lowest order(s) yields both an intuitive and powerful method to compute in a unified scheme both universal and nonuniversal quantities, either at or away from criticality. We show in particular how a single set of equations allows us to retrieve all known results of the O(N) models in all dimensions (including the Kosterlitz-Thouless transition, the large N limit and accurate results in three dimensions). Then, we will show how the BMW method allows us to compute the momentum dependence of the two-point functions which is out of reach of the DE (and the perturbative approach). A comparison between the results thus obtained and the best experimental and numerical measurements will be presented on the example of the critical structure factor of the Ising model in three dimensions. If time allows, we will review some important results obtained in different areas of statistical physics.

Friday mornings : 09:30 - 11:30am
January 2015 : 9, 16, 23, 30,
Februray 2015 : 6, 13, 20.
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