UCLouvain

# lphys2215

*2024*

# Statistical field theory

| 5.00 credits | 30.0 h | Q2 |
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**This biannual learning is being organized in 2024-2025**

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| Teacher(s) | Walmsley Hagendorf Christian ; |
| Language : | English<br>> French-friendly |
| Place of the course | Louvain-la-Neuve |
| Prerequisites | Having followed LPHYS2131, LPHYS2113 and LPHYS2114 is an asset. |
| Main themes | This teaching unit provides an introduction to field-theoretic methods in statistical mechanics. In particular, it deals with path integrals and functional integrals, perturbative expansions and Feynman diagrams, renormalisation theory and Wilson's renormalisation group. The theoretical concepts are illustrated via their applications to statistical mechanics and condensed matter physics. |
| Learning outcomes | **At the end of this learning unit, the student is able to :**<br>**a. Contribution of the teaching unit to the learning outcomes of the programme (PHYS2M and PHYS2M1)**<br>1.1, 1.2, 2.1, 3.1, 3.2, 3.3, 3.4, 4.1, 5.4<br>**b. Specific learning outcomes of the teaching unit**<br>1 At the end of this course, the student will be able to :<br>' apply path-integral methods to solve problems in statistical mechanics and quantum mechanics ;<br>' derive Feynman rules and the perturbation theory of a quantum field theory from quantisation via functional integration ;<br>' use methods of perturbative renormalisation in order to compute critical exponents ;<br>' apply the ideas of Wilson's renormalisation group to systems of statistical mechanics. |
| Evaluation methods | The evaluation is based on an oral exam. The students are asked to present their personal work on a physical or mathematical problem that is related to the teaching unit's topics. The evaluation tests the student's knowledge and his/her understanding of the notions seen in the theoretical course, his/her ability to apply them to new problems and his/her oral presentation skills. |
| Teaching methods | The learning activity consists of lectures. They aim to introduce the fundamental concepts of statistical field theory and, by establishing results, to show their interrelationship and their relationship with other courses in the Master of Physical Sciences programme. |
| Content | The aim of statistical field theory is to describe the behaviour of a system in the vicinity of a critical point using (Euclidean) quantum field theory methods. The aim of this course is to give an introduction to this approach and to present renormalization theory in a statistical physics framework.<br>The teaching unit will attempt to cover the following topics: quantum field theory (reminder), Euclidean field theory, random fields and functional integrals, free fields, interacting fields and the Ginzburg-Landau model, systematics of perturbation theory, perturbative renormalization, renormalization group. |
| Inline resources | The MoodleUCL website of this teaching unit contains a detailed plan of the covered topics and a bibliography. |
| Bibliography | • F. David, *Théorie statistique des champs.* EDP Sciences (2019).<br>• G. Parisi, *Statistical field theory.* Addison-Wesley (1988).<br>• M. Salmhofer, *Renormalisation: An introduction.* Springer (1999).<br>• J. Zinn-Justin, *Intégrale de chemin en mécanique quantique : introduction*. EDP Sciences (2003). |
| Faculty or entity in charge | PHYS |

| Programmes containing this learning unit (UE) | | | | |
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| Program title | Acronym | Credits | Prerequisite | Learning outcomes |
| Master [60] in Physics | PHYS2M1 | 5 | | 🔍 |
| Master [120] in Physics | PHYS2M | 5 | | 🔍 |