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THEORY LECTURE: Some chosen pieces of quantum physics in low dimension

THIERRY GIAMARCHI

May 14, 2026 to May 22, 2026
10:00 to 12:00
Blue Lecture Room

ABSTRACT:

To describe the materials that surround us and that we use daily, quantum physics has proven to be an essential tool. Through a description largely based on a physics without interaction between particles, it has allowed to understand many properties of materials. However, this description without interaction has its limitations, and understanding the effects of interactions represents a huge challenge. In the case of systems that are one-dimensional, the interactions between particles even lead to a radically new physics compared to what we are familiar with in three-dimensional systems. What may seem like nothing more than a mathematical game or an academic curiosity is, in fact, extremely important for many systems existing in condensed matter or cold atomic gases. The need to understand such systems has now become a central point in the physics of quantum systems, both in terms of the physics itself and in terms of the methods for solving such problems.

In this set of lectures, I will provide an overview of this very particular physics and its consequences, such as the existence of fractional charge excitations and topological phase transitions. I will also showcase the experimental scenarios that recent advancements in materials science, nanotechnology, and ultracold gas physics have offered, in particular with the possibility to perform quantum simulations of such problems and discuss the state of the field and its prospects and challenges for the 21st century.
- May 14th: Basics of 1D quantum physics; bosonization; Notion of Tomonaga-Luttinger liquid for bosons, spins and fermions.
- May 15th: Some examples in condensed matter and cold atoms; Beyond TLL : example of Mott insulator; notion of renormalization group. Transport.
- May 20th: Beyond simple 1D structures; ladders. Effect of Gauge field; transport and Hall properties.
- May 22th: Dimensional crossover for Bosons and spins; Fermionic systems; mixed dimensionality.

BIOGRAPHY:

Thierry Giamarchi studied in Toulouse and Marseille and after preparatory classes at the Lycee Thiers became a student at the Ecole Normale Superieure (1982). He passed his thesis under the direction of H.J. Schulz at the Paris-Sud University (now Paris-Saclay) in 1987. He has been a permanent researcher at the CNRS since 1986, and during the period 1990-1992 did a postdoctoral fellowship at Bell Laboratories (USA). In 2002 he became full professor at the University of Geneva in the Department of Quantum Matter Physics (DQMP) and was head of this department from 2013 to 2019. He is currently vice-president (since 2017) of a Swiss association on materials with remarkable electronic properties (MaNEP). In addition to his research activities, he has been in charge of several administrative activities such as the direction of the Department of Quantum Matter Physics (DQMP) (2013-2019), member of the Research Commission of the University of Geneva (2018-2020), member of the CNRS National Committee for Theoretical Physics (2000-2002), member of the Scientific Committee of the School of Physics of Les Houches (2007-2016) or member of the Scientific Council of the Commissariat a l'Energie Atomique (CEA) (2015-2018). Since 2013, he has been a member of the French Academy of sciences and a Fellow of the American Physical Society.
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