Quantum entanglement in many-body physics

Professor F. Verstraete

The theory of quantum entanglement provides a new language for describing correlations in quantum many-body systems, thé central problem in theoretical physics. One of the big challenges is to develop the grammar and semantics of that new language. This course will provide an introduction to this field of research and touches upon topics from quantum computation, condensed matter physics, quantum field theory and quantum chemistry.

The course will cover a selection of topics including:

- Introduction to the theory of entanglement
- Area laws of the entanglement entropy
- Quantum tensor networks
- Topological quantum order

Prerequisites

It will be assumed that you have taken an advanced quantum mechanics course, similar to Part II Principles of Quantum Mechanics. Familiarity with quantum computation (e.g., from Part II and Part III Quantum Information and Computation) will be beneficial.

Literature

1. B Zeng, X Chen, DL Zhou, XG Wen, *Quantum information meets quantum matter*, Springer.
2. M.B. Hastings, *Locality in Quantum Systems*, arXiv:1008.5137.
3. J.I. Cirac, D. Perez-Garcia, N. Schuch, F. Verstraete, *Matrix product states and projected entangled pair states: Concepts, symmetries, theorems*, Reviews of Modern Physics 93 (4), 045003 (2021).

Additional support

Four examples sheets will be provided and four associated examples classes will be given. There will be a one-hour revision class in the Easter Term.