Quantum simulation and quantum computing with ultracold atoms

Société Française de Physique

Immanuel BLOCH

Quantum Many-Body Systems Division
Max-Planck Institute of Quantum Optics, Munich

Séminaire SFP

Vendredi
4 juillet 2025
11h

Salle de séminaires
FeRMI
Bât. 3R4
Université de Toulouse

CONTACT :
Nicolas Laflorencie

Quantum simulation has become a powerful interdisciplinary tool for probing quantum matter with microscopic resolution, both in and out of equilibrium. Platforms based on ultracold atoms in optical lattices and tweezers have played a crucial role in the development of the field, with applications ranging from strongly correlated electronic or spin systems, the investigation of out-of-equilibrium dynamics to novel quantum optical light matter interfaces. These systems offer complementary insights to those obtained from advanced numerical methods. In particular, fermionic quantum simulators have begun to reveal new aspects of strongly interacting regimes that challenge conventional computational approaches.

Alongside analog approaches, gate-based quantum computing offers broader universality, though it remains limited by scalability and error correction demands. Hybrid strategies combining both paradigms may offer a promising route to address complex quantum many-body problems in the near term.

This talk will survey recent progress, highlight key challenges, and discuss future directions at the interface of quantum simulation, computation, and many-body physics.