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JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Seminar über Quanten-, Atom- und Neutronenphysik (QUANTUM)

Feb. 9, 2023 at 2 p.m. c.t.
IPH Lorentzraum 05-127

Prof. Dr. Immanuel Bloch
Max-Planck-Institute of Quantum Physics, Garching

Quantum Simulation and Quantum Optics using Ultracold Atoms in Optical Lattices

Quantum Simulations using Ultracold Atoms in Optical Lattices 40 years ago, Richard Feynman outlined his vision of a quantum simulator for carrying out complex calculations of physical problems. Today, his dream has become a reality and a highly active field of resarch across different platforms ranging from ultracold atoms and ions, to superconducting qubits and photons. In my lecture, I will outline how ultracold atoms in optical lattices started this vibrant and interdisciplinary research field 20 years ago and now allow probing quantum phases in- and out-of-equilibrium with fundamentally new tools and single particle resolution. In addition, I will show how fundamentally new avenues of controlling light-matter interactions can be realized based on the rich interplay of photon-mediated dipole-dipole interactions in structured subwavelength arrays of quantum emitters. In the experiments, we directly observe the cooperative subradiant response of such an ordered array of ultracold atoms. Through spatially resolved spectroscopic measurements, our experiments show that the array acts as an efficient mirror formed by only a single monolayer of a few hundred atoms. Finally, I will discuss latest experiments, where the optical properties of the entire array can be switched via a single Rydberg impurity that is deterministically prepared in the center of the array. This opens the path towards novel structured quantum light matter interfaces with unique properties in free space.

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