AKjDPG 1: Rydberg Atoms

Time: Sunday 14:00–15:30 Location: C 02

Tutorial AKjDPG 1.1 Sun 14:00 C 02

Many-body physics with Rydberg atoms — •Christian Gross — Physikalisches Institut, Universität Tübingen

In this tutorial we will discuss the potential of Rydberg atoms for exploring quantum many-body physics for quantum simulation and computing. We will highlight the unique properties of this platform for precision experiments with synthetic and fully controlled quantum magnets. After setting the stage with this general overview, we will discuss key experiments to showcase the experimental state of the art for different atomic spin encoding schemes. We will end with a brief discussion of future prospects and challenges in this rapidly evolving field.

Tutorial AKjDPG 1.2 Sun 14:45 C 02

Neutral Atom Quantum Computing using Rydberg Physics — •Yuri van der Werf — Eindhoven University of Technology, De Rondom 21, 5612 AP, Eindhoven, the Netherlands

Single atoms trapped in arrays of optical tweezers have lately been on the rise as a scalable architecture for quantum computing applications. Constructing a complete gate set for these neutral atom qubits requires the full coherent control over the internal qubit state as well as a means to deterministically entangle two qubits.

This entanglement is achieved by employing highly-excited Rydberg states, which inherently exhibit strong long-range interactions. These interactions result in an excitation blockade effect which can be used to coherently manipulate the two-qubit state of pairs of atoms.

In this tutorial we will explore the recent developments in tweezer platforms for quantum computing, including the two machines being built in Eindhoven. We will discuss the choice of atomic species and qubit type, qubit control mechanisms and computational architectures.

We then focus on how to construct a two-qubit gate using the Rydberg excitation blockade. There are several technical limitations that impact the achievable gate fidelity, such as Rydberg state lifetime, atom temperature, and laser phase noise. We will go into how to overcome these limitations by the choice of Rydberg state, pulse optimization, and laser locking techniques and architectures.