AKjDPG 2: Tutorial Quantum Computing

Time: Sunday 16:00–17:40 Location: K 1.016

Tutorial AKjDPG 2.1 Sun 16:00 K 1.016

An Introduction to Quantum Computers — •Norbert Schuch — Max-Planck-Institut für Quantenoptik, Garching, Germany

Quantum computers use the laws of quantum mechanics to carry out computations much more efficiently than classical computers. This lecture will provide an introduction to the theory of quantum computers, assuming only basic knowledge of quantum mechanics. I will explain how quantum superpositions can in principle be used to speed up computations by quantum parallelism, why it is yet so challenging to find new quantum algorithms, and which promises make quantum computers such an exciting topic. Throughout, the discussion will be guided by simple examples of quantum algorithms. Towards the end, I will also briefly discuss how quantum computers can be made robust against noise.

10 min break

Tutorial AKjDPG 2.2 Sun 16:55 K 1.016

The Quantum Way of Doing Computations — •Rainer Blatt — Institut für Experimentalphysik, Universität Innsbruck — Institut für Quantenoptik und Quanteninformation Innsbruck, Österreichische Akademie der Wissenschaften

Since the mid-nineties of the 20th century, it became apparent that one of the centuries' most important technological inventions, computers in general and many of their applications could possibly be further enhanced by using operations based on quantum physics. This is timely since the classical roadmap for the development of computational devices, commonly known as Moore's law, will cease to be applicable within the next decade. This is due to the ever-smaller sizes of the electronic components that will enter the realm of quantum physics. Building a quantum computer requires the implementation of quantum bits (qubits) as storage sites for quantum information, quantum registers and quantum gates for data handling and processing as well as the development of quantum algorithms.

In this talk, the basic functional principle of a quantum computer will be reviewed. It will be shown how strings of trapped ions can be used to build a quantum information processor and how basic computations can be performed using quantum techniques. In particular, the quantum way of doing computations will be illustrated with analog and digital quantum simulations, which range from the simulation of quantum many-body spin systems over open quantum systems to the quantum simulation of a lattice gauge theory.