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【3】The Quantum Way of Doing Computations

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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. Computations, whether they happen in our heads or with any computational device, always rely on real physical devices and processes. Data input, data representation in a memory, data manipulation using algorithms and finally, data output require physical realizations with devices and practical procedures. Building a quantum computer then 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. The quantum way of doing computations will be illustrated with analog and digital quantum simulations. Ways towards scaling the ion-trap quantum processor will be discussed.

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