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The Quantum Way of Doing Computations

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Prof. Dr. Rainer Blatt

Institute for Experimental Physics,
University of Innsbruck, Technikerstrasse 25, A-6020 Innsbruck, Austria
Rainer.Blatt@uibk.ac.at, www.quantumoptics.at

and

Institute for Quantum Optics and Quantum Information,
Austrian Academy of Sciences, Otto-Hittmair-Platz 1, A-6020 Innsbruck, Austria
Rainer.Blatt@oeaw.ac.at, www.iqoqi.at

A few decades ago, it became apparent that computers and many of their applications can 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. The technology for quantum computers 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 state-of-the art of current quantum computer technology is briefly reviewed and exemplified with strings of trapped ions, which are harnessed as a quantum register in a quantum information processor. The quantum way of doing computations is illustrated with analog and digital quantum simulations. Ways towards scaling the ion-trap quantum processor are discussed.