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First ever "Quantum Byte" achieved

Decisive step towards a quantum computer

In Innsbruck, for the first time ever, scientists have succeeded in entangling a larger number of atoms with each other. The scientists around Prof. Rainer Blatt and Dr. Hartmut Häffner report on their achievement in the current issue of the science journal NATURE. As a worldwide first, a so-called „quantum byte" (qubyte) was created through controlled entangling of eight ions.

Producing a "quantum byte" counts as an important step towards a quantum computer. "The fact that we were the first to reach this goal confirms the success of our work at the Innsbruck quantum physics unit", explained Rainer Blatt proudly. "Crucial for our research, however, is the tool this experiment has given us for investigating the processes of quantum information processing in more detail," he went on. In close cooperation with the theoretical physicists Dr. Otfried Gühne and Dr. Wolfgang Dür from the Innsbruck working group of Prof. Hans J. Briegel, the scientists around Rainer Blatt and Hartmut Häffner proved that they can entangle four, five, six, seven or eight ions in a controlled fashion. The calcium ions are trapped in an ion trap with electromagnetic fields, arranged in a row and entangled in so-called W states using sophisticated laser technology.

Complex calculations

The real difficulty with the experiment was proving that the particles were indeed entangled. 650,000 measurements had to be carried out in order to describe the eight "quantum bits (qubits)" with numbers. This measuring process alone lasted over ten hours. The computation of the numbers and their graphic representation on a high-performance computer of the university took up several weeks. This gives us a hint of how vastly superior quantum information processing is over traditional computers. "What happens with the eight qubits in about one millisecond, a general-purpose processor takes many hours to calculate and characterize," Prof. Blatt explained. The successful experiment also proves that ion traps like the ones currently used in Innsbruck are the most promising technology to date for realizing larger calculation ranges. In the case of the eight ions, this calculation range consists of 65,536 largely independent elements.

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Innsbruck – a quantum hotbed

Last year the group around Rainer Blatt succeeded in teleporting atoms for the first time. The current experiment confirms the leadership of the nationally and internationally renowned quantum physics unit at Innsbruck. In recent years, the close cooperation of theoretical and experimental physicists and the high concentration of top-qualified researchers under the aegis of professors Rainer Blatt, Hans J. Briegel, Rudolf Grimm and Peter Zoller has made Innsbruck a hotbed of quantum physics. Crucial support came from the Austrian Academy of Sciences, which established the Institute for Quantum Optics and Quantum Information (IQOQI) here, the Austrian Science Fund (FWF), which established a national special research area in this field, as well as the European Union, the federal province of Tyrol, the city of Innsbruck, and Tyrolean industry. The latest success of the Innsbruck quantum physicists is paving the way for an even better understanding of future quantum computers and offers the scientists the first opportunity ever for detailed analyses of several entangled particles.

Pictures: http://www.iqoqi.at/media/download/

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