14-01-2007

Media alert 1/2007

Largest one-way quantum computer to date created with expert knowledge from Innsbruck

Institut für Quantenoptik und Quanteninformation
Österreichische Akademie der Wissenschaften

Otto Hittmair-Platz 1 / Technikerstraße 21a
6020 Innsbruck, Austria, Europe
Tel +43 512 507 4701
Fax +43 512 507 9815
iqoqi-ibk@oeaw.ac.at
www.iqoqi.at

Geschäftsführender Direktor
Univ.Prof. Dr. Rainer BLATT
rainer.blatt@oeaw.ac.at

A group of researchers in China has succeeded for the first time in entangling six photons, thus building the largest one-way quantum computer so far. And it was theoretical physicist Dr. Otfried Gühne of the Institute for Quantum Optics and Quantum Information (IQOQI) in Innsbruck who contributed a method for proving this entanglement. The previous record for entangling photons stood at five and had been realised by the same working group in 2004.

It was a group led by Professor Jian-Wei Pan at Hefei University in China who succeeded in carrying out this experiment. The researchers first entangled three pairs of photons with each other and then fused them to form a six photon state with which they managed to create two different graph states. The Chinese scientists were able to produce a so-called Greenberger-Horne-Zeilinger state in which two extremely different states overlap. This is the equivalent of Erwin Schrödinger's thought experiment of the cat that is dead and alive at the same time. The researchers also managed to create a cluster state in their experiment, which is an important resource for a one-way quantum computer. For this they prepared a highly entangled state of several particles. The sheer act of measuring is enough to realise a quantum computer from this. The measuring process destroys the entanglement of the particles, hence the name "one-way quantum computer" for this model. The resulting six photon state is the largest one-way quantum computer to date.

Ideas from Innsbruck

The concept for the cluster state and the one-way quantum computer based on it was developed by Dr. Robert Raussendorf and by Professor Hans Briegel, who heads the working group at the Institute for Quantum Optics and Quantum Information in Innsbruck to which Dr. Otfried Gühne belongs. Gühne suggested a method to his Chinese colleagues that enabled them to prove the entanglement of the photons. "The problem with such experiments is the fact that only a small rate of successful events (ca. 1.5 events per minute) occur," Otfried Gühne explains. "It would take much too long to measure the complete state. Instead, only a few measurements can be captured. From these you can deduce whether

the six photons are indeed entangled." In this way the experimental physicists in China were able to prove the entanglement of all six photons and to determine other important measures such as the quality of the state. By changing the experiment slightly they will in future be able to realise many more graph states, thus widening the scope for exploring and applying entangled states for quantum communication and quantum computers.

International cooperation

Dr. Otfried Gühne studied mathematics and physics in Münster, Germany. From 2001 to 2004 he did his doctorate as a member of Professor Maciej Lewenstein's working group at the University of Hannover, Germany. Since June 2004 he has been working in the research group led by Professor Hans Briegel at the Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences in Innsbruck. Professor Jian-Wei Pan, who heads the Chinese research group, had been involved in the first successful teleportation of photons at the University of Innsbruck as early as 1997. He took his doctorate here and for several years was part of Professor Anton Zeilinger's working group. He has been cooperating closely with the Austrian quantum physicists ever since.

Publication: Experimental entanglement of six photons in graph states. Chao-Yang Lu, Xiao-Qi Zhou, Otfried Gühne, Wei-Bo Gao, Jin Zhang, Zhen-Sheng Yuan, Alexander Goebel, Tao Yang, and Jian-Wei Pan. Nature Physics, January 15, 2007
Preprint: http://arxiv.org/ftp/quant-ph/papers/0609/0609130.pdf

You can find pictures on: http://www.iqoqi.at/media/download/

For further informtation, please contact:

Dr. Otfried Gühne
Institut für Quantenoptik und Quanteninformation
Österreichische Akademie der Wissenschaften
Technikerstr. 21a, A-6020 Innsbruck
Tel: +43 512 507 4754
Email: Otfried.Guehne[at]oeaw.ac.at

Dr. Christian Flatz
Public Relations
Tel. +43 650 5777122
Email: pr-iqoqi[at]oeaw.ac.at