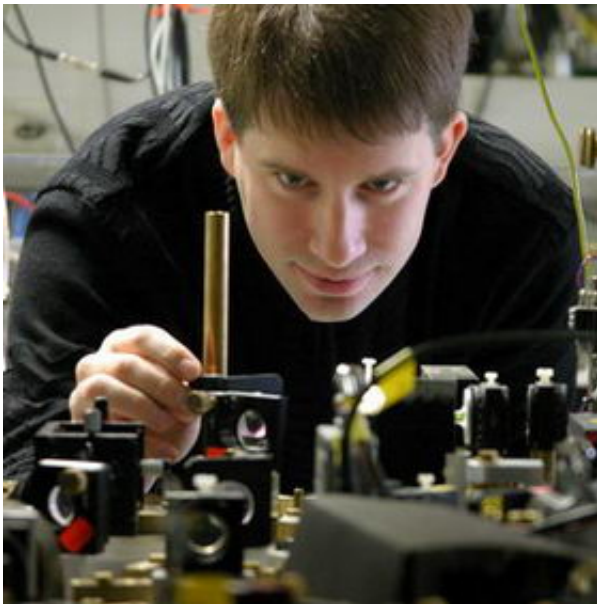


Quantum Computer: Laser tweezers sort atoms

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Physicists of the University of Bonn have taken one more important hurdle on the path to what is known as a quantum computer: by using 'laser tweezers' they have succeeded in sorting up to seven atoms and lining them up. The researchers filmed this process and report on their breakthrough in the next issue of the prestigious journal *Nature* (13th July 2006).

In the experiment the research team headed by Dr. Arno Rauschenbeutel

and Professor Dieter Meschede decelerated several caesium atoms for a period of several seconds so that they were hardly moving, then loaded them onto a 'conveyor belt' consisting of lasers. This conveyor belt is made up of a standing light wave composed of many peaks and troughs – possibly comparable to a piece of corrugated iron. 'Unfortunately it cannot be predicted which trough precisely the atoms will land in,' Arno Rauschenbeutel explains. 'It's rather like pouring several eggs from a big dish into an egg carton – which section each egg rolls into is a matter of chance.'

However, anyone wishing to calculate with atoms must be able to place them exactly. 'All the atoms on the conveyor belt have to have the same distance from each other,' is how Arno Rauschenbeutel sketches the challenge. 'Only then can we get them to interact in a controlled way in what is called a quantum gate.' By lining up gate operations like these it would already be possible to carry out simple quantum calculations.

The Bonn physicists therefore subsequently 'sorted' the atoms in their experiment on the conveyor belt. They did this by first taking a photo to record their positions. They next set the conveyor belt moving – and with it the caesium atoms 'trapped' in the troughs. In this way they transported the wrongly placed atoms to their 'laser tweezers' – this is basically nothing more than another conveyor belt consisting of laser beams which is oriented orthogonally to the first conveyor belt. 'When we set the tweezers' light wave in motion, we can lift the wrongly placed atoms off the conveyor belt,' Arno Rauschenbeutel explains. 'Then we move the conveyor belt to the desired position and simply pop the atom back in.'

The film shows how well this works: the tweezers select two atoms consecutively from the belt and put them back on again in such a way that they are exactly the same distance from each other and from a third atom. 'Sorting seven atoms in this way takes us about two seconds,' Dr. Rauschenbeutel says.

The next aim of the Bonn physicists is to construct a quantum gate. For this purpose they want to 'write' quantum information onto two caesium atoms and then place them between two tiny mirrors. The intention is that they should interact there with each other, i.e. exchange information by emitting and absorbing fluorescent light. If this is successful, it will be the next milestone for the Bonn researchers on their way to the quantum computer.

Citation: An atom-sorting machine. Yevhen Miroshnychenko, Wolfgang Alt, Igor Dotsenko, Leonid Fürster, Mkrtych Khudaverdyan, Dieter Meschede, Dominik Schrader, Arno Rauschenbeutel. *Nature*, 13th July 2006 (Vol. 442, No 7099)

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