

30-01-2007
Media alert 2/2007



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

Innsbruck physics in the limelight

Last year the quantum physicists in Innsbruck succeeded in an astonishing experiment: they linked two atoms in a repulsively bound pair. The particles repel each other and yet form a pair precisely because of this. The scientists reported on their findings in the June 2006 issue of the journal Nature. Now the US magazine Discover has chosen their article as one of the six top physics discoveries of the year 2006. And the scientist's string of successes continues: they are starting the new year with a further coup in the quantum control of such particle systems.

Working together with the group of theoreticians headed by Andrew Daley and Peter Zoller, the experimental physicists led by Johannes Hecker Denschlag and Rudolf Grimm last year succeeded for the first time in an experiment that allowed them to observe the unruly atomic pairs in a bound state. They used a Bose-Einstein-condensate of rubidium atoms, which they slowly surrounded with a three-dimensional optical lattice of laser beams. Wherever two atoms come to lie on a lattice site, a repulsive pair forms. Even though the atoms repel each other, they cannot leave the lattice because they are preventing each other from doing so. "In this way a strongly correlated system emerges with remarkable resemblance to a molecule," Johannes Hecker Denschlag explains, "except that the binding energy has the "wrong" sign." Even when the pairs collide with other atoms, they do not lose their eerie bond. "This experiment can be used to simulate very abstract models and will thus find an application in the development of a future quantum computer," Andrew Daley explained.

Successful cooperation

Strange signals marked the beginning of this discovery. The experimental physicists turned to their theoretician colleagues for advice. These were familiar with repulsive pairs from model calculations, but nobody had proven them in an experiment yet. The discovery of the fatal bond was made possible by the close cooperation between the working groups of the Institute of Experimental Physics at the University of Innsbruck and the Institute of Quantum Optics and Quantum Information of the Austrian Academy of Sciences. Being chosen as one of the success stories of the past year underlines the international



OAW
Österreichische Akademie
der Wissenschaften

standing of quantum physics at Innsbruck. Each year, science magazine *Discover* chooses the 100 best research contributions from various disciplines. The Innsbruck quantum physicists were among the six projects selected in the area of physics.

New breakthrough

In addition to forming a repulsive bond, the pairs of atoms can also be manipulated in such a way that they enter a genuine chemical bond. The researchers led by Johannes Hecker Denschlag have now been able to demonstrate for the first time, how, with the help of laser pulses, it is possible to change intentionally back and forth between different bound states of the molecules. This can be done in a highly efficient way and with precisely defined quantum states of the particles. The researchers reported their findings last week in the renowned scientific journal *Physical Reviews Letters*.

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

Publications:

Coherent Optical Transfer of Feshbach Molecules to a Lower Vibrational State. K. Winkler, F. Lang, G. Thalhammer, P. v. d. Straten, R. Grimm, and J. Hecker Denschlag. *Phys. Rev. Lett.* 98, 043201 (2007)
<http://dx.doi.org/10.1103/PhysRevLett.98.043201>

Repulsively bound atom pairs in an optical lattice. Winkler K, Thalhammer G, Lang F, Grimm R, Hecker Denschlag J, Daley AJ, Kantian A, Buchler HP, Zoller P. *Nature*. 2006 Jun 15;441(7095):853-6.
<http://dx.doi.org/10.1038/nature04918>

Discover Magazine: The Top 6 Physics Stories of 2006

<http://www.discover.com/issues/jan-07/features/physics/?page=2#71>

For further information please contact:

a.Prof. Dr. Johannes Hecker Denschlag

Institut für Experimentalphysik

Universität Innsbruck

Technikerstrasse 25 / IV

A-6020 Innsbruck

Tel. +43 512 507 6340

Fax +43 512 507 2921

Email: Johannes.Denschlag@uibk.ac.at

Dr. Christian Flatz

Public Relations

Tel. +43 650 5777122

Email: pr-iqoqi@oeaw.ac.at