February, 22 2009

IQOQI Media alert 3/2009

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

Quantum Physics: An Exceptional Trio

For the first time, physicists observe Efimov quantum states of atoms and molecules

Three years ago, experimental physicists of the University of Innsbruck caused worldwide sensation when they experimentally demonstrated Efimov states for the first time ever. Now the scientists have found a new way to observe these quantum states, which are hard to detect. With their experiment, the researchers have been able to prove the universality of the Efimov theory experimentally. They have recently published an article in the prestigious journal Nature Physics.

At the beginning of the 1970s, the Russian physicist Vitali Efimov proposed that when using their quantum mechanical states, three particles could be coupling to form one entity while a two-particle system of the same particles is unstable. This proposition was controversial among theoretical physicists as it could not be proved experimentally; until in 2006 a team of physicists of the University of Innsbruck, led by Rudolf Grimm and Hanns-Christoph Nägerl, demonstrated the very existence of Efimov states. "In 2002 we already observed strange phenomena in our data", Grimm recounts. "After having successfully completed Bose-Einstein condensate experiments, we took another look at these phenomena and came to an astonishing conclusion." Since experimental physicists can accurately tune the interaction conditions between ultracold particles of an atomic cloud, they could also control the conditions under which bound trimer states (Efimov trimer) could be achieved.

Efimov states of atoms and molecules

"For the first time we have been able to demonstrate that Efimov states can also arise as a result of coupling an atom to a dimer molecule", the Italian researcher Francesca Ferlaino and the Dutch scientist Steven Knoop, who have worked as junior scientists in Innsbruck for three years, explain. The researchers used an ultracold gas of free caesium atoms, with a temperature of just a few billionths of a degree above absolute zero. By using a magnetic field, some atoms were coupled to dimers. After manipulating the magnetic field, the atoms and molecules coupled to build Efimov trimers. The scientists, however, didn't observe the trimer state directly but as the result of giant three-body recombination loss resonance in the ultracold caesium gas.

ÖAW
Österreichische Akademie der Wissenschaften

Understanding complex systems

"In comparison to the previously observed atom trimer resonance, this new atom dimer resonance approach offers additional information", Ferlaino and Knoop explain. For instance, the scientists from Innsbruck can now evaluate the universality of Efimovs theory. "Our experiments show that the theory is correct qualitatively but some details will have to be corrected with regard to real-world systems", Rudolf Grimm sums up. "As a result, we expect that our data will stimulate many more theoretical investigations of Efimov states in real-world systems."

A better understanding of Efimov states may lead to the establishment of theories of more complex few-body systems, which are considered to be even more difficult to grasp. The recent findings of the Austrian physicists will provide a stimulus for further investigations by the international scientific community.

For illustrations go to http://iqoqi.at/media/download

Observation of an Efimov-like trimer resonance in ultracold atom-dimer scatterin. Knoop S, Ferlaino F, Mar M, Berninger M, Schöbel H, Nägerl HC, grimm R. Nature Physics, Advanced Online Publication, 22 February 2009. (http://dx.doi.org/10.1038/NPHYS1203)

Kontakt:

Dr. Steven Knoop
Institute for Experimental Physics
University of Innsbruck
Technikerstraße 25, A-6020 Innsbruck, Austria
Phone: ++43 512 507 6316
Email: Steven.Knoop@uibkc.ac.at
Web: http://www.ultracold.at

Dr. Christian Flatz
Public Relations
Institute for Quantum Optics and Quantum Information of the Austrian Academy of Sciences
Technikerstraße 21a, A-6020 Innsbruck, Austria
phone: ++43 650 5777122
Email: pr-iqoqi@oeaw.ac.at