A new state of matter created

The electron (blue) orbits the nucleus (red) - and its orbit encloses many other atoms of the Bose-Einstein-condensate (green). | Photo Credit: TU Wien

An international team of physicists have successfully created a "giant atom" and filled it with ordinary atoms, creating a new state of matter termed "Rydberg polarons". These atoms are held together by a weak bond and is created at very cold temperatures.

"For us, this new, weakly bound state of matter is an exciting new possibility of investigating the physics of ultracold atoms," says Joachim Burgdörfer, theoretical physicist from TU Wein and one of the authors of the paper published in *Physical Review Letters*.

Dr.Ganesh Ramachandran from the Condensed Matter Group at Institute of Mathematical Sciences, Chennai explains the new Rydberg polarons

This is an intricate experiment that builds upon several advances that were achieved over the past two decades.

It uses ideas from two different fields: Bose Einstein Condensation and Rydberg atoms.

A BEC (Bose Einstein Condensate) is a liquid-like state of matter that occurs at very low temperatures. A BEC can be perturbed to create excitations which are akin to ripples on a lake. Here, the authors have used a BEC of strontium atoms.

Electrons in an atom move in regular orbits around the nucleus, somewhat like planets around the sun. A 'Rydberg atom' is an atom in which an electron has been kicked out to a very large orbit. These have interesting properties and have been studied for a long time.

In this work, the authors used laser light on a BEC of strontium atoms so that it impinges on one strontium atom at a time. This excites an electron into a large orbit, forming a Rydberg atom. This orbit is large enough to encircle many other strontium atoms inside it.

As the electron moves around many strontium atoms, it generates ripples of the BEC. The Rydberg atom becomes inextricably mixed with these ripples and forms a new super-atom called a 'Rydberg polaron'.

A particularly interesting implication is for cosmology. We know that our universe is filled with a mysterious 'dark matter' which exerts a gravitational force on other forms of matter.

Some theories of dark matter postulate that it is a cosmic Bose Einstein Condensate, perhaps composed of an as-yet-unknown type of particle. If we are indeed living in an invisible all pervading Bose Einstein Condensate, this experiment can suggest ways to detect it.

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