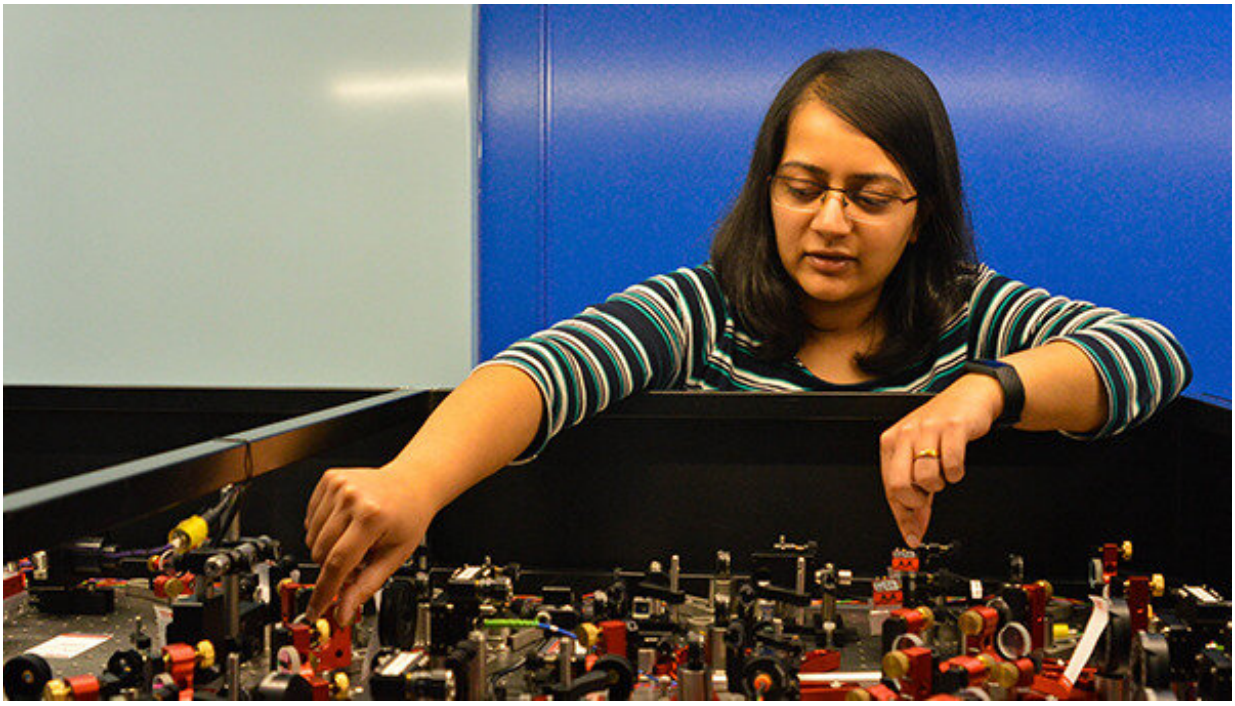
Physicist creates fifth state of matter from the living room

May 26 2020, by Neil Vowles



Dr Amruta Gadge setting up the lasers prior to lockdown. Credit: University of Sussex

A physicist has created the fifth state of matter working from home using quantum technology.

Dr. Amruta Gadge from the Quantum Systems and Devices Laboratory successfully created a Bose-Einstein Condensate (BEC) at the University

of Sussex facilities despite working remotely from her living room two miles away.

It is believed to be the first time that BEC has been created remotely in a lab that did not have one before.

The research team believe the achievement could provide a blueprint for operating quantum technology in inaccessible environments such as space.

Peter Krüger, Professor of Experimental Physics at the University of Sussex, said: "We believe this may be the first time that someone has established a BEC remotely in a lab that didn't have one before. We are all extremely excited that we can continue to conduct our experiments remotely during lockdown, and any possible future lockdowns.

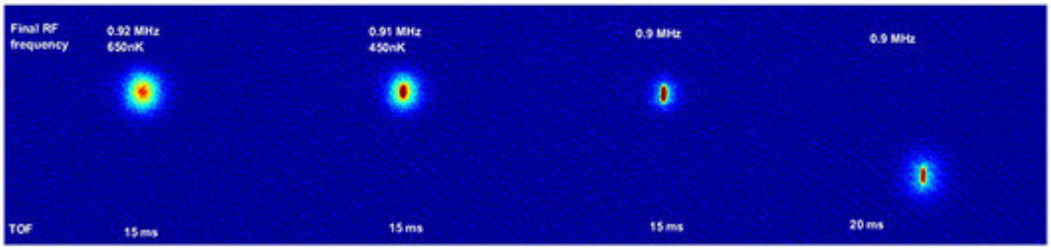
"But there are also wider implications beyond our team. Enhancing the capabilities of remote lab control is relevant for research applications aimed at operating quantum technology in inaccessible environments such as space, underground, in a submarine, or in extreme climates."

A BEC consists of a cloud of hundreds of thousands of rubidium atoms cooled down to nanokelvin temperatures which is more than a billion times colder than freezing.

At this point the atoms take on a different property and behave all together as a single quantum object. This quantum object has special properties which can sense very low magnetic fields.

Professor Krüger said: "We use multiple carefully timed steps of laser and radio wave cooling to prepare rubidium gases at these ultralow temperatures. This requires accurate computer control of laser light, magnets and electric currents in microchips based on vigilant monitoring

of environmental conditions in the lab while nobody is able to be there to check in person."



The image confirming the successful creation of the BEC. Credit: University of Sussex

The Quantum Systems and Devices Group have been working on having a second lab with a BEC running consistently over the past nine months as part of a wider project developing a new type of magnetic microscopy and other quantum sensors.

The research team uses atomic gases as magnetic sensors close to various objects including novel advanced materials, ion channels in cells, and the human brain.

Trapped cold quantum gases are controlled to create extremely accurate and precise sensors that are ideal for detecting and studying new materials, geometries and devices.

The research team are developing their sensors to be applied in many

areas including electrical vehicle batteries, touch screens, solar cells and medical advancements such as brain imaging.

Just in time before lockdown, researchers set-up a 2-D magnetic optical trap and have returned only a couple of times to carry out essential maintenance.

Dr. Gadge, Research Fellow In Quantum Physics And Technologies at the University of Sussex, was able to make the complex calculations then optimising and running the sequence from her home by accessing the lab computers remotely.

She said: "The research team has been observing lockdown and working from home and so we have not been able to access our labs for weeks. But we were determined to keep our research going so we have been exploring new ways of running our experiments remotely. It has been a massive team effort.

"The process has been a lot slower than if I had been in the lab as the experiment is unstable and I've had to give 10-15 minutes of cooling time between each run. This is obviously not as efficient and way more laborious to do manually because I've not been able to do systematic scans or fix the instability like I could working in the lab.

"We're hopeful of establishing a skeleton crew back in the labs with social distancing measures in place as soon as it is safe to do so and permitted but we will be able to have many of the team continuing to work from home on a rota basis thanks to the progress we have made with remote working."

Provided by University of Sussex