Research Highlights

THE AUSTRALIAN NATIONAL UNIVERSITY

Putting the Big Chill on Excited Atoms

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ARC COE FOR QUANTUM-ATOM OPTICS

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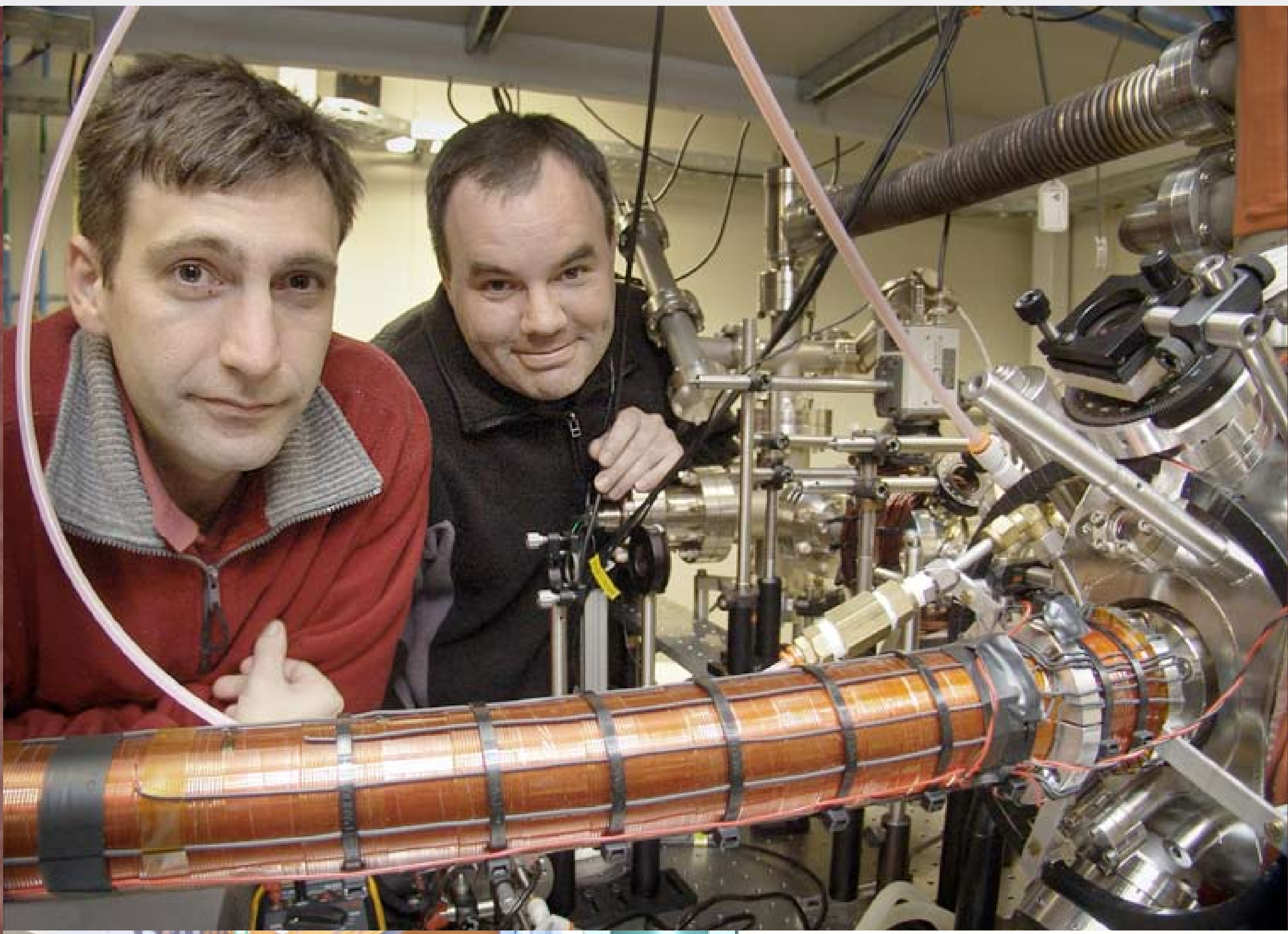
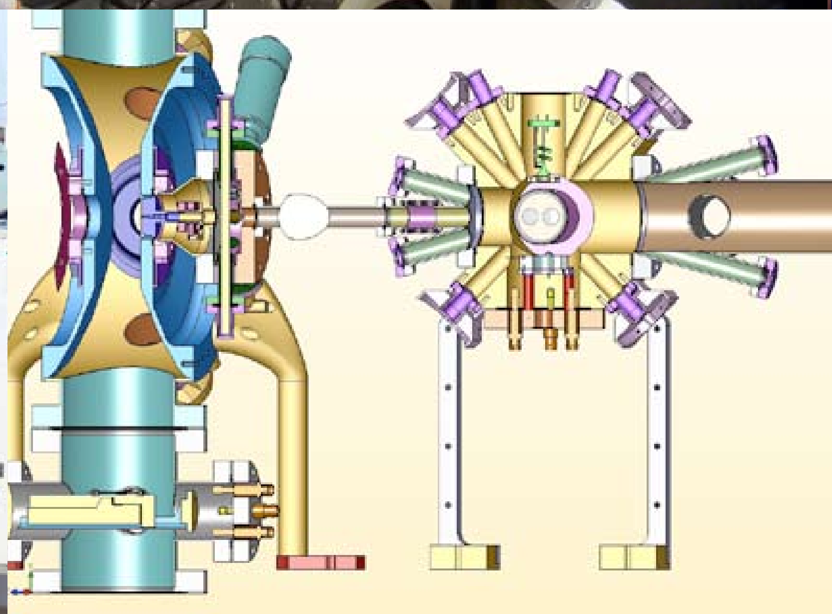


In 1925, based on work by Satyendra Nath Bose, Albert Einstein proposed that if one could make a collection of atoms cold enough, they would condense into a single quantum state making each atom identical to its neighbours in a similar way to photons in a laser beam. It wasn't until seventy years later that scientists were able to actually create the world's first Bose Einstein-Condensate (BEC) in the laboratory.

BECs are interesting because they represent an entirely new state of matter not found naturally anywhere in the universe. Even the coldest depths of space are a billion times too hot for a BEC to exist because of residual radiation from the big bang. BECs have strange quantum properties that may yield useful future technologies. However, in order unlock this potential, scientists need to better understand BECs and especially their process of formation. Studying the formation process in conventional ground state alkali atom BECs is complicated by the inability to detect individual constituent atoms. Measurements on such systems are limited to averaging over the quantum ensemble.

To get around this, scientists at the ANU have recently become one of only four groups in the world to develop a novel laser cooling apparatus capable of creating BECs using excited helium atoms rather than atoms in the ground state. The advantage in using excited atoms in the BEC is that they can be detected individually. This is because they decay to their ground state on contact with a detector, the energy thereby released liberating an electron and producing a detectable signal in the process. Since the atoms in the BEC cloud are all quantum identical, probing one yields a perfect snapshot of the others and individual quantum effects become visible in much greater detail. The ANU team is hopeful that this newly commissioned system will yield vital clues to the mechanism of BEC formation.

The history of physics is full of examples of strange and exotic phenomena that having been developed out of pure curiosity, have gone on to spawn unimaginable technological advances. Lasers, X-rays, and transistors all belong to this family and BECs may well be its newest member.



Much of the new BEC Beamline was designed and built within the School's workshops. The facility for inhouse design and production of unique experimental facilities underpins much of the School's research activity.

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The helium BEC project is part of the ARC Centre of Excellence for Quantum-Atom Optics (ACQAO - see www.acqao.org) headquartered at ANU.