Atoms colder than outer space are the key to futuristic nano-sensors

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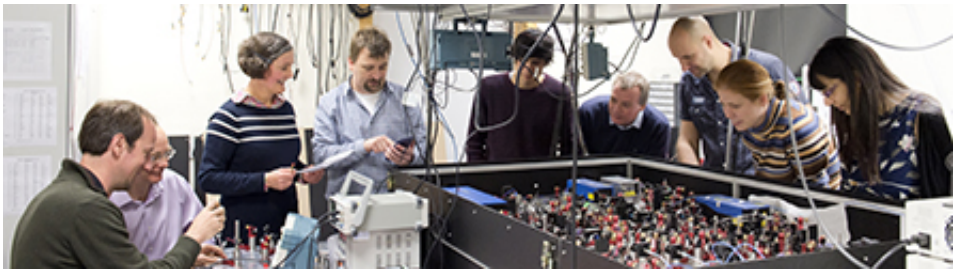

Experts at The University of Nottingham have secured a £6 million grant to build a research facility to prototype a new generation of tiny nano-sensors.

The research centre, based in the University's School of Physics and Astronomy, will use super-cooled atoms that are 10 million times colder than outer space, and only a few billionths of a degree above the lowest possible temperature, to build sophisticated sensors which could revolutionise diagnostic medicine and navigation technologies.

In a development mirroring the progress of computer technology, the new Quantum Technology Hub will focus on miniaturising existing laboratory-based sensors, which are currently so large that they fill an entire room.

To achieve this miniaturisation, the researchers will make microchips that operate by using a levitating atom cloud instead of traditional electrical circuits.

Amazing behaviour

Professor Mark Fromhold, who is co-ordinating the Nottingham work, said: "In the Hub, physicists, nanofabrication and biomedical imaging experts, engineers, and industry partners will work together to develop new sensor technologies that exploit the amazing quantum behaviour of atoms that are made really cold by using laser beams and magnetic fields."

The new devices could have a wide range of useful applications including:

- More robust navigational sensors with superior capabilities to existing GPS technology. Unlike traditional GPS systems, the new technology would not be reliant on satellites at all and would even be able to operate inside buildings or underground.
- Detecting pipes and cables buried beneath our roads and pavements to produce a reliable map of subterranean utilities, some of which date back to Victorian times. This could reduce traffic delays due to roadworks by making it easier for companies to locate utilities for vital maintenance work and preventing pipes and cables from being damaged accidentally.
- New cold-atom microscopes that can image the flow of electric currents through materials, microchips, or biological systems so providing new information about how they work.
- Improved medical diagnostic technology, including more effective magnetoencephalography (MEG) scanners, specialist brain mapping scanners that Nottingham is already using to advance our knowledge of neurological diseases and mental

illness.

Strategic partnership

The new Quantum Technology Hub will bring together expertise from the School of Physics and Astronomy, the Faculty of Engineering, and the Faculty of Medicine and Health Sciences. This includes the University's Engineering and Physical Sciences Research Council (EPSRC) Centre for Innovative Manufacturing in Additive Manufacturing, the George Green Institute for Electromagnetics Research, Nottingham Geospatial Institute, the Energy Technologies Research Institute and EPSRC Centre for Doctoral Training in Carbon Capture and Storage and Cleaner Fossil Energy, as well as its EPSRC and MRC Centre for Doctoral Training in Biomedical Imaging, run jointly with the University of Oxford.

Professor Saul Tendler, Pro-Vice-Chancellor for Research, said: "We are delighted to be recognised with this important grant from the EPSRC.

"The Hub builds on the University's world-leading expertise in Physical Sciences and Engineering and on our strategic partnership with the University of Birmingham, in particular our joint Midlands Ultracold Atom Research Centre."

The new Hub will also work closely with a range of industry partners to take new prototypes out of the lab and into the marketplace.

The funding is part of a wider £80 million grant awarded to a consortium of universities, led by the University of Birmingham. It forms part of a new network involving 17 universities and 132 companies and will be funded by the EPSRC from the £270 million investment in the UK National Quantum Technologies Programme announced by the

Chancellor, George Osborne in his Autumn Statement of 2013.

The Government investment aims to harness UK expertise in quantum physics to lead the international development and application of new quantum technologies and devices.

The programme will deliver a suite of research and innovations investments from a number of partners including EPSRC, Innovate UK, BIS, National Physical Laboratory (NPL), GCHQ, Dstl and the Knowledge Transfer Network.

Pushing the boundaries

Greg Clark, Minister of State for Universities, Science and Cities, said: "This exciting new Quantum Hubs network will push the boundaries of knowledge and exploit new technologies, to the benefit of healthcare, communications and security.

"This investment in Quantum technologies has the potential to bring game-changing advantages to future timing, sensing and navigation capabilities that could support multi-billion pound markets in the UK and globally.

"Today's announcement is another example of the Government's recognition of the UK's science base and its critical contribution to our sustained economic growth."

Professor Philip Nelson, EPSRC's Chief Executive, said: "These new Hubs will build on our previous investments in quantum science. They will draw together scientists, engineers and technologists from across the UK who will explore how we can exploit the intriguing properties of the quantum realm. The area offers great promise, and the Hubs will keep the UK at the leading edge of this exciting field."

The capabilities in Quantum Technologies offer potentially transformative impacts in key areas such as quantum metrology & sensors; quantum simulators; quantum computers and quantum secure communications.

Provided by University of Nottingham