New sensor devices recycle atoms

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The atom interferometer uses the quantum ‘wave-like’ nature of atoms to make precise measurements. Credit: University of Queensland

Next-generation sensors to be used in fields as diverse as mineral exploration and climate change will be turbo boosted thanks to University of Queensland and University of Sussex research.

Theoretical physicist Dr Stuart Szigeti, of UQ's School of Mathematics and Physics, said future precision sensing technology would exploit unusual effects of quantum mechanics.

"Our research showed a way to recycle atoms and reuse them in a device called an atom interferometer," Dr Szigeti said.

"This technique will vastly improve the performance of these devices, leading to improved sensing technology.

"An atom interferometer uses the quantum 'wave-like' nature of atoms in order to make very precise measurements of accelerations, rotations, and gravitational fields"

Dr Szigeti, who works within one of five nodes of the Australian Research Council Centre for Engineered Quantum Systems, said the devices would have applications on land and sea.

"They can be used in mineral exploration, allowing us to more easily locate mineral reserves underground, and in hydrology, allowing us to track the movement of water across the planet as we monitor the effects of climate change," he said.

"They'll also be important in navigation."

Dr Simon Haine, from the University of Sussex, said the development of precise atom interferometers had been hampered by an effect known as quantum noise, which was uncertainty in a quantum system signal.

"Quantum noise can be combatted with a property of quantum mechanics known as 'entanglement'," he said.

"Proof-of-principle experiments have recently shown how to generate entanglement within atom interferometers, and have used this to alleviate the effects of quantum noise.

"However, this comes at a cost, as in the process of creating entanglement, most of the atoms are wasted, which hinders the performance of these devices.

"Our project has found a way to harvest and recycle these atoms to improve the sensitivity of ultra-precise measurement devices."

More information: Stuart S. Szigeti et al. Pumped-Up SU(1,1) Interferometry, *Physical Review Letters* (2017). DOI: 10.1103/PhysRevLett.118.150401

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