Real-world applications for atom interferometric quantum sensors

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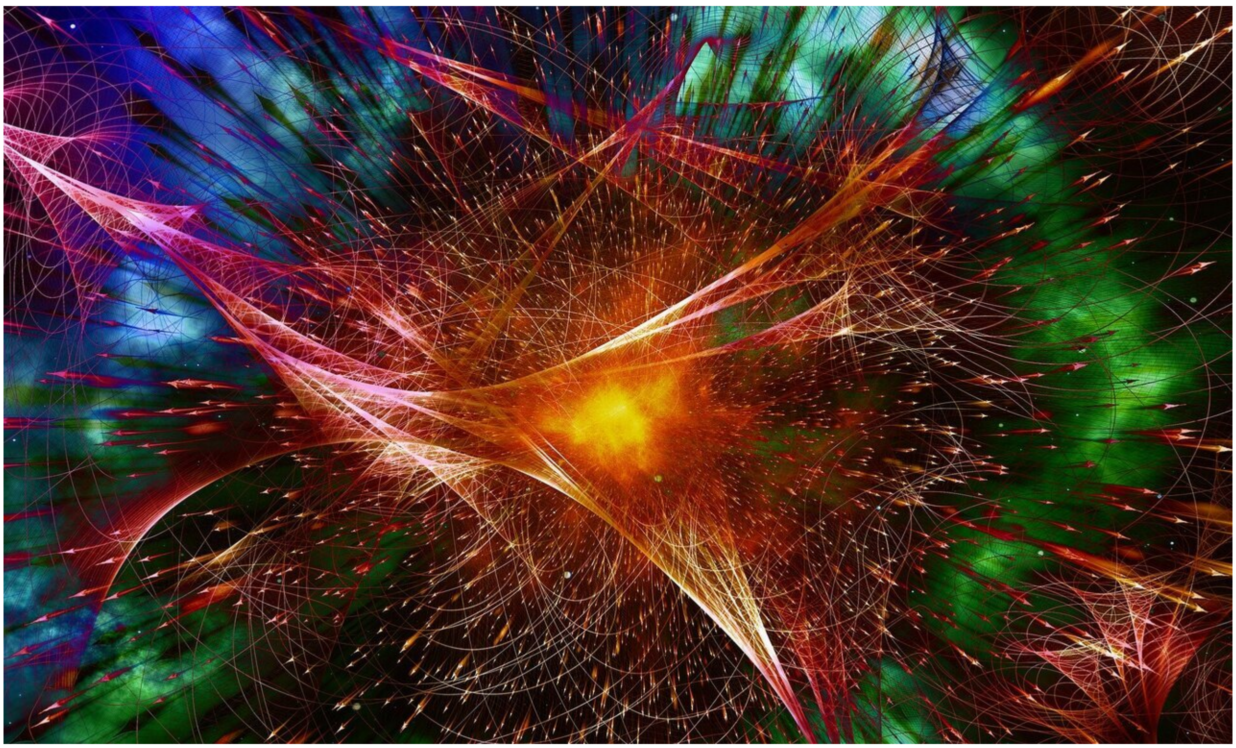

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Experts in quantum cold-atom sensors are delving deep underground in a new project aimed at harnessing quantum gravity sensing technology in harsh underground borehole environments.

The Gravity Delve project, funded by Innovate UK, brings together academics from the UK Quantum Technology Hub Sensors and Timing, which is led by the University of Birmingham and Nemein Ltd, with the aim of investigating the benefits and challenges associated with using quantum gravity sensors down boreholes.

Quantum gravity sensors based on atom interferometry are already being developed for use in the oil and gas sector. Quantum cold-atom sensors designed to operate on the surface will be able to detect and monitor objects beneath the ground better than any current technology. However, little attention has been paid to-date to the benefits that borehole deployable quantum gravity sensors could have. Gravity Delve aims to address this.

Nemein is developing borehole deployed equipment primarily focussed on energy harvesting and environmental sensing. The new technology will enable the quantum sensor developed by the University of Birmingham to venture out of the lab and into the extremely harsh downhole environment.

Dr. Jamie Vovrosh, of the University of Birmingham, is technical lead for the project. He says: "This project provides us with the opportunity to investigate using the extraordinary performance of quantum cold-atom sensors in new applications and to potentially open up a pathway towards realizing future economic and societal benefits."

Borehole applications to be investigated in the project will include carbon capture and storage (CCS), and hydrocarbon and geothermal reservoirs. Existing techniques for reservoir optimization include conventional microgravity, electrical and nuclear logging. These techniques however are limited by sensitivity, resolution and cost. Gravity Delve is investigating how a commercially relevant quantum device could replace or enhance current technology to optimize CCS reservoirs, minimize the environmental impact from hydrocarbon extraction, and enhance the transition from fossil fuels to renewable energy such as geothermal. The project will develop a design for an innovative borehole quantum cold-atom gravity sensor, as well as the associated harsh environmental packaging and ancillary equipment. This will lead to the first cost effective and efficient method deep borehole quantum sensor deployment.

This project will build upon the work already undertaken by the University of Birmingham in cold atom gravity sensors, which is reviewed in Nature Reviews Physics, authored by the University's academics and their collaborators. While gravity sensing is already used in a number of applications including oil and minerals prospecting, once developed atom interferometer-based technologies are expected to reduce the SWAP (size, weight and power), with improved sensitivity and faster measurement times.

Mr Lawrence Till, co-founder and technical director for Nemein, says, "Gravity Delve is not just a project which will optimize CCS and borehole energy extraction. It is very significant as a relatable project to show Quantum Technology can be deployed in some of the harshest environments in the real world and demonstrate tangible benefits to the environment."

More information: Kai Bongs et al. Taking atom interferometric quantum sensors from the laboratory to real-world applications, *Nature Reviews Physics* (2019). DOI: 10.1038/s42254-019-0117-4

Provided by University of Birmingham