Quantum-enhanced sensors for the gravity-quantum interface

We are looking for a post-graduate student to join the quantum information science group of Animesh Datta at the University of Warwick. The goal of this theoretical project will be to develop schemes for quantum-enhanced sensing of novel physics such as potential quantum fluctuations in space-time, collapse of massive quantum superpositions, and the quantum aspects of gravity more generally. Emphasis is to be placed on the experimental feasibility of these schemes in optical, mechanical, optomechanical or other platforms.

The student must be interested in a close interplay of quantum mechanics and gravity at low energies, quantum optics, and quantum information science

Background: The laws of quantum mechanics set the fundamental limit of precision sensing. Quantum metrology is the study and application of these fundamental limits. Quantum metrology, using ideas from quantum information science, is ushering in a new era of precision sensing. This includes the sensing of exquisitely small forces, phases, or displacements.

Project: This PhD project shall leverage recent advances such as the experimental signatures of the quantum aspects of gravity [1] and quantum fluctuations in space-time [2] to invent new routes for attacking open problems in fundamental physics. It will apply be applied to physical systems such as atomic, optical, and opto-mechanical interferometers, and their performance in the real world. Each one of these systems possesses features that make them ideal for specific open problems. For instance, quantum correlations in mechanical systems seem suitable for testing quantum aspects of gravity [1].

This project will also advance recent results from Warwick [2, 3] towards experimental systems that can be realized in the coming years [4]. The outcomes of this project will also have applications in designing the next generation of quantum-enhanced imaging, magnetometry, and time keeping.

A close interaction between theory and experimental systems will place the student in a uniquely beneficial position for a future in fundamental physics and the quantum technologies sector. The interaction with premier scientific projects (such as QINP) will provide the student with a privileged perspective on quantum sensing and metrology in a complementary setting, unavailable to any other in the UK or elsewhere.

For informal enquires, email Animesh Datta with a CV, explaining your excellence and suitability for the project.

1. Animesh Datta, Haixing Miao, Signatures of the quantum nature of gravity in the differential motion of two masses, Quantum Science and Technology **6**, 045014 (2021)
2. Sharmila Balamurugan, Sander Vermeulen, Animesh Datta, Extracting electromagnetic signatures of quantum space-time fluctuations, arXiv:2307.02204
3. Dominic Branford, Christos Gagatsos, Jai Grover, Alexander J. Hickey, Animesh Datta, Quantum enhanced estimation of diffusion, Phys. Rev. A, **100**, 022129 (2019)
4. Rainer Kaltenbaek *et al.*, MAQRO -- BPS 2023 Research Campaign Whitepaper, arXiv:2202.01535