Quantum-enhanced interferometry for new physics

We are looking for a post-graduate student to join the quantum information science group of Animesh Datta at the University of Warwick. The goals of this theoretical project will be to develop schemes for quantum-enhanced sensing of novel physics such as dark matter, emergent gravity, holographic noise, and the quantum aspects of gravity more generally. Particular emphasis is to be placed on the experimental feasibility of these schemes in interferometric setups on optical, mechanical, optomechanical or other platforms. Consequently, it will also develop methods of combating decoherence effects in these schemes, for instance by employing strategies from quantum error correction and quantum control.

The student must be interested in a close interplay of quantum metrology, quantum information science, quantum optics, and quantum mechanics.

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 the concepts and developments underlying these recent advances such as the experimental signatures of the quantum aspects of gravity [1] and multi-mode [2] quantum metrology to invent new routes for attacking open problems in fundamental physics. It will apply quantum metrology 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 between mechanical systems are ideal for testing the quantum aspects of gravity [1].

Another aim of this project is to advance recent results from Warwick [3] towards experimental systems that can be realized in the coming years. 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 market. The interaction with premier scientific projects will provide the student 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. Haixing Miao, Denis Martynov, Huan Yang, Animesh Datta, Quantum correlations of light mediated by gravity, Phys. Rev. A, **101**, 063804, (2020)
2. Dominic Branford, Haixing Miao, Animesh Datta, Fundamental Quantum Limits of Multicarrier Optomechanical Sensors, Phys. Rev. Lett. **121**, 110505 (2018)
3. Dominic Branford, Christos Gagatsos, Jai Grover, Alexander J. Hickey, Animesh Datta, Quantum enhanced estimation of diffusion, Phys. Rev. A, **100**, 022129 (2019)