Quantum light spectroscopy of complex quantum systems

We are looking for a post-graduate student to join the quantum information science group of Animesh Datta at the University of Warwick. The theoretical project will develop schemes for quantum-enhanced spectroscopy of complex quantum systems – that is, to exploit the tools of quantum metrology for precisely estimating parameters of quantum systems coupled to quantum and classical environments. Instances include the estimation of parameters such as energies, dipole moments, and coupling strengths of atoms and molecules placed in natural or artificial environments. Particular emphasis is to be placed on the experimental feasibility of these schemes.

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

Background: The laws of quantum mechanics set the fundamental limit of precision sensing. Quantum metrology is the study of these fundamental limits and designing experimental schemes of attaining them. It uses ideas from quantum information science and is ushering in a new era of precision sensing. This includes the sensing of exquisitely small energies, phases, or displacements.

Project: This PhD project shall leverage the concepts and developments underlying these recent advances such as quantum-enhanced spectroscopy [1] and microscopy [2]. It will apply quantum metrology to atomic and molecular systems, and their performance in the real world. Each one of these systems possesses features that make them ideal for specific open problems – such as atomic electric dipole moments in atoms.

Another aim of this project is to advance recent results from Warwick on quantum-enhanced nonlinear optical spectroscopy [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 spectroscopy and sensing [4].

A close interaction between theory and experimental systems will place the student in a uniquely beneficial position for a future in 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. Konstantin E. Dorfman, Frank Schlawin, Shaul Mukamel, Nonlinear optical signals and spectroscopy with quantum light, Rev. Mod. Phys. 88, 045008, (2016)
2. Evangelia Bisketzi, Dominic Branford, Animesh Datta, Quantum limits of localisation microscopy, New J. Phys. 21, 123036 (2019)
3. Evangelia Bisketzi, Animesh Datta, Quantum limits of estimating electric dipole moments, *In preparation*
4. Aiman Khan, Francesco Albarelli, Animesh Datta, Nonlinear optical spectroscopy with quantum light, *In preparation*