Solid-state cavity quantum electrodynamics

UCL Lead department: Physics & Astronomy

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Project Summary:

The maser was the microwave progenitor of the now ubiquitous laser but was hampered in its development by the need for cryogenic refrigeration and high vacuum systems. Despite this it found application in deep-space communications and radio astronomy due to its unparalleled low-noise when used as an amplifier. Furthermore, atomic maser oscillators are used as stable clocks for global positioning systems. UCL recently demonstrated a diamond maser – the first continuous-wave room-temperature solid-state maser using engineered quantum defects in synthetic diamond. These defects, known as nitrogen-vacancy (NV) centres can serve as solid-state quantum bits (qubits) for quantum information processing, quantum optics and quantum sensing. Diamond masers could find application in a diverse array of field, from magnetic resonance imaging, quantum sensing, quantum computing, communications, security and metrology.

You will be working in Dr Breeze's group at UCL and will be collaborating with groups in the UK, Germany, Italy and the USA. You will also work with our industrial partners Element-Six and Airbus Space.

The project will use experimental techniques such as pulse electron paramagnetic resonance (EPR), nuclear magnetic resonance (NMR) and optically detected magnetic resonance (ODMR) to characterise spin-defects in candidate materials and apply theoretical techniques from quantum optics and cavity quantum electrodynamics to describe their behaviour when coupled to microwave photons within state-of-the-art cavities. There is scope for exploring the application of masers in quantum information processing using the QUES^{2}T (Quantum Engineering with Solid-State Technologies) facility.

This project would suit someone with a good mix of experimental, theoretical and computational capabilities who enjoys building experiments and apparatus. Being proficient in Python programming is a must. An aptitude in electronics would be beneficial.