

2531cs1106

Quantum sensors for biological detection and imaging.

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ProjectID	2531cs1106
Project title	Quantum sensors for biological detection and imaging.
EPSRC theme	Healthcare Technologies
Principal supervisor name	Benjamin Miller
Principal supervisor UCL profile website	https://profiles.ucl.ac.uk/44209-benjamin-miller
Host faculty and host department	Mathematical and Physical Sciences (MAPS) London Centre for Nanotechnology (LCN)
Lead department website	https://www.ucl.ac.uk/mathematical-physical-sciences/london-nano
Department PGR administration email	t.mahjaben@ucl.ac.uk ; lucy.keepking@ucl.ac.uk
Standard or collaborative project	Standard project
Restrictions for candidates applying	Only Home fees candidates can apply

Project summary

Sensitive biological measurements are limited by optical background, nonspecific signals and difficulty multiplexing targets. The optically addressable quantum sensors used here are fluorescent probes whose emission depends on their spin state. Combining biofunctionalisation with spin initialisation and control can enable nanoparticle-hosted probes to detect biomolecules, measure molecular interactions and sense local biochemical environments. These biomedical applications exploit the spin-optical properties of these probes to transduce biological interactions into optical signals. Surface functionalisation, transduction methods, spin dynamics, sample environment, instrumentation and measurement determine performance.

This project aims to develop biological sensing and imaging methods by integrating optically addressable solid-state and molecular spin probes into bioassays. Building on our work using nanodiamonds containing nitrogen-vacancy spin defects for biomolecule detection with optical background suppression [1,2], we will investigate nanoparticle probes, including organic triplet [3,4] and singlet-fission materials [5]. Directions include multiplexed diagnostic assays, measurements of molecular binding, and cell fluorescence and super-resolution microscopy. This will involve biofunctionalisation, assay development, and development of transduction methods, instrumentation and measurement protocols, progressing from model systems to biological proof-of-concept, to clinical samples.

The student will gain expertise in optics, fluorescence microscopy, spin control, nanoparticle and biomolecular chemistry, assay development, computational modelling and data analysis, working at the intersection of physics, engineering, chemistry biology and clinical science.

The project will be aligned with the Quantum Biomedical Sensing (Q-BIOMED) Research Hub, a £24m cross-institution collaboration. This will provide opportunities to contribute through collaborative, interdisciplinary research, Hub training activities, and engagement with academic, clinical and industry partners to develop quantum sensors for biomedical applications.

1. Miller et al. Nature 587, 588–593 (2020).
2. Thomas DeCruz et al. Nature Communications 16, 8778 (2025).
3. Mann et al. JACS 147, 22911–22918 (2025).
4. Ishiwata et al. Science Advances 12, eaeb5422 (2026).
5. Grüne et al. Nature Communications 17, 777 (2026).