Quantum sensing and simulations using NV centres in diamond

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In the last decade, colour defects in diamond, like Nitrogen Vacancy centres (NVs), have been established as a robust platform for quantum sensing and quantum simulations. They allow optical access to the electronic spin and act as a nanoscale quantum sensor of magnetic fields at room temperature [1]. In our newly established lab, we are interested in utilising single NV centres in diamond in combination with nearby nuclear spins towards two main objectives. Firstly, to perform nanoscale sensing experiments on different surface modifiers using nanoscale Nuclear Magnetic Resonance (NMR) [2]. The precession of NMR active nuclei in an external magnetic field is detected by the NV sensors as an additional phase which can be extracted using Dynamical Decoupling (DD) MW pulse sequences applied to the NV spin. Secondly, to perform quantum simulations of thermodynamic [3] and many-body effects [4] in quantum systems. We aim to realise quantum thermal devices to manipulate energy transfer between interacting spins. To realise these devices, we plan to use a small cluster of nuclear spins that are coupled to a nearby single NV by hyperfine interaction.

[1] Zhou, Hengyun, et al. Physical review X 10.3 (2020): 031003.

[2] Pham, Linh M., et al. Physical Review B 93.4 (2016): 045425.

[3] S, Pal., et al. Physical Review A 100.4 (2019): 042119.

[4] Hernández-Gómez, Santiago, et al. New Journal of Physics 23.6 (2021): 065004.