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Programmable quantum simulators based on spins in diamond

Tim Taminiau

QuTech and Kavli Institute of Nanoscience, Delft University of Technology, the Netherlands

Abstract

Spins associated to optically active defects in diamond provide a versatile platform for quantum science and technology. In this talk, I will discuss our recent advances in realizing programmable quantum simulators based on individually controllable carbon-13 nuclear spins in diamond. I will present how one can use a single nitrogen-vacancy (NV) centre to sense, characterize and control a large number of spins in its environment [1,2,3]. By controlling the interactions between the spins it becomes possible to create a variety of many-body Hamiltonians with tunable parameters. As an example, I will discuss our investigation of a discrete-time crystal stabilized by many-body localization, a new out-of-equilibrium phase of matter [4].

[1] M. H. Abobeih et al., Nature 576, 411 (2019)
[2] C. E. Bradley et al., Phys. Rev. X. 9, 031045 (2019)
[3] M. J. Degen et al., Nature Commun. 12, 3470, 2021 (2021)
[4] J. Randall et al., arXiv:2107.00736 (2021)