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Detecting ferromagnetic dynamics using spinwave induced relaxation of NV spins in diamond[1]

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Nitrogen-Vacancy (NV) centers in diamond have emerged as a leading platform for an ultra-sensitive tool to study magnetic phenomena at the nanoscale. This is due to their atomic size and spin-sensitive fluorescence that enables sensitive transduction of magnetic signals into optical signals. Detection and spectroscopy of target spins or magnetization using the NV centers typically relies on resonant and pulsed manipulation of the NV spins. We have recently demonstrated a broadband modality for detecting ferromagnetic dynamics with NV-centers that uses a simple continuous wave protocol and does not rely on resonant manipulation of the NV spins themselves [1]. We found that the NV centers fluorescence responds to ferromagnetic dynamics at frequencies far from the NVs' intrinsic spin resonances. We investigated the mechanism for this surprising observation by measuring the effect of FMR excitation on the NV spin lifetime [2]. This study provides evidence that the decay and scattering of the driven FMR mode results in spinwaves that produce fluctuating dipolar fields at the NVs' resonance frequency and cause enhanced relaxation of the NV spins. We have measured ferromagnetic dynamics in diverse materials using this protocol [2] and have performed spectroscopy of various branches of magnetization dynamics [3]. This research could lead to a new method for studying relaxation processes in ferromagnets and extending this idea to scanned-probe sensing will offer a unique modality for nanoscale magnetic imaging. This work is done in collaboration with groups of P. C. Hammel, G. D. Fuchs and F. Y. Yang. [1] C. S. Wolfe, V. P. Bhallamudi, et. al., Phys. Rev. B 89, 180406(R), [2] M. R. Page et. al., arXiv:1607.07485 [cond-mat.mes-hall], [3] C. S. Wolfe et. al. Appl. Phys. Lett. 108, 232409 (2016)

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