The detailed microscopic origin of magnetism in many materials depend crucially on the relaxation mechanism of the spins. In typical material it is not controlled because of the lack of efficient tuning knobs and because of the very short damping, making a complete determination of the Gilbert-damping coefficients and dipolar interactions a complicated task. The interaction the electronic spins also play a role in similar spin-mechanical platforms at the quantum level. In this work we control both the interaction and the relaxation on a paramagnetic material (the doped-diamond).

Our work could be considered both as a bottom-up approach for the study of magnetic forces.

The exquisite sensitivity of the spin-torque read-out that we employ also enables high precision read-out of dipolar interactions. Our work may thus open a path towards using NV centers to probe microscopic effects in magnetism. And for applications in spin-mechacnis at the quanrtum lvel.