A quantum sensor made of spin defects in an atomically-thin van der Waals material

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The considerable and steady interest for van der Waals (vdW) materials had triggered the development of a new sensing platform based on a two-dimensional (2D) material [1]. Such 2D sensing unit would be perfectly suited to probe vdW materials and vdW heterostructures in addition to provide an unprecedented sensor-sample proximity.
The most studied system at this regard is the negatively-charged boron-vacancy (V_B^-) center in hexagonal boron nitride (hBN). The electronic spin state of this point defect can be initialized and readout by optical means under ambient condition [2], enabling *dc* magnetic field sensing through optically-detected magnetic resonance (ODMR) [3-5] as well as *ac*-sensing *via* T_1 and T_2 relaxometry [6,7]. However, after a first round of proof-of-principle experiments, working exclusively on thick hBN flakes or bulk samples, it is now crucial to ascertain the operability of this sensor down to the few atomic-layers limit.
Working with mono-isotopic hBN samples [8], we will start by demonstrate that V_B^- centers can be monitored even in atomically-thin hBN flakes. We will then investigate, in a more systematic way, how both the optical and spin properties of the defect are evolving when the thickness of the flake approaches the 2D limit [9,10].
As a main result we observe an unexpected behaviour of the spin relaxation times. While T_1 is significantly reduced in thin flakes, the spin echo coherence time T_2 seems to be preserved and can even be improved in thin films. These results are in strong contrast with previous studies on shallow NV^- centers in diamond for which coherence is notoriously deteriorated. This work highlights the potential of the flake thickness as a parameter to engineer the coherence properties of spin defect in vdW materials and is a first step toward sensing near surfaces and interfaces.

References

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Figures

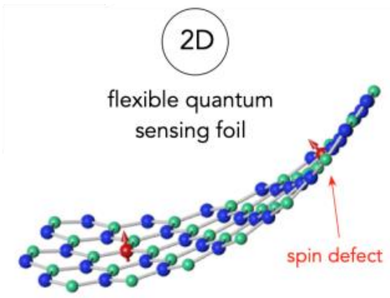

Figure 1: Illustration of V_B^- centers in an hexagonal boron nitride mono-layer.