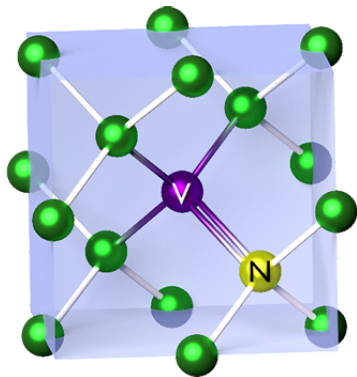


# Group meeting : Cross-relaxation with NV centers ensemble in diamond

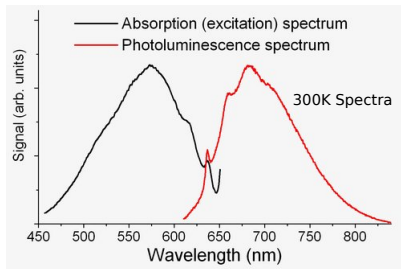
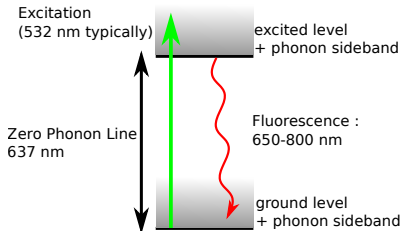
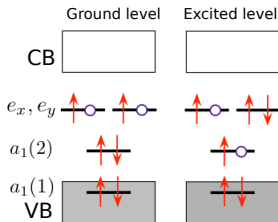
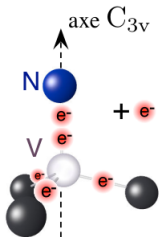
October 10, 2021

# The Nitrogen Vacancy Center

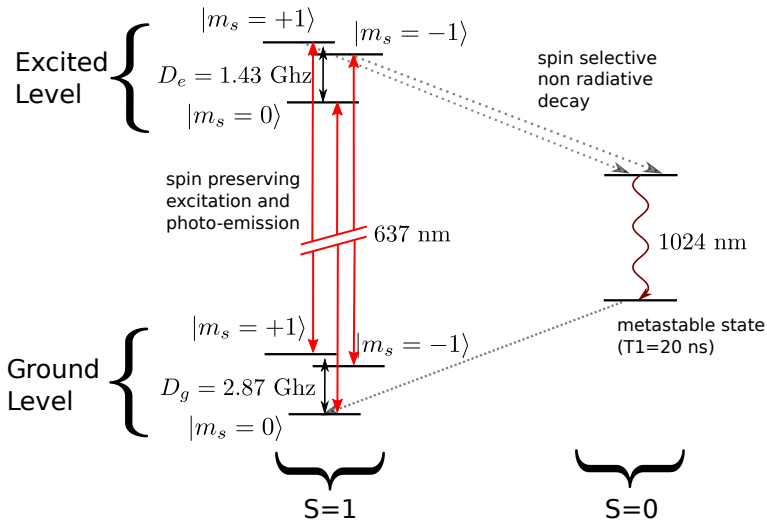


- 0D fluorescent object with ZPL at 638 nm
- Controllable and readable spin at room temperature (!)
- Working with  $10^9$  emitters (typ.)

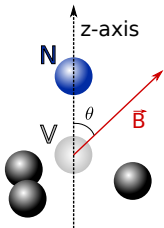
# NV center : Optical properties



# NV center : 8 levels



# NV center : 3 levels

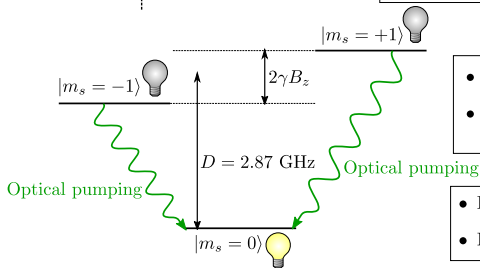


## Ground level spin Hamiltonian

$$\hat{\mathcal{H}}_s = DS_z^2 + \gamma_e \mathbf{B} \cdot \hat{\mathbf{S}}$$

$$D = 2.87 \text{ GHz and } \gamma_e = 2.8 \text{ MHz/G}$$

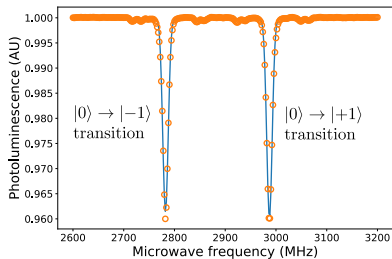
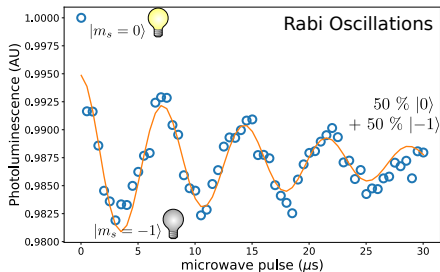
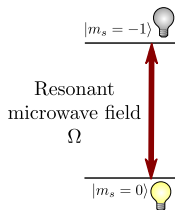
$$\mathcal{H}_s = \begin{pmatrix} D - \gamma_e B \cos \theta & \gamma_e B \sin \theta & 0 \\ \gamma_e B \sin \theta & 0 & \gamma_e B \sin \theta \\ 0 & \gamma_e B \sin \theta & D + \gamma_e B \cos \theta \end{pmatrix}$$



- $|0\rangle$  state brighter than  $|\pm 1\rangle$  state by  $\sim 30\%$
- polarization in  $|0\rangle$  state of  $\sim 80\%$  (equivalent to  $\sim 65 \mu\text{K}$ )

- Longitudinal lifetime  $T_1 \sim 5 \text{ ms}$  (phonons)
- Dephasing time  $T_2^* \sim 1 \mu\text{s}$  (magnetic noises)

# Spin manipulation

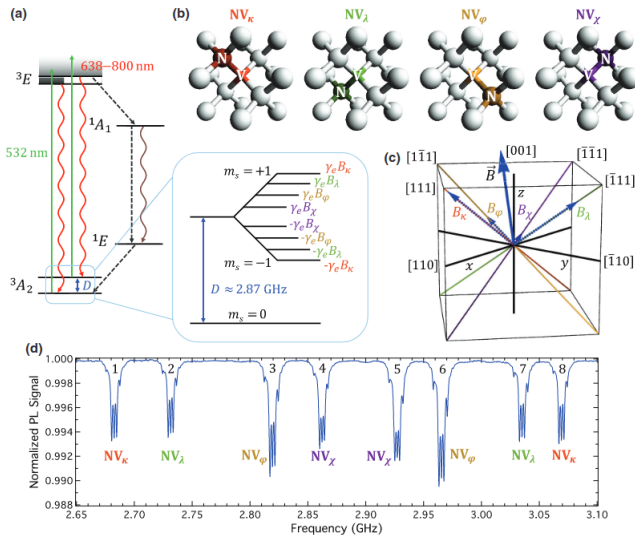


Optically Detected  
Magnetic Resonance  
(ODMR)

# Summary : Magnetometry with NV centers

SCHLOSS, BARRY, TURNER, and WALSWORTH

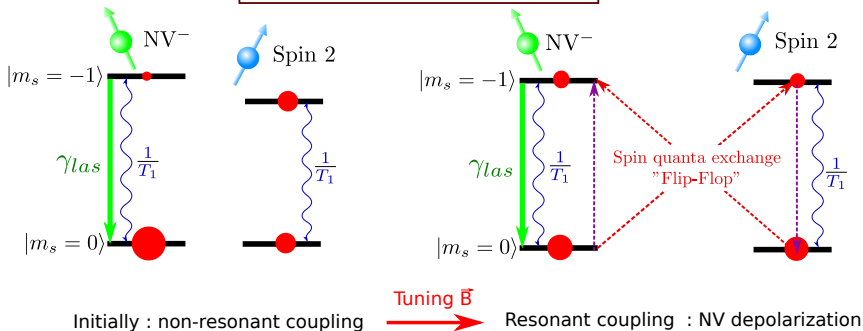
PHYS. REV. APPLIED **10**, 034044 (2018)



# Principle of spin cross-relaxation (CR)

Dipole-dipole coupling Hamiltonian :

$$\mathcal{H}_{dd} \approx -\frac{\mu_0}{4\pi r^3} \vec{\mu}_1 \cdot \vec{\mu}_2 \propto \frac{\hat{S}_1 \cdot \hat{S}_2}{r^3}$$





# Detection of dark spins in CVD sample

Optical detection of paramagnetic defects in diamond grown by chemical vapor deposition

C. Pellet-Mary, P. Huillery, M. Perdriat, A. Tallaire, and G. Hétet  
Phys. Rev. B **103**, L100411 – Published 24 March 2021

CVD sample from  
Alexandre Tallaire

