

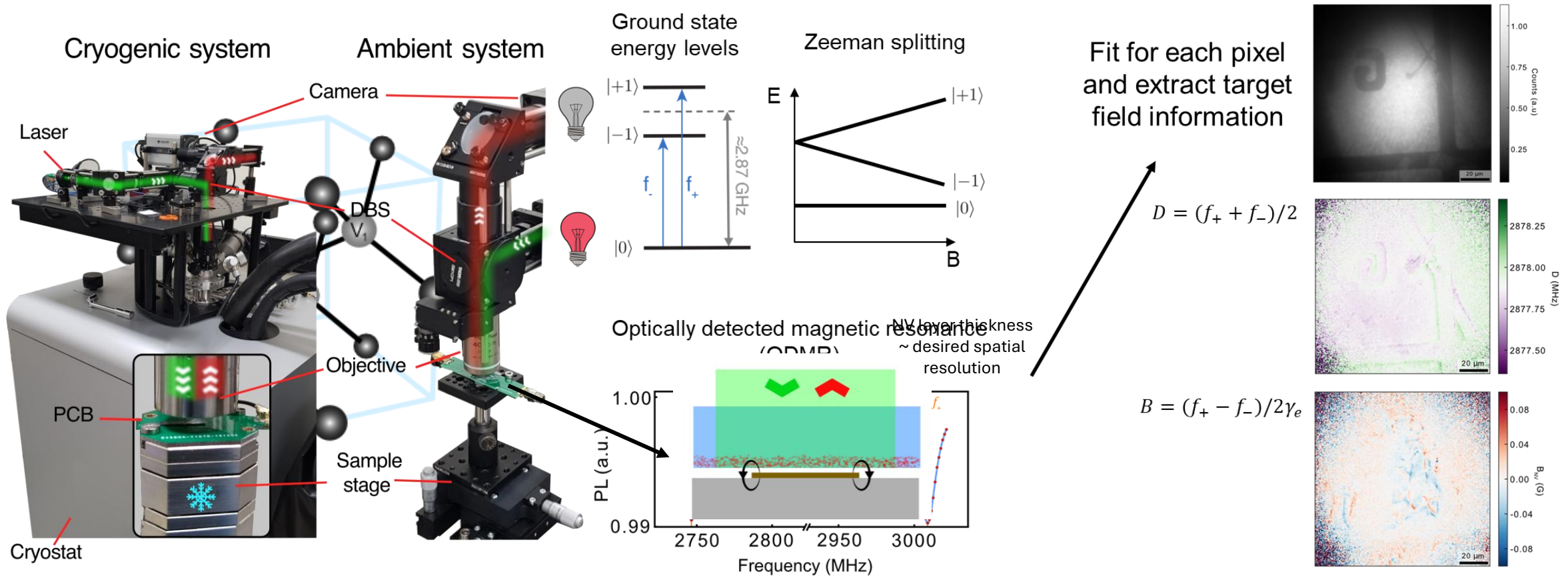
Quantum microscopy platforms for magnetic imaging

Alexander J Healey, RMIT University, Melbourne, Australia

With A/Prof. J-P Tetienne and Dr David Broadway

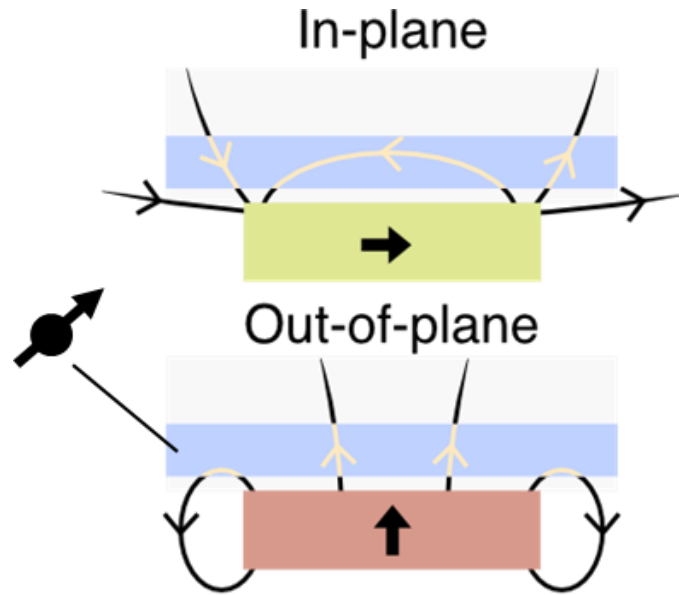


Widefield nitrogen-vacancy centre microscopy

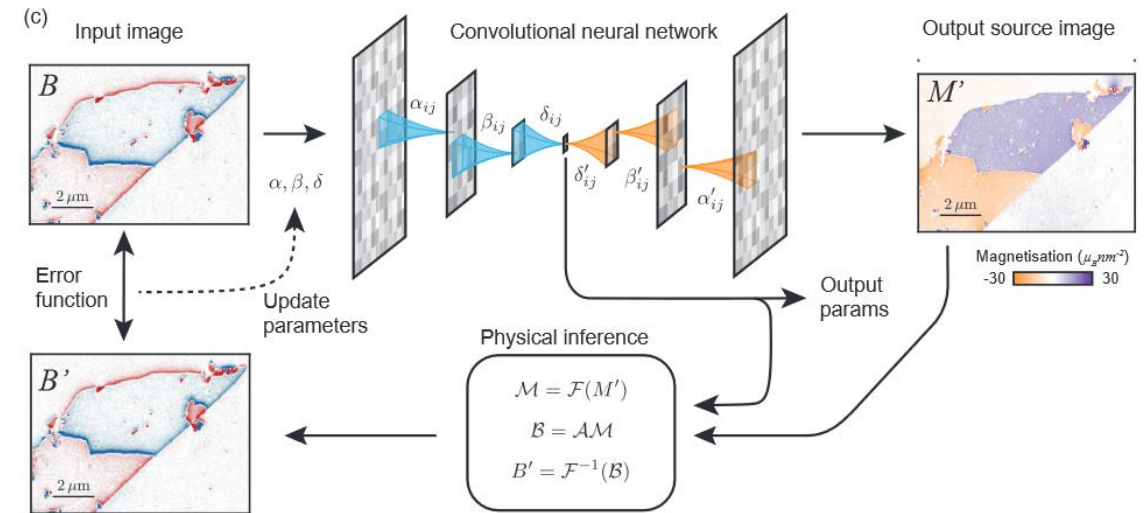
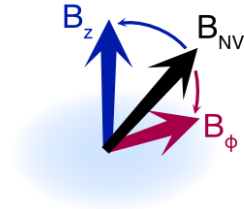


Perspective: Scholten, AJH, *et al.* J. Appl. Phys. **130**, 150902 (2021)

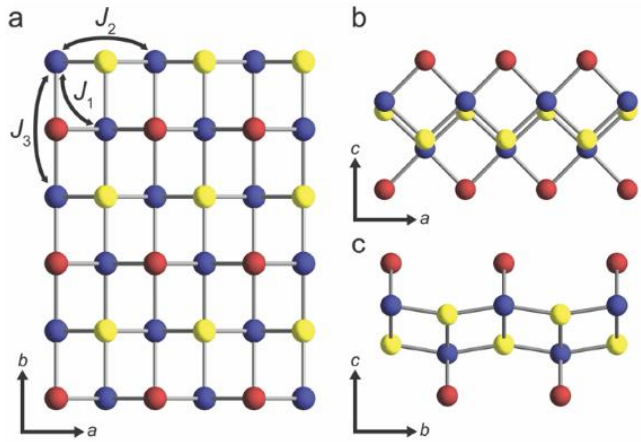
Vector mapping capabilities



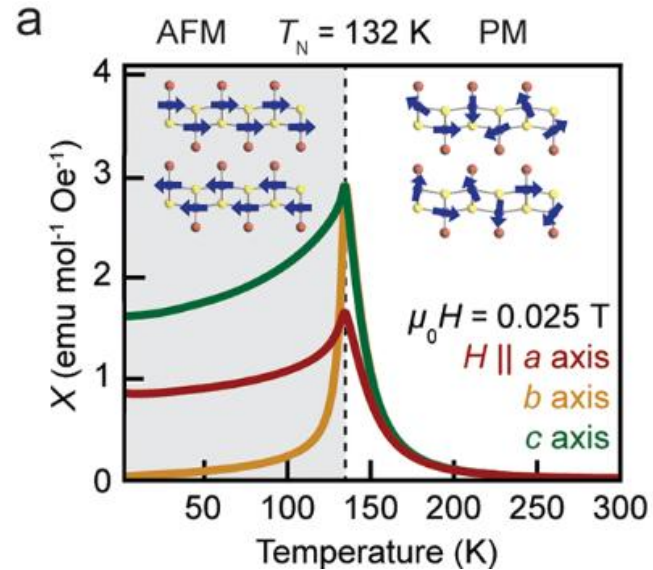
Fourier reconstruction

A. Dubois ... AJH et al., *Phys. Rev. Appl.* **18**, 064076 (2022)

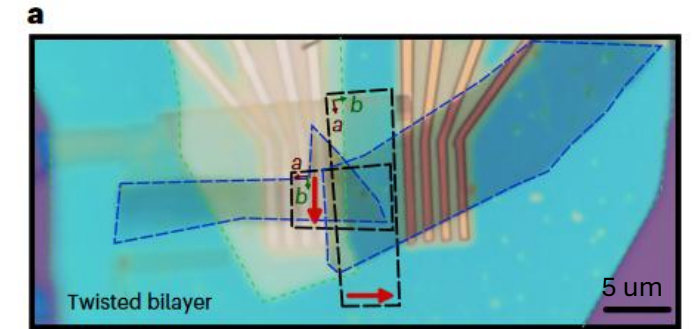
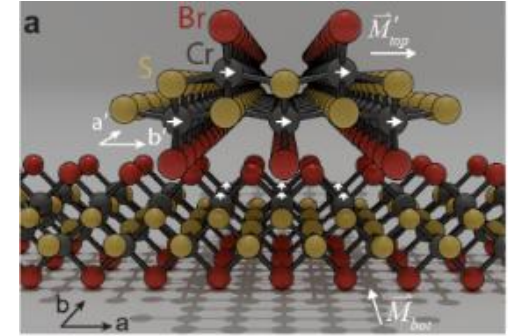
CrSBr



→ Air-stable van der Waals magnetic semiconductor



→ A-type antiferromagnetic order
→ Strong uniaxial anisotropy, $T_N \sim 132$ K

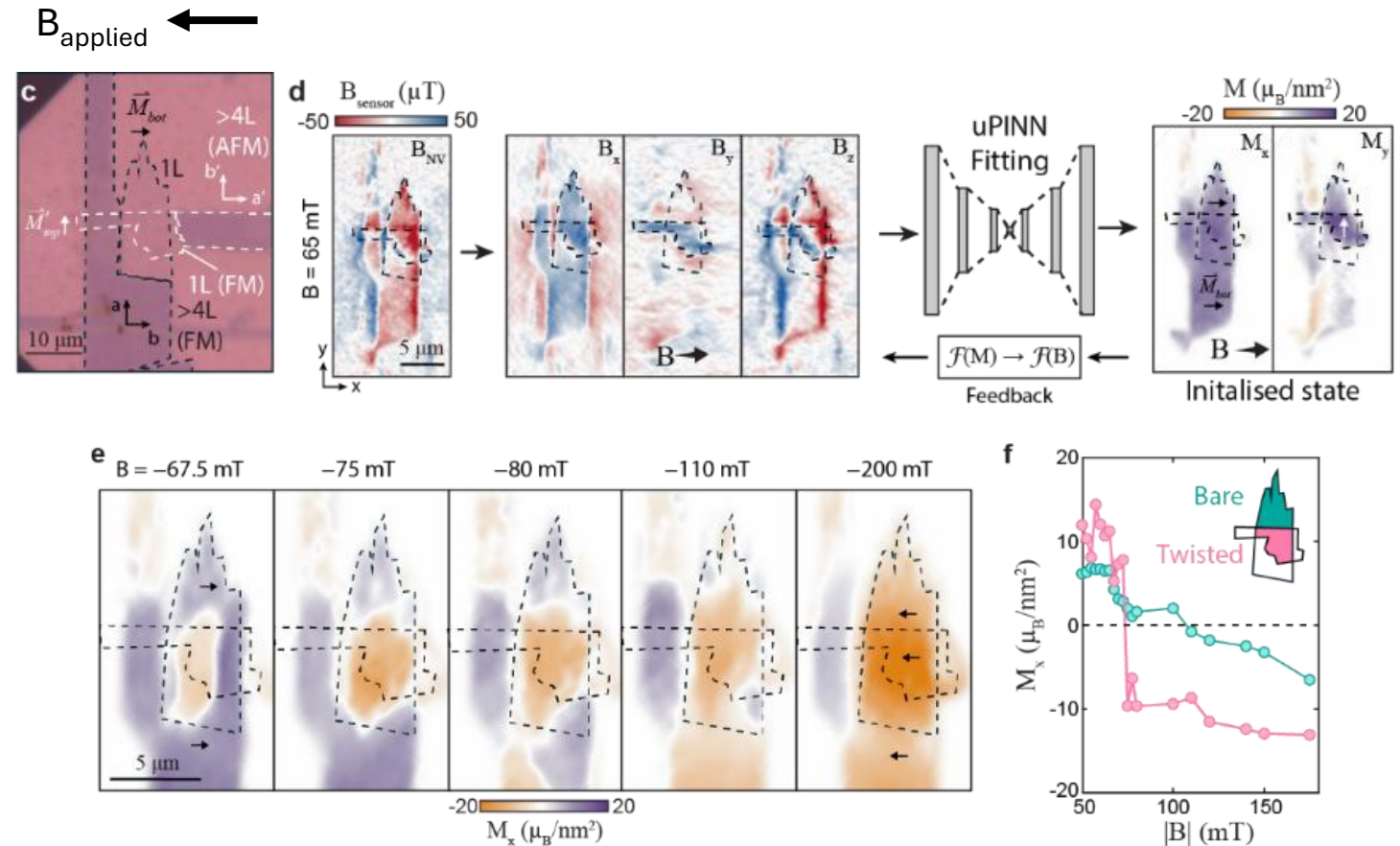
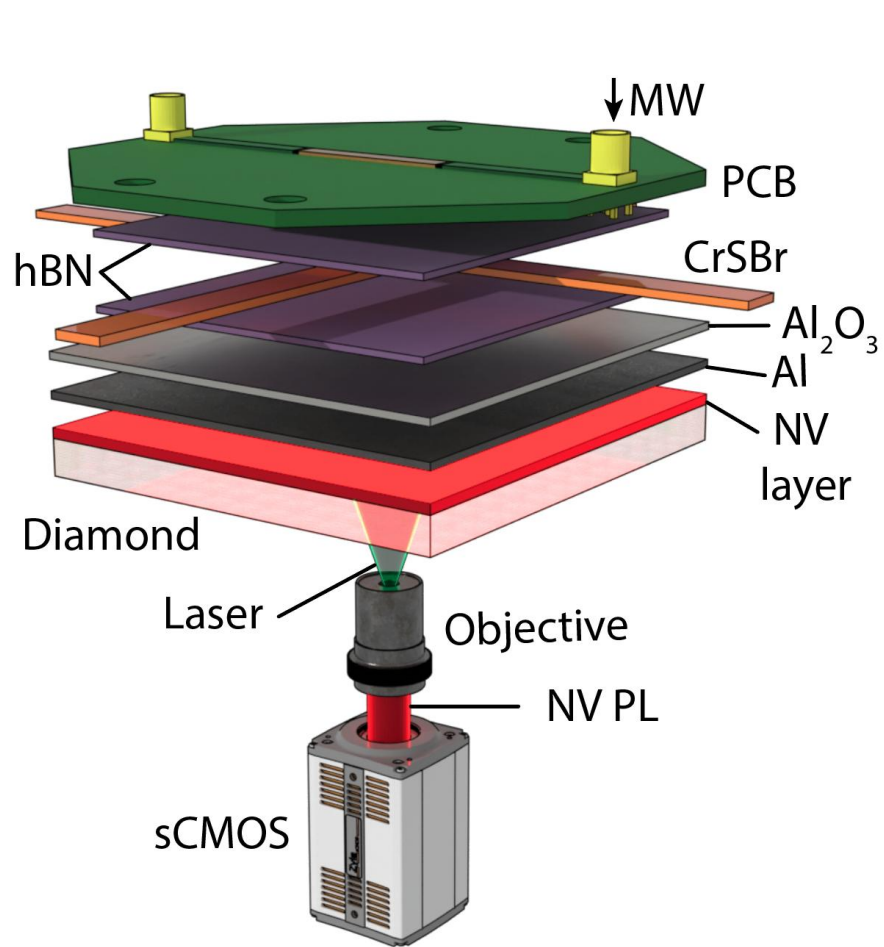


→ Suggestion of magnetic complexity in twisted stacks

Boix-Constant *et al.* Nat. Mater. 2023, Adv. Mater. 2025

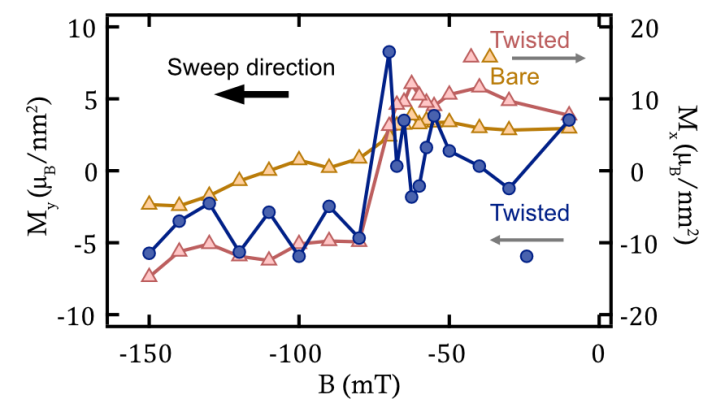
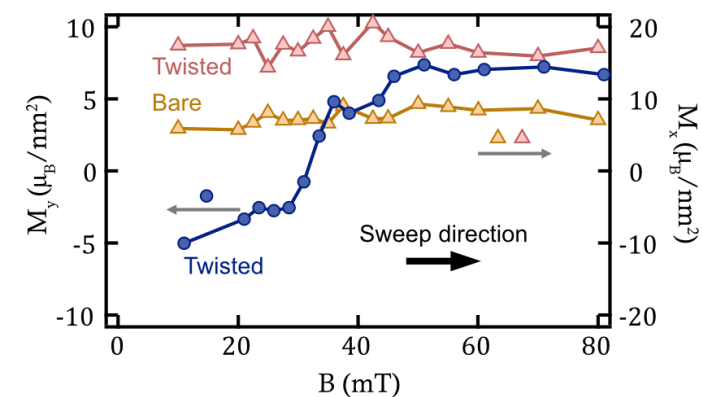
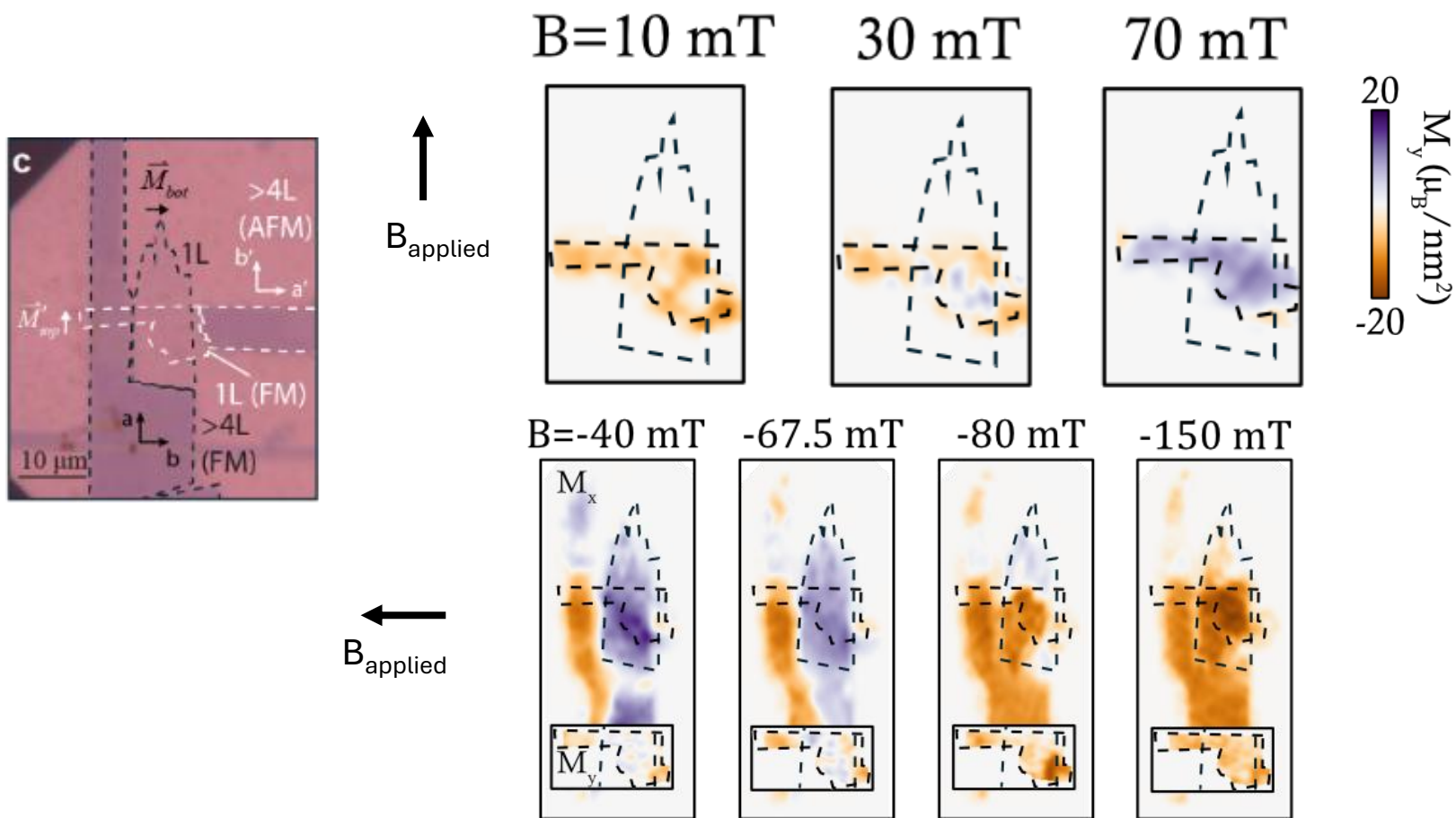
Review: M. Ziebel, *et al.* Nano Lett. 24, 4319-4329 (2024)

Imaging twisted bilayer switching behaviours

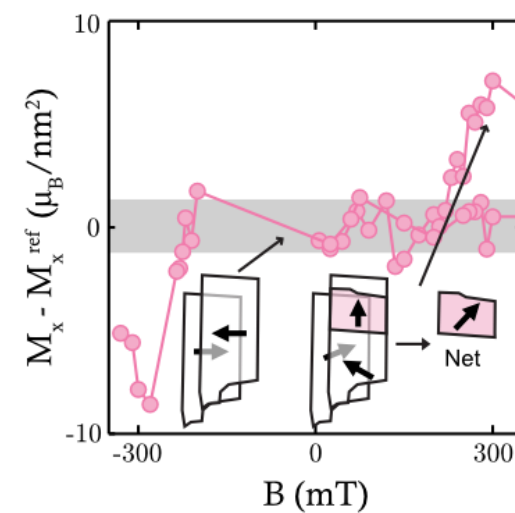
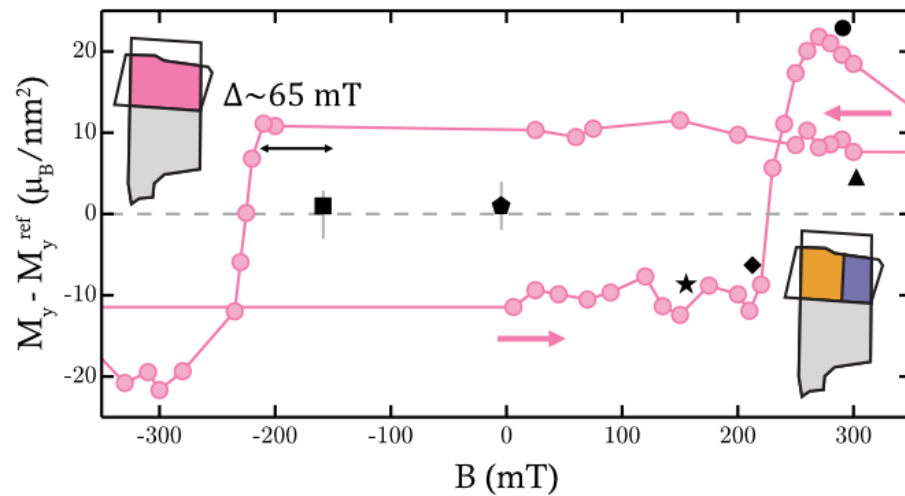
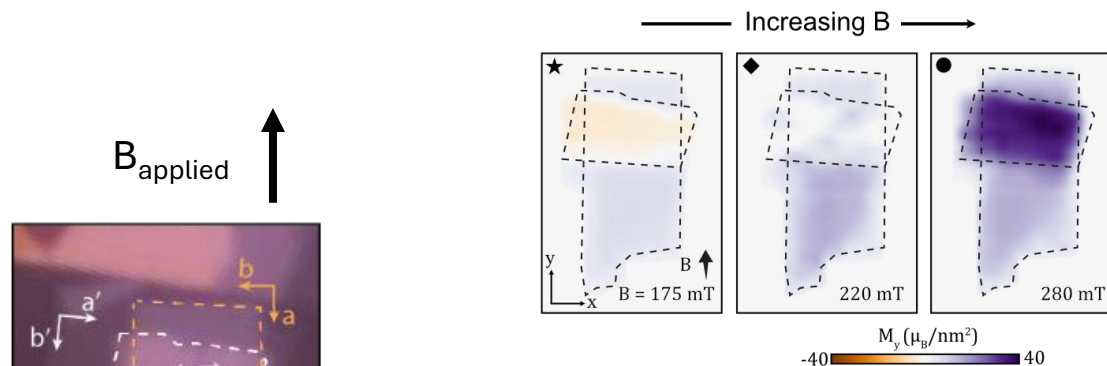


AJH *et al.* arXiv:2410.19209

Hint of coupling across twisted interface

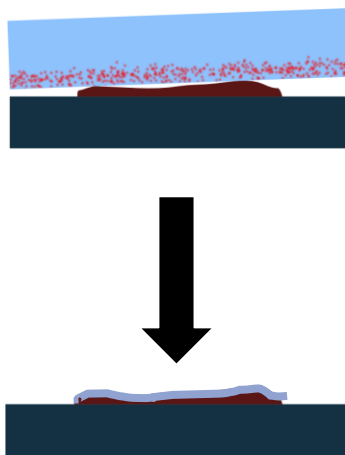


Trilayer switching



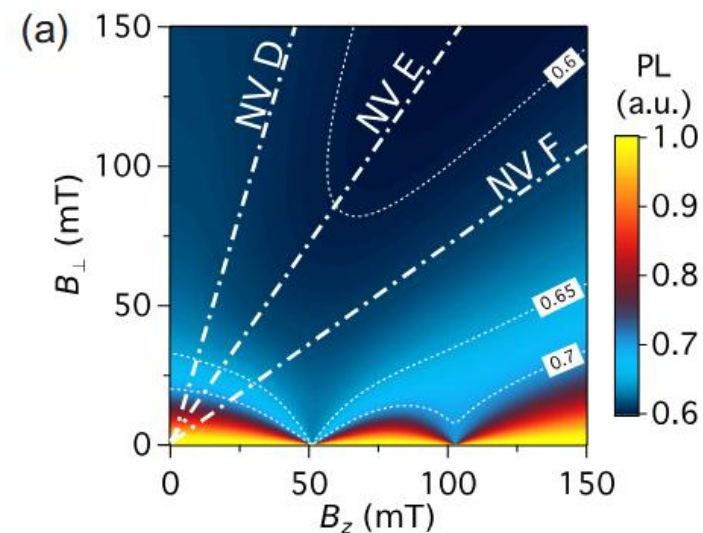
Limitations to NV-based sensing

Can be problematic to interface with bumpy topologies or more complex devices



Possible solution: image using spins in a vdW material instead

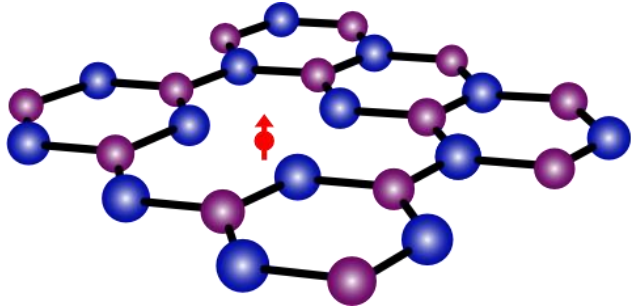
NV properties degrade in presence of strong off-axis fields



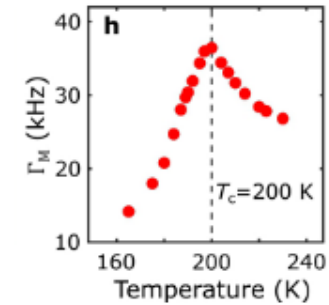
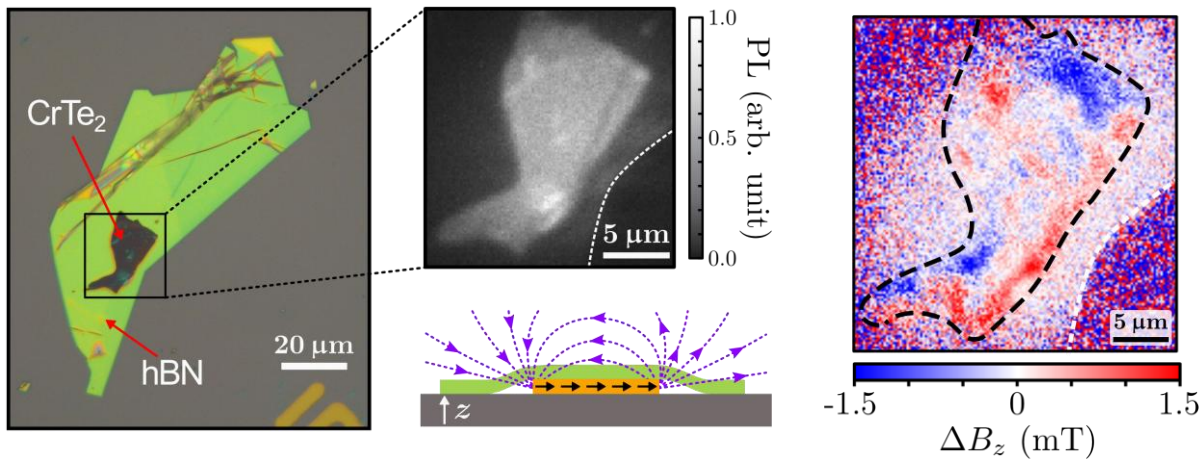
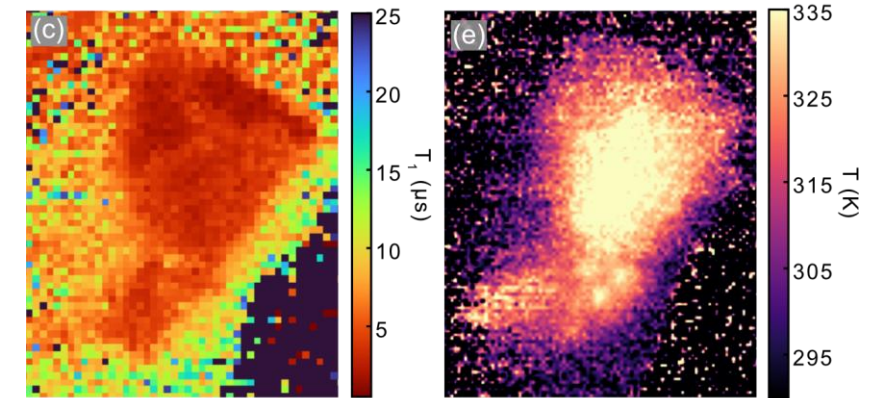
Tetienne et al. NJP 2012



Sensing with spins in hexagonal boron nitride



Negatively-charged boron vacancy centre – spin-1 NV analogue

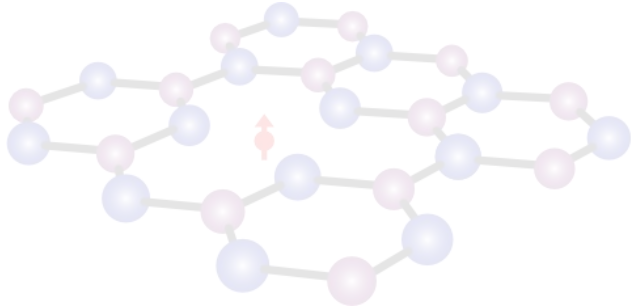


Huang *et al.* Nat. Comms. 2022

AJH & Scholten *et al.* Nat. Phys. 2022



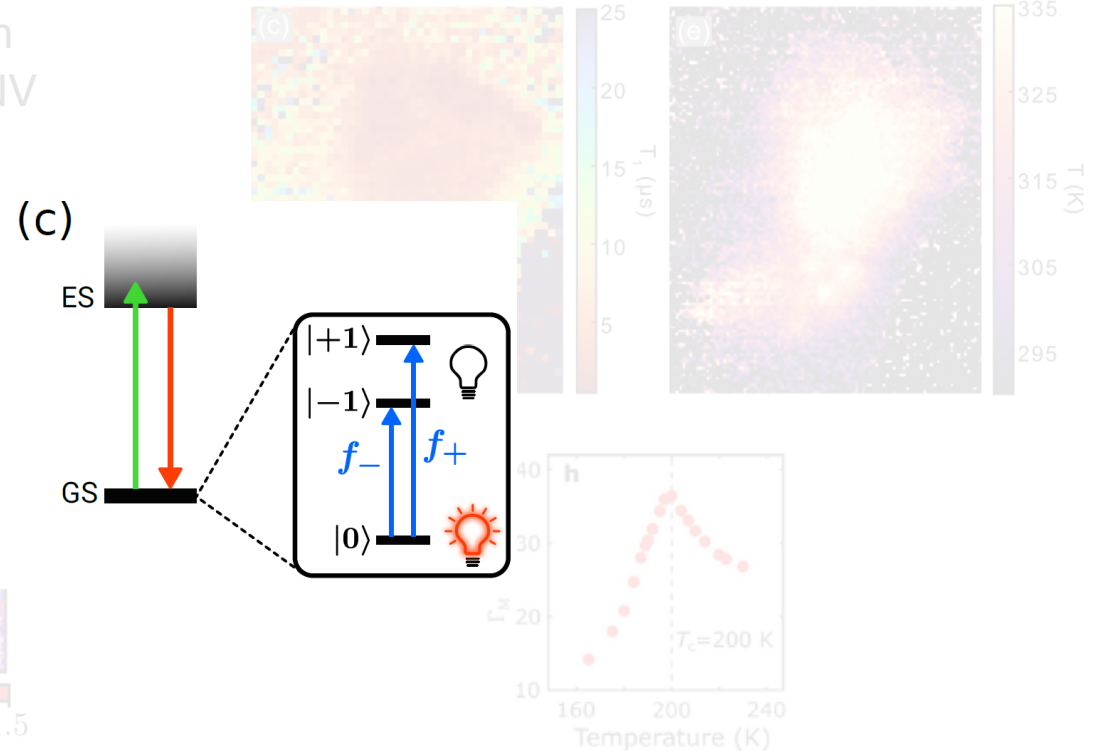
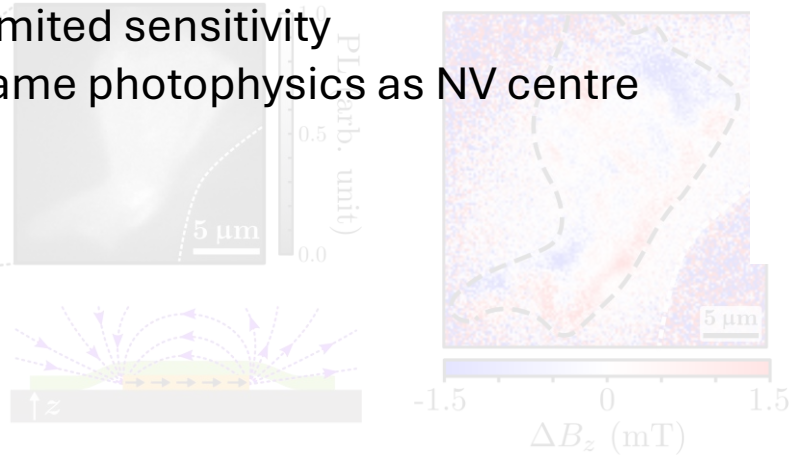
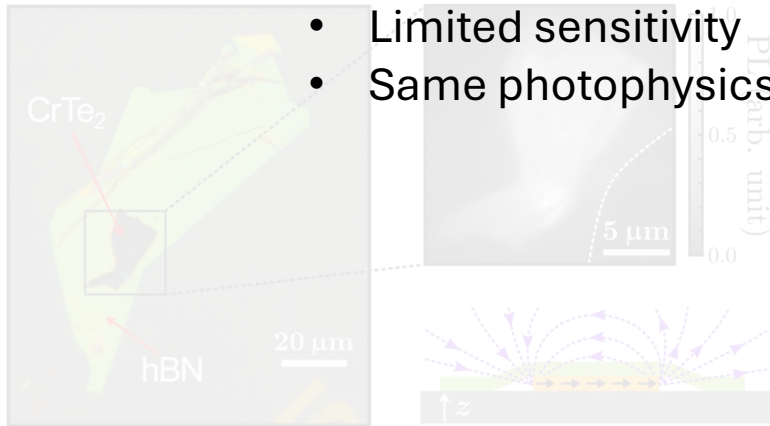
Sensing with spins in hexagonal boron nitride



Negatively-charged boron vacancy centre – spin-1 NV analogue

But:

- Limited sensitivity
- Same photophysics as NV centre

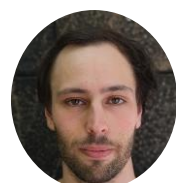


Huang *et al.* Nat. Comms. 2022

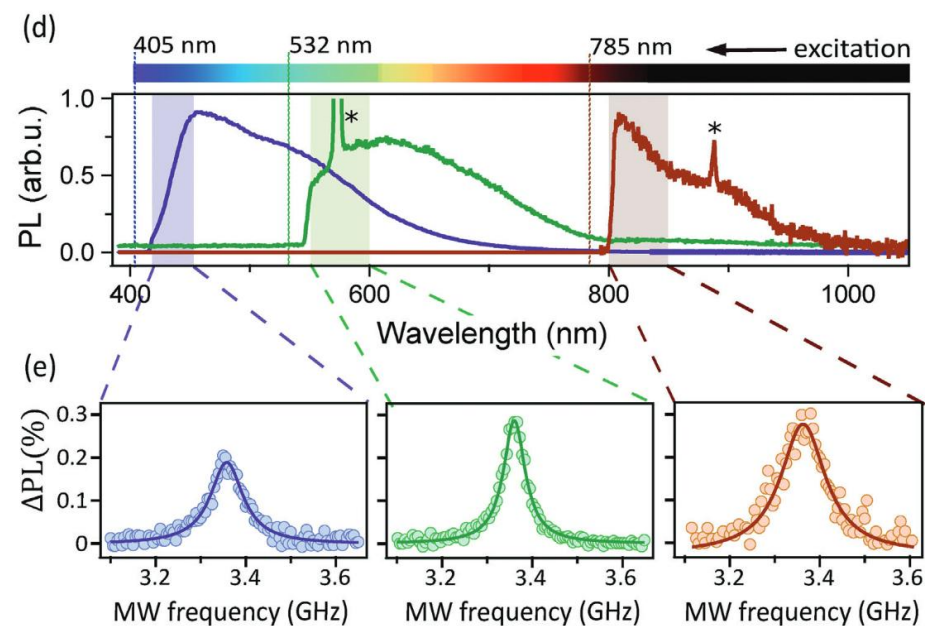
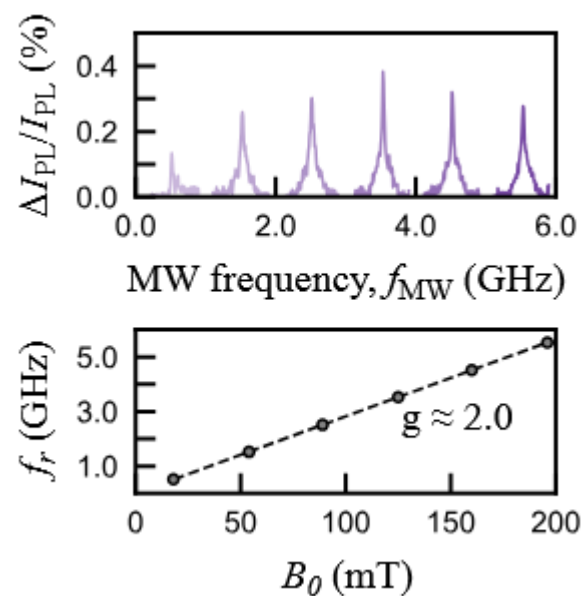
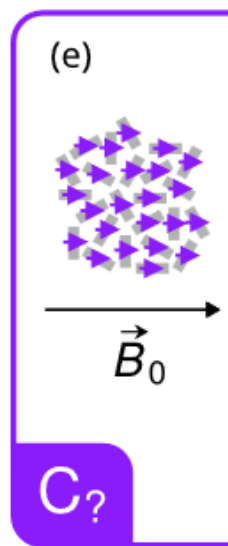
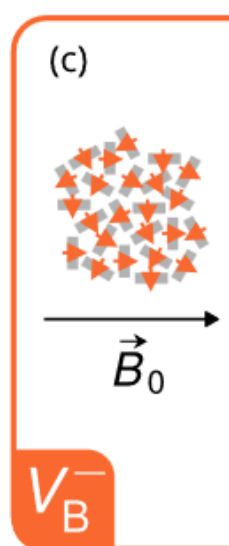
AJH & Scholten *et al.* Nat. Phys. 2022



Isotropic spin pair system



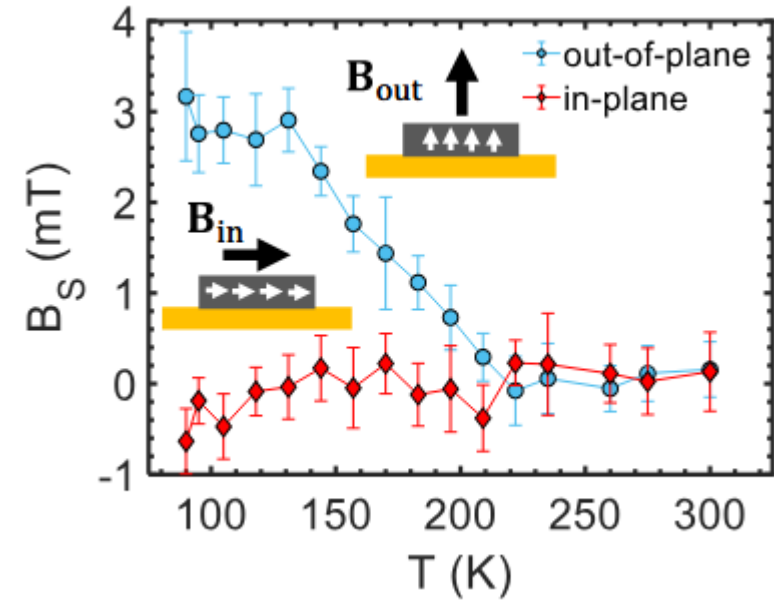
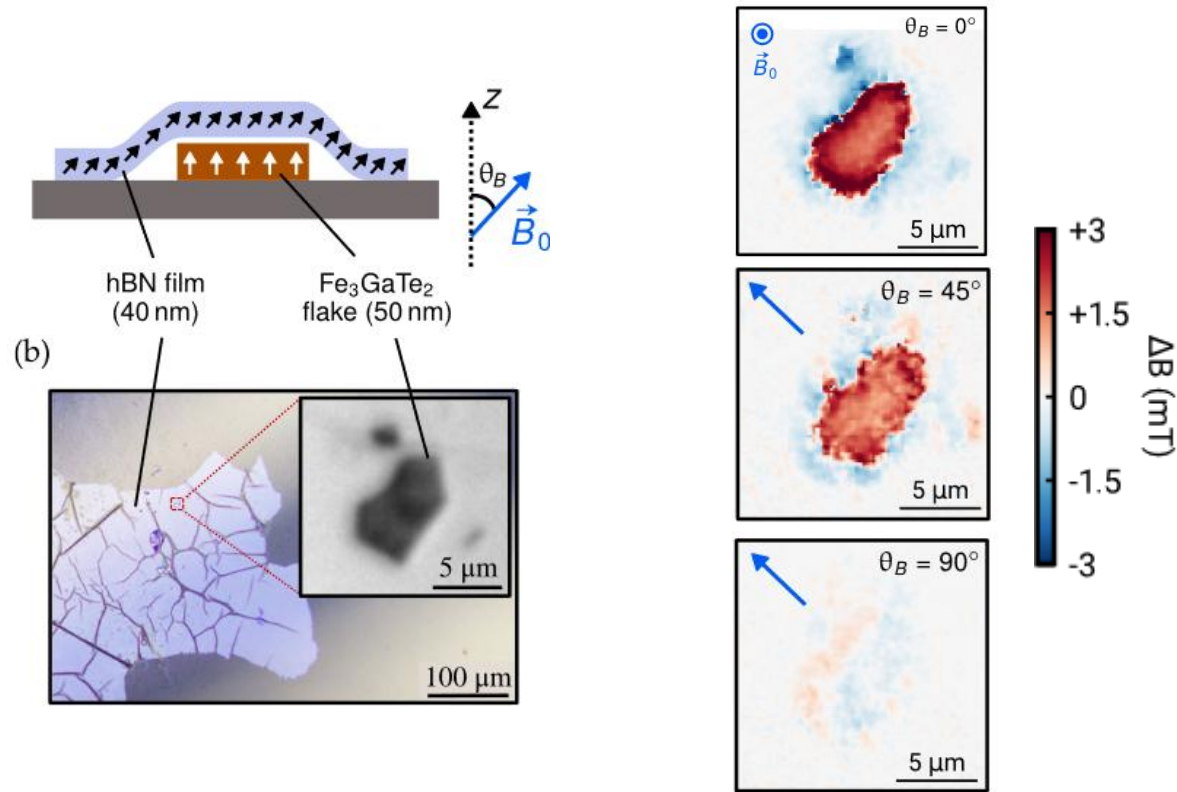
Dr Sam Scholten, Priya Singh, Islay Robertson



Scholten & Singh, AJH *et al.* Nat. Comms. 2024
Robertson, ... AJH *et al.* arXiv:2407.13148

Singh, ... AJH *et al.* Adv. Mater. 2025

Magnetic imaging with arbitrary field



Scholten & Singh, AJH *et al.* Nat. Comms. 2024

Gao *et al.* Nat. Comms. 2024

Acknowledgements

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