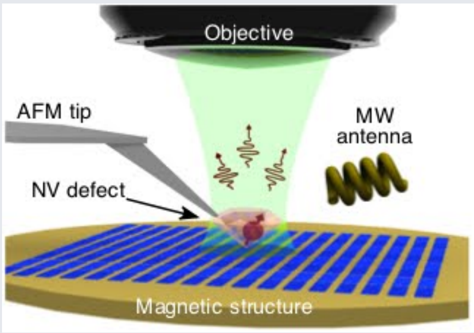
NV Scanning Probe Magnetometry

Jean-François Roch (LAC)

The ability to map magnetic field distributions with high sensitivity and nanoscale resolution is of crucial importance for fundamental studies ranging from material science to biology, as well as for the development of new applications in spintronics and quantum technologies. In that context, an ideal scanning probe magnetometer should provide quantitative magnetic field mapping at the nanoscale under ambient conditions. In addition, the magnetic sensor should not introduce a significant magnetic perturbation of the probed sample.

We follow a recently proposed approach to magnetic sensing based on optically detected electron spin resonance (ESR). It was shown that this method applied to a single nitrogen-vacancy (NV) defect in diamond provides an unprecedented combination of spatial resolution and magnetic sensitivity under ambient conditions. The principle of the measurement is similar to the one used in optical magnetometers based on the precession of spin-polarized atomic gases. The applied magnetic field is evaluated by measuring the Zeeman shifts of the NV defect spin sublevels.



More precisely, a diamond nanocrystal hosting a single NV defect is attached at the end of the tip of an atomic force microscope (AFM). A microscope objective placed on top of the AFM tip is used both for exciting and collecting the NV defect spin-dependent PL. Combining nano-positioning instrumentation and microwave excitation, the NV defect electron spin can then be used as a non-perturbing atomic-sized scanning probe magnetometer. If the probe spin is brought near a target, it will feel the presence of any local magnetic field emanating from the vicinity, causing a shift of the associated electron spin resonance, and thus providing a quantitative measurement of the magnetic field projection along the NV defect quantization axis. The spatial resolution of such magnetometers is fundamentally limited by the size of the NV center's electron spin wave function, which is in the Angström range.

Our group concentrates on developing such a scanning-NV magnetometer, with an emphasis on cryogenic environments, for applications in nanomagnetism and solid-state physics. T. J. Salez , B. Tao Huang, M. Rietjens, M. Bonetti, C. Wiertel-Gasquet,

Résultats obtenus dans le cadre du projet MAGIR financé par le thème émergence du LabEx PALM et porté Jean-François Roch (LAC)