Contribution ID: **81** Type: **Poster Only**

Probing Spin Defects via Single Spin Relaxometry

Spin defects in solid-state systems are powerful platforms for quantum sensing and quantum information storage due to their long coherence times and compatibility with scalable architectures. In this work, we present scanning probe microscopy utilizing the nitrogen vacancy (NV) center in diamond to locally detect and image spin-based quantum sensors at the nanoscale. Specifically, we study the negatively charged boron vacancy (V_B^-) center in hexagonal boron nitride (hBN), itself a promising two-dimensional quantum sensing platform. Rather than relying on the V_B^- center optical properties, we detect its spin transitions through their impact on the longitudinal spin relaxation time (T_1) of a nearby NV. Relying on cross-relaxation between NV and V_B^- spins, this indirect detection scheme circumvents the need for optical excitation or fluorescence collection from the hBN itself. When the NV and V_B^- spin transitions become resonant, the T_1 of the NV shortens significantly, allowing selective sensing of the local V_B^- density. We use this mechanism to spatially map the distribution of V_B^- centers with nanoscale resolution, well beyond the diffraction limit of optical imaging. In isotopically purified $h^{10}B^{15}N$, we further resolve hyperfine interactions, highlighting the sensitivity of the technique to fine spectral features. Our results showcase a hybrid sensing architecture in which 3D NV sensors serve as readout channels for 2D spin systems, opening new possibilities for characterization of optically inactive spin defects in layered materials.

Topical Area

Hard matter: quantum, electronic, semiconducting materials

Author: MELENDEZ, Alex (Center for Nanophase Materials Sciences, Oak Ridge National Laboratory)

Co-authors: GONG, Ruotian (Department of Physics, Washington University in St. Louis); HE, Guanghui (Department of Physics, Washington University in St. Louis); WANG, Yan (Computational Sciences and Engineering Division, Oak Ridge National Laboratory); WU, Yueh-Chun (Materials Science and Technology Division, Oak Ridge National Laboratory); POIRIER, Thomas (Tim Taylor Department of Chemical Engineering, Kansas State University); RANDOLPH, Steven (Center for Nanophase Materials Sciences, Oak Ridge National Laboratory); GHOSH, Sujoy (Center for Nanophase Materials Sciences, Oak Ridge National Laboratory); LIANG, Liangbo (Center for Nanophase Materials Sciences, Oak Ridge National Laboratory); JESSE, Stephen (Center for Nanophase Materials Sciences, Oak Ridge National Laboratory); LI, An-Ping (Center for Nanophase Materials Sciences, Oak Ridge National Laboratory); DAMRON, Joshua (Chemical Sciences Division, Oak Ridge National Laboratory); LAWRIE, Benjamin (Materials Science and Technology Division, Oak Ridge National Laboratory); EDGAR, James (Tim Taylor Department of Chemical Engineering, Kansas State University); VLASSIOUK, Ivan (Center for Nanophase Materials Sciences, Oak Ridge National Laboratory); ZU, Chong (Department of Physics, Washington University in St. Louis); ZHAO, Huan (Center for Nanophase Materials Sciences, Oak Ridge National Laboratory)

Presenter: MELENDEZ, Alex (Center for Nanophase Materials Sciences, Oak Ridge National Laboratory)