# Nebraska Center for Materials and Nanoscience

## 2019 Fall Seminar Series

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## Diamond Nitrogen Vacancy Centers for Quantum Sensing

Research in solid-state atomic defects seeks to merge atomic physics and condensed-matter nanotechnology to tackle outstanding problems in the physical and quantum information sciences. Isolated color centers hosted in defect-engineered, wide-bandgap semiconductors may offer the best of both worlds. In particular, the nitrogen vacancy center center (NVC) in diamond is a promising system due to its atomic-scale electron wavefunction, long-lived paramagnetic ground state, and spin-selective optical transitions even at room temperature. NVC is an attractive candidate for solid-state quantum sensing and nanoscale imaging. In this talk I will discuss recent experiments that explored several applications of NVC quantum sensing. These include: (i) microfluidic nuclear magnetic resonance spectrometer capable of sensing small quantities (<1 pL) of analyte [1], achieving spectral resolutions capable of distinguishing proton with heteronuclear J-splittings [2]; (ii) studying magnetization relaxation of individual magnetic nanoparticles (size < 25 nm), showing a variation of Néel relaxation times, explained by size variation (~5%) [3]. Finally, I will talk about current projects at UNL on using NVCs for mapping chiral spin textures, spin torque effect, and surface spin current in magnetic thin films, two dimensional magnetic materials, oxide heterostructures, and topological insulators. [1] Nature Communications 8, 108 (2017). [2] Science Advances 5 eaaw7895 (2019). [3] http://adsabs.harvard.edu/abs/2019APS..MARY41011L

Dr. Laraoui joined The Mechanical & Materials Engineering Department at the University of Nebraska-Lincoln in August 2019 as an Assistant professor within UNL new initiative in Quantum Materials and Technologies. Dr. Laraoui earned his PhD in Physics from University of Strasbourg -Louis Pasteur (France), where he developed a time resolved magneto-optical microscope to study the magnetization dynamics of magnetic nanomaterials excited with femtosecond laser pulses. Soon after his graduation, Dr. Laraoui received a Marie Curie fellowship from the European Research Training Network to carry a postdoctoral position at the University of Kaiserslautern (Germany). He used Brillouin Light Scattering Microscopy to study the spin current induced spin-wave emission in spin-torque nano-oscillators. After that, Dr. Laraoui joined CUNY-City College of New York as a research associate to work on a methodology to use the spin of NVC in diamond as a probe for high-resolution magnetic and temperature sensing. He worked on different research projects, including development of a novel approach for imaging thermal conductivity and temperature at the nanometer scale, introducing novel methods for hyperpolarizing nuclear spins at arbitrary magnetic fields, and implementing NVC-assisted magnetometry of paramagnetic centers in diamond nanocrystals and nuclear spins as quantum registers in CVD diamond. In September 2016, Dr. Laraoui joined Center for High Technology Materials at the University of New Mexico as a Research Assistant Professor. He used NVCs for quantum sensing and nanoscale magnetic bioimaging and his research was funded by NSF (DMR, CHE) and NIH.

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**October 16, 2019 | 4 p.m.**
**136 Jorgensen Hall**
Refreshments in 1st floor vending area at 3:45