PCSI
Room Ballroom South - Session PCSI-1TuM
Quantum Emitters and Excitations

Moderator: Javier García de Abajo, ICFO-Institut de Ciencies Fotoniques

8:30am **PCSI-1TuM-1 The NV Center in Diamond: A Versatile Quantum Technology***, **Ania Bleszynski Jayich,*** University of California, Santa Barbara*; A Jenkins, D Bluvstein, S Meynell, S Baumann, Z Zhang,* University of California, Santa Barbara **INVITED**

The nitrogen vacancy (NV) center in diamond is an atomic-scale defect that exhibits remarkably coherent quantum properties in a uniquely accessible way: at room temperature, in ambient conditions, and even immersed in biological environments. NV centers are being explored for a variety of quantum technologies, including quantum sensing and quantum information processing. In this talk, I introduce the physics and materials science behind the success of the NV center and I highlight some of the major achievements of NV-based quantum sensors, the most advanced of NV-based technologies. I present a versatile NV-based imaging platform where we have incorporated an NV center into a scanning probe microscope and used it to image vortices in superconductors [1], skyrmions in thin film magnetic multilayers, and conductivity on the nanoscale [2].

I also outline the challenges facing the widespread use of NV centers in quantum applications, including spin decoherence [3] and charge state instabilities near interfaces. Using the NV center as a quantum probe of its local environment, we have identified several of the microscopic mechanisms responsible for reduced quantum functionality of near-surface NV centers, thus guiding the ongoing development of quantum control techniques and materials design, pushing towards the ultimate goal of NV-based single nuclear spin imaging.

9:05am **PCSI-1TuM-8 Stark Tuning of Single Photon Emitters in Hexagonal Boron Nitride***, G Noh, D Choi,* Ajou University, Korea*; J Kim, D Im, Y Kim,* POSTECH, Korea*; H Seo, **Jieun Lee**,* Ajou University, Korea

Single photon emitters are fundamental resources of quantum optics and quantum information technologies. Recently, the emergence of single photon emission in atomic defects in hexagonal Boron Nitride (*h*-BN) at room temperature has evoked great interests in 2D-material-based single photon sources. For full exploitation of 2D single photon emitters for quantum technologies, however, the ability to control each atomic defect individually is critical. In this work, we show the electrical control of single photon emission in *h*-BN induced by an out-of-plane electric field [1]. This has been possible by fabricating a vertical heterostructure of *h*-BN containing atomic defects with graphene gates. A diverse spectral trail of Stark shifts is measured, providing information on defects' dipole transitions. The effect also persists at room temperature. We will also show possible ground states of defect structures that can induce the observed Stark shifts.

9:20am **PCSI-1TuM-11 Quantum Magnonics in V[TCNE]$_2$***, **Ezekiel Johnston-Halperin,*** The Ohio State University

The study of quantum coherent magnonic interactions relies implicitly on the ability to excite and exploit long lived spin wave excitations in a magnetic material. That requirement has led to the nearly universal reliance on yttrium iron garnet (YIG), which for half a century has reigned as the unchallenged leader in high-Q, low loss magnetic resonance, and more recently in the exploration of coherent quantum coupling between magnonic and spin [1] or superconducting [2] degrees of freedom. Surprisingly, the organic-based ferrimagnet vanadium tetracyanoethylene (V[TCNE]$_2$) has recently emerged as a compelling alternative to YIG. In contrast to other organic-based materials V[TCNE]$_2$ exhibits a Curie temperature of over 600 K with robust room temperature hysteresis with sharp switching to full saturation. Further, since V[TCNE]$_2$ is grown via chemical vapor deposition (CVD) at 50 C it can be conformally deposited as a thin film on a wide variety of substrates with Q rivaling the very best thin-film YIG devices [3], which must be grown epitaxially on GGG substrates at temperatures over 800 C. Work in preparation shows that this Q can be as high as 8,000 (linewidth of 0.50 Oe at 9.86 GHz). Here, we will present evidence of coherent magnonic excitations in V[TCNE]$_2$ thin films and nanostructures, pointing to magnon-magnon coupling that can be tuned into the strong coupling regime and spin-magnon coupling that allows for the transduction of quantum information from 0D to extended quantum states. These results demonstrate the remarkable potential for these structures to play a major role in the emerging field of quantum magnonics, with applications ranging from the creation of highly coherent magnon crystals to quantum sensing and information. This work is supported by DARPA/MTO MESO program and NSF Grant No. DMR-1507775 and EFRI NewLAW EFMA-1741666.

[1] P. Andrich, et al. NPJ Quantum Information 3, 28 (2017).

[2] Y. Tabuchi, et al. Science 349, 405 (2015).

[3] N. Zhu, et al. Applied Physics Letters 109, 082402 (2016).

Author Index

Bold page numbers indicate presenter