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Online Seminar

Quantum Information Hardware Based on Color Center Nanophotonics



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Color centers in wide band gap materials have been prominently studied for applications as quantum bits, quantum light sources, quantum sensors, and spin-photon interfaces [1]. Silicon carbide, in particular, has been an attractive host of color centers due their NIR single photon emission, long spin-coherence times, nonlinear optical properties, and commercial substrate availability. Integration of color centers with nanophotonic devices has been a challenging task, but significant progress has been made with demonstrations up to 120-fold resonant emission enhancement of emitters embedded in photonic crystal cavities [2].

In this talk, I will discuss new geometries for silicon carbide quantum device integration [3], including waveguides, photonic crystal cavities, and photonic crystal molecules which can be applied in quantum light generation, quantum repeaters, integrated quantum circuits, and quantum simulation. Using the parameters of the state-of-the-art color center-cavity systems, we explore the light and matter interaction using open quantum system modeling. By carefully including the inhomogeneous broadening in emitter frequencies into the Tavis-Cummings-Hubbard model, we explore multi-emitter interactions in coupled cavity arrays evaluating cavity-protection, localization and superfluid phase transition effects.

[1] V. A. Norman, S. Majety, Z. Wang, W. H. Casey, N. Curro, M. Radulaski, "Novel color center platforms enabling fundamental scientific discovery," *InfoMat*, 1-24 (2020).

[2] D. M. Lukin, C. Dory, M. A. Guidry, K. Y. Yang, S. D. Mishra, R. Trivedi, M. Radulaski, S. Sun, D. Vercruysee, G. H. Ahn, J. Vučković, "4H-Silicon-Carbide-on-Insulator for Integrated Quantum and Nonlinear Photonics," *Nature Photonics* 14, 330-334 (2020).

[3] S. Majety, V. A. Norman, L. Li, M. Bell, P. Saha, M. Radulaski, "Quantum photonics in triangular-cross-section nanodevices in silicon carbide," *J. Phys. Photonics* 3, 034008 (2021).