Quantum Optics with Semiconductor Double Quantum Dots

Y.-Y. Liu[a], X. Mi[a], J. Stehlik[a], J. V. Cady[a], D. M. Zajac[a], C. Eichler[a], T. Hartke[a], M. J. Gullans[b], J. M. Taylor[b], and **J. R. Petta**[a]

[a]Department of Physics, Princeton University, Princeton, New Jersey 08544, USA
[b]Joint Quantum Institute and Joint Center for Quantum Information and Computer Science, NIST and University of Maryland, College Park, Maryland 20742, USA

Cavity-coupled double quantum dots (DQDs) allow the investigation of non-equilibrium physics in strongly-driven quantum systems. I will describe recent experiments that examine light-matter interactions at the single particle level. The application of a source-drain bias across a DQD results in single electron tunneling and population inversion. The interdot tunneling process generates photons and leads to above-threshold maser action.[1] We also demonstrate a novel Sisyphus light source, where one and the same electron is repeatedly pushed uphill in energy, only to relax back to the ground state by emitting a photon.[2] Working towards coherent spin-photon interactions, we have recently demonstrated strong coupling of a single electron in silicon to a single microwave frequency photon.[3]

[1]Y.-Y. Liu, J. Stehlik, C. Eichler, M. J. Gullans, J. M. Taylor, J. R. Petta, Science **347**, 285 (2015).
[2]J. Stehlik, Y.-Y. Liu, C. Eichler, T. R. Hartke, X. Mi, M. J. Gullans, J. M. Taylor, and J. R. Petta, Phys. Rev. X **6**, 041027 (2016).
[3]X. Mi, J. V. Cady, D. M. Zajac, P. W. Deelman, J. R. Petta, Science **355**, 156 (2017).