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Probing light-matter interactions at the level of single photons and electrons[1]

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Pioneering experiments by Fujisawa *et al.* examined the detuning dependence of the current in semiconductor double quantum dots (DQDs) and highlighted the important role of electron-phonon coupling in inelastic transport.[1] Later experiments by the same group directly measured orbital relaxations rates, which were consistent with a phonon-mediated relaxation process.[2] By placing semiconductor DQDs inside of high quality factor microwave cavities it is now feasible to achieve charge-cavity coupling rates that are comparable to the phonon emission rate. I will describe recent experiments that examine masing in cavity-coupled semiconductor DQDs. The application of a source-drain bias results in single electron tunneling and population inversion. The interdot tunneling process generates photons and leads to gain in the cavity transmission. We measure the detuning dependence of the gain and find that the gain feature is very broad compared to the cavity linewidth. Recent theory accounts for the broad gain feature by considering a second-order process that involves the simultaneous emission of a cavity photon and a phonon.[3] With sufficient cavity driving, it is feasible to achieve above-threshold maser action, which is verified by comparing the statistics of the emitted microwave field above and below the maser threshold.[4]

References

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