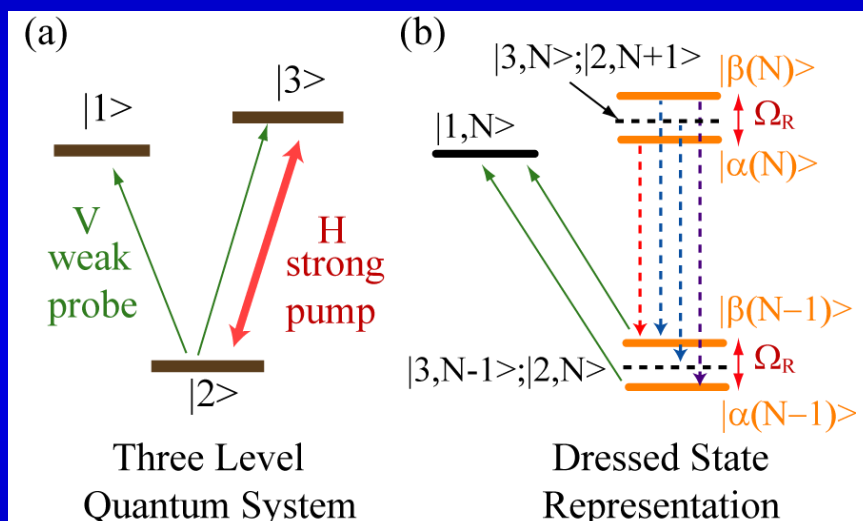


Optically Driven Quantum Dot Electrons for Quantum Computing: High speed switching by Rabi oscillations of Optically Driven Quantum Dots.

Xiaodong Wu, Lu Sham, Paul Berman, D.G. Steel
University of Michigan, UC-SD

In this work, experiments are aimed at exploring the feasibility and fundamental physics associated with using a single electron in a doped quantum dot, produced by the Coulomb blockade, as a spin qubit for quantum information processing. In theory, we have shown that networks of quantum dots coupled by an optically induced transient Heisenberg type interaction can be produced to yield a universal quantum gate.



Dressed State Picture

Mollow Absorption
Spectrum: New physics
and Gain without Inversion

Autler Townes Splitting

A partial energy level diagram for an InAs quantum dot is shown on the left. When a strong optical field (H) is on resonance and drives the $|2\rangle \rightarrow |3\rangle$ transition, the 2 states appear to split as shown on the right in the dressed atom picture that is used to predict the 3 peak fluorescence spectrum. Probing the $|2\rangle \rightarrow |1\rangle$ transition reveals the Autler-Townes splitting while probing the $|2\rangle \rightarrow |3\rangle$ transition reveals the Mollow absorption spectrum, shown in the next illustration. The absorption goes negative showing gain without inversion.

Center for the Advancement of Frontiers in Optical Coherent and Ultrafast Science
The University of Michigan and the University of Texas at Austin
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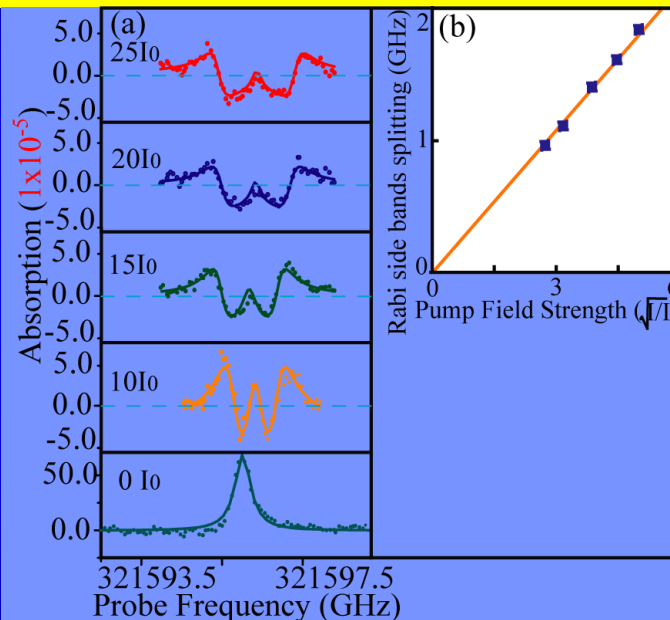
Optically Driven Quantum Dot Electrons for Quantum Computing :

Observation of the Mollow absorption spectrum in a single quantum dot corresponding to a Rabi oscillation frequency in excess of 1.4 GHz

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For quantum information storage, it is essential to be able to control the state of a qubit. Changing the state from a 0 to a 1 amounts to a Rabi oscillation in the time domain. In the frequency domain, this is observed as a splitting of the atomic transition by an amount determined by the Rabi frequency.

Driving the 1-photon dipole transition demonstrates the viability of self-assembled quantum dots for devices and is the first step toward demonstrating the two-photon Mollow spectrum of the spin system.



X. Xu, B. Sun, P. R. Berman, D.G. Steel, A. Bracker, D. Gammon, L. J. Sham, "Coherent optical spectroscopy of a strongly driven quantum dot," *Science*, 317 p 929 (2007).

Driving an electronic transition on resonance with a strong optical field leads to a splitting of the energy levels. We probe this with a weak field coupling between the driven transition. The result is the Mollow absorption spectrum that goes negative on each side of line center showing gain without inversion.

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