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SAND2016-1823C

Magneto-transport studies of a few hole p-GaAs double quantum dot in tilted magnetic fields

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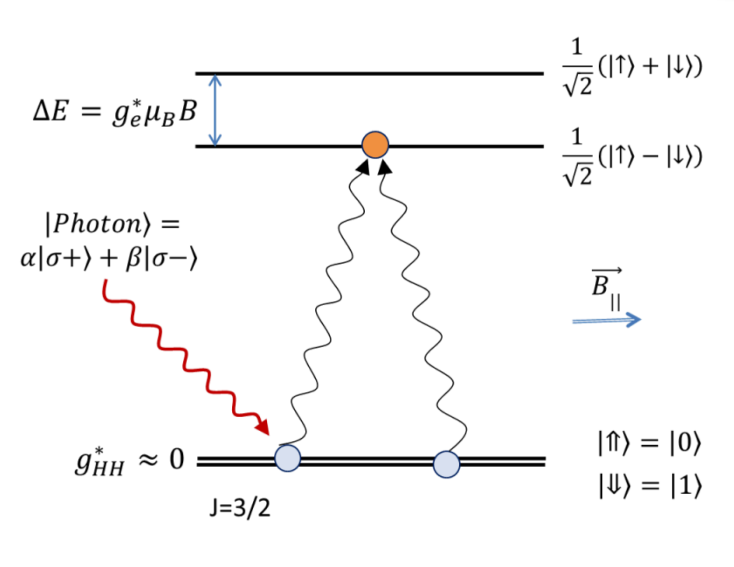
Motivations: p-Type Dots Are Promising as Spin/Photon Interfaces

- Holes have reduced hyperfine interaction compared to electrons => longer spin coherence times
- *Heavy hole g*-factor can be tuned in-situ (required for hybridization protocols)*
- *GaAs features direct band gap (unlike Silicon - requirement for hybridization with photons).*

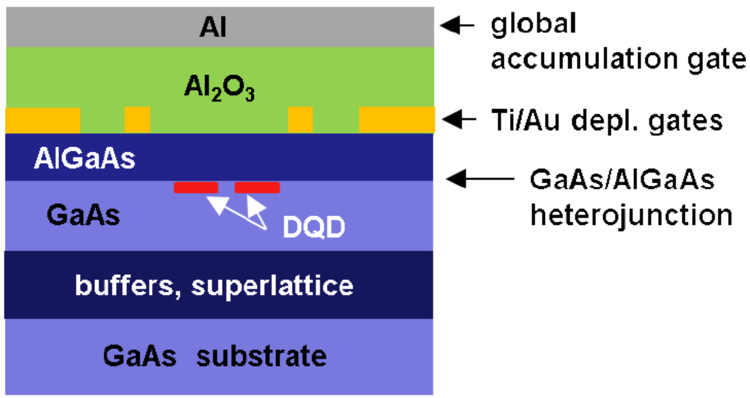


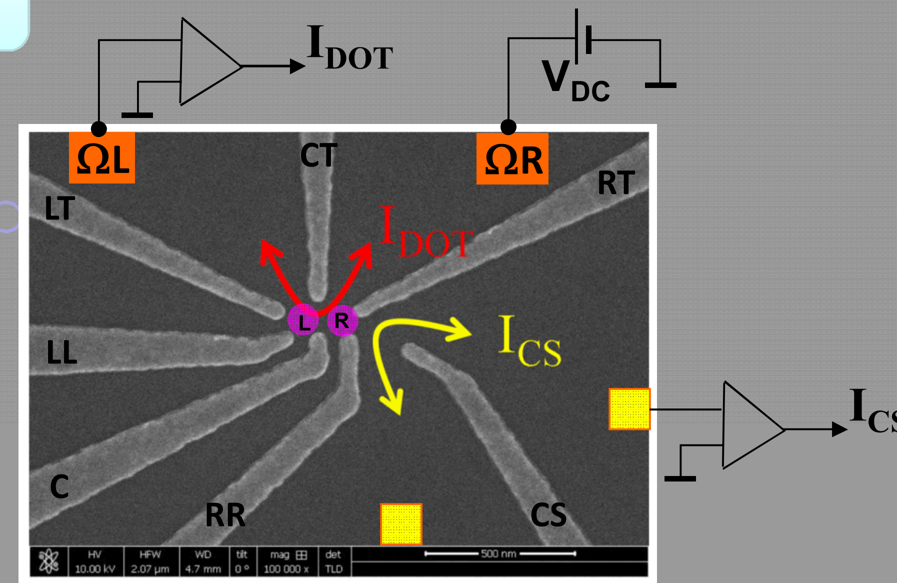
Quantum information transfer from a flying qubit to hole spin qubit

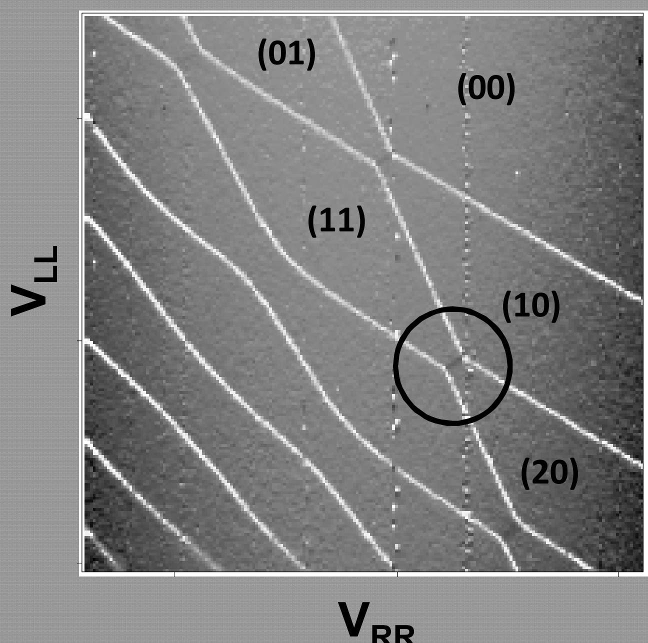
First proposal for electrons with g*≈0:
E. Yablonovitch, et. al, *"Optoelectronic quantum telecommunications based on spins in semiconductors," Proc. IEEE,* ***v. 91,*** *761-780 (2003).*

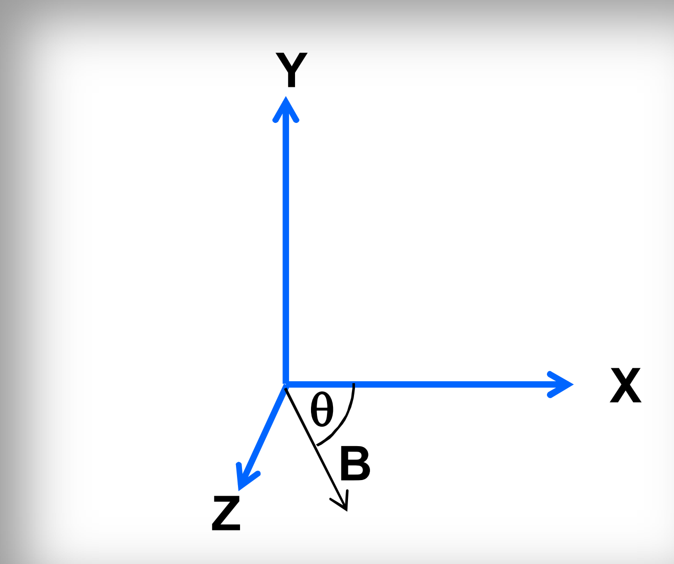
The p- Double Quantum Dot Device

L. A. Tracy, et al. *"Few-hole double quantum dot in an undoped GaAs/AlGaAs heterostructure," **APL, v. 104**, 123101 (2014).*



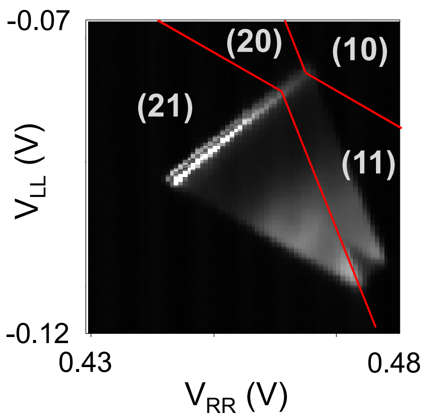




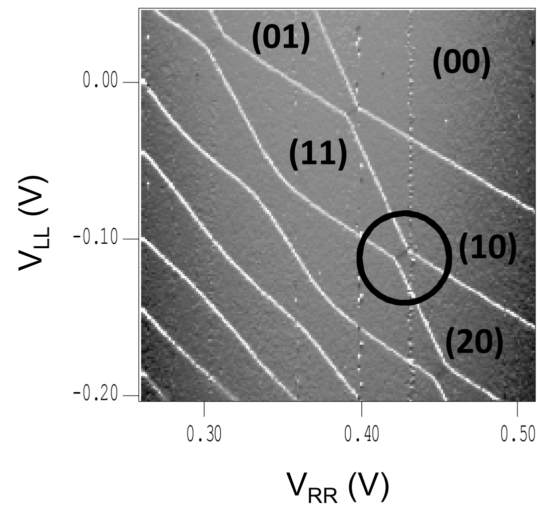


High-Bias Hole Transport in (20)-(11) Regime

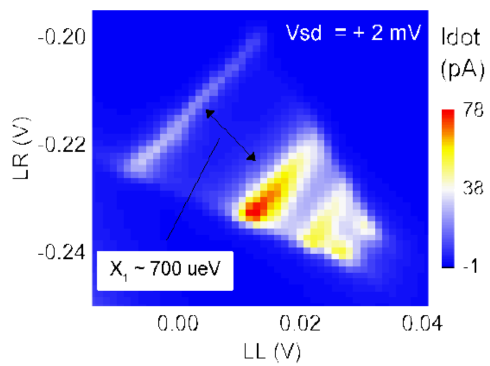
Transport Current (I_{DOT})



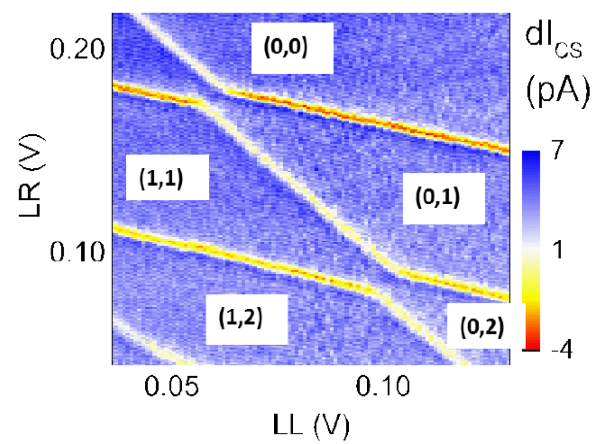
Charge Sensor Current (dI_{CS})



← **NRC** →

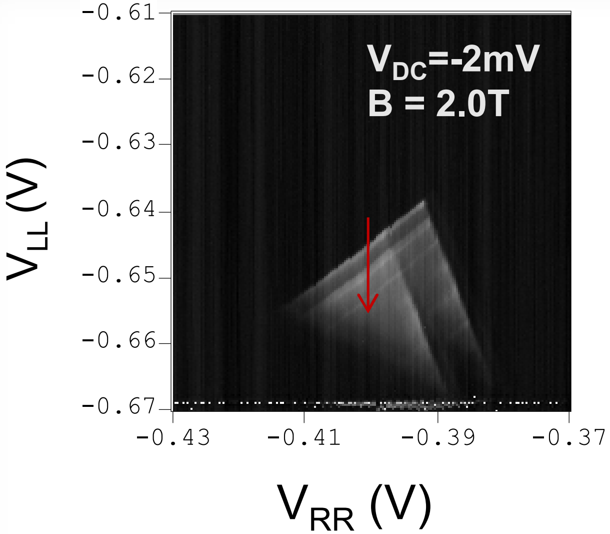


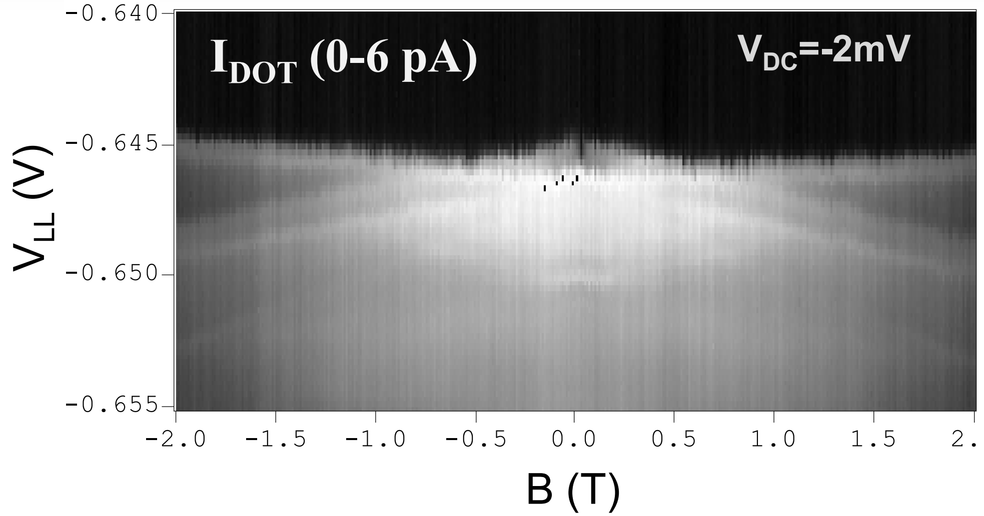
← **Sandia** →

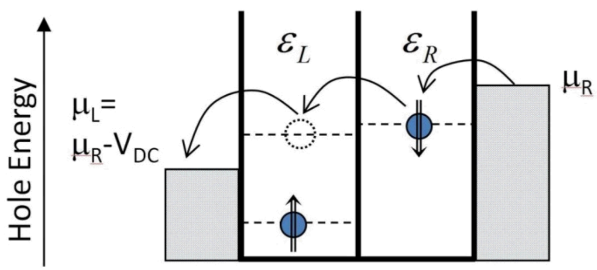


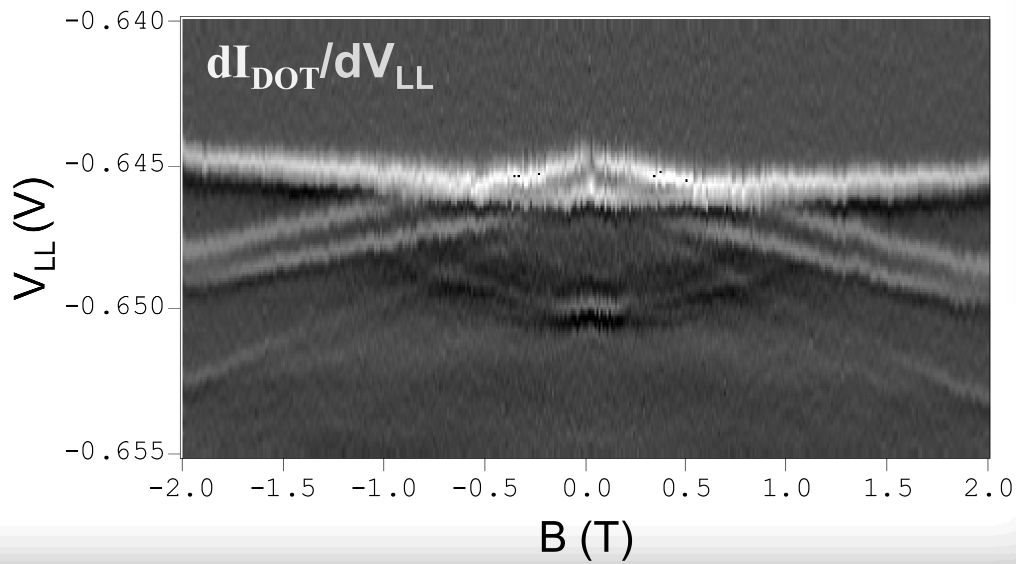
SANDIA REPORT SAND2015-8132 (October 2015)

High-Bias Magneto-transport Spectra

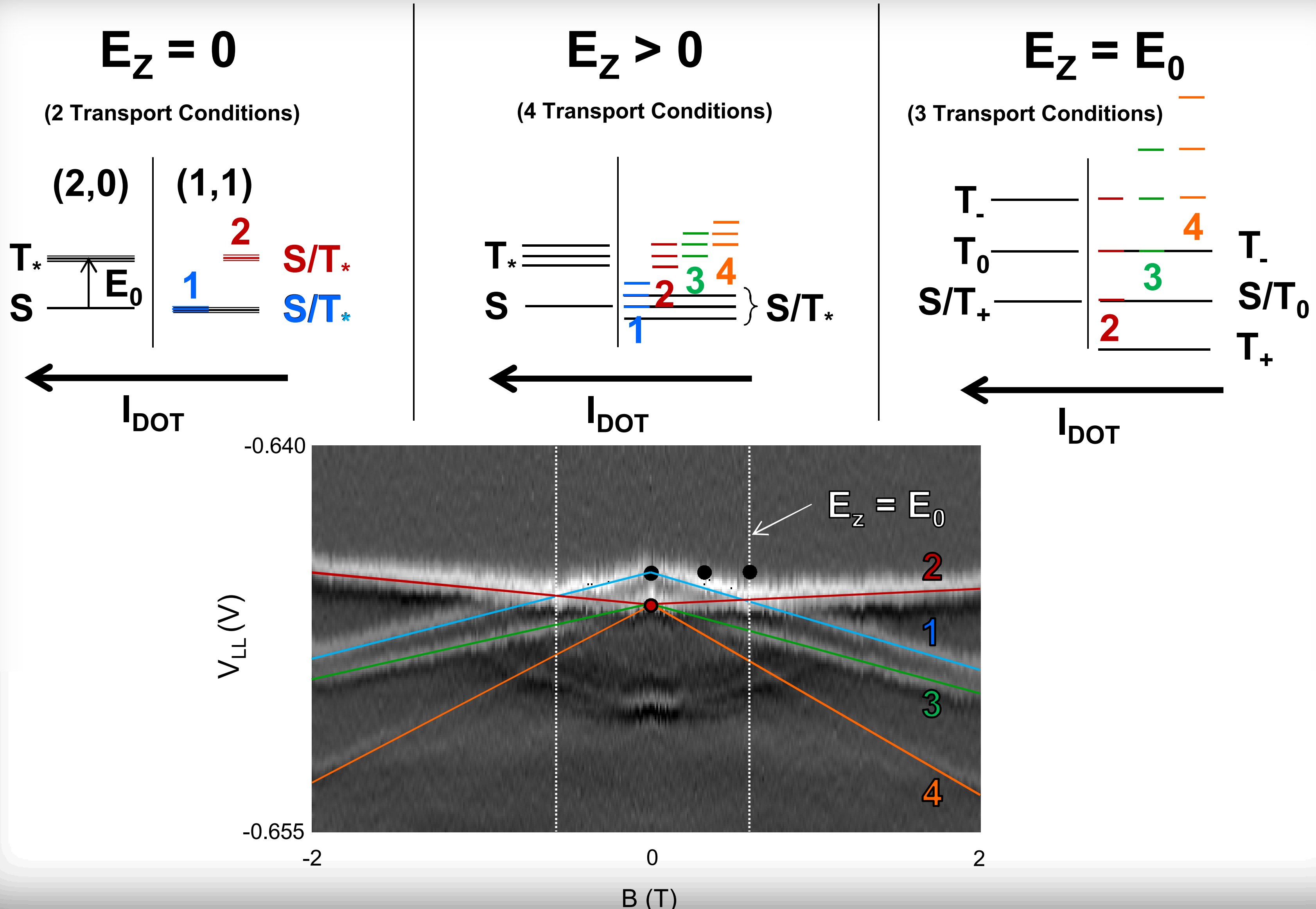




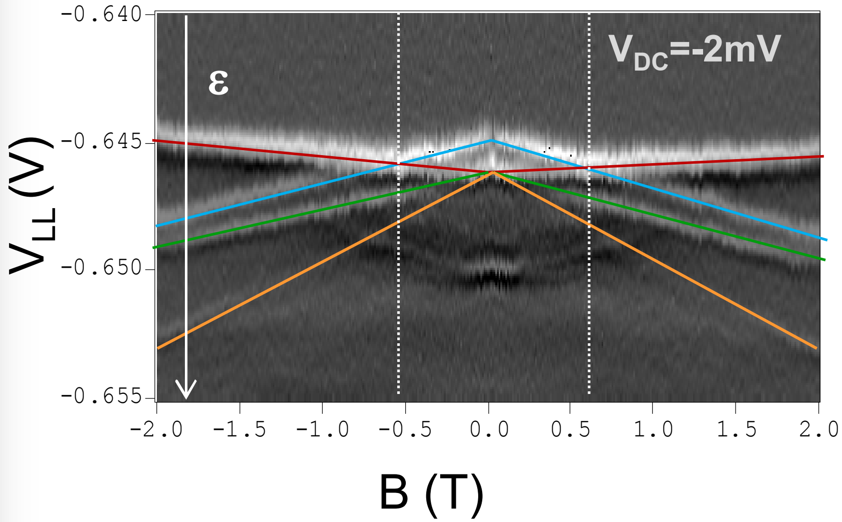




High-Bias Magneto-transport Spectra: Model



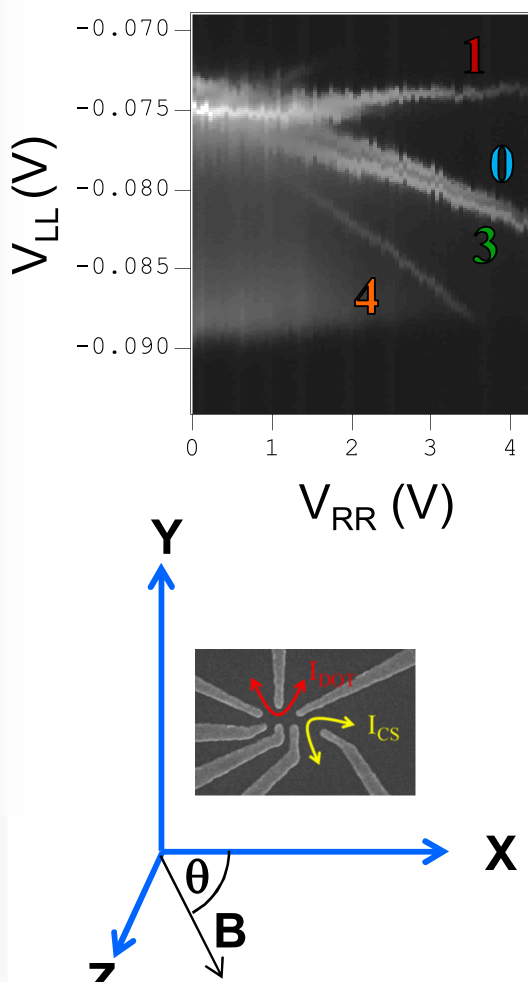
Analysis of Resonant Transitions

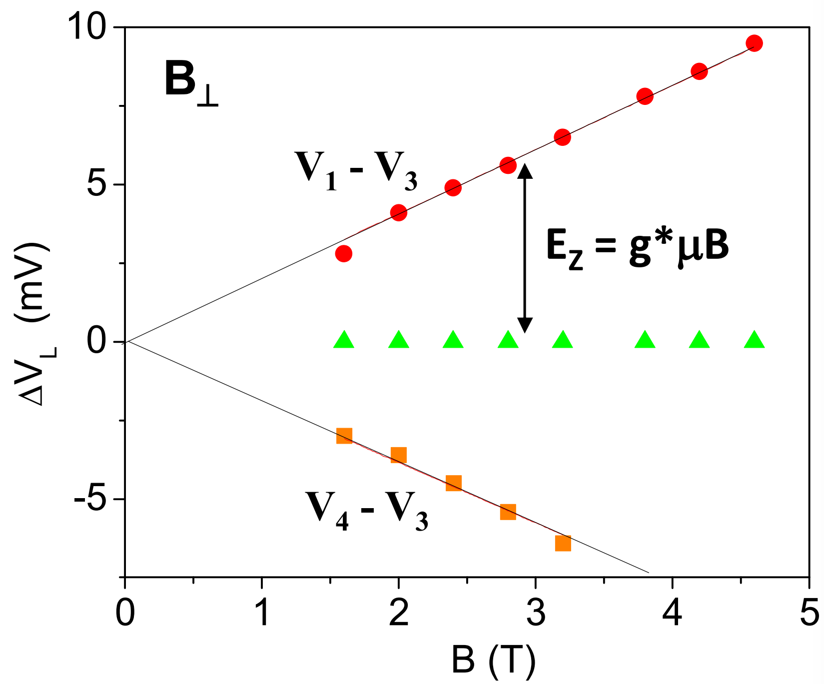


Resonant Transition(s)	Enabling Detuning
T_+ to S	$\varepsilon = E_Z$
S/T to T (no flip)	$\varepsilon = E_0$
S/T to T (spin flip)	$\varepsilon = E_0 + E_Z$
S/T to T (2 spin flips)	$\varepsilon = E_0 + 2E_Z$

$E_0(B=0) = 60\ \mu eV$

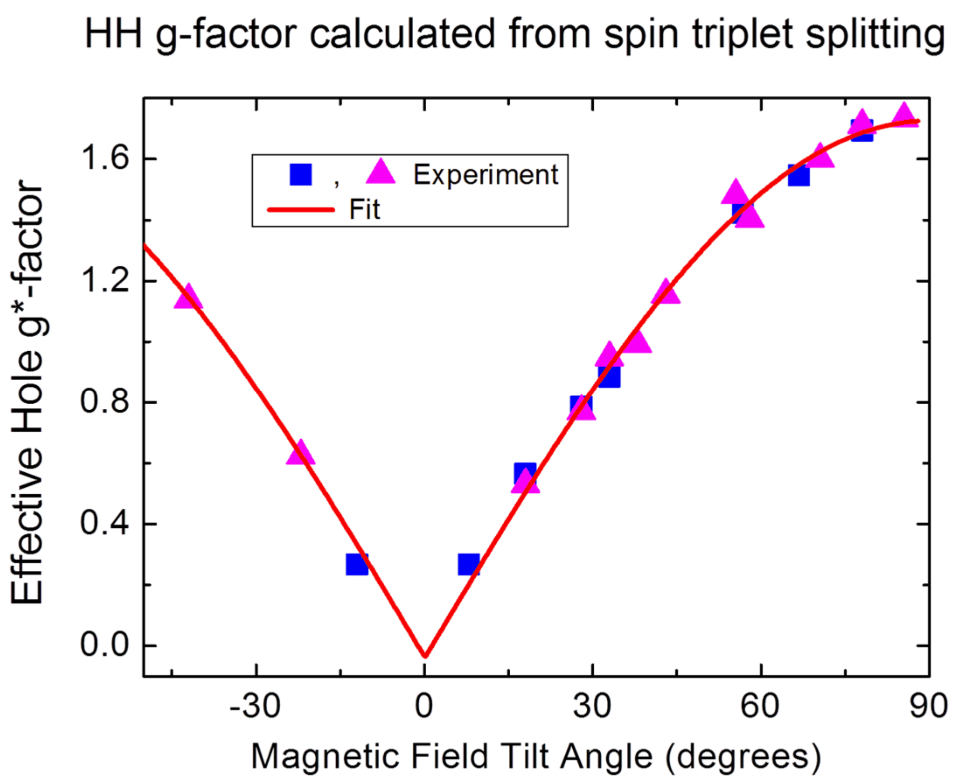
Effective Hole g*-Factor From Magnetotransport spectra





g* = 1.70

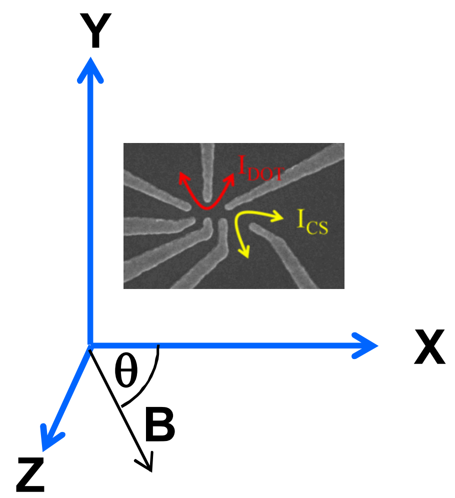
Effective Hole g*-Factor in Tilted Magnetic Field



$$g^*(\theta) = g_0\,|\sin\theta| + gmi_n$$

g_0 = 1.7 ± 0.1
g_{min} = -0.04 ± 0.04

Minimal heavy/light-hole mixing



Summary

- High-bias transport studies in two-hole regime in a lateral DQD were performed.
- The anisotropic g-factor of the hole was extracted from magneto-transport spectra.
- The heavy hole g-factor was tunable from 1.7 to ~0 by tilting the magnetic field direction