

# Towards measurement of individual coherent spins in room temperature quantum dots

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## Introduction

Colloidal nanocrystal quantum dots (NCQDs) are a promising platform for harnessing room temperature spin coherence in semiconductor nanostructures. Individual NCQD's spin may be measured via polarization of their photoluminescence (PL). Subsequent challenges arise including the spin pump initialization, spin lifetime, their shape and orientation, and blinking. Through time-resolved polarimetry measurements, we are capable of analyzing many NCQDs and determining their polarization characteristics.

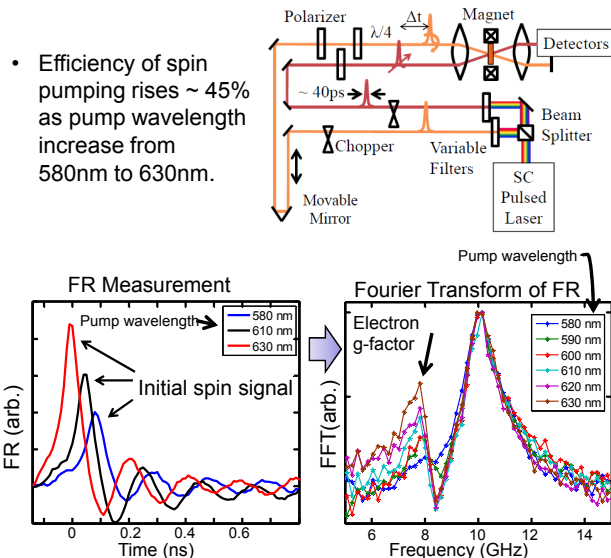
## Optimizing Spin Initialization

### Spin pumping

- Optical excitation using circularly polarized light.

### Faraday Rotation (FR)

- Excitation wavelengths are selected from FR measurements of a concentrated film of NCQDs.

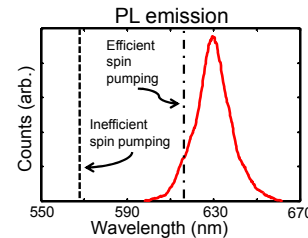


- Electron g-factor becomes more prominent with increasing spin pumping efficiency.

## Read-out Challenges

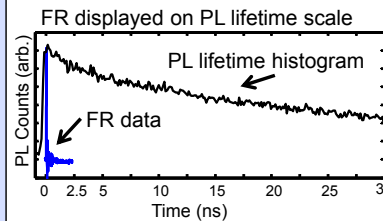
### Wavelengths

- Must optimize excitation wavelength for efficient spin initialization.



### Shape and Orientation

- Limits the spin pumping efficiency.



### Lifetimes

- Spin lifetime ( $\sim 2$  ns) is a magnitude shorter than exciton lifetime ( $\sim 20$  ns).

### Blinking

- Having different charge states at different times will likely present different PL characteristics.

## Time-Resolved Polarimetry Setup

### Laser

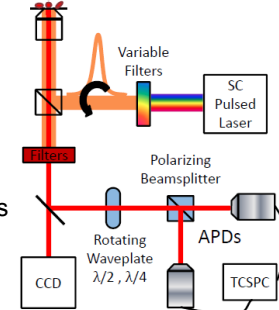
- Supercontinuum fiber laser provides sizeable range of wavelengths.

### Detectors

- CCD (EMCCD) combined with a spectrometer allows to visually locate single NCQDs for alignment and measure their PL.
- Time-Correlated Single Photon Counting system in time-tagged mode allows to record individual photon events with picosecond resolution.

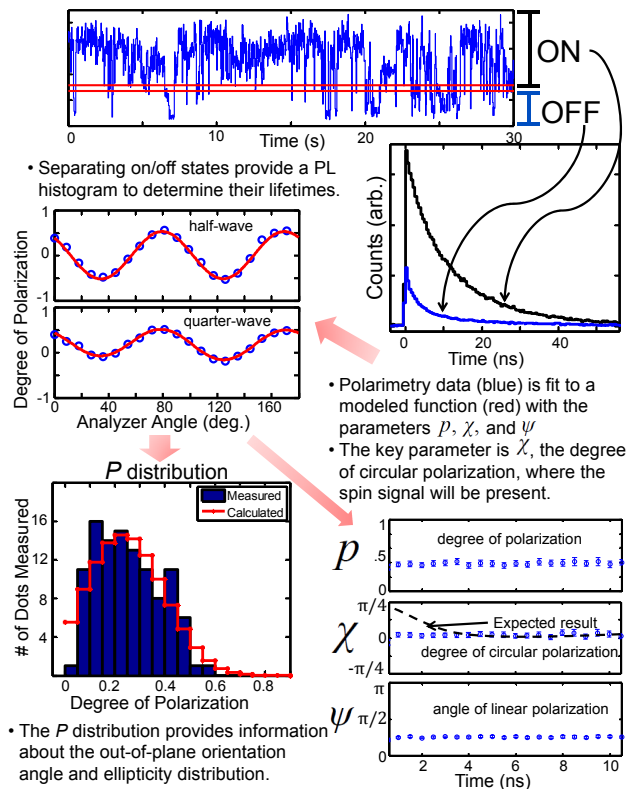
### Polarization optics

- A rotating variable calibrated to half wave plate and quarter wave plate, and a polarizing beamsplitter.



## Time-Resolved Single QD Polarimetry

- Binning the data on millisecond timescales produces a blinking trace.



## Conclusions

Investigating the spin of a single room-temperature NCQD by measuring PL polarization presents several challenges. These include spin pumping efficiency, lifetime mismatch of spin and charge dynamics, shape and orientation dependence of spin effects, and PL blinking. By using time-resolved polarimetry on many NCQDs in series, we have developed tools to overcome these challenges, leading towards time-resolved measurement of single coherent spins in a room-temperature semiconductor.

## Acknowledgements

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