

# Strain-induced traps in colloidal QDs

## Lifetime measurements and blinking statistics

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K. Doré, P. Charette, C. Nì. Allen

Nano and Giga 2009



# Overview

- ▶ Colloidal quantum dots: In general
- ▶ Our shell-alloy cQDs: synthesis and spectral characteristics
- ▶ Lifetime measurements
- ▶ Blinking: model and experiment
- ▶ Blinking statistics of shell-alloy cQDs

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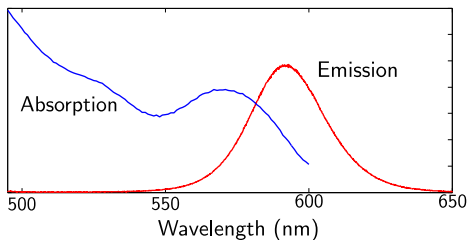
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# Colloidal quantum dots (cQDs)

- ▶ Size-dependent emission wavelength
- ▶ Narrow emission spectra
- ▶ Broad absorption spectra
- ▶ Easily functionalized
- ▶ Blinking

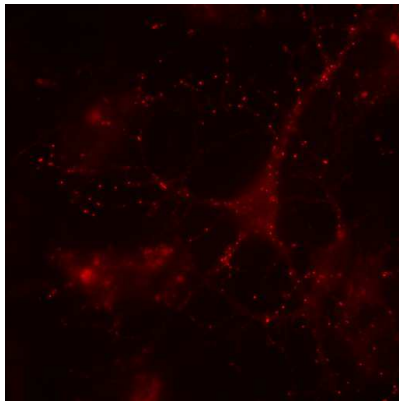
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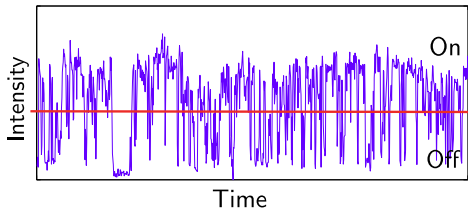
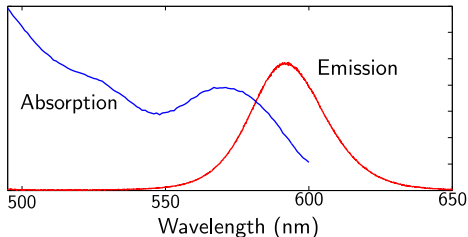
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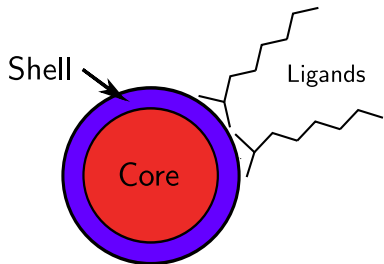
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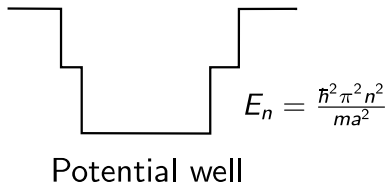


# Colloidal quantum dots (cQDs)

An exciton-in-a-box

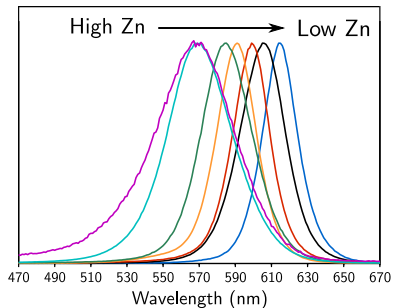
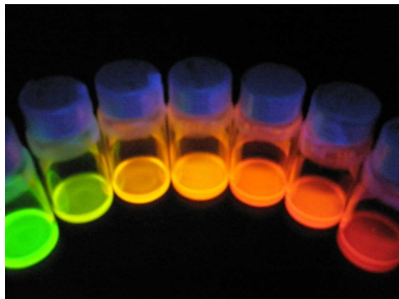


- ▶ The shell is thin
- ▶ Ligands passivate the surface



# Our cQDs have a $\text{Cd}_x\text{Zn}_{1-x}\text{S}$ shell alloy

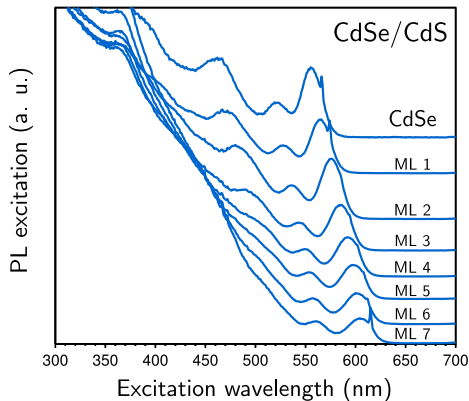
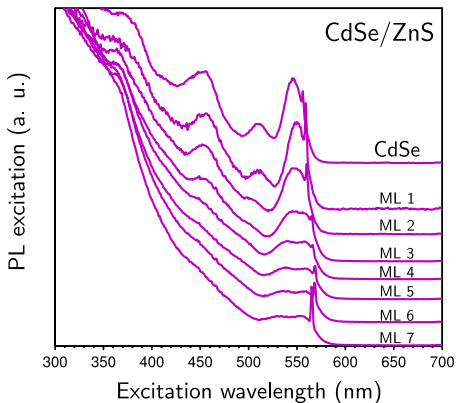
$\text{Cd}_x\text{Zn}_{1-x}\text{S}$  shell grown on CdSe cores



$x = 0$  (left) to  $x = 1$  (right)

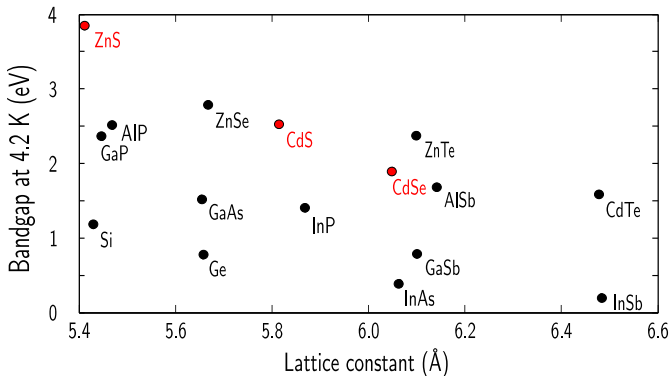
# Shell-alloy cQDs are synthesized by the SILAR method

The precursors define the Cd:Zn proportion of the shell

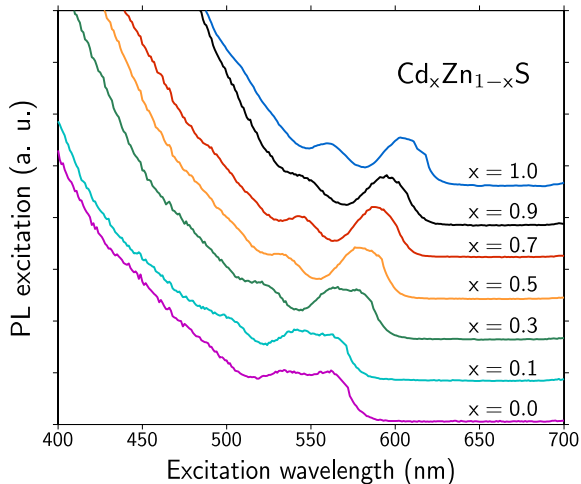


# Shell-alloy cQDs have a varying lattice mismatch

$\text{CdSe/CdS} \simeq 3.9\%$  while  $\text{CdSe/ZnS} \simeq 12\%$

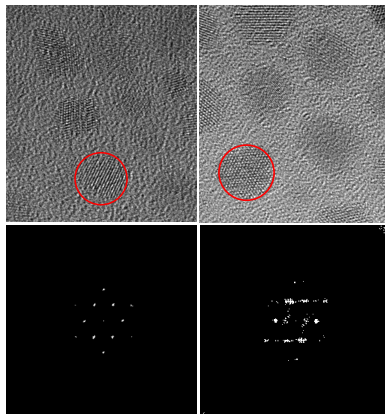


## PLE spectra reveal 1<sup>st</sup> exciton level split





# The FT of HRTEM images show the quality of crystals



HRTEM

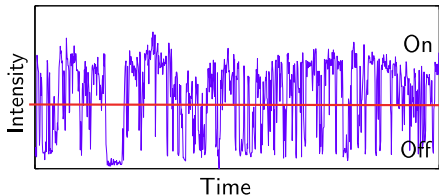
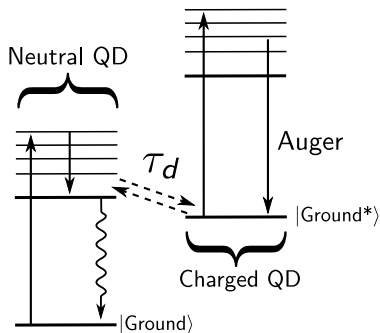


FFT

$x=0.9$        $x=0$

Other indication that "More Zn = More defects"

# Blinking occurs when QDs go from neutral to charged

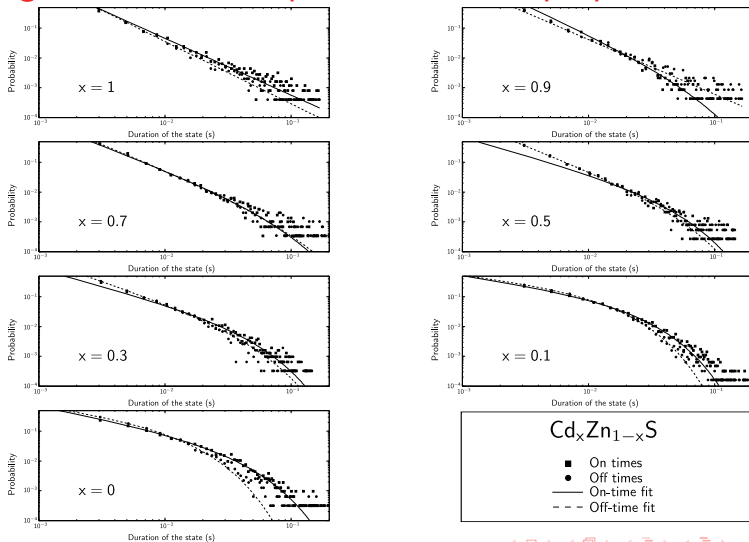


DCET predicts:  $P(t) = t^{-3/2}e^{-\Gamma t}$

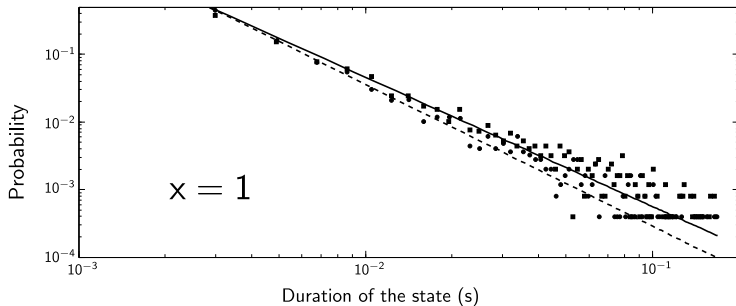
$$\Gamma \propto \frac{1}{\tau_d}$$

for on and off-time distributions

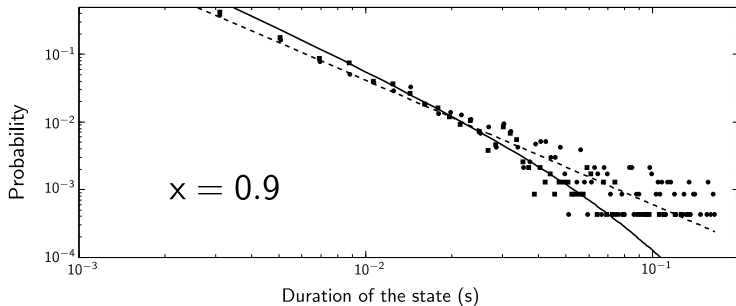
# Blinking distributions depend on the Zn proportion



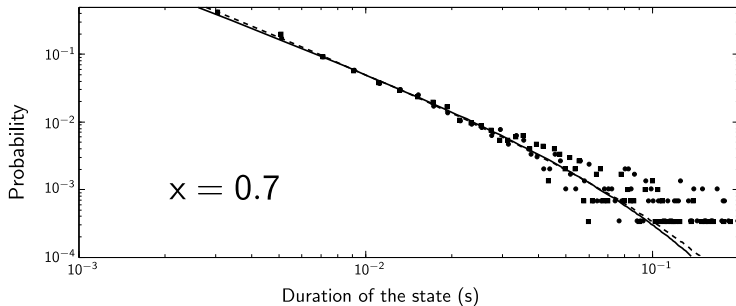
# Close-up of blinking time distributions



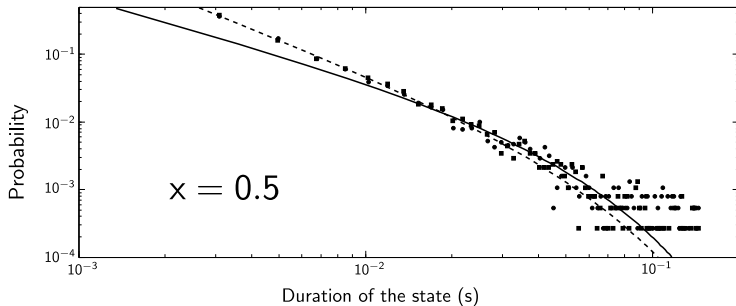
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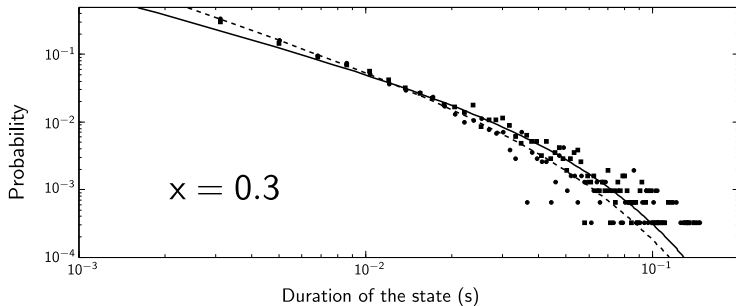
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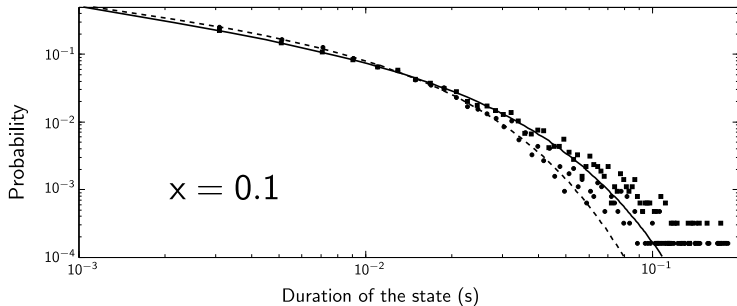
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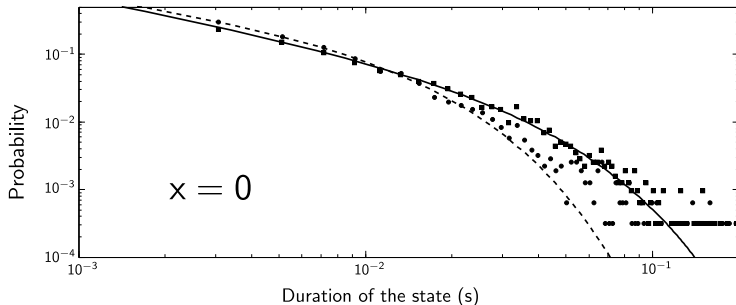
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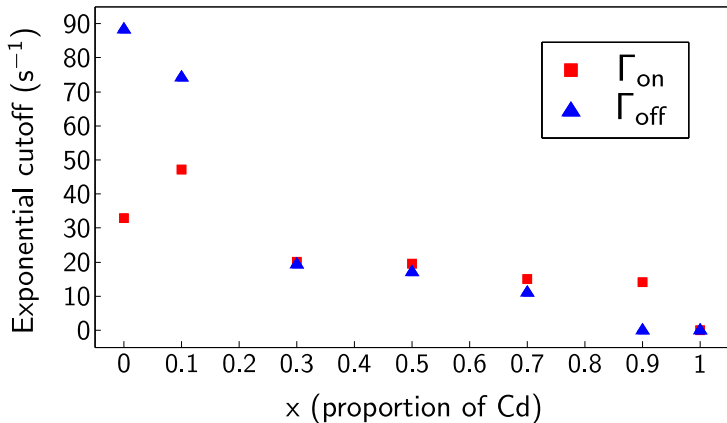
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## Distributions bending mean greater diffusion rates



# Conclusion

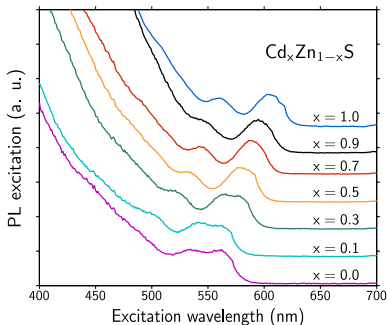
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- ▶ Lattice-mismatch causes strain which leads to defects
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- ▶ Defects lead to shorter radiative lifetimes
- ▶ Defects correlate with greater diffusion rates

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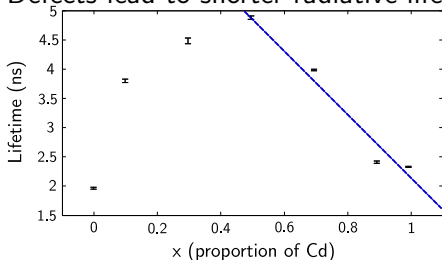
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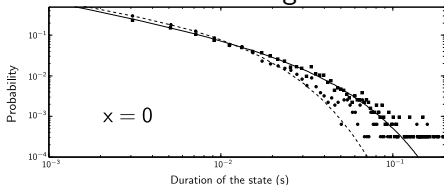
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I would like to thank...

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Fonds de recherche  
sur la nature  
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