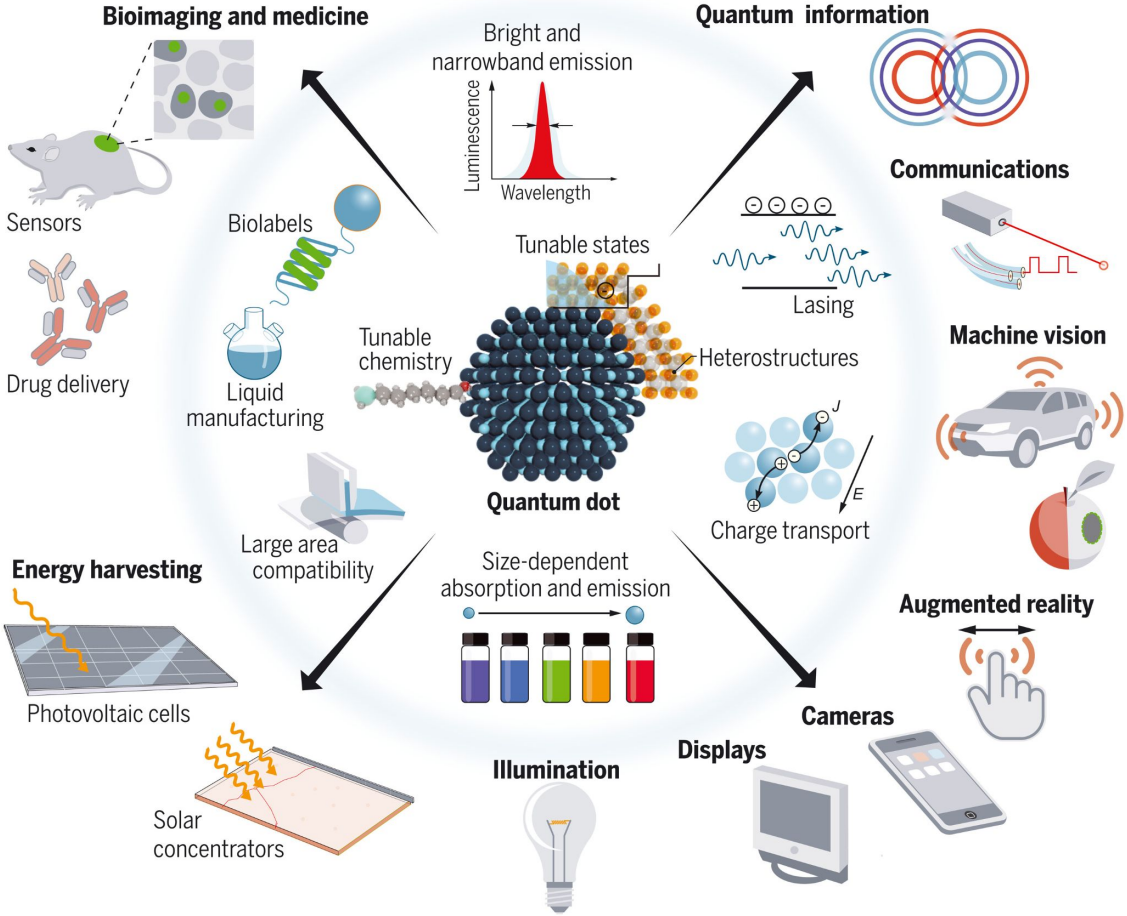
Nanotechnology - Quantum dots
Group L

Paper presentation

Introduction - Quantum dots



Introduction - Quantum dots

Paper 1:

Quantum Size Effect in Three-Dimensional Microscopic Semiconductor Crystals

A. I. Ekimova and A. A. Onushchenkoa

-> when QDs were first realized experimentally

Paper 2:

Single-shot read-out of an individual electron spin in a quantum dot

J. M. Elzerman, R. Hanson, L. H. Willems van Beveren, B. Witkamp, L. M. K. Vandersypen & L. P. Kouwenhoven

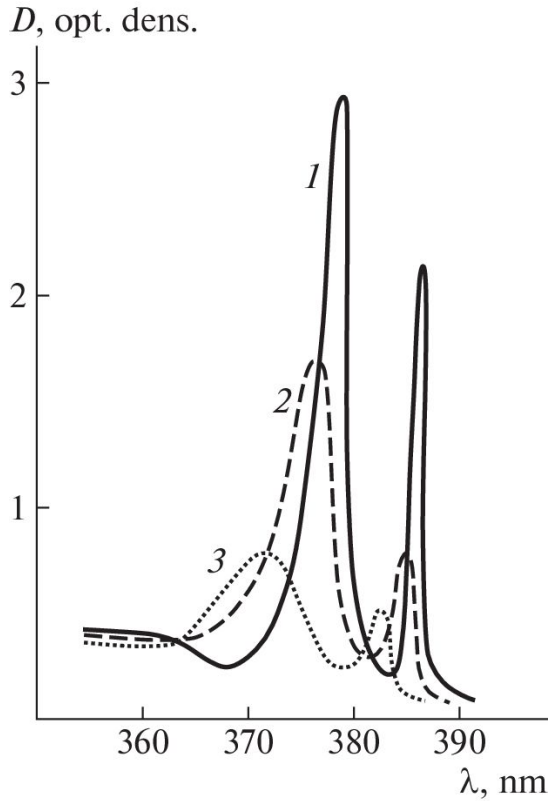
Paper 1 Quantum Size Effect in Three-Dimensional Microscopic Semiconductor Crystals

Why quantum size effect?
Quantum confinement alters electronic states → optical properties change.

Why 3D crystals?
Early experiments: 3D nanocrystals were easier to make (glass matrix).

Advantage:
Direct observation: exciton absorption shifts with decreasing crystal size.

Challenge?
Size control and distribution still rough — broadening of spectral lines.



Absorption spectra at T = 4.2 K of samples having microscopic CuCl crystals with average radii a= (*1*) 310, (*2*) 100, and (*3*) 25 Å.

Principle:

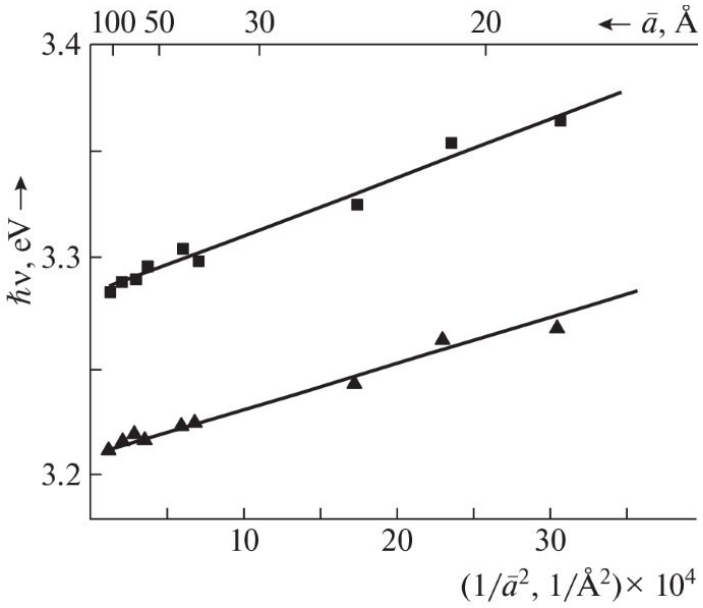
Synthesize CuCl nanocrystals inside glass →
Small crystals have stronger quantum confinement.

Quantum confinement →
Energy levels shift to higher energy.

Result:
Absorption peak moves to shorter wavelen

Size quantization of a particle of mass m can be described by

$$\Delta E = \hbar^2\pi^2/2m\bar{a}^2.$$



Dependence of the positions of the exciton absorption lines at T = 4.2 K on the average radius of the microscopic crystals.

Paper 2 single shot readout of spin state

Why single shot readout?

Projective readout, only one readout available!

Why need to readout spin state?

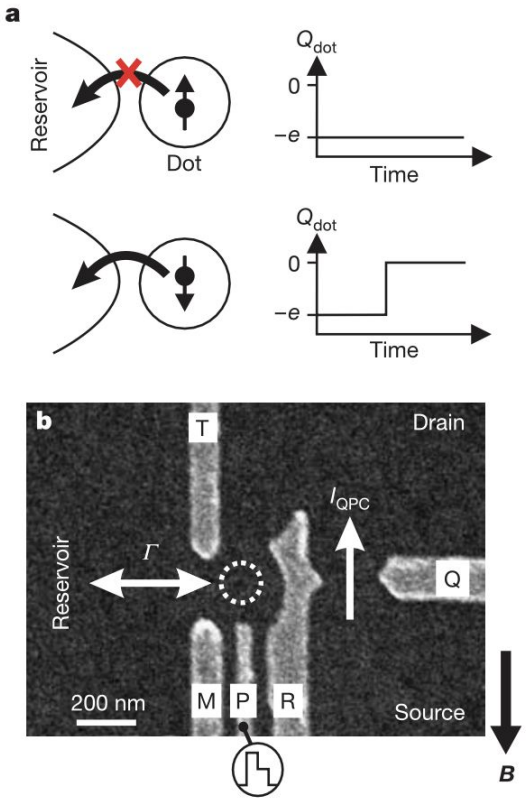
Quantum computing, quantum optics.

Advantage:

High Fidelity.

Challenge?

DC control instead of RF, readout process too slow!



Principle:

1. Apply positive voltage pulse to load one Electron.
2. Apply less positive voltage, if spin up No electrical signal otherwise a small Electrical Pulse(dashed line). This is Due to different energy level govern by Zeeman splitting.