

What makes Nano Special?

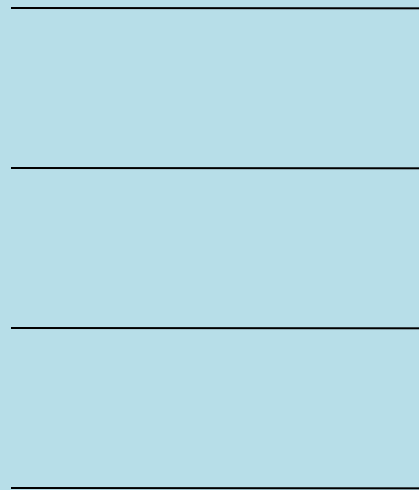
Andrew Richter

Holden Village

Summer 2009

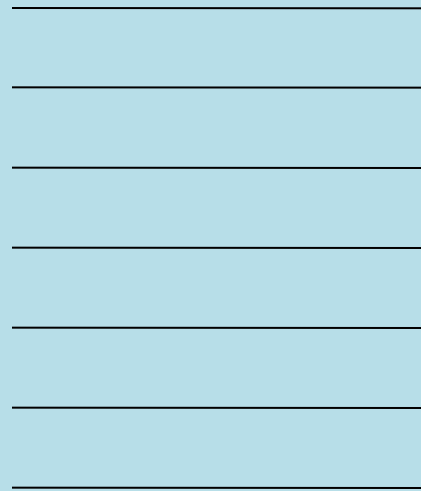
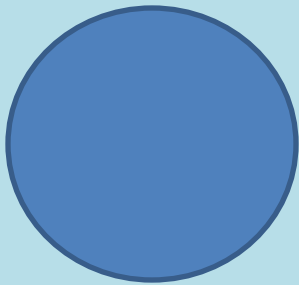
Quantum Effects

- Localization produces quantized energies.



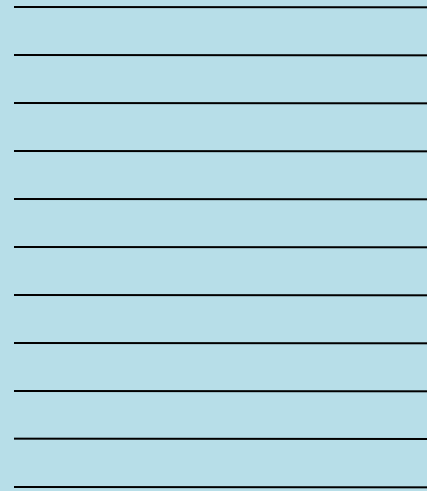
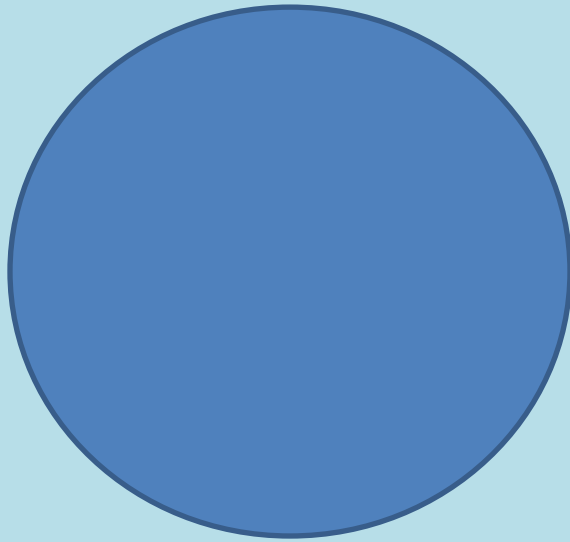
Quantum Effects

- Localization produces quantized energies.



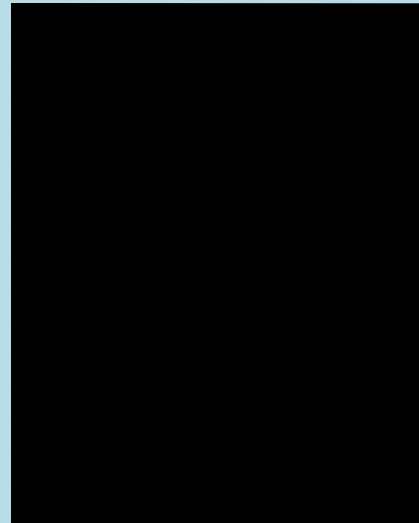
Quantum Effects

- Localization produces quantized energies.



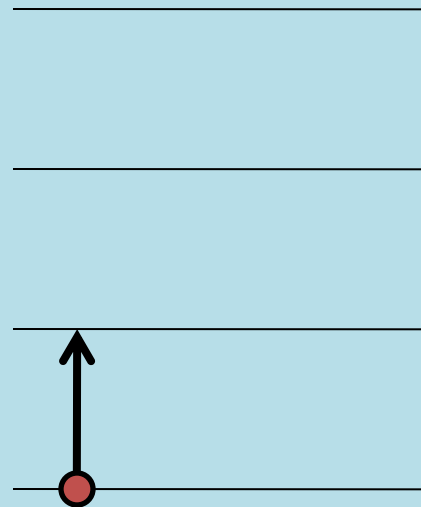
Quantum Effects

- Localization produces quantized energies.



Quantum Effects

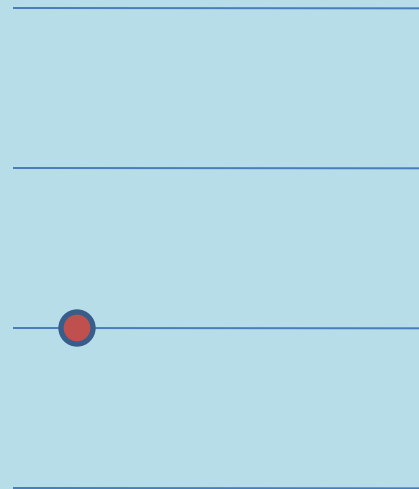
- Transitions between allowed energies can produce light.



Excite an Electron.
Makes a “Quantum Leap”

Quantum Effects

- Transitions between allowed energies can produce light.

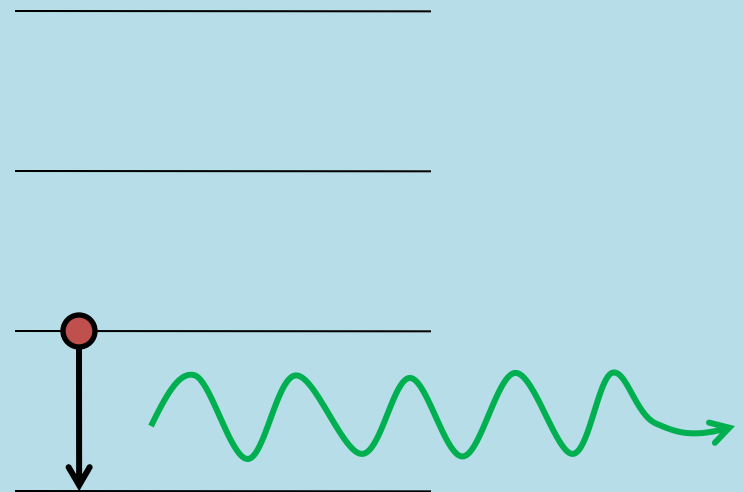


Excited electron will fall back to lower energy.

Gives off extra energy as light with specific energy (color).

Quantum Effects

- Transitions between allowed energies can produce light.



Excited electron will fall back to lower energy.

Gives off extra energy as light with specific energy (color).

Quantum: Tunneling

- In Quantum, particles can move through barriers.
 - Classically, this is not possible.
- Happens naturally in some kinds of radioactive decay.

Simulation

Surface Area

- Lots of useful phenomena happen at surfaces
 - Catalytic Converters
 - Adsorption of chemicals.
 - Hydrogen storage/fuel cells.
- What is meant by a “surface”?
 - Where one thing can come into contact with another.

Nano = Large Surface Area

- Think of a jar of coins.
 - A large jar holds a lot of coins, but only a small fraction of these are at the surface (in contact with the glass)
 - A very small container, like a roll of the coins, would have all or nearly all the coins at the surface.



Surface Area

- 1 gram = 1 dollar bill
- Surface area of dollar bill = 30 square inches
 - About 200 cm²
- 1 gram of nanoparticles has ~ 30,000,000 cm² surface area.
 - About the size of a football field.

Biorelevant

- Biomolecules are nature's nanomachines
 - Proteins, DNA, chromosomes all carry out life's functions on the nanoscale.
- Artificial constructs that are on the same scale can often be used in similar ways
 - They can enter cells, adhere to organs, catalyze bio processes.

Electronically Fast

- Electrons (electricity carriers) move fast through wires, but it still takes some time to get from A to B.
- Nano electronic devices shorten the transit time.
- Also can often behave in “superconductor” like ways, reducing energy consumption and waste.

High Density

- Computer memory takes up space for each “bit” of information.
- If that space can be shrunk to the size of a molecule or nanoparticle, more memory can be fit into similar areas.

Less Material

- A chunk of material can cost a lot.
- A nano-scale thin film can do the same thing (or more) for fractions of the material.