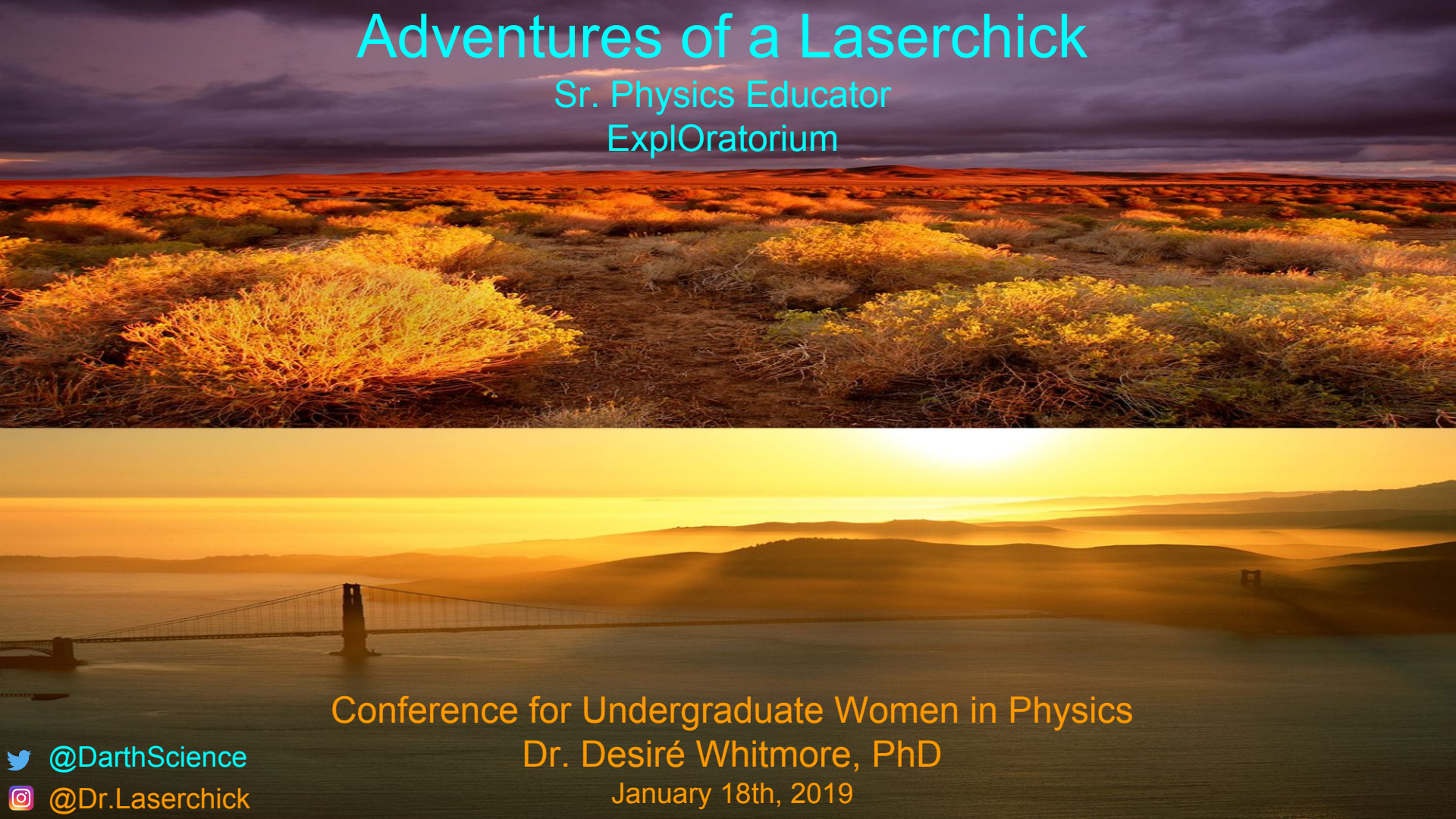
Adventures of a Laserchick

Sr. Physics Educator
ExplOratorium



Conference for Undergraduate Women in Physics
Dr. Desiré Whitmore, PhD
January 18th, 2019

@DarthScience
@Dr.Laserchick

Who am I?

- I am the oldest of 8
- Like taking stuff apart, learning how it works
- Love teaching- best way to learn
- Love Cars
- Love dogs
- Bowling
- Roller skating

I’m Finally Done With School!

AS, Physical Sciences

BS, Chemical Engineering
Research: Physical Chemistry

MS, PhD, Chemical and Material Physics
Research: Laser Spectroscopy

Postdoc, Chemical Physics
Research: Attosecond Spectroscopy

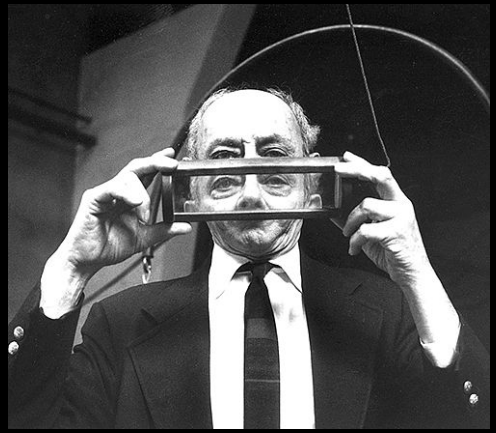
Curriculum Developer,
K-8 Science Curriculum

Professor of Physics, Laser
and Photonics Technology

Sr. Physics Educator

Exploratorium

- Museum of Science, Art, and Human Perception



Dr. Frank Oppenheimer

Inquiry-Based Learning

Over 650 hands-on exhibits currently on display*

80% of the world's science centers use Exploratorium-designed exhibits, programs, or ideas*

Teacher Institute works with MS and HS teachers to support them in Inquiry-based Teaching

- Made up veteran classroom teachers and PhD scientists.

*exploratorium.edu

How can I get your attention?

Waterfall waterfall!!

What does a waterfall sound like?

What does a waterfall look like?

Prediction Time!

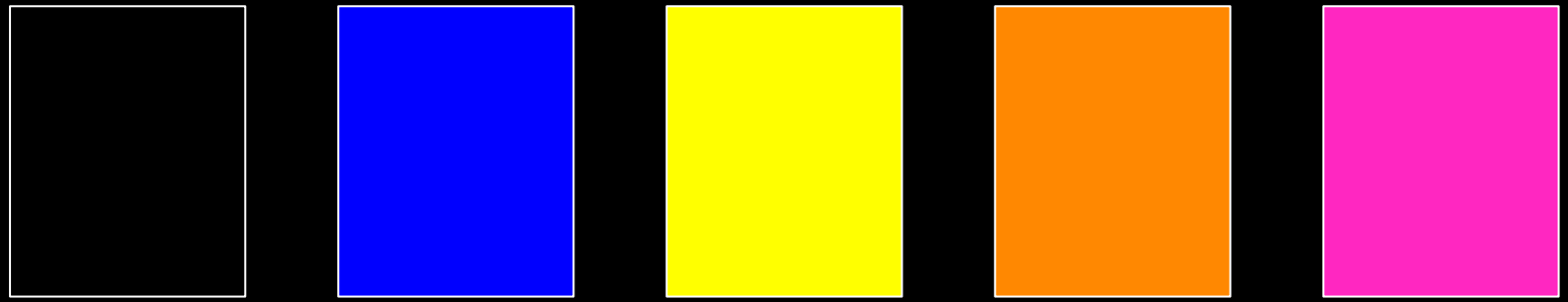
What will happen when I shine a **RED** laser pointer onto these sheets of paper?

What will happen when I shine a **GREEN** laser pointer onto these sheets of paper?

What will happen when I shine a **VIOLET** laser pointer onto these sheets of paper?

Write down your predictions, ~ 1 min.

Feel free to talk with your neighbors



Were You Right?

What did you notice?

What do you wonder?

What do you want to try?

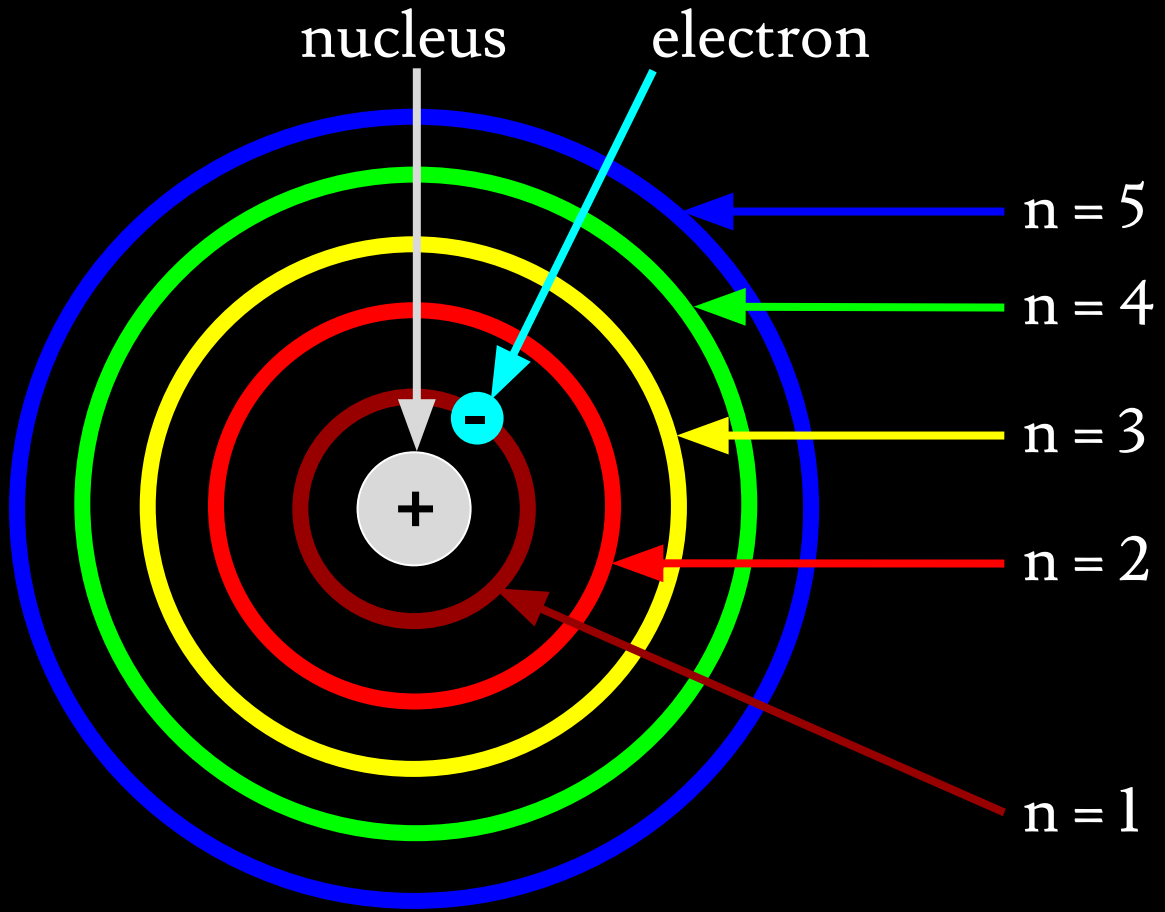
Were you surprised by anything?

What's Going On?

Electrons exist in orbitals

Farther orbitals
→ more energy

Electrons need energy to get to them

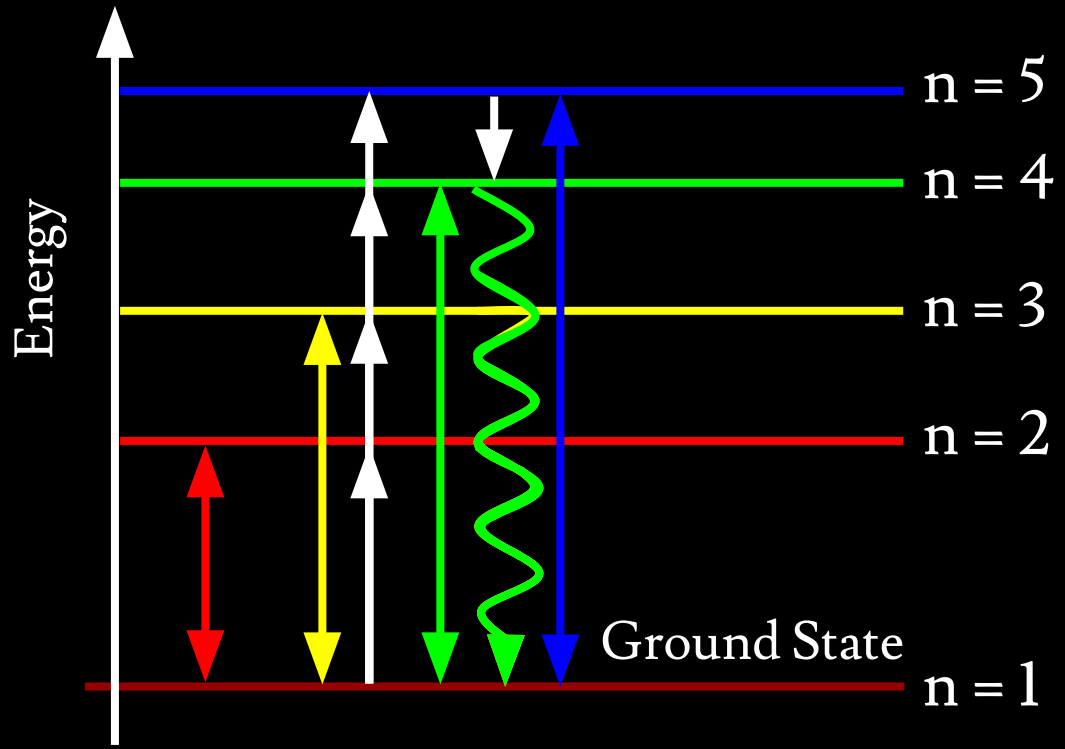


Jablonski Diagram → much easier to read

Can give electrons energy to jump up to the higher levels.

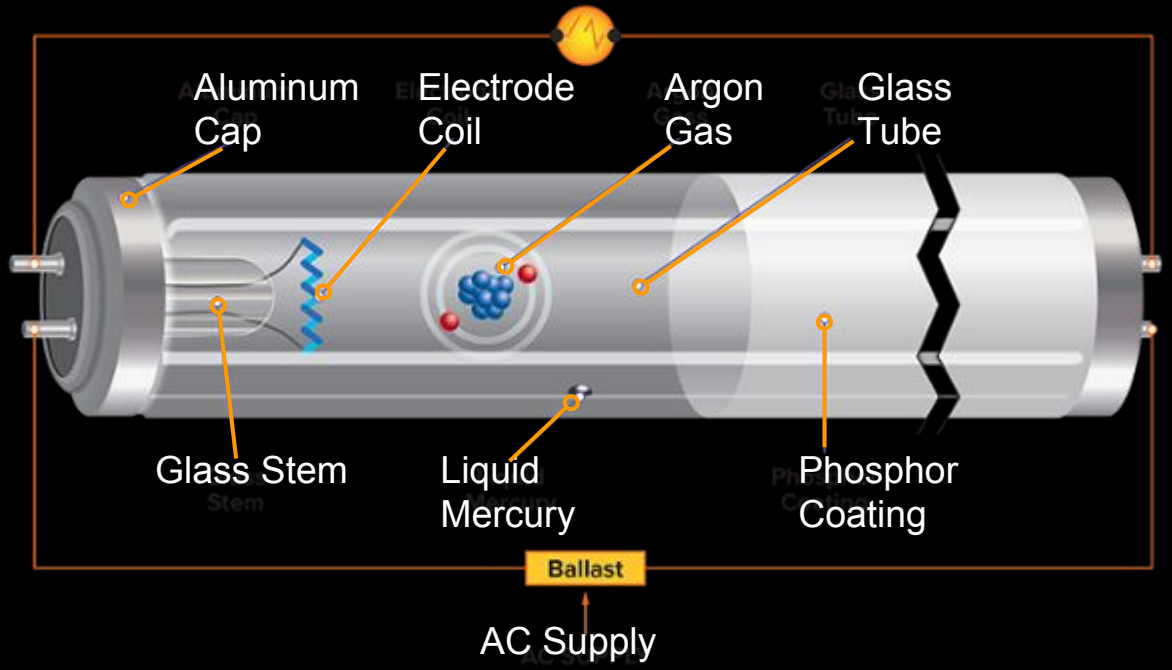
Once in higher levels, they can jump back down.

Some states are special (singlet) and emit photons

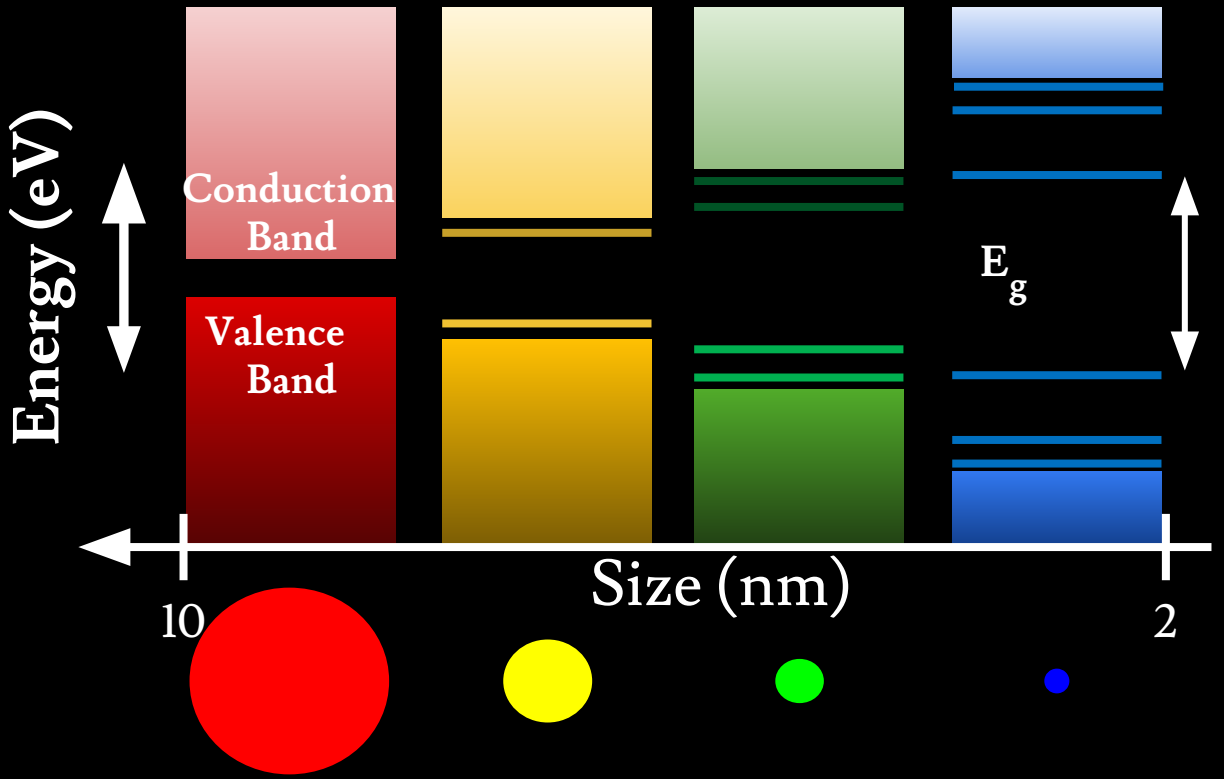


Fluorescent lamps

- Electrons excite Argon gas
- Emit UV and blue light
- Light causes Phosphor to fluoresce



Semiconductor Confinement → Man-Made Atoms!



Semiconductors have bands instead of orbitals.

Smaller → more atom-like!

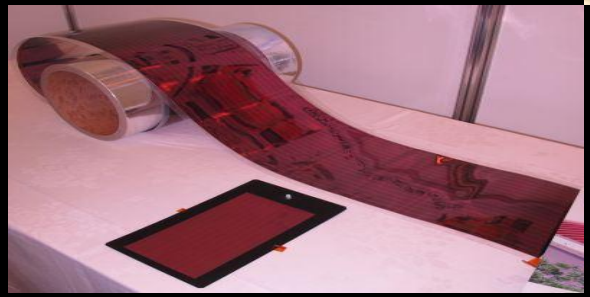
Quantum Dots!!

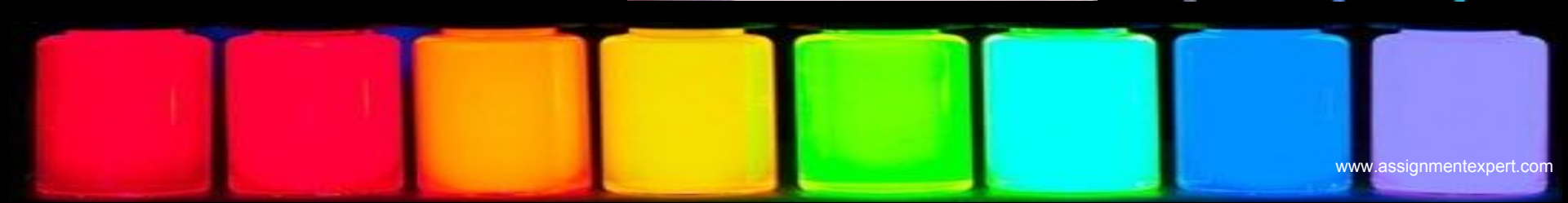
QDs can be tuned to fluoresce in the entire visible range!

Just change size.

Why are they important?

- Highly tunable!
- Solar Cells
- Biological Studies
- Optical Displays

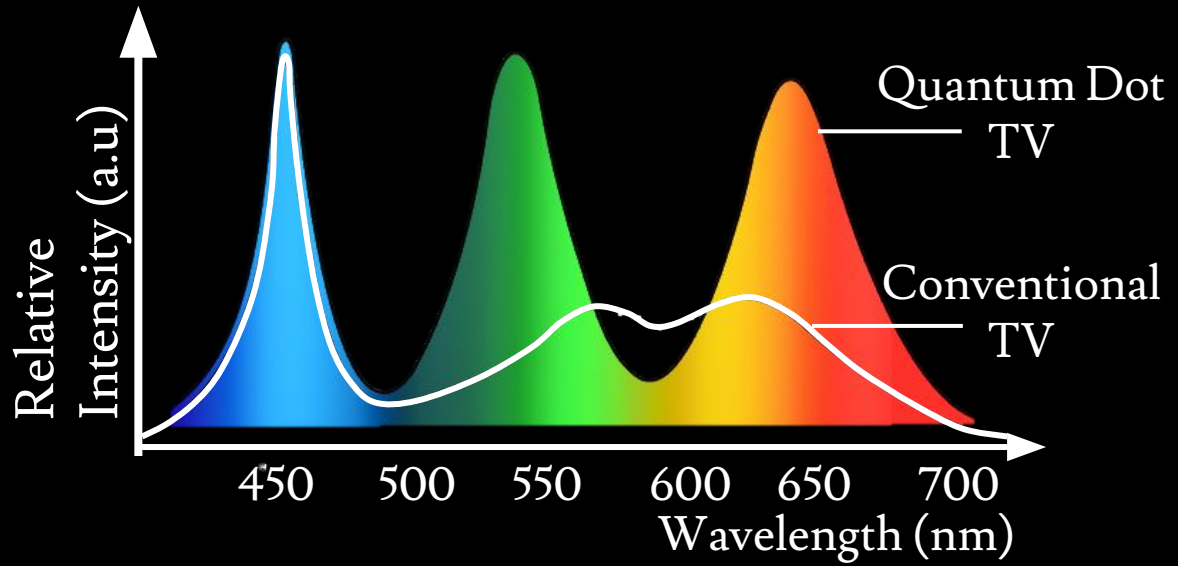




Quantum Dot Displays are More Efficient

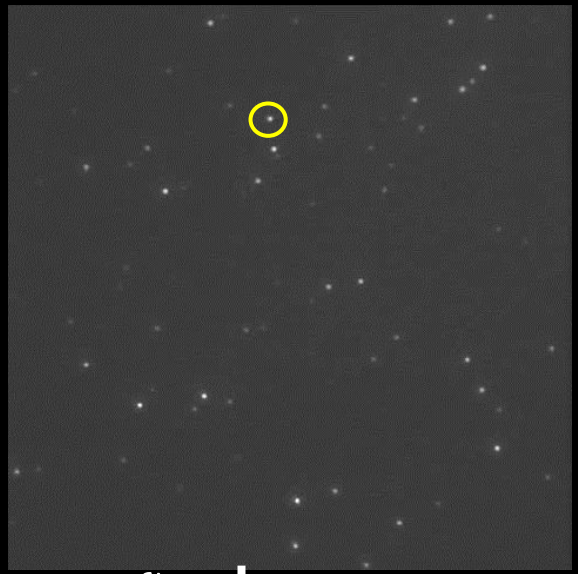
Tunability means very narrow spectral bands

- Can make ANY color
- Colors don't bleed into each other
- More efficient
- Don't need as much backlight



Quantum Dot Fluorescence Efficiency

Quantum Dot Fluorescence Efficiency

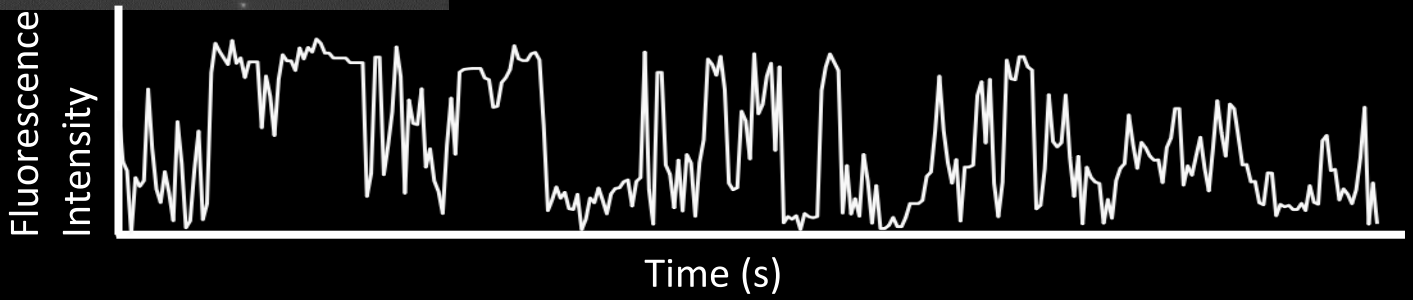


Choose regions around blinking dots to analyze

Record Blinking trajectory for all dots simultaneously

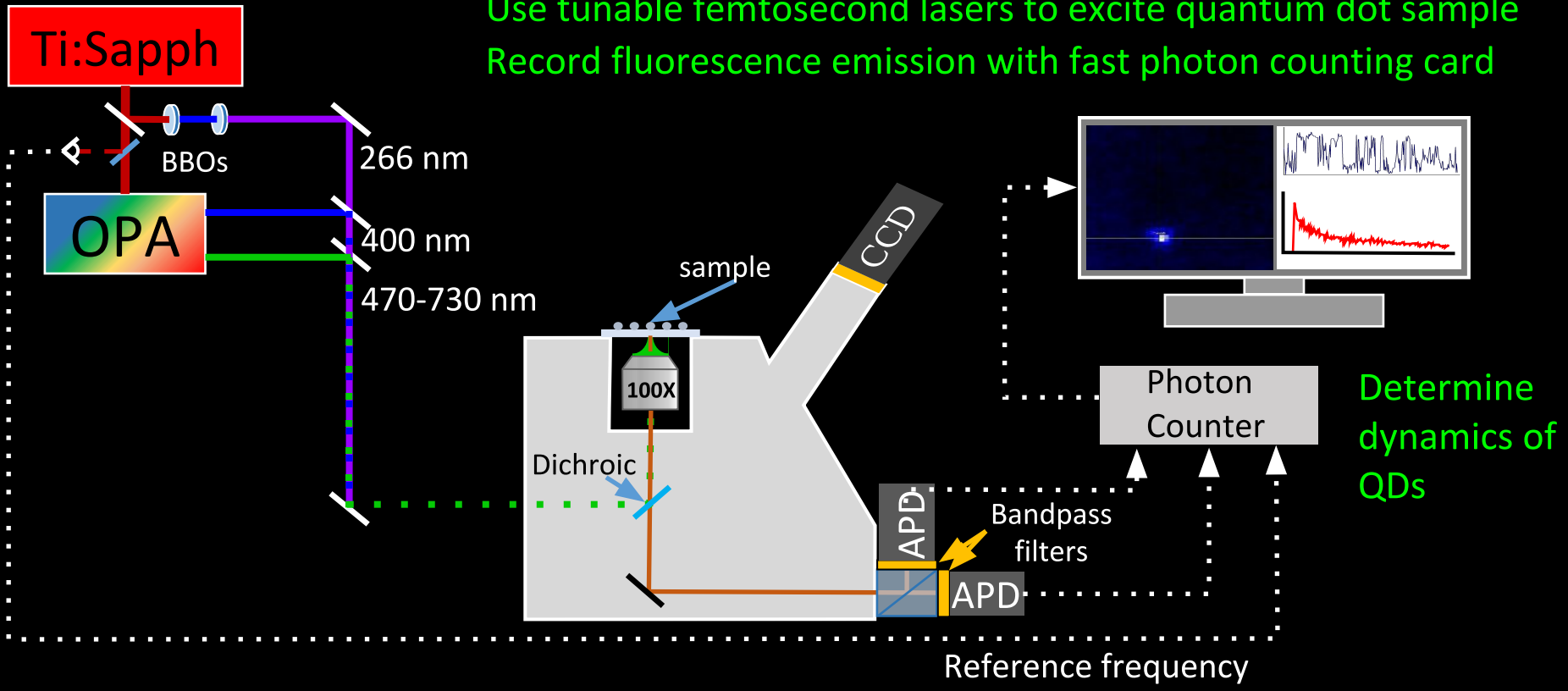
Can measure many blinking traces at once

Use this information to understand electron and hole trapping in semiconductors.



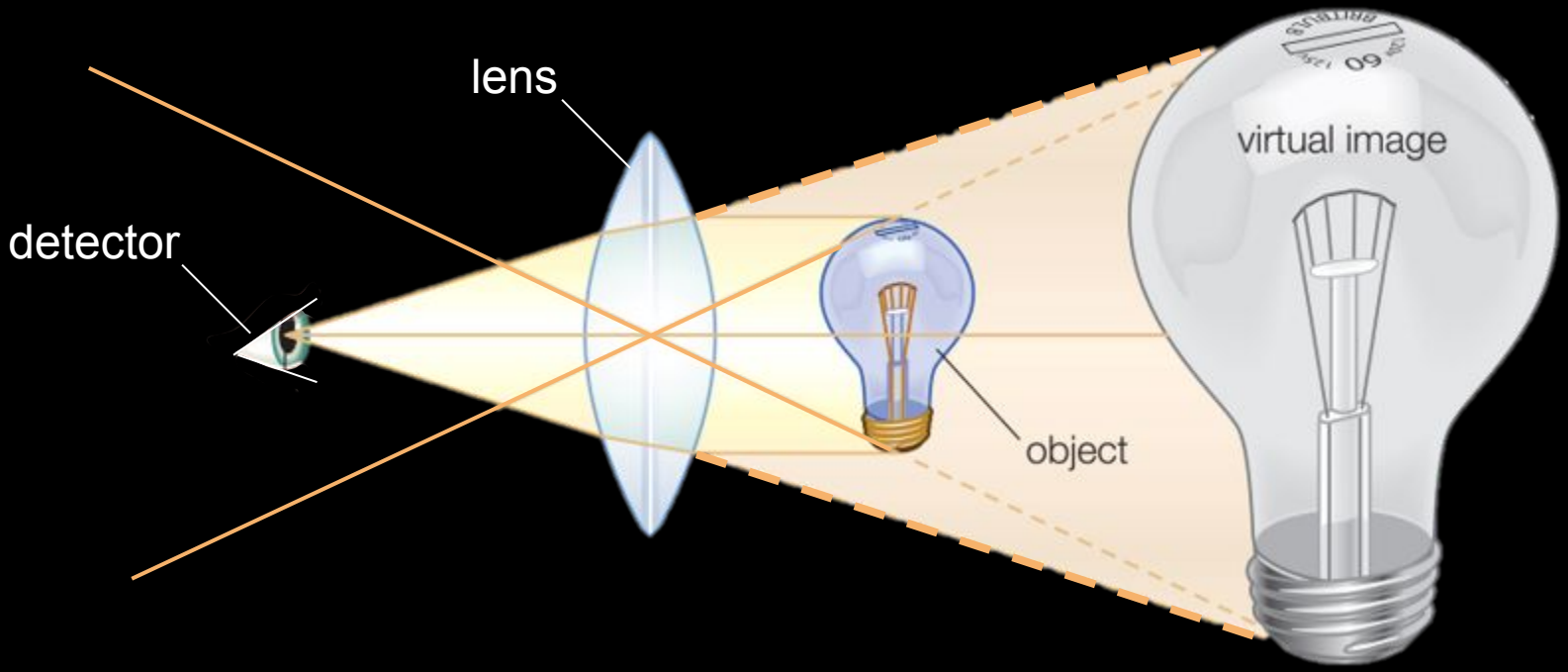
QD Efficiency Measurement

Use tunable femtosecond lasers to excite quantum dot sample
Record fluorescence emission with fast photon counting card



Determine dynamics of QDs

Simple Microscope - Only 3 components



Cell-Phone Mini-scopes!

You have a single lens

You have a CCD (hopefully)

Construction:

- Roll out poster tack to make a noodle, ~ 1” long
- Wrap the noodle around the lens
- Turn on the device camera on
- Place the lens onto the camera. It will be in place when you can see your fingerprints!

Take some pics of stuff ~5 min

Debrief

What do you notice?

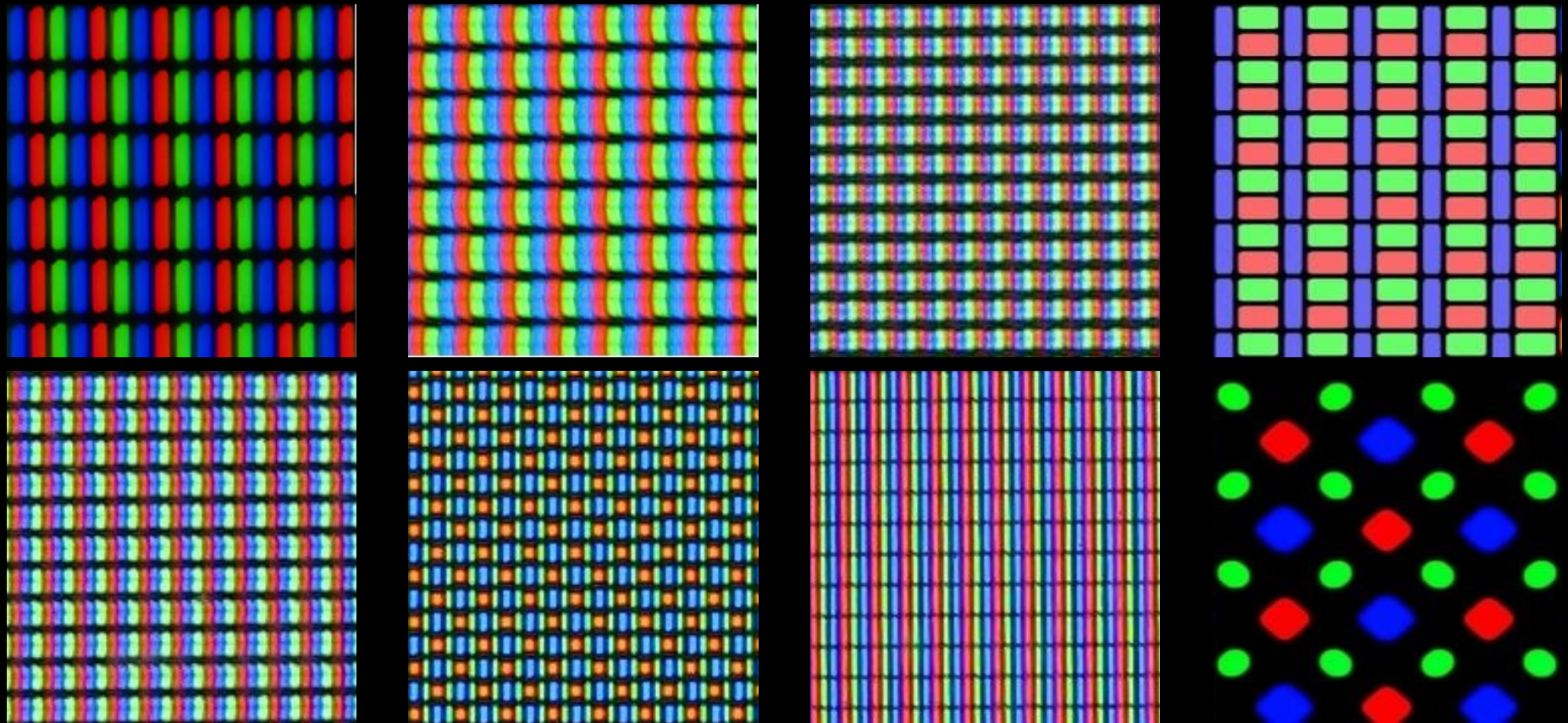
What do you wonder?

What do you want to try?

Did anyone look at the pixels on their neighbor’s phone?

- What did they look like?
- What patterns?

Different Pixel Configurations



Exploratorium Statement

Our vision is a world where people think for themselves and can confidently ask questions, question answers, and understand the world around them.

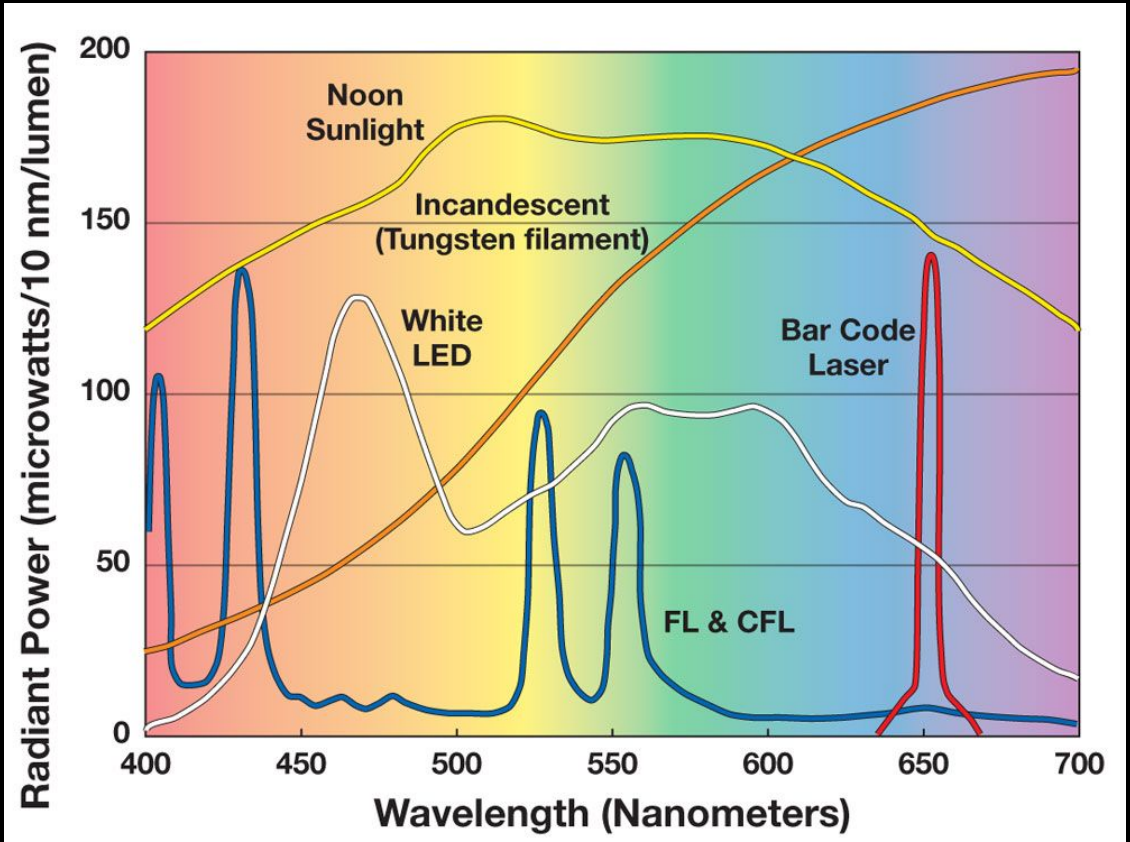
Thank you for your attention!

@Dr.Laserchick

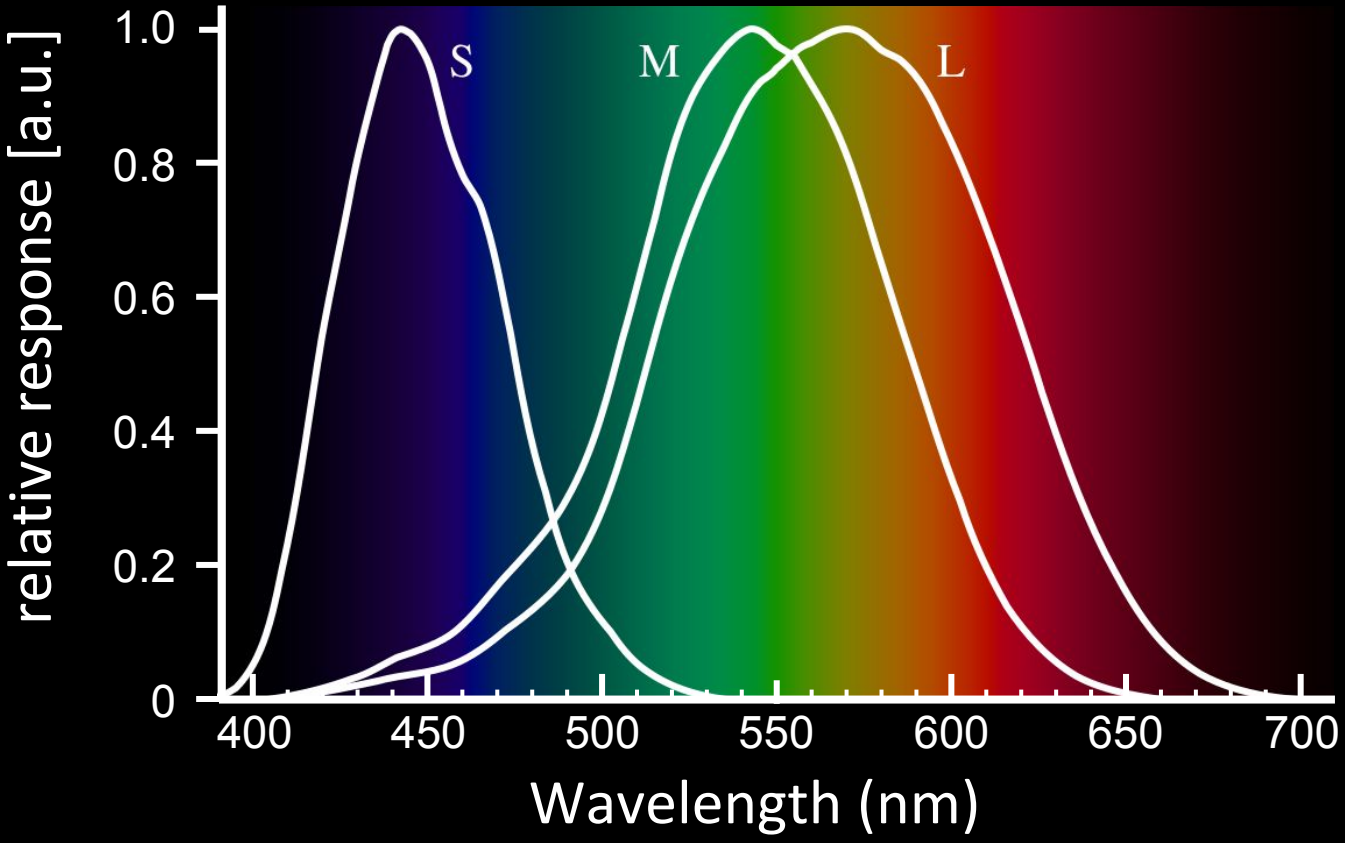
Resolution of your microsope

- Resolution is the smallest part of a picture that is displayed, the picture element or pixel
- Resolution equals the number of pixels per area
- Similarly, an imaging system's resolution corresponds to the smallest line-pair spacing that it can discern

Spectral Output of Different Light Sources



Spectral Response of Typical Eyeball



Quantum Dot efficiency

Look at single QDs to determine how efficient they are.

- Single QDs don’t emit very much light, how can I measure it?
- Had to build a microscope!
- Show QD blinking video
  - Can look at individual dots
  - Can look at different sized dots by changing the filters in front of the detectors

Optical Displays

- RGB pixels
- LEDs, QDs
- Optical response
- QD spectral output
- Bayern Filters
  - RGB pixels
  - Arrangement
    - Chevrons
    - Diamonds
    - Circles
- What did I study?