

# Emission of Electromagnetic Radiation Upon Electric Stimulation of Preserved *Cucumis sativus*:

## The Glowing Pickle

What You Will Need

How to Put it Together

What to Do

What to Expect

Power Point  
Presentation (ppt)

Back to Physics  
Outreach

# What you will need:

- Pickles (dill pickles work best)
- Insulated Platform (I used wood, but I recommend plastic as it is easier to clean)
- Skewer (a nail or screw works best)
- Transparent Cover (I used a plastic ice bucket. An empty pop bottle would also work, but it doesn't come with convenient handles)
- 2 Elastic Bands
- 2 Small Hooks
- 2 Wire Holders
- 2 Screws
- 3-Pronged Electrical Cord
- Electrical Tape
- 2 Pins
- Variac
- Spectroscopes

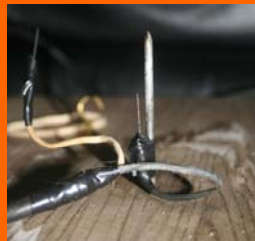


# How it all goes together:

- Drill a hole in the middle of your insulated platform. Insert your skewer into the hole such that it does not wobble around.
- Cut the end off of the electrical cord and separate the hot, cold, and ground wires. You won't need the ground, so wrap some electrical tape around this part of the wire to keep it from being exposed.
- Attach the 2 pins to each of the hot and cold wires using electrical tape.
- Secure the electrical cord to the platform using the wire holders and screws. Make sure the cord is secure enough that it can't be pulled out.



- Attach one of either the hot or cold pins to the skewer using electrical tape such that the pin points upwards and is parallel to the skewer.



- Screw the 2 hooks into the platform such that they are positioned outside the perimeter of your cover. These will be used with the elastic bands to secure to cover during the demonstration.



# What to do:

- Put the pickle onto the skewer/pin.
- Stick the other pin into the pickle.
- Place the cover over the pickle and pins.
- Secure the cover by attaching the elastic bands between the hooks and handles of the ice bucket.
- Plug the pickle into the variac.
- Plug the variac into an outlet.
- Turn the power of the variac on.
- Increase the voltage supplied to the pickle to 110V.
- Use spectroscopes to view the sodium spectrum or just sit back and enjoy the show.



# What to expect:

- The pickle will first start to crackle as it heats up. As water boils out of the pickle, a vapour cloud will form. Since this vapour cloud is non-ionic (and therefore non-conductive) it will allow the formation of a spark which excites the electrons in the sodium atom making the pickle glow.
- Different pickles glow for different amounts of time, usually lasting between 20 – 120 seconds.
- Pickles can be preserved in other salts to get emission of different colours. Lithium chloride is supposed to work well. Potassium chloride is dominated by a yellow glow, so don't waste your time trying to make a purple pickle.



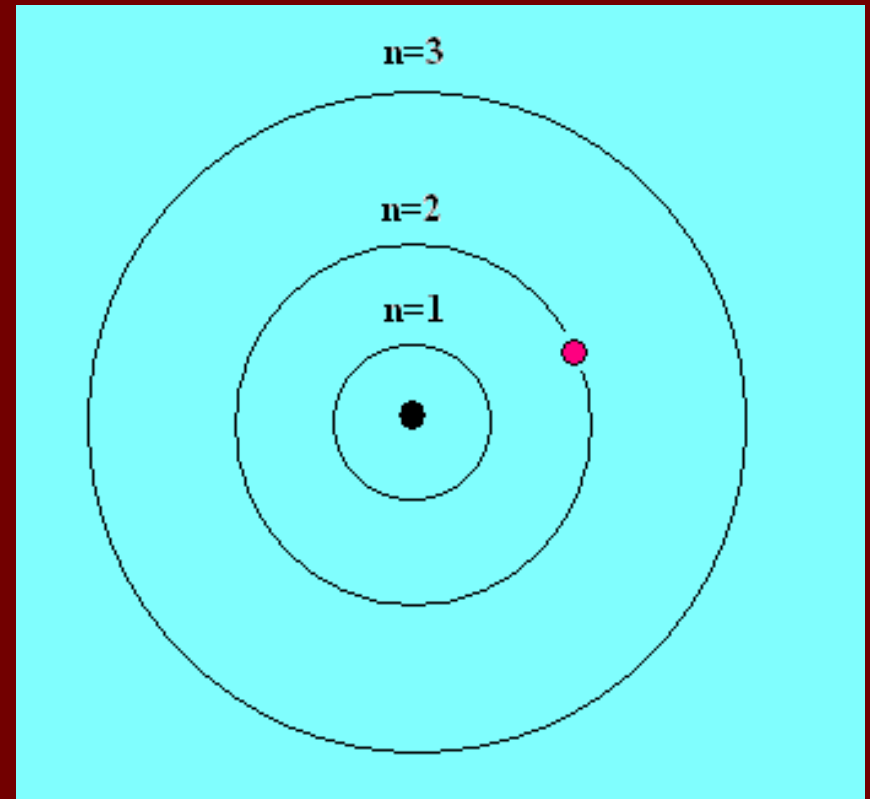
# Emission of Electromagnetic Radiation Upon Electric Stimulation of Preserved *Cucumis sativus*

The Glowing Pickle



# Bohr's Atomic Model

- Proposed by Niels Bohr in 1916 to explain why electrons do not spiral into nucleus



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- Main Ideas:
  - Electrons orbit in discrete energy levels





# Bohr's Atomic Model

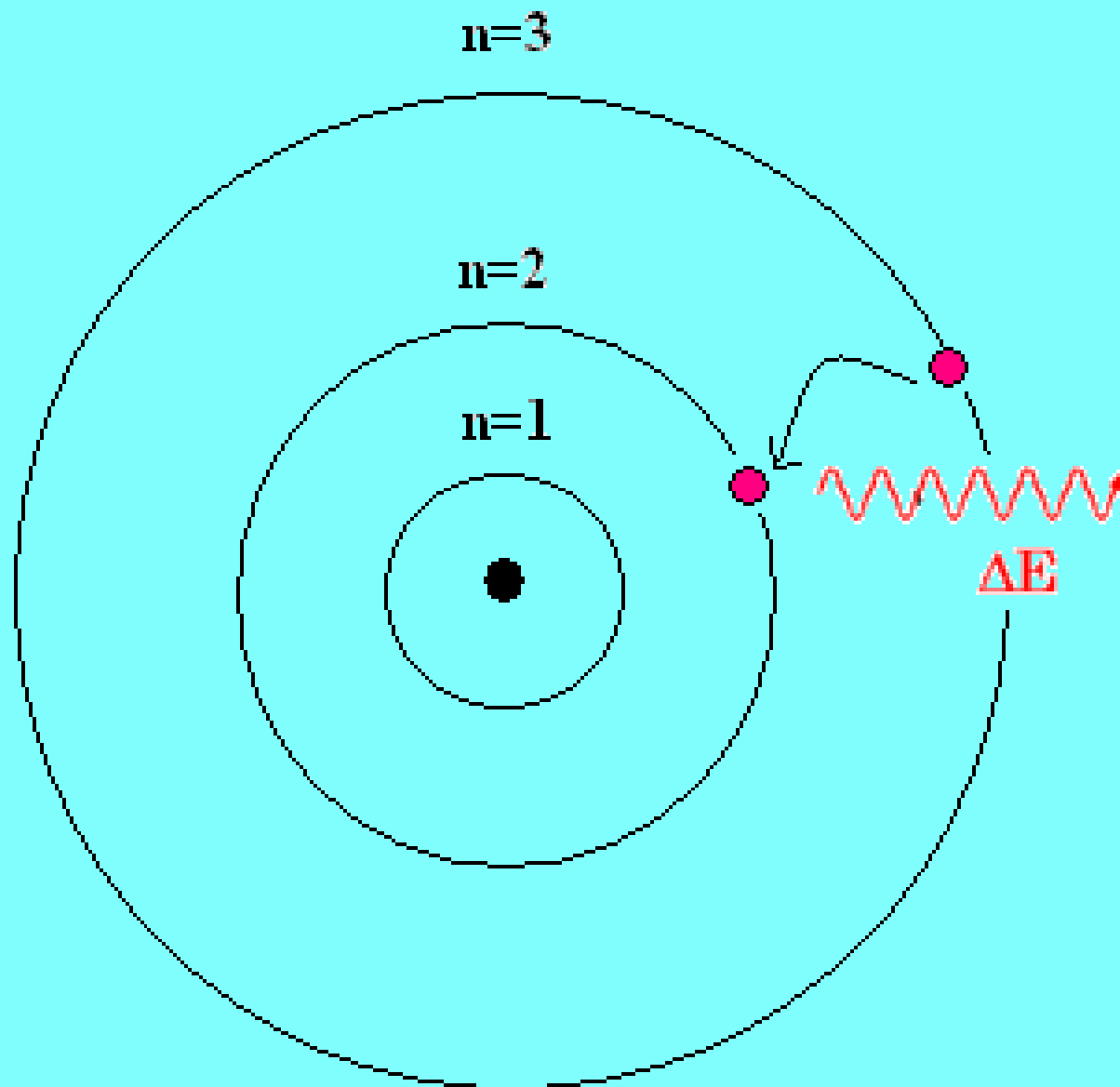
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  - Electrons do not lose energy during orbit



# Bohr's Atomic Model

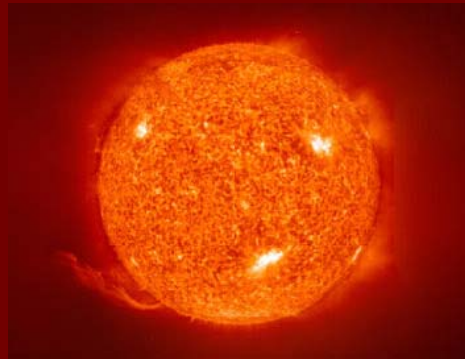
- Proposed by Niels Bohr in 1916 to explain why electrons do not spiral into nucleus
- Main Ideas:
  - Electrons orbit in discrete energy levels
  - Electrons do not lose energy during orbit
  - When electrons change orbit, the energy emitted or absorbed is exactly the energy difference between orbits





# Excitation

- Electrons gain energy and jump to higher orbitals by:
  - Photoexcitation: electron absorbs light energy



<http://voyager.jpl.nasa.gov/multimedia/images/sun.jpg>

- Electrical excitation: electron absorbs energy from another electron



# De-excitation

- Electron wants to return to lowest energy state



# De-excitation

- Electron wants to return to lowest energy state
- Reverse of excitation



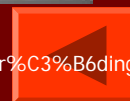
# De-excitation

- Electron wants to return to lowest energy state
- Reverse of excitation
- The energy of the emitted photon (or absorbed photon for excitation) is the same as the energy difference between orbitals
  - $E = hf = hc/\lambda$



# Quantum Model

- Bohr model useful, but not exactly correct
- Erwin Schroedinger and Werner Heisenberg





# Quantum Model

- Bohr model useful, but not exactly correct
- Erwin Schroedinger and Werner Heisenberg
- Quantum model states that electron energy is dependent on more than just orbital number:
  - Principal quantum number,  $n$
  - Orbital quantum number,  $l$
  - Magnetic quantum number,  $m$
  - Spin,  $s$



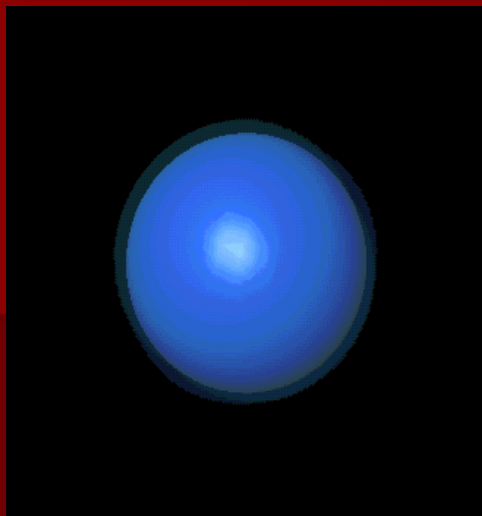
# Heisenberg Uncertainty Principle

- Position and momentum of a particle cannot both be defined with certainty simultaneously
- $\Delta x \Delta p \geq \hbar/2 = h/4\pi$

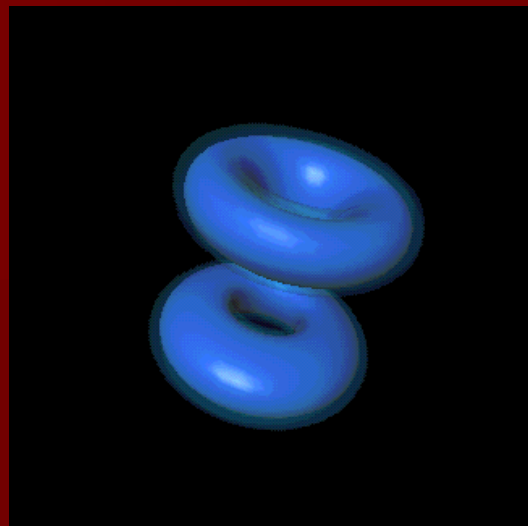


<http://www.aip.org/history/heisenberg/p08.htm>

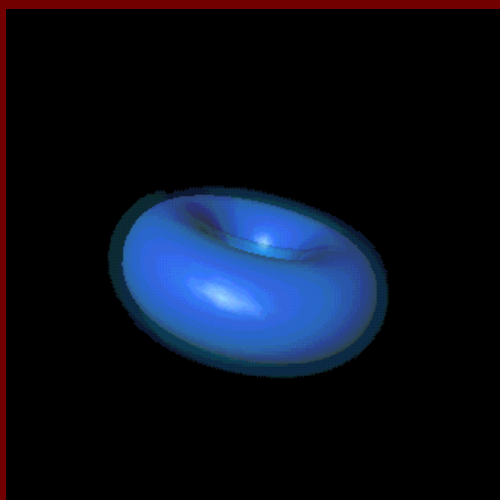




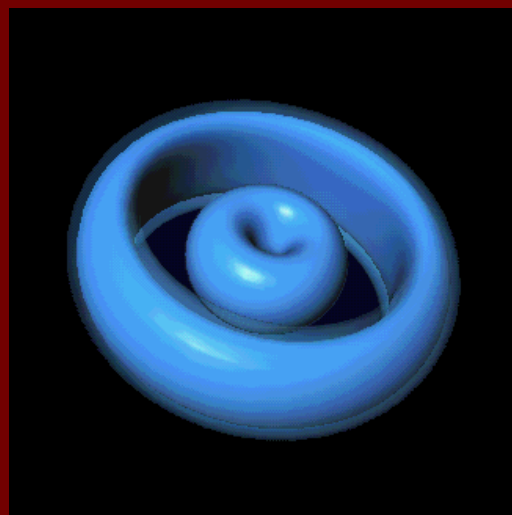
$n=1, l=0, m=0$



$n=3, l=2, m=1$



$n=3, l=2, m=2$



$n=4, l=2, m=2$



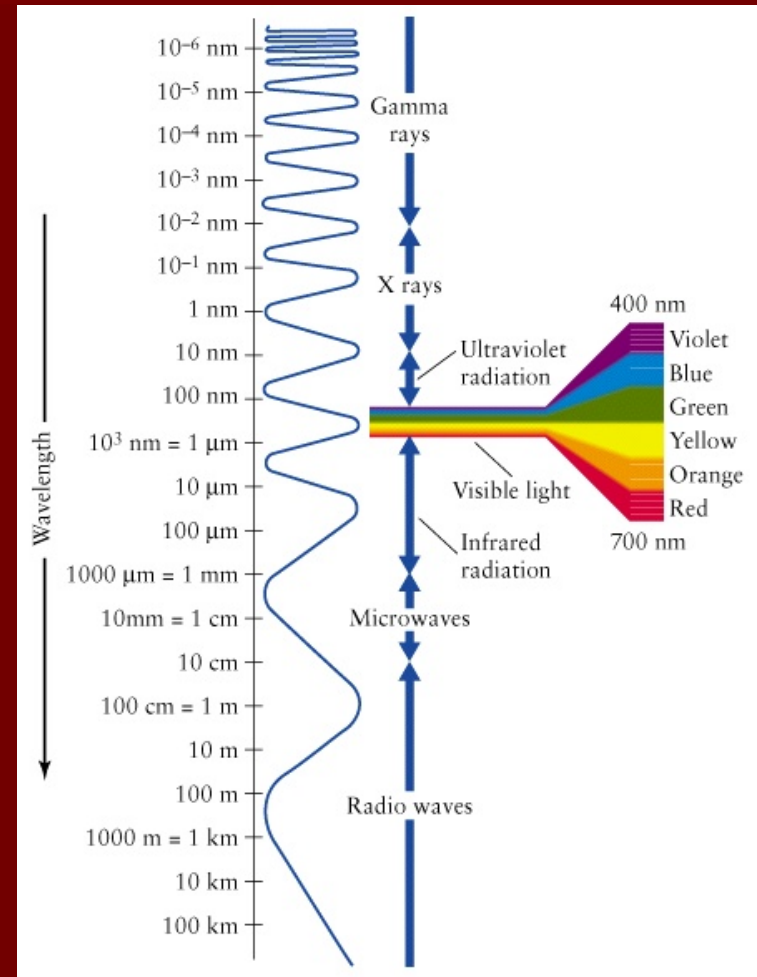
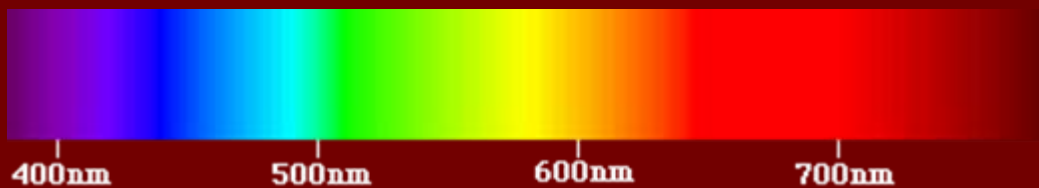
# Spectra

- Each element has distinct energy levels and therefore emits (or absorbs) distinct colours of light
- A spectrum is the combination of all of the different colours of light that can be emitted (or absorbed) by an element



# Spectra

- Continuous spectrum:
  - All colours in the visible wavelength range



# Spectra

- Continuous spectrum
- Emission spectrum:
  - Light emitted during transition from a higher to lower energy level



HYDROGEN



# Spectra

- Continuous spectrum
- Emission spectrum
- Absorption spectrum:
  - Light absorbed during transition from lower to higher energy level



# Sodium Spectrum

- The dominant hue produced by sodium is in the yellow range of the spectrum





# Sodium Spectrum

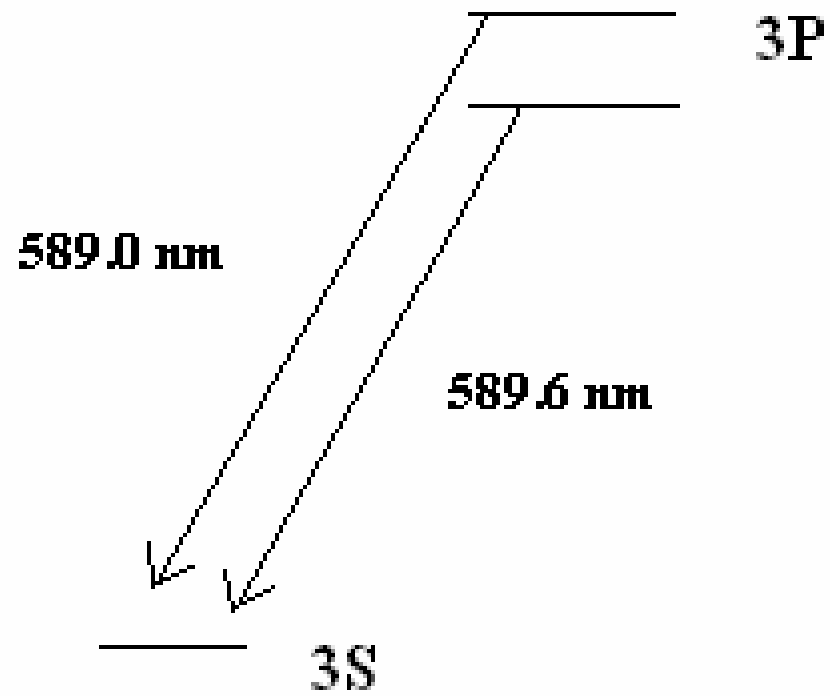
- The dominant hue produced by sodium is in the yellow range of the spectrum
- This wavelength is produced by an electron falling from a 3p (higher energy) to a 3s (lower energy) orbit



# Sodium Spectrum

- The dominant hue produced by sodium is in the yellow range of the spectrum
- This wavelength is produced by an electron falling from a 3p (higher energy) to a 3s (lower energy) orbit
- What is actually seen through a spectroscope are two yellow lines (not one) at 588.9950nm and 589.5924nm





# Quantum Pickle?

- Pickles are preserved in salt, NaCl, which dissociates into Na<sup>+</sup> and Cl<sup>-</sup> ions when in solution
- When an electric current is passed through the pickle, the current excites the sodium electrons into higher energy levels which quickly drop back down to their lowest energy state making the pickle glow yellow



# Details

- Current boils water



# Details

- Current boils water
- Vapour non-conductive



# Details

- Current boils water
- Vapour non-conductive
- Conduction and heating start again



# Details

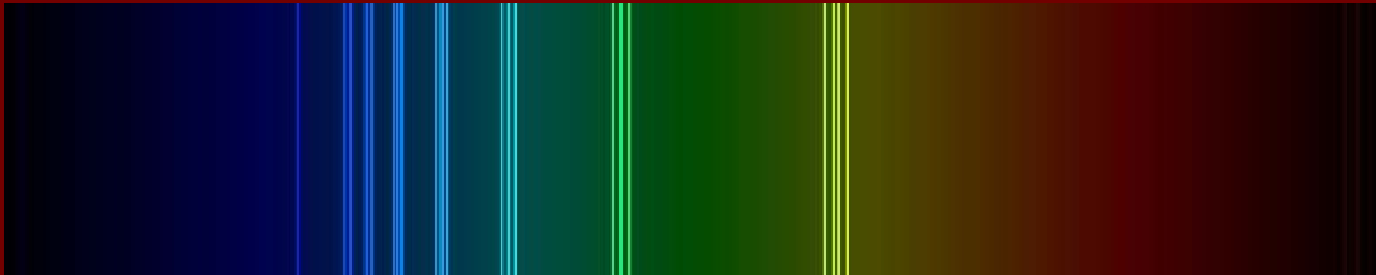
- Current boils water
- Vapour non-conductive
- Conduction and heating start again
- Characterization of Organic Illumination Systems
  - Hamburg, et al.





# Potassium

- Characteristic colour in violet range



<http://webmineral.com/help/FlameTest.shtml>







