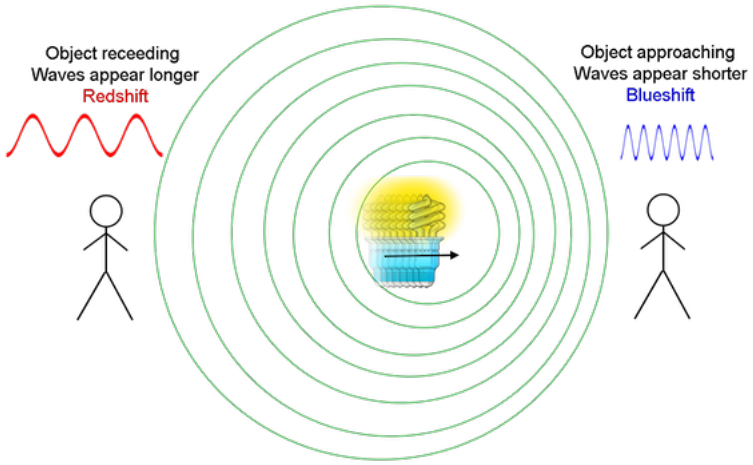
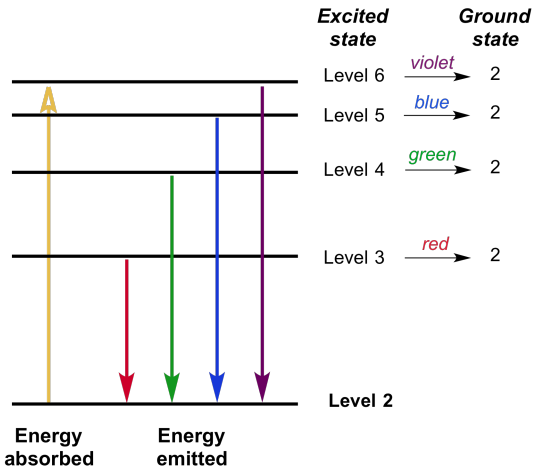
Doppler Effect and Photoelectric Effect

Definitions

Doppler effect: Change in wavelength (or frequency) of light coming from an object because it is in motion.



Photoelectric effect: Electron may be excited to a higher (discrete) energy level from the ground state (potentially by a photon) and when it drops down energy levels it emits a photon with the same energy that it lost.

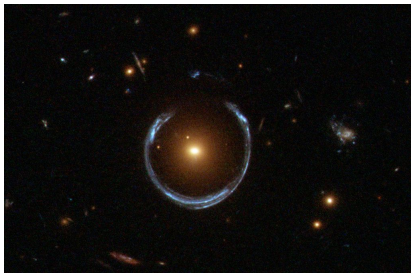


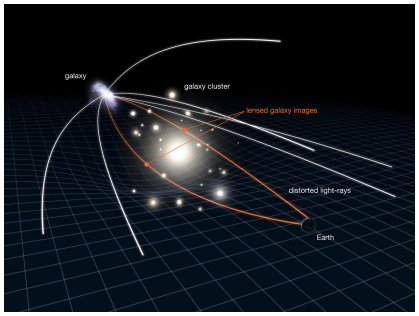
Formulas

1. $z = \frac{\Delta\lambda}{\lambda} \approx \frac{\Delta f}{f} \approx \frac{v}{c}$
2. $v = H_0 d$
3. $v = f\lambda$
4. $E = hf$
5. $hf = \phi + \frac{1}{2}mv^2$

Age of the universe (simplified)

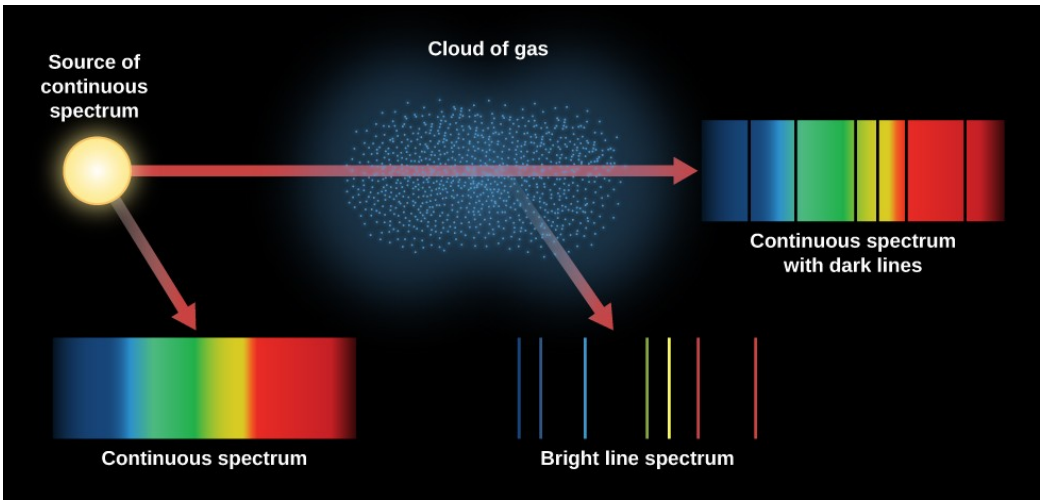
In the formulas above, H_0 is the Hubble's constant. Why is this constant so important? Recall that $v = d/t$ (speed = distance/time). Subbing in $v = H_0 d$ and rearranging you get $t = 1/H_0$. This allows us to calculate the age of the universe.
H_0 (measures the rate of expansion of the universe) seems to be accelerating which means the universe may expand forever at an increasing rate. This is known as the Big Freeze or Big Rip theory (open universe). On the other hand, some people believe the rate will slow down and the universe will start contracting back into a singularity. This is know as the Big Crunch theory (closed universe).
Some evidence for dark matter comes from the fact that certain galaxies behave as if they have much more mass in them. Other evidence is via gravitational lensing.





Spectra Lines

Spectra lines are like the fingerprints of an element. They are the bits of the spectrum that are absorbed by the element when photons pass through it. These frequencies correspond to the differences between the discrete energy levels of the element.



Photoelectric Effect

The photoelectric effect provides some evidence for light being a particle as only specific energies of light can excite electrons instead. If light was a wave it would slowly transfer energy to electrons and they would be excited given enough time from light of any wavelength or frequency. (Recall that the double slit experiment)

Work Function and Threshold Frequency

The work function, ϕ, is the minimum amount of energy required to remove an electron from the atom. The electron that is removed is called a photoelectron. Threshold frequency is the corresponding to the work function. So using $E = hf$ we see the threshold frequency is ϕ/h.