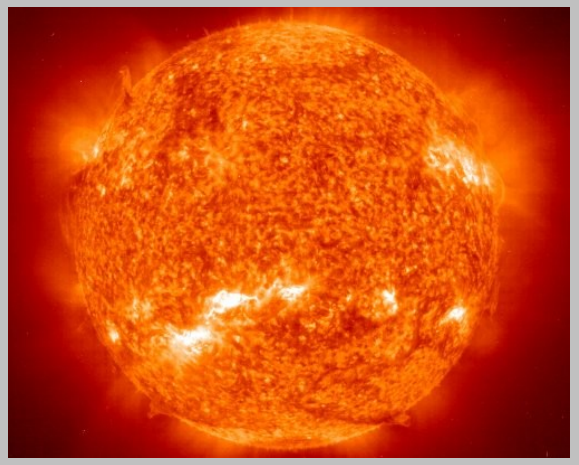
One shift...

...two shift...

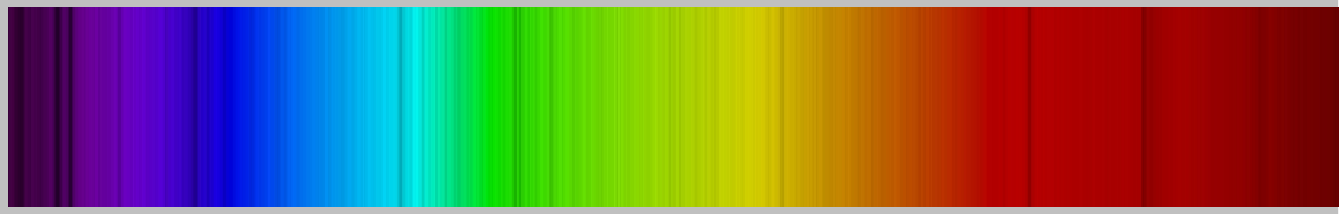
...redshift...

...blueshift.

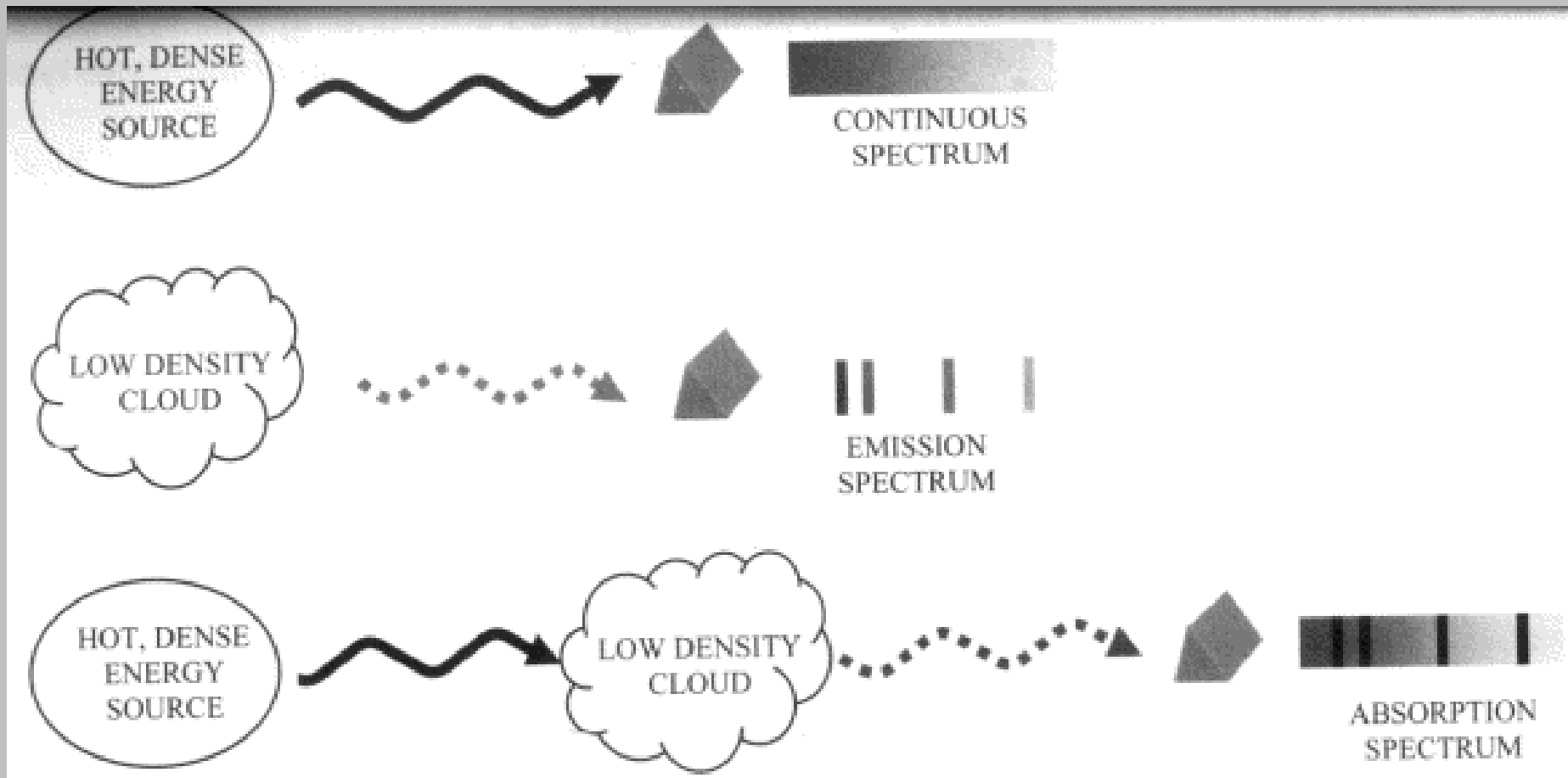
(with acknowledgments to Dan and apologies to Dr. Seuss)



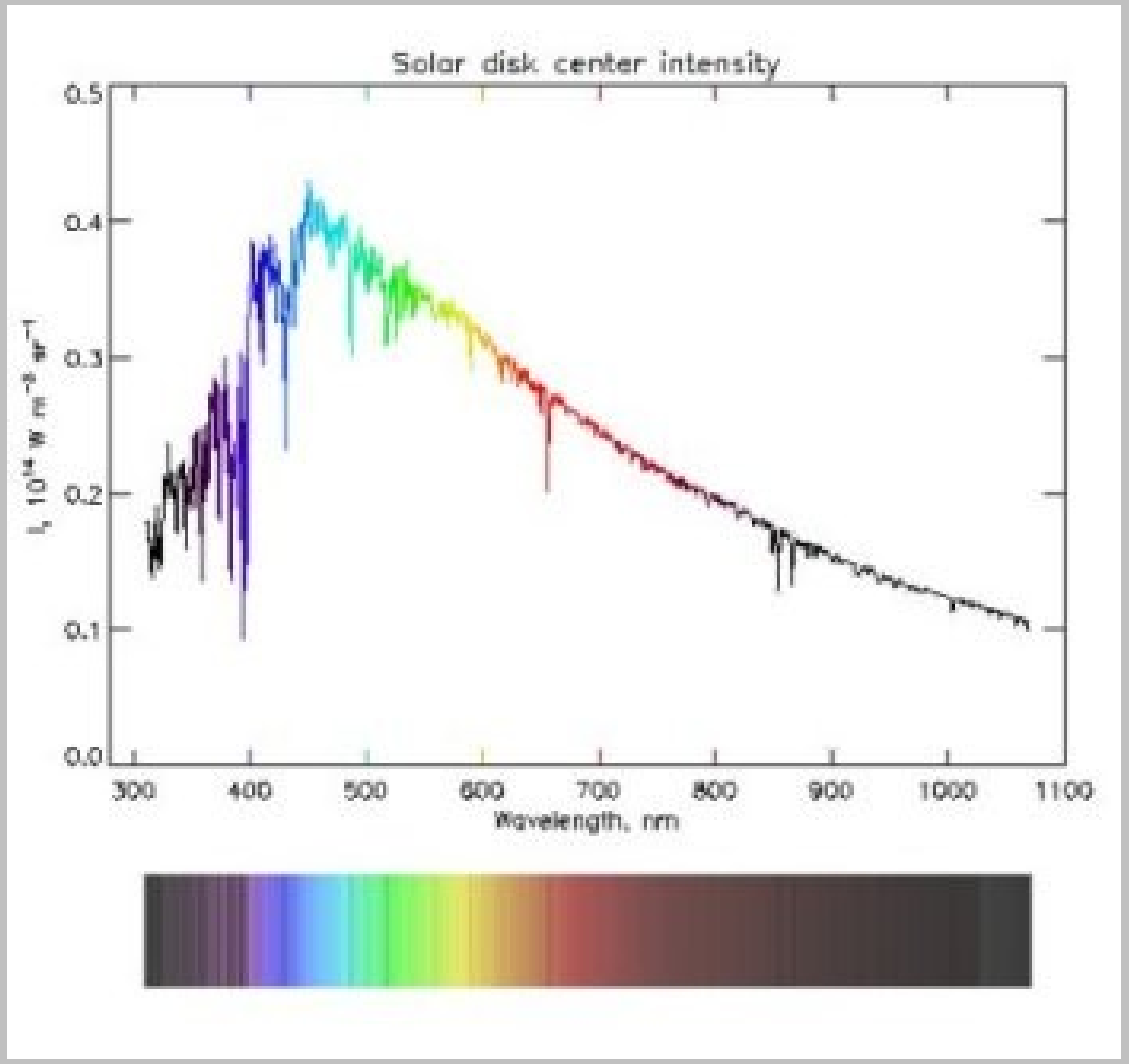
Stars: Absorption Lines



Nebulae: Emission lines

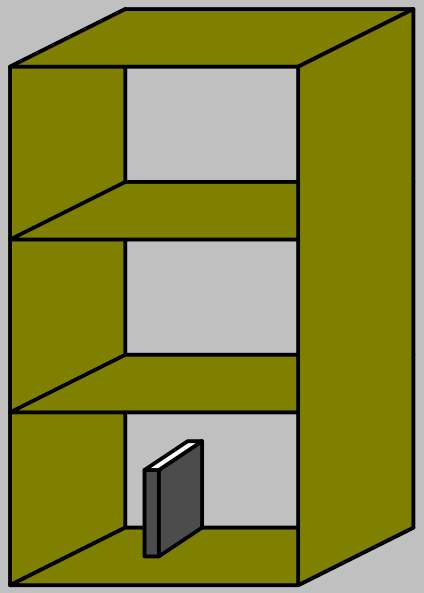

HOT, DENSE ENERGY SOURCE
CONTINUOUS SPECTRUM
LOW DENSITY CLOUD
EMISSION SPECTRUM
HOT, DENSE ENERGY SOURCE
LOW DENSITY CLOUD
ABSORPTION SPECTRUM

Sun's “Atmosphere” (size exaggerated)

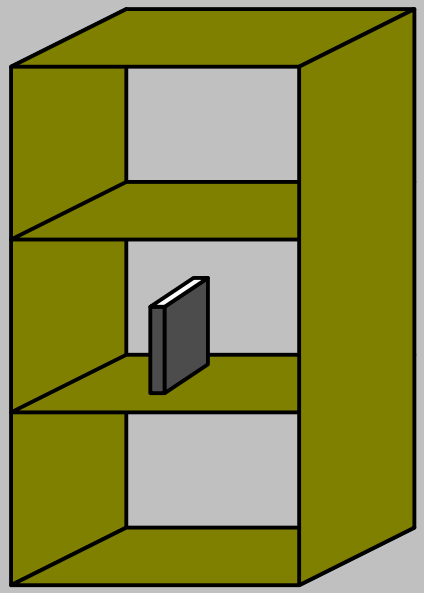


Electrons in atoms can only be in specified energy levels or “orbitals”.

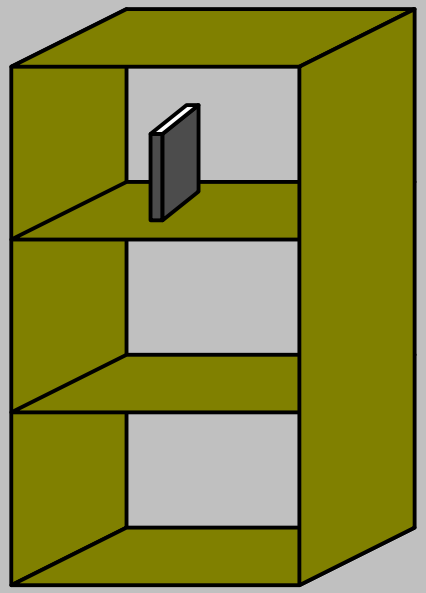
Analogy : bookcase



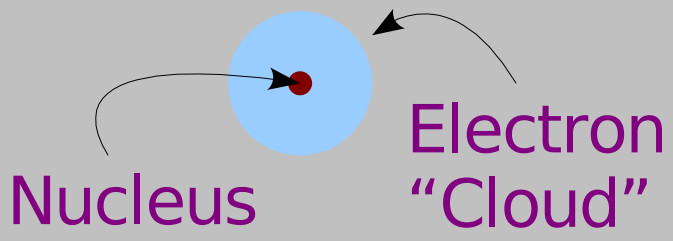
Ground State

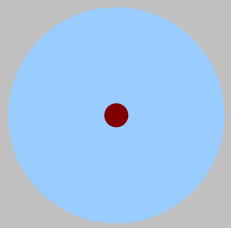


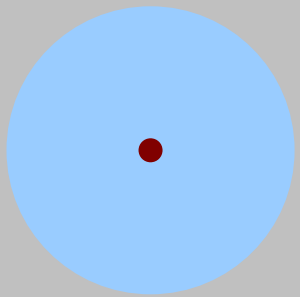
First Excited State

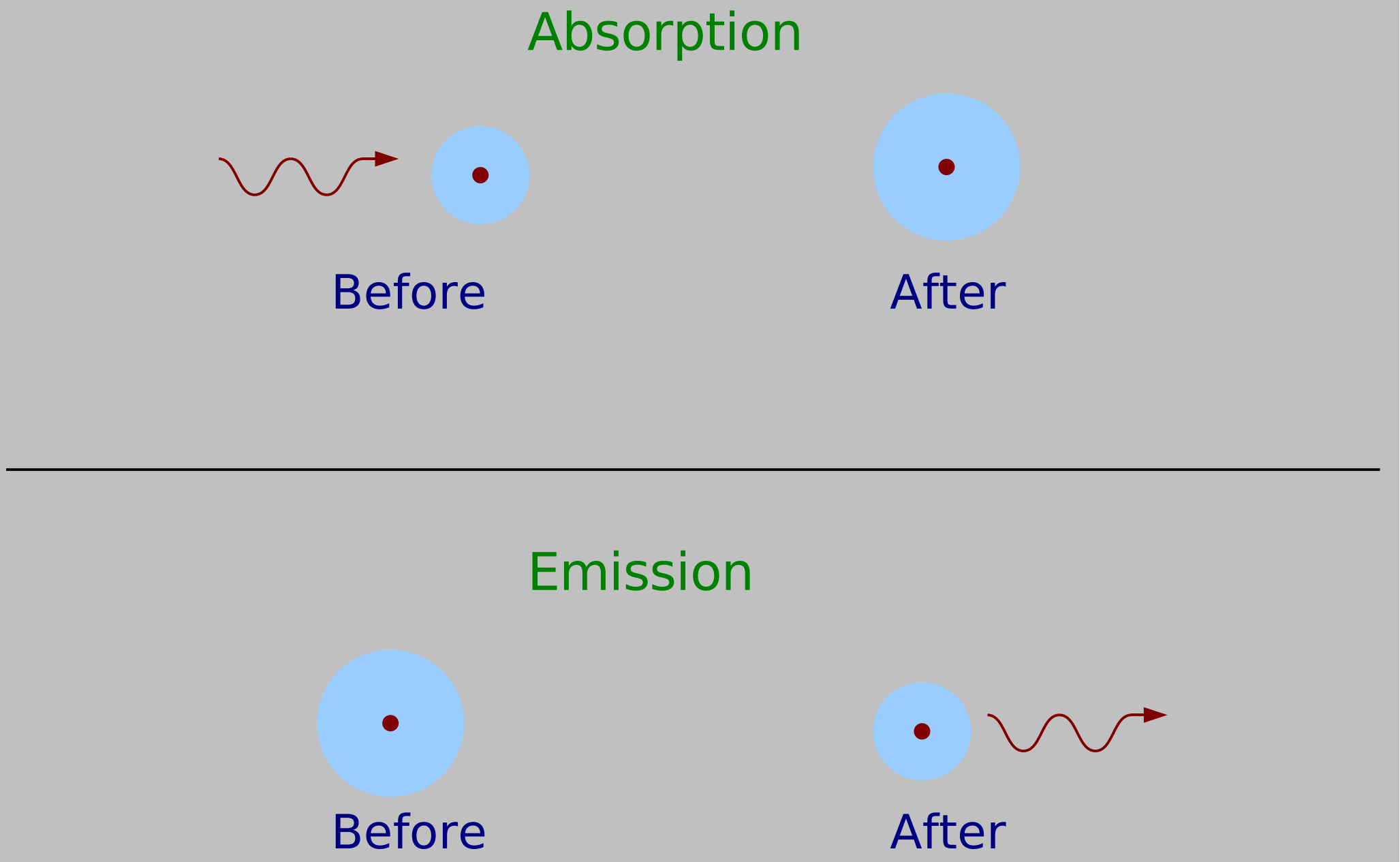


Second Excited State








Absorption
Before
After
Emission
Before
After

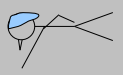
A An Emission Spectrum

B An Absorption Spectrum

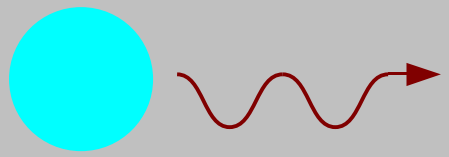
C Nothing

D Something else

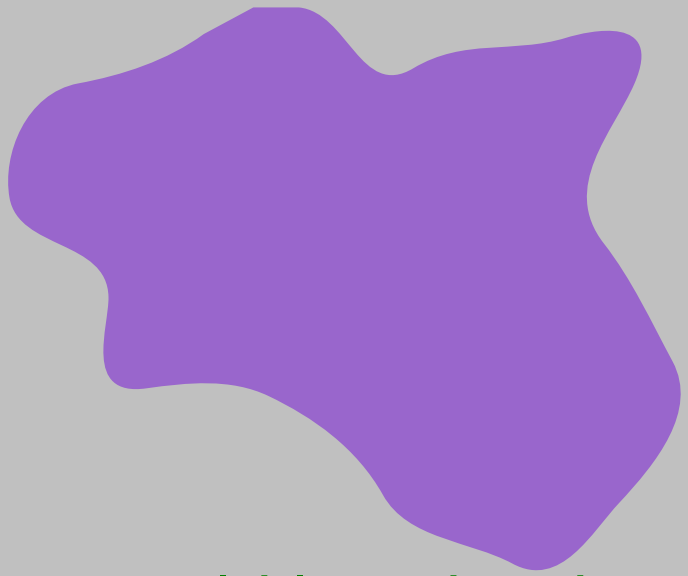
E Not Enough Info



Observer 2



Hot star
(assume pure
continuum source)



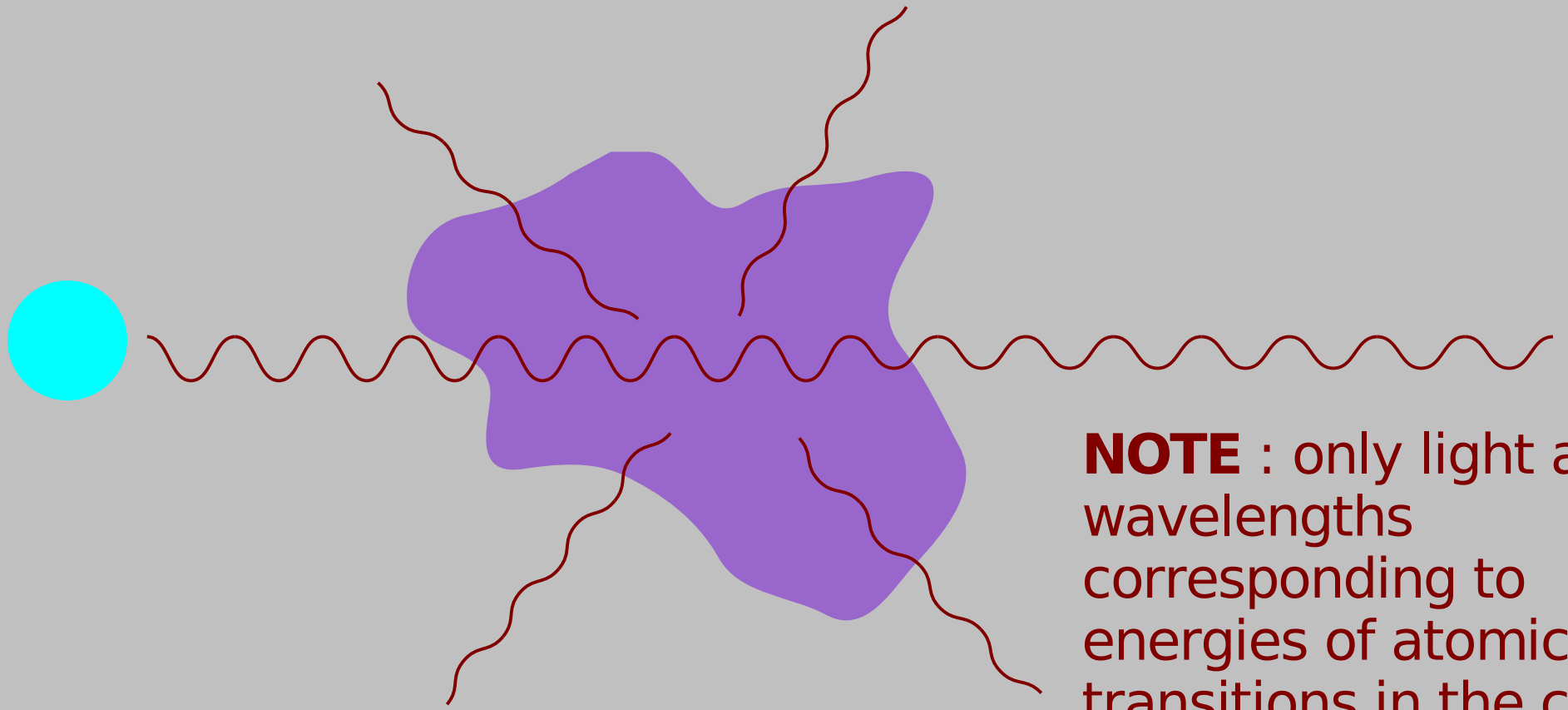
Cold low-density
nebula

Observer 1

What does Observer 1 see? B

What does Observer 2 see? A

Where does the energy absorbed by atoms in the cloud go?

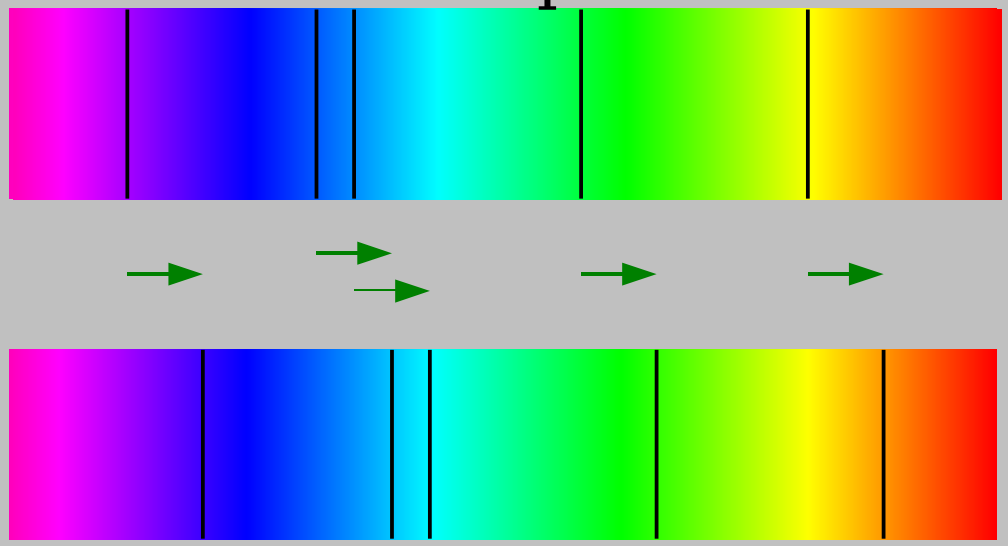


NOTE : only light at wavelengths corresponding to energies of atomic transitions in the cloud will be absorbed!

- It can be re-radiated away in all directions
- It may go to heating up the cloud (motion of the atoms in the cloud.

Redshift

Lines in a spectrum

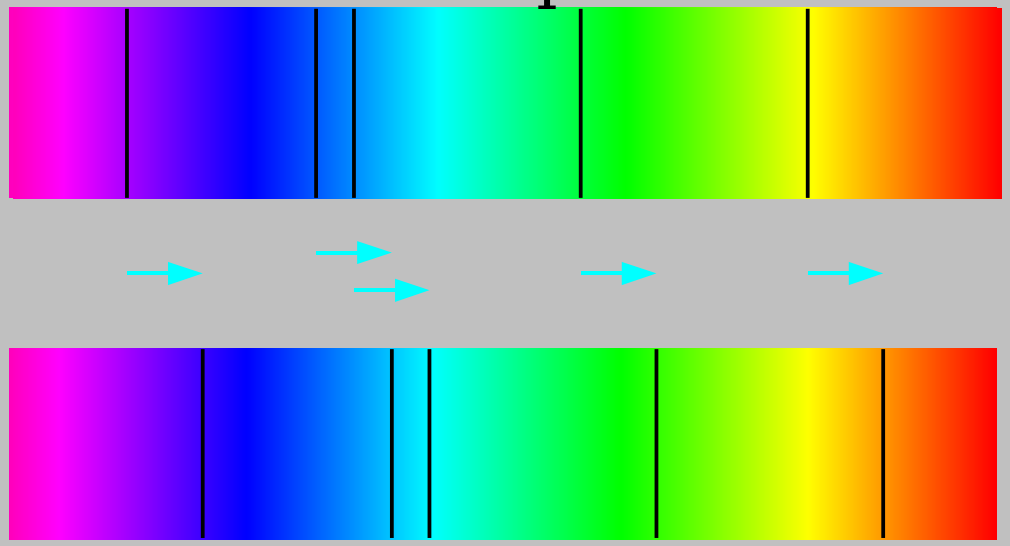


Redshfited Lines

Redshift or Blueshift

Doppler Shift
(for $|v| \ll c$)

$$\frac{v}{c} = \frac{\lambda_{obs} - \lambda_{orig}}{\lambda_{orig}}$$



λ_{obs} = observed wavelength

λ_{orig} = original (emitted or absorbed) wavelength

c = speed of light = 3×10^8 m/s = 3×10^5 km/s

v = speed of source along line of sight

v>0 : receeding

v<0 : approaching

NOTE : If this slide confuses you, ignore it!
You do not need to know or use this equation for this class!

Full Doppler shift formula for any speed :

$$z = \frac{\sqrt{1+\left(\frac{v}{c}\right)^2}}{\sqrt{1-\left(\frac{v}{c}\right)^2}} - 1 = \frac{\lambda_{obs} - \lambda_{orig}}{\lambda_{orig}}$$

Redshift or Blueshift?

What will you see?

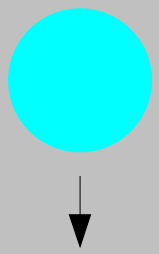
A Redshift
B Neither
C Blueshift
D Not Enough Info

A source emits in the infrared at 11,000 Å.
You observe it in blue light at 4,500 Å. C

A source emits in the infrared at 11,000 Å.
You observe it in red light at 6,700 Å. C

A source is moving towards you at 300 km/s. C

You are moving towards a source at 300 km/s. C



...answer hazy, ask again later...