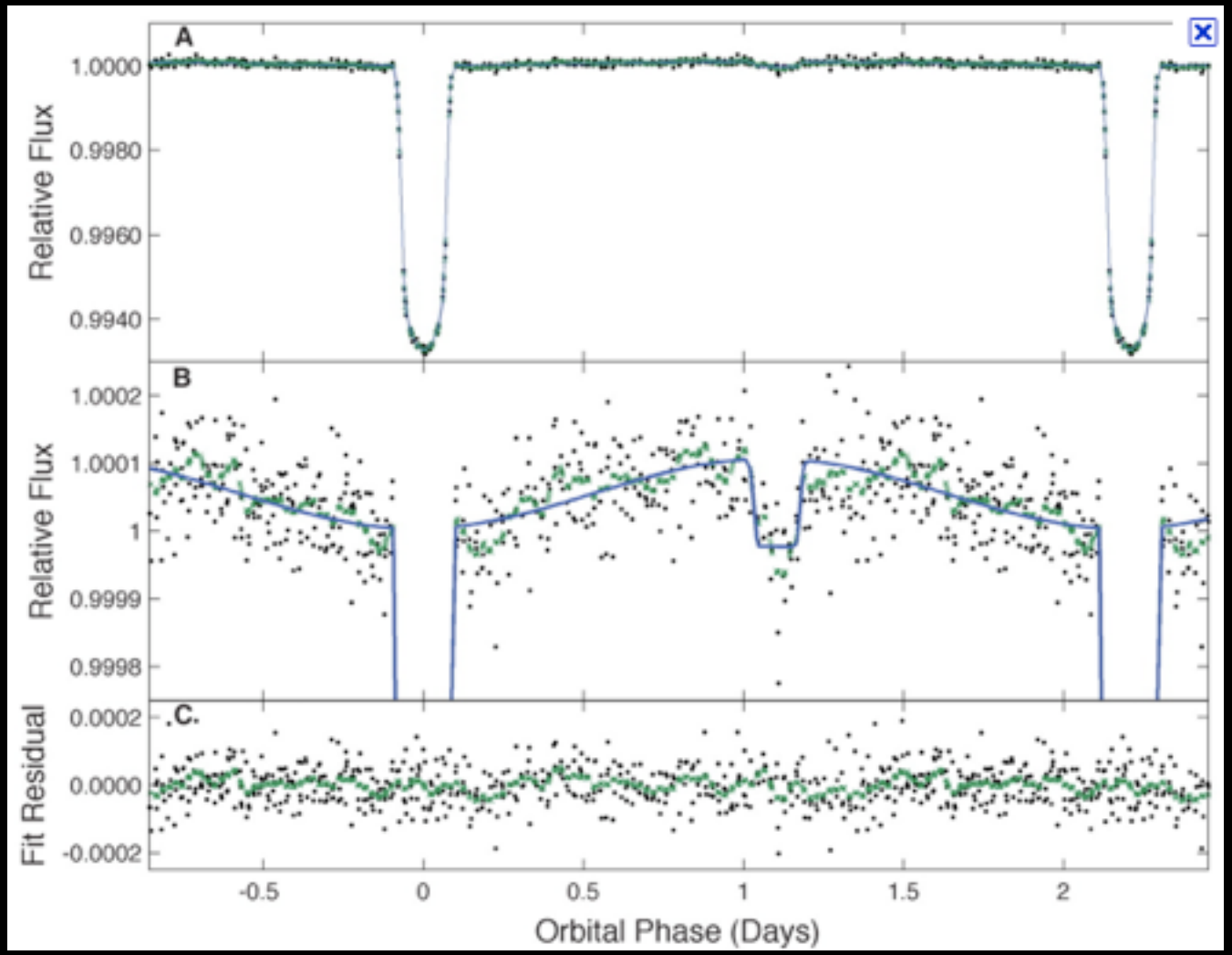
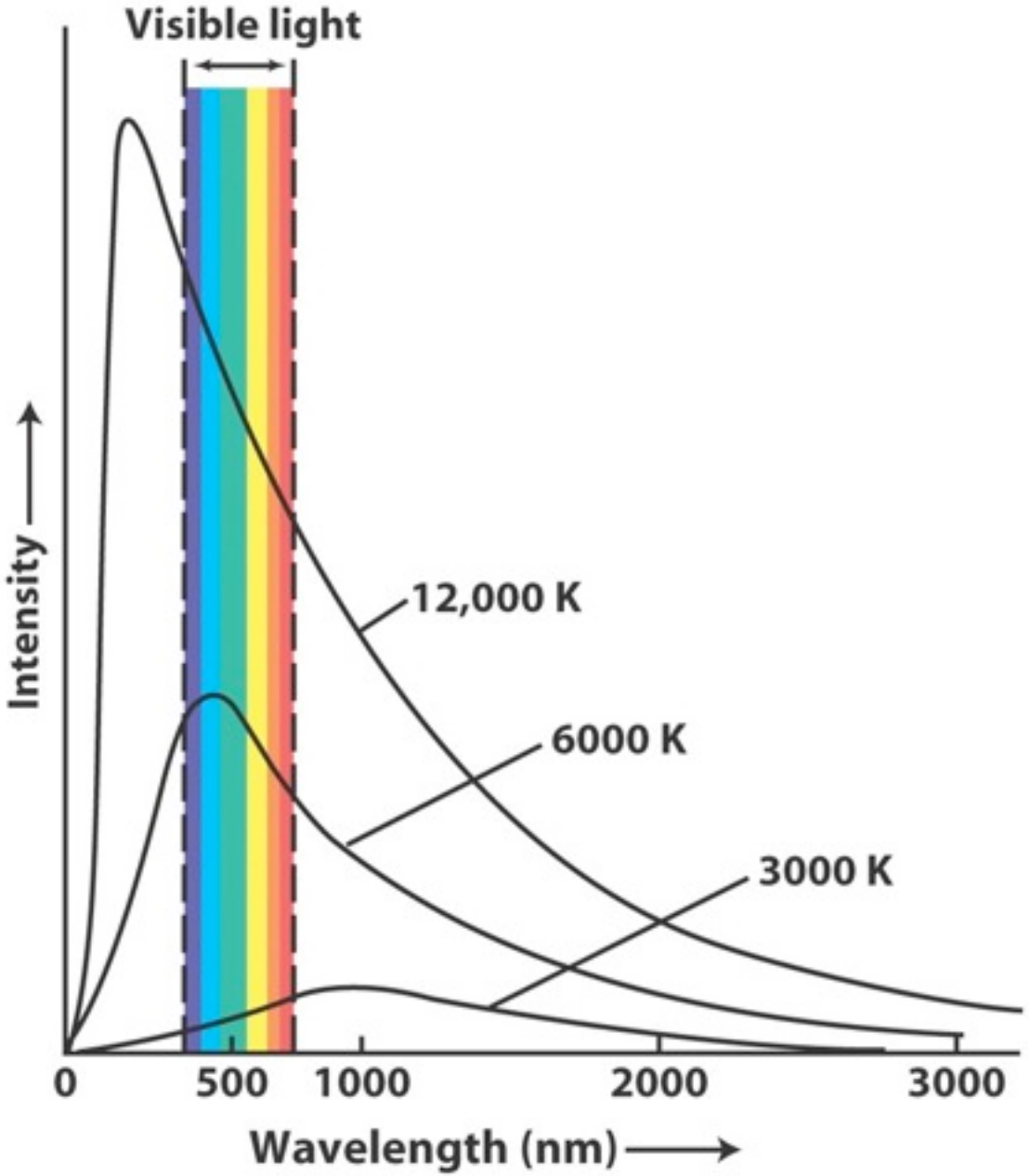
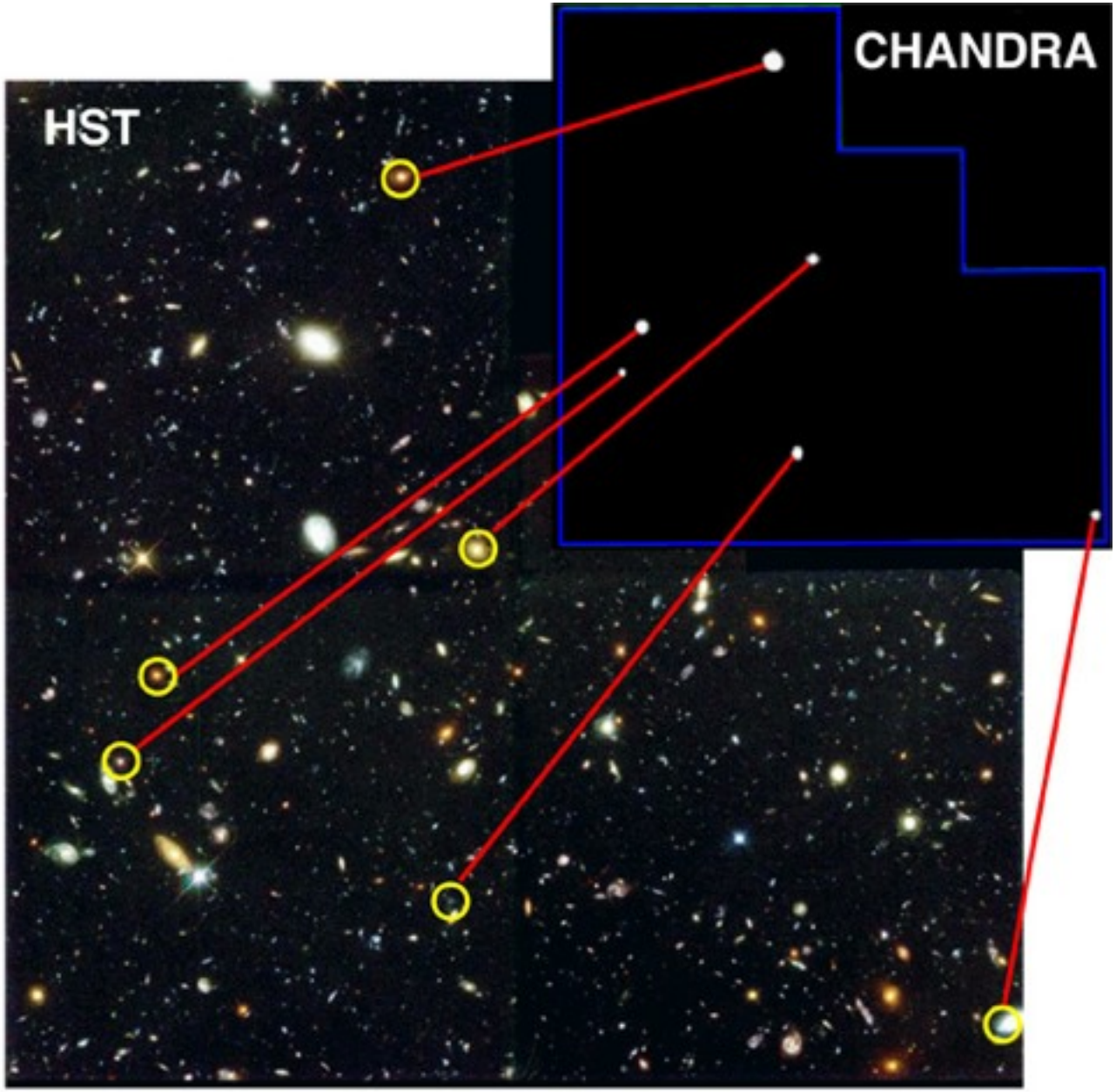
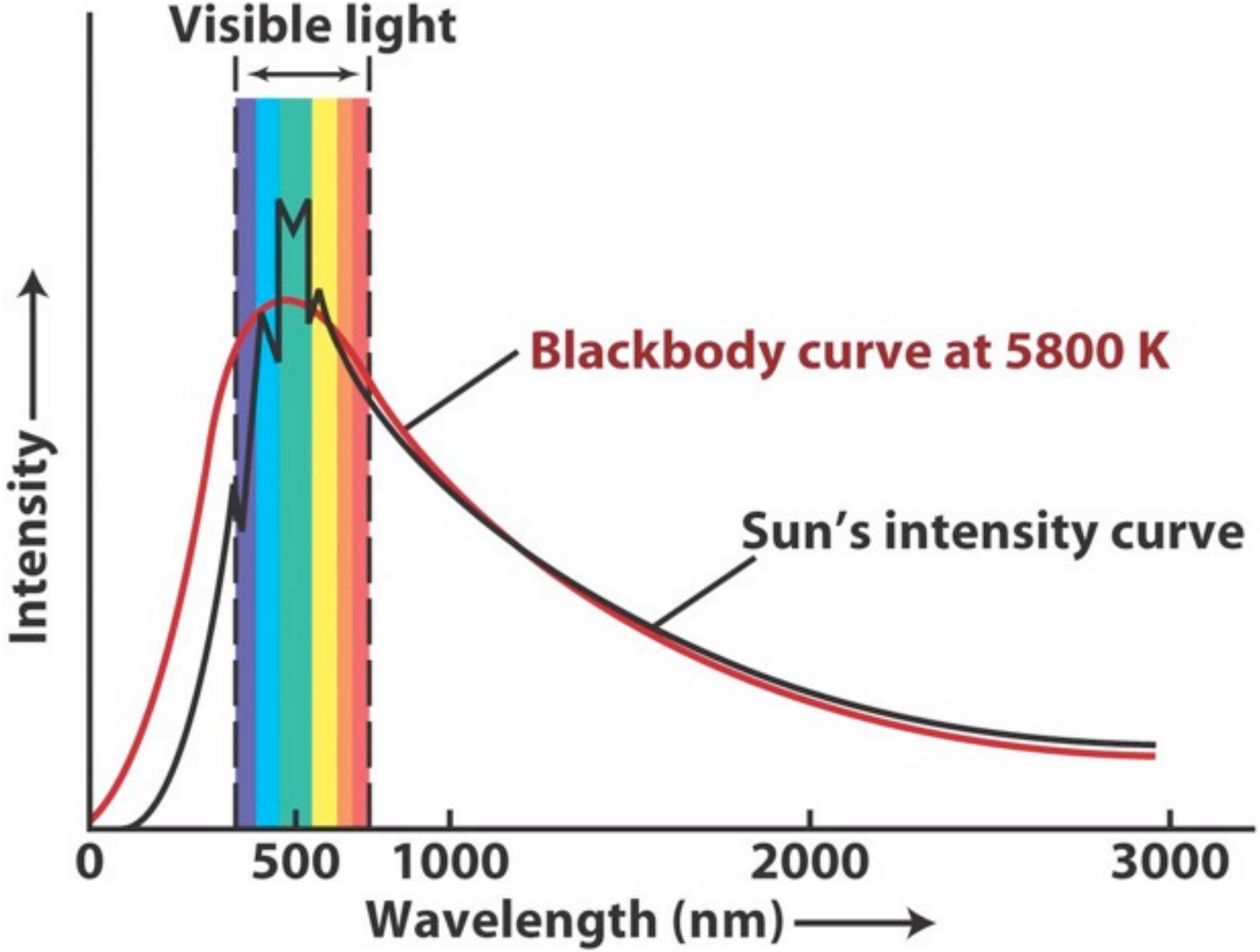
Astro 220:
Galaxies and cosmology

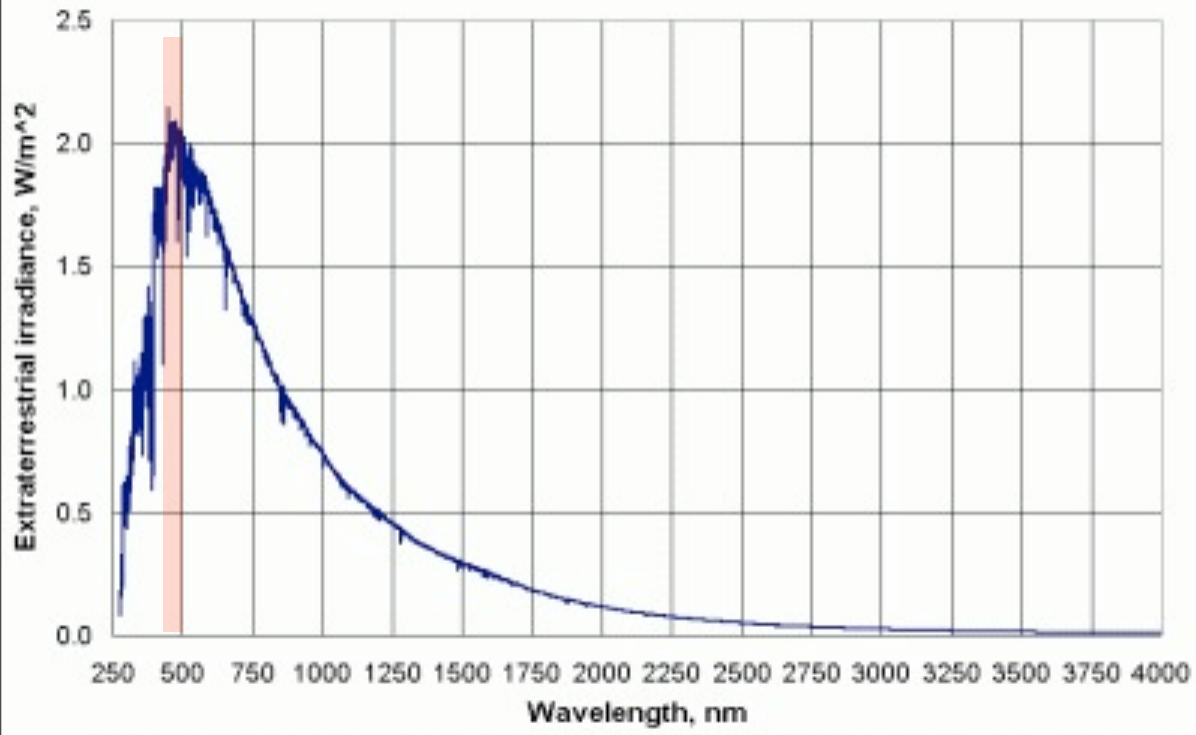


Sept 8, 2010

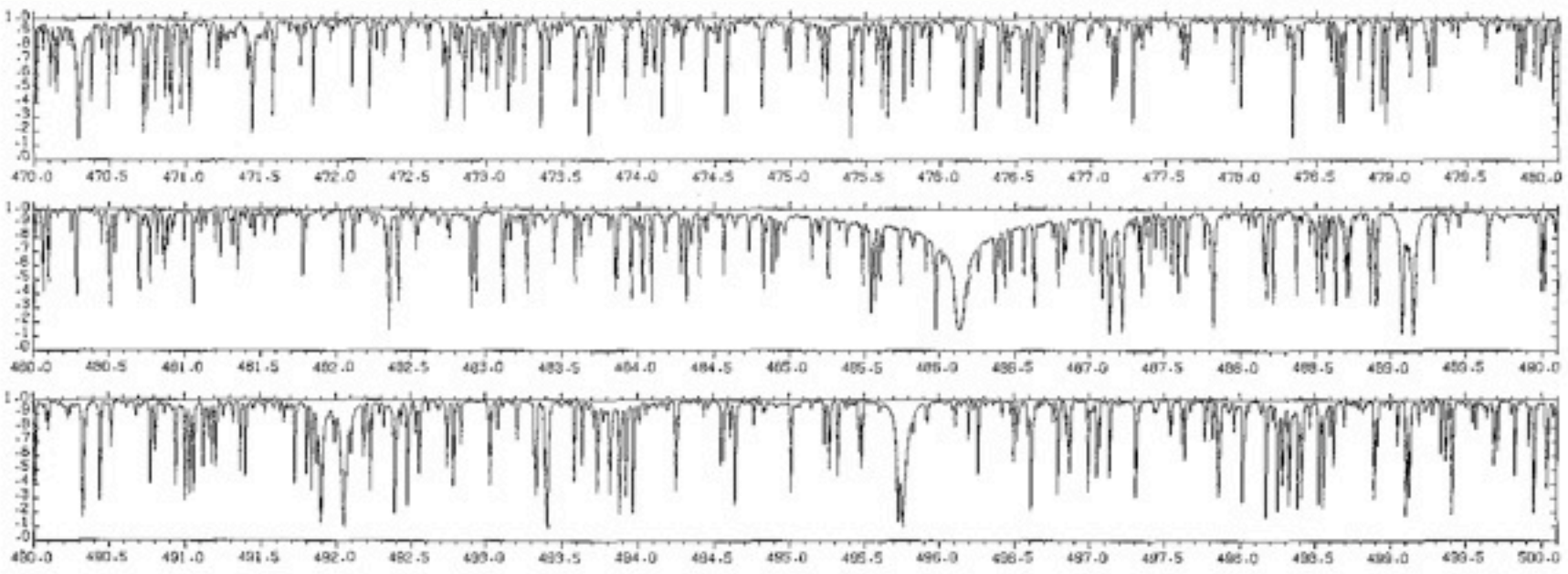

Visible light
Intensity
12,000 K
6000 K
3000 K
0
500
1000
2000
3000
Wavelength (nm)

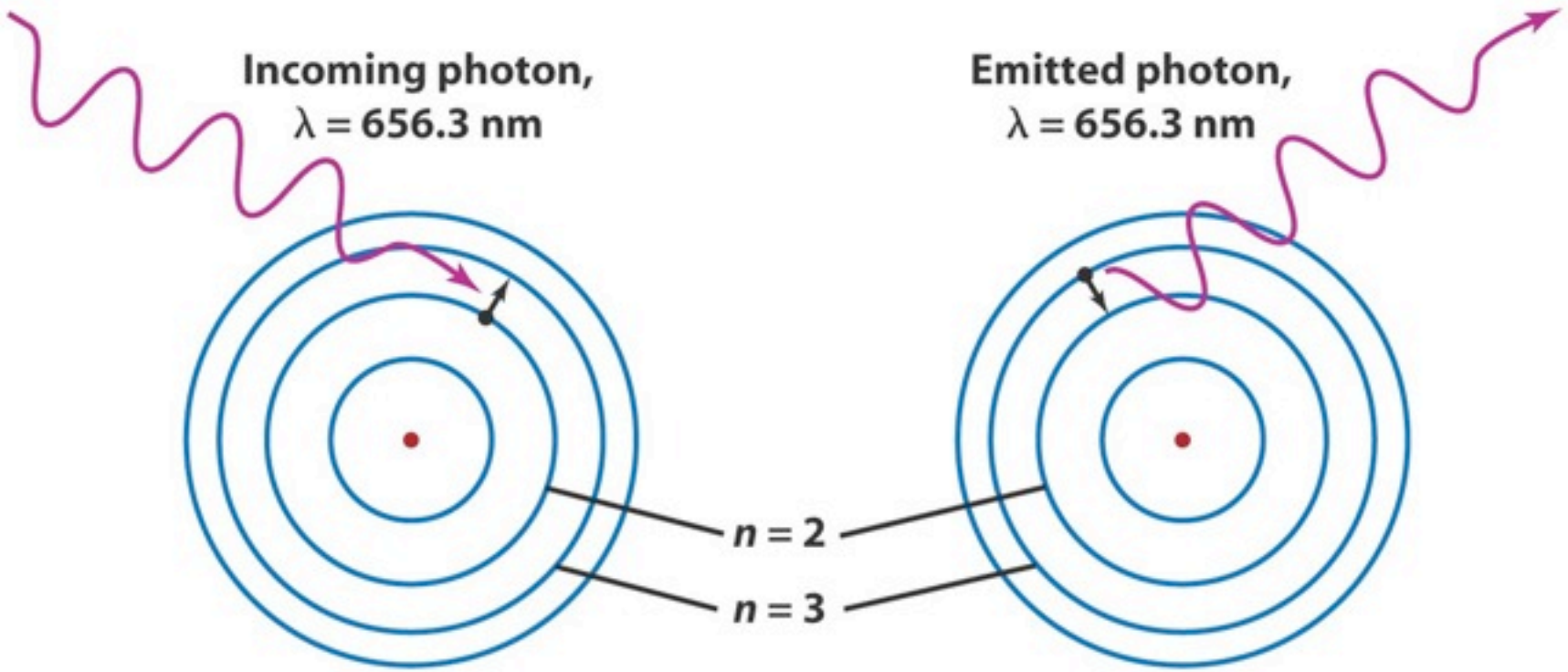

CHANDRA
HST


Visible light
Intensity
Blackbody curve at 5800 K
Sun's intensity curve
0
500
1000
2000
3000
Wavelength (nm)



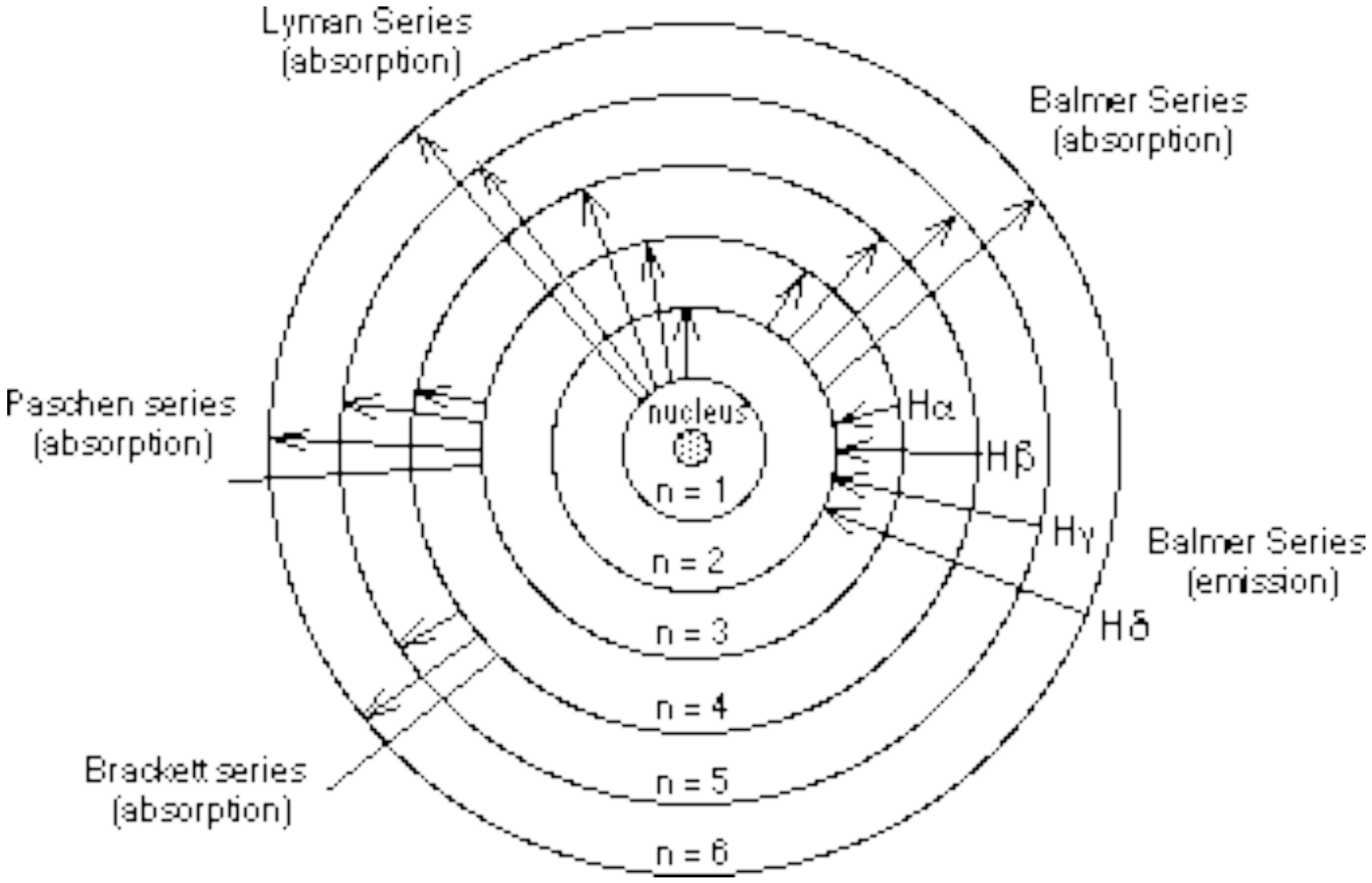
Solar spectrum has many absorption lines

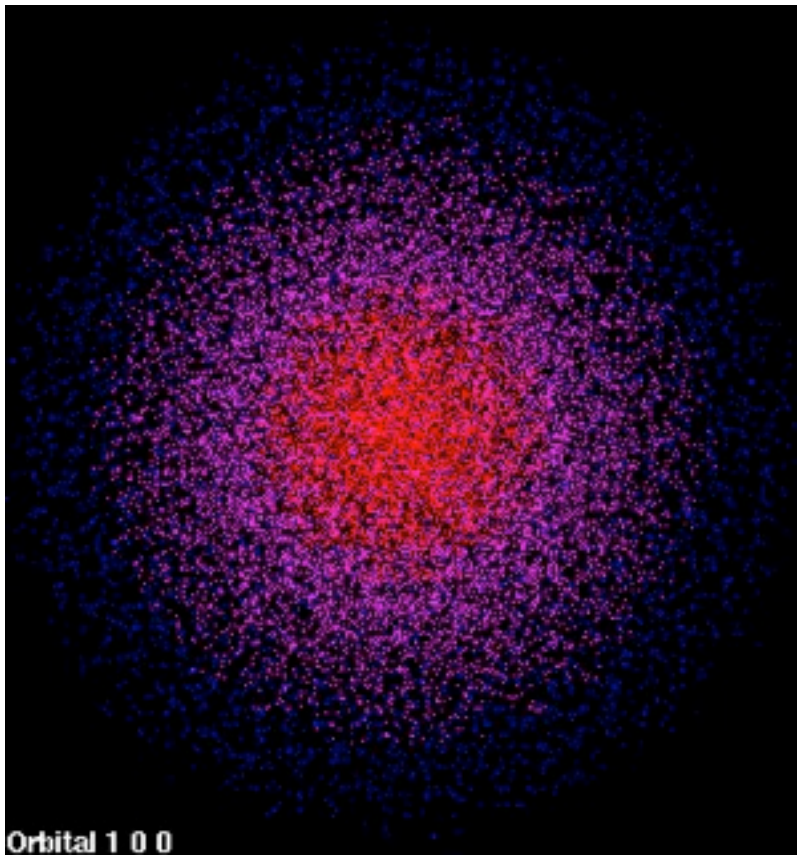


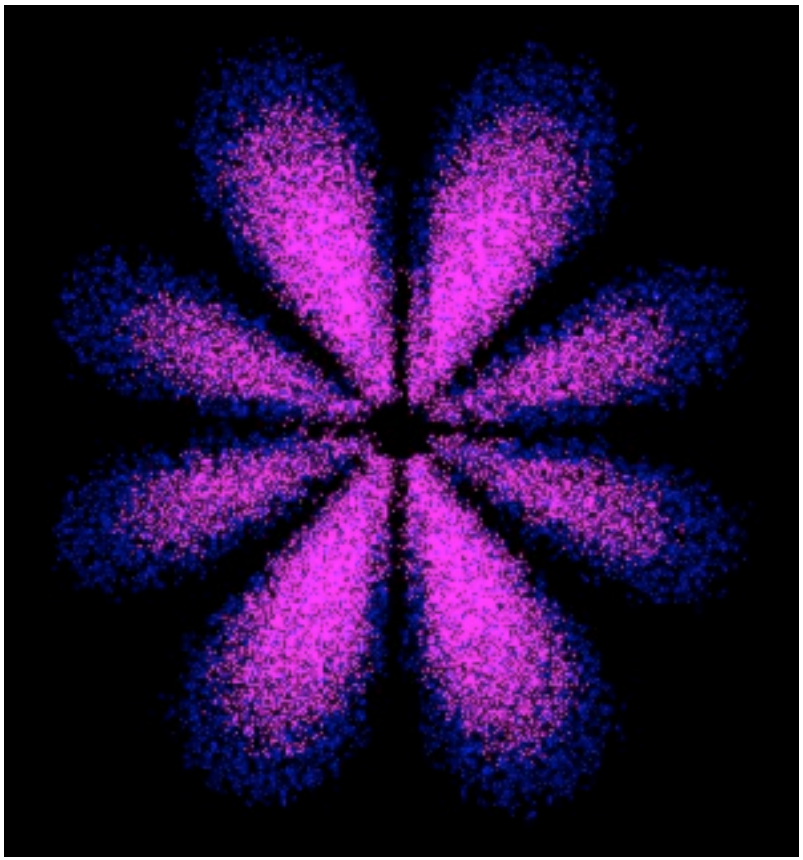


(a) Atom absorbs a 656.3-nm photon; absorbed energy causes electron to jump from the $n = 2$ orbit up to the $n = 3$ orbit

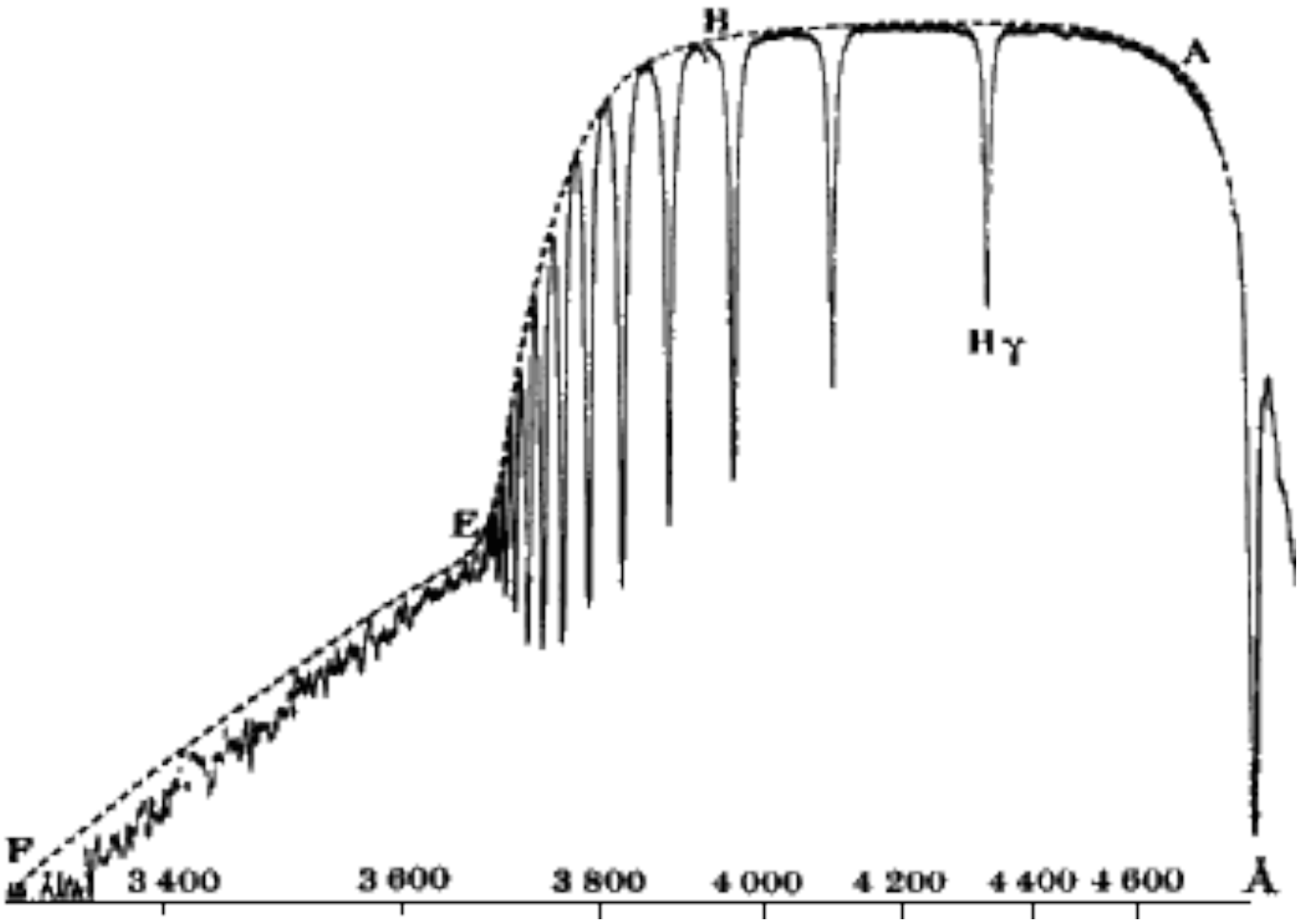
(b) Electron falls from the $n = 3$ orbit to the $n = 2$ orbit; energy lost by atom goes into emitting a 656.3-nm photon


Lyman Series
(absorption)
Balmer Series
(absorption)
Paschen series
(absorption)
nucleus
n = 1
n = 2
n = 3
n = 4
n = 5
n = 6
Hα
Hβ
Hγ
Hδ
Balmer Series
(emission)
Brackett series
(absorption)

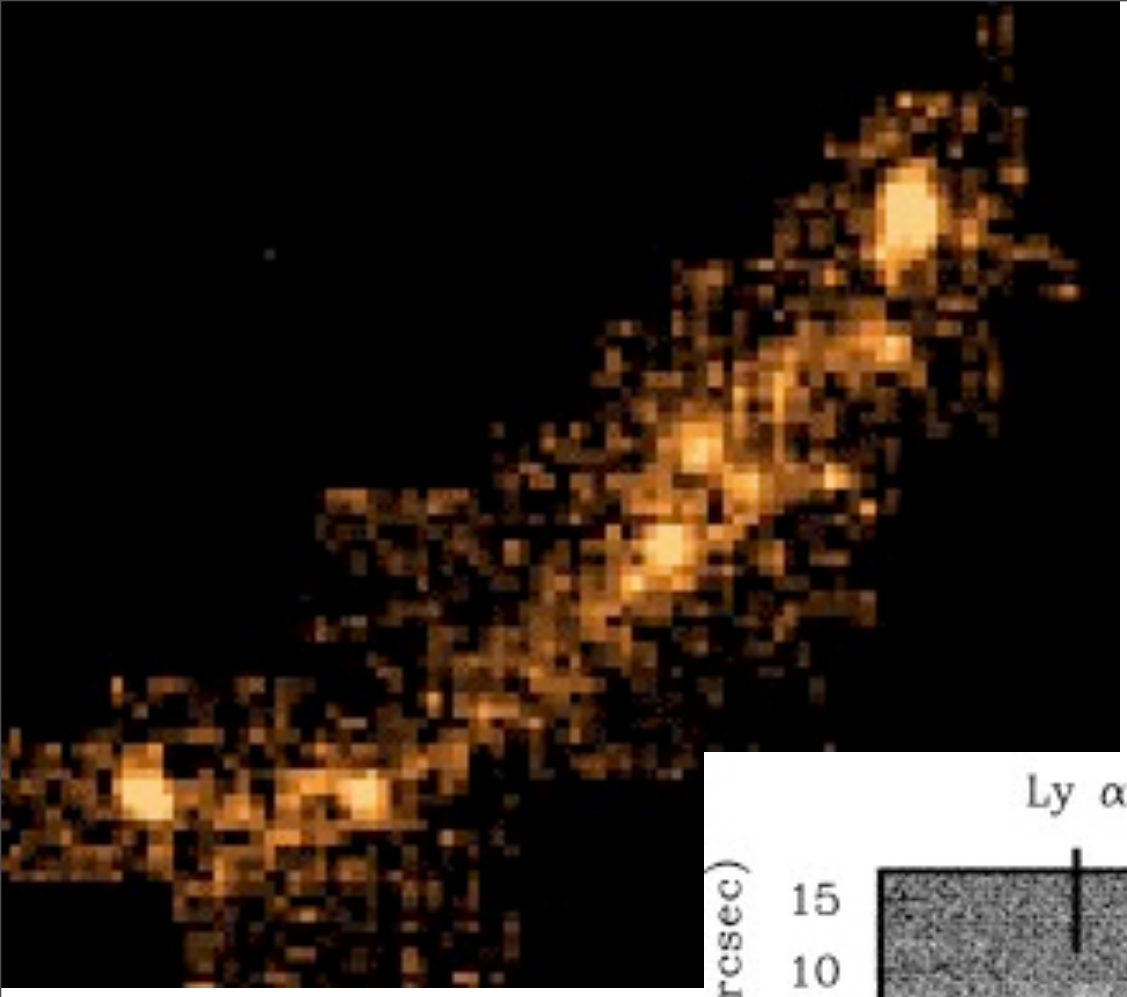


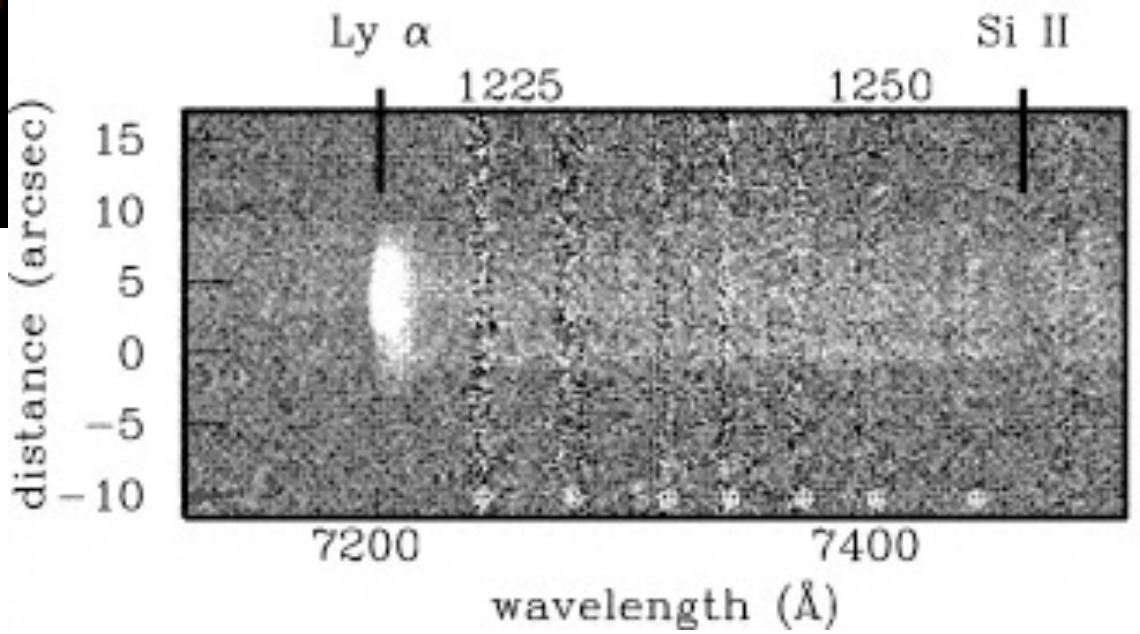


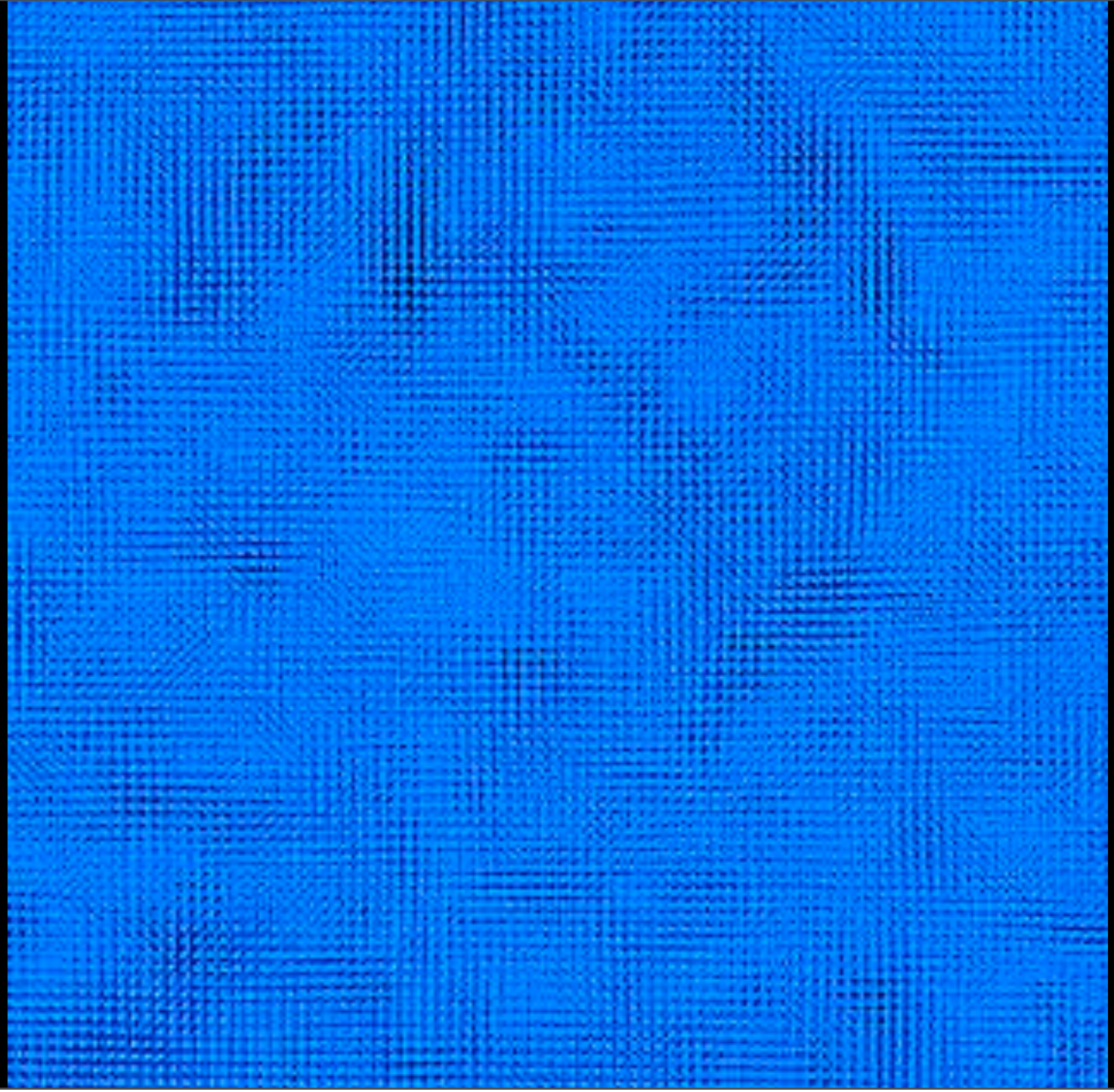
Electron probability distributions in Hydrogen atom
left: n=1,l=0,m=0; right: n=5,l=4,m=1

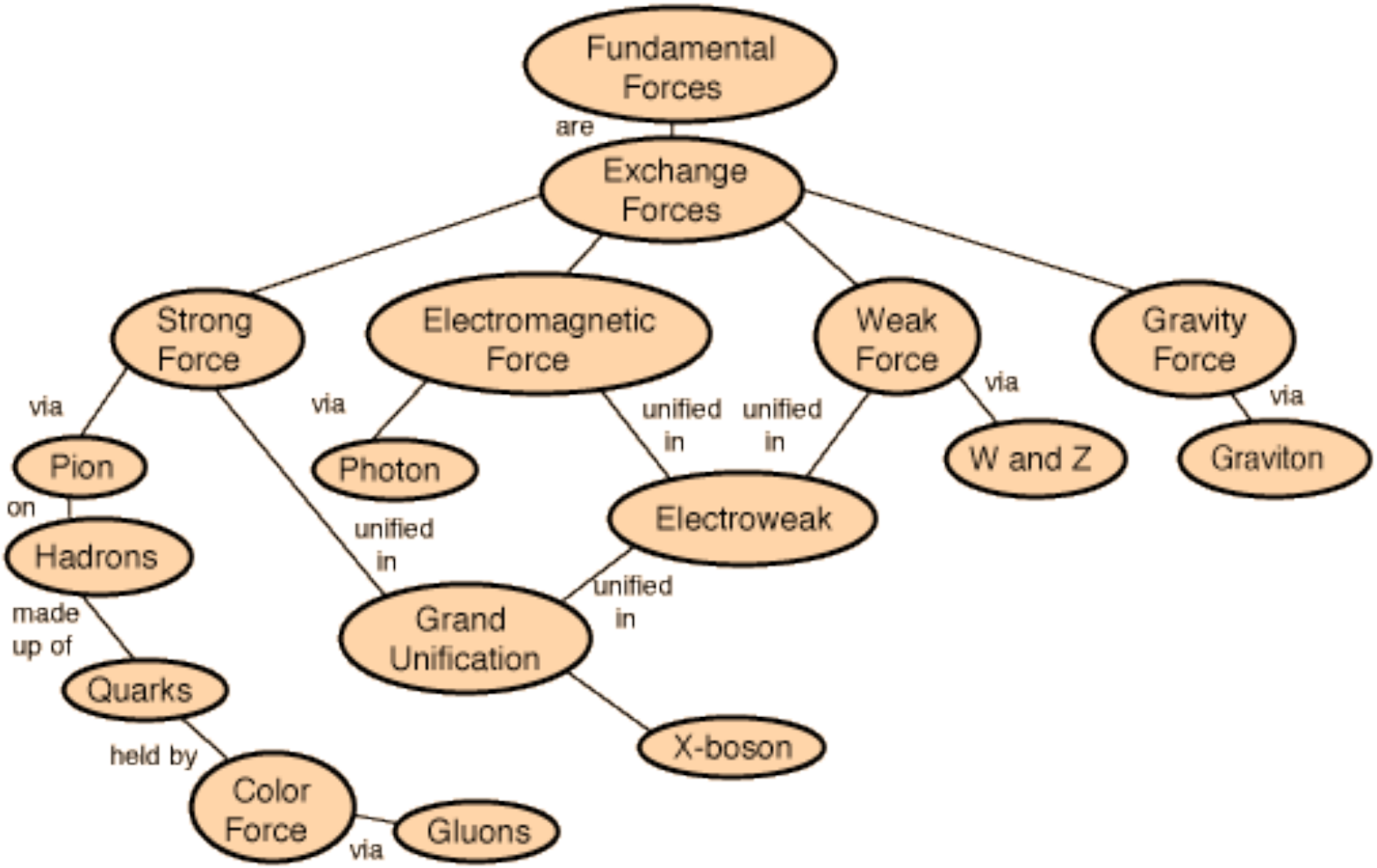


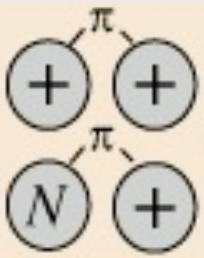
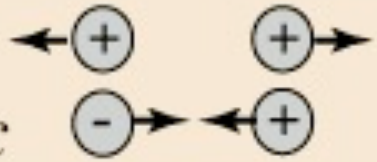
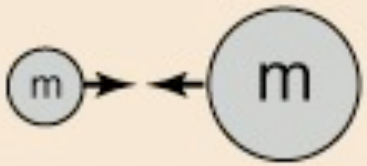
Spectrum of Vega, showing Balmer lines of Hydrogen

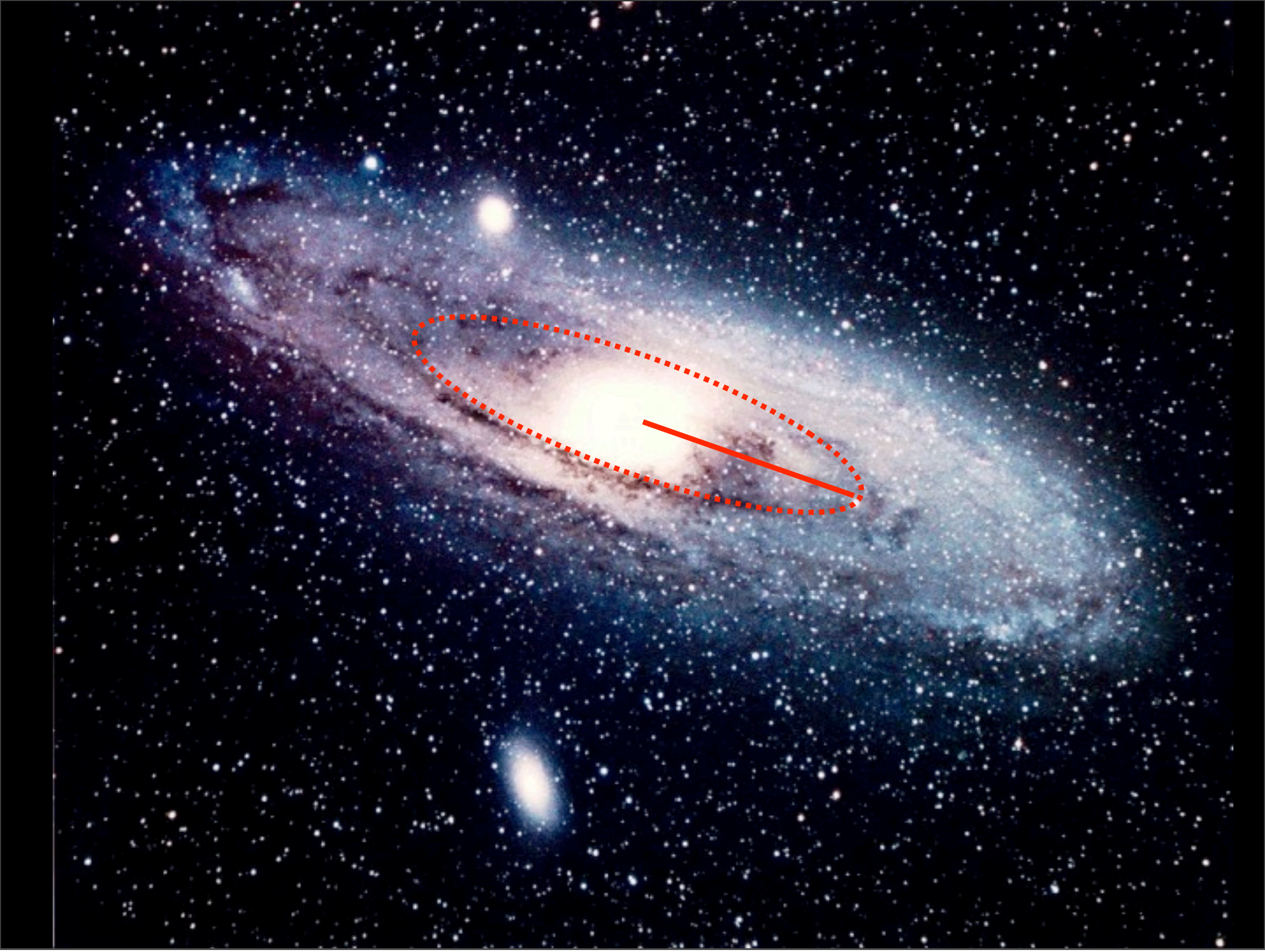


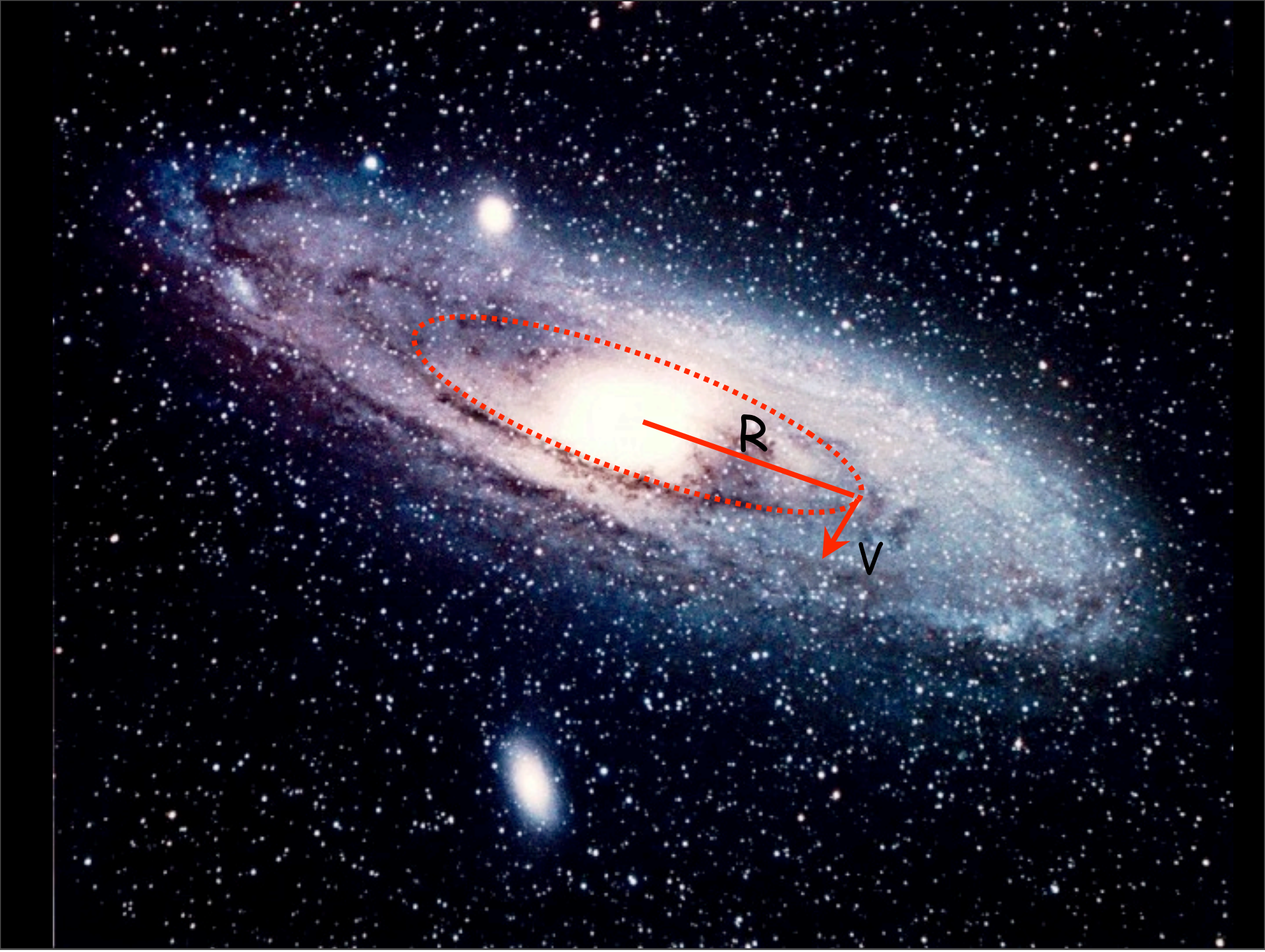

Ly α
Si II
1225
1250
15
10
5
0
−5
−10
distance (arcsec)
7200
7400
wavelength (Å)

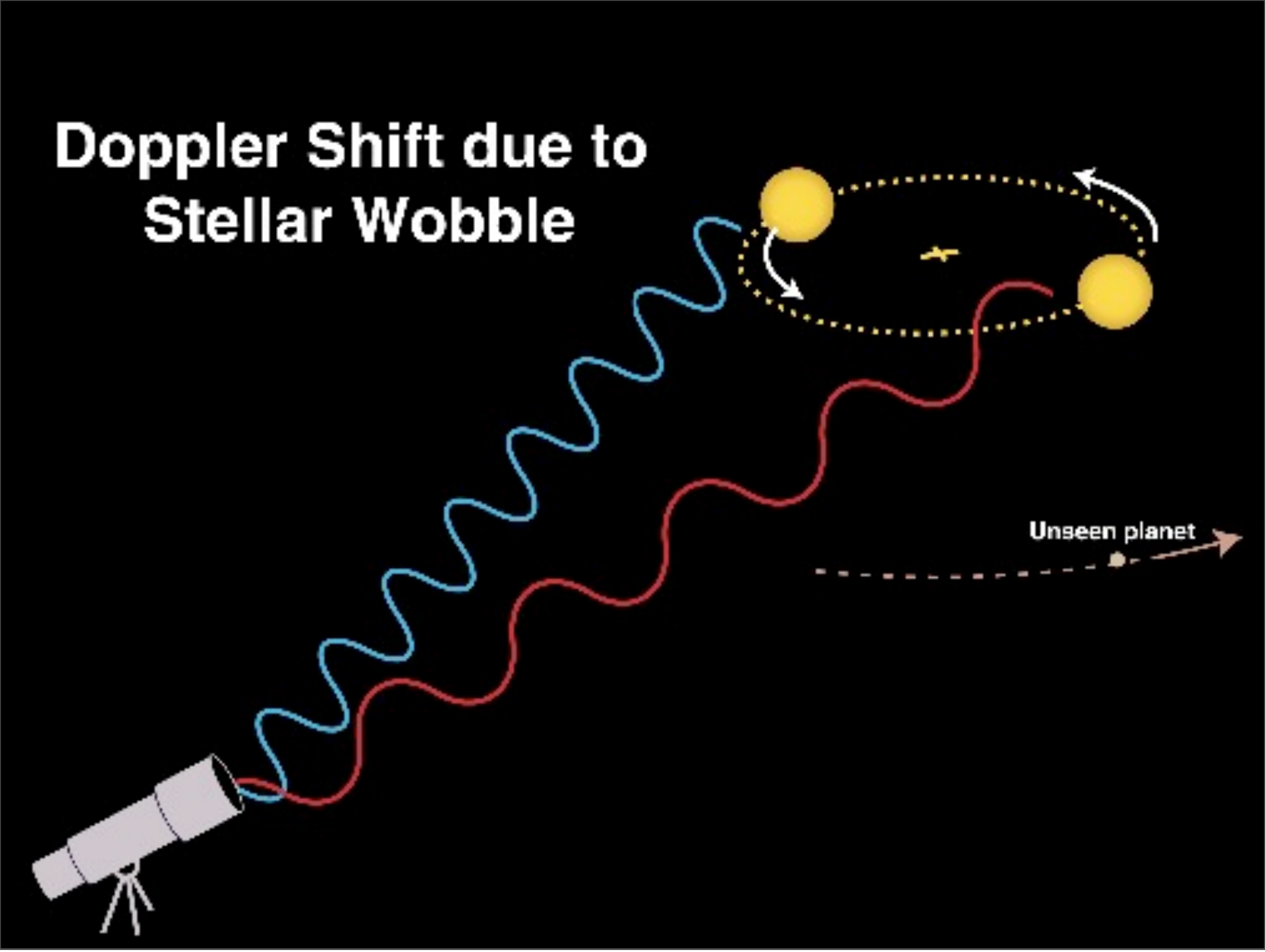


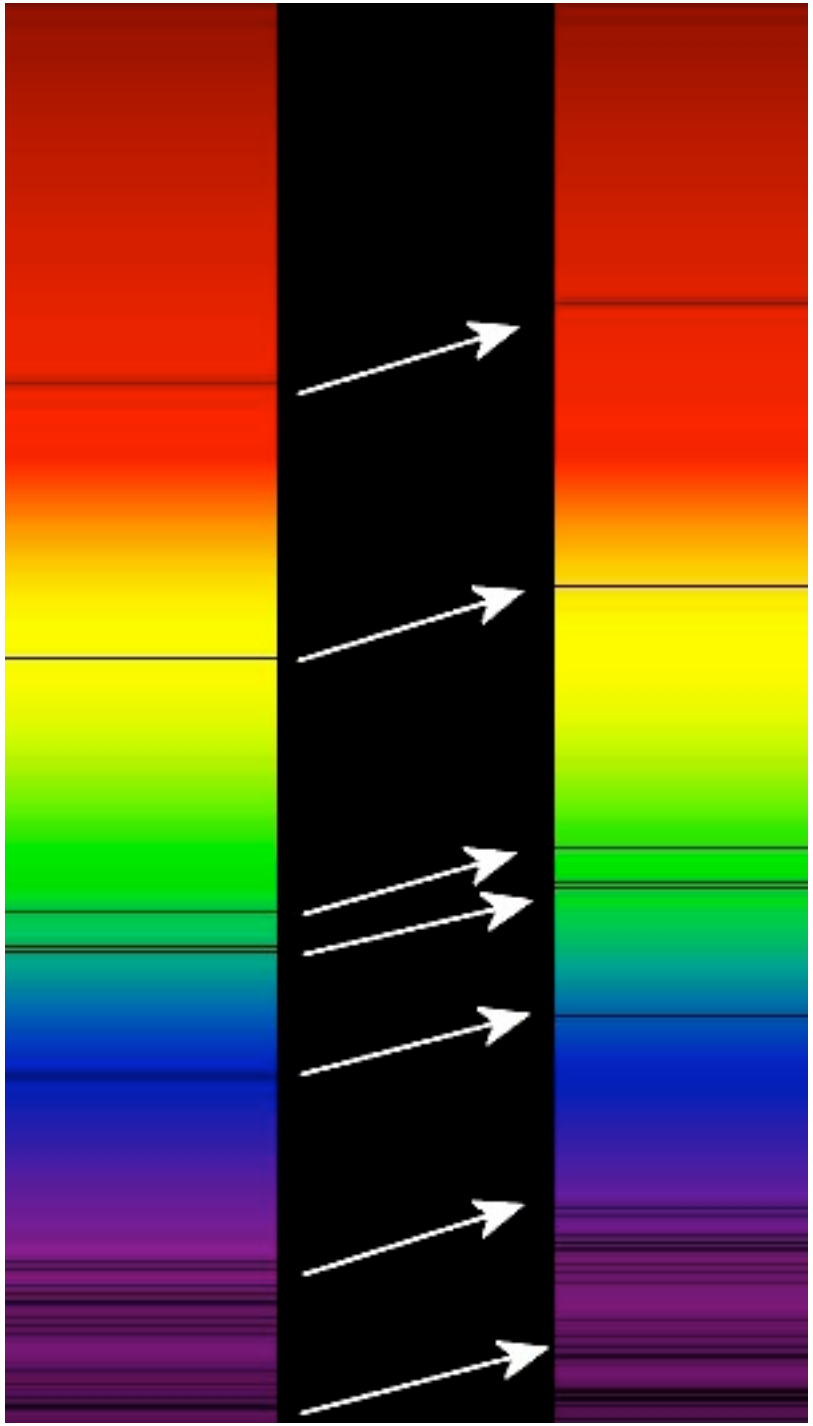

Fundamental Forces
are
Exchange Forces
Strong Force
Electromagnetic Force
Weak Force
Gravity Force
via
Pion
on
Hadrons
made up of
Quarks
held by
Color Force
via
Gluons
via
Photon
unified in
Grand Unification
unified in
Electroweak
unified in
X-boson
via
W and Z
via
Graviton

		Strength	Range (m)	Particle
Strong	 Force which holds nucleus togeher	1	10^{-15} (diameter of a medium sized nucleus)	π, others mass > 0.1 GeV
Electro-magnetic		$\frac{1}{137}$	Infinite	photon mass = 0 spin = 1
Weak	 neutrino interaction induces beta decay	10^{-5}	10^{-17} (0.1% of the diameter of a proton)	Intermediate vector bosons W^+, W^-, Z_0, mass > 80 GeV spin =1
Gravity		6×10^{-39}	Infinite	graviton ? mass = 0 spin = 2




R
V


Doppler Shift due to
Stellar Wobble
Unseen planet



Lines displaced
because object
is moving

Away from us:
redshift (larger wavelength)
Toward us:
blueshift (smaller wavelength)