Lecture 14:Astronomy Picture of the Day

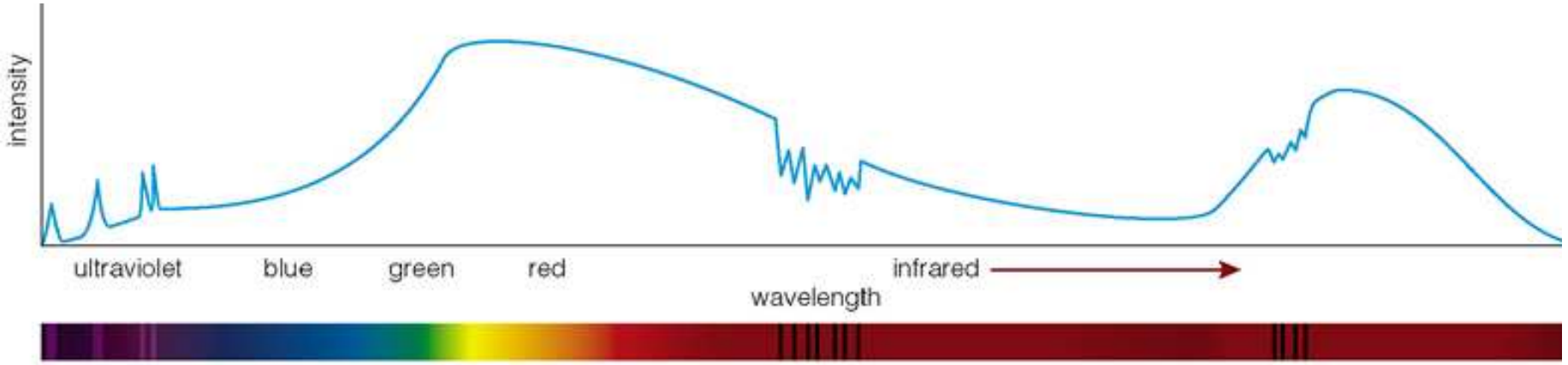
Center of Virgo Cluster. …. See the human face?

Virgo = the closest cluster of galaxies at 60 million ly away ; contains> 100 galaxies

Lecture 14: Announcements

- Selected notes from lectures 11+12 +13 online
  http://www.as.utexas.edu/~sj/a301-sp05.html
- Homework assignment due today by noon. No late HW accepted.
- Pick up homework set 2
- **Exam on Wed Mar 9**

A Spectrum

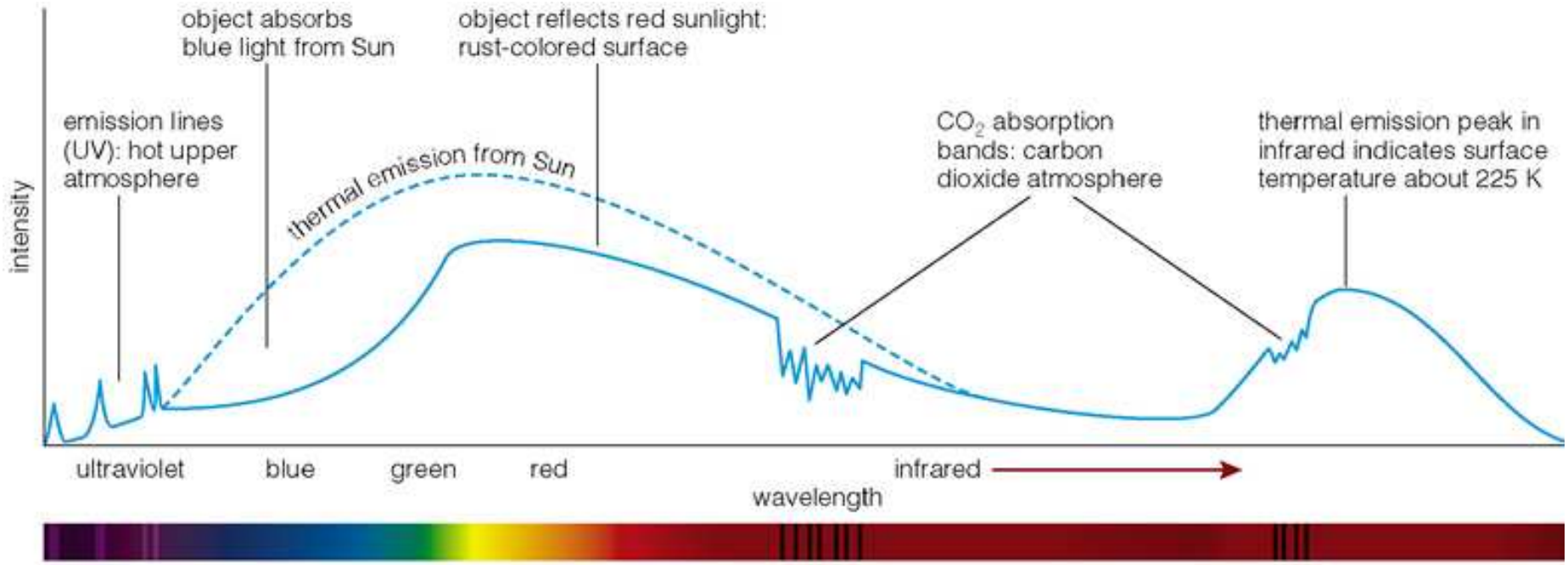


à the discrete emission lines are due to the emission of photons at specific wavelengths by bound electrons that move from a high to a low energy level

à the discrete absorption lines are due to the absorption of photons at specific wavelengths by bound electrons that move from a low to a high energy level

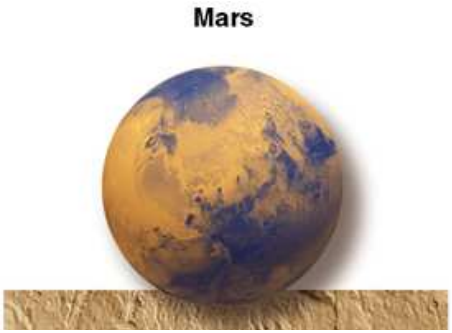
à the underlying continuum emission emitted over a continuous range of wavelengths is thermal radiation emitted by the body, according to its temperature T

Spectrum of a mystery planet as seen from Earth



- Sun's thermal spectrum (peaks at yellow λ as T= 5800 K) is incident on planet .
- Planet absorbs blue λ, reflects red λ (due to its composition) à red planet
  It also emits its own thermal spectrum which peaks at long λ (due to its low T)
- (Reflected spectrum of Sun + Planet's thermal spectrum) travel
  from Planet à through Earth's atmosphere à to us
- Earth's atmosphere adds : UV emission lines + absorption bands due to CO_2

Planet is Mars!



- Planet absorbs blue λ, reflects red λ : a visual wavelengths It looks red.

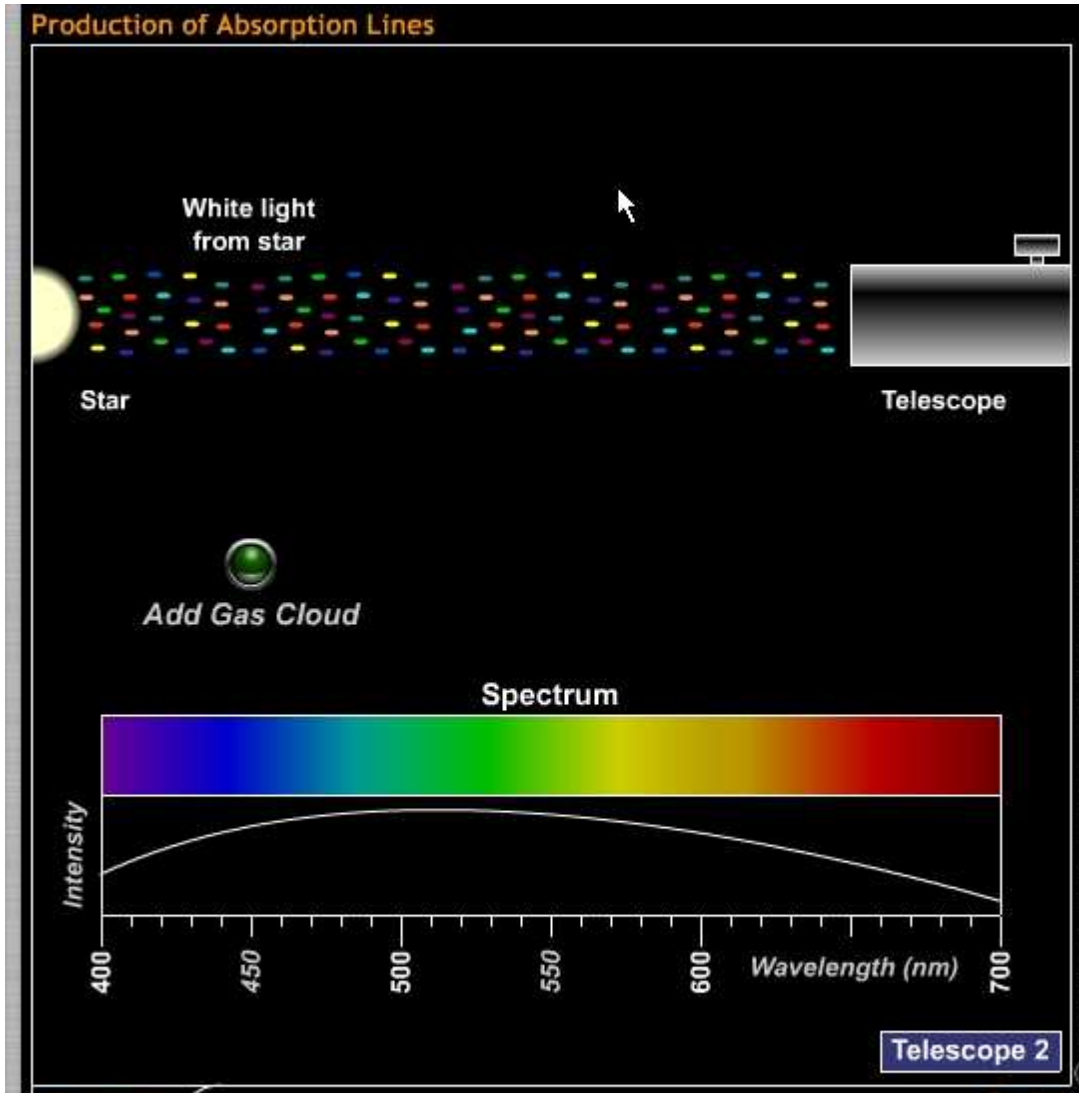
  à Surface composition: Iron oxide, rust

- It also emits its thermal spectrum which peaks at invisible infrared $\lambda = 1.2 \times 10^{-5}$ m

  à Wien's law: Temperature of planet $T = W/\lambda_{peak} = (2.9 \times 10^{-3})/ (1.2 \times 10^{-5}) = 225$ K

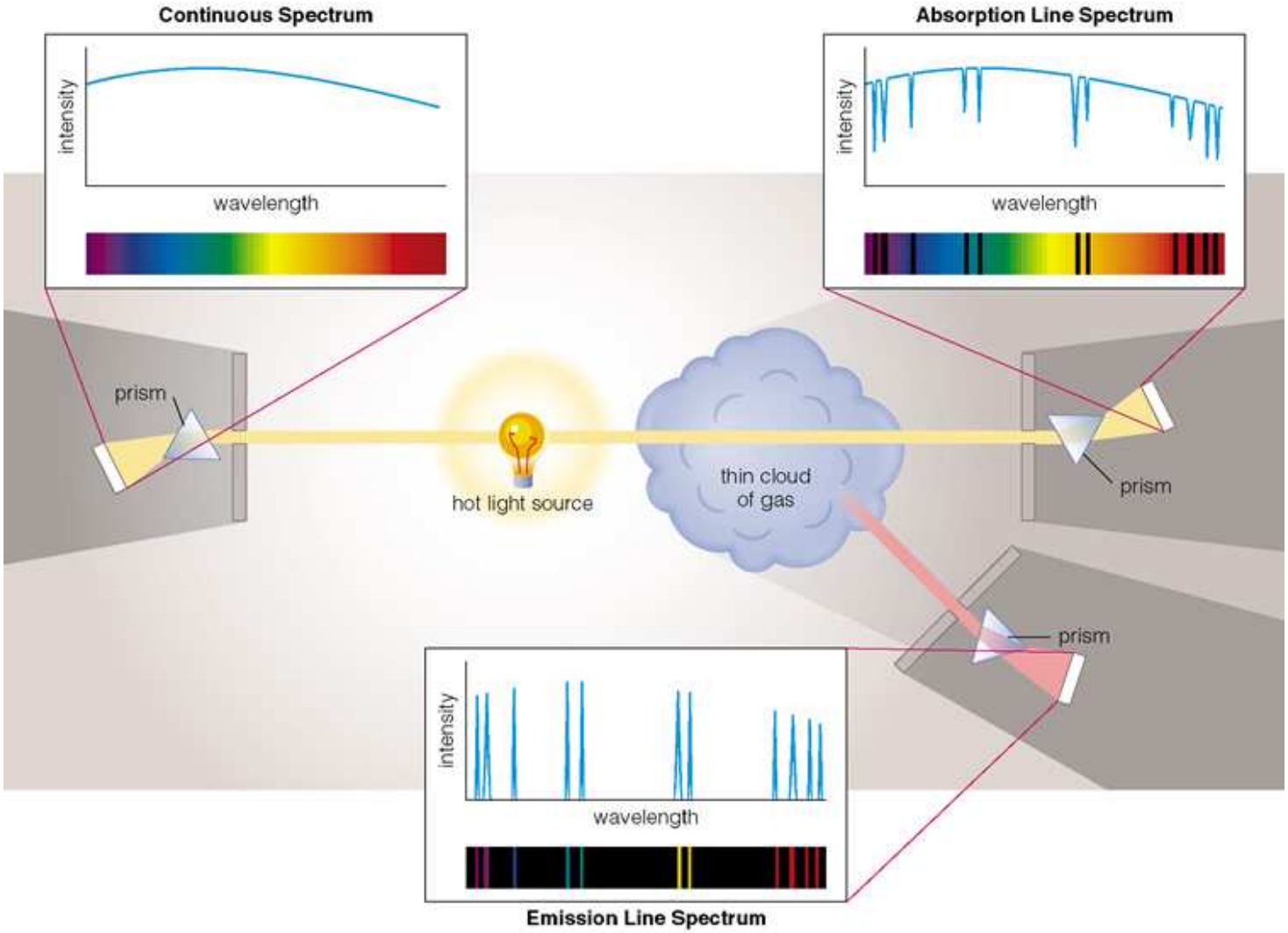
  à Planet is Mars: cold (T=225 K) , looks red visually

Kirchoff's Laws on the production of thermal, emission and absorption spectra



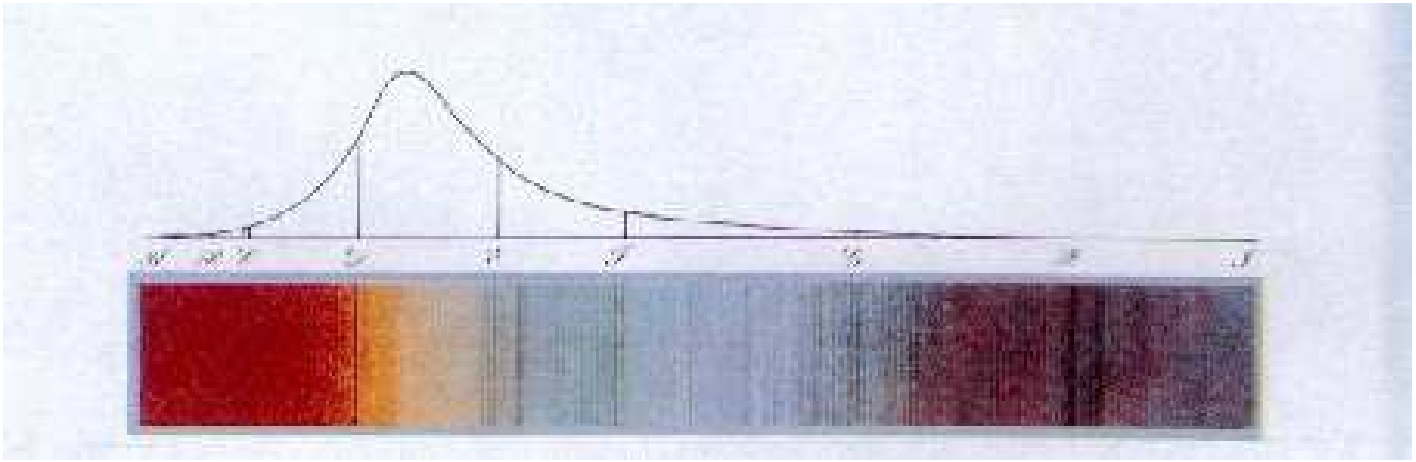
à In-class animation : Production of Absorption lines !!

Kirchoff's Laws on the production of thermal, emission, and absorption spectra



Kirchoff's Laws on the production of thermal, emission, and absorption spectra

- See in-class notes for Kirchoff's 3 laws



Solar spectrum

- Fraunhoffer observed in 1814 H and Sodium absorption lines in the Solar spectrum. Where and at what temperature are layers that produce these lines ?

- Also see emission lines from Ca
  Where and at what temperature is the layer that emits these lines?

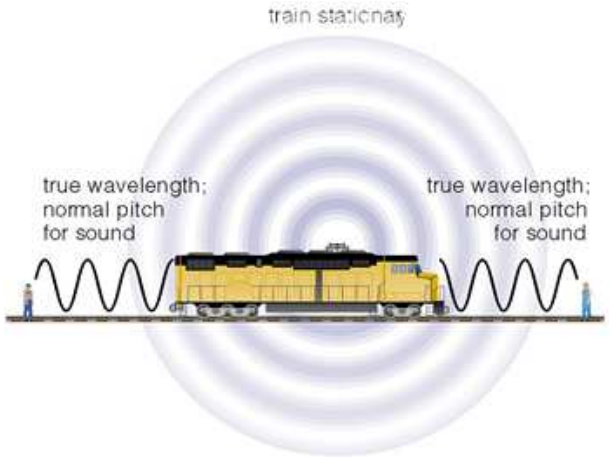
Doppler Shift

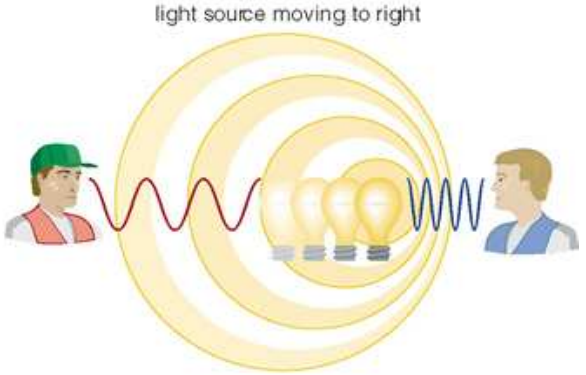
See in-class notes for definition and examples

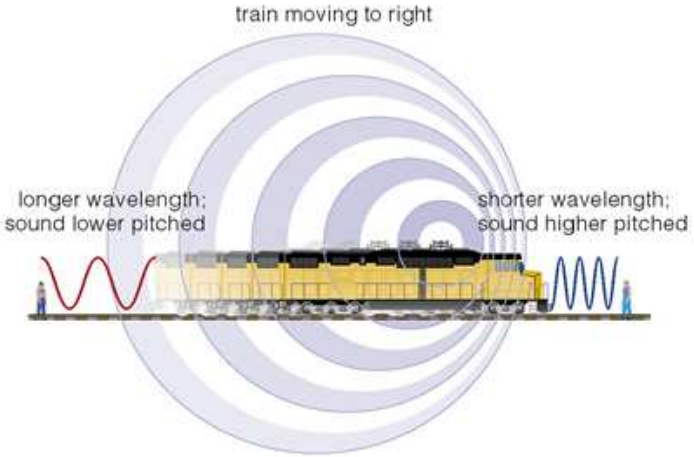
Doppler Shift

à In-class animation : Doppler shift of sound waves

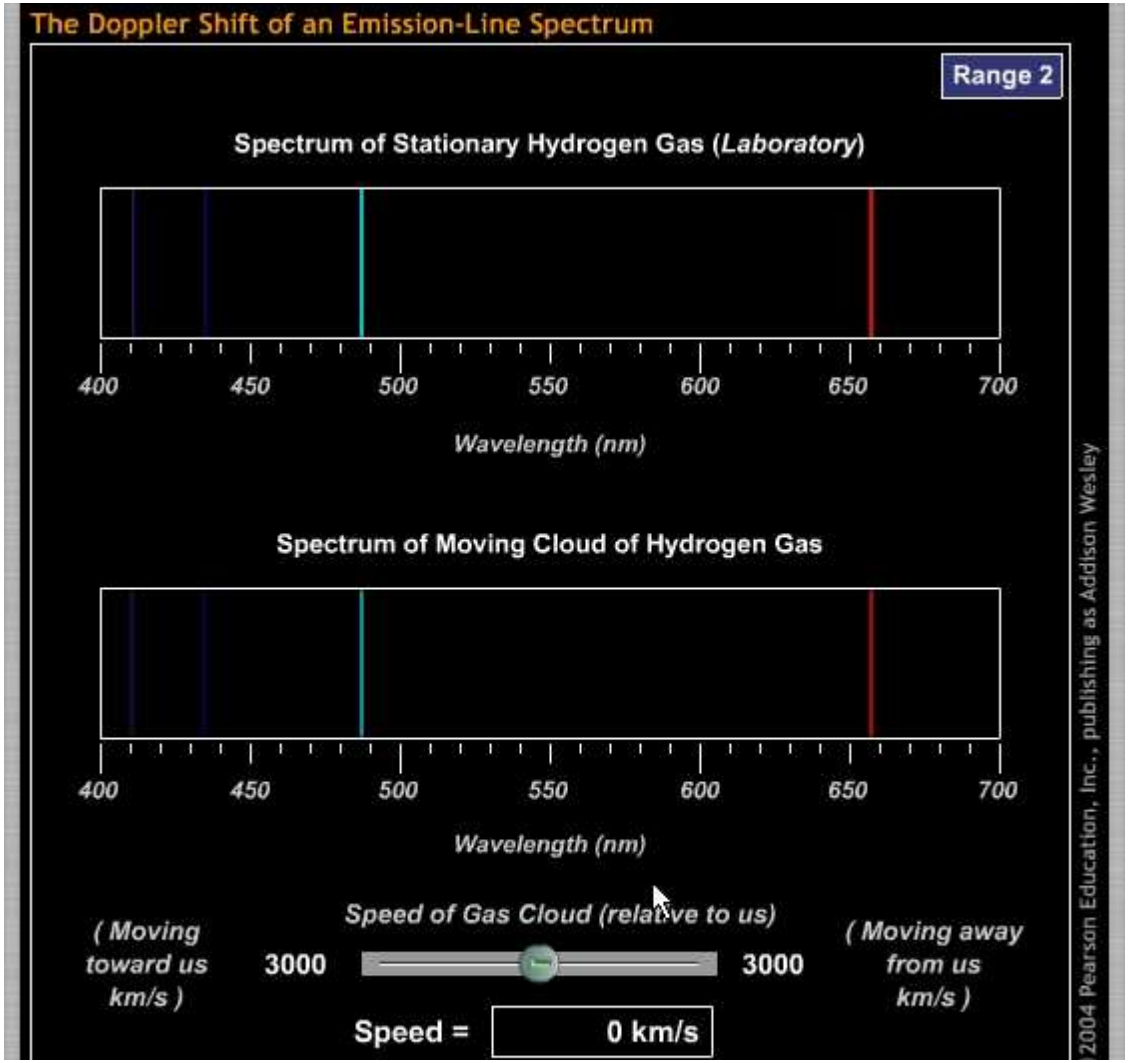
Doppler Shift







Doppler Shift



à In-class demo: Doppler shift of light waves : blueshift and redshift

Doppler Shift

Lines at rest wavelengths
(as measured in a laboratory).

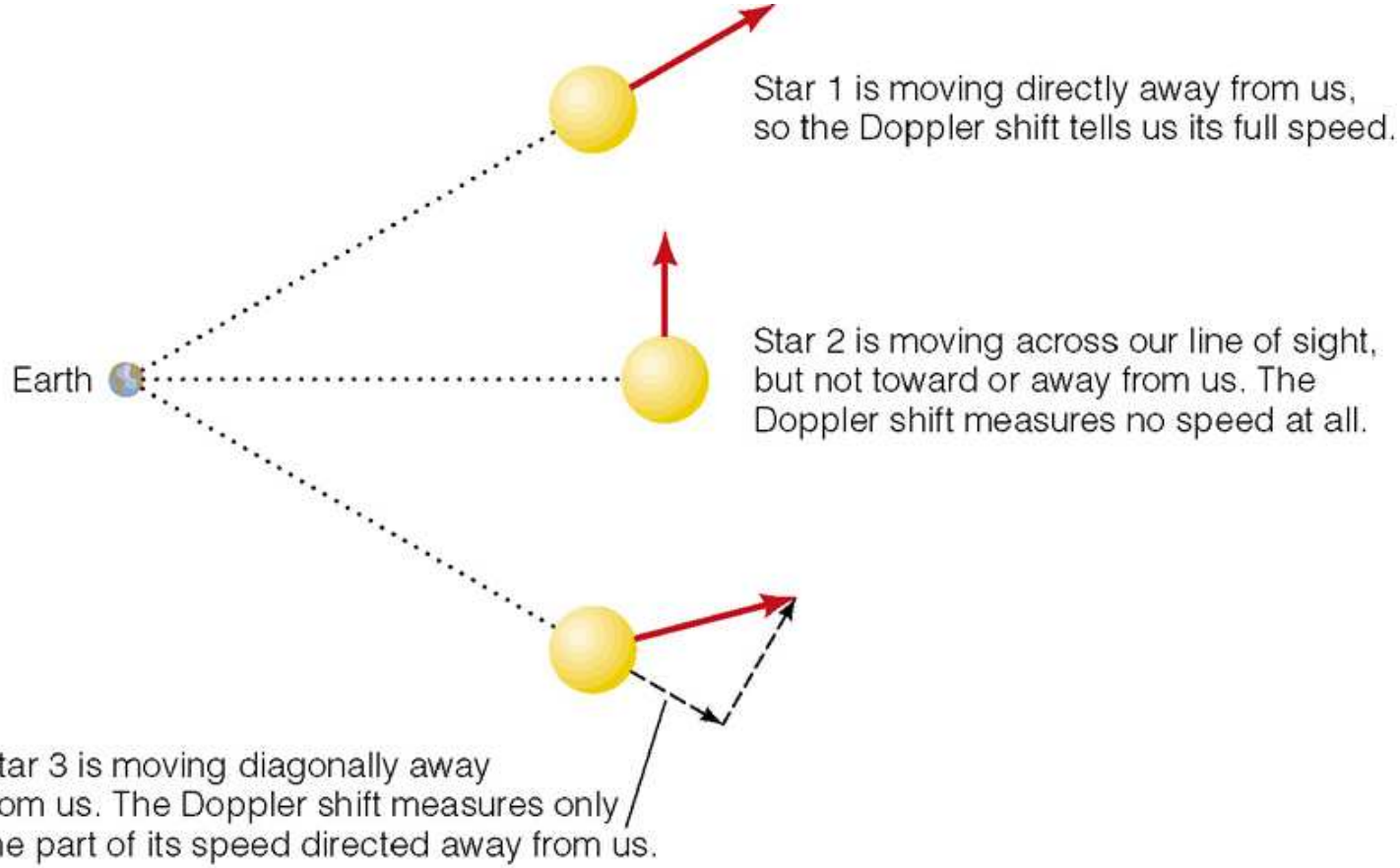
Object 1
Lines redshifted: Object is moving away from us.

Object 2
Greater redshift: Object is moving away faster than Object 1.

Object 3
Lines blueshifted: Object is moving toward us.

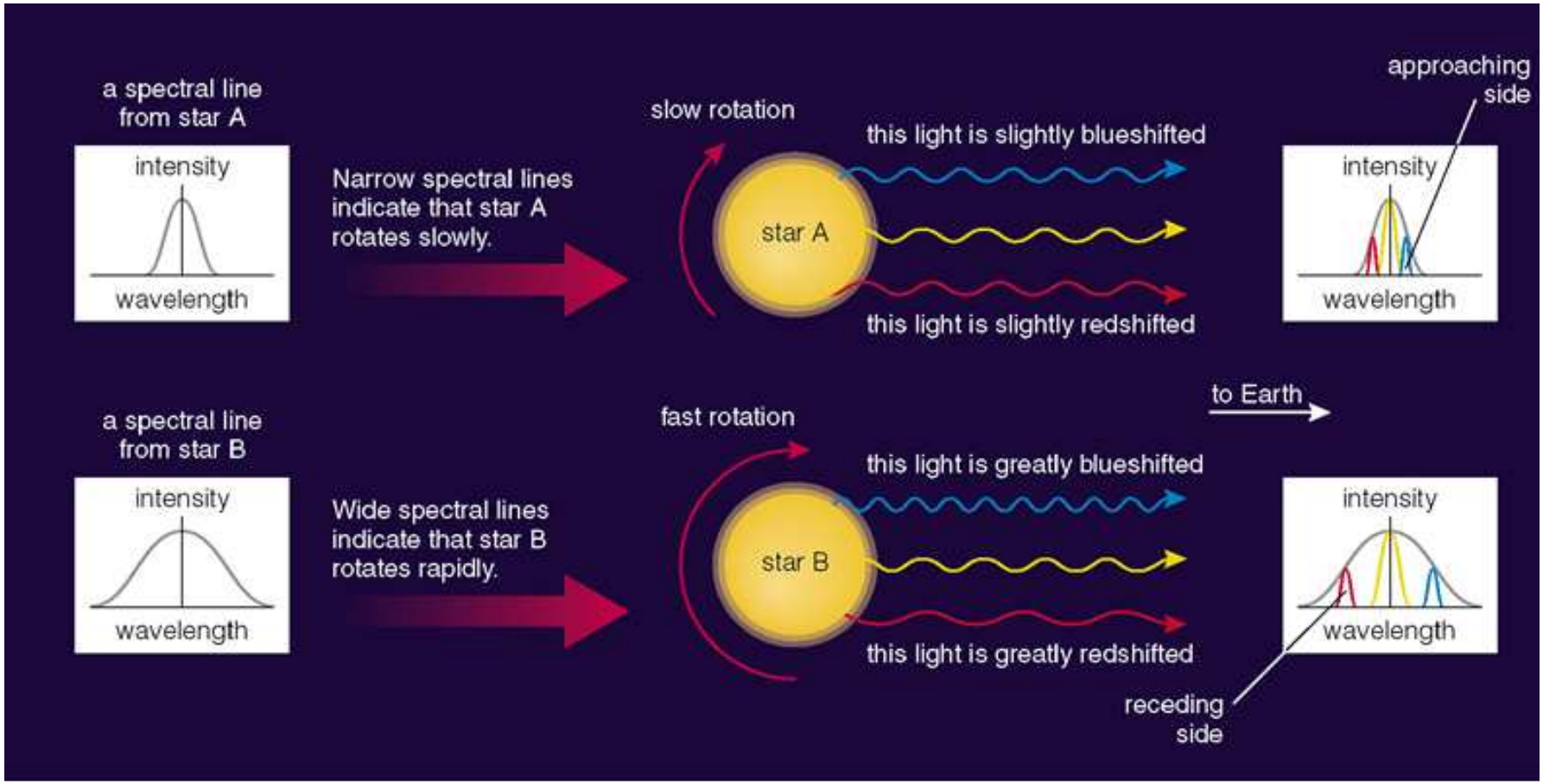
Object 4
Greater blueshift: Object is moving toward us faster than Object 3.

Doppler Shift



Only the component of the velocity that is along the line of sight counts!

Line Broadening due to Rotational Motion



Broadening of the linewidth due to redshifted and blueshifted velocities (along the line of sight) of rotating gas