ASTR 1020: Stars & Galaxies
January 28, 2008

• Reading: Chapter 14, sections 14.1.

• *MasteringAstronomy* Homework on Light and Spectroscopy is due Feb. 4th.

• Volunteer for "Astronomy in the News".

Astronomy Video of the Day
Hotel Mauna Kea

Clickers today

- 50% for any answer
- 100% for correct answer

- 5 free clicker days to take care of technical problems and missed classes.

- Clicker registration problems? Send Jason Henning or your LA an E-mail, include clicker number.

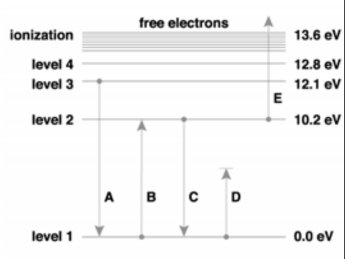
Today's Class

- Chapter 6: Review of Light & Matter

Light and Atoms
Types of Spectra
Light and Atoms

Electrons can move between levels if they are given energy or can lose that exact amount of energy.

For hydrogen, if an electron at level 1 (Ground state) is given more than 13.6 eV of energy, the electron will fly free (ionize)



Example: Energy jumps A, B and C allowed; D is not possible for this atom. E ionizes the atom with an energy gain of >3.4 eV

- Each atom has a different set of energy levels → different emission/absorption spectrum
- Examples: mercury, sodium, neon, hydrogen, mercury….
- Demo: diffraction grating spectroscopes

Clicker Reading Question: The light we see from stars is mostly thermal radiation. Antares is a star with a distinct reddish color. How is its surface temperature different from the Sun?

a) It's greater than the Sun.
b) It's the same as the Sun.
c) It's less than the Sun.

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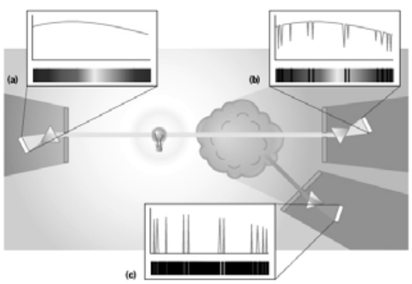
When do you see thermal, vs. emission vs. absorption spectra?



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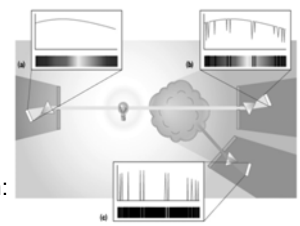
- Continuous spectrum (e.g. thermal spectrum): solid, opaque object.
- Emission spectrum: hot, thin gas.
- Absorption spectrum: cool gas being illuminated by a continuum spectral source.
- Don't forget reflection: the color light reflected depends on what the stuff is made of!



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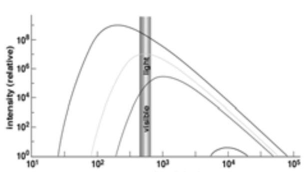
Types of spectra and what they teach us: Thermal Spectra

- Emitted by all solid/opaque objects, including stars, planets, humans
- Also called "blackbody spectra"
- Smooth, broad spectrum rising to a peak at some wavelength, where most of the radiation is emitted



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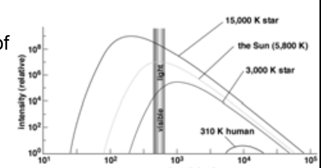
- Shape and intensity if thermal spectra are set by the TEMPERATURE of the object.
- Higher the temperature, the higher the intensity of emitted light at all wavelengths for a given size object
- Shift in maximum wavelength: Higher the temperature, higher the energy of light (shorter the wavelength)



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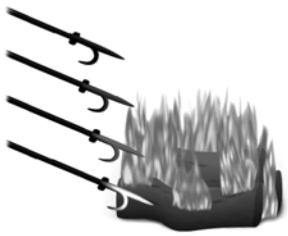
- Classic example: red hot pokers. As the iron heats, it glows brighter and emits more white/blue light (shorter wavelength). As it cools, it dims and emits redder light, and finally mostly invisible IR light.

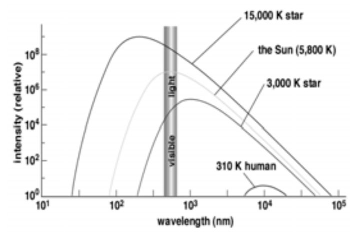


Wien's law:

- λ (maximum) =

$$\frac{2{,}900{,}000 \text{ nm}}{T (K)}$$

$$= \frac{0.0029 \text{ meters}}{T (K)}$$



Quick guide to thermal spectra (be familiar with these)

- 3 K (coldest natural things): 1mm (microwaves)
- 300 K (people, planets, warm dust): 10^{-5} meters (IR)
- 3000-30,000 (stars): 10^{-6} m to 10^{-7} m
  = 1000 to 100 nm
  (IR – visible –UV)
- 300,000- 30,000,000: weird and intense places
  (UV through X-rays)

Images of the Milky Way

- IR: emission from dust warmed by starlight (e)
- Optical- emission from the stars; dust absorbs light and causes dark bands (c)
- UV/X-ray points: black holes, other intense regions (d)
- Radio, some X-ray and gamma-ray light comes from non-thermal sources- we'll talk about these soon! (a)