Spectra, Emission, and Absorption

9-28-2005

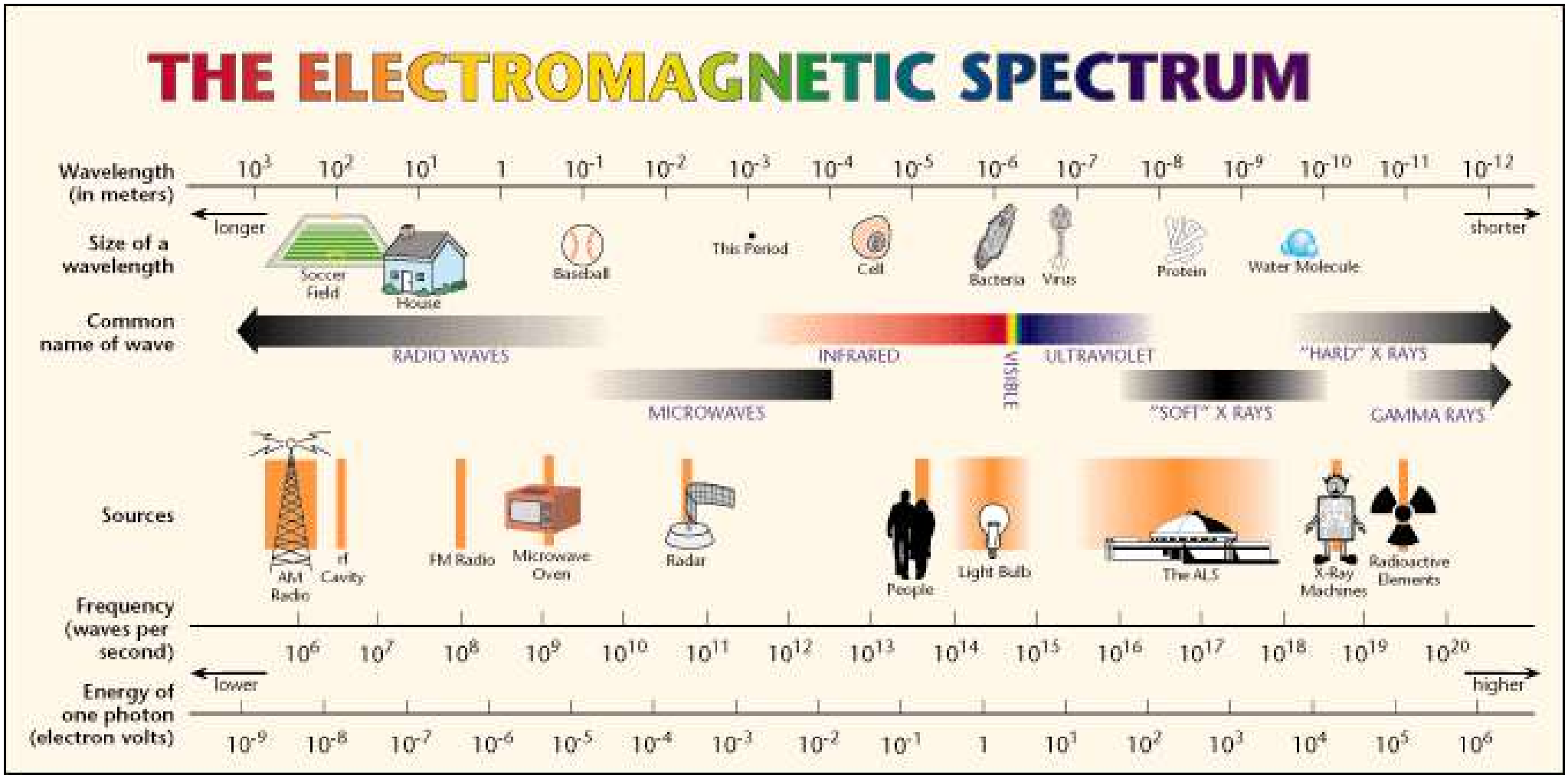
Opening Discussion

- Have you seen anything interesting in the news.
- What did we talk about last class?
- Why is mixing paint different from mixing colors on a computer? Subtractive vs. additive.
- What is light? Do we know?
- Are microwaves harmful to your brain?
- Newton's 3rd law.

The Full Spectrum

- Light can have effectively any wavelength going from nearly zero out toward infinity. The light that we see is known as visible light and it has wavelengths from about 400 nm (blue) to about 700 nm (red).
- Light with wavelengths a bit longer than red is called infrared and light with extremely long wavelengths is radio.
- Light with shorter wavelengths than blue is ultraviolet. Going even smaller gives you X rays and eventually you get to what we call gamma rays.

Picture of the Spectrum and Scales



Doing Science with Light

- The way we learn things about distant objects is to take the light that comes from the object and break it up into a spectrum. Typically this is done with a diffraction grating instead of a prism.
- Looking at the intensity of light at different colors tells us a lot about an object.
- What we see in spectra depends on what we are looking at and the various ways in which light interacts with different material.

Thermal Emission

- All objects with a temperature above absolute zero (-273 C) emit thermal radiation with a spectra that is known as the blackbody curve.
- The total emission and peak emission vary with temperature.
- Power emitted per square meter

$$P = \sigma T^4 \left(\sigma = 5.7 * 10^{-8} \frac{watts}{m^2 * Kelvin^4} \right)$$

- Maximum wavelength

$$\lambda_{max} \approx \frac{2{,}900{,}000}{T\,(Kelvin)}\, nm$$

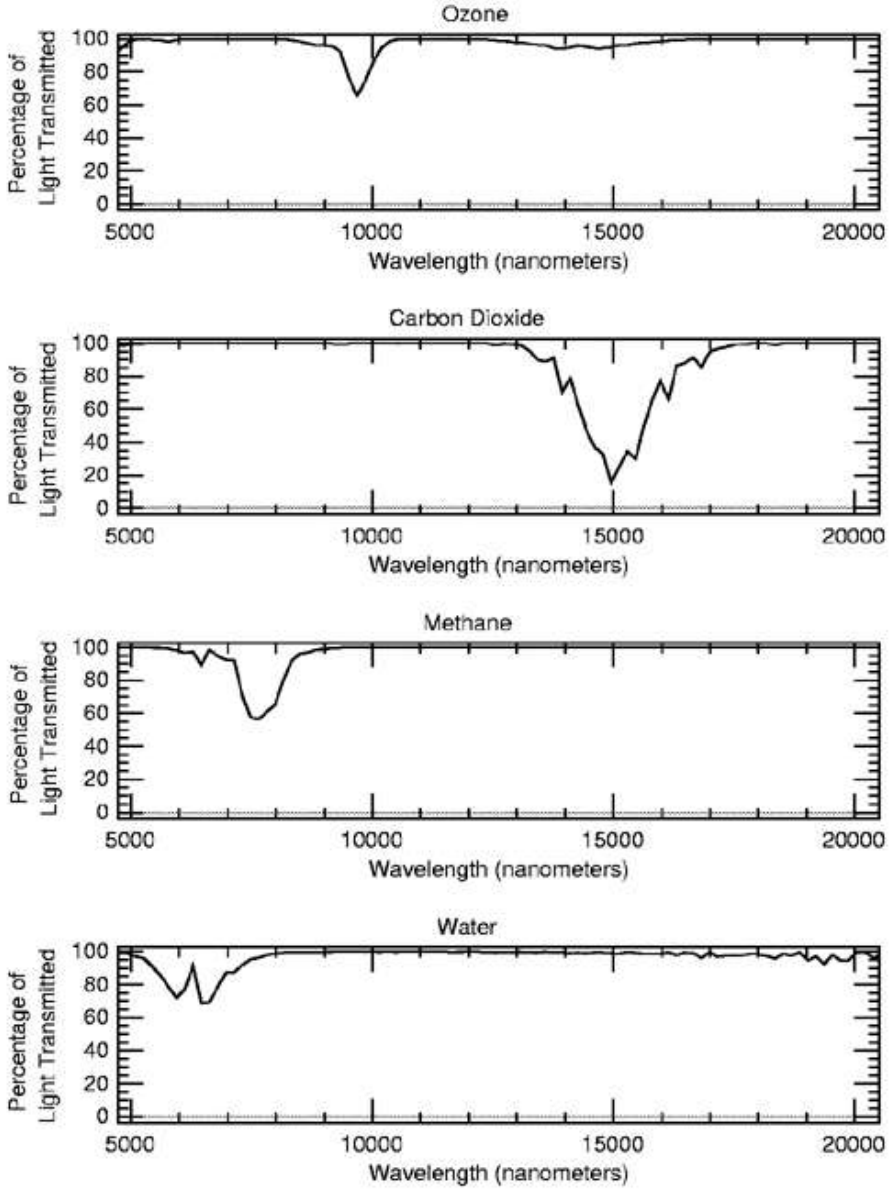
Thin Gases

- Thin gases can either emit light or absorb light. What is critical for us though is that they only do it at certain energy levels.
- Remember how when we talked about the structure of atoms we said that electrons could only take on certain energies? That matters now because when an electron moves from one energy to another it emits or absorbs a photon of light of a very specific energy which we see as a particular color.
- http://www.spectroscopynow.com/Spy/tools/HELApplet.html

Elements and Spectra

- Every element has different transition energies and as a result, every element looks different in an emission or absorption spectra.
- Not only that, but each ion looks different as well.
- Molecules also have specific energies not only for the electrons in them, but also for the vibration and rotations states of the molecule. Those are typically much lower energy and are in the IR region. Molecular spectra are generally broad, made of many tiny lines that are often hard to distinguish.

Molecular Absorption Spectra



Minute Essay

- Understanding spectra is incredibly important to understanding how the science of astronomy works. Do you have any questions about what we talked about in the last two classes?
- Quiz #3 is next class.