Electromagnetic Radiation (Light) + Types of Spectra
Lecture outline -- 1

Reading: sections 7.1 through 7.3 in ***Astronomy Notes***

Vocabulary terms used:

electromagnetic radiation—a form of energy made of oscillating electric and magnetic fields. It is a fancy word for "light". Includes (in order of *increasing* energy) radio, infrared, visible light (optical), ultraviolet, X-rays, gamma rays. All forms travel at *same* speed in empty space.

wavelength—the distance between two crests or two troughs of a wave.

frequency—the number of wave crests that pass a point every second. Measured in **hertz** (Hz). For electromagnetic radiation, the frequency is inversely proportional to the wavelength.

photon—a distinct "chunk" or particle of electromagnetic energy.

intensity—the *number* of waves or photons reaching your detector every second. It is *NOT* the energy of the light wave or photon.

temperature—a measure of the random motion energy of the particles in a gas, liquid, or solid.

spectrum—display of the intensity of light at different wavelengths or frequencies.

continuous spectrum—also called **thermal spectrum**—a spectrum that has energy at all wavelengths. Produced by solids, liquids, and dense (high-pressure) gases.

Wien's law—equation that relates the temperature of a thermal source to the wavelength of peak emission intensity: $\lambda_{peak} = 2.9 \times 10^6$ nanometers / temperature in Kelvin.

emission line—bright line in a spectrum that is produced by a hot, thin (low-pressure) gas. Made by an electron jumping down closer to the nucleus.

absorption line—dark line in a continuous spectrum that is produced by a cool, thin (low-pressure) gas. Made by an electron jumping up farther from the nucleus.

Outline

Electromagnetic radiation is made of _____ fields and _____ fields.
Direction of their oscillation _____; direction wave moves _____
Forms of light _____ (see definition above — memorize the order!)

Properties of electromagnetic radiation

1. Travels through _____. Why important _____
2. Speed of _____ forms of electromagnetic radiation is _____ in empty space.
3. Definition of wavelength _____; symbol for wavelength _____

Rainbow made of _____

Frequency = speed of wave / _____ (see definition above)

Frequency vs. wavelength

"Bluer" light: _____ wavelength, _____ frequency, _____ energy
"Redder" light: _____ wavelength, _____ frequency, _____ energy

Light as a photon

Intensity vs. energy of light _____

Types of Spectra

Continuous (thermal) spectrum is _____ and is produced by _____

Thermal spectrum depends on _____ only.

Chunk of solid lead and same-sized chunk of solid iron *at the same temperature* will have _____ spectrum.

How color depends on temperature:

very hot object has color _____, cool object has color _____

Example of Wien's law

Hotter objects are _____ and _____ than cooler objects

Spectral lines produced by _____

Emission lines produced by _____

Absorption lines produced by _____ and require _____ in the background.

Pattern of spectral lines depends on _____

Why the *pattern* of lines must be used and not just one line _____

Bohr Atomic Model and Doppler Effect
Lecture outline -- 1

Reading: sections 7.4 through 7.6 in ***Astronomy Notes***

Vocabulary terms used:

electron—negatively-charged subatomic particle that moves around the nucleus in specific energy levels. It has about 1800 times less mass than the proton and neutron.

proton—positively-charged subatomic particle that is found in the nucleus of an atom. It has about 1800 times more mass than its negatively-charged electron counterpart.

neutron—subatomic particle with zero charge (neutral charge) that is found in the nucleus of an atom. It is slightly more massive than the positively-charged proton.

element—a substance that cannot be decomposed by chemical means into simpler substances. All atoms of an element have the same number of protons in the nucleus.

isotope—a sub-group of an element in which the atomic nucleus has the same number of neutrons, as well as, the same number of protons. All of the atoms of an element will have very nearly the same chemical properties, but the isotopes can have very different *nuclear* properties.

ground state—the lowest energy state of an atom—all of the electrons are as close to the nucleus as possible.

doppler effect—an apparent change in the wavelength of energy produced by an object that is caused by the object's motion towards or away from the observer (along the line of sight). In astronomical spectra, the doppler effect is seen in the shifting of spectral lines.

blueshift—the shift of spectral lines from an object to shorter wavelengths because the object is moving *toward* the observer. The greater the speed of the object, the greater the blueshift will be.

redshift— the shift of spectral lines from an object to longer wavelengths because the object is moving *away from* the observer. The greater the speed of the object, the greater the redshift will be.

Outline

Bohr's model of the atom

Positively-charged particles in the nucleus _____
Neutral particles in the nucleus _____
Negatively-charged particles moving around the nucleus _____
Where the negative charges can be found _____

Every type of atom (= _____) has _____

Every type of atom produces _____

Same unique pattern for all atoms of a type and laws of nature _____

Three basic rules of atoms:

1. Where electrons can be found _____
2. Which energy orbits have lower energy _____
3. Desired state of an atom _____

Bohr Atomic Model and Doppler Effect
Lecture outline -- 2

How atoms produce emission and absorption lines

The total of _____ + _____ = _____ always.

What happens to the electron when the atom *absorbs* light (photon) energy _____

What happens to the electron when the atom *emits* light (photon) energy _____

Big jump of electron produces spectral line of _____ wavelength
Small electron jump produces _____ wavelength spectral line
Photon energy = _____ – _____

Why spectral lines of only specific wavelengths produced _____

Why absorption lines pattern = emission lines pattern _____

Emission line example

Absorption line example
What happens to photons with the wrong energy _____

Atom with energy levels at 3 eu, 7 eu, 8 eu can have emission lines at energies _____

Atom with energy levels at 2 eu, 10 eu, 15 eu can absorption lines at energies _____

Doppler Effect

How wavelengths of light can be changed _____

Direction object is moving if observer sees **blueshift** _____
Direction object is moving if observer sees **redshift** _____

How determine speed of object _____
Greater wavelength shift means _____

How radar guns work

Why spectral lines are used to measure doppler shifts