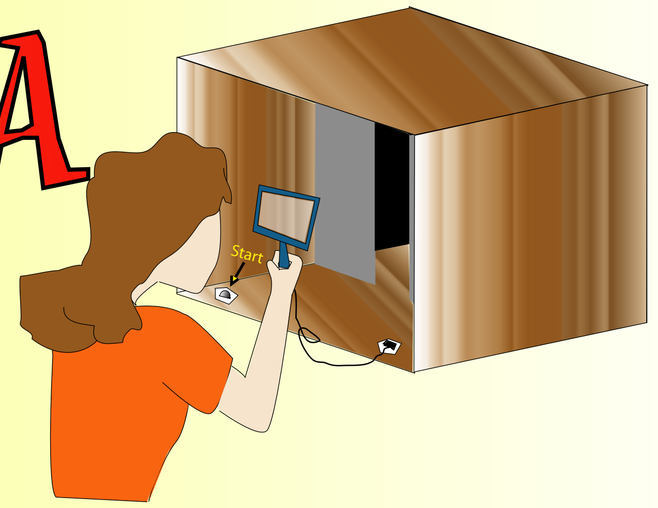
VISIBLE SPECTRA

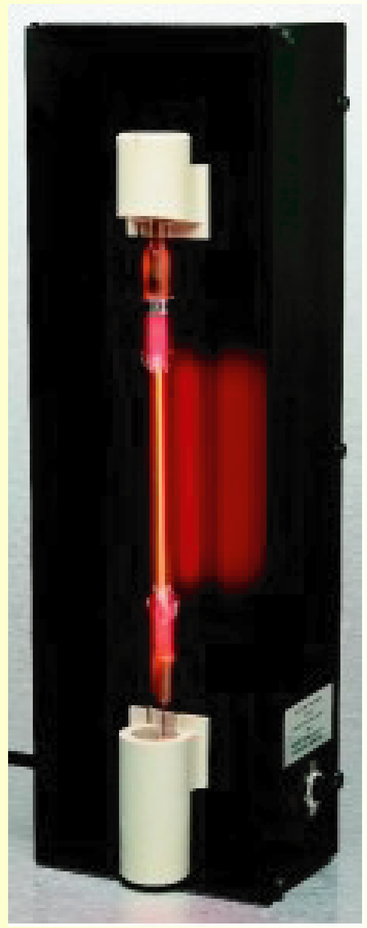


Things to do and see:

Press the button to turn on the light sources whose reflections can be seen in the mirrors. An incandescent filament glows white hot in the light bulb at the top with atomic and molecular discharge tubes below.

Look through the transmission grating to the left and right of the line of sources. The rainbows and colored lines show the emission spectrum of each source.

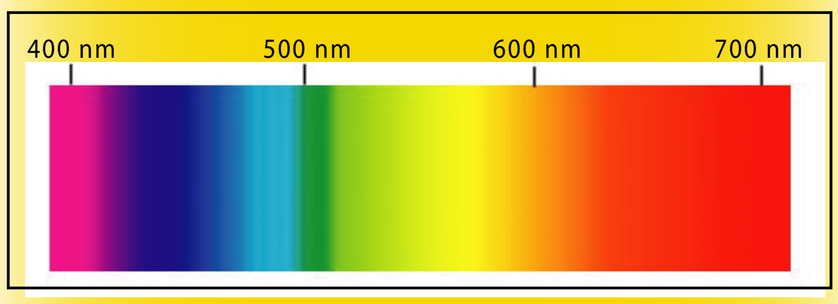
Look off to the sides of other small light sources to see their spectra. What kind of source gas is the guitar sign? This kind of sign uses fluorescent dyes coated inside a discharge tube to get additional colors. These dyes can absorb discharge light as well as emit light with their own specific spectrum.



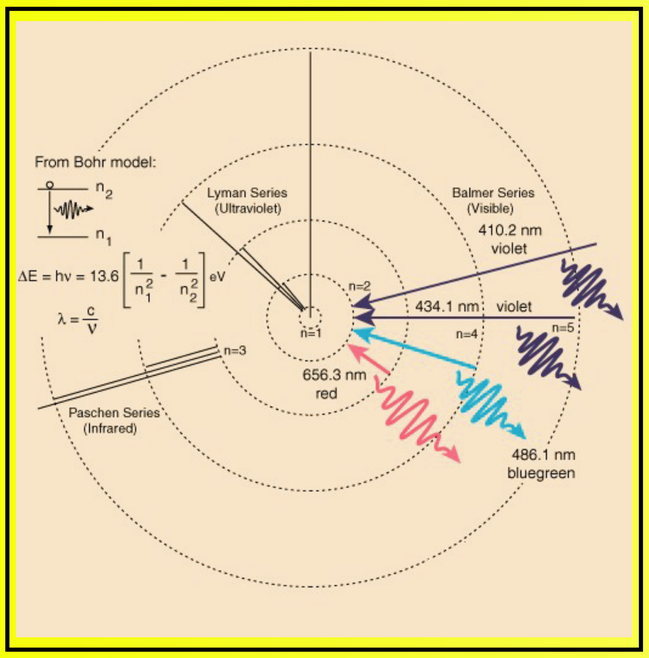
A discharge tube is a low-pressure gas lit by a high voltage applied to the ends of the tube. Electrons moving at high velocities sometimes collide with an atom knocking out an additional electron. Sometimes, the collisions only excite the atoms to higher energy quantum states, which later emit photons of light. Emission spectra, like those seen in this display, are a fingerprint of the source that can be used to identify it anywhere in the universe.

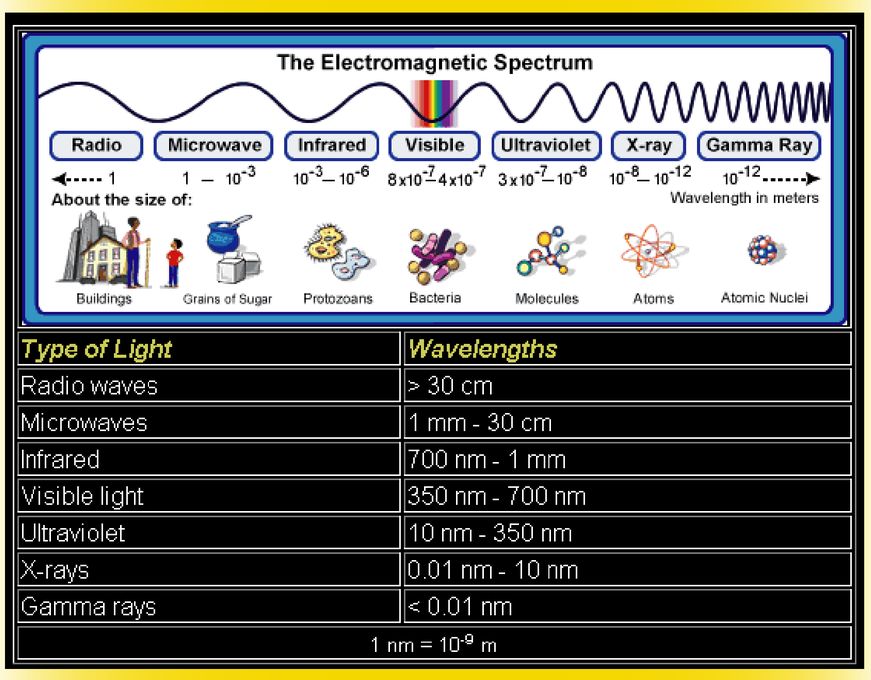
The incandescent filament is heated to thousands of degrees by collisions with the electrons flowing through it (the electric current). The excited energy levels in the solid become so close together and so numerous that they emit all the colors of the visible spectrum.

Electrons in an isolated atom orbit the nucleus in quantum states having particular energy levels. When an atom goes from a higher energy level to a lower energy level it emits a photon of light that carriers away the excess energy. Red photons correspond to lower energies; blue photons correspond to higher energies. Atoms with more electrons often have more energy levels and show more lines in their emission spectra. The energy levels in molecules are so numerous that their spectral lines are very close together.

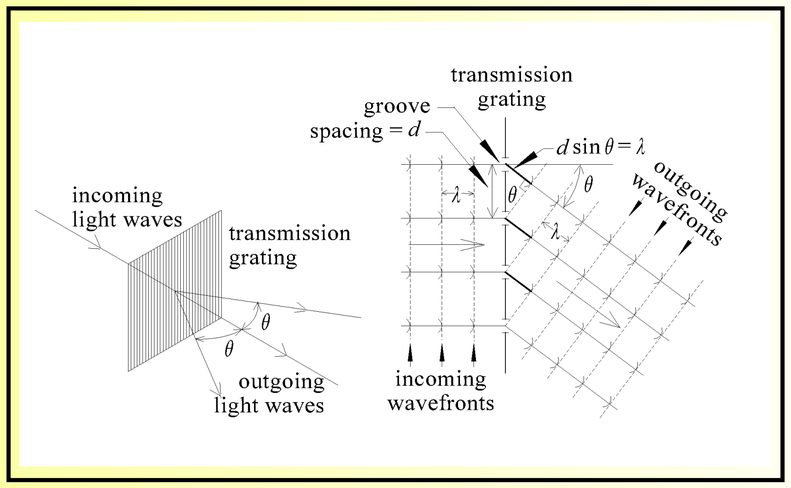


The visible spectrum is the small range of electromagnetic waves observable to the human eye as the colors red through orange, yellow, green, blue, and violet.





Type of Light	*Wavelengths*
Radio waves	> 30 cm
Microwaves	1 mm - 30 cm
Infrared	700 nm - 1 mm
Visible light	350 nm - 700 nm
Ultraviolet	10 nm - 350 nm
X-rays	0.01 nm - 10 nm
Gamma rays	< 0.01 nm
1 nm = 10^{-9} m	



A transmission grating is a film with a very large number of fine grooves cut into its surface (about 100,000 for our grating). The interference between waves scattered from the grooves cause a nearly perfect cancellation (and thus no outgoing light) except along certain directions that depend on the wavelength. Each different color from the source is seen in a different direction.