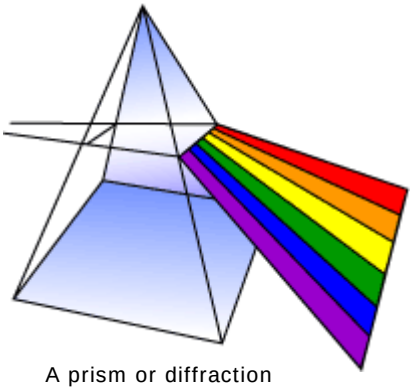
Lunar CRater Observation and Sensing Satellite

Spectroscopy and Spectra

Spectroscopy is the technique of spreading out the component colors of electromagnetic radiation[1] that is emitted or reflected by astronomical objects. For visible light, a prism[2] can serve as a spectrometer[3], dividing up white light into its component colors, to form a spectrum[4].



A prism or diffraction grating can serve as a spectrometer for visible light.
Courtesy NASA

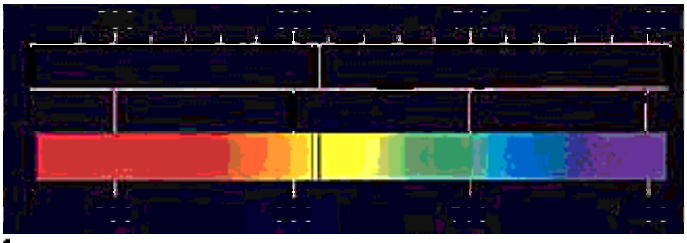
The study of spectra[5] can yield vital information about what is emitting the electromagnetic radiation. Solid material or very dense gasses, whose atoms are packed very closely together, emit radiation in a continuous spectrum.

A Continuous Spectrum
Courtesy NASA

Thin gasses, whose atoms or molecules are well separated, conversely emit light at specific frequencies when heated. This is called an emission spectrum[6].

An Emission Spectrum
Courtesy NASA

When radiation from a hot, dense body passes through a cooler gas, specific frequencies are missing from the resulting spectrum, since radiation is absorbed at specific energies by the cooler gas. This spectrum is called an absorption spectrum. The atoms in the gas will absorb radiation at the same frequencies that they will emit in a laboratory when heated. So, scientists have the "fingerprints" on file for elements on the periodic table[7] to identify them in the absorption or emission spectrum they obtain from light from a celestial body.



An Absorption Spectrum (bottom) shows dark lines or missing parts in the continuous spectrum. These absorption lines coincide to the exact locations of bright lines in the emission spectrum (top) of the element Sodium, when heated as a thin gas in a laboratory. The numbers on the graph indicate the wavelength of light, and are in nanometers (1.0E-9 meters).
Courtesy NASA

Spectra from astronomical objects yield important information about the composition and temperature of the body emitting the radiation. For scientists to garner all the available information from spectra, they must also know the relative intensities and shape of emission and absorption features on spectra. Most spectra used in science look like graphs, with the frequency of the light in the spectrum plotted against the intensity of the light.

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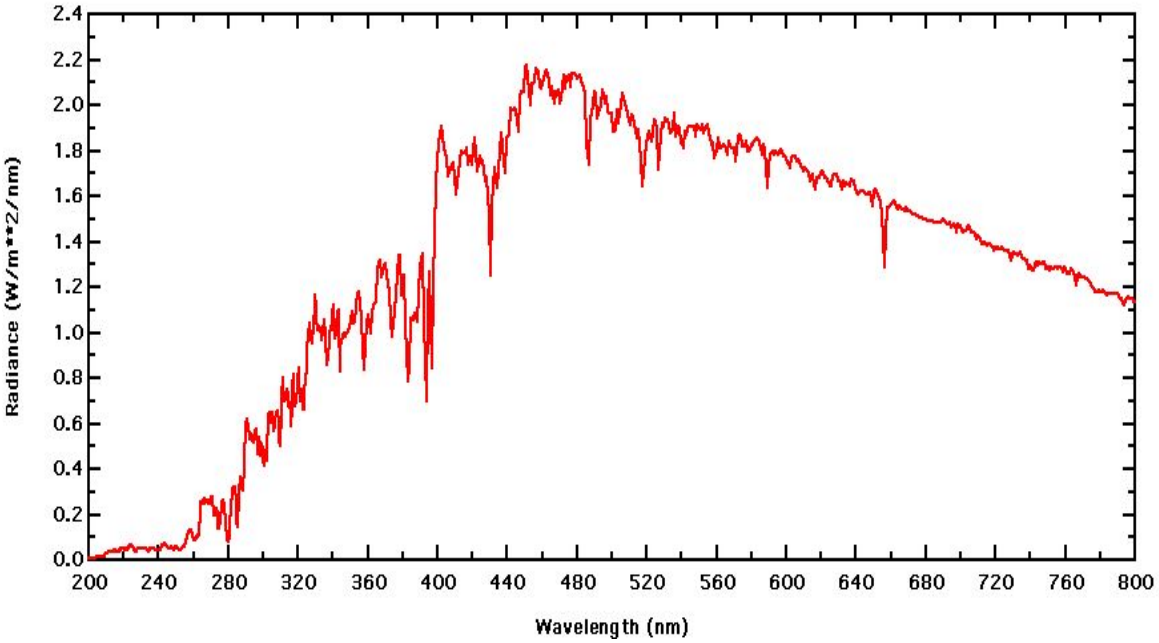
Spectroscopy and Spectra, (continued)



The spectrum of the sun as observed by the SOLSPEC instrument during a flight on the Space Shuttle. Our eyes are sensitive to wavelengths from roughly 400 to 700 nanometers (nm), corresponding to purple and red, respectively. Data courtesy of Dr. Gerard Thuillier.".

The LCROSS Spacecraft: Students monitoring the LCROSS spacecraft on its trek to the Moon may have the opportunity to analyze the spectra of the spacecraft's signal.

In radio astronomy, scientists use radio telescopes to analyze the light and spectra from natural emitters in space at radio wavelengths. But, not all emitters from space are natural sources. Spacecraft are equipped with radio transmitters and receivers for sending information to and from Earth-based tracking stations. In addition to whatever information is deliberately coded into the signal, the spectrum of the transmitted signal can provide information on the velocity[8] and orientation of the spacecraft.

1: Electromagnetic radiation - radiation consisting of waves propagated through the building up and breaking down of electric and magnetic fields; include radio, infrared, light, ultraviolet, x-rays, and gamma rays. 2: Prism - a transparent solid body, often having triangular bases, used for dispersing light into a spectrum or for reflecting rays of light. 3: Spectrometer - the instrument connected to a telescope that separates the light signals into different frequencies, producing a spectrum. 4: Spectrum - a plot of the intensity of light at different frequencies. 5: Spectra - a plural of *spectrum*, the plot of the intensity of light at different frequencies. 6: Emission Spectrum - spectrum of electromagnetic radiation emitted by a self-luminous source. 7: Periodic Table: a table illustrating the periodic system, in which the chemical elements, formerly arranged in the order of their atomic weights and now according to their atomic numbers, are shown in related groups. 8: Velocity - rapidity or speed of motion; specifically, the distance traveled per unit time.