Spectrum

A **spectrum** (plural *spectra* or *spectrums*[1]) is a condition that is not limited to a specific set of values but can vary infinitely within a continuum. The word saw its first scientific use within the field of optics to describe the rainbow of colors in visible light when separated using a prism; it has since been applied by analogy to many fields other than optics. Thus, one might talk about the *spectrum of political opinion*, or the *spectrum of activity* of a drug, or the *autism spectrum*. In these uses, values within a spectrum may not be associated with precisely quantifiable numbers or definitions. Such uses imply a broad range of conditions or behaviors grouped together and studied under a single title for ease of discussion.

The spectrum in a rainbow

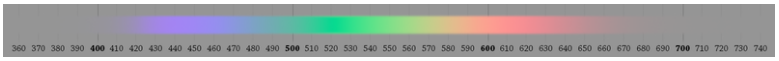
In most modern usages of *spectrum* there is a unifying theme between extremes at either end. Some older usages of the word did not have a unifying theme, but they led to modern ones through a sequence of events set out below. Modern usages in mathematics did evolve from a unifying theme, but this may be difficult to recognize.

Origins

In Latin *spectrum* means "image" or "apparition", including the meaning "spectre". Spectral evidence is testimony about what was done by spectres of persons not present physically, or hearsay evidence about what ghosts or apparitions of Satan said. It was used to convict a number of persons of witchcraft at Salem, Massachusetts in the late 17th century. The word "spectrum" [Spektrum] was strictly used to designate a ghostly optical afterimage by Goethe in his *Theory of Colors* and Schopenhauer in *On Vision and Colors*.

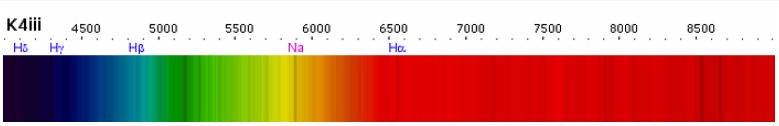
Modern meaning in the physical sciences

In the 17th century the word *spectrum* was introduced into optics, referring to the range of colors observed when white light was dispersed through a prism. Soon the term referred to a plot of light intensity or power as a function of frequency or wavelength, also known as a spectral density.



The spectrum of a uniform light source rendered into the sRGB color space.

The term *spectrum* was soon applied to other waves, such as sound waves, and now applies to any signal that can be decomposed into frequency components. A spectrum is a usually 2-dimensional plot, of a compound signal, depicting the components by another measure. Sometimes, the word *spectrum* refers to the compound signal itself, such as the "spectrum of visible light", a reference to those electromagnetic waves which are visible to the human eye. Looking at light through a prism separates visible light



The spectrum of a star of spectral type K4III

into its colors according to wavelength. It separates them according to its dispersion relation and a grating separates according to the grating equation and if massive particles are measured often their speed is measured. To get a spectrum, the measured function has to be transformed in their independent variable to frequencies and the dependent variable has to be reduced in regions, where the independent variable is stretched. For this imagine that the spectrum of pulse with a finite number of particles is measured on a film or a CCD. Assuming no particles are lost, any nonlinearity (compared to frequency) on the spectral separation concentrates particles at some points of the film. The same is true for taking a spectrum by scanning a monochromator with a fixed slit width. Violet at one end has the shortest wavelength and red at the other end has the longest wavelength of visible light. The colors in order are violet, blue, green, yellow, orange, red. As the wavelengths get bigger below the red visible light they become infrared, microwave, and radio. As the wavelengths get smaller above violet light, they become ultra-violet, x-ray, and gamma ray.

See also

Physical science

- Electromagnetic spectrum
  - Visible spectrum or optical spectrum, a subset of the electromagnetic spectrum
  - Emission spectrum observed in light
  - Absorption spectrum observed in light
- Energy spectrum of a collection of particles (particle physics)
- Frequency spectrum of a signal
- Mass spectrum chemical analysis of atoms and molecules
- Power spectrum of a signal
- Spectrogram
- Spectrometer

Social and medical sciences

- Economic spectrum
- Political spectrum of opinion
- Spectrum disorder, in psychiatry

Mathematics

- Spectrum (homotopy theory)
- Spectrum of a matrix, in linear algebra
- Spectrum of an operator, in functional analysis (a generalisation of the spectrum of a matrix)
- Spectrum of a ring, in commutative algebra
- Spectrum of a C*-algebra
- Spectrum of a theory, in mathematical logic
- Stone space of Boolean algebra

References

[1] Dictionary.com (http://dictionary.reference.com/browse/spectrum). *The American Heritage Dictionary of the English Language*, Fourth Edition. Houghton Mifflin Company, 2004. (accessed: January 25, 2008).

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