Dispersion

Dispersion (light)

A single ray of light consists of seven different colors with varying wavelengths. When a ray of light travels from one transparent medium to another (e.g., from air to glass) then it splits into its constituent colors (Red, Orange, Yellow, Green, Blue, Indigo, Violet). This phenomenon by which a ray of light splits into its constituent color when it is passed through a transparent medium is called dispersion. Refraction is the cause and dispersion is the result.

Understanding Chromatic Dispersion with analogy

Fig 01: A dispersive prism, material dispersion (a wavelength-dependent refractive index) causes different colors to refract at different angles, splitting white light into a rainbow.


Refractive index

The refractive index (or index of refraction) of a medium is a measure for how much the speed of light (or other waves such as sound waves) is reduced inside the medium. For example, typical glass has a refractive index of 1.5, which means that in glass, light travels at $1 / 1.5 = 0.67$ times the speed of light in a vacuum. Two common properties of glass and other transparent materials are directly related to their refractive index. First, light rays change direction when they cross the interface from air to the material, an effect that is used in lenses and glasses. Second, light reflects partially from surfaces that have a refractive index different from that of their surroundings. Definition: The refractive index $n$ of a medium is defined as the ratio of the phase velocity $c$ of a wave phenomenon such as light or sound in a reference medium to the phase velocity $v_p$ in the medium itself: $n = c / v_p$

Simply, it is the specific property of medium to propagate or refract light or radiation.
Chromatic Aberration

In Optics, **chromatic aberration** (CA, also called **achromatism** or **chromatic distortion**) is a type of **distortion** in which there is a failure of a **lens** to focus all **colors** to the same convergence point. It occurs because lenses have a different **refractive index** for different wavelengths of light (the **dispersion** of the lens). The refractive index decreases with increasing wavelength.

In simple, it is condition in which the lens fails to focus all colors at converging point due to Dispersion Of the lens.

![Image](image_url)

**Fig 02:** Showing effect of aberration on photography and correction with use of wide angle Lens

**Source:** Wikipedia Chromatic aberration

**Mathematical analysis of Dispersion of light**

A material's dispersion is measured by its **Abbe number**, $V$, with low Abbe numbers corresponding to strong dispersion. For optics in the visual range the amount of dispersion of a lens material is often quantified by the Abbe number $V$.

$$V = \frac{n_{\text{yellow}} - 1}{n_{\text{blue}} - n_{\text{red}}}$$
References


2) Isaac Newton: adventurer in thought, by Alfred Rupert Hall, page 67