Module B. Colour from the Cosmos

Lesson 12: Colour, Light and Optics 1

Dispersion

We described earlier how light rays that pass from one medium to another (at angles other than 90 degrees) undergo refraction and that the degree of refraction of light is dependant on its wavelength. Recall that "white" light is a mixture of light with wavelengths across the visible range. Thus when white light enters or leaves a material at angles other than 90 degrees, individual spectral wavelengths (colours) will be refracted by different amounts. This is called dispersion. Longer wavelengths (e.g., red) are refracted the least and shorter wavelengths (e.g., violet) are refracted the most. This phenomenon of dispersion is what gives gemstones their fire.

In gemology, dispersion is calculated as the difference in the refractive index for light of the shortest and the longest wavelengths. Because we are only dealing with light in the visible range, we use the refraction indices of violet and red, 430.8 and 686.7 nm, respectively. Gemstones with higher values of dispersion will show greater spreading, or dispersion, of colour.

Most notable of the gemstones is diamond, which has a dispersion value of 0.044. Here, the refractive index for violet light is 2.451 and for red it is 2.407. Thus, the dispersion is 2.451 - 2.407 = 0.044. However, there are many other stones with higher dispersion values, for example, demantoid garnet = 0.057 and titanite = 0.051.

Plot showing the change of diamond's refractive index as a function of wavelength --- the definition of dispersion. Note how violet light (shorter wavelength) has a higher refractive index than red light (longer wavelength). (Image from Green et al 2001, GIA, Diamond Optics Part 2)

Dispersion of white light through a prism. Note how violet light (shorter wavelength) is refracted more than red light (longer wavelength).

Reflection, refraction, total internal reflection, and dispersion in a Round Brilliant-cut diamond. Note that without total internal reflection light would be lost from the stone and therefore would not generate 'sparkle' or 'fire'.