Refraction

The phenomenon of refraction can be explained geometrically with the aid of Figure 4.4. A beam of light incident on a boundary surface is composed of wavefronts that are perpendicular to the direction of propagation of the beam. This beam will propagate more slowly through a dense medium than it does through air.

If the incident beam is not normal to the boundary surface, one edge of the wavefront will enter the denser material first and be slowed down. This effect will propagate across the wavefront, changing the direction of the refracted beam relative to the incident beam.

This change in direction is always toward the normal to the boundary surface when the light beam crosses into a denser medium. It will be the opposite for a beam crossing into a less dense medium.

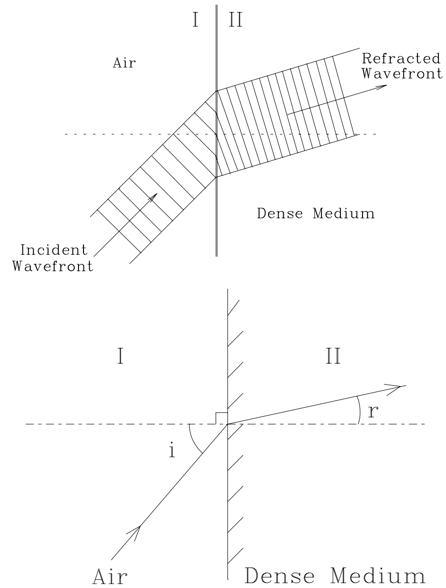

Figure 4.4: Geometry of refraction

The mathematical relationship between the incident angle i and the refracted angle r of the light beam is given by Snell's Law:

$$\frac{\sin i}{\sin r} = \frac{n_{\mathrm{II}}}{n_{\mathrm{I}}} \tag{4.2}$$

The angles i and r are measured from the normal (i.e., perpendicular) direction to the boundary. The numbers n_I and n_{II} are characteristic of each medium, and are called the refractive indices. For a vacuum, $n = 1$, the refractive index of air is approximately 1, and *all* other materials have $n > 1$.

The refractive index is also a function of the wavelength of the light, and therefore light rays of different colour have different angles of refraction r for identical angles of incidence i. This effect, called the *dispersion of light*, is observed when white light from a source such as sunlight or a light bulb crosses a boundary. Light from a source of monochromatic light, such as a laser, consists of a single wavelength and therefore will not be dispersed.

Note that when a ray travels from a medium to a more dense medium (e.g. from air to plastic), it always refracts *towards* the normal ($r \leq i$). Conversely, when a ray travels from a medium to a less dense medium (e.g. plastic to air), it always refracts *away* from the normal ($r \geq i$).