

## 5.4: Optical Depth

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The product of linear extinction coefficient and distance, or, more properly, if the extinction coefficient varies with distance, the integral of the extinction coefficient with respect to distance,

$$\tau = \int \kappa(x) dx \quad (5.4.1)$$

is the *optical depth*, or *optical thickness*,  $\tau$ . It is dimensionless. Specific intensity falls off with optical depth as

$$I = I^0 e^{-\tau}. \quad (5.4.2)$$

Thus optical depth can also be defined by  $\ln(I^0/I)$ . While the optical depth  $\ln(I^0/I)$  is generally used to describe how opaque a stellar atmosphere or an interstellar cloud is, when describing how opaque a filter is, one generally uses  $\log_{10}(I^0/I)$ , which is called the *density*  $d$  of the filter. Density is 0.4343 times optical depth. If a star is hidden behind a cloud of optical depth  $\tau$  it will be dimmed by  $1.086\tau$  magnitudes. If it is hidden behind a filter of density  $d$  it will be dimmed by  $2.5d$  magnitudes. The reader is encouraged to verify these assertions.

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