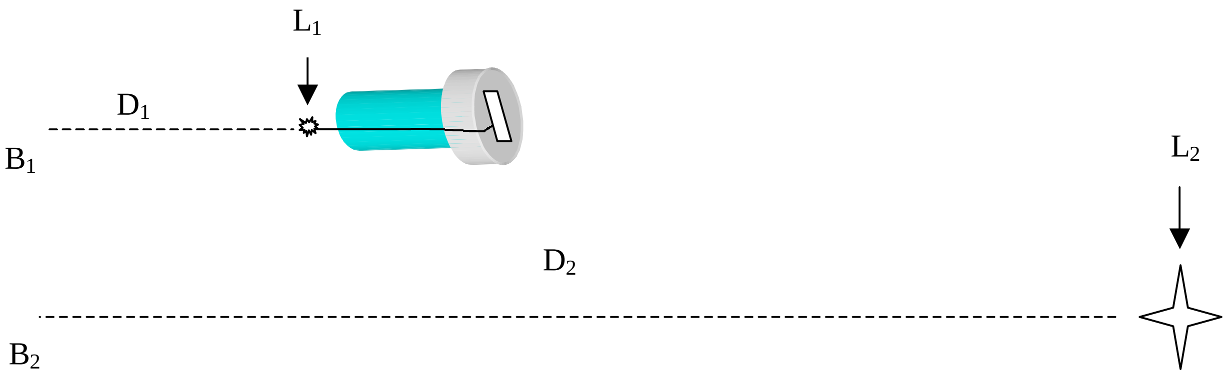
Distance to Stars Using the Inverse Square Law



L_1 = luminosity of flashlight = 1×10^{-6} watt
D_1 = distance from observer to "artificial star" on flashlight in meters
B_1 = apparent brightness of "artificial" star (fiber optic strand)

L_2 = luminosity of the star determined from astronomical catalog
D_2 = distance from observer to the star (this is to be determined)
B_2 = apparent brightness of the star

According to the inverse square law

$$B_1 = \frac{L_1}{D_1^2} \quad \text{and} \quad B_2 = \frac{L_2}{D_2^2}$$

Now if we adjust D_1 so that $B_1 = B_2$ we have

$$\frac{L_1}{D_1^2} = \frac{L_2}{D_2^2}$$

Since we know L_1, D_1 and L_2, we can solve for D_2, the distance to the star

$$D_2^2 = \frac{L_2}{L_1} D_1^2 \text{ and}$$

$$D_2 = \sqrt{\frac{L_2}{L_1}} D_1$$

If D_1, the distance to the flashlight, is in meters, then D_2, the distance to the star will also be in meters. To convert to light years use

9.46×10^{15} m/ly

thus,

$$D_2(ly) = \frac{D_2(m)}{9.46 \times 10^{15}}$$

The luminosity of the sun is approximately: **3.9×10^{26} watts**

Luminosities of a few selected stars:

Star	Luminosity (*relative to the sun*)
Betelguese	13500
Rigel	55000
Vega	50
Deneb	80000
Polaris	5500
Arcturus	98
Altair	10
Sirius	21
Aldebaran	137

For example, to determine the distance to Vega, we first determine the luminosity of Vega in watts:

$$L_{Vega} = 50 \times 3.9 \times 10^{26} = 1.95 \times 10^{28} \text{ watts}$$

Then,

$$D_2 = \sqrt{\frac{1.95 \times 10^{28}}{1 \times 10^{-6}}} D_1$$

Here, D_1 is the distance in meters necessary to make the star and the flashlight appear equally bright, and D_2 is the distance to Vega in meters.