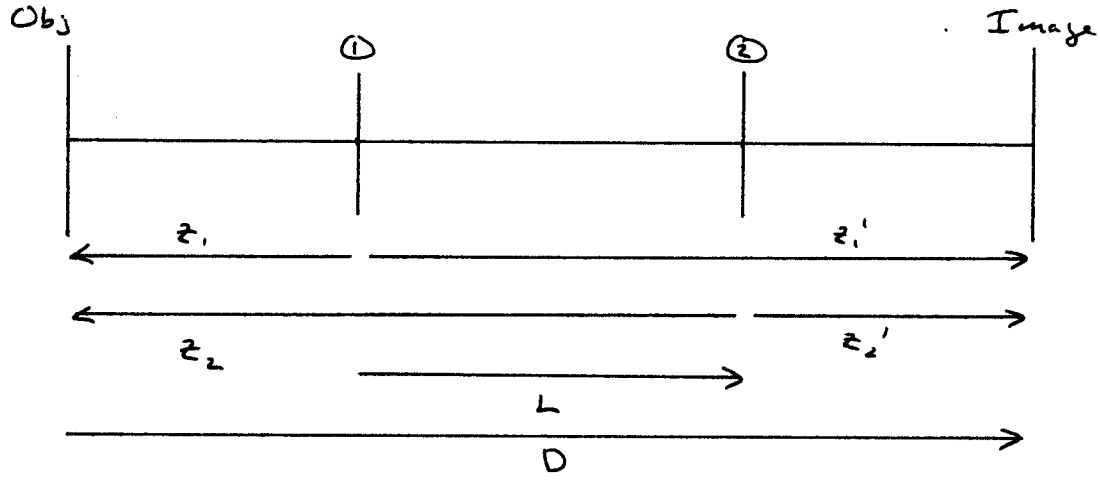
Focal Length Measurement

Bessel's Method: Reciprocal Magnification



$$D - L = z_2' - z_1$$

$$D = z_1' - z_1$$

$$D + L = z_1' - z_2$$

Reciprocal Magnification $\rightarrow$ $z_2' = -z_1$

$z_1' = -z_2$

$$D - L = -2z_1$$

$$D + L = -2z_2$$

$$\frac{1}{z_1'} = \frac{1}{z_1} + \frac{1}{f} \qquad f = \frac{z_1' z_1}{z_1 - z_1'} = \frac{z_1 z_2}{D}$$

$$f = \frac{(D-L)(D+L)}{4D}$$

$$\boxed{f = \frac{D^2 - L^2}{4D}}$$

Abbe's Method

$$\frac{1}{z_1'} = \frac{1}{z_1} + \frac{1}{f} \qquad \frac{1}{z_2'} = \frac{1}{z_2} + \frac{1}{f}$$

$$z_1' = \frac{f z_1}{f + z_1} \qquad z_2' = \frac{f z_2}{f + z_2}$$

$$\frac{1}{m_1} = \frac{z_1}{z_1'} = \frac{f + z_1}{f} \qquad \frac{1}{m_2} = \frac{z_2}{z_2'} = \frac{f + z_2}{f}$$

$$\frac{1}{m_1} - \frac{1}{m_2} = \frac{f + z_1}{f} - \frac{f + z_2}{f} = \frac{z_1 - z_2}{f}$$

$$\boxed{f = \frac{z_1 - z_2}{1/m_1 - 1/m_2}}$$