Module 1:
The evolution of the q parameter

Course 2 of *Optical Engineering*: Optical efficiency and resolution

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How does q evolve with transfer & refraction?

Transfer

$$q_1 = z_1 + j\, z_0$$

$$q_2 = z_2 + j\, z_0 = q_1 + (z_2 - z_1)$$

$$\therefore$$

$$\boxed{q_2 = q_1 + \Delta z}$$

Refraction

$$\frac{1}{q(z)} = \frac{1}{R(z)} - j\frac{\lambda}{\pi\, w^2(z)}$$

$$\frac{1}{R'} = \frac{1}{R} - \frac{1}{f}$$

Thin lens equation expressed as change in curvature. NOTE GAUSSIAN BEAM SIGN CONVENTION!

$$\frac{1}{q'} = \frac{1}{q} - \frac{1}{f}$$

Change of q at thin lens

$$\boxed{q' = \frac{q}{-q/f + 1}}$$

Solve for q'

First order design w/ Gaussian beams (1/2)

Evolution equation:

$$\boxed{q' = \frac{Aq + B}{Cq + D}}$$

Transfer

$$\mathcal{T}_k = \begin{bmatrix} 1 & t'_k \\ 0 & 1 \end{bmatrix}$$

$$q' = \frac{1q + t'_k}{0q + 1} = q + t'_k \quad \checkmark$$

Refraction

$$\mathcal{R}_k = \begin{bmatrix} 1 & 0 \\ -\phi_k & 1 \end{bmatrix}$$

$$q' = \frac{1q + 0}{-\phi_k q + 1} = \frac{q}{-q/f + 1} \quad \checkmark$$