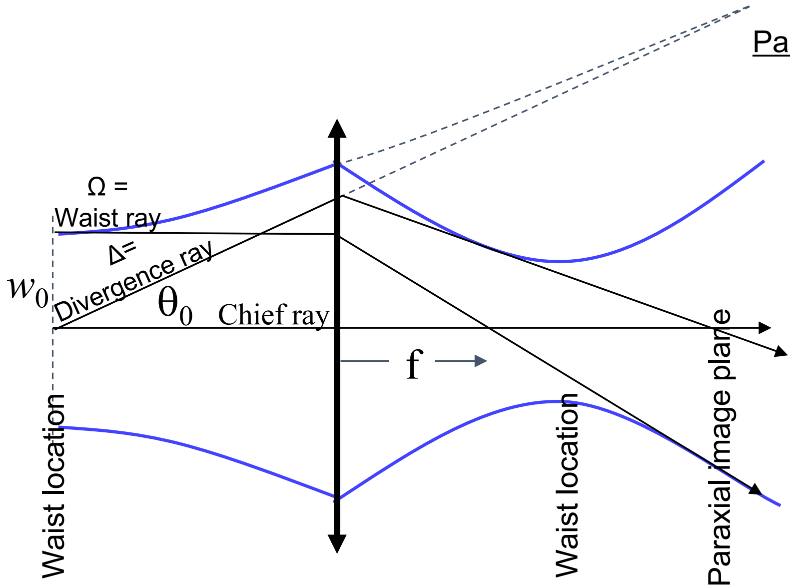
Module 1:
Ray tracing with Gaussian beams

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

with **Dr. Robert R. McLeod and Dr. Amy C. Sullivan**

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

Define the following three rays. Note their suggestive names and relationship to the Gaussian beam.



Paraxial ray trajectory form

$$\Omega(z) = w_0$$

$$\Delta(z) = z\,\theta_0$$

ABCD vector form

$$\Omega_0 = \begin{bmatrix} w_0 \\ 0 \end{bmatrix}$$

$$\Delta_0 = \begin{bmatrix} 0 \\ \theta_0 \end{bmatrix}$$

References:

1. J. Arnaud, Applied Optics, V24, N4, p. 538, 15 Feb 1985
2. A. W. Greynolds, SPIE V 560, p. 33, 1985
3. Mouroulis & Macdonald Appendix 2.5

Define the complex ray trajectory †

$$\Gamma(z) = \Delta(z) + j\Omega(z)$$

You can then show that this ray contains $q(z)$

$$\frac{\Gamma(z)}{d\Gamma/dz} = \frac{y_\Delta + j\,y_\Omega}{u_\Delta + j\,u_\Omega}$$

y and u all functions of z

$$= \frac{z\theta_0 + jw_0}{\theta_0} = z + j\,z_0 = q(z)$$

Relation of the two rays to Gaussian parameters

$$\boxed{\theta_0 = \sqrt{u_\Delta^2 + u_\Omega^2}} \qquad \boxed{w(z) = \sqrt{y_\Omega^2(z) + y_\Delta^2(z)}}$$

† This is Greynolds' definition and yields q. Arnaud's definition yields q*.