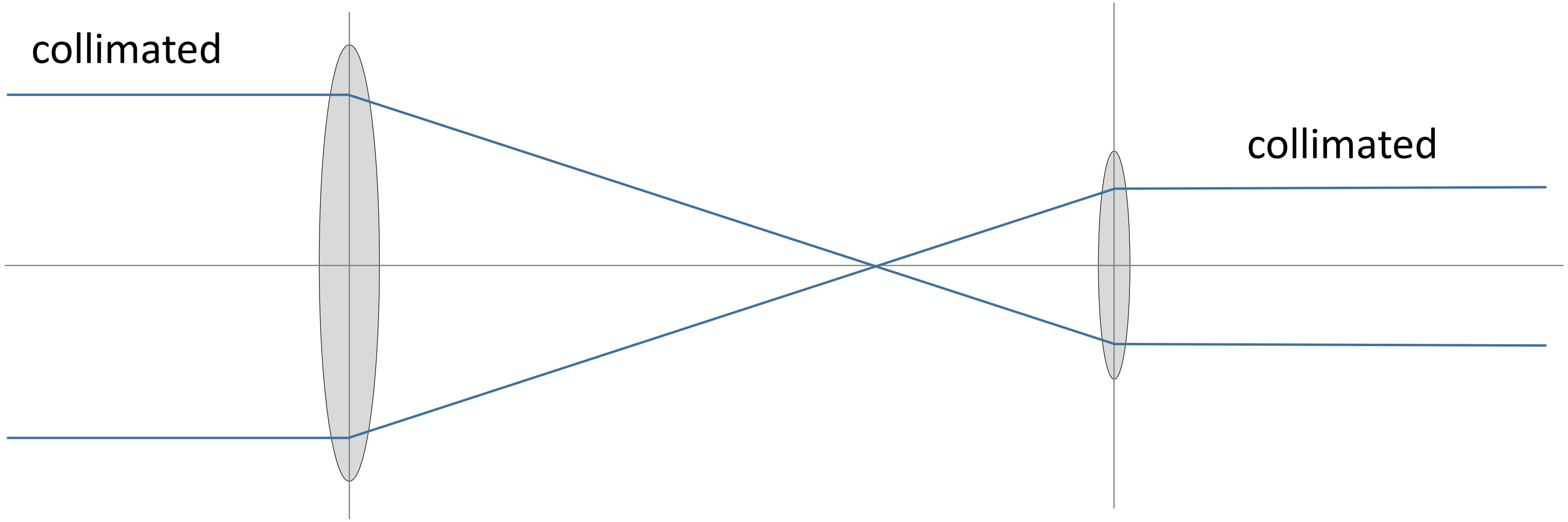
Gaussian laser beams

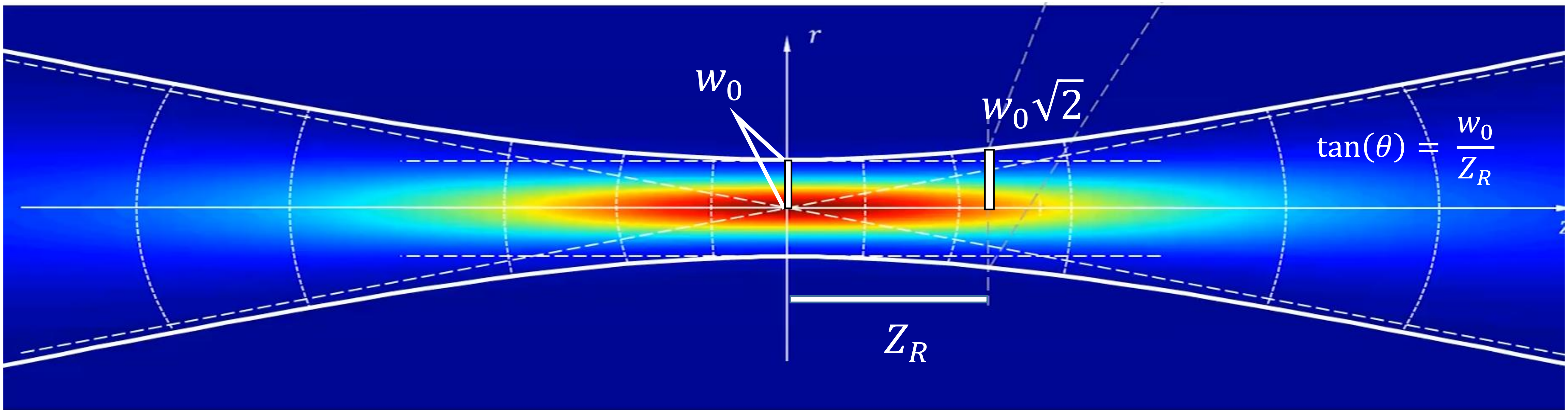


Collimated beam is an idealized concept

Real beams loose collimation as they propagate

Rayleigh length: $Z_R = \dfrac{\pi\, w_0^2}{\lambda}$

w_0 - beam waist radius,
λ - laser wavelength

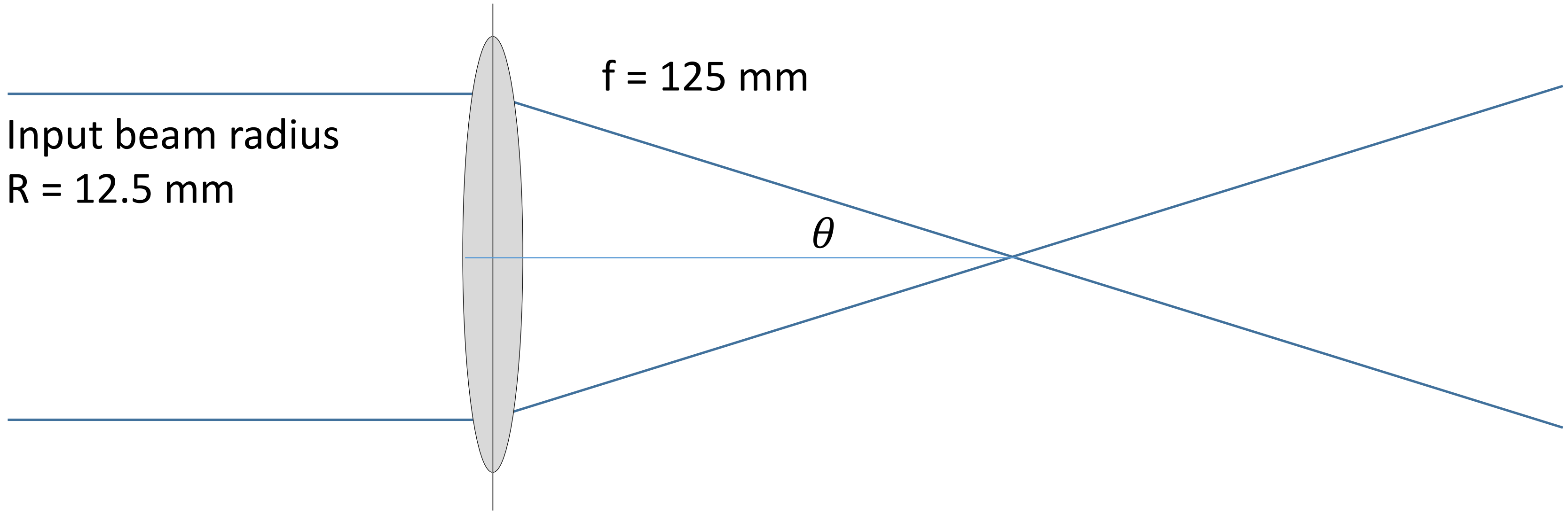


Think of light-sheet

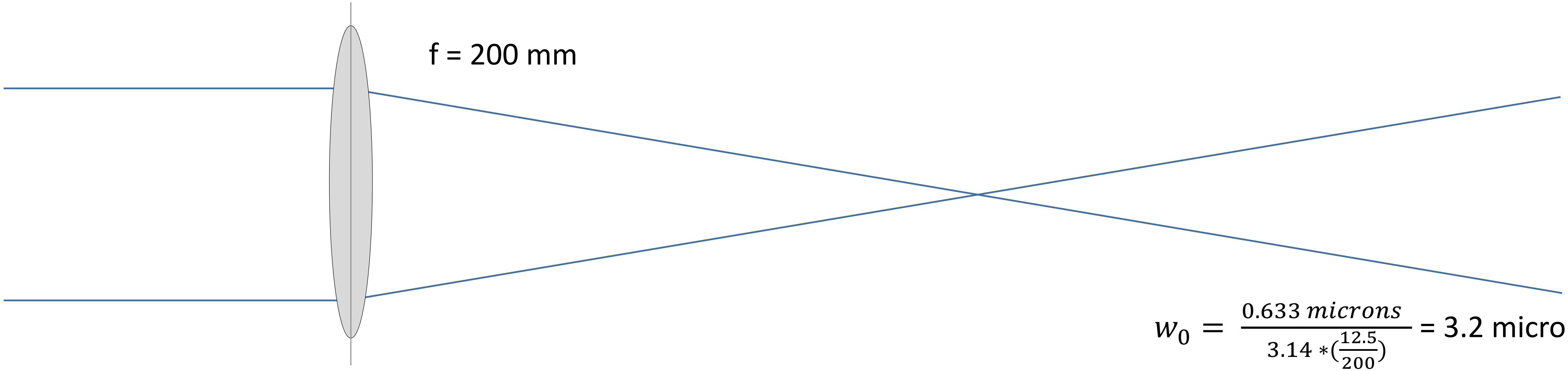
Demo: How large is the beam waist, $i.e.$ w_0 radius ?

$$Z_R = \frac{\pi\, w_0^2}{\lambda}, \qquad \tan(\theta) = \frac{w_0}{Z_R}$$

$$\boxed{w_0 = \frac{\lambda}{\pi \tan(\theta)}}$$



$$w_0 = \frac{0.633\ microns}{3.14 * (\frac{12.5}{125})} = 2 \text{ microns}$$

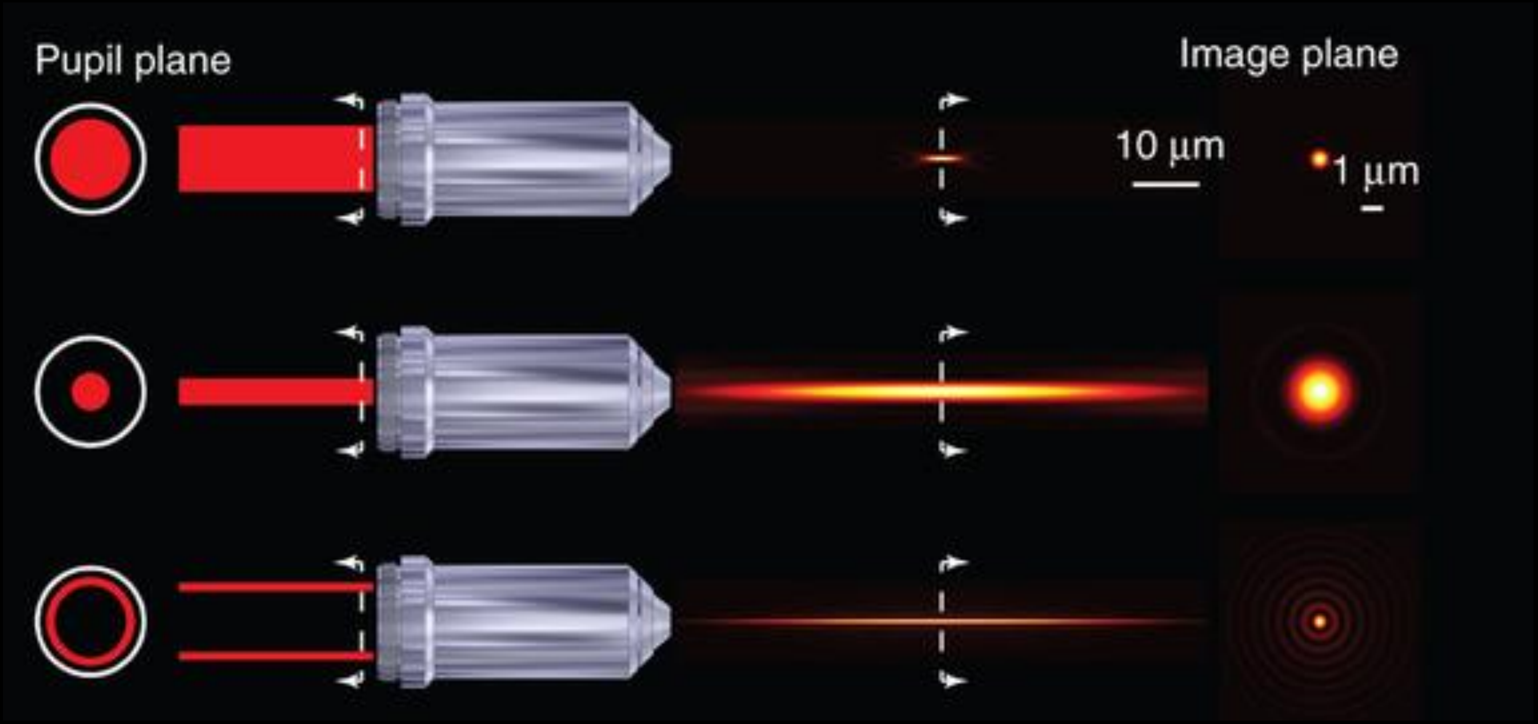


$$w_0 = \frac{0.633\ microns}{3.14 * (\frac{12.5}{200})} = 3.2 \text{ microns}$$

Gaussian, high NA

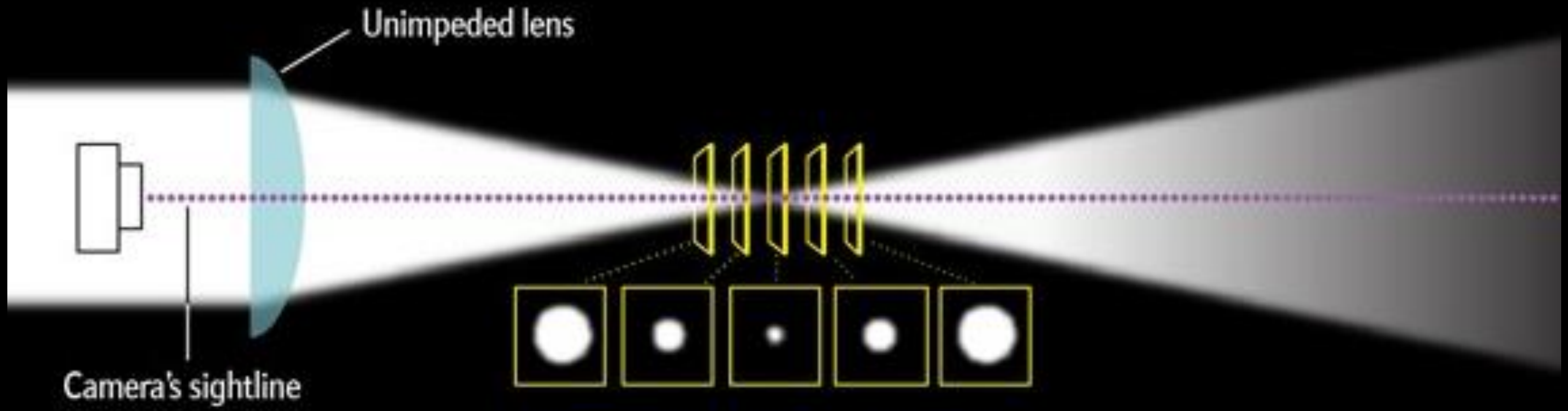
Gaussian, low NA

Bessel



Gao et al, Nature Protocols, 2014

Gaussian



Bessel

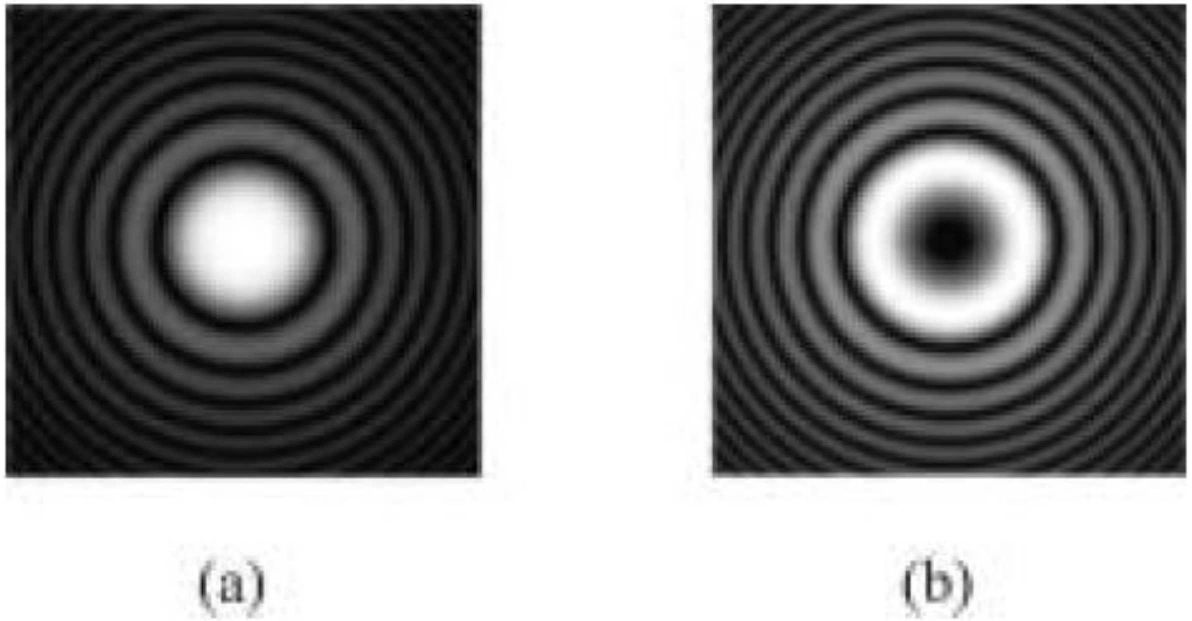


Figure 1. Bessel beam intensity profiles: (a) for a zeroth-order beam and (b) a first-order beam (J_1 beam). Both beams have the same k_r values.

McGloin & Dholakia, *Contemporary Physics*, 2004