Recap: Gaussian beams

1. Approximations:

- scalar
- paraxial

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2. Electric field:

In terms of complex beam parameter (depending on convention: might be complex conjugate):

$$E(x,y,z,t) = E_0 e^{i\omega(z/c-t)} \frac{1}{q(z)} \exp\left[+ik\frac{x^2+y^2}{2q(z)}\right] \qquad q(z) = z - iz_R = z - i\frac{\pi w_0^2}{\lambda} \qquad k = \frac{\omega}{c}$$

In terms of z-dependent beam size, and wavefront radius:

$$E(x,y,z,t) = E_0 e^{i\omega(z/c-t)} \frac{w_0}{w(z)} \exp\left[-\frac{x^2+y^2}{w(z)^2}\right] \exp\left[+i\frac{k(x^2+y^2)}{2R(z)}\right] e^{-i\arctan(z/z_R)}$$

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3. Important characteristics:

$$P = AI_0 \qquad A = \frac{\pi w_0^2}{2} \qquad z_R = \frac{\pi w_0^2}{\lambda}$$

$$w(z) = w_0\sqrt{1+\left(\frac{\lambda z}{\pi w_0^2}\right)^2} \equiv w_0\sqrt{1+\left(\frac{z}{z_R}\right)^2} \qquad w(z) \to \frac{\lambda z}{\pi w_0}$$

$$R(z) = z\left(1+\left(\frac{z_R}{z}\right)^2\right) \qquad \frac{I(z)}{I(0)} = \frac{1}{1+\frac{z^2}{z_R^2}}$$