

[Optics](#) ➔ [Gaussian Beam Optics](#) ➔ [Real Beam Propagation](#)[Home](#)[Optics Guide Contents](#)[Fundamental Optics](#) ➤[Gaussian Beam Optics](#) ➤[Optical Specifications](#) ➤[Material Properties](#) ➤[Optical Coatings](#) ➤[Optics Glossary](#)

## Gaussian Beam Optics

### Real Beam Propagation

In the real world, truly Gaussian laser beams are very hard to find. Low-power beams from helium neon lasers can be a close approximation, but the higher the power of the laser, the more complex the excitation mechanism (e.g., transverse discharges, flash-lamp pumping), and the higher the order of the mode, the more the beam deviates from the ideal.

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[Laser Modes](#)[The Propagation Constant](#)[Incorporating  \$M^2\$  Into the Propagation Equations](#)

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To address the issue of non-gaussian beams, a beam quality factor,  $M^2$ , has come into general use.

For a typical helium neon laser operating in  $TEM_{00}$  mode,  $M^2 < 1.1$ . Ion lasers typically have an  $M^2$  factor ranging from 1.1 to 1.7. For high-energy multimode lasers, the  $M^2$  factor can be as high as 10 or more. In all cases, the  $M^2$  factor affects the characteristics of a laser beam and cannot be neglected in optical designs, and truncation, in general, increases the  $M^2$  factor of the beam.

In *Laser Modes*, we will illustrate the higher-order eigensolutions to the propagation equation, and in *The Propagation Constant*,  $M^2$  will be defined. The section *Incorporating  $M^2$  into the Propagation Equations* defines how non-Gaussian beams propagate in free space and through optical systems.

[Back to Top](#)[Previous](#) [Next](#)

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