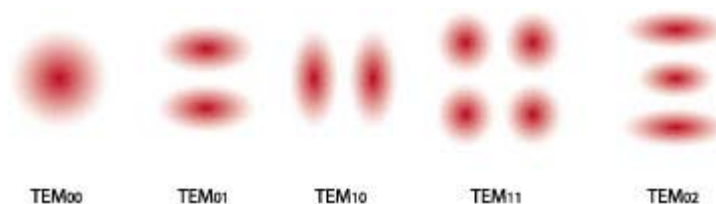


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Real Beam Propagation

Laser Modes

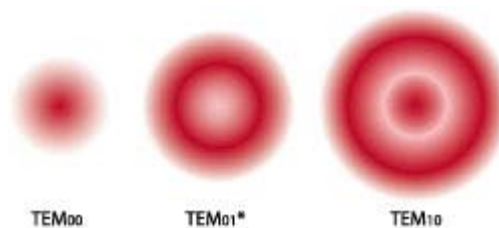
The fundamental TEM_{00} mode is only one of many transverse modes that satisfy the round-trip propagation criteria described in the section on [Gaussian Beam Propagation](#). The figure below shows examples of the primary lower-order Hermite-Gaussian (rectangular) solutions to the propagation equation.



Low-order Hermite-gaussian resonator modes

Note that the subscripts n and m in the Eigenmode TEM_{nm} are correlated to the number of nodes in the x and y directions. In each case, adjacent lobes of the mode are 180° out of phase.

The propagation equation can also be written in cylindrical form in terms of radius (ρ) and angle (ϕ). The eigenmodes ($E_{\rho\phi}$) for this equation are a series of axially symmetric modes, which, for stable resonators, are closely approximated by Laguerre-Gaussian functions, denoted by $TEM_{\rho\phi}$. For the lowest order mode, TEM_{00} , the Hermite-Gaussian and Laguerre-Gaussian functions are identical, but for higher order modes, they differ significantly, as shown in the figure below.



Low-order axisymmetric resonator modes

The mode, TEM_{01}^* , also known as the "bagel" or "doughnut" mode, is considered to be a superposition of the Hermite-Gaussian TEM_{10} and TEM_{01} modes, locked in phase quadrature.

In real-world lasers, the Hermite-Gaussian modes predominate since strain, slight misalignment, or contamination on the optics tends to drive the system toward rectangular coordinates. Nonetheless, the Laguerre-Gaussian TEM_{10} "target" or "bulls-eye" mode is clearly observed in well-aligned gas-ion and helium neon lasers with the appropriate limiting apertures.

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