### Paraxial Equation and Gaussian Beams

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Wave Eq.



assume propagation within small angle of z axis



 is the envelope. Plug in, use ‘slowly varying envelope approximation’



The general solution is a linear combination of the following basis





  

, , 

This is called the **Hermite-Gauss mode**, denoted . are Hermite polynomials and  is the **Gouy phase-shift**,  is the **Rayleigh length**. The second exp factor makes the wave front a spherical wave with curvature , because





 is the **fundamental Gaussian mode**.

In cylindrical coordinates, the basis change to **Laguerre-Gauss modes** 





This is analogous to solving SHO in polar coordiantes while Hermite-Gauss modes are in Cartesian coordinates.