RAY AND WAVE MECHANICS FOR STRUCTURING LIGHT

Mark R DENNIS,[1,2]

[1]*School of Physics and Astronomy, University of Birmingham, Birmingham B15 2TT;*
[2]*EPSRC Centre for Doctoral Training in Topological Design,*
University of Birmingham, Birmingham B15 2TT;
m.r.dennis@bham.ac.uk

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A systematic approach to the understanding of structured light is enhanced using wave mechanics familiar from quantum theory, where families of optical modes are eigenfunctions of an appropriate operator [1]. Simple examples include: Gaussian modes as eigenfunctions of the beam quality operator corresponding to a quantum 2D harmonic oscillator Hamiltonian, and propagation-invariant beams as eigenfunctions of the free 2D Hamiltonian. The approach can be extended into the semiclassical regime of Hamiltonian optics, with rays weighted by complex phases and polarisations, arising from the WKB approximation [2]. In particular, the ray approach allows the controlled shaping of caustics as bright regions in both Gaussian [2] and propagation-invariant beams [3].

I will describe how this approach can be used to design optical modes with desired properties useful for applications. These are eigenfunctions of some appropriately chosen operator, rather than the numerical optimization routes frequently taken. Examples include bottle beams, superresolved beams, and tightly-focused Gaussian beams.

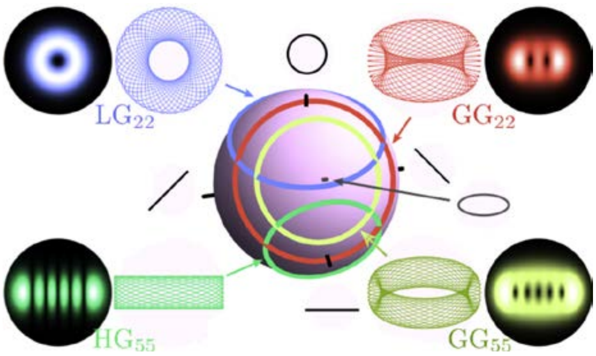

Fig. 1: Examples of Gaussian beams (LG: Laguerre Gaussian, HG: Hermite-Gaussian, GG: Generalised Gaussians) and ray representations. In this interpretation, Gaussian modes are identified with closed paths on the Poincaré sphere, which is arises from the ray structure of the beam quality operator. Figure from Ref. [1].

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