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Wigner distribution function and the complex curvature applied to Laguerre-Gaussian modes propagating through first order systems

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Abstract content
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A general rotational symmetric laser field can be represented as (i) a superposition of rotationally symmetric modes such as an infinite set of the discreet Laguerre-Gaussian functions or (ii) simply by fitting a Gaussian function. In the first approach, the propagation of the field through a first-order system is represented by the propagation of each mode. The field at any subsequent plane is evaluated by a sum of the modes calculated at that plane. With this method, we can make the fit as accurate we want by making the number of modes as large as required. The second approach is to calculate the moments of the rotational symmetric field in phase space using the Wigner distribution function. This method is simpler and presents closed form results. The beam width, far-field divergence and the space-angular moment of the beam were calculated using the moment definition of these parameters using both approaches. In the limiting case of a single mode, preliminary results show that these parameters increase with the mode order.
Expressions for the evolution of each of these parameters through first order systems are extracted and provided in terms of the complex beam parameter, q. The invariance of the propagation is expressed in terms of the beam parameter product. Other parameters, such as the waist width, waist position and Rayleigh range, are presented in terms of the second moment parameters, including even less familiar but equally important parameters such as the local divergence, curvature divergence and focusing parameter. Applications of the results in the analysis of the radiometry of these modes during first order propagation are presented. The radiometric parameters concerned are the geometric vector flux and the total radiant flux.

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