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The Beam Expansion Method, A Simplified and Efficient Approach of Field Propagation and Resonators Modes Study

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Abstract : The study of a beam throughout an optical path is generally achieved by means of diffraction integral. Unfortunately, in some problems, this tool turns out to be not very friendly and hard to implement. Instead, the beam expansion method for computing field profiles appears to be an interesting alternative. The beam expansion method consists of expanding the field pattern as a series expansion in a set of orthogonal functions. Propagating each individual component through a circuit and adding up the derived elements leads easily to the result. The problem is then reduced to finding how the expansion coefficients change in a circuit. The beam expansion method requires a systematic study of each type of optical element that can be met in the considered optical path. In this work, we analyze the following fundamental elements: first order optical systems, hard apertures and waveguides. We show that the former element type is completely defined thanks to the Gouy phase shift expression we provide and the latters require a suitable mode conversion. For endorsing the usefulness and relevance of the beam expansion approach, we show here some of its applications such as the treatment of the thermal lens effect and the study of unstable resonators.

Keywords : gouy phase shift, modes, optical resonators, unstable resonators
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