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Coherent-mode representation of self-imaging optical fields

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Abstract

The coherent-mode representation is a fundamental tool that helps us understand the processes of producing and propagating optical fields. In this work, such representation for self-imaging phenomena under partially coherent illumination is presented within the frame of partial coherence theory in the space-frequency domain. Additionally, it is shown that the well-known Talbot and Lau effects are particular cases included in this new formalism. When complete coherence of the field is considered, the general expression for coherent self-imaging of optical fields is obtained (Talbot effect for both linear and circular gratings are presented); on the other hand, when an incoherent superposition of an infinite number of modes are considered, the expression to describe the Lau effect is obtained.

Introduction

The diffracted optical field from a periodic object under coherent illumination replicates itself along the propagation axis. This effect was first observed by H. F. Talbot[1], and it is known as the Talbot effect or self-imaging effect under coherent illumination. Later, W. D. Montgomery[2] showed that the object's lateral periodicity was a sufficient but not a necessary condition for the Talbot effect to