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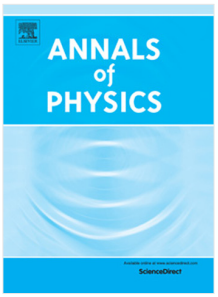

Group approach to the paraxial propagation of Hermite-Gaussian modes in a parabolic medium

S. Cruz y Cruz, Z. Gress

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Group approach to the paraxial propagation of Hermite-Gaussian modes in a parabolic medium

S. Cruz y Cruz and Z. Gress

Instituto Politécnico Nacional, UPIITA, Av. Instituto Politécnico Nacional 2580, Col. La Laguna Ticomán, C.P. 07360, Ciudad de México, Mexico

Abstract

A group-theoretical approach to the paraxial propagation of Hermite-Gaussian modes based on the factorization method is presented. It is shown that the $su(1,1)$ and the $su(2)$ algebras generate the spectrum of propagation constants at any fixed transversal plane. The complete set of HG modes is decomposed into hierarchies that are used to establish the representation spaces of $SU(1,1)$ and $SU(2)$. The corresponding families of generalized coherent states are constructed and the variances of the quadratures and canonical variables are determined.

Keywords:
Hermite-Gaussian modes, dynamical algebras, coherent states
PACS: 02.20.Qs, 03.65.Fd, 42.25.Kb

1. Introduction

The set of Hermite-Gaussian (HG) modes has been one the most studied families of paraxial beams. They play an important role in the study of laser resonators and optical waveguides [1] and have a number of applications in particle trapping [2], communications and signal processing [3], micro- and nano-manipulation of matter [4, 5] and high resolution imaging [6] among other areas (see also [7] and references quoted therein). Yet, the study of HG modes is far from being completely exhausted. New developments about their properties, generation and applications are currently addressed [8, 9, 10, 11]. In the paraxial approximation, where the directions of the normals to the wavefronts are close to the optical axis, the exact wave equation can be reduced to a parabolic-type one, the paraxial wave equation,