

One- and two-dimensional topological charge distributions in stochastic optical fields

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Abstract

Quasi-random (stochastic) optical fields are found in laser speckle, scintillated beams and the output beams of highly complex diffractive optical elements. Such stochastic optical fields often contain distributions of optical vortices. There is currently no generally accepted theory for the collective behaviour of the optical vortices in stochastic optical fields, which is remarkable in view of the fact that optical vortices in stochastic optical fields can display a complicated transient behaviour under specific initial conditions. Such initial conditions include the situation where the initial topological charge density in the optical field is inhomogeneous, being a function of either one or two transverse spatial coordinates. This scenario can be produced by an appropriate (coherent and incoherent) combination of random optical fields (speckle beams). The optical setups with which such inhomogeneous initial topological charge densities can be produced will be discussed. The resulting transient behaviour of such inhomogeneous topological charge densities are studied both numerically and analytically. The numerical procedure and the analytical calculations will be presented, together with their respective results, and will be shown to be in remarkable agreement with each other. The observed transient behaviour shows that the one-dimensional case obeys a modified diffusion equation. The evolution of the two-dimensional case is much more complicated, displaying a nonlinear behaviour. Possible mechanisms for this nonlinearity will be discussed.

1. Short biography

Filippus Stefanus Roux (Stef) has an PhD in Electronic Engineering from Univ. of Pretoria 1990, and a PhD in Theoretical Particle Physics from Univ. of Toronto 2000. He held positions at the Univ. of Pretoria and at Univ. of Potchefstroom in South Africa, and also at Univ. of Ottawa and at JDS Uniphase Corporation in Ottawa, Canada. Currently, he is Principal Researcher in the Mathematical Optics group at CSIR National Laser Centre in Pretoria, South Africa.