PROPAGATION OF LASER VORTEX BEAMS WITH AN ARBITRARY TOPOLOGICAL CHARGE IN A CRADED-INDEX PARABOLIC FIBER

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In this work, we discuss the propagation of the laser vortex beams $\exp\{i\mu\varphi\}$ in a parabolic fiber. The relationship between the complex amplitude and the transverse coordinates and the distance on the optical axis is described as the integral operator of propagation in a parabolic medium acting on the input beam amplitude distribution. This integral is analogous to the Fresnel integral that describes the propagation of paraxial laser beams in a uniform medium. The result of action of the integral operator onto the vortex beam can be analytically represented in two ways. In the first case, the kernel of the analytical expression for the amplitude is given by a degenerate hyper-geometric function. In the second case, the amplitude is represented as a composition of an infinite number of Gauss-Laguerre modes, which are eigenmodes of the parabolic fiber. The analytical relations derived are verified by numerical modeling with use of the integral operator and the method for propagating the light beams through thin lenses, which relies on the fast Fourier transform. The results of the numerical modeling and the analytical calculations agree within the method's accuracy.

Laser vortex beams, Gauss-Laguerre modes, parabolic optical fiber, light beam propagation method, paraxial integral operator of propagation

References

1. M. S. Soskin and M. V. Vasnetsov, Progress in Optics. – 2001. – 42. – P.219.
2. Soifer V.A., Kotlyar V.V., Khonina S. N., Physics of Particles and Nuclei 35(6), 733 (2004)
3. Kotlyar V.V., et al, J. Opt. Soc. Am. A 22(5), 849 (2005)
4. Strilec, A.S. The coordination and re-search of the methods based on differential and integrated operators of distribution of laser ra-diation in the environment with small inho-mogeneity / A.S. Strilec, S.N. Khonina // Com-puter Optics. – 2008. – V.32, N1. – P.33-38.
5. Snayder, A. The theory of optical wave guides / A. Snayder, D. Love – Moscow, "Radio I Svyaz" (Radio and communication), 1987.
6. Methods of Computer Optics / Edited by V.A.Soifer. – Moscow, Fizmatlit, 2003. – 688p.
7. Feit, M.D. Light Propagation in Graded-Index Optical Fibers / M.D. Feit, J.A. Fleck // Appl. Opt. – 1978. – Vol. 17 (24). – PP. 3990-3998.
8. Okoshi, T. The Beam Propagation Method / T. Okoshi, S. Kitazawa // Analysis me¬thods for electromagnetic wave problems. Editor E. Yama¬shita, Artech House, 1990. Chapter 10.
9. Huand, W. The Finite-Difference Vector Beam Propagation Method: Analysis and Assesment / W. Huand [and other] // J. of Lightwave Technology, 1992. Vol. 10 (3).
10. Lu, Y.Y. Some Techniques for Com-puting Wave Propagation in Optical Waveguides / Y.Y. Lu // Communications in Computational Physics. – 2006. – Vol. 1. – P. 1056-1075.

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