

DIFFRACTION OF THE SPACE-LIMITED BEAM ON THE DIFFRACTIVE OPTICAL ELEMENTS WITH RADIAL SYMMETRY

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We discuss a method for solving the diffractive problem on the optical elements with the symmetrical distribution of the permittivity. The method under discussion is the generalization of the rigorous coupled wave analysis (RCWA) for structures with the radial symmetry. As the basis for the decomposition of the solution the conic waves are chosen. This conic waves are the solution of the Maxwell's equations in the medium with the constant permittivity.

Focusator, diffractal optical element, Maxwell equations, diffraction

References

1. **Belanger, P.A.** Ring pattern of a lens-axicon doublet illuminated by a Gaussian beam / P.A. Belanger, M. Rioux // *Applied Optics*. – 1978. – Vol. 17, № 7. – P.1080-1086.
2. **Belanger, P.A.** Diffraction ring pattern at the focal plane of a spherical lens-axicon doublet / P.A. Belanger, M. Rioux // *Journ. Canadien de Physique*. – 1976. – Vol. 54. – P.1774-1780.
3. **Farn, M.W.** Effect of VLSI fabrication errors on kinoform efficiency / M.W. Farn, J.W. Goodman // *Proceedings SPIE*. – 1990. – Vol. 1211. – P.1256-136.
4. **Golub, M.A.** Computing experiment with elements of flat optics / M.A. Golub [and other] // *Avtometriya*. – 1988. – N 1. – P. 70-82. – [in Russian].
5. **Golub, M.A.** Diffractal calculation of the optical element focusing in a ring / M.A. Golub [and other] // *Avtometriya*. – 1987. – N 6. – P. 8-15. – [in Russian].
6. **Kazanskiy, N.L.** Research diffractal characteristics of focusator in a ring using a method of computing experiment / N.L. Kazanskiy // *Computer Optics*. – 1992. – N. 10-11. – P.128-144. – [in Russian].
7. **Doskolovich, L.L.** Focusators into a ring / L.L. Doskolovich [and others] // *Optical and Quantum Electronics*. – 1993. – Vol. 25. – P.801-814.
8. **Fedotowsky, A.** Optimal filter design for annular imaging / A. Fedotowsky, K. Lehovec // *Applied Optics*. – 1974. – Vol. 13, № 12. – P.2919-2923.
9. **Koronkevich, V.P.** Kinoform optical elements: calculation methods, manufacturing techniques, practical application / V.P. Koronkevich [and other] // *Avtometriya*. – 1985. – N 1. – P.4-25. – [in Russian].
10. **Koronkevich, V.P.** Kinoform optical elements with the ring pulse response / V.P. Koronkevich [and other] // Preprint 265 ИАиЭ СО Academy of Science of USSR. – Novosibirsk, 1985. – 23 p. – [in Russian].
11. **Belanger, P.A.** Diffraction ring pattern at the focal plane of a spherical lens-axicon doublet / P.A. Belanger, M. Rioux // *Journ. Canadien de Physique*. – 1976. – Vol. 54. – P.1774-1780.
12. **Golub, M.A.** Focusing of coherent radiation in the set area of space by means of the hologrammes synthesised on the computer / M.A. Golub [and other] // *Letters for GTF*. – 1981. – V. 7, N 10. – P.618-623. – [in Russian].
13. **Kazanskiy, N.L.** The analysis of characteristics of laser radiation focusators by a method of computing experiment / N.L. Kazanskiy // The dissertation on competition of a scientific degree of a Cand. Tech. Sci. – Kujbyshev: KuAI, 1988. – 183 p. – [in Russian].
14. **Kazanskiy, N.L.** Procedure of updating of phase function of a focusator by results of computing experiment / N.L. Kazanskiy // *Computer Optics*. – 1987. – N 1. – P. 90-96. – [in Russian].
15. **Paljchikova, I.G.** Kinoform optical elements with the increased depth of focus /

I.G. Paljchikova // Computer Optics. – 1989. – N 6. – P. 9-19. – [in Russian].

16. **Vasin, A.G.** Calculation and research of a coherent wave field in focal area of radially-symmetric optical elements / A.G. Vasin [and other] // Preprint 304 FIAN USSR. – Moscow, FIAN, 1983. – 38 p. – [in Russian].

17. **Soifer, V.A.** To focusator calculation in a coaxial piece / V.A. Soifer // Optical recording and information processing. – Kuibyshev, KuAI, 1988. – P. 45-52. – [in Russian].

18. **Doskolovich, L.L.** Analysis of quasiperiodic and geometric optical solutions of the problem of focusing into an axial segment / L.L. Doskolovich [and other] // Optik. – 1995. – Vol. 101, № 2. – P.37-41.

19. **Kazanskiy, N.L.** Correction of focuser phase function by computer-experimental method / N.L. Kazanskiy // Computer Optics. – 1989. – Vol. 1, № 1. – P.69-73.

20. **Khonina, S.N.** Calculation of the focusators into a longitudinal line-segment and study of a focal area / S.N. Khonina, V.V. Kotlyar, V.A. Soifer // Journal of Modern Optics. – 1993. – Vol. 40. – P. 761-769.

21. **Michaltsova, I.A.** Kinoform axicon / I.A. Michaltsova, V.I. Nalivaiko, I.S. Soldatenkov // Optik. – 1984. – Vol. 67, № 3. – P. 267-270.

22. **Kolodziejczyk, A.** The light sword optical element - a new diffraction structure with extended depth of focus / A. Kolodziejczyk [and other] // Journal of Modern Optics. – 1990. – Vol.37, № 8. – P.1283-1286.

23. **Brenden, B.B.** Optical playback apparatus focusing system for producing a prescribed energy distribution along an axial focal zone / B.B. Brenden, J.T. Russel // Applied Optics. – 1984. – Vol. 23, № 19. – P. 3250-3253.

24. **Tremblay, R.** Laser plasmasoptically pumped by focusing with axicon a CO₂-TEA laser beam in a high-pressure gas / R. Tremblay [and other] // Optics Communications. – 1979. – Vol. 28, № 2. – P. 193-196.

25. **Vorontsov, M.A.** To calculation of focusators of laser radiation in diffracting approach / M.A. Vorontsov, A.N. Matveev,

V.P. Sivokonj // Computer Optics. – 1987. – N 1. – P.74-79. – [in Russian].

26. **Rioux, M.** Linear, annular and radial focusing with axicons and applications to laser machining / M. Rioux, R. Tremblay, P.A. Belanger // Applied Optics. – 1978. – Vol.17, № 10. – P.1532-1536.

27. **Moharam, M.G.** Stable implementation of the rigorous coupled-wave analysis for surface-relief gratings: enhanced transmittance matrix approach / M.G. Moharam [and other] // J. Opt. Soc. Am. A. – 1995. – Vol. 12(5). – P. 1077-1086.

28. **Moharam, M.G.** Formulation for stable and efficient implementation of the rigorous coupled-wave analysis of binary gratings / M.G. Moharam [and other] // J. Opt. Soc. Am. A. – 1995. – Vol. 12(5). – P. 1068-1076.

29. **Li, L.** Use of Fourier series in the analysis of discontinuous periodic structures / L. Li // J. Opt. Soc. Am. A. – 1996. – Vol. 13(9) – P. 1870-1876.

30. **Kazanskiy, N.L.** Compact record of decisions of system of Maxwell equations in spatially-frequency representation / N.L. Kazanskiy, M.L. Kalyaev, S.I. Kharitonov // Aerials. – 2007. – N 10. – P. 13-21. – [in Russian].

31. **Dirak, P.A.M.** Principles of quantum mechanics / P.A.M. Dirak – Moscow, Science, 1979. – [in Russian].

32. **Khonina, S.N.** An analysis of the angular momentum of a light field in terms of angular harmonics / S.N. Khonina [and other] // Journal of Modern optics. – 2001. – 48(10). – P. 1543-1557.

33. **Kotlyar, V.V.** Measurement of the orbital angular moment of a light field with the help an diffractive optical element / V.V. Kotlyar [and other] // Avtometriya. – 2002. – 8(3). – P. 33-44. – [in Russian].

34. **Khonina, S.N.** Astigmatic Bessel laser beams / S.N. Khonina [and other] // Journal of Modern optics. – 2004. – 51(5). – P. 677-686.

35. **Khonina, S.N.** Rotation of microparticles with Bessel beams generated by diffractive elements / S.N. Khonina [and other] // Journal of Modern optics. – 2004. – 51(14). – P. 2167-2184.

36. Skidanov, R.V. Micromanipulation in Higher-Order Bessel Beams / R.V. Skidanov [and other] // Optical Memory & Neural Net-

works (Information Optics), Allerton Press. – 2007. – 16(2). – P. 91-98.

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