

Rotation of microparticles in light fields

V.A. Soifer^{1,2}, V.V. Kotlyar^{1,2}, S.N. Khonina^{1,2}, R.V. Skidanov^{1,2}

¹Image Processing Systems Institute of RAS

²Samara State Aerospace University (SSAU)

Abstract

The article reviews the experiments on manipulating microspheres in Bessel light beams and in beams with angular harmonics formed by diffractive optical elements.

Keywords: microparticles, light field, Bessel light beam, diffractive optical

Citation: Soifer VA, Kotlyar VV, Khonina SN, Skidanov RV. Rotation of microparticles in light fields. *Computer Optics* 2005; 28: 5-17.

[Access full text \(in Russian\)](#)

References

- [1] Durnin J, Miceli JJJr, Eberly JH. Diffraction-free beams. *Phys Rev Lett* 1987; 58: 1499-1501.
- [2] Turunen J, Vasara A, Friberg AT. Holographic generation of diffraction-free beams. *Appl Opt* 1988; 27: 3959-3962.
- [3] MacDonald RP, Boothroyd SA, Okamoto T, Chrostowski J, Syrett BA. Interboard optical data distribution by Bessel beam shadowing. *Opt Commun* 1996; 122: 169-177.
- [4] McQueen CA, Arlt J, Dholakia K. An experiment to study a "nondiffracting" light beam. *Am J Phys* 1999; 67: 912-915.
- [5] Soroko LM. What does the term "light beam" mean? Preprint of JINR (Dubna) 1999: E13-99-226.
- [6] Volke-Sepulveda K, Garcés-Chavez V, Chavez-Cerda S, Arlt J, Dholakia K. Orbital angular momentum of a highorder Bessel light beam. *J Opt B Quantum Semiclass Opt* 2002; 4: S82-S89.
- [7] Khonina SN, Kotlyar VV, Soifer VA, Paakkonen P, Simonen J, Turunen J. An analysis of the angular momentum of a light field in terms of angular harmonics. *J Mod Opt* 2001; 48(10): 1543-1557.
- [8] Kotlyar VV, Khonina SN, Soifer VA. An algorithm for the generation of laser beams with longitudinal periodicity: rotating images. *J Mod Opt* 1997; 44: 1409-1416.
- [9] Paakkonen P, Lautanen J, Honkanen M, Kuittinen M, Turunen J, Khonina SN, Kotlyar VV, Soifer VA, Friberg AT. Rotating optical fields: experimental demonstration with diffractive optics. *J Mod Opt* 1998; 45(11): 2355-2369.
- [10] Khonina SN, Kotlyar VV, Soifer VA, Lautanen J, Honkanen M, Turunen J. Generating a couple of rotating nondiffracting beams using a binary-phase DOE. *Optik* 1999; 110(3): 137-144.
- [11] McLeod JH. The axicon: a new type optical element. *J Opt Soc Am* 1954; 44(8): 592-597.
- [12] Khonina SN, Kotlyar VV, Soifer VA, Shinkaryev MV, Uspleniev GV. Trochoson. *Opt Commun* 1992; 91(3-4): 158-162.
- [13] Arlt J, Hitomi T, Dholakia K. Atom guiding along Laguerre-Gaussian and Bessel light beams. *Appl Phys* 2000; 71: 549-554.
- [14] Arlt J, Dholakia K. Generation of high-order Bessel beams by use of an axicon. *Opt Commun* 2000; 177: 297-301.
- [15] Arlt J, Dholakia K, Soneson J, Wright EM. Optical dipole traps and atomic waveguides based on Bessel light beams. *Phys Rev A* 2001; 63: 063602.
- [16] MacDonald MP, Paterson L, Volke-Sepulveda K, Arlt J, Sibbett W, Dholakia K. Creation and manipulation of three-dimensional optically trapped structures. *Science* 2002; 296: 1101-1103.
- [17] Arlt J, Garcés-Chavez V, Sibbett W, Dholakia K. Optical micromanipulation using a Bessel light beams. *Opt Comm.* 2001; 197: 239-245.
- [18] Garcés-Chavez V, McGloin D, Melville H, Sibbett W, Dholakia K. Simultaneous micromanipulation in multiple planes using a self-reconstructing light beam. *Nature* 2002; 419: 145-147.
- [19] Garcés-Chavez V, Volke-Sepulveda K, Garcés-Chavez S, Sibbett W, Dholakia K. Transfer of orbital angular momentum to an optically trapped low-index particle. *Phys Rev A* 2002; 66: 063402.
- [20] Miller W. Symmetry and separation of variables. Reading, MA: Addison-Wesley Publishing Company; 1977.
- [21] Prudnikov AP, Brychkov IA, Marichev OI. Integrals and series: special functions [In Russian]. Moscow: "Nauka" Publisher; 1983.
- [22] Paterson L, MacDonald MP, Arlt J, Sibbett W, Bryant PE, Dholakia K. Controlled rotation of optically trapped microscopic particles. *Science* 2001; 292: 912-914.
- [23] McGloin D, Garcés-Chávez V, Dholakia K. Interfering Bessel beams for optical micromanipulation. *Opt Lett* 2003; 28(8): 657-659.
- [24] Kotlyar VV, Khonina SN, Soifer VA. Algorithm for the generation of non-diffracting Bessel modes. *J Mod Opt* 1995; 42(6): 1231-1239.
- [25] Kotlyar VV, Khonina SN, Soifer VA. Calculation of phase formers of non-diffracting images and a set of concentric rings. *Optik* 1996; 102(2): 45-50.
- [26] Born M, Wolf E. Principles of optics. London: Pergamon Press; 1968.
- [27] Allen L, Beijersbergen MW, Speeuw RJC, Woerdman JP. Orbital angular momentum of light and the transformation of Laguerre-Gaussian laser modes. *Phys Rev A* 1992; 45: 8185-8189.
- [28] Kotlyar VV, Khonina SN, Soifer VA, Wang J. Measuring the orbital angular momentum of the light field with a diffractive optical element [In Russian]. *Avtometriya* 2002; 38(3): 33-44.
- [29] Durnin J. Exact solution for nondiffracting beams. I. The scalar theory. *J Opt Soc Am* 1987; 4: 651-654.
- [30] Paterson C, Smith R. Higher-order Bessel waves produced by axicon-type computer-generated holograms. *Opt Commun* 1996; 124: 123-130.
- [31] Cheong WG, Lee WM, Yuan X-C, Zhang L-S, Dholakia K, Wang H. Direct electron-beam writing of continuous spiral phase plates in negative resist with high power efficiency for optical manipulation. *Appl Phys Lett* 2004; 85(23): 5784-5786.