3D-vortex labyrinths in the near field of solid-state microchip laser.

A.Yu.Okulov[1]

[1] *P.N.Lebedev Physical Institute of Russian Academy of Sciences*
Leninsky prospect 53, 119991 Moscow, Russia
e-mail: *okulov@sci.lebedev.ru*

Optical dipole traps for neutral atoms [1] are a subject of considerable interest. We consider the new configuration based on properties of self-imaging optical fields[2] relevant to quantum computing architectures. The theoretical analysis of spatiotemporal vortex lattices spontaneously arising in high Fresnel number solid-state microchip lasers[3] is presented. The connection with Talbot phenomenon generic to spatially periodic electromagnetic fields [4] is studied. The different host crystals implanted by different resonant impurities Nd, Yb, Ho, Er are analysed. We compare the spatial layout of light field obtained via dynamical model based on reduced model of Maxwell-Bloch equations for class-B laser[5] and static model based on superposition of copropagating [6] Gaussian beams. The spatial patterns observed experimentally and obtained numerically are interpreted as nonlinear superposition of vortices with helicoidal phase dislocations. The usage of vortex labyrinths and Talbot lattices as optical dipole traps for neutral atoms is considered for the wavelength of trapping radiation in the range 0.98 - 2.79 mkm. We built qualitatively the macroscopic wavefunction for quantum particles trapped in vortex labyrinth and spatially - periodic array of Gaussian beams and discuss wavefunction properties.

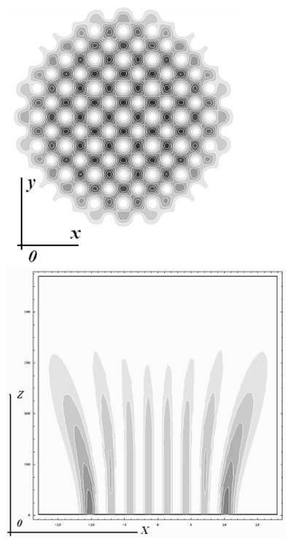

Figure 1: Transverse (in XOY plane) distribution of intensity in the near field of solid-state microchip laser [5]. Z - axis is directed along optical axis. The longitudinal scale is 6 Talbot length.

References

[1] R.Grimm, M.Weidemuller and Yu.B.Ovchinnikov., *Adv.At.Mol.Opt.Phys.* **42**, 95 (2000).

[2] A.Yu.Okulov., *"The structure of the 3D-vortex lattices in microchip laser resonator"*. Bulletin P.N.Lebedev Physical Institute, **9**, p.3, Sept. (2003).

[3] Y.F.Chen, Y.P.Lan., Phys.Rev., **64A**, 063807 (2001)

[4] A.Yu.Okulov., Opt.Comm., **99**, p.350-354 (1993).

[5] A.Yu.Okulov., *"3D-configuration of the vortex lattices in microchip laser cavity"*., QCMC-2004, AIP Conference Proceedings, **734**, p.366 (2004)

[6] Yu.B.Ovchinnikov., Phys.Rev., **73A**, 033404 (2006).