

LAGUERRE – GAUSSIAN BEAM CONVERSION BY INTERACTION OF TWO OPTICAL VORTICES WITH A ATOMIC SYSTEM, INDUCED BY MICROWAVE TRANSITION

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Optical vortices are the states of light with non-zero value of Orbital Angular Momentum (OAM) which can be used in experiments based on trapped atoms by putting them in rotation or allow breaking the classic spectroscopic selection rules [1, 2]. One of the most recent application of Laguerre – Gaussian beams (LG modes) is performing optical quantum memories based on OAM transfer from photons to matter [3].

This speech is related to controlled mapping of atomic gases quantum states on states of light with OAM and the issue of the LG mode's intensity profile conversion caused by interaction with gallium atoms, whose state is controlled by simultaneous excitation by another optical vortex or Gaussian beam. In addition, the fixed microwave field is used to control this process. Presented research is a development of previously published works [4]. The analysis and numerical simulations carried out allow for considering the presented case when changing such experimental parameters as microwave field intensity or detuning light frequencies form resonant dipole transitions in gallium Λ system ($3d^{10}4s^24p^2P_{1/2} (F = 2) \rightarrow 4s^25s^2S_{1/2}$ and $3d^{10}4s^24p^2P_{3/2} (F = 3) \rightarrow 4s^25s^2S_{1/2}$).

The factor that distinguishes the analysis presented in this speech from previously published works was the modelling of processes occurring in the considered stationary system based on the master equation, in the form of Lindblad. The obtained results show the conversion of optical vortices resulting from their interaction with a three-level atomic system and are consistent with the results obtained for calculations performed using a different theoretical model [5]. Presented simulations predict interesting effect which has not been shown in alternative model. The ring-shaped intensity profile of LG mode is deformed to the shape of regular polygons which number of sides is directly related to the value of topological charge l of optical vortex (related to its OAM).

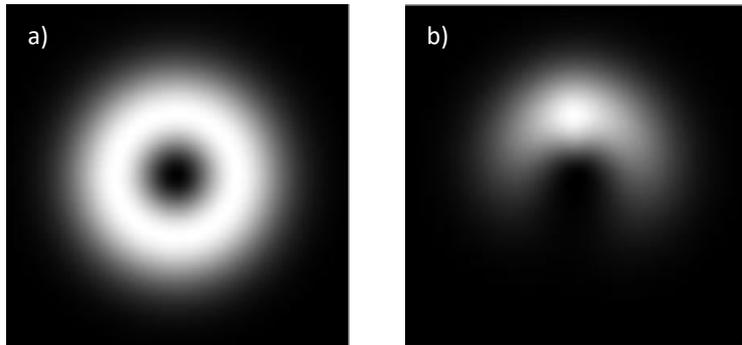


Fig. 1. Intensity profile of Laguerre – Gaussian beam: a) in free space, b) after interaction with gallium atoms cloud

Ultimately, the planned experiment, after preliminary tests on neutral atoms, will be carried out on a cloud of ions trapped in the Paul's trap, where the experiments with the double optic-microwave resonance technique were carried out as standard. This work is aimed at extending earlier techniques of manipulating quantum states of atoms and light.

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