The paper “LASER-BEAMS WITH SCREW DISLOCATIONS IN THEIR WAVE-FRONTS “

BAZHENOV V.Y.; VASNETSOV M.V.; SOSKIN M.S. (1990)

Usually propagation of an electromagnetic wave (light) is represented schematically as sequence of wave-front surfaces equidistant shifted on one wavelength and running with the light velocity. However, in this ideal structure of a monochromatic wave an existence of defects is possible similar to dislocations which appear in a crystal lattice [1]. Moreover with the presence of multiple defects light propagates in a manner of a turbulent flow. At the time of the article preparation the dislocations in complex speckle-fields of a laser radiation scattered in a non-uniform medium were just known. There was also known that laser cavities are able to emerge the output in a shape of a “doughnut” mode i.e. with axial zero of intensity and a wave-front in a form of a helicoid. These “optical vortices ” were considered as exotic and rather useless objects without practical applications.

In the article [1] it was shown that the generation of beams with optical vortices is possible in laboratory conditions by low-angle scattering of a beam in an optical fiber. More substantial was the ability shown for the transformation of an ordinary He-Ne laser beam to an optical vortex beam, that is a beam with screw dislocation, with the aid of a simple diffraction grating printed on a paper and photocopied with reduction to a film. The peculiarity of this diffraction grating was central “fork” i. e. splitting of a stripe into two (or more) stripes. The idea was a synthesis of an elementary hologram being an interference pattern of a plane wave and a beam with azimuthal dependence of the phase (along full turn around beam axis the phase varies on $2m\pi$, where integer m is called topological charge). Laser beam diffraction on such a grating restores the structure of a beam which was used in the hologram synthesis, i. e. carrying optical vortex of corresponding charge. According to the laws of diffraction, in the first and minus-first diffraction orders the charges of vortices are opposite. Apart of the proposal of a simple technique of beams with optical vortices creation, first time the beams were generated with topological charges higher than unity.

One year after the article publication similar paper was independently published by Australian researchers. Then the number of reports began grow quickly. A wavefront tear corresponding to the phase jump (singularity) was accepted for a common appellation “singular beams”. As a result 10 years after a new direction in a physical optics appeared, called “singular optics”

1. BAZHENOV V.Y.; VASNETSOV M.V.; SOSKIN M.S. JETP Letters, **52** , 490 (1990)