

Expert evaluation of the Extended Resume  
for Candidate of Science Thesis of  
**Bohdan SOKOLENKO**  
**“Polarization singularities evolution in paraxial light beams  
that propagate in single-optical-axis crystal normally to its axis”**

The research work in question deals with a problem of appearance and transformation of optical singularities in beams that propagate in optically anisotropic media. This research domain is already traditional for V.Vernadsky Taurida National University, where the studies of vortex bearing beam propagation in birefringent crystal have been initiated roughly ten years ago. There is however a distinct difference of the present study from all what was done in the past in this and in others research laboratories. A major part of previous studies concentrated on beam propagation in the vicinity of optical axis itself. The birefringence in this case is small and it can be controlled easily by angular deviation of beam from the optical axis. It is possible therefore to treat the birefringence as a small perturbation for propagation in isotropic medium. The studies that Bohdan Sokolenko performed for his dissertation required a qualitatively different approaches, because for beam propagation normal to the optical axis the initial birefringence is already the largest possible.

The particularity mentioned above have several other important consequences. At first, the measurements should be very careful because even small angular deviation of the beam affects quite strongly their results; here the impressive experimental skills of applicant should be distinguished. Second, this high sensitivity to experimental conditions can be used successfully for developing new metrological techniques (temperature sensors, angular position sensors, etc.) The applicant understood it in full and he proposed as an example a model of optical vortex scanning microscope.

The thesis includes a large amount of experimental data; some measurements were suggested by previous theoretical works performed in the same research team. It is important, that some other experimental observations of Bohdan Sokolenko initiated further theoretical studies and their results appeared to be in good agreement with the experimental data. One example is a generation of vortex singularity in a nearly circularly polarized beam (very small ellipticity) which is slightly tilted to direction normal to the optical axis. It was shown that moving the beam along the conical surface with a fixed small apex angle allows for periodical switching of the vortex charge and for precise control of switching periodicity. The polarization singularities were also the subject of study in this thesis; the appearance of the star-type and lemon-type C-points was revealed and their particular mutual positions were explained.

Some experimental results described in B. Sokolenko' thesis look from the first glance unexpected and even counterintuitive; they are however in good agreement with specially performed calculations. I have in mind first of all the behavior of the focused beams with acentric

vortex in the vicinity of the focal point. The trajectory of the vortex displacement in the focal plane in response to lateral displacement of the diffractive element that generates this singularity might look quite uncorrelated to each other: the vortex may move along the lines tilted from  $0^\circ$  to  $90^\circ$  with respect to the vertical direction. It is important that the rate of vortex displacement can be quite high, this gives a tool, for example for sensitive measurements of small step-like thickness variations of the optical substrates.

Several times I had an opportunity to assist the B. Sokolenko' presentations at international optical conferences. I know that he has a positive experience of working within research programs of foreign universities; this common work resulted in several valuable publications in addition to those issued from his home laboratory.

Summarizing I am convinced that the results included in Bohdan Sokolenko thesis and the scientific level of applicant himself are sufficient for claiming the PhD degree (or Candidate of Science Degree in independent states of former Soviet Union).



Serguey Odoulov,

Dr.Sc, Professor

Leading scientist

Institute of Physics, National Academy of Sciences

Kyiv

Victor Manzharo



Scientific Secretary

Institute of Physics, National Academy of Sciences

Kyiv

