Singular Optics With Polychromatic Light
G. Gbur, T. D. Visser and E. Wolf

During the past few years, a great deal of attention has been paid to the structure of wave fields in the neighborhood of points where the field amplitude has zero value. At such points, the phase of the wave is singular. Studies of phenomena associated with phase singularities are gradually developing into a new branch of physical optics, sometimes called singular optics. It is a rich subject, because many different kinds of behavior—such as wave-front dislocations and optical vortices—may exist near singular points.

The majority of publications concerned with singular optics deal with monochromatic waves. We have recently studied the spectral structure of light near phase singularities in the focal region of a spatially fully coherent but polychromatic, converging, spherical wave. We found that in this region, the spectrum changes drastically from point to point along a closed loop around the singularity. In particular, when the spectrum of the incident light consists of a single line of Gaussian profile centered at a frequency \( \omega_0 \), the spectrum of the focused field on a closed loop around a phase singularity of the spectral component of frequency \( \omega_0 \) is red-shifted at some points, blue-shifted at others and splits into two lines elsewhere, as shown in Fig. 1.

Our investigation demonstrates that the spectrum of light in the focal region has a complicated, nontrivial structure. Understanding this structure may be relevant to fluorescence microscopy, in which the exciting field can have a spectrum that varies strongly in the volume that is probed, leading to a higher resolution. (Author, if the sentence as edited is not correct, please clarify to what the word "Its" refers. Thank you.) Since this research was carried out, it was discovered that this kind of behavior is not restricted to fields in the focal region but also takes place in the neighborhood of phase singularities in other kinds of fields. References 3-5 Some of the theoretical predictions made in these papers were recently confirmed experimentally by G. Popescu and A. Dogariu. An account of these experiments is given in the next article (Author, is this a reference to the Popescu and Dogariu summary to appear in this same issue: "High-Resolution Spatial and Spectral Characterization of Optical Fields." If so, we need to refer to the page. If not, please supply complete reference.)

References
1. A review of singular optics was recently presented by M. S. Soskin and M. V. Vasnetov in Progress in Optics 42, ed. by E. Wolf, (Elsevier, Amsterdam, 2001) 219.

G. Gbur is with the Department of Physics and Astronomy, University of Rochester, Rochester, New York. T. D. Visser is with the Department of Physics and Astronomy, Free University, Amsterdam, The Netherlands. E. Wolf (ewlupus@pas.rochester.edu) is with the Department of Physics and Astronomy and the Institute of Optics, University of Rochester, Rochester, New York.

Figure 1. Schematic illustration of the spectrum along a loop encircling the first axial zero of the center frequency. [After G. Gbur, T. D. Visser and E. Wolf, Phys. Rev. Lett. 88 013901 (2002).]