RELATIVE ENHANCEMENT IN THE AXIALLY POLARIZED FIELD IN THE FOCAL PLANE OF A RADially POLARIZED BEAM

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1. INTRODUCTION
A radially polarized beam when focused tightly by a high numerical aperture (NA) lens gives rise to a stronger on-axis axially polarized field in the focal plane, relative to the peak laterally polarized field [1]. Consequently, radially polarized beam is finding number of important applications such as in confocal microscopy, where the radially polarized beam can probe the orientation and re-orientation of fluorescent molecules. The crucial parameter in all such experiments, is the ratio of the peak axially polarized intensity to the peak laterally polarized intensity in the focal plane. For a radially polarized beam with uniform amplitude profile focused by a water immersion lens of NA=1.2, this ratio is about 2.8. In this paper we show that by adding a combination of defocus and spherical aberration into the radially polarized beam, the axially and the laterally polarized fields in the focal volume can be axially separated, contributing to an enhancement in the ratio that can be even larger than 6.

2. METHODOLOGY AND RESULTS
We compute the Cartesian components of the field and the respective intensities in the focal volume of a tightly focused radially polarized beam using both the integral form [2] and the fast fourier transform form of the vectorial diffraction theory [3]. We show how defocus and spherical aberration, added to the beam, can have diverse effects on the two orthogonally polarized focal field components. We then obtain the magnitudes of defocus and spherical aberration that provide the optimum axial separation between axially and laterally polarized focal fields, simultaneously ensuring that the axially polarized focal field peaks at the nominal focal plane of the objective lens. Figure 1 (a) and (b) show resultant focal plane intensities due to a radially polarized beam without and with an optimized pair of defocus and spherical aberration, respectively, and plots of the corresponding axially and laterally polarized field intensities. In this paper we will present our findings using the both the versions of the vectorial diffraction theory.

3. REFERENCES