

RESOLUTION ENHANCEMENT FOR SCANNING FLUORESCENCE MICROSCOPES USING IMAGE INVERSION INTERFEROMETERS

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1. THE IDEA

In analogy to a scheme for 4Pi microscopes by Sandeau et al. [1], we proposed adding an interferometer with partial image inversion to the output of a confocal microscope in order to increase its lateral resolution [2]. For a point source far away from the inversion axis the coherent point spread function (PSF) and its mirrored partner have hardly any spatial overlap and thus cannot interfere. This leads to 50% of the light being detected in both interferometer outputs. For a source on the inversion axis, the two coherent PSFs are nearly identical and will therefore interfere. Most of the light will be detected in the interferometer's constructive output, whereas the destructive output will remain largely dark. This rejection of off-axis light in the constructive output leads to said resolution improvement.

Simulations predict a lateral resolution better than the limiting case of a confocal with closed pinhole, however under pinhole free conditions. In two-photon microscopy a two-fold improvement in lateral resolution can be expected.

2. RESULTS

We present two different types of image inversion interferometer. One of these relies purely on reflections off planar surfaces and does not require the use of dispersive elements (apart from beam splitters). Its simple geometry allows easy alignment. This achromatic setup allowed the observation of the resolution enhancing effect for broad band light sources. We show that the measured detection PSF exhibits an enhancement in full width at half maximum (FWHM) resolution consistent with the theoretical predictions.

[1] N. Sandeau and H. Giovannini, "Increasing the lateral resolution of 4Pi fluorescence microscopes", *J. Opt. Soc. Am. A*, **23**, 1089–1095 (2006).

[2] K. Wicker and R. Heintzmann, "Interferometric resolution improvement for confocal microscopes", *Opt. Express*, **15**, 12206–12216 (2007).