WHAT IS THE EMISSION PSF OF STIMULATED EMISSION?

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KEY WORDS: Stimulated emission

ABSTRACT: Min et al. used stimulated emission as a contrast mechanism for microscopy [1], measuring the total change in the stimulation beam's intensity due to stimulated emission. The shape of their illumination point spread function (PSF) entirely determined the spatial resolution. Many microscopy techniques rely exclusively on their illumination PSF for spatial resolution, but just as much information can be carried by the emission PSF [2]. Does the emission PSF of stimulated emission contain information?

Stimulated emission is often described as indistinguishable from the stimulating beam, implying it can only be detected as a change in the total intensity of the stimulating beam. However, waves cannot simultaneously travel in a well-defined direction while having a well-defined position (Figure 1). This apparent paradox was addressed and solved long ago [3, 4], but has never been examined in the context of imaging fluorescent molecules. The stimulated emission PSF is similar to the PSF for elastic (Rayleigh) scattering, differing only in magnitude and phase. We describe how existing techniques techniques for imaging via coherent scattering can be adapted to image stimulated emission from fluorescent molecules, with the added advantage that excitation and stimulation can be separately controlled, combining the high signal levels of transmitted light microscopy with the specificity of fluorescence microscopy.