STIMULATED EMISSION IMAGING

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ABSTRACT: At the 2015 Focus on Microscopy conference in Göttingen, Germany, we raised the question, "Does the emission point spread function (PSF) of stimulated emission contain information?" and discussed possible advantages of imaging via stimulated emission instead of spontaneous emission. Imaging via stimulated emission could potentially combine the high signal levels of transmitted light microscopy with the specificity of fluorescence microscopy.

In order to be useful for imaging in this way, stimulated emission must convey information about a particle's location, and must be measurable with reasonable signal-to-noise ratio (SNR). Following our 2015 presentation, there was spirited discussion but no clear consensus on what result to expect from the thought experiment described in Figure 1.

Since then, we have built an imaging system to investigate both the information content and SNR of stimulated emission. We present our experimental results (Figure 2) and compare them to those predicted by the models proposed in 2015.

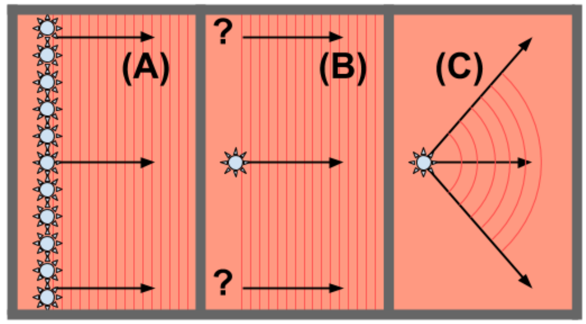

Figure 1: Blue "stars" are electronically excited molecules. Light red background indicates a beam traveling left-to-right, stimulating these molecules to emit radiation. (a) A homogeneous plane of mutually coherent in-phase emitters will emit waves with flat phase fronts (light red lines) traveling in a well-defined direction (black arrows). (b) An isolated point-like particle cannot produce well-directed waves with flat phase fronts. Question marks indicate regions where radiation would have to appear without a source. (c) An isolated point-like radiating particle must produce a diverging wave with curved phase fronts.

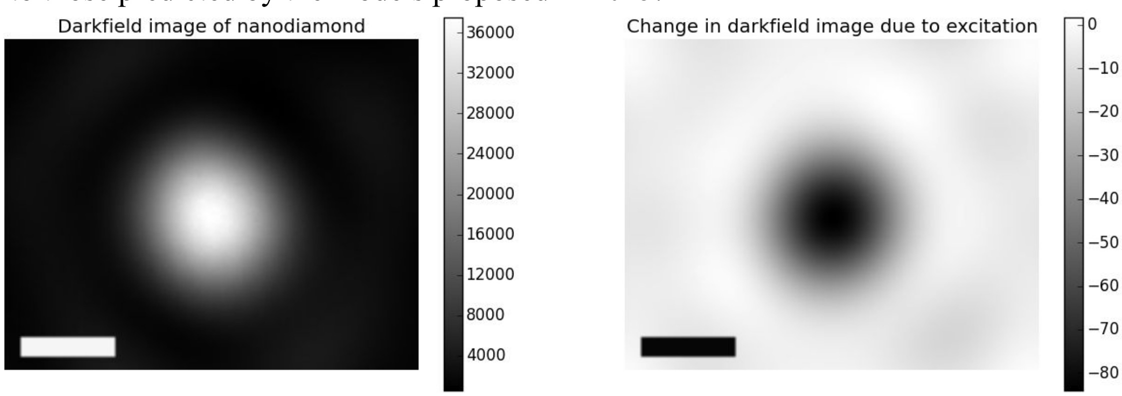

Figure 2: Excitation of nitrogen vacancies in a nanodiamond changes scattered light signal. The scattered light wavelength is 721 nm, which is within the spontaneous emission bandwidth of nitrogen vacancies. The excitation wavelength is 532 nm. Scale bar: 250 nm.

[1] S. Varma, S. Patangé, A.G. York. "What is the emission PSF of stimulated emission?" Focus on Microscopy Annual Meeting, Göttingen, Germany (2015).