

A PLANAR AIRY LIGHT-SHEET FOR TWO-PHOTON MICROSCOPY

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1. INTRODUCTION

Light-sheet fluorescence microscopy enables high resolution optical sectioning of biological samples. Unlike confocal and two-photon microscopes, a light-sheet microscope illuminates the focal plane with an objective orthogonal to the detection axis. To uniformly illuminate a wide field-of-view without compromising axial resolution, propagation-invariant light-fields such as Bessel and Airy beams have been proposed^{1,2}. These beams do however irradiate the sample with a relatively broad transversal structure. With single-photon excitation, the detailed transversal structure of the Airy beam captures the high-frequency components that contribute positively to the axial resolution. However, this advantage does not carry over when switching to two-photon excitation, where its fine transversal structure is suppressed^{2,3}. Here, we propose a symmetric and planar Airy light-sheet for two-photon excitation.

2. DECONVOLUTION-FREE AIRY LIGHT-SHEET MICROSCOPY

The Airy beam can be transformed into a virtual light-sheet by rapidly scanning. Unlike most other beams, it forms a curved light-sheet with a parallel structure that contribute to single-photon excitation image formation. This does rely on digital deconvolution and the correction of the curvature of the image in a post-processing step. The additional complexity can be avoided with a straightforward 45°-rotation of the modulating element so that the Airy beam accelerates transversally in the direction of the virtual light-sheet scan. The resulting planar Airy light-sheet is symmetric and consists of a single bright central core. This obviates the need for geometric curvature correction as well as any form of deconvolution. It combines the simplicity of the Gaussian light-sheet with the propagation invariance of the Airy beam. We demonstrate the method with rapid two-photon imaging of large volumes of brain tissue⁴.

3. CONCLUSION

We proposed the planar Airy light-sheet for uniform two-photon excitation light-sheet microscopy across a wide field-of-view. A straightforward rotation of one element ensures that the light-sheet is both planar and symmetric. This eliminates the need for deconvolution and significantly simplifies the dual-use single and two-photon imaging instrument.

4. REFERENCES

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