A route to sub-diffraction-limited CARS microscopy

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Coherent anti-Stokes Raman scattering (CARS) microscopy is a powerful nonlinear microscopy technique offering chemical selectivity and high 3D spatial resolution. However, it is still limited by diffraction and thus confined to imaging above the diffraction limit. Here, we present theoretical investigations based on a density matrix formalism of different schemes for sub-diffraction-limited spatial resolution in CARS microscopy. Spatial resolution below the diffraction limit is realized in a STED-like approach [1], i.e., based on additional control light fields. The control light fields are used to manipulate the population and coherence distribution of the sample, ultimately resulting in a saturable suppression of the CARS signal generation. Using a donut-shaped beam profile for the control light fields the saturable suppression of the CARS signal causes a narrowing of the effective excitation profile below the diffraction limit. Sub-diffraction-limited spatial resolution is demonstrated in a numerical simulation using computer-generated test images.

References

1. V. Westphal et al., Science 320, 246 (2008).