RADIATION PATTERN AND IMAGE FORMATION IN COHERENT ANTI-STOKES RAMAN SCATTERING MICROSCOPY

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By using molecular vibrations as a contrast mechanism, Coherent Anti-Stokes Resonant Scattering (CARS) microscopy represents a unique approach to imaging chemical and biological samples. CARS is a four-wave mixing nonlinear process in which two laser fields of pulsations ω_p and ω_s ($\omega_p > \omega_s$) interact with a medium to generate a field at the pulsation $\omega_{as}=2\omega_p-\omega_s$. This field is dramatically enhanced when the pulsations difference $\omega_p-\omega_s$ equals the pulsation of a molecular vibration in the medium. The radiation pattern from a scatterer and, therefore, its own image formation are specific to the coherent dipolar emission at ω_{as}. While the radiation pattern was studied theoretically [1-2], no study has focused on the image formation process in CARS microscopy.

In this presentation, the radiation pattern and the image formation process in CARS microscopy in isotropic media are investigated theoretically. While we assume no refraction index mismatch between the scatterers and the environing medium, numerical electromagnetic computations take into account the exact polarizations of the excitation laser beams and of the induced nonlinear dipole. Forward (F) and epi (E) CARS radiation patterns, as well as their divergence, are studied as a function of the size of the scatterer. Defocus and polarization effects on the CARS images of the scatterer are furtherly investigated. Experimental CARS images of polystyrene beads are presented and compared to simulations.

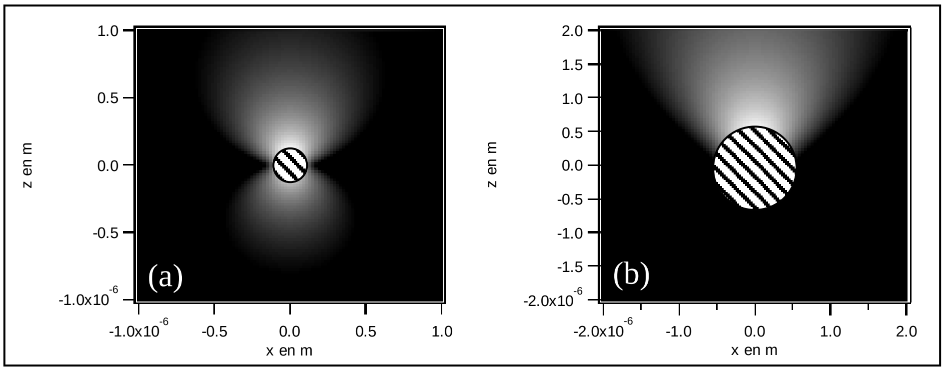

Figure 1: Computed radiation patterns of a (a) 200nm diameter bead and a (b) 1µm diameter bead (intensity is depicted on a log scale). Note that the (a) and (b) length scales are not equal.

[1] E.O. Potma; W.P. de Boeij and D.A. Wiersma, "Nonlinear coherent four-wave mixing in optical microscopy", *JOSA B*, 17, 1678-1684 (2000).
[2] J.-X.Cheng; A. Volkmer and X.S. Xie, "Theoretical and experimental characterization of anti-Stokes Raman scattering microscopy", *JOSA B*, 19, 1363-1375 (2002).