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Stimulated Raman scattering microscopy: theory and applications

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Since its discovery in 1928, Raman spectroscopy has become a powerful tool for molecular identification due to its ability to detect molecular fingerprints. It is widely applied in various fields such as pharmacology, food analysis, and mineralogy. The integration of Raman spectroscopy with optical microscopy has advanced hyper-spectral imaging, enabling detailed spectral acquisition within sample volumes. This breakthrough offers new opportunities in drug industry quality control, biomedical tissue function research, and numerous other fields. However, its broader application is limited by the low Raman scattering cross-section (˜10^{-30} cm^2) and interference from fluorescence. Non-linear coherent Raman techniques, such as Coherent Anti-Stokes Raman Scattering (CARS) and Stimulated Raman Scattering (SRS), offer promising solutions. CARS enhances the detectable signal by coherently summing Raman scattered light, reducing image acquisition time by more than 10 000 times compared to spontaneous Raman scattering. This enables the development of fast video-rate Raman microscopy. SRS, which is free from the non-resonant background signal inherent to CARS, produces spectra identical to traditional Raman spectra, simplifying data interpretation and allowing the use of existing molecular fingerprint databases. A further step, Stimulated Raman Gain and Opposite Loss Detection (SRGOLD), addresses limitations in SRS signal detection, enhancing the detected signal and facilitating biomedical applications of the SRS technique.
This progress in Raman-based imaging techniques holds great potential for expanding the practical applications of molecular diagnostics and research.

Type of presence

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Primary author: Dr SHYNKAR, Vasyl (HORIBA Scientific)

Presenter: Dr SHYNKAR, Vasyl (HORIBA Scientific)

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