M2/PhD position on
Super-resolution coherent Raman microspectroscopy

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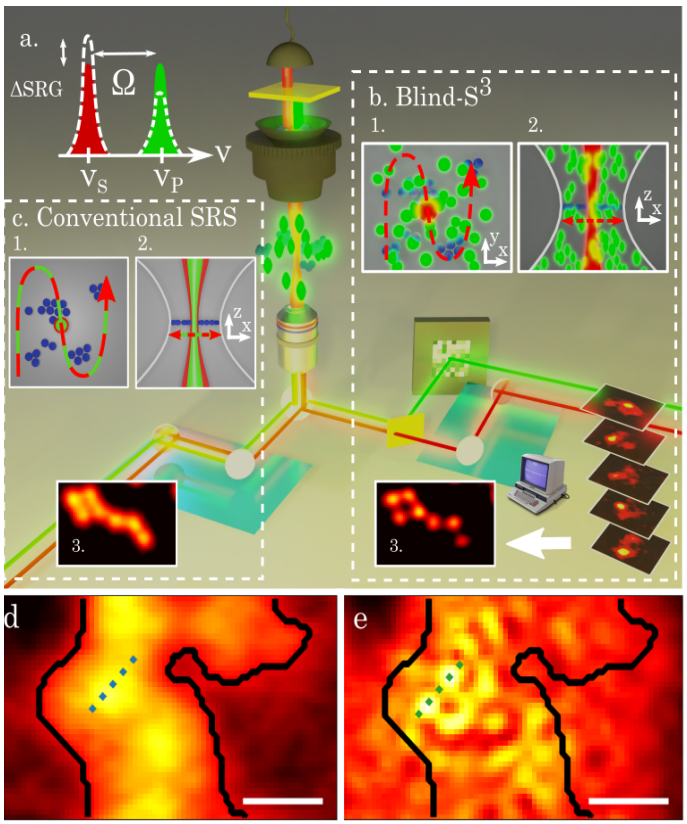
Raman-based microscopies exploit the intrinsic vibrational spectrum of molecules, achieving video-rate imaging speeds without the need of labelling fluorophores[1]. While there has been a tremendous improvement in speed for Raman microscopy, the spatial resolution has barely enhanced and, as a matter of fact, reaching resolution at the 100 nm-scale still remains a very challenging topic[2].

Multiple scattering, otherwise seen as a nuisance in any optical device, can enable super-resolution[3]. We have recently developed a novel sampling methodology in Stimulated Raman Scattering microscopy (figure below) that allowed to enable for the first time super-resolution imaging of biological specimens[4]. However, due to constraints in the laser source used, we could only focus on (shallow) microscopy up to now, leaving aside the powerful spectroscopy approach that is typically gained in Raman micro-spectroscopy. Furthermore, we could not demonstrate the advantage of our method for deep imaging.



As a next step, we will exploit a new laser source technology to enable super-resolution micro-spectroscopy. In particular, we set up an add-on technique, coherent anti-Stokes Raman scattering microspectroscopy that will enable to go beyond our current super-resolution gain due to its higher-order nonlinearity. Furthermore, the new laser source will be well adapted to perform deep super-resolution microscopy[5], going beyond Raman-based methods.

The development of the project* will be **experimental**, and will require **numerical calculation**.

depending on the outcome, this could be followed by a PhD project

[1] Donaldson Jr. and de Aguiar, *J. Phys. Chem. Lett. 9*, 1528 (2018); Saar *et al., Science 330*, 1368 (2010).
[2] Watanabe et al., *Nat. Comm. 6*, 10095 (2016); Gong et al., *Nat. Photon. 14*, 115-122 (2020).
[3] Mudry *et al.*, *Nat. Phot. 6*, 312 (2012); van Putten et al., *Phys. Rev. Lett. 106*, 193905 (2011).
[4] Guilbert, et al. "*Label-free super-resolution chemical imaging of biomedical specimens*." *bioRxiv* (2021)
[5] Wu and Shroff, *Nat. Methods 15*, 1011 (2018).

the group on X : comedialkb

Site du groupe : https://www.lkb.upmc.fr/opticalimaging/