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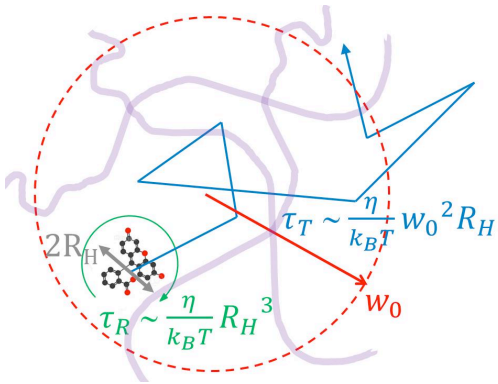
Sensing intratissular mechanical pressure by measuring rotational diffusion

During morphogenesis, homeostasis or tumour development, mechanical cues are though to play an important role. However it is still almost impossible to measure, quantitatively, the mechanical pressure within a tissue. We propose to use the rotational diffusion of a small molecule within hydrogel beads (of a few tens of µm in diameter) as pressure sensors: when the tissue undergoes a stress, it in turn strains the beads which, so doing, induces higher drag forces on the contracted polymer network and thus, slows down the rotational diffusion. Although translational diffusion and rotational diffusion times are both proportional to the viscosity η, the rotational diffusion time is independent on the optical adjustments (laser waist w_0) and depends only upon the hydrodynamic radius of the fluorescent probe, R_H. It makes this technique promising to explore tissue mechanics without being biased by optical aberrations, even if it suffers from the much smaller number of photons available in a time range one thousand times shorter than that of translational diffusion.



The internship will start by setting up and characterizing the Fluorescence Correlation Spectroscopy (FCS) system dedicated to estimate the rotational diffusion using well-known fluorescent molecules in standard solutions. Then FCS will be applied to measurements within hydrogel beads submitted to mechanical pressures (osmotic stress). Finally, the beads will be inserted in living tissues such as multicellular spheroids. The experiments and scientific discussions will take place in the Laboratory for Interdisciplinary Physics and Institute for Advanced Biosciences (IAB).

Ref:

Cell-like pressure sensors reveal increase of mechanical stress towards the core of multicellular-spheroids under compression
M. E. Dolega, M. Delarue, F. Ingremeau, J. Prost, A. Delon, G. Cappello
Nat. Com. 14056 (2017) http://www.nature.com/articles/ncomms14056

Optical sensing of mechanical pressure based on diffusion measurement in polyacrylamide cell-like barometers
F. Ingremeau, M. E. Dolega, I. Wang, J. Gallagher, G. Cappello, A. Delon
Soft Matter 13, 4210 (2017) doi: 10.1039/c6sm02887j

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