MASTER INTERNSHIP
2020

PROJET TITLE: Developing a deconvolution method for the quantitative analysis of atomic force microscopy data (AFM)

KEY WORDS: Atomic force microscopy (AFM), Spatial resolution, Imaging, Artefact, AFM tip, deconvolution.

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CONTEXT :

Since its invention in 1986, atomic force microscopy (AFM) has largely evolved and it now offers a battery of options that make it possible the exploration of new biophysical processes through, for instance, the refined imaging of complex structures of cell surfaces. Contrary to electronic microscopy, AFM allows the analysis of bio-surfaces in a non-invasive manner under physiological conditions. However, the results obtained by AFM may still be impacted by several artefacts, inherent to the measurement principle of the technique based on the use of probes (tips) of various geometries whose characteristic size easily coincides with that of the imaged biostructures, thereby generating convolution effects that, in turn, decrease the lateral resolution of the technique.

More than an imaging tool, AFM monitored in so-called force spectroscopy mode leads to evaluation of *e.g.* mechanical and physico-chemical properties of the biosample. Mapping proxys such as cellular nanomechanics (Young modulus), or detecting biomolecules or specific biosurface-ligands interactions require to define *a priori* a range of parameters such as the maximum applied force, the pixel size or the indentation/retraction speed of the tip. Then, in order to reach a quantitative interpretation of the obtained results, it appears mandatory to understand the way each of these parameters impact on the measured physico-chemical sample characteristics and to propose adequate data treatment options (*e.g.* deconvolution) with the objective to improve the quality and accuracy of micro/nanometric objects imaging.

INTERNSHIP SUBJECT:

The internship objectives are multiple. First, the candidate will define an experimental plan to identify the key instrumental parameters that could affect the spatial resolution achievable by AFM. This first task will be performed *via* measurements on 'ideal', well-controlled samples of known dimensions that are not prone to deformation during tip scanning. From comparison between the dimensions obtained on the collected AFM images with the theoretical sample size, the candidate will have to propose a deconvolution method for tracing back the true sample morphology. In a second part of the internship, this deconvolution algorithm will be applied to biological samples. Nanomechanical maps of biological samples (*e.g.* bacteria or micro-algae) will be further measured under various experimental conditions to evaluate how the signal-to-noise ratio and pre-defined acquisition parameters in force spectroscopy can be optimised. This internship, at the interface between physical-chemistry, signal processing and microbiology, will provide the student a strong expertise in AFM, which could be a decisive asset to start a PhD program.

Internship duration: 6 months from January 2020.
To apply, send your cover letter, CV and Master marks to the email addresses above.

EXPERTISE REQUIRED:

Candidate should have a strong background in physical-chemistry, physical measurements or instrumentation. Knowledge in mathematics (*e.g.* statistics, matrix calculation) and AFM (even theoretical) would be a plus. She (he) should also be autonomous in programming (especially in MATLAB) and have a special interest for experimental work.