Advanced methods in biological physics and soft matter :

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Physics is an experimental science. Its progress is due to a constant exchange between theory and experiments. A lot of conceptual progress in physics requires more and more precise and quantitative experiments used by theoreticians to produce new models or used to (in)validate models. This course will present some of the most recent and used advances in experimental physics used in soft matter and biological physics.

A few, typically 5, courses will be dedicated to provide a general theoretical background required to understand the basics of these techniques (Fourier optics, Superresolution , Fluorescence, Micromanipulation techniques (AFM, optical or magnetic tweezers), X rays, Microfabrication and Microfluidics).

Then 4 courses will be dedicated to practical courses. Students will be asked to chose 2 practical courses and will spend 2 4 hours courses in lab using some of those recent techniques (single molecule imaging and manipulation, advanced optical microscopy, AFM, X rays....).

The remaining courses will be based on inverted pedagogy. They will be directed by the students who will use those practical courses and recent scientific articles to present in a more detailed and applied way those techniques to the class. The goal of this course is to provide a modern experimental culture to students so that they know which techniques can be used in their future research projects.

Evaluation will be based on a brief final written exam and the courses students will construct.

The number of students is limited to 16.

Potential topics for the experimental classes :

- Chaotic mixing in microfluidics.
- Droplet-based microfluidic towards cell biology.
- Magnetic tweezers : polymer elasticity and enzymatic activity at the single molecule level.
- Fluorescence Correlation Spectroscopy : in situ measurement of absolute concentrations and diffusion coefficients.
- Super-resolution on fixed cells : 2D and 3D.
- Cell mechanics : force measurement on artificial cells and in vivo.
- Nanofluidics : confinement of fluids with an Atomic Force Microscope.
- Different implementations of confocal microscopy : from the optical bench to freely moving mouse imaging.
- Small Angle scattering : from individual objects to collective behavior investigation. From dilute to concentrated suspension : form factor, structure factor. Self-assembly, nano-colloidal crystals, cubosomes