Stochastic Systems And Signals
- theory, data analysis, modeling, simulations, ...

Who could do a project in our group?

You are interested in **theory and modeling** within soft-matter physics, statistical/biological physics, or quantitative life science.

You will learn, e.g., how:

- to connect experimental data and theory
- to simulate a stochastic process
- to do data-driven modeling and analysis
- data acquisition influences measurements

You want to do **experimental work** within biology, biophysics, drug delivery, etc.

In a project you will learn, e.g.,

- how to analyze noisy experimental data
- the physical principles behind sophisticated equipment like optical tweezers, super-resolution microscopy, atomic force microscopy, or fluorescence correlation spectroscopy (FCS).

Project Example 1: Super-resolution microscopy

A fluorophore molecule observed through a microscope gives rise to an intensity distribution that depends on its position and its angle in space. By modeling the light transmission through the optics, we optimally determine the **position** (few nm-precision) and the **orientation** (few degree-precision) of such fluorophores.

Conventional microscopy is limited by diffraction... but proper treatment allows NANOscopy and more...

![Fluorophore molecule through microscope](image)

- A myosin molecular motor steps along actin. A fixed fluorophore is attached to it.
- Experimental images of the fluorophore at three positions.
- Theoretical fits to the images to extract positions and orientations of the motor.

Project Example 2: Fluorescence Correlation Spectroscopy (FCS)

Fluorescence Correlation Spectroscopy (FCS) is widely used in biophysics and life science to, e.g., find the size of nm-sized particles or characterize the interactions between particles.

A proper treatment of FCS data requires both knowledge of Brownian motion and time-series analysis.

**Example**: Identical diffusing particles

![FCS example](image)

**Example**: Protein-binding to lipid vesicles

- Fast diffusion
- Slow diffusion

We have experimental data from DTU Nanotech!

Other ideas:

Extracting the physical properties of DNA in nanochannels (modeling, data analysis, time-series analysis), analysis of cell motility, analysis of single-particle tracking experiments, or bring your own data!

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