M2 internship in Biophysics 2027
Possibility of continuation into a funded PhD

Nanoparticle diffusion in a cytoplasmic extract

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Context: The interior of a cell is dense and crowded with polydisperse molecules, and subjected to biochemical activity that fluidizes it (1). Crowding and activity endow the intracellular milieu with specific properties. In particular, using single particle tracking of genetically-encoded nanoparticles (2), we found that particle diffusion is not Brownian *in vivo* (Fig. 1). Many reasons can explain this non-Brownian diffusion, such as particle interactions, the type of biochemical noise, or local heterogeneities due to the ultrastructure of the cytoplasm.

M2 project: The purpose of this project is to investigate why diffusion is non-Brownian. To this end, we propose to work with cytoplasmic extracts *in vitro*, which are easier to control in terms of biochemistry. The main objective will be to develop means of encapsulating extract into vesicles, and control their volume osmotically in order to modulate crowding. Single particle tracking will be realized to assess how different crowding levels and biochemistry impact particle tracking.

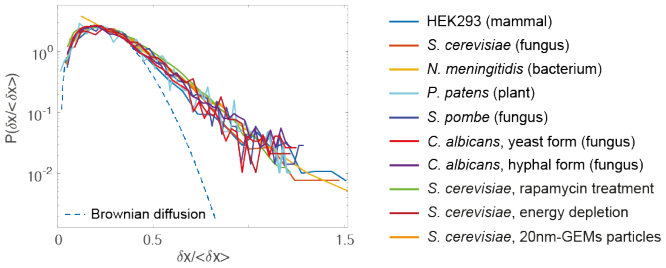

Figure 1: 40 nm particle diffusion is not Brownian, and this seems to be conserved across organisms and metabolic conditions, such as energy depletion.

Profile: We are looking for a motivated M2 student with a strong background in physics, and willing to work at the interface between physics and biology.

Practical information and PhD opportunity: The internship will take place at the LAAS-CNRS LAAS, under the guidance of Morgan Delarue. It will also include close collaboration with Wylie Ahmed (https://slam-lab.com) within the **ActiveCyt** ANR project. The internship is funded according to the standard French M2 internship allowance. Funding is also available for a three-year PhD that will extend this research. An excellent intern interested in continuing the project may therefore be considered for the funded PhD, subject to mutual interest and the formal doctoral recruitment process. To apply, please send a CV, a brief cover letter describing your interests and relevant experience, and recent academic transcripts to M. Delarue. (morgan.delarue@laas.fr).

Selected references:

1. H. Kim and M. Delarue, "Dynamic organization of the cytoplasm", *Curr Op Cell Biol* (2025)
2. M. Delarue et al., "mTORC1 controls phase separation and the biophysical properties of the cytoplasm by tuning crowding," *Cell* (2018).
3. W. W. Ahmed et al., "Active mechanics reveal molecular-scale force kinetics in living oocytes," *Biophysical Journal* (2018).