# 6 months Master 2 internship in theoretical biological physics (starting from February 2022)

| Title of the research topic | Modelling the long road to neural growth and structural maintenance |
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| **Laboratory** | **Laboratory Charles Coulomb, UMR5221 CNRS/University of Montpellier, Pl. E. Bataillon, 34095 Montpellier, France** |
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**Scientific Project:**
Neuromuscular junction (NMJ) disruption is a key event in motor neuron disease. Recent studies have identified axonal messenger RNA (mRNAs) whose localization is impaired in motor neurons diseases such as Spinal Muscular Atrophy (SMA) and Amyotrophic lateral sclerosis (ALS).

The goal of this project is to develop a first physical model of mRNA axonal transport driven by motor proteins during NMJ formation in motor neurons (Mns) and, possibly, compare numerical simulations and analytical results with video-microscopy experiments performed by our colleagues in biology and biophysics laboratories. We aim therefore to understand the molecular origins of SMA and ALS neurodegenerative diseases.

In this case we will try to model and understand:
1) the general relation among the flux of cargoes transported and their local density in a confined environment such an axon;
2) how this can be generalized to bidirectional motion of cargoes;
3) how this process can be modelled in a branched structure such an axon with dendritic and synaptic terminations;
4) how these in-silico results and data can be compared with video-microscopy experiments and super-resolution microscopy.

**The Master internship could open to the possibility of a PhD thesis or a research engineer position on this topic.**

**Techniques used :**
Statistical Physics, stochastic processes, non-linear physics, partial differential equations (PDE), numerical methods for integration of PDE, Monte-Carlo and lattice-gas numerical simulations, image segmentation and image analysis.

**Publications related to the topic :**

• Axonal transport: Driving synaptic function, Pedro Guedes-Dias and Erika L. F. Holzbaur, Science 366, 199 (2019)
• Dendritic trafficking faces physiologically critical speed-precision tradeoffs, Alex H Williams, Cian O'Donnell, Terrence J Sejnowski, Timothy O'Leary, eLife 2016;5:e20556.



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