18-month Postdoctoral Position in Statistical Physics of Biological Matter
Laboratoire Charles Coulomb (L2C), University of Montpellier, France

Subject: Stochastic thermodynamics of small systems: principles and their application to the study of molecular rotary motors of biological origin.

Position and deadlines. We offer a full-time position for 18 months available and starting no later than December 2023. The successful candidate will join the Complex Systems and Nonlinear Phenomena [*Systèmes Complexes et Phénomènes Non-linéaires* (*SCPN*)] research team in the Theoretical Physics Department of the L2C.

Scientific project. The successful postdoctoral candidate will conduct a theoretical investigation into the dynamics of rotary molecular motors of biological origin [1], using approaches inspired by non-equilibrium statistical mechanics [2], more precisely by the thermodynamics of small systems [3]. The main task will be to model different aspects of the Bacterial Flagellar Motor (BFM) [4, 5, 6]: 1) its cooperative assembly, 2) torque production, and 3) asymmetric relaxation dynamics. Furthermore, supported by our results on the BFM, we would like to develop a more general theoretical framework adapted to the physical study of rotary molecular motors of biological origin by employing the methods of stochastic thermodynamics [7, 8]. We will build our models and test their predictions by analyzing experimental single-motor measurement data from our CBS (Center for Structural Biology, Montpellier) collaborators, Ashley Nord and Francesco Pedaci [9], with whom we have an ongoing collaboration on studying the BFM [10].

References:

1. Howard, Jonathon. *Mechanics of Motor Proteins and the Cytoskeleton.* Sinauer Associates Inc, 2001.
2. Jülicher, F., Ajdari, A., & Prost, J. (1997). Modeling molecular motors. *Reviews of Modern Physics*, *69*(4), 1269.
3. Hayashi, K., Ueno, H., Iino, R., & Noji, H. (2010). Fluctuation theorem applied to F1-ATPase. *Physical review letters*, *104*(21), 218103.
4. Sowa, Y., & Berry, R. M. (2008). Bacterial flagellar motor. *Quarterly reviews of biophysics*, *41*(2), 103-132.
5. Nirody, J. A., Sun, Y. R., & Lo, C. J. (2017). The biophysicist's guide to the bacterial flagellar motor. *Advances in Physics: X*, *2*(2), 324-343.
6. Nord, A. L., & Pedaci, F. (2020). Mechanisms and dynamics of the bacterial flagellar motor. *Physical Microbiology*, 81-100.
7. Seifert, U. (2008). Stochastic thermodynamics: principles and perspectives. *The European Physical Journal B*, *64*(3), 423-431.
8. Peliti, Luca, and Simone Pigolotti. *Stochastic Thermodynamics: An Introduction*. Princeton University Press, 2021.
9. Nord, A. L., Gachon, E., Perez-Carrasco, R., Nirody, J. A., Barducci, A., Berry, R. M., & Pedaci, F. (2017). Catch bond drives stator mechanosensitivity in the bacterial flagellar motor. *Proceedings of the National Academy of Sciences*, *114*(49), 12952-12957.
10. Perez-Carrasco, R., Franco-Oñate, M. J., Walter, J.-C., Dorignac, J., Geniet, F., Palmeri, J., Parmeggiani, A., Walliser, N.-O., & Nord, A. L. (2022). Relaxation time asymmetry in stator dynamics of the bacterial flagellar motor. *Science advances*, *8*(12), eabl8112.

Candidate's profile. We are looking for an experienced postdoctoral fellow with a Ph.D. in physics, applied mathematics, or a related field, with a strong background in stochastic processes and non-equilibrium statistical physics. Experience in the stochastic thermodynamics of biological matter, more specifically of molecular motors, would be highly desirable. Knowledge of Bayesian techniques for data analysis and model comparison, such as Approximate Bayesian Computation, would be welcome. The candidate should feel comfortable with analytical and numerical methods for stochastic differential equations and dispose of solid computational skills: Markov-Chain Monte Carlo, Kinetic Monte Carlo, or Molecular Dynamics simulations.

About the environment. The successful candidate will work with Nils-Ole Walliser in close collaboration with other members of the SCPN team. Our team's research activities focus on the theoretical modeling of complex systems and the study of nonlinear phenomena in fundamental physics. Our team has expertise in analytical and numerical techniques and Monte Carlo simulations for applications to non-equilibrium statistical physics, polymer physics, and stochastic processes. Our interests range from supramolecular and cellular biological systems, through fluid mechanics and spin physics, to nonlinearities and instabilities in optics, nanosciences, and radiative transfer. Montpellier is an enjoyable, culturally vibrant, and student-friendly city near the Mediterranean in the sunny South of France.

The future postdoctoral fellow could be involved in teaching at different levels. The fellow could deliver seminar-like courses, as well as supervise internship and Ph.D. students.

Application. To apply, please send a cover letter, your CV with a list of publications, and contact information for references to Nils-Ole Walliser at nils-ole.walliser@umontpellier.fr before the 9 of October 2023.