Modeling of active structuring in microtubule-motor assemblies

We are looking to fill a Ph.D. position in the MC^2 group at the Laboratoire Interdisciplinaire de Physique in Grenoble on modeling pattern formation in microtubule-motor assemblies. This interdisciplinary joint experimental-theoretical project aims at understanding the origin of the spatial and temporal organization of microtubules in the presence of competing processive molecular motors.

Context & Objective: Microtubules are key elements of the cytoskeleton of living cells, that participate in many cellular functions: long-range active transport, cell division, and motility. To perform this multitude of functions microtubules need to dynamically adapt their spatial organization, a task which is believed to be a result of a self-organization process triggered by molecular motors. However, the cell possesses a multitude of motors with varying properties, which may favor different types of microtubule organizations. Assemblies of microtubules and molecular motors are of form of active matter, which has been widely studied experimentally in vitro and theoretically in various settings. Recently, the Cytomorpholab group of Laurent Blanchoin and Manuel Théry has identified the formation of stationary patterns in microtubule-motor assemblies on supported lipid bilayers, which rely on the presence of two types of competing processive motors. In this experimental system, stationary labyrinth-like patterns compete with active nematic microtubule flows depending on the concentrations of the two motor species.

The mechanism of pattern formation is yet unclear. The objective of this Ph.D. project is to explore in detail the macroscopic properties and underlying microscopic mechanisms of this pattern forming system. While experiments are conducted in parallel by a Ph.D student at the CEA Grenoble in the Cytomorpholab group, the prospective theoretical Ph.D. student at the LIPhy will work on the theoretical description of the experimentally observed phenomenon using continuous phenomenological models as well as particle based microscopic models.

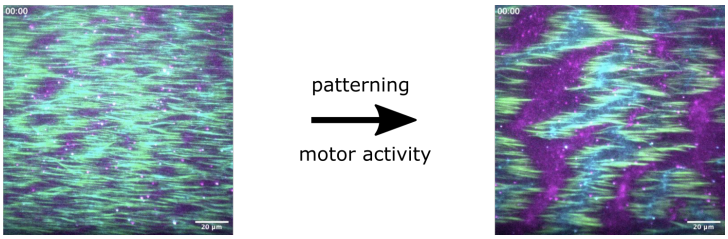

Figure 1: Stationary pattern formation in microtubule-motor assemblies upon increasing the motor activity. *pic credit to Clothilde Utzschneider & the Cytomorpholab.*

Environment: We offer an interdisciplinary research environment with a close collaboration between experimentalists and theoreticians. Grenoble is a dynamic city with a big university (Université Grenoble-Alpes) and host to several big research facillites (CNRS, CEA, ILL, ESRF,...). Its unique location in the heart of the french Alpes makes it the ideal place for outdoor activities.

Contract information: 3 years (35 hrs/week), starting date 01/10/2023, monthly gross salary ~2050 €

Application requirements: The successful applicant has a background in physics or life sciences with a strong interest in deciphering complex biological systems and mathematical modeling. Excellent written and oral communication skills (English) are desirable. Interested candidates are invited to contact Karin John (karin.john@univ-grenoble-alpes.fr) by email as soon as possible. They should provide: (1) a detailed CV, (2) the full transcript of their Master's degree(s), (3) a motivation letter describing past activities and research interests, and (4) contact information of 2 academic references.