**Name: Quan Manh Nguyen**

**Faculty Supervisor: Julien Tailleur**

**Direct Supervisor: Sunghan Ro**

**Term: Fall 2023**

**September 9, 2023**

**Mechanisms for Motility Induced Phase Separation**

**Project Overview**

*Provide an explanation/background of your UROP project that includes with whom you are conducting research.*

Self-propelled particles are endowed with new properties which have attracted a lot of attention and motility-induced phase separation (MIPS) is one of them. At large self-propulsion velocity, the particles can spontaneously separate into a high density phase and a low density phase similar to liquid-gas separation even if the interaction between them is repulsive. The underlying theory has been worked out in specific cases, such as for quorum sensing interactions by Professor Tailleur’s group. Recent progress has been made for repulsive pairwise interactions. However, the mixing of repulsive pairwise forces and quorum sensing has never been explored theoretically while it has been realized experimentally. The same is true for pairwise forces with attractive tails, which exhibits a richer phase diagram. We aim to use analytical calculations and simulations to explain the observations.

**Personal Responsibilities & Goals**

*Describe your planned role in the project. Be as specific as you can about your personal research duties/responsibilities, expected deliverables, and research goals you hope to accomplish by the end of term.*

At the beginning of the term, I will do calculations to familiarize myself with the coarse-graining and approximation techniques in the literature. After that, I will also learn simulation techniques already used by students in the group. I will use the techniques I learn to explore the phase diagram and the macroscopic dynamics of the systems. I will first focus on the mixing of pairwise forces and quorum sensing and hopefully complete it in the spring semester. After that, I might continue to address the attractive pairwise forces.

**Personal Statement**

*Briefly state why you are interested in this UROP and explain what you hope to gain from it.*

I like statistical physics and biophysics; this project gives me a flavor of both. I like the counterintuitive phenomena, the tractable calculations, and the potential applications of this field, for example with pattern formation arising as a result of MIPS.

I hope to gain experience with calculations and simulations in stochastic dynamics and thermodynamics, which have a wide range of usage. I also hope to get a taste of biophysics research to see if I like the field. The structure of the group might be new to me, with me working with both Professor Tailleur and his graduate students, which I believe will be a helpful experience to me.