

Protein clustering and signaling

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We are seeking a candidate for a master internship on theoretical models for spatial-localization mechanisms in cell biology.

The aim of the project is to study the physical processes by which a large number of molecules, e.g., proteins, form distinct spatial localization patterns, such as multiple protein clusters within a cell. A notable example of such a mechanism is the assembly pathway, i.e., the sequence of binding events which lead to the formation of large clustered structures. In the simplest version of these ideas, two prototypic pathways which can lead to clusters are either a single binding of two large complexes, or a large number of single-molecule bindings. As a result, one may aim at characterizing and controlling the assembly pathways, as well as other physical mechanisms, that lead to cluster formation on a desired time scale, or that may allow cells to achieve specific biological functions.

The theoretical study above will be combined with an ongoing experimental project at Institut Curie on protein localization in uveal melanoma (UM)—a cancer for which no systemic treatment has improved survival for the last decades. Our colleagues at Institut Curie are assessing experimentally the localization of specific proteins in UM, providing data which will allow us to construct a sensible model for their clustering. Given that such clustering is correlated with UM proliferation, our theoretical model may allow us to understand, leverage and control protein assembly mechanisms in an effort to enhance, inhibit and ultimately control UM growth according to clinical needs.

The theoretical part of project involves a variety of topics, including the analytical and numerical treatment of reaction-diffusion equations, the statistical-physics description of the processes to which molecular species are subject, and numerical simulations. The candidate should have a solid background in theoretical and statistical physics, and strong technical skills, both from the analytical and numerical standpoint. The project is part of an Agence Nationale de la Recherche (ANR) grant, and includes available funding for a Ph.D. scholarship, which will start in the Fall of 2018.