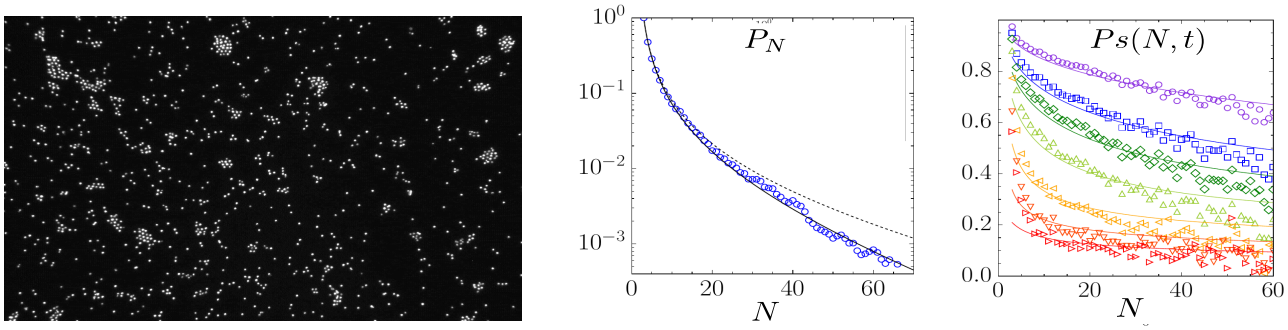
M2 Research internship

Simulations of active clusters

Active matter is a class of systems where a large number of discrete entities endowed with self-propulsion interact. Examples range from Janus colloids developed in the laboratory to bacteria colonies, mosquito swarms and bird flocks. Active matter is currently under intense scrutiny, as it exhibits properties that are uncommon in systems at thermodynamic equilibrium. One striking instance is the cluster phase [1], wherein **active particles spontaneously self-organize into transient groups** (figure). Such "**active clusters**" are broadly distributed in size, constantly move and evolve through particle exchange, internal fission or fusion with others. The cluster phase was investigated recently using an experimental realization based on Janus colloids [2], yet much remains to be understood.

The goal of the internship is to illuminate the nature of the cluster phase using **numerical simulations,** an approach whose advantages are twofold. First, simulations give access to properties that are inaccessible in experiments. Second, they will allow to investigate a variety of situations that have remained unexplored in the literature.



(Left) Active clusters of self-propelled colloids. (Middle) Probability distribution of cluster size N. (Right) Probability that a cluster has the same size N after a time interval t=1,2,3,5,10,20,40 (a.u) from top to bottom [2].

In practice, the student will develop a code to simulate active clusters and analyze their properties. A taste for **statistical physics** is necessary and **coding skills** are recommended. Simulation results will be interpreted with **simple theoretical models**.

Opening toward a PhD: yes (funding with «bourse ministère»).

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1. Theurkauff, Cottin-Bizonne, Palacci, Ybert, and Bocquet. Dynamic clustering in active colloidal suspensions with chemical signaling. *Phys. Rev. Lett.* (2012).

2. Ginot, Theurkauff, Detcheverry, Ybert, and Cottin-Bizonne. Aggregation-fragmentation and individual dynamics of active clusters. Submitted (2017).