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Institut d'Electronique, de Microélectronique et de Nanotechnologie
UMR CNRS 8520

Master or Engineer internship 2025-2026

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Title: **Physics of microtumors: statistical descriptions and emergent phenomena**

Abstract:

How do tumors self-organize? In a dense cell aggregate, some cells are more "sticky" and stay in clusters (epithelial-like), while others are more mobile and detach more easily (mesenchymal-like). Even in the absence of central coordination, these simple differences can be enough to trigger spontaneous sorting, creating mesenchymal regions separated from epithelial regions. Indeed, as in mixtures of active particles in physics, a simple interaction between two particles, combined with a random component in their motion, can give rise to behaviors reminiscent of phase transitions. Knowing when the mixture remains homogeneous or breaks into domains is crucial, because such spatial rearrangements are linked to the earliest steps of tumor dissemination and the formation of metastasis—a stage of cancer that is difficult to treat. In this context the adhesion properties are crucial.

To better understand these under-explored phenomena, we combine experiments with models from statistical physics. Using controlled 3D imaging of in-vitro microtumors, you will map the phase diagram; using numerical simulations of active particles or using simple analytical models of cellular adhesion, you will identify the minimal ingredients that reproduce the observed behaviors. Depending on your appetite for experimental versus theoretical work, the balance between these components can be adjusted. No prior knowledge of biology is required.

Keywords: Emergent phenomena, Stochastic dynamics, Microtumors