« PROPOSITION DE STAGE »

Titre: Cellular membrane deformation by a dynamic active gel

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Ce stage peut être poursuivi en thèse : Oui
Si oui, la thèse est-elle financée : Oui

Sujet du stage :
Cells can change their shapes and mechanically interact with their environment through active stress generation by their cytoskeleton, an active visco-elastic network of actin filaments undergoing polymerization and depolymerization, and of molecular motors generating active contraction. Shape changes can be spontaneous, or a response to mechanical and geometrical cues from the environment. We have recently developed a theory of active gel on deformable surfaces that showed that an active gel can both push and pull on a membrane, generating outward and inward deformation (Fig.1) [1]. Interestingly, the stress on the membrane is second order (depending on the square of the local membrane curvature), which means that membrane deformation does not occur spontaneously, but needs to be activated (second order phase transition). It has recently been observed by our cell biologist collaborators [2] that cells respond to topographic features of their environment by recruiting curvature-sensitive proteins which enhance actin polymerization. The goal of this internship will be to extend the existing model to account for the coupling between local geometry and actin polymerization (Fig.2). We will establish the conditions under which such coupling may lead to spontaneous cellular protrusions and assist important cellular functions, in particular cell motility. This project will be part of a larger program where we aim at understanding how non-adhering cells use the topography of their environment for moving by pushing on it. We will work in collaboration with the experimental team of Patricia Bassereau at Institut Curie, which will use *in-vitro* reconstitution to measure the actin stress under controlled conditions [3].

Keywords:
Cell mechanics, active gels, non-equilibrium hydrodynamics, soft interfaces, biological membranes

Skills:
Physical modeling, statistical physics, soft matter physics, interdisciplinarity

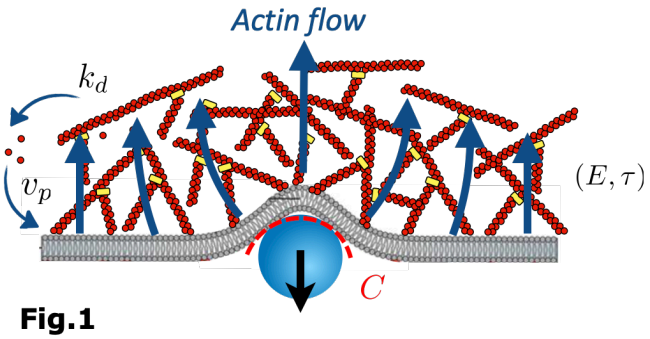

Fig.1

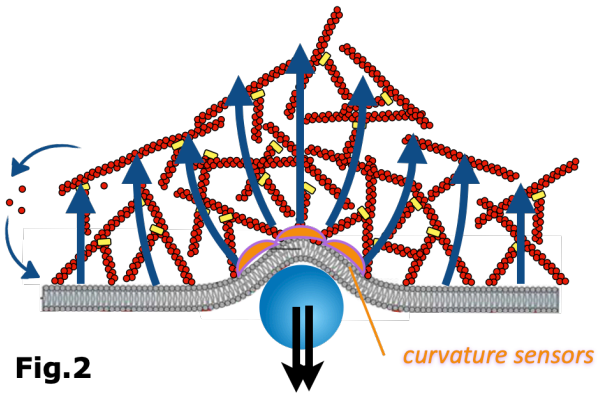

Fig.2

References:
[1] Actin dynamics drive cell-like membrane deformation. Simon *et al.* Nature Physics 15, 602-609 (2019)
[2] Gaertner *et al*. *Dev. Cell* 57 47-62.e49 (2022)
[3] Simunovic M… Bassereau P. *Annu. Rev. Cell Dev. Biol.* 35 111–129 (2019)