M2 Internship/Thesis: Viral self-assembly and thin-shell elasticity

Internship/Thesis advisor:
Martin Castelnovo (CR1,HDR)
Laboratoire de Physique, Ecole Normale Supérieure de Lyon, *Lyon*, *France*

Abstract: A virus is a molecular object mainly composed of a genome and a protective proteic shell. Various morphologies of these thin shells, ranging from ideal icosahedron to conical shape, are observed across viral families. Thin shell elasticity allows to rationalize the observations of most shapes based on the value of the spontaneous curvature of the shell. In particular, it has been recently suggested using numerical simulations that a low value of spontaneous curvature leads to cylindrical of conical capsids [1], explaining partially the mysterious origin of the conical shape observed for the HIV-1 capsid.

Yet, additional experimental observations suggest that the interaction between the genome and the self-assembling shell are important. It is the purpose of the present internship to explore the influence of genome-protein interaction on the shape of the resulting viral capsid. Based on an analytical analysis of thin shell elasticity, it is expected that this interaction should induce *pentameric* defects in the otherwise *hexameric* proteic self-assembly, favoring the closure of the shell. This question will be mainly investigated using (an existing) numerical model of growing triangulated surfaces. This study should lead to relevant biological consequences on the viral self-assembly scenario of HIV-1 for example.

More generally, several related questions can be explored using analytical and numerical methods: the role of enclosing membrane in the generation of defects of a growing proteic surface, the elastic response of closed elongated shells to external deformations (nanoindentation), the generalization of analytical thin shell theory in the presence of spontaneous curvature, the influence of elastic properties on the kinetics of self-assembly, etc… All these questions can be gathered into a consistent thesis project.

[1] Levandovsky A., Zandi R., *Nonequilibrium Assembly, Retroviruses, and Conical Structures*, **Phys. Rev. Lett.** 102, 198102 (2009).

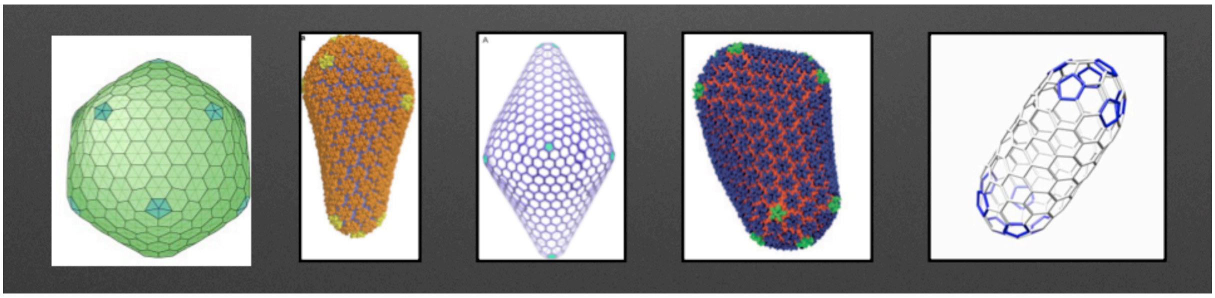

Figure : Various viral morphologies corresponding to different distribution of pentameric defects.

Contact
Email : martin.castelnovo@ens-lyon.fr