Active colloids at biomimetic membranes

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Active colloids are an emerging class of particles which are designed to perform autonomous motion by converting chemical, or other forms of energy, into work and propulsion. These particles are now one of the most investigated model systems of Active Matter, since they are able to consume energy at the local level, which drives them out-of-equilibrium. Active colloids are also investigated to perform primitive tasks such as transport cargo, and degrading or adsorbing contaminants for wastewater treatment [1]. In this project, motion of active colloids and interaction with biomimetic membranes will be investigated to understand and control fundamental and new phenomena occurring on model cell membranes. Particle crossing of membranes (endocytosis) or active transport of membranes are two examples of those phenomena. Janus colloids possessing two distinct faces with tunable properties will be fabricated in order to tune the interaction between the particle and the lipid membrane, and to ensure active motion.

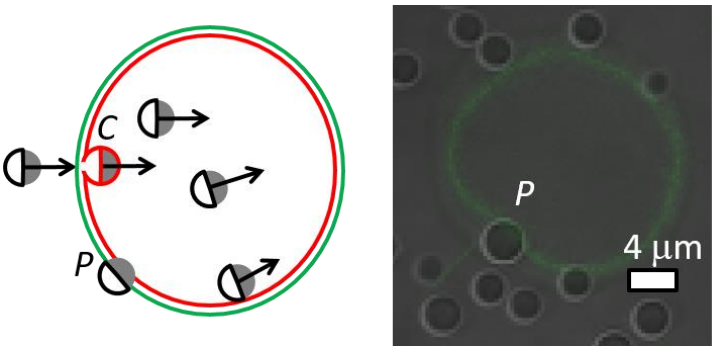

Figure 1 : (left) Sketch of Active Janus colloids completely C or partially P engulfed by a lipid membrane. (right) Microscopy image of colloids interacting with a lipid vesicle.

Janus particles possessing different adhesion properties will be used to control the membrane wrapping and the particle engulfment regimes, see Figure 1. First, we aim at finding experimental conditions to realize partial and complete particle engulfment by the membrane. Once partial and complete engulfment regimes will be controlled, we will exploit the activity of the Janus particles to let the membrane perform active tasks. In particular, we plan experimental investigations on (i) vesicle transport by active colloids in partial engulfment and (ii) driven particle endocytosis or encapsulation inside the vesicle in the completely engulfed regime. Finally, active colloids encapsulated inside lipid vesicles may create “active membranes” able to undergo driven shape changes and to perform active motion [2].

The PhD candidate will implement her/his scientific program within the experimental and theoretical environment of the MCube group at the Charles Sadron Institute. She/he should have a strong interest for starting an experimental carreer in Soft Condensed Matter and Biophysics.

[1] Elgeti, J., Winkler, R. G., & Gompper, G. Reports on Progress in Physics, 78(5), 56601 (2015)
[2] Abaurrea Velasco, C., Dehghani Ghahnaviyeh, S., Nejat Pishkenari, H., Auth, T., & Gompper, G. Soft Matter, 13, 5865–5876 (2017).