Light-Driven Self-Propulsion of Rod-like fd-Virus Functionalized Janus Particles

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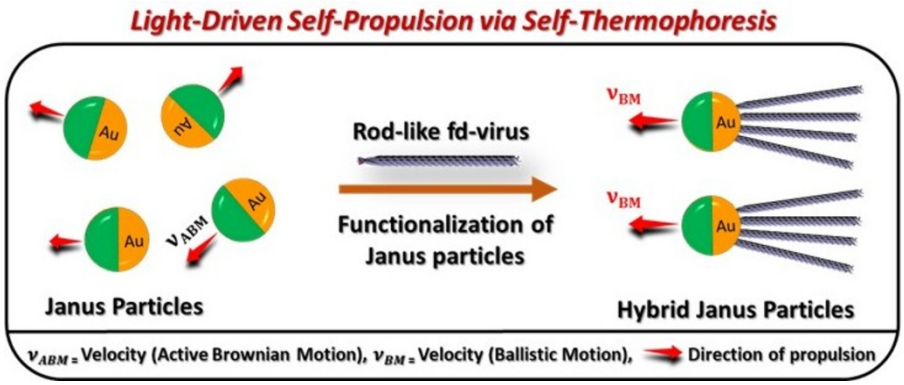
Abstract: Active matter systems, which convert energy into autonomous motion, offer various strategies for designing synthetic devices capable of self-propulsion [1]. Among the different propulsion mechanisms, light-driven self-thermophoresis is more appealing and stands out as it is fuel-free and provides on-demand switchable motion [2]. However, achieving controlled directional motion at the nanoscale remains challenging as Brownian motion rapidly randomizes particle trajectories. To overcome this limitation, an effective strategy is required to suppress rotational diffusion and enable directional ballistic motion.

Herein we show the engineering of hybrid Janus particles by selectively functionalizing the gold hemisphere of the Janus particles with rod-like filamentous viruses. This approach was previously successfully used for fabricating star-like colloids from gold nanoparticles [3]. In this work, we investigate whether grafting of filamentous viruses, acting as long macromolecular tails, onto Janus particles can significantly inhibit rotational diffusion thereby promoting ballistic motion driven by light induced self-thermophoresis. This approach establishes a novel strategy for enhancing directional persistence in the motion of active hybrid colloids and paves the way toward more efficient advanced active matter systems.

Keywords:
Active matter, Janus particles, self-propulsion, self-thermophoresis, fd virus



Schematic illustration showing the functionalization of Janus particles with fd-virus and their self-propulsion via light-induced self-thermophoresis. fd-virus functionalization suppresses rotational diffusion and enable directional ballistic motion.

References:

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Acknowledgements:
I would like to sincerely thank my supervisor, Prof. Eric Grelet, for his continuous guidance and support. I would also acknowledge the Paul Pascal Research Center (CRPP) and the National Centre for Scientific Research (CNRS) for providing the experimental facilities and financial support for my research and participation in this conference respectively.

I am grateful to Isabelle Ly, Dr. Lionel Buisson, Dr. Ducrot Etienne, and Sabrina Bichon for their valuable assistance at CRPP. Finally, I acknowledge the French National Research Agency (ANR) for funding the research project.