MECHANICAL ENGINEERING PhD SEMINAR (50 min.)

Thursday, July 10 2025 at 14:00-15:00, Zoom meeting
Link: https://technion.zoom.us/j/91824835761?pwd=mK7MeUCDwc2LKeTpLYelLeMrRo0J7I.1

Microswimmer Robots and Optically Modulated Electrokinetic Propulsion

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This research aims to enhance the functionality and capabilities of electrically-powered microswimmer robots using optical fields. Microswimmers are synthetic microstructures that operate in fluid environments and can perform a range of tasks, including guided motion, cargo transport and release, chemical activation, and more. Optical signals provide a powerful and versatile method for microswimmer control, enabling multi-dimensional modulation through variations in intensity, frequency, and spatial distribution. Additionally, they provide design flexibility by enabling functionalities to be encoded into the optical system, the fluidic chamber or channel, or directly onto the microswimmer itself.

We first investigated the enhancement of established electrokinetic propulsion mechanisms that depend on symmetry breaking between conductive and dielectric regions of an active particle. By leveraging the photoconductive response of a semiconductor coating, we modulated the polarizability of the conductive hemisphere of a Janus particle (JP), thereby optically tuning both its electrokinetic mobility and the collective behavior of multiple JPs. This phenomenon, which we termed Optically Modulated Electrokinetic Propulsion (OMEP), was systematically characterized.

Building on this foundation, we designed a microswimmer robot that leverages OMEP to address the longstanding challenge of decoupling propulsion and steering. This was achieved through the design and fabrication of engineered, non-spherical active particles with selectively placed photoconductive patches that function as optical rudders upon illumination. This advancement enables robust and controllable navigation.

Seminars Coordinator: Assoc. Prof. Shmuel Gal.

Publications:

- Zehavi, M., Sofer, D., Miloh, T., Velev, O. D., & Yossifon, G. (2022a). Optically Modulated Propulsion of Electric-Field-Powered Photoconducting Janus Particles. Physical Review Applied, 18(2). https://doi.org/10.1103/PhysRevApplied.18.024060

- Zehavi, M., Rachbuch, I., Park, S., Miloh, T., Velev, O. D., & Yossifon, G. (2025). Programmable Motion of Optically Gated Electrically Powered Engineered Microswimmer Robots. Small. https://doi.org/10.1002/smll.202501317

Note: the seminar will be given in Hebrew

Seminars Coordinator: Assoc. Prof. Shmuel Gal.