Colloquium

Programming Cell Behavior with Light

Roberto di Leonardo
Sapienza Università di Roma

Host: Jérémie Palacci

Many unicellular organisms can sense light, reflecting their long evolutionary history in aquatic environments where sunlight provides both energy and environmental information. This has given rise to a broad diversity of light-sensitive proteins that enable cells to exploit photons for multiple functions. Modern synthetic biology allows us to repurpose these natural photoreceptors as biological analogues of optoelectronic components such as switches, photoresistors, and solar cells. In this talk, I will focus on three light-activated proteins from evolutionarily diverse unicellular organisms and show how they can serve as an optical interface to program motility and gene expression. Using a light-driven proton pump, we can establish feedback loops in which computer programs dynamically modulate cell motility. This enables bacteria to act as light-reconfigurable paint, transport microscopic passive objects by shaping the mechanical pressure of surrounding swimming cells, and program biohybrid microrobots for the collection and delivery of microscopic cargo. By rewiring a cyanobacterial light-activated kinase into a synthetic genetic clock in E. coli, light can serve as a zeitgeber, driving coherent population-wide oscillations in gene expression. Finally, we exploited the natural photophobic response triggered by a light-activated cyclase in Euglena gracilis to design static “light containers” that can spatially sort cells, leveraging the non-equilibrium nature of this biological version of the billiards problem.

Monday, June 8, 2026 11:30am - 12:30pm
Raiffeisen Lecture Hall

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