Title: Programming bacterial dynamics with light

Abstract: The flagellar motility of bacteria is a prime example of the engineering power of evolution. It consists of an electric rotary nanomotor, an optimally crafted propeller and a simple and robust sensing and control network. The discovery of light-driven proton pumps in bacteria adds to this toolbox of biological components a nano "solar cell", proteorhodopsin, which allows optical control of swimming speed with high spatial and temporal resolution. Using light for rapid and precise remote control, we can establish feedback loops in which computer programs can dynamically modulate cell motility. With this approach, we can optically confine dense clouds of swimming bacteria, transport colloidal cargoes by shaping the mechanical pressure of an active gas of swimming cells, and program biohybrid micro-robots to navigate through a sequence of predefined checkpoints. Finally, I will demonstrate how to connect a genetic "photoresistor" to a synthetic biological clock and use light pulses to entrain oscillations of gene expression in a bacterial population.