

CHEMICAL ENGINEERING

SEMINAR SERIES



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Biomolecular Engineering for Non-Invasive Imaging and Control of Cellular Function

ABSTRACT: The study of biological function in intact organisms and the development of targeted cellular therapeutics necessitate methods to image and control cellular function in vivo. Technologies such as fluorescent proteins and optogenetics serve this purpose in small, translucent specimens, but are limited by the poor penetration of light into deeper tissues. In contrast, most non-invasive techniques such as ultrasound and magnetic resonance imaging, while based on energy forms that penetrate tissue effectively, are not effectively coupled to cellular function. Our work attempts to bridge this gap by engineering biomolecules with the appropriate physical properties to interact with magnetic fields and sound waves. In this talk, I will describe our recent development of biomolecular reporters and actuators for ultrasound. The reporters are based on a unique class of gas-filled protein nanostructures from buoyant photosynthetic microbes. These proteins produce nonlinear scattering of sound waves, enabling their detection with ultrasound. I will describe our recent progress in understanding the biophysical and acoustic properties of these biomolecules, engineering their mechanics and targeting at the genetic level, developing methods to enhance their detection in vivo and expressing them heterologously as acoustic reporter genes. Our actuators are based on temperature-dependent transcriptional repressors, which provide switch-like control of bacterial gene expression in response to small changes in temperature. This allows us to use focused ultrasound to remote-control engineered cells in vivo.

RECEPTION 3:30 • LECTURE 4:00 – 5:00
PHYSICS ASTRONOMY BLDG. PAA A 118



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BIOGRAPHY: Mikhail Shapiro is an Assistant Professor of Chemical Engineering and a Heritage Principal Investigator at Caltech. He received his PhD in Biological Engineering from MIT and his BSc in Neuroscience from Brown. He conducted post-doctoral research in biophysics at the University of Chicago and was a Miller Fellow at the University of California, Berkeley. He has received the Burroughs Wellcome Career Award at the Scientific Interface, the DARPA Young Faculty Award, the Pew Scholarship, the Sontag Foundation Distinguished Scientist Award, the Packard Fellowship and the Technology Review TR35 award for top innovators under age 35. More information about the Shapiro Lab can be found online at shapirolab.caltech.edu.