Tuesday, October 5th, 2:30 pm

Speaker: Janaki Sheth

Institution: University of Pennsylvania

Title: Inner ear dynamics as adaptive nonequilibrium steady state systems

Abstract: The living world provides numerous examples of nonequilibrium steady states. These systems remain in a controlled out-of-equilibrium state due to the continuous input of energy from an endogenous drive and rejection of heat into the surrounding environment. While such systems are not unique to biology, they are often distinguished from inanimate ones by the fact that their drive includes feedback mechanisms necessary for homeostatic control. In essence, the drive measures some properties of the system and then modifies its input in a manner reminiscent of a Maxwellian demon. We call these adaptive nonequilibrium systems.

In my talk, I will focus on the nonequilibrium steady states associated with the sensory receptors of the inner ear – its hair cells – to explore novel fluctuation theorems associated with such nonequilibrium systems. Hair cells of the inner ear have protruding cilia (or hair bundles) whose deflection in response to an incoming pressure wave initiates the transduction of sound into electrochemical signals transmitted to the brain. Several experiments have shown that the hair cells and their cilia are not just passive sensory detectors but exhibit an internal active amplifier that also provides an adaptation mechanism allowing the sensory organelle to continuously maintain its sensitivity in the presence of varying sound fields. Furthermore, this active, adaptive process leads to an inherent mechanical instability, which manifests as the spontaneous limit cycle oscillations of the hair bundles observed *in vitro* in several species. Using these hair cells as a testing ground, my work demonstrates that new ideas from nonequilibrium statistical physics will be required to elucidate fundamental biological phenomena, which involve energy consuming cellular processes.