
The Dynamical Basis of Hearing
(1R01DC007294-01-FY04)
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This project is a collaboration using computational, theoretical, and experimental approaches to analyze early events in hearing, at various scales ranging from the motion of hair bundles to neural coding in the auditory nerve. A recent focus of our collaboration has been the active process that injects mechanical energy into the cochlea to assist the mechanical amplification of signals, in particular the hypothesis that the active process poises the organ's elements at the threshold of an oscillatory instability, called a Hopf bifurcation. Our current focus extends to examine the interaction of the active process with its environment: adaptive mechanisms, other elements, and downstream processing. At the microscopic scale the environment of the active process consists of the adaptation mechanisms that regulate it and keep it poised, and detailed analysis of various candidate mechanisms is undertaken. At the mesoscopic scale the environment includes other nearby active elements: so we study the interactions between hair cells in the whole cochlea, and the mechanism and process through which the dynamical behavior of each hair cell contributes to the overall function of the cochlea without a massive cacophony of feedback oscillations. At the coarsest level we study the encoding of the auditory stream into the acoustic nerve, with an emphasis on neurophysiologically feasible time-frequency representations, and particularly how level-independent auditory percepts can be extracted from the level-dependent responses of the cochlea. Our recent results show plausible time-frequency computations can result in sparse representations.

Project Website

http://asterion.rockefeller.edu/