MTH 995-1, Mathematical modeling of human sensory systems I: Fundamentals of human sensory systems

(Fall 2011)

Instructor: Professor Guowei Wei

Human sensory systems are a part of the nervous system that is responsible for processing of vision, hearing, somatic sensation (touch), taste and olfaction (smell). They consist of sensory receptors, neural pathways, and parts of the brain involved in sensory perception. Human brain recognizes only electric signals, while external stimuli are chemical, physical, mechanical, thermal, acoustic, and photonic ones. It is ion channels that transform external stimuli are into electric signals. Neurons amplify and preprocess electric signals before relay and transmit them to the related brain regions. We will try to understand the molecular mechanism of sensory systems, from various sensors and receptors (chemosensor, mechanoreceptor, nociceptor, photoreceptor, thermoreceptor), to second massagers, electrostatic depolarization, ion channel transport, action potential, and neuron transmitters and gene regulation.

MTH 995-1, Mathematical modeling of human sensory systems II: Mathematical models of human sensory systems

(Spring 2012)

Instructor: Professor Guowei Wei

We will discuss a number of deterministic and stochastic models, such as Boltzmann equation, Boltzmann-Vlasov equation, Liouville equation; Zwanzig's equation, Fokker-Planck equation, Brownian dynamics, Langevin dynamics, molecular dynamics, master equation, Poisson-Nernst-Planck equations, Kohn-Sham equation, Navier-Stokes equation, Laplace-Beltrami equation, mean curvature flow, Willmore flow, Poisson-Boltzmann equation, Maxwell's equations, wave equation, anisotropic diffusion equation, and generalized Kohn-Sham equation. Emphases will be placed on how to utilize the aforementioned models in a consistent manner for the description of sensory systems. We will make extensive use of fundamental laws of physics via variational approaches to derive governing equations for stimulus receptors, neural pathways and brain perceptions so as to understand sensory transduction from the physical world to the realm of the mind.