COLUMBIA | ENGINEERING
The Fu Foundation School of Engineering and Applied Science

Distinguished Colloquium Series in Interdisciplinary & Applied Mathematics

Michael Brenner

Glover Professor of Applied Mathematics and Applied Physics
Harvard University

Geometrical Transformations and the Shape of Bird Beaks

Evolution by natural selection has resulted in a remarkable diversity of organism morphologies. But is it possible for developmental processes to create "any possible shape?" Or are there intrinsic constraints? I will discuss our recent exploration into the shapes of bird beaks. Initially, inspired by the discovery of genes controlling the shapes of beaks of Darwin's finches, we showed that the morphological diversity in the beaks of Darwin's Finches is quantitatively accounted for by the mathematical group of affine transformations. We have extended this to show that the space of shapes of bird beaks is not large, and that a large phylogeny (including finches, cardinals, sparrows, etc.) are accurately spanned by only three independent parameters -- the shapes of these bird beaks are all pieces of conic sections. After summarizing the evidence for these conclusions, I will delve into our efforts to create mathematical models that connect these patterns to the developmental mechanism leading to a beak. It turns out that there are simple (but precise) constraints on any mathematical model that leads to the observed phenomenology, leading to explicit predictions for the time dynamics of beak development in song birds. Experiments testing these predictions for the development of zebra finch beaks will be presented.

Michael Brenner is the Glover Professor of Applied Mathematics and Applied Physics at the Harvard University School of Engineering and Applied Science. He received his Ph.D. in Physics at the University of Chicago under the direction of Leo Kadanoff. Brenner's research uses mathematics to examine a wide variety of problems in science and engineering, ranging from understanding the shapes of whale flippers, bird beaks and fungal spores, to answering ordinary questions about daily life, such as why a droplet of fluid splashes when it collides with a solid surface. Brenner is a Fellow of the American Academy of Arts and Sciences.

Wednesday, November 5, 3:30pm
Davis Auditorium, CEPSR (Shapiro Center)