Senior Research Honors Thesis Defenses  
Thursday, May 9, 2013  
1:30pm – 4:00pm, Abelson 229  

1:30pm – 2:00pm, Michal Dichter  
*Signatures of Incipient Jamming in Collisional Hopper Flows*  
Advisors: Profs. Aparna Baskaran and Bulbul Chakraborty  

Abstract: The gravity-driven hopper is a ubiquitous complex system that suffers from arch-induced jamming---a troublesome phenomenon wherein a few granules of matter impede the system outlet and cause complete dynamical arrest. We report on the results of numerical simulations of dense granular flows of bidisperse 2D disks in a hopper with a tapered outlet---as in an hourglass. We find that the spatial distribution of velocity autocorrelation relaxation times follows a simple pattern that reverses for slower flow rates. For faster flow rates the center of the hopper has lower kinetic temperatures and longer autocorrelation times than the shear layer. For slower flow rates the contrary is true. We also find that the distribution of the transverse velocity is non-Gaussian for many areas of the hopper---a trend most salient at slower flow rates. We use the transverse velocity to form space-time snapshots of slow-moving disk clusters that stem from zero-massflow events at the system outlet and propagate upward into the bulk---as in the wave of cars that propagates backward from the point of a traffic jam.  

2:00pm – 2:30pm, Walter Simons-Rose  
*The Effects of Confinement in Determining Chemical Rates*  
Advisors: Profs. Aparna Baskaran and Jané Kondev  

Abstract: I consider the problem of a ligand binding to a receptor by diffusion when one or both molecules are confined. We examine the dependence of the first passage time on the size of the confining region and the ratio of the diffusion constants. Finally, we compare our simulation to cases where the analytical results have been solved.  

2:30pm – 3:00pm, Adam Ollanik  
*Techniques in Microfluidics*  
Advisors: Profs. Zvonimir Dogic and Jané Kondev  

Abstract: Droplet microfluidics provides a means for high throughput, low volume, highly controllable experimentation. The technology allows many identical, small volume samples to be created, manipulated, stored, and observed, and has many potential uses. This presentation will cover three distinct projects in microfluidics. The first project regards a Fluorescence Activated Cell Sorter (FACS) created by an Olin Scope team during the 2011-2012 school year. The purpose of the machine, and the goal of the project, is to sort and count microfluidic droplets accurately and with very high throughput as determined by fluorescent signature. The second project regards the extension of a project currently being pursued by graduate student Sathish Akella. Sathish is currently in the final stages of a project studying the nucleation rate of lysozyme crystals from solution through use of microfluidic droplets. This second project intends to extend his work to a non-organic molecule, paracetamol. The third, and final, project regards work being done by the Fraden Lab on the Belousov-Zhabotinsky (BZ) reaction. The project aims to develop and produce a simple platform on which the coupling between droplet-enclosed reactions in various organizations may be studied.
3:00pm – 3:30pm, Aaron Chevalier
*Search for twisted polarization in arcsecond scale Quasar jets*
Advisors: Profs. David Robert and John Wardle

Abstract: The Quasar 3C345 a seemingly singular 35 degree twist in the polarization of its kiloparsec scale jet. Because of the vast number of quasars known, it seems unlikely that 3C345 is alone in this respect. By imaging Quasars identified is having structure by Murphy, Brown and Perley (1993), and Perley (1982) and by sampling sources from the VLA Calibrator manual, we hope to find additional examples of this property that could help us to better understand the nature of Quasar jets.

3:30pm – 4:00pm, Valerie Marchenko
*Testing the iC/CMB Model for X-ray Emission: Constraining the Orientation of Extragalactic Jets*
Advisors: Profs. Richard Fell and John Wardle

Abstract: The purpose of this research is to test the inverse–Compton/Cosmic Microwave Background (or iC/CMB) model for x–ray emission from radio jets. Andreas Rauch of the Brandeis Physics Department has developed methods for containing the orientation of extra–galacticradio jets. We will apply these constraints to jets detected by the Chandra X–Ray Observatory. By doing so, we perform a strong test of whether the iC/CMB mechanism is viable.