

ABSTRACTS OF SENIOR THESES

Matthew Mallory (advisor: Professor Roberts) We present radio wavelength images of SS433 from 16 archival observations taken with the Very Large Array (VLA) over a 100 day period during the summer of 2003. The 4.86 GHz and 8.46 GHz observations provide comprehensive maps that hold a wealth of details about the source. The total intensity plots show us blobs that move along with the source near the accepted value of $0.26c$. The 14.94 GHz data contains hot spots that also move, reassuring the previous find. The total intensity plots of the east and west jets for July 11th, which were observed over an entire day, prove that the two jets are very similar in makeup. Polarization data shows that the polarization intensity and electric vector polarization angle are connected with the jet morphology. Fractional polarization plots yield a very interesting high percentage section off the helix of the jet that rise interest. Two methods to correct improper polarization calibrations and the complications that come with them will also be described.

Kabir Hussein (advisor: Professor Lawrence) We study the dynamical failure of the classical limit of quantum mechanics in the propagation of wavepackets through the coulomb potential in one-dimension. Classical dynamics, when placed into a suitable quantum framework, is found to break down close to the singularity and the necessity of full quantum methods to correctly describe the dynamics is discussed. It is found that, while the coulomb potential is not essentially self-adjoint, there exists a choice of boundary conditions that yields a physically reasonable classical limit. The importance of above-barrier reflection to non-classical evolution is explored, and a reflection co-efficient for the 1D coulomb problem consistent with the chosen boundary conditions is calculated.

Roy Rotstein (advisor: Professor Fraden) Measuring the phase transition concentrations of novel liquid crystalline material in bulk may prove to be unpractical due to the low volume of product yielded from chemical synthesis. In this thesis, I detail a new method for measuring phase transition concentrations by using a microfluidic device, known as a "Phase Chip", that requires only nanoliter volumes of material. Transition concentrations of fd and fd/dextran mixtures were measured using this method and compared to published data from bulk experiments. Results from the Phase Chip are in agreement with results from previous experiments.

Tapiwa Mushove (advisor: Professor Wardle) Can we find a systematic way of elucidating the whole magnetic field structure in quasar jets and characterizing them from simple measurements of the moments of cross-sectional cuts along the jets? Magnetic field structure seems to evolve chaotically as the plasma flows at relativistic speeds down the jet, from the accretion disk near the super-massive black hole which powers the quasar. However, simple polarization patterns have also been observed along the whole jet during some epochs. This presents a great opportunity to investigate whether there is a simple relationship between centralized moments and the magnetic field structure in the jet. By comparing central moments computed from theoretical jet models with those measured from stacked images of MOJAVE Survey sources monitored with the Very Long Baseline Array, we hope to characterize the magnetic field structure in the observed sources in a systematic way. This work represents the first steps in an on-going project.

Victoria Schairer (advisor: Professor Dogic) The long term goal of our research is to quantify the behavior of semiflexible actin filaments under confinement in various 2D geometries. We first show that actin filaments can be confined onto a 2D glass coverslip surface using a well known depletion force. Next, we demonstrate that a glass surface coated with polyacrylamide brush effectively repels actin filaments. We use microcontact printing to engineer an array of 10-30um boxes of adsorbing glass surface juxtaposed against background polyacrylamide brush. By finding the right concentrations we hope to confine the actin filaments so that they will continue to fluctuate in the 2-dimensional box. These experiments can be used to test recent theoretical predictions for the structure and fluctuations of semi-flexible filaments in confined spaces.

Keith Cheveralls (advisor: Professor Kondev) Bimolecular reaction rates between freely diffusing receptors and their corresponding ligands are limited by diffusion even when the chemical reaction between them occurs very rapidly. We investigate the effect on this reaction rate of confining receptors to flexible polymers, and show that this confinement mechanism, under certain conditions, enables the reaction to occur at a rate faster than the diffusion limit. We approach the problem using the framework provided by diffusion-reaction equations, and develop two approaches to obtaining approximate solutions for the reaction rate in terms of the parameters of the reaction and the tethering polymer.