Manisha Shrestha (Research Advisor: Dr. Jennifer Hoffman)
Polarization Signatures of Stellar Bow Shocks

Bow shocks around massive stars provide important information regarding the motion of the star, the stellar wind properties and the density of the surrounding ISM. Since bow shocks are asymmetric structures, they produce polarization signal which is a function of stellar wind and surrounding ISM. We use a Monte Carlo based radiative transfer code (SLIP) to investigate the polarization created when photons from the source get scattered by electrons or dust in a surrounding bow shock. We vary parameters such as optical depth, temperature, and brightness of the bow shock and compare the simulated UX and polarization behavior with observational data. We discuss the behavior of the observed polarization with viewing angle and other parameters in both the resolved and unresolved cases. We also compare the bow shock results with those produced by other circumstellar morphologies such as disks and shells.

Devin Wesenberg (Research Advisor: Dr. Barry Zink)
Thermal gradients, Nernst and Hall Effects in metallic ferromagnets using suspended thermal platforms

Research into spincaloritonics, particularly the interaction between heat and spin currents in ferromagnetic structures is ever-growing. Understanding the fundamentals of these effects is important in order to differentiate between spincaloritronics, thermoelectric and spintronic effects. Our experiments strive to distinguish these effects by accurately controlling and measuring thermal gradients and electric currents on thin films and nanostructures. We have designed experiments to probe the thermal Planar Nernst Effect and its electric analog the Planar Hall Effect.

Taylor Firman (Research Advisor: Dr. Kingshuk Ghosh)
Modeling Switch-Like Cellular Decision-Making Using Maximum Caliber

Throughout biological decision-making, many switch-like behaviors are observed in which the state of one particular aspect of a cell can change drastically in a short amount of time in response to some unforeseen stimulus, external or otherwise. Noise and stochasticity can play a crucial role in such processes since small random perturbations away from average behavior can be sufficient to initiate these large shifts in behavior. In our research, we analyze the dynamics of a synthetic genetic circuit that allows cell populations to switch between two different phenotypes characterized by high and low expression of a fluorescent protein that provides antibiotic resistance to that cell. We model this stochastic switching by using the principle of maximum caliber, a concept akin to maximum entropy in equilibrium statistical mechanics but applied to trajectories, natural observables in experimental settings.

Timothy VanDerleest (Research Advisor: Dr. Dinah Loerke)
Quantitative Analysis of Drosophila germ-band elongation

Tissue elongation is a fundamental morphogenetic process crucial to embryogenesis and organogenesis in vertebrates and invertebrates. One widely studied example of tissue elongation is Drosophila germ-band extension (GBE) in which an initially hexagonal array of cells approximately doubles in length along the anterior-posterior axis. Using automated computational image segmentation we have tracked the motion of cells during GBE with high spatial and temporal resolution, which includes the tracking of cell-cell junctions and junction vertices. We present some of our results on the dynamics of this system.