Physics Oral Session 4 Titles and Abstracts
Oral Session 4: 11:00 – 12:30pm Saturday, November 7th, 2009

O4-1
Presenter: Kyle Weigand, Augustana College
Title: Picosecond Pulse Fiber-Laser using a Semiconductor Saturable Absorber Mirror
Advisor: James van Howe, Department of Physics, Augustana College

Fiber lasers using saturable absorption in a semiconductor mirror can produce optical pulses on the order of picoseconds in an all-fiber configuration. My talk will review the components of this fiber-laser and how they work to produce ultrafast pulses. In addition to showing experimental results, I will review some of the theory and background of mode-locked fiber-lasers, particularly the semiconductor saturable absorber mirror configuration.

O4-2
Presenter: Alyssa Stephenson, Lawrence University
Title: EIT with a noisy laser
Advisor: Shannon O'Leary Physics, Lawrence University

Electromagnetically Induced Transparency (EIT) is a quantum mechanical phenomenon which allows light to pass through an otherwise opaque material. Our project studies the lifetime of this transparency in Rubidium-87 atoms as it relates to laser beam power. We found that the EIT lifetime is independent of laser power at low laser powers; however, once a power threshold is crossed, the lifetime shortens with increasing power. We believe this dependency is evidence of radiation trapping within the atomic vapor.

O4-3
Presenters: Julia Ziege and Kelsey Gray, Lawrence University
Title: An Investigation of the Gait of Kinesin
Advisor: Doug Martin, Department of Physics, Lawrence University

Active transport mechanisms are vital for cell division and organization. Tiny motor proteins, called kinesins, carry cargo through the cell along tracks. Our research investigates how kinesin moves. Previous research has shown that kinesin walks with one foot in front of the other, similar to humans; however, the timing of these steps remains unclear. We seek to determine whether kinesin walks with equal time between each step, or with one step consistently longer than the other. To do so, we attach a small fluorescent molecule to the kinesin in order to track progress. Using fluorescent microscopy, we follow this motion with nanometer precision. We are able to observe the kinesin moving and can detect step-like motion. However, we are still working toward an observation of how long each individual step takes.

O4-4
Presenter: Bryce Bjork, Gustavus Adolphus College
Title: Noncontact Modal Excitation of Cantilevers Using Ultrasound
Advisor: Tom Huber, Department of Physics, Gustavus Adolphus College
Coauthor: Hunt, CJ

The ultrasound radiation force can be used as a noncontact method for exciting vibrational modes. An audio-range modulation signal is combined with a 440-kHz carrier to form a double-sideband suppressed-carrier (DSSC) waveform that is emitted from an ultrasound transducer. The frequency of the ultrasound radiation force is at the difference between the sidebands, or twice the modulation frequency. The ultrasound radiation force has been used to excite samples ranging from macroscopic objects such as a hard-drive suspension, to objects as small as microcantilevers. One of the unique capabilities of this technique is that it can be used for selective excitation of different vibrational modes. To demonstrate this capability, a pair of 400 kHz ultrasound transducers were focused at the corners of a rectangular brass cantilever with dimensions: 0.07x0.75x2.64 cm. The waveforms for these transducers were generated in software, and the phase of the resulting radiation force could be varied. The radiation force was swept through a frequency range encompassing a nearly overlapping transverse (1665 Hz) and torsional (1685 Hz) vibrational modes. When the radiation force from the two transducers were in phase, the transverse mode was at a maximum and the torsional mode was strongly suppressed. In contrast, when the transducers were driven out of phase, the torsional mode was at a maximum and the transverse mode was suppressed. Conventional base excitation using a mechanical shaker cannot be used to separately resolve these two modes. Thus, not only is the ultrasound radiation force a noncontact excitation method, but it also enables selectivity that is not possible using conventional base excitation.

O4-5
Presenters: Bradley Bodee and Joseph O'Halloran , Lawrence University
Title: Three Dimensional Hydrodynamics Simulations of Protoplanetary Disks
Advisor: Megan Pickett, Department of Physics, Lawrence University

The origin of gas giant planets like Jupiter is greatly disputed. Observational data to date show the existence of 374 (up from 358 in August) exoplanets - planets which are not in our solar system - most of which are probably Jupiter-like. We use a 3-D hydrodynamics program to study one of the proposed planet forming mechanisms: the disk instability model, in which a gas planet is formed via interactions of spiral arms in a gravitationally unstable circumstellar disc of gas and dust. We know that most young, planet forming systems - including our own - are exposed to a variety of environmental factors such as the presence of a companion or star cluster. However, the vast majority of work by computational astrophysics groups assumes instead that such a disk is in a closed system consisting of only the disk and the star it surrounds. This summer, our group has altered a state of the art solar system simulator to address this deficiency. We have focused on removing the commonly used assumption of vertical symmetry, with the goal of adding simulated companions or other perturbers as orbiting point masses. This will allow warping and vertically asymmetric heating and cooling. In today's talk, we will present preliminary results of our additions to the code.

O4-6
Title: Repose Angles of Lunar Mare Simulants in Microgravity
Presenter: Isa Fritz, Carthage College
Advisor: Kevin Crosby, Department of Physics, Carthage College

Repose angles for lunar mare simulants were measured in rotating drum experiments aboard NASA's microgravity aircraft, Weightless Wonder. We measured both the maximum critical angle of stability and the static angle of repose for simulants JSC-1A and GRC-3 as a function of drum rotation rate. These measurements were conducted under vacuum to simulate conditions of the $1/6 - g$ lunar environment, and under standard atmospheric pressure to examine the effects of interstitial gasses on inter-particle cohesivity. We find no detectable difference in repose behavior between simulant flow at standard atmosphere and flow in a low pressure environment
of 10^{-2} Torr. We further investigate a plausible scaling relationship for the dependence of repose angles on effective gravitational acceleration. The relevant scaling parameter is $\sqrt{Fr}$ where $Fr = \omega^2 R/g_{eff}$ is the Froude Number, with ω the drum rotation rate, R the drum radius, and g_{eff} is the effective gravitational acceleration acting on the simulant. We find sufficient evidence in the data to support the scaling hypothesis.