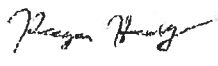
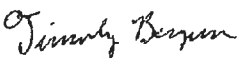
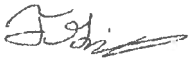
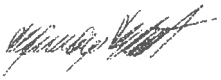
Juniata College

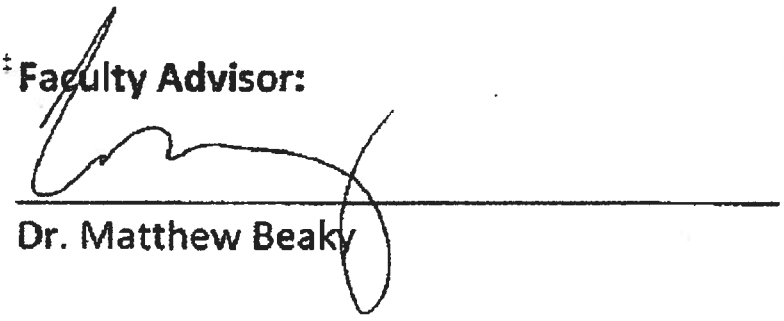
Society of Physics Students
1700 Moore Street
Huntingdon, PA 16652

Asteroid Occultation Observations

Proposal Writers:

Keegan Healy		Caitlin Everhart	
†Timothy Berguson		†Tess Ginley	
Matthew Flaugh		MaryElizabeth Petrie	
†Chris Arnold		Robert Draham	
Jon Bogue		†David Milligan	
Teresa Turmanian		Alexander Debrecht	

‡**Faculty Advisor:**



Dr. Matthew Beaky

Amount Requested: $1,960.00
Date Submitted: November 15, 2012

†SPS Officers
‡SPS Advisor

The Juniata College chapter of the Society of Physics Students is seeking funds to purchase equipment for observing and timing asteroid occultation events. Previously, Juniata College SPS students have taken part in the effort of the International Occultation and Timing Association (IOTA) to observe lunar occultations, which occur when the Moon passes between a star and the line of sight of an observer on Earth, which can provide highly precise information about the Moon's orbit and its surface. IOTA also oversees an ongoing project collecting asteroid occultation data, an effort we are now looking to join.

Asteroid occultations occur when an asteroid passes between the observer on earth and a visible reference star. By carefully measuring the timing of the occultation event from multiple observation locations, an estimate of the asteroid's cross section can be constructed.

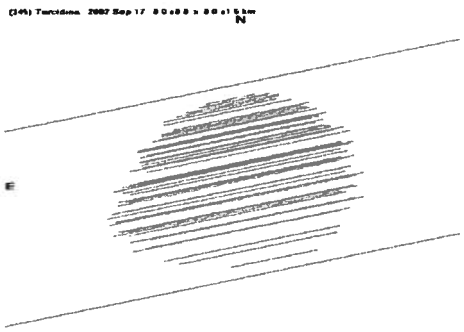


Figure 1: A representation of the cross sectional area of asteroid as determined by multiple occultation observations.

Because the incident starlight is nearly parallel, the shadow cast on the earth by an occulting asteroid is approximately the size of the asteroid itself, usually less than 50 miles. The need for highly precise timing measurements has meant that historically these events have been observed only infrequently, but with the advent of GPS technology and the availability of more detailed data on asteroid orbits, occultation data is supplying more and more data about the physical properties of asteroids in our solar system. In addition to estimating the shape of an asteroid, occultations can provide information about the asteroid as part of a binary or multiple system, and even about the star being occulted.

Several lunar occultations were observed at Juniata College in the spring of 2012, and the methods for recording asteroid occultations are very similar. Observations require a telescope, a low-light video camera, a video time inserter, a video recorder, and a power supply. Our goal is to have up to four groups observing each occultation from different locations. Juniata currently has one complete occultation timing system, and we aim to establish two more mobile setups as well as a timing setup for use at the Paul E. Hickes Observatory, a permanent observatory on the Juniata campus that houses a 16-inch telescope. Each occultation timing system will consist of a Supercircuits PC164CEX-2 low light camera, an OWL focal reducer and adapter for the telescope, and an IOTA Video Time Inserter. The two mobile systems will also require their own telescopes, for which we will use the Meade ETX80 which comes with a backpack setup for field observations, as well as their own portable power supply, the Celestron 12 amp-hour PowerTank. To record the captured video we will use JVC digital camcorders owned by the Physics Department. There exist a number of freely available web resources such as OccultWatcher for predicting upcoming occultations and LiMovie for data analysis.

On the night of an occultation, SPS will send three groups to predetermined locations spread across the predicted shadow path. The surrounding area in central Pennsylvania provides several sites for observation such as the College-owned Field Station on Raystown Lake approximately 25 km away. If the occultation's shadow path is close enough to the Juniata College campus, the Paul E. Hickes Observatory will be used as a fourth observation location.

Each group will independently locate the star and measure the timing of the occultation event, recording the star field that includes the occulted star to video tape for several minutes before and after the event. Occultations are typically brief, just a few seconds to perhaps one minute in duration. The video will be analyzed using LiMovie software, which extracts the brightness of the star frame-by-frame. When combined with the GPS timing information overlaid on the video by the video time inserter, the start and end of the occultation can be determined to within $1/30^{th}$ of a second. Timing

data from the three or four Juniata groups is enough to establish the rough shape of the asteroid. The results of all timing observations will also be submitted to IOTA, where it will be combined with observations of the same occultation by all observers along the shadow path in order to produce a more detailed cross sectional outline of the asteroid.

Juniata College's SPS chapter is an extremely involved and close-knit community of students whose enthusiasm is reflected in Juniata's continual inclusion in the list of SPS Outstanding Chapter Awards for the past 12 years, despite the small size of our school and department. Juniata is devoted to graduate school preparation and undergraduate research, and providing equipment for a research project such as this that has the potential to continue for several years will be instrumental in providing more hands-on undergraduate experience to our students in areas of planning, proposing and carrying out an experiment. The requirement for multiple teams to concert their efforts from separate locations will involve many members of the chapter in coordination, data collection, and data analysis, and will serve as an excellent team-building exercise for students in the department. Furthermore, since this project entails breaking up into multiple groups, only one group at a time could have our faculty advisor with them to help record the event. This means that the other teams will need to utilize their troubleshooting and problem solving skills without the crutch of a professor while under a time crunch, and from our past experience, there are plenty of problems that can arise when trying to record an observation. This will build self-sufficiency and individual responsibility in a research setting.

Observations of occultations can begin as soon as the equipment is purchased. Using the asteroid occultation predictions from OccultWatcher for the year 2012 as our baseline, we expect to be able to observe around eight to twelve occultation events during 2013.

Bibliography:

[1] Nugent, R. *Chasing the Shadow: The IOTA Occultation Observer's Manual.* 2007.

[2] Buchheim, R. *The Sky is Your Laboratory.* 2007.

[3] Occult Watcher 3.2: http://www.hristopavlov.net/OccultWatcher/OccultWatcher.html


SPS
Why Major in Physics?

Budget:

Item	Cost
Supercircuits PC164CEX-2 Low Light Camera (x3)	$420.00
OWL Focal Reducer & Adapter (x3)	$150.00
Celestron 12 AH Powertank (x2)	$120.00
IOTA GPS Video Time Inserter (x3)	$750.00
Meade ETX80 Telescope (x2)	$520.00
Total:	$1,960.00