



Variable Star Discoveries for Research Education at Phillips Academy



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ABSTRACT

The discovery and publication of unknown variable stars by high school students is a highly engaging activity in a new hands-on research course developed and taught by Caroline Odden at Phillips Academy in Andover, Massachusetts. Students use *MPO Canopus* software to recognize candidate variable stars in image series typically recorded for asteroid rotation studies. Follow-up observations are made using the 16-inch DFM telescopes at the Phillips Academy Observatory and at the HUT Observatory near Eagle, Colorado, as well as with a remote-access 20-inch at New Mexico Skies Observatory near Mayhill, New Mexico. The Catalina Sky Survey can provide additional photometric measurements. Confirmed variables, with light curves and periods, are submitted to the *International Variable Star Index* and *Journal of the American Association of Variable Star Observers*. Asteroid rotation studies are published in *Minor Planet Bulletin*.

CATALINA SKY SURVEY DATA ARCHIVE

- The Catalina Sky Survey Data Release 2 consists of photometry from seven years of images taken with CSS telescopes. The project provides open-access to all archival photometry.
- When coverage is available, this resource provides students with immediate feedback regarding their candidates.
- Students are amazed that such a resource exists – what a wonderful introduction to the power of using public astronomy archives!

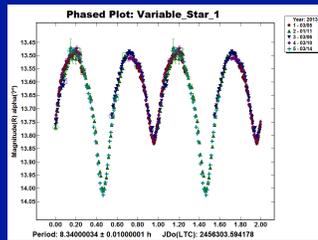
PHILLIPS ACADEMY VARIABLE STAR DISCOVERY TEAM



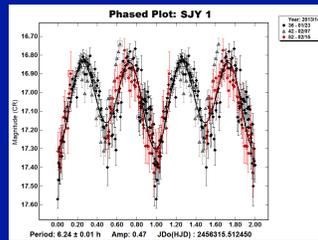
Ji Seok Kim, Emily Zhu, Seokjun Yoon, Isabel Taylor, and John Little pose with the Phillips Academy telescope. These five students are a subset of the Astronomy Research Class.

RECENT DISCOVERIES

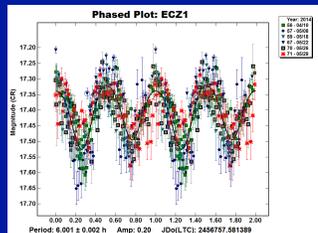
- The light curves shown below were generated from images taken at PAO and HUT Observatories.
- Three are registered to the International Variable Star Index (VSX), and a fourth will be submitted soon.
- In addition to submitting discoveries to the VSX, students use this resource to ensure that potential discoveries are not already known to be variable.
- Image series from asteroid rotation studies typically last from six to eight hours, and this introduces a selection effect to the process. In order for students to notice variability, it must occur over short timescales. As a result, most discoveries are of short period variables.
- Many discoveries are likely contact binaries, but three intrinsic variable candidates have been uncovered.



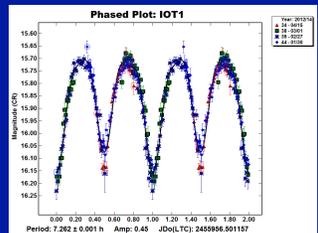
Discovery by Ji Seok Kim
Registered in the VSX as 2MASS J06420747-1809146



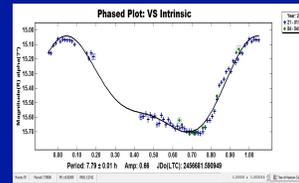
Discovery by Seokjun Yoon
Registered in the VSX as 2MASS J06310775-1938577



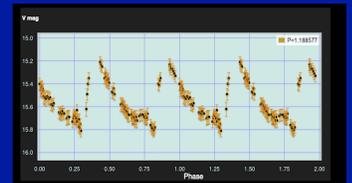
Discovery by Emily Zhu, to be submitted to the VSX



Discovery by Isabel Taylor and John Little
Registered in the VSX as 2MASS J07174816+0900096



Potential variable lightcurve produced by Seokjun Yoon, using images from Phillips Academy Observatory



Follow up lightcurve of the same source, produced from photometric measurements available through Catalina Sky Survey Data Release 2

COLLABORATION

Among telescopes that have been used to support the new research course at Phillips Academy is a 20-inch f/6.8 PlaneWave set up at New Mexico Skies Observatory by David Mittelman and operated remotely. Another telescope that is supporting student discovery and publication is the 16-inch DFM at HUT Observatory near Eagle, Colorado. John W. Briggs of HUT Observatory facilitates student access to data from both facilities. Although the telescope control system is different between the 16-inch at Phillips and the 20-inch at New Mexico Skies, ACP software for remote access is used at both locations.



View of 20-inch PlaneWave at New Mexico Skies near Mayhill, New Mexico. This dome is one of 14 similar structures at New Mexico Skies Observatory.



Exterior view of HUT in Eagle, Colorado.

WE NEED YOUR IMAGES!

- Our students have searched through all of Phillips Academy Observatory's image archive, and they want more!
- In the coming months, we plan to establish a web portal through which observatories may contribute batches of images for variable star scanning. This project is supported by the Andover Institute.
- Contributing observers will be listed as co-discoverers in all submissions to the International Variable Star Index (VSX), and will be invited (but not required) to participate in follow-up observations.
- Please consider contributing to this project, which is inspiring great enthusiasm among high school students.

THE 2013-2014 ASTRONOMY RESEARCH GROUP

Students completed variable star work in the context of the Astronomy Research Course. This science elective provides motivated high school students with an opportunity to pursue independent astronomy research goals. Projects included scanning for strong gravitational lenses in Dark Energy Survey Verification Data (in collaboration with Dr. Thomas Diehl, Fermilab), asteroid rotation studies, meteor studies, and spectroscopy. Odden is also a mentor teacher for the NASA/IPAC Teacher Archive Research Program (NITARP), through which she and her students are working on a project to isolate sources of infrared excess in the new Spitzer Enhanced Imaging Products (SEIP) catalog.



ACKNOWLEDGEMENTS

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