STEM Scholars 2019 ASC Projects

Row 4

Research Group	Lovell
Project Title	**Astronomical Source Brightness Variations in Digital Optical Images**
Research Question, Hypothesis, or Conjecture	The specific research question will depend on the student's project selection, so in the questions below "astronomical sources" would be replaced with a particular object or class of objects (pulsating stars, eclipsing binary stars, rotating asteroids, galactic nuclei): How do astronomical sources vary in brightness and on what timescales? How do brightness variations relate to the underlying physics (temperature, reflectivity, size, rotation, magnetic fields, etc.) of the observed astronomical body? [e.g. How does the shape and spin rate of an asteroid influence its lightcurve? How do differences in size and temperature of binary stars predict the total brightness during eclipses?]
Project Description	Astronomical sources are large and astronomical distances are vast, which means that astronomy is unlike most other sciences where sources and subjects can be studied first-hand in a laboratory. Astronomers study the light variations - known as a lightcurve - from remote objects to assess the underlying physics of the object being studied. This project is focused on the monitoring of brightness variations of astronomical sources, as observed with professional astronomical telescopes approximately 1m in diameter. The telescopes are available for remote operation under Agnes Scott's membership in the Southeastern Association for Research in Astronomy (SARA), and the selected student will learn to operate the telescopes to acquire high-quality astronomical images. The student will be responsible for planning and executing the observations as well as carrying out the image processing and data analysis. The observations may be carried out during late afternoons, evenings, and weekends, according to the telescope time allocations. The student will determine sources which are accessible for the telescope, given the date, time, location, and observational capabilities of the system in use. Once appropriate sources are identified, the student will make an observing plan for which object(s) will be observed, with what filters and exposure lengths, at which times. The student will also design an appropriate sequence of calibration images to account for variations within the camera chip, local temperatures and sky conditions. Once the images are acquired, the student will apply calibrations and identify appropriate comparison stars to enable the production of a light curve. In collaboration with mentors, the student will carry out an observing project of their own design, drawing on both new observations during the summer and archival images from past faculty and student projects. Potential targets would be active galactic nuclei, pulsating variable stars, eclipsing binary stars, exoplanetary transits, binary asteroids, or irregular asteroids. By studying the changes in brightness, whether periodic, semi-periodic, or unpredictable, the student will determine the period of variations, if applicable, and compare the lightcurve to predicted behavior and offer hypotheses

	for the underlying causes of the variations. This analysis may be used to determine the spin rate or orbital period of an asteroid or binary pair, to constrain relative temperatures of two stars that are seen to eclipse one another, or to estimate the size of an active region within a galaxy. Along with answering a specific research question of the student's choosing, the project will emphasize the development of professional astronomical skills such as observation planning, curation of source lists, identifying sources in an archive, keeping detailed records and comparing with expectations from other published results.
Introductory References	The Remote Observatories of the Southeastern Association for Research in Astronomy (SARA), Keel, W., et al., Publications of the Astronomical Society of the Pacific, 129:015002 (2017)
Project Timeline (weekly)	Weeks 1-2 Orientation to the telescopes, how to make observations, and how to do basic data analysis; background reading for potential projects Weeks 2-3 Project selection, observing sessions Weeks 4-5 Assessment of what is in the archives for the selected targets, literature review, observing sessions (according to the SARA time allocation not yet released for July) Weeks 6-8 Continue observations, Data analysis and interpretation, Write up results
Expected Learning Outcomes	The student will operate remote astronomical telescopes safely. The student will plan observations and successfully acquire appropriate science and calibration images. The student will produce calibrated lightcurves from telescopic images. The student will make and test predictions for brightness variations based on published results and expectations from basic physics.
Research Team	This project involves two faculty mentors who will work as a team with the student. The working environment is non-standard because telescopic observations will require work in the evenings and overnight. The telescopes are accessible via internet connection from computers at Bradley observatory. The student should be comfortable working with computers and software, and working late into the evening or overnight (on these occasions, the student would not be expected to work the following morning!)
PI Last Name	Lovell
PI FirstName	Amy
PI Email	alovell@agnesscott.edu
Department	Physics & Astronomy
4 or 8 Week Project	8 weeks
Project Dates	Jun 1 - Jul 31, 2019
# of full-time student positions requested (1-3)	1
Novice Requirements	The student should have completed AST 120 (Intro to the Solar System) or AST 121 (Galaxies and Cosmology)
Advanced Requirements	

Recommended Preparation	AST 200L