THE UNIVERSITY OF ARIZONA
COLLEGE OF SCIENCE
Astronomy
& Steward Observatory

Spring 2018 Undergraduate Research Opportunities

Name: **Dr. Nathan Smith**
Office: N514
Contact Info: nathans@as.arizona.edu

Title: **Observational studies of Supernovae**

Summary: Observational research on supernova explosions, massive star eruptions, massive star evolution, and star forming regions. Students can be involved with observing using Arizona's optical/infrared telescope facilities, as well as reducing and analyzing optical and infrared data taken with these telescopes and the Hubble Space Telescope. Our goal is to try to understand the violent death throes of massive stars by constraining the physical properties of their explosions, progenitor stars, and the local environments in their host galaxies using the change in time indicated by their imaging photometry and spectroscopy. A wide range of different research projects are available; contact Prof. Smith if interested.

Name: **Dr. Michael Lesser**
Contact Info: lesser@itl.arizona.edu

Title: **UA Imaging Technology Laboratory**

Summary: (US citizens or permanent residents only; paid positions possible)
There are multiple undergraduate opportunities to work on imaging sensors at the UA Imaging Technology Laboratory (ITL; located off-campus near Broadway and Euclid). Projects include development, fabrication, and programming of cameras for telescopes, CCD and CMOS sensor testing, image processing software development, LSST sensor characterization support, and hands-on research activities related to scientific sensors. See www.itl.arizona.edu for ITL info.

Name: **Dr. Gijs Mulders**
Office: LPL Kupier 425
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Title: **Statistical signatures of atmospheric evaporation and gas accretion in the Kepler exoplanet population**

Summary: The Kepler spacecraft has revolutionized our view of exoplanet systems by discovering more than four thousand planet candidates orbiting close to their host stars. The sizes of these planets are set by accretion and evaporation of gaseous envelopes during and after planet formation. While direct observations of planet atmospheres are sparse, a statistical analysis of planet radii can be used to glance information on planet atmospheres.

In this project, we will use EPOS, the Exoplanet Population Observation Simulator, to constrain the planet radius distribution at different distances from the star. The goal of the project is to connect these distributions to different formation and evolutionary models of exoplanets.

An interest in exoplanets, statistical methods, and python programming is preferred.

Name: **Dr. Dara Norman**
Office: NOAO
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Title: **Feeding Virgo: Measuring Stars and Star Formation in Filament Galaxies**

Summary: It has been known for a long time that star formation within galaxies in the densest regions of the universe, galaxy clusters and groups, is suppressed relative to the general population. Very recently, the community has turned its attention to the filamentary network that feeds clusters and groups, and initial results show that star formation is suppressed in these environments, as well. If true, this could pinpoint filaments as the site where galaxies first encounter environmental effects.

The proposed project is part of a collaboration with Rose Finn (Siena College) and Vandana Desai (IPAC/CalTech) to study the stellar masses and star formation rates of a sample of filament galaxies near the Virgo cluster. Goals of the project will be to measure and compare stellar masses using SDSS optical and WISE IR data and star formation rates using Galex UV and WISE IR data. The project is highly modular in that the student will be able to pursue any or all of the science goals as time permits. The galaxy sample that this project will use is part of a larger project and there will be opportunities for the UA student to work remotely with other students from Siena College, possibly including an observing run at the KPNO 0.9m. Time to observe H-alpha for a sample of these galaxies has already been awarded for the spring (mid-March). It would be helpful if the student has coding experience (especially Python) but NOT necessary.

Name: **Dr. Monika Soraisam**
Office: NOAO Room 118
Contact Info: soraisam@noao.edu (Office: 520-318-8425)

Title: **Real-time Classification of Variables and Transients Using Optical Data**

Summary: The near future is touted to see the richest astronomical yield in the time domain through several large surveys (e.g., the Zwicky Transient Facility and the Large Synoptic Survey Telescope sweeping the optical sky).

The proposed project is one of the priority development works of the ANTARES collaboration, whose goal is to build a data-analysis system operating in real-time between the alert data (representing changes in the imaged night sky) produced by telescopes and the broad astronomical community to facilitate rapid follow-up of rare and novel events. It will annotate the alerts with useful information (e.g., archival observations from different wavelength regimes) that will help assess their novelty/rarity, and subsequently assign priority ranks for follow-up. The fact that some of the most interesting of these events are going to be short-lived (e.g., the electromagnetic counterparts of gravitational wave alerts) necessitates the execution of this assessment as quickly as possible (typically within a minute or less).

The building blocks of ANTARES comprise the software system and highly efficient algorithms for processing the alerts. The software architecture is already up and running, and we are presently focusing on designing algorithms for fishing out the rare and novel events.

In this project, we will explore one algorithm for characterizing novelty—the unknown un-known. The algorithm is based on using the most basic properties of the alerts that will be available to us, namely changes in magnitudes over given intervals in time, thereby avoiding expensive computations, but being supported by a robust statistical analysis. An essential part of this project is understanding and building a library of the various known types of stellar variabilities in the night sky and utilizing this library as a touchstone, to judge/score the novelty. We plan a publication out of this project, and the student(s) is (are) expected to contribute significantly to it.

There are three goals we envisage the student(s) to achieve through this project;
• learn about the different types of stellar variability phenomena, diving into active time-domain research,
• obtain hands-on experience with various machine learning tools, and
• gain an insight into the operation of ANTARES and its various supplementary components.

Requirements:
• programming experience in python
• interest in time-domain astronomy and computational and statistical tools
• familiarity with MySQL (preferred)

Name: **Dr. Eric Pearce**
Office: N514
Contact Info: epearce@email.arizona.edu

Title: **Space Situational Awareness (SSA)**

Summary: (Paid position). Students have multiple opportunities to support our Steward Observatory Space Situational Awareness (SSA) team. This team strives to develop and adapt astronomical techniques and instruments to the challenging task of detecting and characterizing man-made objects in Earth orbit. Students will help operate and process photometric data from a 3-channel very high speed photometer on the 61" Kuiper telescope. Specific tasks include the planning, collection, calibration, processing, and interpretation of multi-color photometric data of both astronomical objects and man-made satellites. All code will be in Python and camera operation is in the Windows 10 environment. With the team's other instrument, a portable small wide field of view telescope, we need observing assistants to help with the deployment and operation of the telescope. This telescope will be monitoring night sky brightness and light pollution at our four observatory sites surrounding Tucson, and performing astrometric/photometric surveys of the sky to measure man-made satellites.

Name: **Dr. Paul Gabor**
Office: VATT Office
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Title: **VATT Telescope Support**

Summary: (Paid position). The Vatican Observatory announces a seasonal, part-time paid position as **on-site telescope support** at VATT on Mt Graham during remote observing runs, and especially during the upcoming VATT-PEPSI-TESS survey. The latter will take place for 50 consecutive nights on May 27 - July 15, 2018, and is similarly scheduled for 2019 and 2020. Multiple candidates are sought to share the work. On-site support entails: opening and closing the telescope in the evening and morning, resp.; monitoring the weather and lightning risks with view of performing a shut-down when required; assisting telescope engineers with diagnostic and corrective measures (in case of telescope failure, on-site support calls the engineer on duty and provides him with on-site assistance). Required: tolerance of altitudes (10,500ft), telescope operator experience (ASTR302 as a minimum).

Name: **Dr. Lucy Ziurys**
Office: CSB 109
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Title: **The Expected Chemistry in Planetary Nebulae**

Summary: This project involves the study of complex molecules in planetary nebulae, the final stage of stellar evolution. Robust chemistry apparently occurs in these objects despite the strong ultraviolet radiation fields present in them. The project will concern observations at the telescopes of the Arizona Radio Observatory of new molecules that might be present in these nebulae, their distributions and abundances, and examination of the processes that produce and preserve them. Of particular interest are the Butterfly, Dumbbell, and the Necklace Nebulae.