

NEW PLANETARY SCIENCE OPPORTUNITIES IN THE DEPARTMENT OF PHYSICS AND ASTRONOMY AT NORTHERN ARIZONA UNIVERSITY. M. Salvatore, N. G. Barlow, C. S. Edwards, D. Koerner, M. J. Loeffler, T. D. Robinson, S. C. Tegler, C. A. Thomas, D. E. Trilling, and C. A. Trujillo. Dept. Physics and Astronomy, Northern Arizona University, Flagstaff, AZ 86011-6010. mark.salvatore@nau.edu.

Introduction: The Department of Physics and Astronomy at Northern Arizona University (NAU) in Flagstaff, AZ, has recently expanded its astronomy and planetary science research and academic programs. The combination of spectacular geology and dark skies make northern Arizona an excellent location for both geological- and astronomical-based planetary science research. NAU has provided a strong undergraduate astronomy program for many years and recently expanded its academic offerings by implementing a PhD program in Astronomy and Planetary Science.

NAU Planetary Science Faculty and Research Programs: The Department of Physics and Astronomy has added six new planetary science faculty members in the past two years in support of the new PhD program. This brings the number of planetary science faculty to 10 and has greatly enhanced the department's research profile. The Department's planetary science research falls into the following four categories:

Surface Processes: Nadine Barlow, Christopher Edwards, and Mark Salvatore conduct research on remote sensing of planetary surfaces using visible, topographic, and infrared datasets from various spacecraft missions. The primary focus is Mars but we also have interests in the geologic evolutions of other solar system bodies and terrestrial analog studies.

Laboratory Studies of Planetary Materials: Mark Loeffler and Stephen Tegler conduct laboratory studies of how the space environment affects planetary materials. This includes the effects of temperature on the spectral properties of icy and non-icy samples and the role of radiation and thermal processing in the compositional evolution of planetary surfaces. In addition, Mark Salvatore's lab investigates terrestrial rock samples from various environments as analogs for the spectral properties of martian surface materials.

Observational Studies of Small Solar System Bodies: Stephen Tegler, Cristina Thomas, David Trilling, and Chad Trujillo utilize a variety of ground-based and space-based telescopes in observational studies of small solar system bodies. These studies involve the search to detect previously unknown bodies in the outer solar system and the composition, physical properties, and dynamics (and associated impact hazards) of asteroids, comets, and Kuiper Belt Objects.

Exoplanet and Planetary Formation Studies: David Koerner and Tyler Robinson lead our exoplanet program. Their research includes the study of planet for-

mation in circumstellar debris disks, detection of exoplanets around low-mass stars, and modeling of exoplanet atmospheres.

Many of these research programs involve the technique of comparative planetology—for example, Dr. Robinson uses the atmosphere of Venus to inform his modeling of exoplanet atmospheres. Our studies also have applications to other areas of planetary research, such as astrobiology. Lastly, Drs. Edwards and Salvatore are Participating Scientists on the Mars Science Laboratory Curiosity rover mission and Dr. Thomas is a collaborator on the OSIRIS-REx mission.

NAU PhD in Astronomy and Planetary Science: The NAU Department of Physics and Astronomy implemented a new PhD Program in Astronomy and Planetary Science in Fall of 2016. Four students matriculated in the 2016-2017 academic year and another four students accepted admissions offers for the 2017-2018 academic year. We are currently reviewing applications for admission to the program in Fall 2018. Our PhD is nominally a 5-year program, with the first two years focused on completing course requirements, a written and oral comprehensive exam by the end of the 5th semester, and a focus on dissertation research for the last three years. Students are admitted into the program on either a teaching or a research assistantship, and several of our students have received additional financial support through the NAU Graduate College Presidential Fellowship Program. The course curriculum is currently undergoing a significant revision as the areas of faculty expertise has expanded significantly over the past two years. In total, students are required to complete eight courses (four required and four electives) with significant flexibility based on student interests. For more information about the PhD program, please visit the program's website at www.physics.nau.edu/AstroPhD.shtml or contact any of the faculty members directly for the most up-to-date information

Students are only admitted for matriculation in the Fall semester. The application deadline for priority admission consideration is December 1 of each year, while the regular application deadline for admission to the PhD program is January 1.

Unique Aspects of the Program: NAU and the Flagstaff area have a lot to offer to students and researchers interested in planetary science. Some of the unique advantages offered in conjunction with our program are the following:

Terrestrial Analog Sites: Northern Arizona is a prime location for field studies of terrestrial analogs for features on other planetary bodies. Meteor Crater (**Fig. 1**), Grand Canyon, the San Francisco Volcanic Field, Grand Falls and its sand dune field, and various slot canyons provide excellent opportunities for in situ studies relevant to planetary geology research.

Telescope Facilities: NAU is a partner in Lowell Observatory's 4.3 m Discovery Channel Telescope (DCT), which is located about an hour south of Flagstaff in the dark sky location near Happy Jack, AZ. NAU also has access to the various telescopes of the University of Arizona Observatories, including the two 6.5 m Magellan telescopes in Chile and the 2 x 8.4 m Large Binocular Telescope and 6.5 m MMT telescope in southern Arizona, as well as numerous smaller telescopes. Faculty and students recently built the Thermal Infrared Planetary Science Imager (TIPSI) to conduct infrared observations using NAU's Barry Lutz 0.5 m campus telescope, restoring this observatory to one of its original uses: demonstrating the feasibility of conducting infrared observations from Earth's surface.

Laboratory Facilities: The NAU Department of Physics and Astronomy is home to several research labs, including the Astrophysical Ice Lab, Terrestrial Analog Sample Lab, PEAXS (Processes, Environments, and Astrochemistry on Extraterrestrial Surfaces) Research Lab, Optics Lab, and Planetary Instrumentation Lab. In addition, we recently opened the Mars Rover and Analysis Operations Center from which Christopher Edwards, Mark Salvatore, and their postdocs and students participate in the operation of the Curiosity rover. The Operations Center is adjacent to Edwards' instrument development and spectroscopy laboratory where he is working with the United Arab Emirates Mohammed bin Rashed Space Centre, the Laboratory for Atmospheric and Space Physics at the University of Colorado Boulder, and Arizona State University to develop a thermal infrared spectrometer to fly to Mars on the upcoming Emirates Mars Mission (EMM).

Other Resources on Campus: NAU Astronomy and Planetary Science researchers collaborate with faculty in NAU's School of Informatics, Computing & Cyber Systems (SICCS), School of Earth Sciences and Environmental Sustainability (SESES), and Department of Biological Sciences. They also utilize NAU's High Performance Computing cluster for a range of investigations.

Connections with Local Research Institutions: Three other astronomy/planetary science facilities are located in Flagstaff: the US Geological Survey Astrogeology Science Center at the USGS Flagstaff Campus, Lowell Observatory, and the US Naval Observatory

Flagstaff Station. The NAU Department of Physics and Astronomy has strong connections with all of these institutions, and scientists at the USGS Astrogeology Science Center and Lowell Observatory often advise our students on research projects. Collaborations between these institutions are facilitated through the Northern Arizona Planetary Science Alliance (NAPSA), of which the NAU Department of Physics and Astronomy is a founding member [1].

Summary: Northern Arizona University's Department of Physics and Astronomy is dramatically expanding its opportunities in the area of planetary science research for students, postdocs, visiting scientists, and faculty. For more information, please visit our website at www.physics.nau.edu/ or contact any of the authors of this abstract.

References: [1] Hagerty J. J. et al. (2018), *LPSC 49*, this meeting.

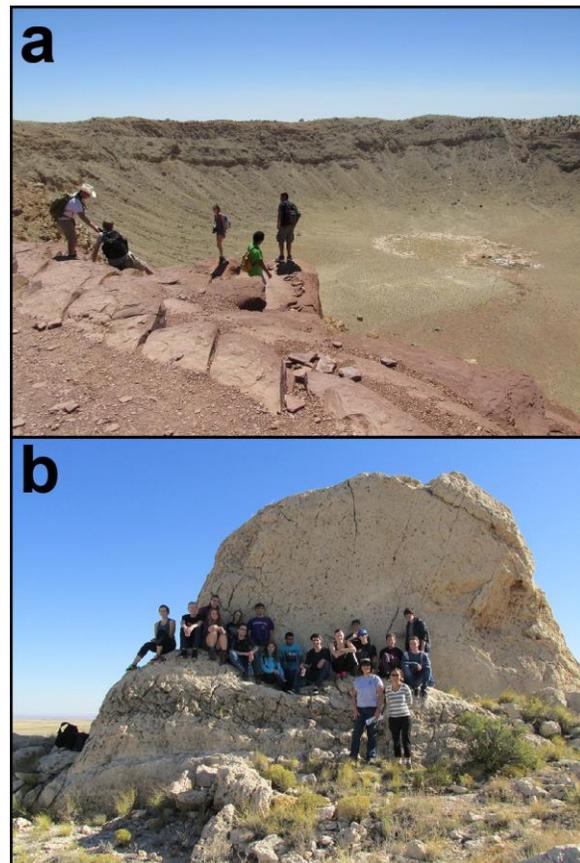


Figure 1. (a) NAU students along the rim of Meteor crater, which is located less than 40 miles from NAU's Flagstaff campus. (b) Students pose for a picture with "House Rock," a ~10 m tall block of ejecta along the rim of Meteor crater.