JPL SIRI INTERNSHIP ANNOUNCEMENTS OF OPPORTUNITY
FALL 2022
(Subject to change without notice)

AO #: 13769
Project: Raman Spatial Heterodyne Spectroscopy - Astrobiology

Background
Raman spectroscopy is a valuable technique for planetary exploration because it is sensitive to organic and inorganic compounds and able to unambiguously identify key spectral markers in a mixture of biological and geological components. Sample manipulation is not required in Raman spectroscopy and any size of a sample can be studied without chemical or mechanical pretreatment. NASA and ESA are considering the adoption of miniaturized Raman spectrometers for inclusion in suites of analytical instrumentation to be placed on robotic landers on Mars in the near future to search for extinct or extant life signals. There are many reviews about the advantages and limitations of Raman spectroscopy for the analysis of complex specimens with relevance to the detection of bio- and geo-markers in extremophilic organisms which are considered to be terrestrial analogs of possible extraterrestrial life that could have developed on planetary surfaces.

Description
We have developed a miniature spectrometer, Spatial Heterodyne Spectrometry, that can achieve high spectral resolution at high throughput in compact formats. The student would investigate Raman biosignatures suitable to be studied with our Raman Spatial Heterodyne Spectrometer onboard small robots in future astrobiology applications.

Background, Skills, Courses
Raman Spectroscopy, Optomechanical engineering, Chemistry, Biology

Major(s): Planetary Science, Physics/Applied Science

AO #: 13744
Project: 174 - Open Source Rover Innovative Development

Background
The 174 Division is responsible for AI, Analytics, and Innovative Development within JPL's IT Directorate. A few years ago, we developed and mobilized an Open Source Rover (OSR) community. Our home page is https://opensourcerover.jpl.nasa.gov/#!/home

Description
We are looking for dynamic and entrepreneurial undergrad interns to join our team and push the boundaries of the OSR further. Specific scope for fall activities will be tailored to each intern’s skillsets, experiences, and interests. However, the main thrust of the internship will be focused on developing a familiarity with the OSR platform (mechanical, electrical, and software) and finding a unique and innovative capability to develop and ultimately publish to the OSR community. Example activities have been but are not limited to - design and 3D print your own components, swap out compute or other hardware to support a more complex function, infuse 174 developed or other Open Source AI/software into the rover to improve autonomy or performance, etc. You will have access to and become familiar with our team, our tools, and so much more as you help ideate and deliver the next iteration of new capabilities to the OSR.

Description
We have developed a miniature spectrometer, Spatial Heterodyne Spectrometry, that can achieve high spectral resolution at high throughput in compact formats. The student would investigate Raman biosignatures suitable to be studied with our Raman Spatial Heterodyne Spectrometer onboard small robots in future astrobiology applications.

Major(s): Mechanical Engineering, Electrical Engineering and Computer Science

AO #: 13734
Project: Mapping of Martian Araneiforms and their Environments

Background
Araneiforms are ~meter-wide tortuous branched negative topography features that are found in the Martian south polar regions. Three main types of araneiforms have been identified: (1) small furrows (meters-long isolated troughs) that form and disappear annually along the edges of many dune margins and crests [Bourke & Cranford 2011; Bourke 2013]; (2) the enigmatic ‘spiders’ which consist of usually radial networks of troughs, spanning diameters from meters up to 1 km) that do not appear to grow in the present day [Piqueux et al. 2003; Portyankina et al. 2017]; and (3) a few dendritic features observed to form over multiple Mars years [Portyankina et al., 2017] with complexity between that of the furrows and spiders. All of these features have been proposed to be formed due to basal sublimation of the seasonal CO_2 ice, with gas scouring troughs in the substrate as it escapes through a point of weakness in the ice [Mc Keown et al., 2021]. Starting from the assumption that all of these araneiforms are forming through the same general process, our science research group will develop and test hypotheses about how specific environmental conditions drive their formation.

Description
The student intern will work with Dr. Lauren Mc Keown within Dr. Serina Diniega’s research group. Student work will primarily be to map and gather measurements of araneiforms and their local environments, based on inspection and analysis of Martian orbital datasets within JMARS (a free GIS program). These measurements will be used to divide the features into categories based on shape, size, and activity. Then we will check for correlations between categories and specific geology/topography and winter-time frost conditions.

Background, Skills, Courses
Most of the work will involve close visual inspection of spacecraft-acquired images of Mars. Thus, this work is appropriate for students new to research; with an appreciation for detail-oriented, somewhat monotonous, mostly brain-exercising work; and an interest in geology and/or planetary science and in seeing how a research project is designed. This project does not require specific background knowledge or skills, beyond basic computer comfort. When permitted by time and the student’s skills, work can be expanded to incorporate the student’s specific interests (such as simple data analysis). The mentor welcomes applications from students from diverse backgrounds and skill sets.

Major(s): Planetary Science, Remote Sensing, Geomorphology

AO #: 13731
Project: Welcome to Our Metaverse Support

Background
Welcome to Our Metaverse is an umbrella effort to bring immersive AR/VR/XR technologies into the JPL workday, under the new post-COVID 19 paradigm of hybrid remote and on-site work. Increasingly, hybrid teams are running into the limits of existing collaboration tools, such as web conference and chat platforms, and immersive technologies may provide a solution -- but where and how to best incorporate these technologies is an area of active research.

Description
The intern will assist the Welcome to Our Metaverse team with researching, testing, and evaluating the use cases for incorporating state of the art immersive AR/VR tools into collaborative work environments and processes.

Background, Skills, Courses
Interest in and experience with AR/VR technologies, interest in and experience with behavioral research, team dynamics and change management

Major(s): Computer Science, Sociotechnical Research

AO #: 13727
Project: Mars exploration - documentation

Background
The Mars Exploration Program Analysis Group (MEPAG) serves as a community-based, interdisciplinary forum for inquiry and analysis to support NASA Mars exploration objectives. MEPAG is responsible for providing the science input needed to plan and prioritize Mars exploration activities. To carry out its role, MEPAG organizes public meetings to gather information and conduct specific studies to address issues and analyze proposed future activities. Based on those activities, MEPAG documents goals, objectives, investigations, and required measurements for the robotic and human exploration of Mars. Updates in response to discoveries and community input are captured in the MEPAG "Goals Document". The four overarching MEPAG goals for the exploration of Mars and its moons are: Goal 1. Determine if Mars ever supported life Goal 2. Understand the processes and history of climate on Mars Goal 3. Understand the origin and evolution of Mars as a geological system Goal 4. Prepare for human exploration

Description
The student will be working with the MEPAG office to create and update the database for all the MEPAG documentations used by the MEPAG Steering Committee to provide overall leadership. These documents are supported by input from the broad Mars community and a MEPAG Goals Committee that maintains the MEPAG Goals Document. The outcome of this project would be used in the updated version of the MEPAG website.

Background, Skills, Courses
Interest in Planetary and Earth science

Major(s): Planetary Science, Physics

AO #: 13709
Project: Analysis and Archiving of Near and Mid-Infrared Observations of Jupiter & Saturn

Background
Images and spectra of Jupiter and Saturn from visible, near- and mid-infrared instruments are sensitive to temperatures, abundances of a major condensate (ammonia) opacity of clouds and the variability of the molecular para vs. ortho-H2 ratio. These define the fundamental state of the atmosphere and constrain its dynamics. This research will focus on observations obtained from a variety of instruments used at large professional telescopes: NASA's Infrared Telescope Facility, Gemini North and South Telescopes, ESO's Very Large Telescope, and the Subaru Telescope, and the Juno mission images of Jupiter in reflected sunlight from the JunoCam instrument. The general objective of the specific tasks below will be to create fully reduced data from unreduced or partially reduced sets. In some cases, our objective is to format the data for input into an atmospheric retrieval code from which atmospheric properties will be derived.

Description
Several specific topics are available: 1. Analyze images made by the JunoCam imaging instrument on the Juno mission. To some extent, each of these tasks may require work with a transformation of the images to a latitude-longitude map using "ISIS3" software supplied by the US Geological Survey. A task associated with any of the following science goals could be automating this process. 1a. Understanding the dynamics of Jupiter's high northern latitudes. Search for sequential JunoCam observations near the north polar region with time dependence in order to determine the wind field of this region and the degree to which Jupiter's winds flow east-west to something different, possibly chaotic, but with a component of east-west prevalent winds. 1b. Search for and measure hazes in Jupiter's atmosphere, i.e., particles lying above Jupiter's main cloud deck. This will include the following, each of which could be a separate research task: (I) Identify clouds near Jupiter's dusk region that appear to have different shapes or positions that are wavelength dependent, creating a "rainbow" appearance. (ii) Identify persistent hazes, their level of transparency and changes in their morphology between successive Juno orbits to determine a velocity. Where possible, verify their appearance in a special filter that is sensitive to high-altitude particles. (iii). Survey JunoCam images of Jupiter's horizons to detect and measure "detached" haze layers. 1c. Continue previous work in the first 20 orbits of the Juno mission to detect and measure small-scale waves in Jupiter's atmosphere to increase statistical evidence for their latitudinal distribution and association with larger features. 2. Archive images of Jupiter made in support of the Juno mission. To fulfill contractual obligations to NASA, we need to archive our infrared imaging of Jupiter from various instruments from the last four years of mid-infrared images and two decades of near-infrared images with NASA's Planetary Data System (PDS). These data must be accompanied by required ancillary files in a specific PDS format. The goal of this work is to collect copies of the images and related files into a single location with a specific nomenclature and submit these to review by the PDS. Aspects of this work could be done concurrently with other student work on the long-term variability of Jupiter. 3. Reduce near-infrared images of Jupiter. We will be acquiring a large volume of observations of Jupiter that are designed to support observations from instruments on the Juno spacecraft. We want to reduce the data

and, to the extent possible, analyze the results. There are several objectives in this broad category. 3a. Develop quasi-automated software for reducing near-infrared imaging observations. The basis of this software exists in the Interactive Data Language (IDL), but the order of operations must be reversed at one stage and a subtracted pair of images must be reversed at another stage. 3b. Develop software for combining Mercator maps derived from images taken at different times as the planet rotates; use these to create full maps of Jupiter over all longitudes, as well as to polar project those maps – for example - to investigate correlations between different phenomena in the neutral atmosphere and the aurora. 3c. Create an absolute calibration of the reflectivity of these images by referencing the flux from measured standards stars. Compare this with a calibration scaled to spacecraft observations of the near-infrared spectrum. 3d. Measure the distribution of cloud properties in the atmosphere with near-infrared reflectivity, including high-resolution adaptive-optics stabilized images. Use these data to characterize the chemistry and dynamics of the atmosphere, associated with specific atmospheric features e.g., polar hazes, the Great Red Spot and its environment, their evolution and their relationship with temperatures and winds. 3e. Reduce scanned spectral observations of Jupiter that create a hypercube of data (two dimensions of imaging and one of wavelength), deriving spectra at each pixel of the slit. Analyze these for properties of clouds and hazes, comparing them with models. 4. Examine the long-term variability of longitudinally averaged temperatures and other properties in Jupiter to create accurate and self-consistent calibrations of all data from a variety of telescopes. Extend a current program to input longitudinally averaged data over Jupiter's full disk to include observations at facilities where only a northern or a southern hemisphere of Jupiter could be captured. Format these data to be an input to an atmospheric retrieval program. Organize the output of this program to enable rapid plotting and correlation with previous studies and between different retrieved atmospheric properties.

Background, Skills, Courses

The data reduction programs are written in the Interactive Data Language (IDL, which is close to Matlab in format). The analysis code is written in FORTRAN. At least rudimentary knowledge of these (or willingness to learn before the beginning of the research) is highly recommended. Some programming experience is required. With a significant level of contribution, students are welcomed as co-authors on papers emerging from this research.

Major(s): Planetary Science, Astronomy/Astrophysics, Computer Science

AO #: 13707
Project: Exoplanet Watch

Background
NASA's Universe of Learning's Exoplanet Watch is a citizen science project, currently geared toward amateur astronomers and astronomy students at colleges and universities, to observe transiting exoplanets — planets outside our solar system — with small telescopes. A transiting exoplanet is a planet outside of our solar system that periodically passes in front of its host star, causing the star to appear to slightly dim (typically by ~1%). Observing exoplanet transits is important, as they provide direct measurement of a planet's radius and composition. Ground-based observations, particularly with small telescopes (<1 meter) constrain the exoplanet's orbital period (how quickly a planet orbits around its host star) which in turn provides better mass measurements. Exoplanet Watch will help increase the efficiency of exoplanet studies by large telescopes to characterize exoplanet atmospheres by reducing uncertainty about the predicted timing of transit events.

Description
The interns will largely work on developments to the EXOTIC data analysis code for the professional astronomy community. Such tasks include leading the development of a paper describing in detail our data reduction and analysis code EXOTIC by providing an in-depth analysis of some archival data, contributing Exoplanet Watch data to the ExoFOP to increase its visibility and use by the professional astronomy community, and help feed back to the NASA Exoplanet Archive missing parameters and units.

Background, Skills, Courses
Python3 proficiency

Major(s): Computer Science, Physics, Astronomy, Engineering