JPL SIRI INTERNSHIP ANNOUNCEMENTS OF OPPORTUNITY
Fall 2021
(Subject to change without notice)

AO# **12188**
Project: **Seismic Activity and Fault Mapping on Venus**

Background

A goal for possible future missions is to measure seismic activity on Venus. A prediction of seismic activity is needed to motivate such a mission, and requires detailed mapping of observable faults. Fault characteristics can lend insight to the style and magnitude of deformation occurring on the surface of Venus. Venus's surface is densely faulted, and these faults are visible as bright lineations in radar imagery from the Magellan mission. Some of these faults are included in regional-scale geologic maps, known as quadrangles. The planet is divided into 62 total quadrangles, and 33 of these quadrangles have geologic maps published by the U.S. Geological Survey. These geologic map quadrangles include geologic structures, units, and surficial features, but the maps vary in the details included – for instance, some authors have broken down fault types into more categories than others (e.g., Bender et al., 2000; McGill, 2000; Bethell et al.). Commonly, authors tend to categorize lineaments into groups as follows: graben, lineament, radial lineament, ridge, tessera (extensional or compressional), trough, and wrinkle ridge. Maps published more recently tend to have digitized maps that are easier to access.

Description

The goal of this project is to calculate a fault density for a reasonably small area, and to extrapolate that density to a larger area. Because these quadrangles are regional-scale, they often include brighter (and possibly larger) faults, but ignore the less bright lineations. In reality, Venus's surface is so densely covered in lineations that it is impossible to map them globally. The student's goal will be to map all the lineations in a limited area, and to categorize the them as extensional or compressional faults, where possible.

Background, Skills, Courses

Geology, plus ArcGIS or similar mapping experience

Major(s): Earth Science, Planetary Science, Geology, Computer Science

AO# 12186

Project: Development of data processing tools for direct imaging of exoplanets with the James Webb Space Telescope

Background

High contrast imaging is a challenging but promising technique to detect exoplanets and characterize their atmospheres. The main limitation of the high contrast imaging instruments is the presence of speckles, which find their origin in wavefront imperfections. These speckles create systematic errors that are extremely difficult to calibrate. Strategies of speckle cancellation are usually based on a calibration of the speckle intensity in the focal plane [Sparks et al. 2002, Marois et al. 2006, Soummer et al. 2012, Lafrenière et al. 2017]. As a consequence, crucial prior information inferred from our knowledge of the instrument is not used as an input for post-processing. Conversely, the Medusae (Multispectral Exoplanet Detection Using Simultaneous Aberration Estimation) technique [Ygouf et al. 2013] is based on an analytical model of multispectral coronagraphic imaging and an inversion algorithm. It estimates jointly the instrumental aberrations and the object of interest, i.e., the exoplanets, in order to separate properly these two contributions. The inversion algorithm is based on a maximum-likelihood estimator, which measures the discrepancy between the data and the imaging model. It is then possible to retrieve directly from the focal plane images, an estimation of the aberration map and of the position and flux of the planets.

Description

This project is part of an on-going effort to prepare direct imaging observations of exoplanets with the James Webb Space Telescope (JWST), which will be launched in 2021. The student will work with Dr. Ygouf and Dr. Beichman to develop simulation and post-processing tools in python to prepare for the analysis of coronagraphic data. In particular, the Medusae algorithm, initially developed in IDL in the context of coronagraphic imaging with the SPHERE planet finder on the VLT, has recently been successfully applied on simulated images of the JWST NIRSpec IFU [Ygouf et al. 2017] and JWST NIRCam [Ygouf et al. 2020]. We are currently developing a simplified version of this code in python and applying it to simulated images of the JWST NIRCam instrument. Possible tasks will depend on the student skills/preferences and include: - simulation of realistic JWST observing scenarios - implementation of optimization tools for wavefront reconstruction from simulated data - implementation of data analysis tools to estimate exoplanet photometry and astrometry from post-processed simulated data

Background, Skills, Courses

Post-processing for high-contrast imaging, excellent coding skills, knowledge of python is preferred, strong willingness to learn.

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

AO# 12172
Project: Deep Learning and Artificial Intelligence

Background

The Intelligent Sensor Processing Object Recognition & Tracking Systems (iSports) Lab in Bio-Inspired Technologies & Systems Group (349B) is conducting research in Deep Learning for automatic object recognition, speech recognition, image understanding and Artificial Intelligence (AI) for assisting first responders to avoid accidents. The research is directly applicable to autonomous guidance of spacecraft landing/docking/rendezvous, hazard avoidance for Rovers, and AI assistant for astronauts.

Description

The candidates will help train intelligent computer programs to automatically detect, recognize, and track objects from various data sources. The AI assistants help the robots and autonomous vehicles to understand the environment, and perform autonomous maneuvers.

Background, Skills, Courses

Critical thinking, creativity, curiosity, good communication skills, C/C++, Python, TensorFlow, Torch, Caffe, etc.; Courses: normal undergraduate math, electrical and computer engineering Useful, but not required: knowledge of image processing, neural networks, computer vision.

Major(s): Electrical Engineering, Computer Science, Computer Engineering, Applied Math

AO# 12147
Project: Developer

Background

The Occupational Safety Program Office is redeveloping OSHA legally required training. Development of these courses provide hazard awareness to help ensure our workforce goes home safely every night.

Description

With guidance from a JPL mentor, the intern will use a template to create online courses using Adobe Captivate and step-by-step job aides using SnagIt and Microsoft Word.

Background, Skills, Courses

Required Qualifications: · Strong written and verbal communication skills and ability to work in a team environment Desired Qualifications: · Experience using Adobe Captivate, Microsoft Word, and Microsoft PowerPoint

Major(s): Information Systems/Technology

AO# 12129

Project: **Analysis and Archiving of Near- and Mid-Infrared Observations of Jupiter and 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 Sciences

AO# 12107
Project: Advanced Low SWaP Sphinx-Based Payload Electronics

Background

Sphinx, a low-SWaP rad-hardened capable avionics technology for deep space mission, has been developed at JPL and is infused to for the SHS instrument electronics system.

Description

Students will work with the mentor and other team members to build the prototype of the Sphinx-based instrument electronics subsystem that may be flown in Blue Origin or other Lunar rover missions. The internship will include hardware board schematic design, layout, and analysis; FPGA firmware development, embedded software development, platform benchmarking, application software development, and integration, test software enhancement, and the system integration and document.

Background, Skills, Courses

Good communication skills, self-motivation. Circuit analysis using PSpice. Hands-on familiarity with instruments such as oscilloscopes, logic analyzers, etc. Python programming will be a plus. Embedded software system development. Coursework: Standard coursework in EE/CE majors with the following emphasis: Circuit Analysis, Digital System Design, Programming Languages, Operating systems, Signals and Systems, Digital Signal Processing, Computer Networks, etc.

Major(s): Electrical Engineering, Computer Engineering, Aerospace/IT, Computer Science