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

AO# 12466
Project: Miniaturize Spectrometer - electronic design

Background
The majority of the NASA missions are looking for water and ocean worlds inside and outside our Solar System. Studying the creation of water and its transfer in the Solar System contains information about the evolution of Solar System and how did water end up on the Earth. One of the approaches to study where the water on Earth came from is by studying spectral signatures from water such as Lyman-alpha, OH, and OD/OH ratio on various objects in the Solar System. However, these spectral signatures are very faint and a very difficult measurement to make, often require in situ bulky spectrometers to be sent to the astronomical bodies with spacecraft. In our lab at JPL, we develop a new generation of technologies that has the capability to make such measurements remotely using small aperture telescopes from ultra-compact instruments. These spectrometers are in the size of a shoebox or a sneaker bar (!00) but have the sensitivity of a 5-meter telescope for observing a targeted spectral signature.

Description
We have multiple ongoing instrument development projects that require electrical engineering/computer science/computer engineering. We have a project to fly our breadboard spectrometer on a Blue Origin Rocket in summer 2021 and test our instrument by making measurements from Earth, Äôs atmosphere as the rocket goes up to +80 km altitude and returns to Earth. We also have a few mission concept studies for studying planetary and astrophysics targets from SmallSats and CubeSats as well as onboard of large spacecrafts. Under this announcement of opportunity, the student(s) will develop the electrical breadboard and data handling software package for the spectrometer given a set of requirements and work on the vibration and thermal analysis to ensure the instrument, Äôs survival and performance after launch and in flight. Depending on the background of the student (s) they can also be involved in reviewing the electrical interfaces and system requirements and system integration strategy and process.
The student will be responsible to take notes and document the process of working and progressing between groups in JPL and other companies.

Background, Skills, Courses
Electrical engineering and analysis Programming, Electronics design and coding, Machine learning

Major(s): Electrical Engineering, Computer Science

AO# 12465

Project: Lunar water exploration

Background

Studying the creation of water and its transfer in the Solar System contains information about the evolution of the Solar System and the process by which water ended up on Earth. For that reason, the majority of NASA missions are looking for water and/or ocean worlds inside and outside our Solar System. One of the approaches used to study the origin and evolution of water on Earth comes from studying spectral signatures of water, such as OH, and OD/OH ratio spectral signatures in near UV and Lyman-alpha. This presents a challenge to the observer because these spectral signatures are very faint and difficult to measure, often requiring in situ, bulky spectrometers are sent to the astronomical bodies in space by spacecraft. In our lab at JPL, we are developing a new generation of technologies that are capable of making such measurements remotely using small aperture telescopes from ultra-compact instruments. These spectrometers smaller than the size of 1 U CubeSat (10 cm x 10 cm x 10 cm) but have the sensitivity of a 5-meter telescope for observing a targeted spectral signature.

Description

We are running multiple ongoing projects considering multiple instruments to investigate lunar water and resources that require Lunar data analysis from previous lunar missions. Under this announcement of opportunity, the student(s) will develop software to participate in analyzing the lunar data given a set of requirements. Depending on the background of the student(s), they can also be involved in reviewing the mission concept requirements and operation scenario for taking the science data from the lunar surface as well as the orbit. The student(s) will be responsible for taking notes and documenting the work and progress between groups.

Background, Skills, Courses

Astronomy, Planetary Science, Lunar science, Python programing

Major(s): Planetary Science, Computer Science

AO# 12463

Project: Cloud and Precipitation Radar Development

Background

Weather radars are remote sensing instruments capable of detecting different hydrometeors (rain, hail, snow, etc), their spatial distribution and motion. Radar data can be used to determine structure of clouds and storms and, hence constrain weather and climate models.

Description

The goal of this research project is to assist with the development of CloudCube project. CloudCube is a multi-frequency millimeter-wave (Ka-, W- and G- band) radar system that uses an architecture that will result in small mass, power and size. The student,Äôs project will consist of designing individual millimeter-wave components using SolidWorks or/and EM simulator (HFSS), characterizing of these components in the lab and participate in outdoor testing of the radar.

Background, Skills, Courses

Good knowledge of Python, FPGA, UNIX/Linux and computer programming. Student should be familiar with basic principles of microwave engineering

Major(s): Electrical Engineering, Computer Science

AO# 12461
Project: Small Satellite Deployable Structure Intern

Background
Typically, when rockets are launched, the spacecraft needs to fit in a small rocket fairing. But once it gets into space, the spacecraft needs expand, or deploy antennas and solar arrays to do its mission. This internship will focus on research related to cutting edge space deployable structures.

Description
This internship has a few key tasks, depending on if the student is available for remote or in-person participation. The first task is assisting with managing a Small Satellite Deployable Structure Database. The results from this database will be written into a research paper. The second task, which may be CAD related or in person prototyping (if available) is to develop highly accurate deployable hinges, using kinematic mounts. The end result of the second task could be a virtual porotype, or a physical prototype, depending on the student's availability.

Background, Skills, Courses
Mechanical Engineering, Machine Design, CAD

Major(s): Mechanical Engineering, Aerospace Engineering

AO# 12459
Project: OCO-2 Operations Data Analysis

Background

The Orbiting Carbon Observatory 2 Project launched on July 2, 2014 on a two-year mission to measure CO2 from space. The Science Data Operations System (SDOS) is a key part the data return process. The SDOS extracts science data from the returned data stream and prepares higher-level products for the public. With an increasingly complicated processing pipeline and a year-long processing campaign coming along, SDOS Operations needs more insight into the efficiency of our processing as well as more ways to monitor the data processing quality.

Description

This project will augment the OCO-2 Science Data Operations System with tools to help us with analyzing our processing metrics and data quality. This will help us during our reprocessing campaign when we are trying to make the most efficient use of our computing resources and making sure all the computers are busy and not idle. We will be leveraging the Elasticsearch, Logstash, Kibana and Python Jupyter notebooks to collect, organize, and visualize our data processing metrics as well as the QA flags associated with our products.

Background, Skills, Courses

Self-starter, Linux or technical background, Python literacy, good communication skills, experience with data analysis and data plotting, Desired: familiarity with AWS, GitHub, JSON/XML, Elasticsearch, Logstash, Kibana, regular expressions,

Major(s): Computer Science, Information Systems/Technology

AO# 12458
Project: Planetary Analogs for Electromagnetic Exploration of Planetary Subsurfaces

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
The student will conduct either modeling, analysis, interpretation or a combination of thereof of either GPR or TEM data from analog sites on Earth.

Background, Skills, Courses
Courses in electromagnetism and/or geologic sciences is a plus. The student may need to use Matlab, Python, or ArcGIS.

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

AO# 12456

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, Lafreni√®re 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# 12454
Project: Mechanical Design of Integrated Oscillating Heat Pipes

Background

Heat pipes are devices capable of effective thermal conductivities orders of magnitude higher than traditional conductive materials. They achieve this by using a constrained volume of working fluid, which is controlled to be able to transition between the liquid and vapor states. By allowing the fluid to transform from a liquid at the hot end, flow migrate to the cold end as a vapor, and then condense, the latent heat of vaporization can be used to transfer heat. Once the vapor has condensed, it needs to be transported back to the hot end as a liquid; this is where much of the difficulty in designing, manufacturing, and optimizing heat pipes lies. Traditional heat pipe technologies use a porous wick to provide capillary forces to pump the liquid back towards the hot end. Oscillating heat pipes (OHPs) are a relatively new variant of heat pipes, having only first been created a few decades ago. Instead of utilizing a wick to pump the liquid phase, they consist of alternating slugs of liquid and vapor in a long, serpentine channel. Localized heating creates more vapor at the liquid/vapor interface, creating high pressure, which then pushes on the liquid creating flow. Similarly, when the vapor loses heat some vapor will condense, depositing a large amount of energy, creating a low pressure region, and pulling the fluid in the tubing. They are traditionally created by manual bending & welding of a hypodermic tube into a long serpentine structure, and then brazed, epoxied, or otherwise fastened to the structure. This technique is difficult, laborious, and inefficient both thermally and for effective uses of mass. JPL has developed a method to integrate these heat pipes directly into additively manufactured structures, enabling all sorts of conformal geometries never before achievable. Systems have been tested with thermal conductivities in excess of 40,000 W/m-K.

Description

While OHPs are a phenomenal tool, the process of actually integrating their design into structures is still non-trivial. The student will develop solid models with integrated OHPs and perform FEA analysis on their mechanical properties for a number of specific point designs. In addition, the student will document best practices and workflows for how to best create similar models for future iterations. Strong solid modeling experience is preferred.

Background, Skills, Courses

Computer Aided Design (CAD), Finite Element Analysis (FEA), Solid Mechanics, Solidworks, NX

Major(s): Mechanical Engineering, Aerospace Engineering

AO# 12447
Project: Europa Clipper - Payload Office

Background
NASA's Europa Clipper spacecraft will conduct a detailed survey of Jupiter's moon Europa to determine whether the icy moon could harbor conditions suitable for life. The spacecraft, in orbit around Jupiter, will make about 40 to 50 close passes over Europa, shifting its flight path for each flyby to soar over a different location so that it eventually scans nearly the entire moon.

Description
We are looking for an enthusiastic systems-thinker who would enjoy working with our science and instrument teams to help gather evidence that the Europa Clipper payload is meeting its requirements as a Payload Verification and Validation Intern. This project may involve supporting tests performed in the system testbed (writing test plans, developing test cases, running tests, analyzing test data, and supporting data reviews), resolving problems that are identified during testing (helping to track down problem failure report closures, supporting engineering change requests or waivers necessary to close gaps), and developing code/tools to help track progress, identify errors or gaps, and improve efficiencies for our verification leads.

Background, Skills, Courses

Major(s): Aerospace Engineering, Systems Engineering, Computer Science

AO# 12437
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‚Äôs Infrared Telescope Facility, Gemini North and South Telescopes, ESO‚Äôs 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 ‚ÄúISIS3‚Äù 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‚Äôs 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‚Äôs 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‚Äôs atmosphere, i.e. particles lying above Jupiter‚Äôs main cloud deck. This will include the following, each of which could be a separate research task: (i) Identify clouds near Jupiter‚Äôs dusk region that appear to have different shapes or positions that are wavelength dependent, creating a ‚Äúrainbow‚Äù 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‚Äôs horizons to detect and measure ‚Äúdetached‚Äù haze layers.
1c. Continue previous work in the first 20 orbits of the Juno mission to detect and measure small-scale waves in Jupiter‚Äôs 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‚Äôs 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 ‚Äì 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‚Äôs 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# 12434

Project: Data analysis of batteries for Deep Space missions

Background

Future missions to the outer planetary moons will likely require energy provided by non-rechargeable batteries. These batteries must survive a long cruise time followed by exposure to radiation prior battery usage. Our group is studying the effects that long-term storage and radiation exposure have on battery performance. We are generating large raw data sets from several different experimental test protocols that require efficient analysis to reveal trends in the performance of the battery.

Description

The student will work with the JPL mentors to develop data analysis techniques including writing Excel macros to help the research team manage the data sets, and to effectively search for trends in the experimental data.To collect more supporting data for this research, the student may be expected to conduct electrical or materials testing of primary battery cells, if lab access is permitted.

Background, Skills, Courses

Preferably students who have completed at least one course of calculus, statistics, and have familiarity with programming languages ie Visual Basic (VBA) and Matlab.

Major(s): Computer Science, Mathematics, Chemistry/Chemical Engineering

AO# 12432

Project: Fast Texture Segmentation using Deep Learning

Background

One of the key drivers of the Mars Exploration Program is the search for evidence of life. The relevant Martian environments to study are those that are associated with liquid water. The process of finding such features on Martian terrain requires development of robust segmentation methods that can evaluate very large number of images and identify those with the features of interest. To automatically locate these features on Mars surface we use deep learning models on HiRISE image set. HiRISE is a large data set (>40TB) covering about 5% of Mars surface.

Description

This project will focus on development and optimization of deep learning models to process the full HiRISE image data. The student intern will learn optimization methods, deep learning-based segmentation, and implement solutions on GPU-based computing clusters.

Background, Skills, Courses

Required: Strong background in statistics, optimization, deep learning, compute clusters, machine learning concepts. Working understanding in image processing and computer vision algorithms. Fluency with Python, SKLearn, SKImage, TensorFlow and/or PyTorch, Docker, Anaconda. Strong communication and writing skills.

Major(s): Computer Science, Mathematics, Deep Learning / Machine Learning

AO# 12426
Project: Mars Data Analysis

Background
The Jet Propulsion Laboratory is seeking highly motivated undergraduate students to participate in Mars data analysis focused on information returned by the Mars Global Surveyor, Mars Odyssey, the Mars Reconnaissance Orbiter spacecraft, the Mars Exploration Rovers, the InSight lander and the Mars 2020 rover and helicopter. Data to be studied will be from the Mars Orbiter Camera (MOC), Mars Orbiter Laser Altimeter (MOLA), Thermal Emission Spectrometer (TES), Thermal Emission Imaging System (THEMIS), High Resolution Imaging Science Experiment (HiRISE), the Context Imager (CTX), and instruments of the Mars Exploration Rover Athena Science Payload, the InSight lander and the Mars 2020 rover and helicopter.

Description
Work will be directed at characterizing the geology and safety of candidate landing sites for future Mars missions, including the Mars Sample Return. Safety issues focus on quantification of slopes of concern for landing safely in potential landing sites and traverses using MOLA data and digital elevation models from stereo images. Work will also be related to measuring rocks on the surface of Mars from orbit, in flight and on the surface and understanding their context. This will include analyzing rocks visible in high-resolution HiRISE images and quantifying their size-frequency distribution to better understand landing safety. InSight work will involve mapping geological features observed in the surface images such as craters, eolian bedforms, rocks, and soils. HiRISE and CTX images will also be georeferenced to lower resolution images (CTX, THEMIS) and topographic maps (MOLA). Additional work may include analyzing craters on Mars to investigate rock distributions in their ejecta, how they change with time and their morphologic state as well as the geomorphology as a clue to the subsurface geology. Terrains, rock abundance, slopes and trafficability of notional traverses between Jezero crater and northeast Syrtis to assist Mars Sample Return landing and sample retrieval may also be studied.

Background, Skills, Courses
Most of the work will be done on personal computers utilizing mixed operating systems (Windows and Macintosh), so experience with them is important. The ability to measure and tabulate rocks, place the data into standard spreadsheets, and plot the results is required for the work on rock distributions. Experience with ArcGIS mapping software (10.x), especially georeferencing imagery, is preferred as our landing site data is specifically formatted to work with this GIS package. Additional knowledge of Integrated Software for Imagers and Spectrometers (ISIS 3.x), SOCET SET, or Matlab software would be a plus. Preference will be given to students with backgrounds in geology or planetary science and other related disciplines such as geographic information science, physics, chemistry, astronomy, engineering, and computer sciences. They may be supervised by one or two research scientists and may also work alongside other researchers and students.

Major(s): Planetary Science, Earth Science

AO# 12424
Project: Europa Clipper Planetary Protection Flight Implementation Support

Background
The icy moons of Jupiter, Callisto, Europa, and Ganymede, may harbor environmental conditions conducive to extraterrestrial life. NASA is embarking on an orbiter mission to characterize the surface of Europa to understanding the hypothesized presence of surface oceans, key chemical elements, and a source of chemical energy. The orbiter will provide insights about Europa,Äôs native composition and implications for life. To ensure the orbiter will not contaminate Europa for current and future missions, the spacecraft undergoes microbial cleaning along with cleanliness from any organic contamination that might affect the in-situ investigations for bio-signatures.

Description
The objectives of the proposed project, are to i) support Europa Clipper sampling activities from spacecraft surfaces, ii) store and identify cultivable microbes collected from Europa Clipper spacecraft surfaces. Additional projects aimed at the improvement of current Planetary Protection procedures and/or investigations of new technologies may be included as time permits.

Background, Skills, Courses
Microbiology background with experience in microbial labs, filtration methods, microbial techniques, and working with live cultures. Experience with performing verification/validation process and data analysis.

Major(s): Biology/Bioengineering, Chemistry/Chemical Engineering, Microbiology

AO# 12419
Project: Space Radiation Effects Test Automation

Background
To make space missions a reality, the electronics that go into space must be able to endure its harsh environment. For many technologies, the effect of radiation on electronics is a driving risk. The processes and practices that are needed to ensure that a mission is successful include disciplines like electronic engineering, device physics, computer science, and material science. Solutions for space range from using electronics design for space, called ‚Äúrad hard‚Äù, to the latest commercial technology one might find in a cell phone or laptop. Assuring that radiation does not affect these electronics, or the systems in which they reside, is the craft of radiation effects engineering.

Description
This internship would focus on the application of basic laboratory skills aimed towards optimizing the operation of the Component Engineering and Assurance Office labs. The applicant would work with radiation effects engineers to develop/implement hardware and software test support. The effort will include work in the radiation effects‚Äô Single Event Effect and/or Dynamitron groups.

Background, Skills, Courses
Embedded Systems, C/C++, Python, Matlab, LabView, FPGAs, Xilinx ISE, Vivado, SDK, Verilog/VHDL, PCB layout, schematic capture, soldering, familiarity with lab equipment (DMMs, Oscilloscopes, Signal Generators, Power Supplies). Junior or Senior undergraduate.

Major(s): Electrical Engineering and Computer Science, Physics/Applied Physics