<table>
<thead>
<tr>
<th><strong>AO ID:</strong></th>
<th>4354</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Title:</strong></td>
<td>Comet Hitchhiker: mechanical analysis of ultra-velocity impactor with small celestial bodies</td>
</tr>
<tr>
<td><strong>Desired Number of Participants:</strong></td>
<td>1</td>
</tr>
</tbody>
</table>
| **Background Information:** | The Comet Hitchhiker concept is literally to hitch rides on comets to tour around the Solar System. This concept is implemented by a tethered spacecraft that accelerates or decelerates itself without fuel by harvesting kinetic energy from a target body. First, the spacecraft harpoons a target as it makes a close flyby in order to attach a tether to the target. Then, as the target moves away, it reels out the tether while applying regenerative brake to give itself a moderate (<5g) acceleration as well as to harvest energy. This idea can be intuitively understood by the analogy of fishing. Imagine a fisherman on a small boat tries to catch a big fish that runs at a high relative speed. Once the fish is on a hook, the experienced fisherman would let the line go while applying a moderate tension on it, instead of holding it tightly. If the line has a sufficient length, the boat can eventually catch up with the fish with moderate acceleration. This concept brings three novel capabilities: 1. Fuel-less landing and orbit insertion. We estimate that a comet hitchhiker spacecraft can obtain up to ~10 km/s of delta-V by using a carbon nanotube (CNT) tether. This level of delta-V enables a spacecraft to land on/orbit around long-period comets and Kuiper belt objects (KBOs), which have not been even visited by any spacecraft yet. With existing technologies only a fly-by is realistic for these targets. 2. Non-gravitational slingshot around small bodies. A comet hitchhiker can obtain ~5 km/s of additional delta-V by utilizing just 25% of the harvested energy for reeling in the tether and/or driving electric propulsion engines. The tether is detached from the target after the desired delta-V is obtained. Our concept enables to design a fast trajectory to a wide range of destinations in the Solar System by taking full advantage of the high relative velocity, abundance, and orbital diversity of small bodies. For example, by hitching a comet with q=0.5 AU, a comet hitchhiker can reach the current orbital distance of Pluto (32.6 AU) in 5.6 years and that of Haumea (50.8 AU) in 8.8 years. 3. Deep space energy production. Assuming 25% efficiency of regenerative brake, a 2-ton comet hitchhiker can produce ~25 GJ of energy, which is sufficient to drive an instrument with 1 kW power consumption over 290 days. If future storage device can achieve the energy density of gasoline, 25 GJ can be stored in 500 kg of mass, making it a potential energy source in the outer Solar System. Science missions enabled by the comet hitchhiker concept are not only intellectually exciting but also crucial to achieve a NASA’s strategic goals to "ascertain the content, origin and evolution of the Solar System." Three particular examples of such missions are 1) exploration of primitive bodies, which preserve the chemical composition at the formation of the Solar System, 2) in-depth observation of KBOs, and 3) mapping of the distribution of interplanetary dust particles. All of the three science missions require a level of delta-V in deep space that is impractical or extremely costly using currently available technologies. Our concept brings important advantages over a related concept of
tether-based flyby, which uses a fixed length of tether in order to change the direction of the relative velocity like gravity assist. This concept cannot be used for landing and orbit insertion because it does not reduce the relative speed. The comet hitchhiker concept is distinct in that it reels out a tether while applying regenerative brake force to accelerate itself, and at the same time, to harvest energy. This approach allows the spacecraft to match its velocity with that of the target, and as a result, enables soft landing on and orbit insertion around unexplored bodies such as long-period comets and KBOs. We strongly believe that the comet hitchhiker concept will advance the frontier of space exploration to the most exotic worlds in the Solar System.

Project Description*: The SIRI student will perform simulation analysis of the impact dynamics of harpoon using a finite element analysis software such as ANSYS. The analysis is a part of a NASA-funded feasibility study of the Comet Hitchhiker concept. The student will work with JPL engineers to design and analyze the Comet Hitchhiker's harpoon mechanism, which is to impact a target body at ~10km/s and reliably attach a tether to it.


Suggested/required Background/skills, Courses*: Expertise in ANSYS or other finite element analysis software

Mentor URL (if applicable): https://www.robotics.jpl.nasa.gov/people/Masahiro_Ono/

Mentor Name*: Masahiro Ono

Mentor Section/Org: 347E

Primary Discipline: Mechanical Engineering

Secondary Discipline: 

Other Discipline: 

*end of record*
under Red Hat/ Scientific Linux tasked with recording downlink waveforms to be processed by the software algorithm suite. This task may include C++ development to improve data throughput through the 10GbE network and the port of software to a portable Linux platform. This task may also include the testing a high rate 640Mmps firmware receiver as well as extending its capabilities as the source for the digital recorder.


**Suggested/required Background/skills, Courses**: Required: strong background in electrical engineering, computer science; Experience in Linux, C/C++ and Matlab

Suggested: Verilog / VHDL

**Mentor URL (if applicable)**: Arby Argueta

Mentor Section/Org: 332C

Mentor Badge Number: 130102

Primary Discipline: Electrical Engineering

Secondary Discipline: Computer Engineering

*end of record*

**AO ID**: 4349

**Project Title**: OSPO Regulatory Compliance Support

**Desired Number of Participants**: 4

**Background Information**: The Occupational Safety Program Office (OSPO) develops, manages, and coordinates JPL occupational safety, industrial hygiene/health, hazardous materials, pressure systems, explosives, and health physics (ionizing and non-ionizing radiation) safety programs. OSPO focuses on people, institutional safety practices, external regulatory agency requirements, safety training and safety equipment. Students will gain experience through field work and documentation of events.

**Project Description**: Projects will vary depending on who the intern is paired with. Overall, the intern will receive an overview of the project with goals and metrics to move the program forward, develop a plan and strategy to meet those goals, and coordinate and schedule meetings or site visits with principal investigators or operators with the guidance of their mentors. Such projects will be: High Noise Quantitative Analyses in Mechanical and Laboratory Locations; Identifying, Assessing, and Measuring Exposure Levels in Welding Operations; or Maintaining the Radiation Calibration Program and Evaluating Calibration Data.

**Web or Literature References**: http://www.dir.ca.gov/samples/search/query.htm

http://www.gpoaccess.gov/cfr/index.html
Background Information*: Unmanned Aerial Vehicles (UAVs) are becoming ever more deployed due to their many civilian and military uses. Analyzing imagery captured by cameras mounted on UAVs poses many challenges. JPL is leading a project to gain a deeper understanding of these images. We wish to find objects of interest on the ground, determine what they are, and track them over time. To do this, we will leverage a variety of machine learning and computer vision algorithms.

Project Description*: The student will assist in developing and evaluating algorithms for saliency, detection, classification, and tracking of objects in UAV imagery. The student will gain experience in machine learning and computer vision, including cutting-edge topics such as deep learning.


Suggested/required Background/skills, Courses*: Computer programming skills, especially in MATLAB, Python, and/or C. Computer vision and machine learning experience are a plus, but are not required.

Mentor URL (if applicable): https://www.robotics.jpl.nasa.gov/people/Christopher_Kanan/

Mentor Name*: Christopher Kanan

Mentor Section/Org: 347J

Primary Discipline: Computer Science

Secondary Discipline: Electrical Engineering

*end of record*
<table>
<thead>
<tr>
<th>AO ID: 4346</th>
<th>Project Title*: Mapping water surfaces using radar data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired Number of Participants*: 1</td>
<td></td>
</tr>
<tr>
<td>Background Information*: The Soil Moisture Active Passive (SMAP) mission has the capability to map water surfaces and help water resources management. Prior to the satellite launch in January 2015, we develop and test the algorithms to classify water surfaces. The results of this research will contribute to SMAP’s water detection algorithms.</td>
<td></td>
</tr>
<tr>
<td>Project Description*: Airborne radar data have been collected in Sacramento Delta, California. With these data, the classification and image processing algorithms will be refined to identify inland water surfaces. The outcome may produce publication.</td>
<td></td>
</tr>
<tr>
<td>Suggested/required Background/skills, Courses*: Image processing, machine vision, programming</td>
<td></td>
</tr>
<tr>
<td>Mentor URL (if applicable): <a href="https://science.jpl.nasa.gov/people/SKim/">https://science.jpl.nasa.gov/people/SKim/</a></td>
<td></td>
</tr>
<tr>
<td>Mentor Name*: Seungbum Kim</td>
<td></td>
</tr>
<tr>
<td>Mentor Section/Org: 329C</td>
<td></td>
</tr>
<tr>
<td>Primary Discipline: Computer Science</td>
<td></td>
</tr>
<tr>
<td>Secondary Discipline: Electrical Engineering</td>
<td></td>
</tr>
<tr>
<td>Other Discipline:</td>
<td></td>
</tr>
</tbody>
</table>

*end of record*

<table>
<thead>
<tr>
<th>AO ID: 4344</th>
<th>Project Title*: Monitoring drought using airborne radar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired Number of Participants*: 2</td>
<td></td>
</tr>
<tr>
<td>Background Information*: The Soil Moisture Active Passive (SMAP) mission will provide global soil moisture products that will facilitate new science and application areas (weather, agriculture, flood, drought etc). Prior to the satellite launch in January 2015, we develop and test the algorithms to derive soil moisture using airborne SMAP-like radar instruments. The results of this research will contribute to SMAP's soil moisture algorithms.</td>
<td></td>
</tr>
<tr>
<td>Project Description*: Airborne radar data and in situ soil moisture data were collected in California and the Prairies during recent drought events. With these data, computer models simulating the radar observation will be refined. Soil moisture will be derived using the radar data and will be validation with truth observation. The outcome may produce publication.</td>
<td></td>
</tr>
<tr>
<td>Suggested/required Background/skills, Courses*: Programming, electrical engineering, physics</td>
<td></td>
</tr>
<tr>
<td>Mentor URL (if applicable): <a href="https://science.jpl.nasa.gov/people/SKim/">https://science.jpl.nasa.gov/people/SKim/</a></td>
<td></td>
</tr>
<tr>
<td>Mentor Name*: Seungbum Kim</td>
<td></td>
</tr>
<tr>
<td>Mentor Section/Org: 329C</td>
<td></td>
</tr>
<tr>
<td><strong>Primary Discipline:</strong></td>
<td>Computer Science</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td><strong>Secondary Discipline:</strong></td>
<td>Electrical Engineering and Computer Science</td>
</tr>
</tbody>
</table>

*end of record*

<table>
<thead>
<tr>
<th><strong>AO ID:</strong></th>
<th>4342</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Title</strong>:</td>
<td>Microorganisms Cultured from Mars-Based Spacecraft, characterization and preservation</td>
</tr>
<tr>
<td><strong>Desired Number of Participants</strong>:</td>
<td>2</td>
</tr>
</tbody>
</table>

| **Background Information**: | Mars is considered a likely place to look for extraterrestrial life, given its proximity to Earth, the presence of carbon and other essential major and trace elements, and the presence of water. Energy sources on Mars that could support microbial growth include sunlight, iron, sulfur, H2/CO2 and perchlorate. Of current debate is whether microorganisms can inhabit Mars by surviving the intense radiation, high oxidation potential and extreme desiccation present on the Mars surface. Knowing if microorganisms survive in conditions simulating the Mars surface is paramount because it addresses the issue of whether microorganisms from Earth, traveling on spacecraft, pose a risk to future life detection missions. Archiving of microbial cultures from spacecraft planetary protection implementation assays is a focus of planetary protection efforts at the Jet Propulsion Laboratory (JPL). Currently, the archive facility at JPL contains over 3500 isolates collected during the assembly, testing, and launch operations of pre-flight from Mars-based spacecraft ranging from Viking to the most recently launched Mars Science Laboratory (MSL) and the current InSight Mission. With the exception of the Viking isolates these organisms have been simply stored in the microbial archive for future study. With the early phases of planning for the upcoming challenging planetary protection mission that may be planned (i.e. Mars or Europa life detection or Mars Sample Return) it is essential to understand the identification and types of biochemical and Mars environmental conditions that NASA standard cleanliness assays are detecting. It is also important to update the microbial archive by providing additional biochemical data and sequence data and MALDI-TOF sequence identification for each isolate. Results from this study will yield details about the microbes that have been isolated from the surfaces of pre-flight spacecraft and, on a broader level, will gauge whether microorganisms from Earth have the potential to survive on Mars. Furthermore, the outcome of this study will benefit those involved in the planning of future Mars missions such as the Mars Sample Return Campaign by being able to correlate vast amounts of parallel genetic inventory datasets to NASA Standard Assays. |

| **Project Description**: | The objectives of the proposed project, are to i) subculture and preserve microbes collected from spacecraft surfaces isolated from missions currently being built. ii) identify these isolates using state-of-the-art MALDI-TOF mass spectrometer data. iii) support the operations of the research lab by helping to meet institutional requirements including maintaining an up-to-date chemical inventory and chemical safety library. The Biotechnology and Planetary Protection Group at JPL (BPPG) invites applications to understand the ecology and evolution of microbes cultured from spacecraft surfaces. The student will join an |
Established group of researchers focusing on molecular systematics/population genetics of microbes isolated from various extreme environments. The student will also be involved in the maintenance and enhancement of various microbial collections. Students will be exposed to state of the art molecular microbial techniques, sequencing, bioinformatics, etc.

Web or Literature References*:


Suggested/required Background/skills, Courses*:

- Relevant requirements for the project: Upper Division Junior/Senior, Microbiology, Molecular Biology, Bioinformatics, Biochemistry
- Mentor's research: Microbial Detection; Molecular Microbial Diversity; Extremophiles.

Mentor URL (if applicable):

Mentor Name*:

Wayne Schubert

Mentor Section/Org:

352N

Primary Discipline:

Biology/Bioengineering

Secondary Discipline:

Environmental Science

Other Discipline:

Microbiology, molecular biology

*end of record*

AO ID: 4341

Project Title*:

Operations and Ground Data System Process Modeling

Desired Number of Participants*:

2

Background Information*:

The Mission Systems Engineering section (394) is expanding the use of model-based systems engineering (MBSE) as an approach to capture and improve the processes and products used in developing and deploying mission operations systems (MOS) and ground data systems (GDS) for many of JPL’s flight missions.

Project Description*:

The student will work with the section staff to continue the capture of the processes into a central model using Systems Modeling Language (SysML). This spring the focus will be on capturing the verification, validation, and training methods used to ready the team and the system for launch. The task will involve collecting data from electronic references and subject matter experts, creating model components and views using MagicDraw, and then reviewing the model with the subject matter experts and others. It may also include integrating capabilities of in-
house MagicDraw plug-ins to improve the user interface with, and output products from, the project model. The student will also have the opportunity to contribute to the development of the next generation system that operates spacecraft on planetary missions.

**Web or Literature References**: [http://www.omg.org/spec/SysML/1.2/PDF/](http://www.omg.org/spec/SysML/1.2/PDF/)  

**Suggested/required Background/skills, Courses**: This opportunity is open to students of engineering and computer science. Students MUST be self-motivated, outgoing, possess great interpersonal and communication skills and be able to collect and organize data from multiple sources. Student must have proficiency in Microsoft Word, PowerPoint, and Excel, and at least basic proficiency in a language such as Java. Students must be willing to learn the basics of OMG System Modeling Language (SysML) and the MagicDraw modeling tool.

**Mentor URL (if applicable):**

**Mentor Name**: Robert Smith  
**Mentor Section/Org**: 394B  
**Primary Discipline**: Aerospace Engineering  
**Secondary Discipline**: Computer Science  
**Other Discipline**: Systems Engineering

*end of record*

**AO ID**: 4329  
**Project Title**: Reduction of Thermal Emission Observations of Jupiter  
**Desired Number of Participants**: 2  
**Background Information**: Ground-based observations have been made of Jupiter from ground-based observatories in the middle infrared, where emission emerging from the atmosphere arises from planetary heat rather than reflected sunlight. Observations at a variety of wavelengths can be used to determine temperature structure and cloud distribution, together with the abundances and distributions of minor and trace constituents that serve as indirect tracers of vertical motions. Data collected in the late spring and summer of 2010 will diagnose the merger of two giant vortices (one the size of the Earth with one half as large) as well as the interaction of this merged vortex with Jupiter’s Great Red Spot.

**Project Description**: The primary task of the student will be the data reduction for absolute radiance (including possible comparisons between calibrations based on similarities with spacecraft results and standard-star observations) and assignment of geometry. These programs are written in an application of the Interactive Data Language (IDL). Time may permit the beginning of a task of deriving appropriate atmospheric parameters from the data, in a FORTRAN-based program. An ongoing task will be to fulfill a NASA requirement by archiving the data with its Planetary Data System. (The opportunity also exists for students to participate in the collection of additional data on these interactions in the fall.)


**Suggested/required Background/skills, Courses**: These opportunities should be open to students of physics, astronomy, computer science, or chemistry. Students must have some experience or course work in numerical or visual programming that is well past the routine application of utilities such as Word, Excel and Power-Point, e.g. FORTRAN, C, C++, Matlab. The programs to be used will be applications of source code in the Interactive Data Language (IDL) and FORTRAN.

<table>
<thead>
<tr>
<th>Mentor URL (if applicable):</th>
<th><a href="http://science.jpl.nasa.gov/people/Orton/">http://science.jpl.nasa.gov/people/Orton/</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mentor Name*</td>
<td>Glenn Orton</td>
</tr>
<tr>
<td>Mentor Section/Org</td>
<td>3222</td>
</tr>
<tr>
<td>Primary Discipline</td>
<td>Planetary Science</td>
</tr>
<tr>
<td>Secondary Discipline</td>
<td>Astrophysics ( Old )</td>
</tr>
<tr>
<td>Other Discipline</td>
<td>Computer Science</td>
</tr>
</tbody>
</table>

**AO ID**: 4328

**Project Title**: Reduction and analysis of reflected sunlight from Jupiter.

**Desired Number of Participants**: 2

**Background Information**: Ground-based observations in the visible and near infrared have been made of Jupiter in the late spring and early summer of 2010 that documents the merger of two giant vortices (one the size of the Earth with one half as large) as well as the interaction of this merged vortex with Jupiter’s Great Red Spot.

**Project Description**: The primary task of the student will be the data reduction for absolute reflectivity (including comparison of different calibration approaches) and assignment of geometry. These programs are written in an application of the Interactive Data Language (IDL). The student will then examine the data to determine properties of the clouds in Jupiter, e.g. their thickness and vertical location, the brightness of their particles, and particle size, using a FORTRAN-based code. An ongoing task will be to fulfill a NASA requirement by archiving the data with its Planetary Data System. (The opportunity exists for students to participate in the collection of additional data on these interactions in the fall.)


Suggested/required Background/skills, Courses*: These opportunities are open to students of physics, astronomy, computer science, and chemistry. Students must have some experience or course work in numerical or visual programming well past the routine application of utilities such as Word, Excel and Power-Point, e.g. FORTRAN, C, C++, Matlab. The programs to be used will be applications of source code in the Interactive Data Language (IDL) and FORTRAN.

Mentor URL (if applicable): http://science.jpl.nasa.gov/people/Orton/

Mentor Name*: Glenn Orton

Mentor Section/Org: 3222

Primary Discipline: Planetary Science

Secondary Discipline: Astrophysics ( Old )

Other Discipline: Computer Science

AO ID: 4327

Project Title*: Reduction and analysis of data on thermal emission from Saturn

Desired Number of Participants*: 1

Background Information*: Ground-based images of thermal emission have been made of Saturn for many years. These data are useful for examining the response of the atmosphere to external radiative equilibrium – that is, seasonal atmospheric heating – and to unknown non-seasonal effects. Most of the data have been reduced for thermal emission and assignment of geometry already.

Project Description*: The student’s task will be to complete the reduction of the data to assign absolute radiance values and determine the latitude and longitude of each pixel by applying a program written in the Interactive Data Language (IDL). Subsequently, the student may (1) examine the data record to track differences in atmospheric heating over a long period and compare these with climate models for the atmosphere, (2) track the development of thermal waves in the atmosphere, or (3) track both the persistence and variability of clouds in Saturn’s deep atmosphere. An ongoing task will be to fulfill a NASA requirement by archiving the newest data with its Planetary Data System.


Suggested/required Background/skills, Courses*: This opportunity is open to students of physics, astronomy, computer science, and chemistry. Students must have some experience or course work in numerical or visual programming well past the routine application of utilities such as Word, Excel and Power-Point, e.g. FORTRAN, C, C++, Matlab. The programs to be used will be applications of source code in the Interactive Data Language (IDL) and FORTRAN.

Mentor URL (if applicable): http://science.jpl.nasa.gov/people/Orton/
Mentor Name*: Glenn Orton
Mentor Section/Org: 3222
Primary Discipline: Planetary Science
Secondary Discipline: Astrophysics (Old)
Other Discipline: Computer Science
*end of record*

AO ID: 4326
Project Title*: Hall Thruster Testing and Data Analysis
Desired Number of Participants*: 2

Background Information*: JPL researchers are actively involved in physics-based experimental and computational investigations of electric propulsion systems as applied to deep-space NASA science missions. Active research areas include all aspects pertaining to the operation and service life of electric propulsion thrusters including Hall thrusters, gridded ion thrusters, hollow cathodes, and electrospray thrusters. We are seeking students to assist in two efforts: improving our plasma diagnostic capabilities and analyzing data generated from a Hall thruster experimental campaign conducted at JPL.

Project Description*: For the first effort, a student will assist in upgrading the plasma diagnostics currently installed in our facilities. He or she will work with the mentor to implement new Labview-based controllers for the diagnostics. The student will then participate in a test campaign to verify and debug the new diagnostics. For the second effort, the student will assist the mentor in data analysis from a Hall thruster experimental campaign conducted at JPL. These data are from two primary plasma diagnostics, providing the student with the opportunity to learn about the various tools used in Hall thruster experiments. Through guidance from the mentor, the student will develop data analysis algorithms and methods for the various probe data sets and analyze the results.

Web or Literature References*: http://sec353ext.jpl.nasa.gov/ep/

Suggested/required Background/skills, Courses*: Highly motivated students in Aerospace Engineering, Mechanical Engineering, Physics, or related fields are sought. Prior laboratory and data analysis experience—particularly with Mathematica and Labview—is a plus, but is not required.

Mentor URL (if applicable):
Mentor Name*: Benjamin Jorns
Mentor Section/Org: 353B
Primary Discipline: Aerospace Engineering
Secondary Discipline: Physics/Applied Physics
Other Discipline: Electric Propulsion
*end of record*

AO ID: 4321
Project Title*: Microwave Atmospheric Sounder on CubeSat (MASC)
Desired Number of Participants*: 1

Background Information*: This project is funded under the Strategic Research and Technology
Development program and focused on smaller-cheaper instruments packaged within a Smallsat/CubeSat to provide science retrievals required for monitoring extreme weather events.

**Project Description**: We are developing a 118/183 GHz sounder radiometer that will enable observations of temperature and humidity profiles. The 118/183 GHz system is well suited for a CubeSat deployment as a 10cm antenna aperture provides sufficient spatial resolution (~25km). This project will enable low cost, compact radiometer instrumentation at 118 and 183 GHz that will fit in a small satellite on a 6U Cubesat with the objective of mass-producing this design to enable a suite of small satellites satellites to image the key geophysical parameters that are needed to improve prediction of extreme weather events. We will take advantage of past and current technology developments at JPL viz. HAMSR (High Altitude Microwave Scanning Radiometer), Advanced Component Technology (ACT’08) to enable low-mass, low-power high frequency airborne radiometers. The MASC radiometers are low-power and compact with extensive heritage. The receiver consists of amplifiers, filters, detectors, digitizers, and associated waveguides. The receiver has a low-mass design using a cascade of 35-nm indium phosphide (InP) high-electron-mobility transistor (HEMT)–based low-noise amplifiers (LNAs). In addition, the low power (consumes 20 mW) 65 nm CMOS Analog ASIC that achieves intermediate frequency down conversion and provides I and Q sub-bands at 1 to 8 GHz with 500 MHz bandwidth allows the instrument to meet the CubeSat power budget with sufficient margin after including the power requirements of the CubeSat Avionics elements. The antenna optics consists of the reflector, dual-frequency feedhorn, and calibration target. The reflector rotates continuously at a rate of 30 rpm (2 seconds per scan) to view the Earth at -45° to +45° from nadir, followed by observation of cold space and a warm blackbody calibration target. Basic Tb calibration begins with two-point calibration provided by the 2.7 K cosmic microwave background and warm calibration target with embedded NIST-traceable temperature sensors. During FY-14, we are building and testing the optics, RF components including front-end, Image-reject filter and IF backend including detectors. In addition, we are also implementing and testing a prototype version of the motor, drive electronics and encoder used for the scanning reflector assembly.


**Suggested/required Background/skills, Courses**: Python, Matlab, Skills with using equipment such as Spectrum Analyzer

**Mentor URL (if applicable):**

**Mentor Name**: Sharmila Padmanabhan

**Mentor Section/Org**: 382F

**Primary Discipline**: Electrical Engineering and Computer Science

**Secondary Discipline**: Electrical Engineering
Background Information*: A loop heat pipe (LHP) is a heat transfer technology that can be used to transport large amounts of waste heat from one location to another using capillary force. The joint NASA/CNES program SWOT plans to employ the use of LHPs to control the temperature of instrument hardware to milli-Kelvin levels. This level of temporal stability via LHP thermal control has not been characterized before and is the primary objective of the SWOT LHP testbed.

Project Description*: - Modify/maintain a LabVIEW data acquisition VI that will integrate with the SWOT LHP test bed.
- Integrate/instrument testbed to enable testing in a variety of environments (ambient and thermal vacuum)
- Conduct testing to determine operational characteristics of the LHP under different conditions and scenarios (ambient and thermal vacuum)
- Post-process and analyze test data to determine and understand LHP performance


Suggested/required Background/skills, Courses*: MATLAB, LabVIEW, instrumentation (heater circuits, temperature sensors), testing, heat transfer, fluid mechanics

Mentor Name*: Ruwan Somawardhana
Mentor Section/Org: 353K
Primary Discipline: Mechanical Engineering
Secondary Discipline: Aerospace Engineering
avoid collisions.

**Project Description**: The student will assist in development and testing algorithms for the USV’s perception systems, particularly using computer vision. The student will improve software for detecting and classifying various on-water hazards and surface traffic. The student will run experiments to evaluate the performance of different computer vision algorithms, working with data logged from live USV mission operations in Norfolk, VA.


**Suggested/required Background/skills, Courses**: Software skills, with experience in C and MATLAB. Linux capable. Computer vision experience is a strong plus but not required. Courses in estimation, filtering, probability would be helpful.

**Mentor URL (if applicable)**: Michael Wolf

**Mentor Name**: Michael Wolf

**Mentor Section/Org**: 347E

**Primary Discipline**: Computer Science

**Secondary Discipline**: Electrical Engineering

*end of record*

**AO ID**: 4332

**Project Title**: Mars Data Analysis

**Desired Number of Participants**: 2

**Background Information**: 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, and the Mars Exploration Rovers. Data to be studied will include data 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.

**Project Description**: Work will be directed at characterizing the geology and safety of candidate landing sites for future Mars missions, including the NASA Discovery Program, InSight mission to land on Mars in 2016 and the Mars 2020 Rover. Safety issues focus on quantification of slopes of concern for landing safely in potential landing sites using MOLA data and digital elevation models from stereo images. Work will also be related to measuring rocks on the surface of Mars 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. 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.


Suggested/required Background/skills, Courses*: Most of the work will be done on personal computers utilizing mixed operating systems (Macintosh and Windows), 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. The students will spend most or all of their time at JPL. They can be from Caltech or other universities and may be supervised by one or two research scientists and may also work alongside other researchers and students.

Mentor URL (if applicable): http://science.jpl.nasa.gov/people/Golombek/
Mentor Name*: Matthew Golombek
Mentor Section/Org: 3223
Primary Discipline: Planetary Science
Secondary Discipline: Earth Science

*end of record*

AO ID: 4357
Project Title*: Ice-Ocean Interactions on Europa
Desired Number of Participants*: 1
Background Information*: Many icy satellites are known or suspected to host extensive liquid water oceans under their surfaces. Understanding ice shell thickness and geology gives us clues into the processes that drive interior
oceans, and also provides insight into fundamental physical and chemical phenomena not found on Earth. Jupiter's moon Europa is geologically active, with a highly irradiated surface providing a possible oxidizing source of chemical energy to complement reducing sources from the interior. Europa is perhaps the most promising candidate for extant life, though its neighbors Ganymede and Callisto are also thought to have internal oceans. Saturn's exotic moons Enceladus and Titan probably also have oceans, to say nothing of the moons Uranus and Neptune of the menagerie of icy worlds farther away and around other stars. This project specifically seeks to understand how melting at the ice-ocean interface may affect measurements of Europa's tidal response, and how short-term freeze-melt cycles might lead to habitability at the ice-water interface.

**Project Description**: This project uses freely available FREZCHEM software, in combination with Matlab routines developed by mentor Vance. The student will work with mentors to assess the amount of melt that can be produced on the time scale of Europa's tidal cycle, and how this would affect the 30 meter tidal bulge height that has been predicted if the ice shell is thin.

**Web or Literature References**: http://solarsystem.nasa.gov/europa/home.cfm

**Suggested/required Background/skills, Courses**: Geochemistry, Thermodynamics, Geology, Introductory Planetary Science, Computer Programming

**Mentor URL (if applicable)**: https://science.jpl.nasa.gov/people/Vance/

**Mentor Name**: Steven Vance

**Mentor Section/Org**: 3225

**Primary Discipline**: Planetary Science

**Secondary Discipline**: Chemistry/Chemical Engineering

**Other Discipline**: Astrobiology

---

**AO ID**: 4366

**Project Title**: Tiptoeing towards the nature of dark matter

**Desired Number of Participants**: 2

**Background Information**: Dark matter is an exotic, as yet undetected particle, that in enormous numbers dominates the gravitational component of the universe. On astronomical scales, we can infer many things about the nature of dark matter through the study of strong gravitational lenses.

Gravitational lenses are objects that are sufficiently massive and concentrated, that light from more distant luminous objects ends up forming multiple images. If the background, lensed object is changing its brightness with time, each brightness variation will be seen at different times at each of the images! Measuring these "time delays" very precisely is potentially very powerful for inferring dark matter properties.

Actually measuring time delays like this, involves making many
independent measurements of a gravitational lens, and effectively making a movie of it, to see how the variations of each image may be matched up. Acquiring such data, and then working with it, involves working with many real astronomical images, making challenging photometric measurements with various modeling approaches, and then studying how the light curves correlate. Each of these tasks are critical steps towards ultimate insights into the nature of dark matter.

The process of robustly extracting and then analyzing these "movies" from observations has its own challenges, and that is the focus of this project, as described below.

Project Description*: Our team has been awarded a significant observing campaign with the Las Cumbras Observatory and Google Telescope (LCOGT), to monitor two remarkable strong gravitational lenses, named HE0435, and RXJ1131. We are also acquiring several extremely high precision observations of HE0435 with the European Very Large Telescope, that are synchronized with the LCOGT campaign. These are all ground-based observations, which means that the atmospheric effects will make the visual images an (interesting) challenge to analyze.

This project will involve working with these observations, and determining the optimal way to analyze and interpret them, building on many tools and experience we have in the team. The successful student will primarily work with the observational data and with photometric measurements and calibrations. This will lead to a time-delay analysis of the data, and participation in work to interpret it. Participation (and potentially leadership) in one or more publications is expected.

Web or Literature References*: http://lcogt.net
http://admin.masterlens.org
http://cosmograil.epfl.ch

Suggested/required Background/skills, Courses*: Advanced physics and math (calculus or analysis), and programming experience, ideally with python.

Mentor URL (if applicable): https://science.jpl.nasa.gov/people/Moustakas/
Mentor Name*: Leonidas Moustakas
Mentor Section/Org: 3260
Primary Discipline: Astronomy/Astrophysics
Secondary Discipline: Information Systems/Technology

*end of record*

AO ID: 4363
Project Title*: Testing and documenting open-MBEE
Desired Number of Participants*: 2

Background Information*: The Integrated Model Centric Engineering initiative is developing a software platform to provide capabilities for Model Based Systems Engineering. The platform is an open source project called open-MBEE (Model Based Engineering Environment). open-MBEE is a platform to develop domain specific applications used by systems engineers to support the design, integration, and test of the highly
complex systems developed at JPL.

**Project Description**: The project will involve developing test cases for an existing automated testing framework used to test the open-MBEE platform. This will include interviewing customers and analyzing customer needs to develop appropriate test cases, setting up the framework, developing test case code, and executing it with the framework. It will also involve updating existing user and development documentation for the open-MBEE platform.

**Web or Literature References**: https://github.com/Open-MBEE
https://angularjs.org/
http://www.alfresco.com/
http://en.wikipedia.org/wiki/Jenkins_%28software%29
http://salt.readthedocs.org/en/latest/
http://www.scalr.com/
http://gruntjs.com/

**Suggested/required Background/skills, Courses**: Java, Java Script, Eclipse, Angular JS, HTTPS REST, Jenkins, Maven, Grunt, Salt, Scalr, Alfresco, Git, UML/SysML modeling

**Mentor URL (if applicable)**:

**Mentor Name**: Robert Karban

**Mentor Section/Org**: 313D

**Primary Discipline**: Computer Science

**Secondary Discipline**: Computer Engineering

**Other Discipline**: Software Engineering

*end of record*

**AO ID**: 4355

**Project Title**: Pattern factory library

**Desired Number of Participants**: 1

**Background Information**: The Integrated Model Centric Engineering initiative is developing capabilities to support the institutional adoption of Model Based Systems Engineering. This includes the development of UI wizards and supporting templates to simplify the development of MBSE artifacts.

**Project Description**: This project will involve developing a library of templates to support the creation of MBSE models, and likely the extension of an existing UI wizard tool written in JAVA to support application of the templates. These templates will be based on institutional “modeling patterns” that have been previously developed. It will also involve updating existing user and development documentation for the template library and corresponding UI wizard.

**Web or Literature References**: http://www.omgsysml.org/

**Suggested/required Background/skills, Courses**: Development with Java and Eclipse
Modeling with UML and or SysML

**Mentor URL (if applicable)**:

**Mentor Name**: Robert Karban

**Mentor Section/Org**: 313D
<table>
<thead>
<tr>
<th><strong>Primary Discipline:</strong></th>
<th>Computer Science</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Secondary Discipline:</strong></td>
<td>Computer Engineering</td>
</tr>
<tr>
<td><strong>Other Discipline:</strong></td>
<td>Software Engineering</td>
</tr>
</tbody>
</table>

**AO ID:** 4353

**Project Title:** Training a Mars Rover: Development of Automated Terrain Classifier

**Desired Number of Participants:** 2

**Background Information:** The greatest single source of risk for Mars rovers is terrain. For example, the Spirit rover ended its mission because it got stuck in a soft terrain; the Curiosity rover has experienced unexpectedly high damage rate of wheels. JPL has recently developed a ground-based Mars rover operation tool that mitigates risks from terrain by automatically identifying hazards on the terrain, evaluating their risks, and suggesting operators safe paths options that avoids potential risks while achieving specified goals. The tool will bring benefits to rover operations by reducing operation cost, by reducing cognitive load of rover operators, by preventing human errors, and most importantly, by significantly reducing the risk of the loss of rovers. The risk-aware rover operation tool is built upon two technologies. The first technology is a machine learning-based terrain classification that is capable of identifying potential hazards, such as pointy rocks and soft terrains, from images. The second technology is a risk-aware path planner based on rapidly-exploring random graph (RRG) and A* algorithms, which is capable of avoiding hazards identified by the terrain classifier with explicitly considering wheel placement.

**Project Description:** The terrain classifier is machine-learning based, meaning that it learns from human experts. Like humans, it requires a lot of training in order to build a high-performing classifier. The SIRI students' role is to train the terrain classifier for Mars rovers. More specifically, they work with Mars rover operators and engineers to generate training data using the on-board camera images taken by the Curiosity rover.

**Web or Literature References:** [http://mars.jpl.nasa.gov/msl/](http://mars.jpl.nasa.gov/msl/)

**Suggested/required Background/skills, Courses:** Programming skill in C, C++, and/or Python is desired but not required. We are looking for hard-working students who is enthusiastic to contribute to Mars exploration.

**Mentor URL (if applicable):** [https://www.robotics.jpl.nasa.gov/people/Masahiro_Ono/](https://www.robotics.jpl.nasa.gov/people/Masahiro_Ono/)

**Mentor Name:** Masahiro Ono

**Mentor Section/Org:** 347E

**Primary Discipline:** Open to any STEM major

**Secondary Discipline:**

**Other Discipline:**

*end of record*
**AO ID:** 4347  
**Project Title:** Produce SysML Metamodel  
**Desired Number of Participants:** 2  

**Background Information:** SysML is the standard systems modeling language. It has been defined as an extension of the popular UML language. Even though such definition has helped SysML be implemented easily on top of existing UML tools, it has increased significantly the complexity of language. For SysML to be widely adopted, it needs to be simplified. One step to simplify it is to define it independently of UML.

**Project Description:** The scope of the project is to design a mechanism to convert the definition of SysML from being an extension of UML to be an independent language for system modeling. This involves choosing the formalism to define the new language in, and designing a mechanism to go from the old definition to the new one.

**Web or Literature References:**  
http://www.omg.org/spec/UML/2.5/Beta1/  
http://www.omg.org/spec/SysML/1.4/Beta/  
http://syseng.omg.org/UML_for_SE_RFP.htm  
http://www.omg.org/syseng/

**Suggested/required Background/skills, Courses:** Good development experience in Java  
Understanding of UML modeling  
Background in computer science

**Mentor URL (if applicable):** http://magedelaasar.com/  
**Mentor Name:** Maged Elaasar  
**Mentor Section/Org:** 313D  
**Primary Discipline:** Computer Science  
**Secondary Discipline:** Systems Engineering  
**Other Discipline:** Computer Engineering  

*end of record*

---

**AO ID:** 4323  
**Project Title:** Circumstellar Matter (Jets, Disks and Torii) in Young and Dying Stars  
**Desired Number of Participants:** 2  

**Background Information:** The research opportunity offered is related to the study of circumstellar matter around young and dying Sun-like stars. Low and intermediate mass stars are born in rotating clouds of gas and dust, and many aspects of this evolutionary phase, such as the production of accretion disks and collimated jets, is poorly understood. As these stars reach the end of their lives, they carry out much of their interesting nucleosyntheses (e.g. production of the biogenic elements C & N), and through extensive mass-loss, disperse nucleosynthetic products and dust into the interstellar medium. The dazzling shapes of planetary nebulae make them not only immensely appealing to the public (as evident by their frequent appearance in popular astronomy magazines) but also a serious challenge to professional astronomers in finding a mechanism to produce their shapes. Many of these results have attracted wide public attention and have been published by
in public media. The study of young and dying stars provides an important contribution to the part of NASA's ORIGINS program which seeks to understand the life-cycles of Sun-like stars and the physical mechanisms whereby the death throes of these stars sow the seeds for the birth of new stars and solar system.

**Project Description**: In support of my research on these stars, I have a large number of past and current observational programs on NASA's space observatories such as the Hubble Space Telescope (HST), the Spitzer Space Telescope (SST), the Chandra X-Ray Observatory (CXO), XMM-Newton, and GALEX. These programs are generating a large amount of high-quality data, and opportunities exist for motivated students to help with the analysis and modelling of these data for addressing important scientific questions related to the death of Sun-like stars.

Specific research goals include an understanding of (1) the mass-ejection processes during the the beginning and end phases of stellar evolution -- how much mass is ejected, what is the history of this ejection, what is the content and composition of dust in the ejecta; (2) the role and origin of highly collimated jets, which are an exciting, dramatic and integral feature of many astrophysical environments, yet are very poorly understood, and (4) the role of binarity in producing jets and equatorial disks/torii. In particular, the jets in dying stars and young stellar objects are, amazingly similar in their empirical properties, so an improved understanding of jets in such stars is crucial for our understanding of both the very early and late phases of the evolution of Sun-like stars. Motivated and energetic students can expect to be co-authors on papers presented at the bi-annual meetings of the AAS, and peer-reviewed journal papers related to their research (in recent years, 9 students have been co-authors on such papers).

6. "High-Velocity Interstellar Bullets in IRAS05506+2414: A Very


SELECTED WEB REFERENCES
1. "Boomerang Nebula- the naturally coldest place currently known in the Universe"
2. "Hubble Finds Stars That Go Ballistic"
3. "Eye in the sky: Time nearly up for Hourglass Nebula as it runs out of nuclear fuel"

Suggested/required Background/skills, Courses*
1) basic background in Physics and/or Astronomy
2) a reasonable level of computational skill is preferred (e.g., some programming language like Fortran, C, C+, or IDL)

Mentor URL (if applicable): http://science.jpl.nasa.gov/people/Sahai/
Mentor Name*: Raghvendra Sahai
Mentor Section/Org: 3262
Primary Discipline: Astronomy/Astrophysics
Secondary Discipline: Physics/Applied Physics
Other Discipline: Computational/Programming

*end of record*