AO ID: 6703
Mentor Name: Seungbum Kim **Mentor Org.:** 329F

Project Information	
Project Title*:	Monitoring flood and water resources using satellite data
Desired Number of Participants*:	1
Background Information*:	The Soil Moisture Active Passive (SMAP) mission has the capability to map water surfaces and help water resources management. The algorithms were developed to monitor the extent of water surfaces on land. A candidate student will apply the algorithms to monitor and apply to land-air carbon exchanges.
Project Description*:	A candidate student will apply the water detection algorithms to the SMAP satellite data on a global scale on a weekly basis to track large-scale floods and waterbodies. The student will compare the outputs with independent data to perform quantitative performance analysis. The algorithms are mature and the student is expected to test the algorithms on diverse cases in the real world. The outcome may produce publication and presentations.
Suggested and/or Required Background/Skills/Courses:	Image processing, machine vision, programming
Web or Literature References:	http://smap.jpl.nasa.gov/
Primary Discipline:	Computer Science
Secondary Discipline:	Electrical Engineering

end of record

AO ID: 6697
Mentor Name: Aliakbar Aghamohammadi **Mentor Org.:** 347F

Project Information	
Project Title*:	Mechanical design of vehicles for Mars navigation
Desired Number of Participants*:	2
Background Information*:	Rovers are slow on Mars and their mobility is limited to flat surfaces. Flying vehicles can fly over obstacle-laden environments but they suffer from short flight-time.
Project Description*:	In this project, we design particular vehicles that have two modes of flying in the air and moving on the Mars surface.
Suggested and/or Required Background/Skills/Courses:	The student will help with the mechanical design of the vehicle (based on an already-designed concept in JPL). Past experience with quadcopter is a plus. The student will collaborate with researchers at JPL fabrication shops; he/she will also help with basic calculations on the weight, material selection, etc.
Primary Discipline:	Mechanical Engineering
Secondary Discipline:	Aerospace Engineering

end of record

AO ID: 6696
Mentor Name: Aliakbar Aghamohammadi **Mentor Org.:** 347F

Project Information	
Project Title*:	Machine learning for rover navigation on Mars
Desired Number of Participants*:	2
Background Information*:	Deep Learning has shown a huge success in recent years. The applications ranges from object recognition, speech recognition, to planning and control. Navigation on Mars is a complex task that can benefit from machine learning techniques in general, and deep learning, in particular.
Project Description*:	In this project, we would like to explore the application of deep learning-based methods to rover navigation on Mars. A lot of generic open-source libraries have been developed for deep learning and are freely available on the web. We would like to feed our data from the years of navigating rover on Mars to one of these open-source software. And try to learn the navigation rules and achieve a higher level of autonomy for the rover and avoid hazards and failures on Mars.
Suggested and/or Required Background/Skills/Courses:	The SIRI students' role is to closely collaborate with Mars rover operators, gather the existing data from previous rover navigation on Mars. Then, the student will train a deep neural network using existing free software on web. Finally, we test the trained navigation system by feeding the new images from the after-training runs and compare the generated path with the path, provided by the operator. If the progress is fast, we will port the method to a physical robot to test in JPL's Mars yard. We will use openAI gym as the simulation and training system: https://gym.openai.com/
Web or Literature References:	We will use openAI gym as the simulation and training system: https://gym.openai.com/
Primary Discipline:	Computer Science
Secondary Discipline:	Computer Engineering

end of record

AO ID: 6694
Mentor Name: Leonidas Moustakas **Mentor Org.:** 3260

Project Information	
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 working with data from an intensive campaign with the Las Cumbres Observatory and Global Telescope (LCOGT) on monitoring a remarkable strong gravitational lenses, named HE0435. We have developed the techniques needed to fully process these images and to analyze the results. Now the real fun begins. The student project will involve working with the analysis results of these observations, and helping design and potentially execute the next state of the art observations, with new targets. The work may involve working with empirical models for the variability of active galactic nuclei, with forecasting calculations for different observational scenarios. Another potential facet of work that is equally important, will be involved with gravitational lens modeling and measurements related to future observational targets. Our team is very friendly, vibrant, and active, and the student will be encouraged (and expected!) to be an active participant and partner. Depending on the level of contributions of the student, participation and potentially even leadership in one or more publications is possible -- and encouraged.
Suggested and/or Required Background/Skills/Courses:	Advanced physics and math (calculus or analysis) will help a great deal. Programming experience, ideally with python, is quite important. Appreciating that it is not always clear what "experience" means, please make sure you just lay out what you have done -- classes, self-teaching, specific projects, applications, anything -- so we can talk about it. Knowledge of statistics, and particularly of Bayesian inference and Markov Chain Monte Carlo sampling techniques, is a strong plus.
Web or Literature References:	http://lcogt.net http://admin.masterlens.org http://cosmograil.epfl.ch
Primary Discipline:	Astronomy/Astrophysics
Secondary Discipline:	Information Systems/Technology

end of record

AO ID: 6688
Mentor Name: Jordan Padams **Mentor Org.:** 398F

Project Information	
Project Title*:	PDS Imaging Node Image Atlas Search Enhancements
Desired Number of Participants*:	1

Background Information*:	The Imaging Node (IMG) of the NASA Planetary Data System (PDS) is the home to over 700 TB of digital image archives, making it one of the richest data repositories for planetary imagery in the world. The Planetary Image Atlas provides access to the entire collection of IMG data through links to online holdings and data node catalogs, enabling users to make scientific discoveries. Because of the immense volume of planetary imagery, the problem arises with remaining in sync with new missions and the data available through the Atlas. By developing an automated pipeline for metadata ingestion for newer missions, it will minimize the cost associated with ensuring data is in sync.
Project Description*:	The candidate will be tasked with leveraging a BPMN-like software package to verify and ingest product metadata for missions not currently accessible through the Atlas, like New Horizons, Dawn, Rosetta, EPOXI, etc. This will involve the parsing of product metadata, verification of data integrity, ingestion into Solr indexes, and processing of raw and derived data products into web-viewable image formats.
Suggested and/or Required Background/Skills/Courses:	Required: Unix/Linux, Python/Java, Eclipse IDE Suggested: BPMN, GDAL, software engineering course work, understanding of image formats
Web or Literature References:	Planetary Image Atlas - http://pds-imaging.jpl.nasa.gov/search/ . PDS Imaging Node - http://pds-imaging.jpl.nasa.gov/ . BPMN - https://en.wikipedia.org/wiki/Business_Process_Model_and_Notation The VICAR Image Processing System - http://www-mipl.jpl.nasa.gov/external/vicar.html . USGS ISIS: Integrated Software for Imagers and Spectrometers - https://isis.astrogeology.usgs.gov/ . GDAL - Geospatial Data Abstraction Library - http://www.gdal.org/ .
Primary Discipline:	Computer Science
Secondary Discipline:	Planetary Science

end of record

AO ID: 6687
Mentor Name: Jordan Padams **Mentor Org.:** 398F

Project Information	
Project Title*:	PDS Imaging Node Archive Inventory Management Software
Desired Number of Participants*:	1
Background Information*:	The Imaging Node (IMG) of the NASA Planetary Data System (PDS) is the home to over 700 TB of digital image archives, making it one of the richest data repositories for planetary imagery in the world. With this large repository of data comes the critical tasks of ensuring the integrity of and access to these data at all times. The Planetary Image Atlas provides access to the entire collection of IMG data through links to online holdings and data node catalogs. Maintaining the integrity of these links is an important task external and internal websites change.
Project Description*:	The candidate will have the opportunity to develop software tools critical to the success of one of the largest planetary data repositories in the world. The Archive Inventory Management Software will include tools to monitor the following: Data Integrity - ensure the integrity of the data in the archive using

	checksum validation. Link Integrity- ensure the links in the Planetary Image Atlas are correct. Data Volumes - how much data do we have in the archive and for which mission? Inventory - what data is in the archive?
Suggested and/or Required Background/Skills/Courses:	Required: Python/Java programming; Unix scripting. Suggested: Apache Solr, Amazon Lambda, Amazon Cloud Services
Primary Discipline:	Computer Science
Secondary Discipline:	Planetary Science

end of record

AO ID: 6686
Mentor Name: Ivria Doloboff **Mentor Org.:** 3225

Project Information	
Project Title*:	Planetary Instrument Lab Safety Analyst and Support
Desired Number of Participants*:	1
Background Information*:	Planetary Science and Instrument Laboratories at JPL are comprised of technically diverse cross-disciplinary teams that include research scientists, hardware/software engineers, and technologists. The teams conduct future mission related astrobiology research and development of unique instrument systems. These multi-user laboratories provide support for the scientific investigation and instrument development life-cycle.
Project Description*:	The student will earn experience in the day-to-day function of high use instrument and chemistry laboratories. Tasks include safety hazard analysis and requirement compliance, communication with science personnel, instrument engineers and safety coordinators, inspection of instrument pressure vessel systems, and materials procurement efforts.
Suggested and/or Required Background/Skills/Courses:	Requires strong communication skills, ability to work independently. Strong willingness to learn and work in support of JPL flight instrument systems safety and JPL personnel safety procedures and requirements. Some college science laboratory experience (chemistry, geology) including general safety practices would be helpful.
Web or Literature References:	http://instrument.jpl.nasa.gov/ http://icyworlds.jpl.nasa.gov
Primary Discipline:	Planetary Science
Secondary Discipline:	Computer Science

end of record

AO ID: 6684
Mentor Name: Michael Tuite **Mentor Org.:** 3225

Project Information	
Project Title*:	Data Management for Astrobiology
Desired Number of Participants*:	1

Background Information*:	The mission of the Astrobiogeochemistry Laboratory (abcLab) at JPL is to explore elemental, mineralogical, molecular, isotopic, and morphological biosignatures in ancient and recent Earth samples in order to understand the potential nature and preservation of signs of life elsewhere in the solar system.
Project Description*:	The abcLab is seeking a student intern to assist with the continuing development of our data management tool, the Sample Data Library (SDL). The SDL runs within Amazon Web Services using HTML, PHP, and MySQL. The project will include the development of interfaces to transfer data to and from the cloud, ensure the security and redundancy of data, and create novel interfaces for data visualization and interpretation.
Suggested and/or Required Background/Skills/Courses:	Requirements include a familiarity with web development, PHP, MySQL, Python, and networking in a multi-platform environment. Applicants should also exhibit an eagerness to learn, an ability to work independently, and a fabulous sense of humor.
Primary Discipline:	Information Systems/Technology
Secondary Discipline:	Planetary Science
Other Discipline:	Astrobiology

end of record

AO ID: 6683
Mentor Name: Rishi Verma **Mentor Org.:** 398M

Project Information	
Project Title*:	JPL Tech Catalog
Desired Number of Participants*:	1
Background Information*:	At JPL, it can be difficult to find lab-developed software or hardware technology that meets a specific technical need. At the same time, open source search engine and web-portal technology has matured greatly in the past decade to make faceted, and domain-specific searches easier than ever to build. We'd like to bridge this gap, and fulfill the need of finding lab-developed technical toolkits with the ease of modern-day Web 2.0 technologies.
Project Description*:	A software web-portal to reduce the time and effort needed to find high-quality and production-ready lab-developed technology (hardware /software) for fulfilling a technical need while reliably assessing its current availability and sustainability. This task will focus on further developing the web front-end or backend search-engine / web-services of the project to make it easier than ever for JPLers to find technical toolkits across lab with a modern day Web 2.0 look and feel.
Suggested and/or Required Background/Skills/Courses:	Courses: Web-Technologies, Databases
Web or Literature References:	https://www.mongodb.com/ https://www.elastic.co/products/elasticsearch http://www.bootstrap.com/ https://lucene.apache.org/solr/
Primary Discipline:	Computer Science
Secondary Discipline:	Information Systems/Technology

end of record

AO ID: 6682
Mentor Name: Renyu Hu **Mentor Org.:** 3262

Project Information	
Project Title*:	Abiotic oxygen in the atmospheres of super-Earths
Desired Number of Participants*:	1
Background Information*:	One of the ultimate goals of studying extrasolar planets (exoplanets) is to assess whether they are inhabited. Because exoplanets are far away from us, astronomers rely on remote sensing of atmospheres to characterize exoplanets. Oxygen in the atmosphere has been widely regarded as the indicator for biotic input on a terrestrial exoplanet, because photosynthesis maintains the oxygen level in Earth's atmosphere. Recently, a number of studies have suggested scenarios where oxygen is produced and maintained by abiotic processes (Hu et al. 2012; Tian et al. 2014; Gao et al. 2015). It is therefore crucial to determine under what conditions oxygen can build up in an exoplanet atmosphere.
Project Description*:	The student will use an advanced atmospheric chemistry and radiative transfer code (called EPACRIS; Hu et al. 2012) to simulate the atmospheres of terrestrial exoplanets. The student will construct model atmospheres of various surface pressures, ranging from 1 to more than 1000 bars, and study how abiotic oxygen level varies with the surface pressure. The student will compare simulations with and without the input from surface gas emission (i.e., volcanic outgassing), and determine at which surface pressure level thermochemical equilibrium would prevail over the gas emission. The results obtained in the project will help constrain the amount of abiotic oxygen on super-Earths that may have atmospheres thicker than Earth's.
Suggested and/or Required Background/Skills/Courses:	The student should have completed colleague-level courses in physics and mathematics. Experience in the C programming language is desired. Knowledge of astronomy or planetary science is not required.
Web or Literature References:	Peter Gao, Renyu Hu, Tyler Robinson, Cheng Li, and Yuk L. Yung (2015), Stabilization of CO2 Atmospheres on Exoplanets around M Dwarf Stars, ApJ, 806, 249; Feng Tian, Kevin France, Jeffrey L. Linsky, Pablo Mauas, Mariela C. Vieytes (2014), High stellar FUV/NUV ratio and oxygen contents in the atmospheres of potentially habitable planets, EPSL, 385, 22; Renyu Hu, Sara Seager, and William Bains (2012), Photochemistry in Terrestrial Exoplanet Atmospheres I: Photochemistry Model and Benchmark Cases, ApJ, 761, 166.
Primary Discipline:	Astronomy/Astrophysics
Secondary Discipline:	Planetary Science

end of record

AO ID: 6680
Mentor Name: Michael Tuite **Mentor Org.:** 3225

Project Information	
Project Title*:	Basic Research in Astrobiology

Desired Number of Participants*:	1
Background Information*:	The mission of the Astrobiogeochemistry Laboratory (abcLab) at JPL is to explore elemental, mineralogical, molecular, isotopic, and morphological biosignatures in ancient and recent Earth samples in order to understand the potential nature and preservation of signs of life elsewhere in the solar system.
Project Description*:	The Astrobiogeochemistry Laboratory (abcLab) at JPL is seeking a student intern who is interested in working at the intersection of bio- and geo- sciences in support of the search for life beyond the Earth. Potential projects may involve work with rocks that date from 3.5 billion years ago to samples of living microbial communities. The abcLab is equipped with cutting-edge instrumentation to investigate a wide range of biosignatures including scanning electron microscopy and elemental mapping at the micrometer scale, light microscopy and advanced imaging techniques, lipid biomarker extraction and analysis, bulk and compound-specific stable isotope analysis, as well as physical sample curation and data management.
Suggested and/or Required Background/Skills/Courses:	Requirements include some experience with basic laboratory procedures, an eagerness to learn, and an ability to work independently.
Primary Discipline:	Planetary Science
Secondary Discipline:	Geological/Geophysical Engineering
Other Discipline:	Astrobiology

end of record

AO ID: 6678
Mentor Name: Glenn Orton **Mentor Org.:** 3222

Project Information	
Project Title*:	Analysis of Near- and Mid-Infrared Observations of Jupiter and Saturn
Desired Number of Participants*:	2
Background Information*:	Images and spectra of Jupiter and Saturn from near- and mid-infrared instruments are sensitive to temperatures, abundances of a major condensate (ammonia), opacity of clouds with large particles, and the variability of the molecular para- vs ortho-hydrogen 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: MIRSI, NSFCam, and SpeX (NASA Infrared Telescope Facility), T-Recs (Gemini South Telescope), VISIR (ESO's Very Large Telescope), and COMICS (Subaru Telescope). These observations consist primarily of radiometrically filtered images. Much of these data sets have been reduced already, and the primary task of the student will be to format the data appropriately as input to an atmospheric retrieval code from which the various properties will be derived. Prioritized specific areas of investigation are given below.
Project Description*:	a. We will be working with a large-volume set of observations of Jupiter, both imaging and spectroscopy, that are designed to support observations of Jupiter

	scheduled from various instruments on the New Frontiers Juno spacecraft. It will be important to reduce and, if possible, analyze these results and report them to the Juno science team during the course of the mission. b. We want to examine long-term behavior of planetary temperatures and distribution of minor constituents using archival through current thermal images that were taken from 1995 to the present. These include some of the behaviors noted below, but the data are to be examined also in a more general sense for unexpected events or phenomena unrelated to changes that are detectable in the visible. A substantial amount of this work was completed through 2010 data by a previous student, and the task will involve corrections to the calibration of the data, combined with their interpretation to be put immediately into a publication in the open literature. c. The last few years have found Jupiter in a state described as one of "global upheaval", during which substantial and rapid changes are observed in the state of its visually prominent axisymmetric regions. Most recently Jupiter's normally dark North Temperate Belt (NTB) turned bright around 2002-2003 and in 2007 suddenly darkened again, coupled with the activity of two massive atmospheric plumes. Its normally dark South Equatorial Belt (SEB) lightened early in 2007 and then darkened later that year; late in 2009 it lightened again. This task will be to examine whether there are temperature changes associated with these visual metamorphoses, even preceding them, along with variations of their dynamical states - tracked through clouds and chemical species - as a means of understanding whether large-scale dynamics are responsible or whether they can be explained by small changes of elevation that induce phase changes in the chemicals that color the clouds. d. An effort related to (b) above is to note whether there are temperature or compositional changes associated with the re-darkening of the South Equatorial Belt (SEB) that began in November of 2007 in a series of spectacular events. Some early work on this will be accomplished by a student in the spring of 2011, but there will be much work left over. e. For Saturn, besides the long-term response to seasonal variations of radiation, we are investigating the appearance of thermal wave trains in the atmosphere. f. For Saturn, we are examining the persistence and frequency of 'patchy' thick clouds in its upper atmosphere that were detected by observations of thermal emission from deep clouds.
Suggested and/or Required 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. At least some programming experience is required of serious candidates. With a significant level of contribution, students are welcomed as co-authors on papers emerging from this research.
Web or Literature References:	Data reduction and the retrieval process are described by Fletcher et al. (2009, Icarus 200, 154). a. Little work has been done on Jupiter in the past, but we did a similar study for Saturn, discovering a long-term (~15-year) wave phenomenon (Orton et al. 2008, Nature 453, 196). b. See Sanchez-Lavega et al. (2007, Nature 251, 437) for an introduction to our initial work in this area. c. Nothing has been done on this phenomena in the thermal. An account of the visible changes of the atmosphere were reviewed by Sanchez-Lavega and Gomez (1996, Icarus, 121, 1). d. We detected thermal waves in Saturn initially in 2003 from Keck Telescope

	data (Orton et al. 2005 Science 307, 696). e. Our initial work in this area was described by Yanamandra-Fisher et al. (2001, Icarus 150, 189).
Primary Discipline:	Planetary Science
Secondary Discipline:	Astronomy/Astrophysics
Other Discipline:	Computer Sciences

end of record

AO ID: 6677
Mentor Name: Lan Dang **Mentor Org.:** 398D

Project Information	
Project Title*:	Enhancing Analytics for Large-Scale Hybrid Cloud Science Data Systems
Desired Number of Participants*:	1
Background Information*:	ARIA (Advanced Rapid Imaging and Analyses) project is a collaboration between JPL and Caltech to exploit radar and optical remote sensing, GPS, and seismic observations for hazard science and response. ARIA investigates the processes and impacts of earthquakes, volcanoes, landslides, fires, subsurface fluid movement and other natural hazards by applying modern geodesy, merged with ground-based observations, to improve society's resilience. ARIA develops state-of-the-art ground deformation measurements, change detection methods and physical models using GPS and synthetic aperture radar observations, automating the required large scale processing, and producing basic data products for the science community.
Project Description*:	To facilitate ARIA science data processing, a Hybrid Cloud Science Data System (HySDS) was developed to support large-scale and cloud-based ingestion, metadata extraction, cataloging, high-volume data processing, provenance management, and publication of science data products. Students will work with the HySDS team to develop cloud economics analytics tools that can provide real-time analytics of cloud computing-based science data processing. Students will work closely with the operations team to develop useful tools for assessing real-time information on science data production ETA, costs, remaining time per job type, usage analytics, etc.
Suggested and/or Required Background/Skills/Courses:	Background: computer science cloud computing machine learning visualization Relevant software: AWS OpenStack Elasticsearch Redis GitHub Celery RabbitMQ W3C PROV Programming skills: python javascript bash java json/xml
Primary Discipline:	Computer Science
Secondary Discipline:	Information Systems/Technology
Other Discipline:	SAR processing and analysis

end of record

AO ID: 6676
Mentor Name: Lan Dang **Mentor Org.:** 398D

Project Information	
Project Title*:	Enhancing Provenance for Large-Scale Hybrid Cloud Science Data Systems
Desired Number of Participants*:	1
Background Information*:	ARIA (Advanced Rapid Imaging and Analyses) project is a collaboration between JPL and Caltech to exploit radar and optical remote sensing, GPS, and seismic observations for hazard science and response. ARIA investigates the processes and impacts of earthquakes, volcanoes, landslides, fires, subsurface fluid movement and other natural hazards by applying modern geodesy, merged with ground-based observations, to improve society's resilience. ARIA develops state-of-the-art ground deformation measurements, change detection methods and physical models using GPS and synthetic aperture radar observations, automating the required large scale processing, and producing basic data products for the science community.
Project Description*:	To facilitate ARIA science data processing, a Hybrid Cloud Science Data System (HySDS) was developed to support large-scale and cloud-based ingestion, metadata extraction, cataloging, high-volume data processing, provenance management, and publication of science data products. Students will work with the HySDS team to further mature and integrate provenance analytics capabilities
Suggested and/or Required Background/Skills/Courses:	Background: computer science data stewardship and preservation provenance semantic web cloud computing machine learning visualization Relevant software: AWS OpenStack Elasticsearch Redis GitHub Celery RabbitMQ Programming skills: python javascript bash java json/xml
Primary Discipline:	Computer Science
Secondary Discipline:	Information Systems/Technology
Other Discipline:	SAR processing and analysis

end of record

AO ID: 6662
Mentor Name: Ivria Doloboff **Mentor Org.:** 3225

Project Information	
Project Title*:	Planetary Instrument Lab Safety Analyst and Support
Desired Number of Participants*:	1
Background Information*:	Planetary Science and Instrument Laboratories at JPL are comprised of technically diverse cross-disciplinary teams that include research scientists, hardware/software engineers, and technologists. The teams conduct future mission related astrobiology research and development of unique instrument systems. These multi-user laboratories provide support for the scientific investigation and instrument development life-cycle.
Project Description*:	The student will earn experience in the day-to-day function of high use instrument and chemistry laboratories. Tasks include safety hazard analysis and requirement

	compliance, communication with science personnel, instrument engineers and safety coordinators, inspection of instrument pressure vessel systems, and materials procurement efforts.
Suggested and/or Required Background/Skills/Courses:	Requires strong communication skills, ability to work independently. Strong willingness to learn and work in support of JPL flight instrument systems safety and JPL personnel safety procedures and requirements. Some college science laboratory experience (chemistry, geology) including general safety practices would be helpful.
Web or Literature References:	http://instrument.jpl.nasa.gov/ http://icyworlds.jpl.nasa.gov
Primary Discipline:	Planetary Science
Secondary Discipline:	Computer Science

end of record

AO ID: 6656
Mentor Name: Matthew Golombek **Mentor Org.:** 3223

Project Information	
Project Title*:	Mars Data Analysis
Desired Number of Participants*:	1
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 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.
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 and/or 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 may be supervised by one or two research scientists and may also work alongside other researchers and students.
Web or Literature References:	Information on the Mars landing sites and selection can be found at: Golombek, M. P., et al., 2003, Selection of the Mars Exploration Rover landing sites: Journal of Geophysical Research, Planets, v. 108(E12), 8072, doi:10.1029/2003JE002074, 48pp. Golombek, M., et al., 2005, Assessment of Mars Exploration Rover landing site predictions: Nature, v. 436, p. 44-48 (7 July 2005), doi: 10.1038/nature03600. Golombek, M. P., et al., 2006, Erosion rates at the Mars Exploration Rover landing sites and long-term climate change on Mars: Journal of Geophysical Research, Planets, v. 111, E12S10, doi:10.1029/2006JE002754. Golombek, M. P., and McSween Jr., H. Y., 2007, Mars: Landing site geology, mineralogy and geochemistry: Chapter 17, p. 331-348, in Encyclopedia of the Solar System, Second Edition, L. A. McFadden, P. R. Weissman and T. V. Johnson, eds., Academic Press/Elsevier, San Diego, 966 pp. Golombek, M. P., et al., 2008, Martian surface properties from joint analysis of orbital, Earth-based, and surface observations: Chapter 21 in, The Martian Surface: Composition, Mineralogy and Physical Properties, J. F. Bell III editor, Cambridge University Press, p. 468-497. Golombek, M., K. Robinson, A. McEwen, N. Bridges, B. Ivanov, L. Tornabene, and R. Sullivan, 2010, Constraints on ripple migration at Meridiani Planum from Opportunity and HiRISE observations of fresh craters, J. Geophys. Res., 115, E00F08, doi:10.1029/2010JE003628. Golombek, M., et al., 2012, Selection of the Mars Science Laboratory landing site: Space Science Reviews, v. 170, p. 641-737, DOI: 10.1007/s11214-012-9916-y. Golombek, M., Redmond, L., Gengl, H., Schwartz, C., Warner, N., Banerdt, B., and Smrekar, S., 2013, Selection of the InSight landing site: Constraints, plans, and progress (expanded abstract)?: 44th Lunar and Planetary Science, Abstract #1691, Lunar and Planetary Institute, Houston. Golombek, M., Warner, N., Schwartz, C., and Green, J., 2013, Surface characteristics of prospective InSight landing sites in Elysium Planitia (expanded abstract)?: 44th Lunar and Planetary Science, Abstract #1696, Lunar and Planetary Institute, Houston. Golombek, M. P., et al., 2014, Small crater modification on Meridiani Planum and implications for erosion rates and climate change on Mars: Journal of Geophysical Research, Planets, v. 119, p. 2522-2547, 10 Dec. 2014 Rock distributions and their importance in landing site selection can be found in: Golombek, M., and Rapp, D., 1997, Size-frequency distributions of rocks on Mars and Earth analog sites: Implications for future landed missions: Journal of Geophysical Research, Planets, v. 102, p. 4117-4129. Golombek, M. P., et al., 2003, Rock size-frequency distributions on Mars and implications for MER landing safety and operations: Journal of Geophysical Research, Planets, v. 108(E12), 8086, doi:10.1029/2002JE002035, 23pp. Golombek, M. P., et al., 2006, Geology of the Gusev cratered plains from the Spirit rover traverse:

	Journal of Geophysical Research, Planets, v. 110, E02S07, doi:10.1029/2005JE002503. Golombek, M. P., et al., 2008, Size-frequency distributions of rocks on the northern plains of Mars with special reference to Phoenix landing surfaces: Journal of Geophysical Research, Planets, v. 113, E00A09, doi:10.1029/2007JE003065. Golombek, M., Huertas, A., Kipp, D. and Calef, F., 2012, Detection and characterization of rocks and rock size-frequency distributions at the final four Mars Science Laboratory landing sites: Mars, v. 7, p. 1-22, doi:10.1555/mars.2012.0001.
Primary Discipline:	Planetary Science
Secondary Discipline:	Earth Science

end of record

AO ID: 6654
Mentor Name: Alexandra Holloway **Mentor Org.:** 397F

Project Information	
Project Title*:	Improving Deep Space Network Operations
Desired Number of Participants*:	3
Background Information*:	The Operations Lab creates the software that is used to command all JPL spacecraft (like Curiosity rover), ranging from desktop to AR and VR systems. As a human centered part of the Ops Lab, the Human Interfaces (HI) group researches, designs, prototypes and develops the ways users interact with these systems. The HI group has many opportunities for interns and full-time professionals in these areas: User Research HI Group User Researchers direct efforts to ground development in observation and evidence. User researchers define critical unknowns, and develop plans to study, interpret and document user needs. User Researchers gather information using user-centered design methods, including but not limited to contextual inquiry, artifact walkthrough, and interviews. They synthesize results and provide design direction. Then, they validate the direction using needs validation, prototype walkthrough, and user evaluation techniques. Interaction Design HI Group Interaction Designers direct efforts to evaluate and translate user needs into actionable insights and system capabilities. They rapidly prototype and evaluate paper and software prototypes, and simulation and role play. Visualization HI Group Visualization Developers direct efforts to create software that allows scientists and engineers to move, parse, analyze, interact with, and share discoveries with the massive data NASA instruments and spacecraft generate every day. They build systems that merge alien landscapes with ambiguous sensor data, create new kinds of interactive maps, and express complex robotic controls in compact visual language.
Project Description*:	The Deep Space Network hopes to change its operations in a way that will help increase efficiency and improve operations. The Human Interfaces group has been tasked with conducting user research and prototyping of initial concepts to support this new method of operations. Interns will work with team members of the Human Interfaces group to conduct user research, sketch and prototype new ideas, program design solutions, and iteratively test ideas with other designers

	and with real operators of the Deep Space Network. The goal of this internship will be to help move the project forward as well as give valuable industry experience to interns.
Suggested and/or Required Background/Skills/Courses:	Desired skills: - Experience with user-centered design - Experience working in a collaborative, iterative development environment - Human Computer Interaction (HCI) project experience - User interface or user experience (UI/UX) design experience - Graphic design, illustration, drawing - Web front end design and/or implementation
Web or Literature References:	http://www.youtube.com/opslabjpl http://deepspace.jpl.nasa.gov
Primary Discipline:	Computer Science
Secondary Discipline:	Undecided
Other Discipline:	Interaction Design

end of record

AO ID: 6641
Mentor Name: Michael Wolf **Mentor Org.:** 347J

Project Information	
Project Title*:	Multi-mission multi-agent robotics for maritime applications: Perception and Autonomy
Desired Number of Participants*:	3
Background Information*:	JPL leads a variety of maritime robotics research projects. We are designing systems for (a) coordinated behaviors for teams of robotic agents, and (b) vision-based situational awareness that aid in guiding that team. The application that will be addressed will be for autonomous unmanned surface vehicles (robotic boats).
Project Description*:	The student will assist in development and testing algorithms for mutli-agent cooperative control and/or vision-based perception systems. This may include prototyping computer vision or control algorithms, building multi-agent simulation environments, and managing experiments to evaluate the performance of existing algorithms. The student will contribute to a JPL team of autonomy and computer vision experts.
Suggested and/or Required Background/Skills/Courses:	Strong software skills, with experience in C++ and Linux preferable. Experience in simulation, computer vision, or multi-agent systems desired if applying for roles in those respective areas. No previous experience or specific software skills required for roles in managing and annotating data sets and running experiments.
Web or Literature References:	M. T. Wolf, C. Assad, Y. Kuwata, A. Howard, H. Aghazarian, D. Zhu, T. Lu, A. Trebi-Ollennu, and T. Huntsberger, “360-degree visual detection and target tracking on an autonomous surface vehicle”, Journal of Field Robotics, vol. 27, Nov. 2010 T. Huntsberger, H. Aghazarian, A. Howard, and D. Trotz, “Stereo vision–based navigation for autonomous surface vessels”, Journal of Field Robotics, vol. 28, Jan. 2011. Y. Kuwata, M. T. Wolf, D. Zarzhitsky, and T. L.

	Huntsberger, "Safe Maritime Autonomous Navigation with COLREGS, Using Velocity Obstacles," IEEE Journal of Oceanic Engineering, 39(1): 110-119, 2014. T. Huntsberger, P. Pirjanian, A. Trebi-Ollennu, H.D. Nayar, H. Aghazarian, A. Ganino, M. Garrett, S.S. Joshi, and P.S. Schenker, "CAMPOUT: A Control Architecture for Tightly Coupled Coordination of Multi-Robot Systems for Planetary Surface Exploration," IEEE Trans. Systems, Man & Cybernetics, Part A: Systems and Humans, Special Issue on Collective Intelligence, 33(5): 550-559, 2003. A. Stroupe, A. Okon, M. Robinson, T. Huntsberger, H. Aghazarian, and E. Baumgartner, "Sustainable Cooperative Robotic Technologies for Human and Robotic Outpost Infrastructure Construction and Maintenance," Autonomous Robots, 20(2): 113-123, 2006.
Primary Discipline:	Computer Science
Secondary Discipline:	Electrical Engineering and Computer Science

end of record

AO ID: 6613
Mentor Name: Arby Argueta **Mentor Org.:** 332C

Project Information	
Project Title*:	Matlab Processing Suite for Spacecraft Downlink Signals
Desired Number of Participants*:	2
Background Information*:	The Deep Space Network (DSN) is responsible for maintaining reliable communications with various NASA spacecraft. By recording the spacecraft data, analysts are able to process the data with new algorithms and provide new capabilities for the DSN. In order to support this task, parallelized processing software must be developed.
Project Description*:	The candidate will work with engineers and analysts to implement a high rate recorder on a portable instrument platform and extend the capabilities of an existing software algorithm suite used to process radio downlink signals from spacecraft. Capability enhancements for the software algorithm suite may include parallelizing Matlab software to run on multiple processors and translating/compiling custom MATLAB software to a C-based environment for release. The high rate recorder is a 10GbE network based recorder running 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 of a high rate 640Msps firmware receiver as well as extending its capabilities as the source for the digital recorder.
Suggested and/or Required Background/Skills/Courses:	Required: strong background in electrical engineering, computer science; Experience in Linux, C/C++ and Matlab Or Verilog / VHDL
Web or Literature References:	Andrews, K. S., A. Argueta, N. E. Lay, M. Lyubarev, E. H. Sigman, M. Srinivasan, and R. Navarro, "Reconfigurable Wideband Ground Receiver Hardware Description and Laboratory Performance," IPN PR 42-180, pp. 1-22, February 15, 2010. (http://ipnpr/progress_report/42-180/180D.pdf) Lay, N., A.

	Argueta, A. Tkacenko, M. Srinivasan, and K. Andrews, "Reconfigurable Wideband Ground Receiver Field Testing," IPN PR 42-191, pp. 1-13, November 15, 2012. (http://ipnpr/progress_report/42-191/191A.pdf)
Primary Discipline:	Electrical Engineering
Secondary Discipline:	Computer Engineering
Other Discipline:	Computer Science

end of record

AO ID: 6586
Mentor Name: Raghvendra Sahai **Mentor Org.:** 3263

Project Information	
Project Title*:	Circumstellar Matter (Jets, Disks and Torii) in Young and Dying Stars
Desired Number of Participants*:	1
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), 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).
Suggested and/or 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+, IDL, python)
Web or Literature References:	1. "A collimated, high-speed outflow from the dying star V Hydrae", Sahai, R.; Morris, M.; Knapp, G. R.; Young, K.; Barnbaum, C. 2003, Nature, 426, 261 2. "Sculpting a Pre-planetary Nebula with a Precessing Jet: IRAS 16342-3814 Sahai, R. et al. 2005, ApJ, 622, L53 3. "Magnetohydrodynamic Models of the Bipolar Knotty Jet in Henize 2-90," Lee, C-F. & Sahai, R. 2004, ApJ, 606, 483 4. "Preplanetary Nebulae: An HST Imaging Survey and a New Morphological Classification System", Sahai, R., Morris, M., S'anchez Contreras, C., & Claussen, M. 2007,AJ, 134, 2200 5. "Binarity in Cool Asymptotic Giant Branch Stars: A Galex Search for Ultraviolet Excesses", Sahai, R., Findeisen, K., Gil de Paz, A., & S'anchez Contreras, C. 2008, ApJ, 689, 1274 6. "High-Velocity Interstellar Bullets in IRAS05506+2414: A Very Young Protostar?", Sahai, R., Claussen, M., S'anchez Contreras, C., Morris, M. & Sarkar, G. 2008, ApJ, 680, 483 7. "An EVLA and CARMA study of dusty disks and torii with large grains in dying stars", Sahai, R., Claussen, M.J., Schnee, S., Morris, M.R., & S'anchez Contreras, C. 2011, ApJ, 739, L3 8. "Shocked and Scorched: The Tail of a Tadpole in an Interstellar Pond", Sahai, R., Morris, M.R., & Claussen, M.J. 2012, ApJ (in press), arXiv:1201.5067 SELECTED WEB REFERENCES 1. "Boomerang Nebula- the naturally coldest place currently known in the Universe" http://en.wikipedia.org/wiki/Boomerang_Nebula 2. "Hubble Finds Stars That Go Ballistic" http://www.physorg.com/news150562469.html 3. "Eye in the sky: Time nearly up for Hourglass Nebula as it runs out of nuclear fuel" http://www.dailymail.co.uk/sciencetech/article-2023696/ MyCn18-The-Hourglass-Nebulas-life-comes-end-runs-nuclear-fuel.html
Primary Discipline:	Astronomy/Astrophysics
Secondary Discipline:	Physics/Applied Physics
Other Discipline:	Computational/Programming

end of record

AO ID: 6478
Mentor Name: Parag Vaishampayan **Mentor Org.:** 352N

Project Information	
Project Title*:	Microorganisms Associated with Mars-Bound Spacecraft: Preservation, Identification, Characterization.
Desired Number of Participants*:	3
Background Information*:	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 3,500 isolates collected during the assembly, testing, and launch operations of pre-flight Mars-based spacecraft ranging from Viking to the most recently launched Mars Science Laboratory (MSL) and two missions currently being built for launch. With the early phases of planning for the upcoming challenging planetary protection missions that may be planned (i.e. Mars or Europa life detection or Mars Sample Return) it is essential to understand the identification, frequency of isolation and biochemical profiles, of microbial isolates that NASA standard cleanliness assays are detecting. It is critical to preserve these organisms for long term storage, and to update the microbial archive database by providing additional biochemical data and sequence data 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) Identify and describe novel microbial species collected from Mars bound spacecraft surfaces using biochemical, genetic and taxanomic approach , ii) Identify existing and new isolates using MALDI-TOF system, The Biotechnology and Planetary Protection Group at JPL (BPPG) invites applications to understand the ecology of microbes found on spacecraft and to assess their potential for survival in extreme environments. The student will join an established group of researchers focusing on molecular systematic/population genetics of microbes isolated from the extreme environments of spacecraft assembly. Students will be exposed to state of the art molecular microbial techniques, sequencing, bioinformatics, etc.
Suggested and/or 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.
Web or Literature References:	http://planetaryprotection.nasa.gov/
Primary Discipline:	Biology/Bioengineering
Secondary Discipline:	Environmental Science
Other Discipline:	Microbiology, molecular biology

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