APPENDIX K
NASA Office of Education MUREP Advanced STEM Training and Research (ASTAR) Fellowship

K.1 OVERVIEW OF THE FUNDING OPPORTUNITY

K.1.1 Executive Summary of Key Information

The NASA Office of Education (OE) MUREP Advanced STEM Training and Research (ASTAR) Fellowship provides fellowship awards for individuals pursuing or planning to pursue graduate studies leading to Masters and Doctoral degrees in relevant NASA-related disciplines at accredited U.S. universities. This funding opportunity is open to students pursuing advanced degrees in Science, Technology, Engineering, and Mathematics (STEM), specifically in areas of projected deficiencies in the NASA STEM workforce. The NASA OE MUREP ASTAR is being conducted in conjunction with the Aeronautics Research Mission Directorate (ARMD) and the Human Exploration and Operations Mission Directorate (HEOMD). All NASA investments in postdoctoral fellows are excluded from this announcement. Graduate researchers interested in conducting earth and space science research must submit their applications directly to the Science Mission Directorate’s NASA Earth and Space Science Fellowship (NESSF): http://nspires.nasaprs.com/external/solicitations/summary.do?method=init&solId={B6CDCEA6-8EDD-A48A-FAF8-E588F66661C3}&path=init

Graduate researchers interested in conducting space technology research must submit their applications directly to the NASA Space Technology Research Fellowship (NSTRF, http://tinyurl.com/NSTRF2015, which is now closed; however, another solicitation is planned in the fall of 2015). For latest information about NESSF and the NASA Space Technology Research Fellowship, please review the websites.

NASA OE MUREP ASTAR students will perform graduate student research at their respective campuses during the academic year under the guidance of their University Faculty Research Advisor, who will serve as the Principal Investigator (PI) on the award. In addition to his or her faculty advisor, each student will be paired with a NASA researcher (based upon the research opportunity for which the student submits a proposal), who will serve as the student’s NASA Center Technical Advisor. Fellows will work with their designated NASA Center Technical Advisor at a host NASA center during an annual 10 - 15 week Center-Based Research Experience (CBRE), typically occurring in the summer months. Through the CBRE, students will advance their degree in STEM education; gain relevant research experience; expand their social network; learn best practices; and enhance their understanding of the research process. Awards resulting from this competitive selection will be made in the form of NASA training grants to eligible U.S. academic institutions.

K.1.2 Goals and Objectives

NASA contributes to national efforts for achieving excellence in STEM education as discussed in the Education Opportunities in NASA STEM (EONS) solicitation. The future prosperity and well-being of our nation and its citizens depends on how well we educate our students today. Our future
workforce needs demand that we have workers with advanced thinking, reasoning, and problem solving skills. The knowledge and STEM-related critical thinking demands on students are greater today than at any time in our nation’s history, as STEM skills are essential for the future economic success of the nation.

NASA’s Office of Education’s mission is to advance high quality STEM education. Through this solicitation, NASA is strengthening involvement with higher education institutions to ensure that NASA can meet future workforce needs in STEM fields. Participation in NASA projects and research stimulates increasing numbers of students to continue their studies at all levels of the higher education continuum and earn advanced degrees in these critical fields.

NASA OE MUREP ASTAR Fellowships:

- Financially support and advance individuals early in their careers in NASA-related disciplines, who demonstrate the potential to contribute to NASA’s mission and future STEM workforce, through the use of innovative research ideas;
- Increase the number of historically underrepresented and underserved populations, such as women, minorities, persons with disabilities, and veterans, who are pursuing advanced degrees in STEM disciplines;
- Develop a highly trained quadrat of researchers and scientists whose skills and competencies directly contribute to the nation’s STEM work force.

NASA OE MUREP ASTAR objectives are to:

- Improve the nation’s future STEM Workforce by developing the skills and competencies of graduate students pursuing degrees in STEM disciplines;
- Provide opportunities for a diverse population to participate and contribute to NASA’s missions and projects;
- Use NASA’s unique mission content, workforce, and facilities in order to enhance and increase the capabilities, diversity and size of the nation’s next generation workforce needed to enable future NASA discoveries.

K.1.3. Guidance/Citations

NASA OE Fellowships are designed to support opportunities for graduate students to pursue their graduate degrees (MS or PhD) in an eligible program at an eligible granting institution and to conduct research and development activities, all of which contribute to the advancement of NASA’s technical missions. Participation in NASA OE Fellowships allows fellows to gain in depth research experience coupled with professional development, networking and collaborations to build technical skills and preparedness for NASA’s future STEM workforce. These opportunities also contribute to institutional capacity due to the experience and knowledge gained by participating faculty. In
working with these graduate students and faculty, NASA fosters new relationships and strengthens existing partnerships with a diverse group of universities across the country.

Examples of ineligible students for this opportunity include undergraduates and graduates who are already supported (i.e., receive tuition and/or stipend) under NASA research grants, contracts, or other forms of federal support. NASA research grant or contract recipients (i.e., institutions) are responsible for the conduct of the research and exercise independent judgment regarding the recruitment and funding of graduate and undergraduate students to complete their work. Thus, students who are currently supported under such grants or contracts are not part of a NASA OE fellowship cohort because such support does not have degree attainment as the primary purpose for student involvement.

K.1.4. NASA Strategic Plan and Relevance to Education

NASA’s education projects work in collaboration with other Federal agencies to improve the quality of STEM education in the United States, which support both NASA’s 2014 Strategic Plan and the Administration’s STEM policy. The NASA OE MUREP ASTAR will address the following long-term NASA Education goals and objectives that are outlined in the 2014 NASA Strategic Plan. These measures will be supported by the agency’s short term Annual Performance Indicators, which set quantifiable targets for NASA’s offices, programs and projects. NASA’s goals and objectives are subject to change over time to adapt to national and agency wide priorities. NASA Strategic Goals and Objectives relevant to education are outlined in the 2014 NASA Strategic Plan:


The NASA OE MUREP ASTAR seeks to increase retention and completion rates of underserved and underrepresented undergraduate students in STEM fields. In order to achieve this goal, this solicitation focuses on the following NASA Strategic Objective:

- **Goal 2**: Advance understanding of Earth and develop technologies to improve the quality of life on our home planet.
  - **Objective 2.4**: Advance the Nation’s STEM education and workforce pipeline by working collaboratively with other agencies to engage students, teachers and faculty in NASA’s mission and unique assets.

NASA’s Annual Performance Indicators are outlined in NASA’s FY 2015 Complete Management and Performance Appendix (http://www.nasa.gov/sites/default/files/files/NASA_FY15_MP.pdf). The NASA OE MUREP ASTAR activity supports the following NASA Office of Education Multi-year Performance Goal and Annual Performance Indicator:

Multi-year Performance Goal

- **FY 2015 and FY 2014 2.4.1**: Assure that students participating in NASA higher education projects are representative of the diversity of the Nation.
Annual Performance Indicator

- **FY 2015 ED-15-1:** Provide significant, direct student awards in higher education to (1) students across all institutional levels and types (as defined by the U.S. Department of Education); (2) racially or ethnically underrepresented students, (3) women, (4) persons with disabilities, and (5) veterans at percentages that meet or exceed the national percentages for these populations, as determined by the most recent, publicly available data from the U.S. Department of Education’s National Center for Education Statistics for a minimum of two of the five categories.

The NASA OE MUREP ASTAR is consistent with national priorities for STEM education established by the Committee on STEM Education (CoSTEM) (see http://www.whitehouse.gov/sites/default/files/microsites/ostp/stem_stratplan_2013.pdf).

Specifically, the NASA OE MUREP ASTAR addresses the following CoSTEM priorities:

- **Design Graduate Education for Tomorrow’s STEM Workforce:** Provide graduate level trained STEM professionals with basic and applied research expertise, options to acquire specialized skills in areas of national importance and mission agency’s needs, and ancillary skills needed for success in a broad range of careers (p. viii).

- **Better Serve Groups Historically Under-represented in STEM Fields:** Increase the number of students from groups that have been underrepresented in STEM fields that graduate with STEM degrees in the next 10 years and improve women’s participation in areas of STEM where they are significantly underrepresented (p. viii).

**K.1.5. NASA Relevance**

Each proposed research project must be formulated in response to one of the Fellowship research opportunities (see Fellowship Opportunities by Center in “Other Documents” associated with the NASA OE MUREP ASTAR Appendix). Coordination with the potential NASA Center Technical Advisor is mandatory. If an applicant has questions about any of the fellowship research opportunities, please contact the Point of Contact (POC) for the appropriate NASA Center listed on the Fellowship Opportunities by Center document. The listed POC will direct the applicant to the appropriate NASA Center Technical Advisor for the opportunity in question. The NASA Center Technical Advisor associated with the opportunity will provide a review and guidance on the work being performed in his or her lab. In addition, proposals should clearly and concisely describe:

- The relevance of the proposed work to NASA’s currently funded research priorities as described in the funding opportunity.
- The relevance of the proposed work to the interests and abilities of the student, as well as how the work will increase the capacity and integrity of executing cutting-edge research at the University.
The NASA Mission Directorates Points of Contact for this announcement are:

Aeronautics Research
http://www.aeronautics.nasa.gov/
Anthony Springer
Tony.Springer@nasa.gov

Human Exploration and Space Operations
http://www.nasa.gov/directorates/heo/home/index.html
Alotta Taylor
Alotta.e.taylor@nasa.gov

Science
http://science.nasa.gov/
Stephanie Stockman
Stephanie.a.stockman@nasa.gov

For detailed information, proposers should review Section 10, Technical Content Description, in the EONS solicitation.

K.2 AWARD INFORMATION

K.2.1 Budgets

The NASA OE MUREP ASTAR Fellowships will be awarded as training grants to accredited U.S. universities on behalf of students selected under this appendix. For each student, the university receives up to a $55,000 annual award, with the following annual maximums per budget category:

- Student Stipend: $25,000 (Master’s) / $30,000 (Doctoral)
- Tuition and Fees: $10,000
- CBRE Allowance: $8,000
- Health Insurance Allowance: $1,000
- University Faculty Research Advisor Allowance: $4,500
- Student Professional Development Allowance: $1,500

K.2.1.1 Allowable Expenses

Student Stipend: A stipend is assumed to be for a student’s personal expenses. Stipend payments should be prorated evenly across a ten-month academic school year.

Tuition and Fees: Provided up to the maximum value to offset student’s tuition and fees.

CRBE Allowance: This allowance is to be used in support of travel and other expenses associated with the CRBE experience. The student should receive the maximum stipend value. May be released to the student according to a prorated schedule determined by the academic institution.

Health Insurance Allowance: Permissible up to maximum value, only to the level of expected actual expense.

University Faculty Research Advisor Allowance: Discretionary allowance made to the university
faculty research advisor.

**Student Professional Development Allowance:** This allowance may be used in direct support of training and academic needs of the student. This stipend can be used in concurrence with the University Faculty Research Advisor Allowance to cover fellowship student travel to technical and scientific meetings. The fellowship student is expected to attend at least one technical conference annually for presentation of the work being conducted under the fellowship. All technical conferences must be vetted and approved by the NASA Fellowships Manager.

Equipment, including computers, may not be purchased with the NASA Office of Education funds. Government furnished equipment will not be provided as part of these awards.

The training grant supports graduate education and does not provide university overhead.

Throughout the duration of this award, student recipients are prohibited from concurrently receiving other Federal fellowships, scholarships, traineeships, apprenticeships, internships, or any other federal funding. 12 CFR section 1260.12(c)(3)(i).

**K.2.2 Period of Performance**

All fellowship awards will provide a maximum of three (3) years of financial support. NASA Office of Education awards are made initially for one year and may be renewed for no more than two additional years. Some awards may be eligible for multi-year funding. Renewals are contingent upon NASA’s acceptance of the renewal application which includes satisfactory progress (as reflected in student academic performance, research progress, recommendation by the faculty advisor, recommendation by the NASA mentor, and effective costing of the annual Fellowship budget). Requests for deferment of awards will not be approved.

**K.2.3 Number and Size of Awards**

Subject to Congressional appropriation of sufficient funds in Fiscal Years 2014 and beyond, and also pending NASA’s receipt of proposals of adequate merit, NASA expects to select a minimum of 10 proposals for award. Individual total award values will range between approximately $45,000 and $55,000 each year for a total award value between $90,000 and $165,000, with a period of performance not to exceed three years. NASA may elect to support some of the proposals submitted under this Appendix through the use of non-OE MUREP ASTAR funds if such funds are available from other NASA programs or federal sources. NASA reserves the right to not make any awards under this Appendix and to cancel this Appendix at any time. NASA assumes no liability (including for bid and proposal preparation costs) for canceling the Appendix or for an entity’s failure to receive an actual notice of cancellation.
K.3 ELIGIBILITY INFORMATION

Proposing institutions shall certify in their proposals that they are eligible to receive the training grant according to the following criteria.

K.3.1 Eligible Institutions

Proposals will only be accepted from accredited U.S. universities on behalf of eligible students. The institution must confirm acceptance of the student in a graduate degree program (by the fall 2015 term) in a NASA-relevant STEM discipline at the time of Fellowship acceptance, no later than July 13, 2015. The student must be affiliated with the above stated academic institution from the date of award (on or about September 1, 2015) through completion or termination of the fellowship.

K.3.2 Degree and Field of Study

Fellowships are awarded for graduate study leading to research-based masters and doctoral degrees in a NASA-specific STEM discipline. For this announcement, a student’s proposed research and graduate study must be aligned to one of the posted MUREP Fellowship Research Opportunities specifically associated with this Appendix. Please refer to the MUREP Fellowship Opportunities by Center under the “Other Documents” associated with the NASA OE MUREP ASTAR Appendix to ensure that proposed research and graduate study aligns with the parameters of the opportunities.

K.3.3 Eligible Students

To be eligible to receive a NASA OE MUREP ASTAR Fellowship, the student must meet the following requirements:

- Be a U.S. citizen (permanent residents are not eligible) at the time of proposal submission. U.S. citizenship is required for participation in the mandatory CBRE.
- Hold a Bachelor’s degree in a STEM field earned prior to fall 2015.
- Be enrolled in a graduate degree program no later than fall 2015.
- Have a minimum 3.0 GPA on a 4.0 scale
- Have a projected degree plan length of two years or more

If the student meets the above eligibility requirements and is planning to start a new graduate degree program at an academic institution that is different from his/her current academic institution, he/she is encouraged to work with faculty at the prospective university in assembling and submitting proposals to this fellowship call.
**K.3.4 Principal Investigator**

All proposals must have a University Faculty Research Advisor identified (who will serve as the Principal Investigator (PI) of the training grant) from the proposing institution. PIs must meet all of the following criteria at the time that the Phase II Application is submitted (See Section K.8 for more information).

The PI shall be a tenure or tenure-track faculty member of an eligible institution (see K.3.1) if a tenure system is established. Eligible institutions that do not have a tenure track will be required to submit a letter of commitment to comply with the rule that any proposed change to the Principal Investigator under the agreement is subject to NASA approval. Also, the PI shall have a Ph.D. or equivalent in an engineering, computer science, technology, mathematics, or science discipline that is relevant to NASA’s research needs.

**K.4 AWARD ADMINISTRATION INFORMATION**

**K.4.1 Award Type and Availability**

Awards made through the NASA OE MUREP ASTAR Appendix will be in the form of a training grant issued to the university on behalf of the selected student and with the University Faculty Research Advisor as the PI. Proposers to this Appendix are advised that, in general, funds are not available to award all solicited activities at the time of the Appendix release. The Government’s obligation to make awards is contingent upon the availability of sufficient appropriated funds from which payment can be made and the receipt of proposals that NASA determines are acceptable for award under this NRA.

**K.4.2 Award Period of Performance**

The maximum period of performance (duration) for awards made under this Appendix is up to three years. NASA may select proposals for shorter award durations than proposed; however, no selection shall be made for durations shorter than two years.

**K.4.3 Cancellation of Opportunity**

NASA reserves the right to not make any awards under this Appendix and/or to cancel this Appendix at any time prior to award. NASA assumes no liability (including bid and proposal costs in case of cancellation) for cancelling the Appendix or for any entity’s failure to receive an actual notice of cancellation.

**K.4.4. Schedule of Awards**
The anticipated announcement date for the Fellowships is June 22, 2015. Selection notifications will be communicated electronically via NSPIRES to the institution’s Authorized Organization Representative (AOR) and the PI. NSPIRES sends a decision notice via email requesting the PI or AOR to log into NSPIRES. This decision notice email means NSPIRES has been updated to indicate the status of a proposal in NASA’s selection review process. When a PI or AOR logs into NSPIRES, the following are examples of the type of decisions possible:

- A “declined” status means that 1) NASA’s review of the proposal is concluded; and 2) no NASA funds are available to support the proposed project.
- A “selected” or “selectable (pending)” status means that the proposal’s review continues and the proposal has NOT received an award. A “selected” or “selectable (pending)” proposal status in NSPIRES is NOT a promise that a proposal has or will receive an award by the NASA Shared Services Center (NSSC) nor that any funds have been or will be transferred from NASA Headquarters to a NASA Field Center.

Proposers are cautioned that only a NASA Grant/Contracting Officer may make commitments, obligations, or awards on behalf of NASA or authorize the expenditure of funds. No commitment on NASA’s part should be inferred from an institution’s technical or budgetary discussions with a NASA education manager, mission directorate employee, or support office coordinator. A PI or organization that makes financial or personal commitments in the absence of a training grant signed by a NASA Grant/Contracting Officer does so at their own risk. Please refer to Section 3.4 of the 2014 NASA Guidebook for Proposers (available at http://www.hq.nasa.gov/office/procurement/nraguidebook/) for more information.

Proposal feedback will be made available upon the proposing institution’s request.

**K.4.5 Proposal Funding Restrictions**

Please see award information – Section K.2.

**K.4.6 Award Terms and Conditions**

Please see award information – Section K.2.

**K.4.6.1 NASA Office of Education One Stop Shopping Initiative (OSSI)**

*Upon selection, all awarded ASTAR Fellows will be required to establish a profile on the NASA Office of Education One Stop Shopping Initiative (OSSI), located at intern.nasa.gov. OSSI provides information regarding NASA Internships, Fellowships and Scholarships (NIFS) for students and recent graduates. For additional information including application process, please visit the following*
website: https://intern.nasa.gov. In the "OSSI Student Opportunities and Recruitment Tools” container, select the "Fellowships" link.

**K.4.6.1 Center Based Research Experience Guidelines**

Students selected under this NASA OE MUREP ASTAR Appendix will participate in a mandatory annual Center-Based Research Experience (CBRE) at a designated NASA center. For each funded academic year, students are expected to participate in a CBRE. Through this experience, students will advance their STEM education; gain relevant research experience; expand their social network; learn best practices; and enhance their understanding of the research process. The CBRE is typically conducted during the summer in coordination with each center’s summer internship session; however, students may arrange a different timeframe if all parties agree. All CBREs are coordinated with the NASA mentor and the respective Center Office of Education.

**K.4.6.2 Requirements for Access to NASA facilities and Information**

14 Code of Federal Regulations (CFR) Section 1260.35, requires in part that recipients needing access to a NASA center, facility, or computer system, or to NASA technical information shall provide the personal background and biographical information requested by NASA. In addition, grant recipients shall comply with the requirements of Grant Information Circular (GIC) 06-02 and its attached "PIV card Issuance Procedures.” Grant Information Circular 06-02 may be found at the following URL: [http://prod.nais.nasa.gov/pub/pub_library/grantnotices/gic06-02.html](http://prod.nais.nasa.gov/pub/pub_library/grantnotices/gic06-02.html)

**K.4.7 Reporting Requirements and Intellectual Property**

All reports are vital to program management and evaluation. It is the responsibility of the University Faculty Research Advisor (the PI), the student, and the university receiving a NASA OE MUREP ASTAR award to ensure prompt submission of all required reports. A listing of interim and final reports is included on the official training grant that will be sent to the student’s host university upon issuance of the award (see 14 CFR sections 1260.22 and 1260.75). A summary of these reports is provided below:

<table>
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<tr>
<th>Interim Reports</th>
<th>Action Required By:</th>
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<tr>
<td><strong>Quarterly Federal Cash Transactions Report (SF272)</strong>: required within 15 working days following the end of each quarter of the Federal fiscal year for all Grants and Cooperative Agreements (Ref. 14 CFR section 1260.26). Submit to Financial Management Officer (FMO). Address will be on the Training Grant.</td>
<td>University Sponsored Research Office</td>
</tr>
</tbody>
</table>
**Progress Reports** (NASA OE MUREP ASTAR requires an annual progress report as part of the annual renewal of the NASA OE MUREP ASTAR award). Submit with annual NASA OE MUREP ASTAR renewal proposal.

**Notification of Decision to Forego Patent Protection** (Required for all Grants and Cooperative Agreements). Submit as applicable, not less than 30 days before the expiration of the response period required by the relevant patent office - (14 CFR section 1260.28).

**Election of Title to a Subject Invention:** (Required for all Grants and Cooperative Agreements). Submit within 2 years of disclosure of a subject invention being elected, except in any case where publication on sale or public use of the subject invention being elected has initiated the one year statutory period wherein valid patent protection can still be obtained in the United States, at least 60 days prior to the end of the statutory period - (14 CFR sections 1260.28 and 1260.57). Submit to Project Officer/Program Manager and Grants Officer.

**Final Reports**

| Properly Certified Final Federal Cash Transaction Report (SF272) – Required for all Grants and Cooperative Agreements. Submit within 90 days after the expiration date of the Grant/Cooperative Agreement - (14 CFR section 1260.26). Submit to Project Officer and Grants Officer. | University Sponsored Research Office |
| Summary of Research (Required for MUREP ASTAR Training Grants). Submit within 90 Days after the expiration date of the Grant/Cooperative Agreement – (14 CFR section 1260.22). Submit to Center MUREP ASTAR Coordinator. | Student |

In accordance with 35 United States Code (U.S.C.) §212, no scholarship, fellowship, training grant, or other funding agreement made by a Federal agency made to an awardee primarily for educational purposes will contain any provision giving the Federal agency any rights to inventions made by the awardee.

**K.4.8 Obligation to the Government**

A student receiving support under the described NASA Office of Education activity does not thereby incur any formal obligation to the United States Government. However, the objectives of the fellowship will be best served if the student actively pursues a career in a STEM-related field after completion of his or her graduate studies.
K.5 PROPOSAL AND SUBMISSION INFORMATION

No more than two NASA OE MUREP ASTAR proposals shall be submitted on behalf of a single student and each proposal for the student must address a separate ASTAR research opportunity.

The ASTAR Fellowships proposal process has two phases: Phase I is the proposal submission by the student. It will consist of the proposal cover page (including Project abstract), impact statement, project description, degree program schedule, biographical sketch, letters of recommendation, and transcripts. Phase II requires a package submission that is described in more detail in Section K.7. Step by step Instructions for Proposal Submission can be found in “Other Documents” under the NASA OE MUREP ASTAR Fellowships Page.

All information needed to apply to this solicitation is contained in this EONS appendix and in the companion document, the 2014 NASA Guidebook for Proposers (available at http://www.hq.nasa.gov/office/procurement/nraguidebook/).

A listing of available research opportunities across the Agency is included in this solicitation. Applicants should review the opportunities and develop their proposal in response to the selected opportunity of interest.

Potential students are urged to access the NSPIRES electronic proposal system well in advance of the application due date to familiarize themselves with its structure and to enter the requested information. See submission instructions for full details.

K.5.1 Application Procedures – Phase I

The student must be the principal author of the submitted Phase I application. By submitting the proposal for consideration, the student and the University Faculty Research Advisor (PI) certify that the student was the principal author.

All proposals must be submitted via NSPIRES in electronic format only. No mail-in materials will be accepted. Fellowship proposals must be submitted electronically by the Authorizing Official Representative (AOR) of the institution (see Step-by-Step Submission Instructions under “Other Documents” for more information) using the NSPIRES features according to the deadline listed in this appendix. Phase I proposals must be received by 11:59 p.m. Eastern Time on May 5, 2015. Proposals received after the deadline will not be accepted.


1. Click on Solicitations
2. Click on Open Solicitations
3. Then Select Education Opportunities in NASA STEM 2014
4. Select List of Open Program Elements
5. Then select NASA OE MUREP ASTAR Fellowships; and
6. For submission instructions, select Phase I Proposal Submission Instructions under “Other Documents.”

Potential students and their respective PIs (University Faculty Research Advisors) are urged to access the NSPIRES electronic proposal system well in advance of the proposal due date to familiarize themselves with its structure and to enter the requested information. See submission instructions for full details.

Phase I proposals must include ALL of the following items, appropriately labeled, in the exact order specified. Proposals should not include extraneous information or materials not specifically requested or outlined in this solicitation. No additional information may be provided by links to web pages within the proposal, except as part of citations in the References Cited section. Images may be included in the page limits. Review of the proposal is based solely on materials received by the proposal deadlines. All statements must be written using the following:

1. Standard 8.5" x 11" page size
2. 12 -point, Times New Roman font or Computer Modem (LaTeX) font
3. 10 -point font may be used for references, footnotes, figure captions and text within figures 1" margins on all sides; and
4. Single spaced or greater line spacing

Proposals not meeting the above requirements may be eliminated from award consideration.

a. **NSPIRES-generated Proposal Cover Page:** The cover page to be completed online includes a **Project Abstract.** This section of the proposal must be entitled “Project Abstract” and may total no more than one paragraph. The abstract should be a complete summary of the proposed project description (see below). As such, it is a very concise statement of the major elements of your research project. It states the purpose, methods, and findings of your research project. The abstract length should not exceed 200 words. Abstracts should be clear, concise, and cohesive. The cover page also includes responses to the Program Specific Data Questions.

Please Note: The following elements b – f are not part of the NSPIRES Proposal Cover Page form and must be combined into a single PDF document and uploaded on the NSPIRES site for submission. Element g – the letters of recommendation must be submitted separately according to the instructions below.

b. **Impact Statement (NASA OE MUREP ASTAR only):** this section of the proposal must be entitled “Impact Statement” and should be jointly written by the student and the University Faculty Research Advisor (PI). It should address the impact of such a fellowship award on both
the student personally and the university. It should be one page or less and focus on the NASA OE MUREP ASTAR objectives articulated in Section K.1.2.

c. **Project Description**: This section of the proposal must be entitled “Project Description” and may total no more than five single-spaced pages (using 12-point font with at least 1-inch margins on all sides). The project description should provide a clear description of the student’s proposed research and should be written in response to the Research Opportunities listed under “Other Documents.” The Project Description must follow the sequence below and contain the following technical elements:

1. Statement of the Problem
2. Hypothesis
3. Approach
4. Predicted Outcomes
5. Conclusion
6. References cited

d. **Degree Program Schedule**: This section of the proposal is a schedule stating the proposed start and completion dates as well as anticipated milestones of the student’s degree program. There is no standard format for this section. This section must be entitled “Degree Program Schedule” and may not exceed one page.

e. **Biographical Sketch** for the student, not to exceed two pages each. The following information should be included:

- Name
- Current position
- Title
- Department
- University address
- University phone number
- Principal publications
- Relevant career experience
- Research
- Awards
- Scholarships
- Other relevant accomplishments

f. **Transcripts**: Transcripts that cover the entire college career, undergraduate and graduate, should be included. These should be legible and unaltered. If transcripts are not current or recent, please provide an explanation. If all, or part of, the student’s social security number and/or the student’s complete date of birth appear on the transcript, these items must be blocked out (redacted) prior to submission. These are the only permitted alterations to a transcript.

g. **Letters of Recommendation**: Each student must arrange for the submittal of three current
Letters of Recommendation. Failure to submit three letters of recommendation may negatively affect the evaluation of the proposal. The letters of recommendation constitute a critical component of the proposal. They must all come from non-family members and be received by the proposal deadline.

One letter is to be from and signed by the student’s proposed University Faculty Research Advisor (PI) on official letterhead and include the following information: name and title of letter writer, department, and institution or organization. It must include a statement indicating the level of assistance provided to the student in the preparation of the project description. (NOTE: If a student has not yet been accepted into his or her university of choice, please submit a letter of recommendation from your current academic advisor.)

The other two letters should come from individuals (professors, undergraduate/graduate advisors, mentors, work supervisors, etc.) with detailed knowledge of the student’s abilities. All letters of recommendations must be submitted electronically by the recommender to NASA.fellowships@nasaprs.com. Please reference the student name and proposal number in the subject line of the email. This information should be obtained from the student applicant.

Respondents without access to the Web or who experience difficulty using the NSPIRES proposal site (http://nspires.nasaprs.com) should contact the Help Desk at nspires-help@nasaprs.com or call 202-479-9376.

Phase I Proposal Submission Deadline: 11:59 p.m. ET (8:59 p.m. PT), May 5, 2015. Please note that no extensions will be granted to accommodate either late proposals or partial proposal submissions.

Step by step instructions for Proposal Submission can be found in “Other Documents” under the NASA OE MUREP ASTAR Fellowships Page.

K.5.2 Pre-proposal Questions and Answers

A pre-proposal teleconference will be held on Thursday, February 19, 2015 at 3:00 p.m. ET. Refer to the NSPIRES NASA OE MUREP ASTAR Fellowships web page for connection details. During this time, prospective students may verbally ask questions they have about the opportunity. Students may also receive technical assistance from project staff at this time, which may include tips and guidance for applying.

Prospective students, University Faculty Research Advisors and academic institutions are requested to submit any written questions as instructed below. Responses to the questions submitted will be provided in a list that will be posted on NSPIRES. The list will be updated periodically during the open period of the opportunity. Questions submitted after the deadline will not receive a response.
Questions regarding this opportunity must be submitted in writing to the NASA Office of Education Fellowships Manager, Brenda Collins (email: NASA.Fellowships@nasaprs.com) by February 12, 2015 within 10 calendar days of the release date in order that answers may be obtained and disseminated in a timely manner. Oral questions will not be answered. Questions and responses will be posted under “Other Documents” associated with this Appendix.

If contacted by a proposer, NASA civil servants assigned to the Appendix as the lead technical officers may only provide general information regarding the application guidelines for NASA ASTAR Fellowships, which includes general information about NASA or NASA assets and referring proposers to a specific part of an appendix or page number without interpretation of any kind.

Civil servants listed in this Appendix as either POCs and/or potential technical officers for future awards, shall not assist in the development (or any formal pre-submission review) of specific proposals. This restriction begins on the release date of this Appendix. Additionally, the civil servants at NASA Headquarters who will serve as internal reviewers for this Appendix cannot “pre-read” proposals or provide letters of support or commitment to an entity that plans to apply. However, proposers may contact the potential NASA technical advisors (as identified in the Research Opportunities by Center Document in Other Documents) for information regarding a review of the work currently being performed in his or her lab.

K.6 PROPOSAL EVALUATION AND SELECTION – PHASE I

K.6.1 Proposal Review and Selection

All eligible Phase I fellowship proposals will be reviewed by technical experts using electronic and/or panel reviews. The following two equally weighted criteria will be used to evaluate the student’s application:

1. **Academic Merit and Distinction.** Based upon the review of the student’s transcripts, impact statement, letters of recommendation and biographical sketch, reviewers will analyze the applicant’s potential to conduct NASA relevant research based upon the following criteria:
   1. The applicant’s ability to synthesize and evaluate original thoughts into a clear and concise document;
   2. The applicant’s previous experiences conducting research and/or desire/potential to conduct research in an authentic lab setting; and
   3. The applicant’s intrinsic motivation and determination to complete an advanced degree at the academic institution of choice.

4. **Scientific Merit of the Proposed Research.** Based upon the review of the applicant’s Project Description, reviewers will analyze the quality of the proposed NASA relevant research based upon the following criteria:
5. The ability of the proposal to address a gap in the scientific literature;
6. The ability of the proposal to clearly describe a collaborative approach to conducting research within a NASA; and
7. The ability of the proposal to clearly describe the connection between the proposed research area and the academic discipline which the student is pursuing.

After the review of Phase I proposals, candidates deemed excellent will be submitted to the appropriate NASA Office of Education Funding Managers at NASA Headquarters for final programmatic consideration and selection.

K.7 ANNOUNCEMENT OF PHASE I SELECTIONS

The target date to announce the fellowship selections is on or about June 22, 2015. Notification letters will be made available via the NSPIRES system; student applicants will be informed (via e-mail) when the notification letters are available for download. The selected student applicant will be asked to verify his/her intention to accept the fellowship within 20 days of notification; the student will also be required to indicate his/her chosen university. The selected student will need to work with his/her chosen university (i.e., the university where the student will be enrolled full-time in fall 2015) to submit the Phase II package. The general scope of the Phase II package is provided in Section K.5. Unless otherwise requested (see Section K.4.7–Terms and Conditions), the planned start date for awards resulting from this solicitation is September 1, 2015.

Feedback to the student applicant regarding the proposal will be provided upon request. Requests for feedback should be submitted as instructed in the notification letter and within 30 days of notification.

K.8 PHASE II SUBMISSION PROCEDURES

Universities and students may only submit Phase II applications if selected in Phase I and invited to proceed to Phase II. The NASA OE MUREP ASTAR Fellowships are awarded as training grants to accredited U.S. universities. This section provides an outline of the required Phase II elements. Detailed instructions will be released, via NSPIRES, concurrent with the Phase I selection announcement. Phase II of this solicitation will require submission of a package, via NSPIRES, by a university Authorized Organizational Representative (AOR). The PI on the training grant award will be the faculty advisor. The faculty advisor will also have a role in the submission of the Phase II package. The selected student shall work with the faculty advisor and AOR to ensure that all of the following components are submitted by the Phase II deadline (currently July 27 2015):

1. NSPIRES Proposal Cover Page (with the advisor as PI and additional Program Specific Data Questions)
2. Unrevised, except as specified below, components b through f of the Phase I submission:
a. The Phase I-submitted Impact Statement  
b. The Phase I-submitted Project Description  
c. The Phase I-submitted Degree Program Schedule  
d. The Phase I-submitted Biographical Sketches  
e. The selected student’s transcripts, with updates as available

3. Curriculum Vitae (CV) for the University Faculty Research Advisor, not to exceed 3 pages each. The following information should be included:
   - Name
   - Current position
   - Title
   - Department
   - University address
   - University phone number
   - Principal publications
   - Relevant career experience
   - Research
   - Awards
   - Scholarships
   - Other relevant accomplishments

4. Statement from the faculty advisor on the planned use of the faculty advisor allowance and a brief description of ongoing or pending research awards from NASA that are related to the selected student’s Project Description

5. The fellowship training grant funding request for Year 1 of the award, by category and with justifications

By submission of the Phase II package, the proposer accepts the Terms and Conditions specified in Section K.4.7. NASA will examine the Phase II packages for completeness (i.e., all components submitted and correct). Training grants will only be awarded when all of the Phase II package components are complete. NASA may require negotiations with the university prior to awarding a training grant. In such cases, the award is contingent upon successful completed negotiations between NASA and the university.

### K.9: Summary of Key Information

<table>
<thead>
<tr>
<th>Total ESTIMATED annual budget for each NASA OE MUREP ASTAR Award</th>
<th>$50K (Masters)/ $55K (Doctoral)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new awards pending adequate proposals of merit</td>
<td>~10 – 15 awards</td>
</tr>
<tr>
<td>Start date (estimated)</td>
<td>September 2, 2015</td>
</tr>
<tr>
<td><strong>Duration of awards</strong></td>
<td>Up to 3 years</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td><strong>Award Type</strong></td>
<td>Fellowships/Training Grant</td>
</tr>
</tbody>
</table>
| **Due date for proposals** | Phase I Applications: May 5, 2015 @11:59 p.m. ET  
Phase II Applications: July 27 2015 @ 11:59 p.m. ET |
| **Pre-Proposal Teleconference** | Thursday, February 19, 2015 at 3:00 p.m. ET |
| **Submission medium** | Electronic proposal submission is required via NSPIRES; no hard copy will be accepted. See Chapter 3 of the *NASA Guidebook for Proposers* (available at [http://www.hq.nasa.gov/office/procurement/nraguidebook/](http://www.hq.nasa.gov/office/procurement/nraguidebook/)). |
| **Web site for submission of proposal via NSPIRES** | [http://nspires.nasaprs.com/](http://nspires.nasaprs.com/) (help desk available at nspires-help@nasaprs.com or (202) 479-9376 from 8 am to 6 pm Eastern Time, Monday to Friday (except federal holidays)). |
| **Selection Official** | Joeletta Patrick  
MUREP Manager  
NASA Office of Education - HQ  
[Joeletta.O.Patrick@nasa.gov](mailto:Joeletta.O.Patrick@nasa.gov) |
| **Points of Contact** | Carolyn Knowles, Director  
NASA Internships, Fellowships, & Scholarships  
Office of Education  
NASA Headquarters  
Washington, DC 20546  
Email: [NASA.fellowships@nasaprs.com](mailto:NASA.fellowships@nasaprs.com)  

Brenda Collins, Fellowships Manager  
Ames Research Center  
Office of Education and Public Outreach  
Mountain View, CA 94035  
Email: [NASA.fellowships@nasaprs.com](mailto:NASA.fellowships@nasaprs.com) |

NASA technical experts and program managers will review proposals and make selections for participation in this program. Selections will be based on the successful submission of a complete
proposal package. The responsiveness of the proposal to a specific (as stated in the submitted proposal) funding opportunity, relevance to NASA, and the academic excellence of the applicant will form the basis for the evaluation. For NASA OE MUREP ASTAR proposals, the stated impact on the student and the university will also be taken into consideration. The appropriate NASA Office of Education Funding Managers at NASA Headquarters will make the final award selections.
Important Notes You Should Review Prior to Initiating Proposal Submission:
In NSPIRES, errors indicate problems that will preclude proposal submission to NASA. Errors must be corrected in order to submit a proposal. Warnings are meant to be used as guidelines for checking a proposal prior to submission to NASA. They indicate potential discrepancies, based on typical proposal requirements. Any actions taken because of warnings are at your discretion.

Please consult the NASA OE MUREP ASTAR Fellowship EONS appendix announcement for specific requirements. In particular, the posted opportunities under “Other Documents” of the solicitation describes the research opportunities available for student proposals. One of these opportunities must be selected during the proposal creation process described below. Please ensure that you select the correct “Option for Proposal Submission” for your proposal.

STEP BY STEP SUBMISSION INSTRUCTIONS for Phase I Submission:

Step 1
1. The University must be registered with NSPIRES through the Electronic Business Point of Contact (EBPOC) listed in the System for Award Management (SAM) database (www.sam.gov). Each registered university will have a designated Authorizing Official Representative (AOR) who will be responsible for submitting the student’s application. (Please see “NOTE” below if you do not have an AOR or cannot locate your AOR)
2. The University Faculty Research Advisor (Principal Investigator - PI) must be registered with NSPIRES and affiliated with the registered university. (Please see “NOTE” below if you have not been accepted into the University of your Choice yet and thus do not have a PI)
3. The Student must be registered with NSPIRES and activate his/her account.

(NOTE:
*Application Tip for Students Not yet accepted into a Graduate Program and Do Not have a PI or AOR:
If you have not yet been accepted into the University of your Choice and thus do not have a PI or AOR associated with the academic institution for your Phase I submission, please select the “ASTAR Proposal Submission Office” as your organization. If selected for a Phase II Submission, your application will need to be relinked with the correct institution. More details will be provided at that time.

**Application Tip for Students Who Have Been Accepted Into Graduate Program Who Cannot Find Their AOR:
Ask your faculty advisor for assistance first. If your faculty advisor does not know, you can contact the NSPIRES helpdesk for assistance in locating the contact information for your university’s designated AOR.

Step 2

1. The Advisor MUST initiate the proposal in NSPIRES for the Student
   a. Advisor logs into NSPIRES
   b. Select “Proposals” link
   c. Click “Create Proposal” button on right side
      i. Select “Solicitation” and click “Continue”
      ii. Select “ASTAR15” and click “Continue”
      iii. Create “Proposal Title” (Note: The title must be entered at this point, and only the Advisor should edit the proposal title), and click “Continue”
      iv. Link the proposal to the submitting organization, and click “Continue”
      v. System will display “Submitting Organization Information” for verification. Click “Continue.”
      vi. Click “Save”

   d. On “View Proposal” page (the Advisor is identified as the PI for the proposal.)
      i. Select “Business Data” link in “Proposal Cover Page”
      ii. Click “Edit” to complete information in each field and click “Save”
      iii. Click “OK”
      iv. On “View Proposal” page, select “Proposal Team” link
      iii. Click “Add Team Member”
      iv. Enter Student’s name and click “Search” for the Member (Student) – system will display search results.
      v. Select the correct Student, and click “Continue”
      vi. On “Team Member” page, Assign Role/Privileges
      vii. Select “Graduate/Undergraduate Role” from pull down menu.
      viii. Grant Student “Edit” privileges by selecting
          • “Proposal Summary”
          • “Program Specific Data”
          • “Proposal Attachments”
      ix. Select “No” to the two questions that follow the section entitled “U.S. Government Agency & International Participation”
      x. Click “Save”
      xi. Click “OK”
      xii. Advisor MUST Logout of NSPIRES
Step 3

Student logs into NSPIRES.

At initial log on, the Student must follow these steps:

• Under “Reminders/Notifications,” click “Need Graduate/Undergraduate Student Confirmation For Proposal: [proposal title] for Solicitation NASA ASTAR Fellowships 2015 ” link

• On “Team Member: Participation Confirmation” page, Student should read and click “Continue”

• On “Team Member Profile” page, click “Link Relationship”

• On “Team Member: Organizational Relationship” page, go to “Link Proposal to a Non-SAM Organization” – enter your institution name, click button, and click “Save”

• On “Team Member Profile” page, verify information and click “Continue,” which will take you to “View Proposal” page. On “View Proposal” page

i. Select “Proposal Summary” link
   (a) Select “Edit”
   (b) Type or cut and paste the proposal summary into the “Proposal Summary” text box
   (c) Click “Save,” and click “OK”

ii. Select “Program Specific Data” link (Note: Required for the proposal to be considered.)
   (a) Select “Edit”
   (b) Respond to the 48 questions listed.
   (c) Click “Confirm” at the end of the questions, and click “OK”

iii. Proposal Attachments
   (a) Click “Add”
   (b) Select “Proposal Document” as “Attachment Type” from the drop down list
   (c) Browse and select your proposal document

Note: All required proposal elements that are not part of the NSPIRES cover page must be combined into a single .pdf document and uploaded on the NSPIRES site for submission.

Document must include:

<table>
<thead>
<tr>
<th>Component</th>
<th>Maximum Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impact Statement</td>
<td>2 pages</td>
</tr>
<tr>
<td>Project Description</td>
<td>5 pages</td>
</tr>
<tr>
<td>Degree Program Schedule</td>
<td>1 page</td>
</tr>
<tr>
<td>Biographical Sketch</td>
<td>2 pages each</td>
</tr>
</tbody>
</table>
Letters of Recommendation 2 pages each
Transcripts N/A

(d) Click “Upload” and click “OK”

iv. Note: “Complete Proposal” section (“Generate” button enables you to review your proposal in draft prior to submission.) However, this option is independent of the submission process. If proposal fails to generate, you should still proceed with your submission.

v. Student MUST Logout of NSPIRES

Step 4

1. Student MUST now coordinate with his or her Advisor to RELEASE the full proposal to the organization.
   a. The Advisor logs into NSPIRES
   b. Select “Proposals” link
   c. On “Current Proposals/NOIs” page
      i. Select the “Proposal Title” to be released
      ii. On “View Proposal” page
      iii. Click “Release to Org” button
      iv. Click “Release”
      v. Click “OK” [If the Advisor has additional Fellowship proposals to release, repeat process]
      vi. If the Advisor has no additional Fellowship proposals to release, Logout of NSPIRES

2. The Advisor MUST now coordinate with the Authorized Organizational Representative (AOR), who will SUBMIT the full proposal to NASA. The advisor will know that the proposal has been successfully submitted when he/she receives an E-mail from NSPIRES stating that it has been received.

For assistance, you may contact the NSPIRES Help Desk at Phone: (202) 479-9376 or E-mail: nspires-help@nasaprs.com. The Help Desk is staffed Monday to Friday (except for federal holidays) from 8:00 AM to 6:00 PM Eastern Time
If you have questions about any of the following opportunities at Ames Research Center, please contact Brenda Collins at Brenda.J.Collins@nasa.gov or (650) 604 -3540.

ARC-001  Rotorcraft and Vertical Lift Aeromechanics
ARC-002  Parametric and Mechanistic Study of Nanostructured Carbon-Based Catalysis
ARC-003  Facilitation of Program Analysis of Evolving Software
ARC-004  Guidance and Control System Design for Planetary Entry Vehicles Configured with Aeroshell
ARC-005  Tensegrity Robotics Research
ARC-006  Investigations of the Current and Past Climates of Mars
ARC-007  Astronaut Autonomous Operations: Complex Planning and Scheduling
ARC-008  Observational Studies of the (Polarized) Interstellar Medium
ARC-009  Development of Atmospheric Pressure Plasmas for Water Sterilization
ARC-010  Effect of Hypergravity on Specific Populations of Neuronal Clusters in Adult Drosophila using GAL4: UAS–GFP Fly Lines
ARC-011  Active Wing Shaping Concept Using Lattice-based Digital Materials
ARC-012  Nanoelectronics: Novel Nanodevices
ARC-013  Prognostics and Health Management in Electronics: Remaining Life Estimation and Prognostics Informed Control Applied to Power Electronics Systems
ARC-014  In-situ and Ex-situ Damage Assessment Methods to enable Prognostics of Composite Structures
ARC-015  Synthesis of Novel Materials for Nanotechnology-enhanced Energy Generation and Storage
ARC-016  Piezoelectric Nanowires for Nanotechnology-enhanced Power Devices
ARC-017  Uncertainty in Prognostics and Health Management
ARC-018  Advanced Life Support Water Recycling
ARC-019  The Role of Depressed Metabolism in Adaptation to Spacelight Environment
ARC-020  Chemical Dynamics Modeling of Hydrocarbon Polymerization under Cold, Isolated Space Conditions

If you have questions about any of the following opportunities at Armstrong Flight Research Center, please contact Karla Shy at Karla.S.Shy@nasa.gov or (661) 276 -7785.

AFRC-001  Advanced Gas Turbine Disk Concepts
AFRC-002  Composite Material/Structural Multiscale Modeling
If you have questions about any of the following opportunities at Glenn Research Center, please contact Mark D. Kankam at Mark.D.Kankam@nasa.gov or (216) 433-6143.

GRC-001  Aviation Fuel Characterization
GRC-002  Fundamental Aerodynamic Studies of 3D Ice Accretion on Swept Wings
GRC-003  Ice Crystal Breakup Study with Applications for Engine Icing Supporting Air-Breathing Propulsion
GRC-004  Impact/Dynamic Modeling of Advanced Composite Aerospace Components
GRC-005  Experimental Superconducting /Cryogenic Power System for Electric and Hybrid Aircraft
GRC-006  Process Modeling and Testing of Advanced Composite Aerospace Components
GRC-007  Atmospheric Propagation
GRC-008  ThermoElectric Materials
GRC-009  Solid State Battery
GRC-010  Next-Generation Woven Composite Materials
GRC-011  Modeling of a Liquid Acquisition Device for Advanced In-Space Cryogenic Propulsion Systems in Microgravity
GRC-012  Quantum Communications
GRC-013  Composite Material/Structural Multiscale Modeling
GRC-014  Control of Interfacial Instability and Mixing in Supersonic Combustion and in Rocket Ignition
GRC-015  High Efficiency Ka-band Gallium Nitride (GaN) Solid-State Power Amplifiers (SSPAs) for Near-Earth and Deep Space Applications

Goddard Space Flight Center (GSFC)---------------------------------

If you have questions about any of the following opportunities at Goddard Space Flight Center, please contact Mablelene S. Burrell at Mablelene.S.Burrell@nasa.gov or (301) 286-1122.

GSFC-001  Suborbital Tests of Inflationary Cosmology
GSFC-002  Novel Instrumentation for Cosmic Microwave Background Polarimetry
GSFC-003  X-ray studies of galaxies near and far Fellowship
GSFC-004  Aerosol Modeling and Data Assimilation Fellowship
GSFC-005  Observing System Simulation Experiments ((OSSEs) for the Pre Aerosol-Cloud-Ecosystem (PACE) Mission Fellowship
GSFC-006  Observations and Model Fitting for Exoplanet Characterization
GSFC-007  Analysis of Near-Infrared Spectroscopy of Gas in Protoplanetary Disks
GSFC-008  Lidar Remote Sensing
GSFC-009  Study of Planetary Atmospheres With ALMA
GSFC-010  Modeling of Cassini Infrared Spectra of Titan - PHD Fellowship
GSFC-011  Exploring the Heating and Dynamics of the Solar Corona
GSFC-012  Optical Metrology for Free-Flying Test Masses
GSFC-013  Data Analysis for LISA Pathfinder
GSFC-014  Research Opportunities for Space-based Gravitational-wave Observatories
GSFC-015  Radar remote sensing of planetary surfaces
GSFC-016 Multi wavelength Studies of X-ray Sources Using Archived Data from Swift, Kepler and Other Observatories
GSFC-017 Testing and characterization of custom mixed-signal ASICs for science instruments
GSFC-018 Analog and mixed-signal ASIC design for science instruments miniaturization
GSFC-019 Using passive remote sensing to study aerosol/cloud interactions
GSFC-020 Balloon Experimental Twin Telescope for Infrared Interferometry (BETTII)
GSFC-021 Energetic Particles in the Heliosphere
GSFC-022 Cognitive Radio (CR) algorithms for space communications systems in the NASA/GSFC Telecommunications and Technology Branch
GSFC-023 CubeSat communication systems in the NASA/GSFC Telecommunications and Technology Branch

If you have questions about any of the following opportunities at Jet Propulsion Laboratory, please contact Jenny Tieu at Jenny.Tieu@jpl.nasa.gov or (818) 393-5386.

JPL-001 Mobile Augmented Reality Vulcanology Link (MARVL) 3461- YL14 Fellowship
JPL-002 Robotic Control for Automated Cargo Handling 3460
JPL-003 Intelligent Computer Vision & Parallel Processing
JPL-004 Telemetry-based ranging analysis 3427
JPL-005 Cubesat Orbital Debris Removal Mission Development
JPL-006 Extraterrestrial and Terrestrial Terrain Mechanics
JPL-007 Dynamics, Control and Simulation of Planetary Vehicles
JPL-008 CubeSat Database and Modeling to Support Team X for CubeSats
JPL-009 Frequency Metrology and Sensor Technologies
JPL-010 Optical/Digital Pattern Recognition
JPL-012 Team X Model-Based Systems Engineering
JPL-013 Actuation, Drilling and Sampling via Piezoelectric Mechanisms
JPL-014 Human-Computer Interaction for Fast-Moving Design Teams
JPL-015 Analysis of Infrared Observations of Jupiter and Saturn
JPL-016 ISAAC - FPGA-based Instrument Computing/Control Platform
JPL-017 Zintl Phases for Cryogenic Thermoelectric Applications
JPL-018 CubeSat Design Models
JPL-019 Foundry IT Architecture Modernization

If you have any questions about the following opportunities at Johnson Space Center, please contact Frank Prochaska at Frank.E.Prochaska@nasa.gov or (281) 483-1999.

JSC-001 Integrating Inference and Complex Event Processing for Autonomous Logistics Management
JSC-002  Robotics Algorithms Engineer
JSC-003  Space Suit Assembly Engineer
JSC-004  Habitation Systems
JSC-005  Active Response Gravity Offload System Design and Development
JSC-006  Exercise Countermeasures
JSC-007  Cardiovascular Physiology Laboratory
JSC-008  Bone & Mineral Laboratory
JSC-009  Radiation Biodosimetry Lab
JSC-010  Microbiology Laboratory
JSC-011  Neurosciences Laboratory
JSC-012  Solid Oxide Electrolysis and Fuel Cell Power
JSC-013  Thermoelectric and Thermonic Power Conversion
JSC-014  Aneutronic Fusion Plasma Confinement and direct energy conversion
JSC-015  Exploration Flight Test 1 Reentry Data Reduction & Analysis
JSC-016  Nanosensors for Health Monitoring
JSC-017  Simulation of the Thermodynamics and Mass Transport of Brine Recovery
JSC-018  Orion Cockpit Development and Testing
JSC-019  Flight Deck of the Future - Google Glass Implementation for spaceflight use
JSC-020  Spacesuit Portable Life Support System Research and Development
JSC-021  US SpaceSuit Knowledge Capture Engineer
JSC-022  IEEE 802.11-2012 (WiFi) mesh implementation in OpenWRT
JSC-023  Knowledge model for Automatic Test Markup Language (ATML)

If you have questions about any of the following opportunities at Kennedy Space Center, please contact Benita Desuza at Benita.W.Desuza@nasa.gov or (321) 867-3671.

KSC-001  Controlled Environment Research with Plants and Crops for Human Life Support
KSC-002  Data Mining and Knowledge Discover
KSC-003  Development of Multifunctional Smart Coatings for Corrosion Detection and Control
KSC-004  Evolvable Optimal Work Flow and Power Management for In Situ Resource Utilization
KSC-005  Examining the Impacts of Long-Duration and Recurring K-12 Hands-On STEM Education Projects
KSC-006  Lunar Advanced Volatile Analysis (LAVA): Water Vapor Generation and Analysis
KSC-007  Numerical Investigation of the Rigid Body Dynamic (RBD) Simulations of Launch Vehicles During Stage Separation: Research in Meshfree Method
KSC-008  Small Payload Development
KSC-009  Wearable Device: Artificial Intelligence Via Voice Recognition

Marshall Space Flight Center
If you have any questions about any of the following opportunities at Marshall Space Flight Center, please contact Jennifer Simmons at Jennifer.Simmons@nasa.gov or (256) 961-1525.

<table>
<thead>
<tr>
<th>MSFC-001</th>
<th>Design and Performance Modeling of Large Space Telescopes</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSFC-002</td>
<td>Large Space Telescope Telescope Integrated Structural Thermal and Optimal Performance (STOP) Modeling</td>
</tr>
<tr>
<td>MSFC-003</td>
<td>Technology Management at Marshall Space Flight Center</td>
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<tr>
<td>MSFC-004</td>
<td>System Engineering Modeling</td>
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<tr>
<td>MSFC-005</td>
<td>Welding Process Modeling Center</td>
</tr>
<tr>
<td>MSFC-006</td>
<td>Research in Structural Dynamics of Turbomachinery</td>
</tr>
<tr>
<td>MSFC-007</td>
<td>Laboratory Experiments and Analysis in Support of Carbon</td>
</tr>
<tr>
<td>MSFC-008</td>
<td>Investigation of GPS Algorithms for High –G, High –Mach Application</td>
</tr>
</tbody>
</table>
Host Center: Ames Research Center - Moffett Field, CA

Opportunity Title: Rotorcraft and Vertical Lift Aeromechanics

Description/Objective (specific student assignment):
The Aeromechanics Office is responsible for aeromechanics research activities that directly support the civil competitiveness of the U.S. helicopter industry and the Department of Defense. Branch programs address all aspects of the rotorcraft which directly influence the vehicle's performance, structural, and dynamic response, external acoustics, vibration, and aeroelastic stability. The programs are both theoretical and experimental in nature. Advanced computational methodology research using computational fluid dynamics and multidisciplinary comprehensive analyses seeks to understand the complete rotorcraft’s operating environment and to develop analytical models to predict rotorcraft aerodynamic, aeroacoustic, and dynamic behavior. Experimental research seeks to obtain accurate data to validate these analyses, investigate phenomena currently beyond predictive capability, and to achieve rapid solutions to flight vehicle problems. Databases from the flight and wind tunnel experimental programs are validated, documented and maintained for the benefit of the U.S. rotorcraft technology base.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
At the conclusion of the internship, the intern will prepare a final report and either make a final presentation of participate in a poster day. The results of the research, if appropriate and documented, can be considered for abstract submittal to a national conference in the appropriate subject area for publication.

Student's Computer and/or Special Skills:
Broad background in science and math classes typical of an upper division undergraduate work in mechanical, aeronautical or aerospace engineering. Knowledge of MatLab, Simulink, ProE/SolidWorks/AutoCad, C++, Python, or other programming/software languages is desired but not mandatory.

Desired Student Academic Level:
Masters/Doctoral

Academic Disciplines:
Aerospace Engineering
Mechanical Engineering

ARC-002

Host Center: Ames Research Center - Moffett Field, CA
Opportunity Title: Parametric and mechanistic study of nanostructured carbon-based catalysis

Opportunity Description/Objective (specific student assignment):
Fabrication of graphene flakes and their integrated structures through top-down (colloidal process) and bottom-up (chemical vapor deposition) approaches. Functionalization of the carbon structure by various treatments (e.g. doping, UV irradiation and nanoparticle coating). Material characterization using X-ray diffraction, X-ray photoelectron spectroscopy, Raman, thermogravimetric analyzer and electron microscopy. Electrochemical measurements for the evaluation of these nanostructures as the air electrode of fuel cells and metal-ion batteries. Parametric study relating the catalytic activity toward oxygen redox with the material properties (nano-structure, chemical composition, valence state, etc.) and also relating the material properties with fabrication processes (synthesis, functionalization and integration processes).

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills:
Wet chemical processing experience Material characterization experience using XRD, Raman, etc

Desired Student Academic Level
Masters/Doctoral

Academic Disciplines
Materials Engineering Mechanical Engineering

ARC - 003

Host Center: Ames Research Center - Moffett Field, CA

Opportunity Title: Facilitation of Program Analysis of Evolving Software

Opportunity Description/Objective (specific student assignment):
Software is a key to all NASA missions. A large effort is expended in verification, validation, and extensive testing of software that is deployed. There are sophisticated program analysis techniques such as static analysis, model checking, and symbolic execution that have been used to assist in the overall verification effort. Software undergoes and a lot of effort is expended in the verification process when a bug is fixed, a new feature is added, or any change is made to the software. Differential program analysis techniques consider the changes between two different program versions. This fellowship looks for students who can innovate in the design and development of novel techniques for the efficient analysis of evolving program versions.
Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Algorithm that facilitates program analysis of software as it evolves, a technical paper to be submitted to a peer-reviewed venue, and present findings to the robust software engineering group at NASA Ames..

Student's Computer and/or Special Skills:
Strong background in some program analysis technique such as static analysis, model checking, or symbolic execution. Familiarity with software model checkers such as SPIN, Java PathFinder, or any other well known model checker. Strong communication and writing skills.

Desired Student Academic Level
Masters/Doctoral

Academic Disciplines
Computer Engineering
Information Technology
Software Engineering
Computer Science

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**ARC - 004**

**Host Center:**
Ames Research Center - Moffett Field, CA

**Opportunity Title:**
Guidance and Control System Design for Planetary Entry Vehicles Configured with Aeroshell

**Opportunity Description/Objective (specific student assignment):**
To develop an active guidance and control (G&C) system for the ADEPT (Adaptable Deployable Entry and Placement Technology) planetary entry vehicle for Aerocapture and Entry, Descent and Landing (EDL) missions with large payloads. This is a game changer and will allow extending the current investment beyond simple ballistic entry to accomplish lift guided entries, including Aerocapture at Venus, Mars and other destinations. The ADEPT concept utilizes a mechanically deployable aeroshell with a flexible carbon fabric that can be used as both drag generating decelerator and thermal protection system for planetary entry. The goal of this research opportunity is to utilize ADEPT aeroshell as a controllable G&C effector through innovative aerosurface actuation concepts and real-time optimization based control methods for planetary entry maneuvers.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**
Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

**Student's Computer and/or Special Skills:**
Familiar with MATLAB/Simulink and C++

**Desired Student Academic Level**
Masters/Doctoral
Academic Disciplines
Aerospace Engineering
Mechanical Engineering
Applied Mathematics

ARC - 005
Host Center: Ames Research Center - Moffett Field, CA
Opportunity Title: Tensegrity Robotics Research
Opportunity Description/Objective (specific student assignment): We are exploring how tensegrity (continuous tension network) robots can be used for NASA missions while also drawing inspiration from biological examples of tensegrity structures in cells and animal physiology. This opportunity is for students who will research the design, construction, and control of dynamic tensegrity robots. Depending on the skills of the student, project work may include physical design and construction of prototype robots, simulated design work in a physics simulation environment, or designing and evaluation control approaches for the robots. To learn more about our research, please visit: http://www.magicalrobot.org/ Review our publications at: http://www.magicalrobot.org/BeingHuman/vytas-sunspirals-publications And explore our open source tensegrity robotics simulator: http://ti.arc.nasa.gov/tech/asr/intelligent-robotics/tensegrity/ntrt/
Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): It is expected that students in this fellowship will be contributing to cutting edge robotics research, and will be co-authors on academic papers being published by the lab. Furthermore, yearly written reports, oral presentations, and posters summarizing the students work will be expected. Depending on the skills and interest of the student, prototype robots may be built, software contributed to our open source tensegrity robotics simulator, embedded control software developed for the robots, or other contributions to the research effort.
Student's Computer and/or Special Skills: The ideal student will have experience in at least one of the following areas: mechatronics, embedded controls, C++, physics simulation engines, biomechanics, tensegrity structures, robotic manipulation, Central Pattern Generators (CPG)'s, computational neuroscience, or machine learning.
Desired Student Academic Level: Masters/Doctoral
Academic Disciplines
Aerospace Engineering
Computer Engineering
Electrical Engineering
Materials Engineering
Mechanical Engineering
Polymer Engineering
Investigations of the Current and Past Climates of Mars

Climate models for Mars are used in conjunction with a variety of observational data sets to address critical questions regarding the atmosphere and its climate. Specific research areas include: investigating the dust, water and carbon dioxide cycles, their mutual interactions, and how they influence the current climate system; characterizing how the climate has changed in the recent past due to Mars' orbital variations; and understanding the nature of the early Mars climate. Such research topics are consistent with NASA's exploration goals and objectives in planetary science because they seek to further our understanding of the content, origin, and evolution of the Solar System.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

1. A written progress report at the end of each of the first two years. 2. A final research report at the conclusion of the fellowship. 3. Either a poster or oral presentation at one scientific conference per year.

Student's Computer and/or Special Skills:

Familiarity with one or more computer languages such as FORTRAN, C/C++, PYTHON, IDL, or MATLAB is preferred.

Desired Student Academic Level:

Masters/Doctoral

Academic Disciplines:

Astronomy
Earth Sciences
Physical Science
Physics
Opportunity Title:
Astronaut Autonomous Operations: Complex Planning and Scheduling

Opportunity Description/Objective (specific student assignment):
Future human spaceflight exploration class missions envision a group of astronauts that work more independently from Earth-bound ground controllers. As astronauts fly further away than low-Earth orbit and/or mission durations become longer, intermittent and time-delayed communications between Earth and crew will compel crew autonomy. However, this concept of operations is a significant shift from current human spaceflight operations. Our research will focus on enabling crew autonomy for future human spaceflight operations. While a variety of research topics are possible in this area, our emphasis will be supporting crew autonomy at the planning and scheduling level. For almost ten years, the NASA Ames Human Computer Interaction (HCI) Group has developed and deployed planning and scheduling software tools for space operations, supporting both human and robotic missions, with and without time-delay. Our experience indicates that planning and scheduling is an integral component of space operations because it serves as the integration point of all operations. From that perspective, if crew is to have autonomy for exploration-class missions, NASA needs to find a way of providing crew the ability to easily incorporate their in-situ information their schedule without burdening them with the complexity of planning that currently requires dozens of ground controllers. Working with the HCI Group will allow our research to be conducted using the state-of-the-art planning and scheduling tools used in current space operations. These tools have supported missions that include Mars landers and rovers, Lunar orbiting satellites, and the International Space Station program. We will use SPIFe (Scheduling and Planning Interface For exploration) and Playbook in order to investigate how we can enable crew to perform planning and scheduling tasks, and the factors affect that performance, such as plan complexity, constraint complexity, and violation resolution. Our goal is not to have a schedule automatically planned for crew, but to investigate how crew can manipulate their schedule to achieve a plan that satisfies mission constraints. This work will contribute to the Human Research Program, as part of Space Human Factors and Habitability. It also will contribute to the Advanced Exploration Systems program as they focus on developing and validating operational concepts for future human missions beyond Earth orbit, which includes autonomous mission operations.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Expected outcomes: - Conduct human-in-the-loop experiments with planning and scheduling support tools. - Quarterly status meetings. - Yearly summary reports. - Poster and oral presentation

Student's Computer and/or Special Skills:
The following skills would be advantageous: - background in human factors, human-computer interaction, or the like. - experimental design experience, statistical analysis experience - computer programming skills (desirable but not required)
Desired Student Academic Level: Masters/Doctoral

Academic Disciplines:
- Aerospace Engineering
- Computer Engineering
- Industrial Engineering
- Software Engineering
- Systems Engineering/Design
- Computer Science

ARC - 008

Host Center: Ames Research Center - Moffett Field, CA

Opportunity Title: Observational Studies of the (Polarized) Interstellar Medium

Opportunity Description/Objective (specific student assignment):
Opportunities exist to participate in programs of multi-wavelength observational astronomy with an emphasis on studies of the interstellar medium (ISM). Current work involves observations and analysis with data from space- and ground-based observatories spanning wavelengths from the visible to radio. Scientific investigations emphasize studies of light polarized by emission from and extinction by interstellar dust, its connection with interstellar magnetic fields, and physics of the same. Ancillary data sets for these studies include spectroscopic measurements of the stellar, atomic, and molecular phases of the ISM and provide additional opportunities to study spectral classification, interstellar extinction, density and temperature profiles of Galactic clouds, and star-formation. For example, one goal is to study correlations between the strength of the polarization signal and the environmental conditions (i.e., temperature, density, radiation field) of interstellar clouds in an effort to test physical models of dust alignment with magnetic fields. In-hand data include (but are not limited to) polarization of background starlight and emission from Galactic molecular clouds, photometric imaging, and spectroscopic observations from facilities such as the Spitzer Space Telescope, the Wide-Field Infrared Survey Explorer (WISE), the Herschel Space Telescope, the W. M. Keck Observatory, and the Green Bank Telescope (GBT). Plans for future observations include the Stratospheric Observatory for Infrared Astronomy (SOFIA) and the Combined Array for Research in Millimeter-wave Astronomy (CARMA). We encourage suggestions for additional observations or analysis tools that could be used to test astrophysical models of interstellar dust and molecular clouds.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Refereed journal articles as first-author and co-author and associated oral and poster presentations at relevant conferences

Student's Computer and/or Special Skills:
Ideal candidates for this opportunity have interests in star-formation, the Galactic interstellar medium, interstellar chemistry, and/or data analysis.
**Desired Student Academic Level** | Masters/Doctoral  
---|---  
**Academic Disciplines** | Astronomy  
| Physics  

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**ARC - 009**  
**Host Center:**  
Ames Research Center - Moffett Field, CA  
**Opportunity Title:**  
Development of Atmospheric Pressure Plasmas for Water Sterilization  
**Opportunity Description/Objective (specific student assignment):**  
Water is a crucial resource in international space station that is recycled and stored for long term use for astronauts. Inactivation of water borne micro-organisms is crucial for long duration manned space missions. Atmospheric pressure plasmas are an emerging technology for several environmental applications. An in-house (NASA ARC) developed atmospheric pressure based dielectric barrier discharge (DBD) technology has been proposed for water sterilization. Preliminary results on decontamination of E. Coli in water, using the proposed technology, demonstrate a clear bactericidal effect. A plasma jet tool with flexible and movable head and with varying configurations, will be developed for high throughput processing. Water sterilization will be performed by spiking different concentrations of micro-organisms in water and treating with plasma jet. The primary objective is to develop a high throughput water sterilization system and understand the inactivation mechanism. Development of a high throughput system in year 1 will be followed by a detailed scientific project jointly with Stanford Synchrotron Radiation Lightsource at Stanford University, to understand the inactivation mechanism. The continued research by the fellow in his/her university, with continued input/support from the host group at NASA ARC, will address a key scientific challenge, understanding of the interaction of plasma generated species with the microbe and the surface chemical changes that result in bactericidal effect.  

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**  
Detailed research report upon conclusion of each CBRE, Poster and Oral presentations at the end of each internship at Ames, a minimum of 1 scientific publication in a peer reviewed journal.  

**Student's Computer and/or Special Skills:**  
Proficiency in Microsoft Office  

**Desired Student Academic Level** | Masters/Doctoral  
---|---  
**Academic Disciplines** | Biomedical Engineering  
| Chemical Engineering  
| Electrical Engineering  
| Environ Engineering
Effect of Hypergravity on Specific Populations of Neuronal Clusters in Adult Drosophila using GAL4: UAS–GFP Fly Lines

So far we have established in our lab that both acute and chronic hypergravity will induce significant oxidative stress across the life stages of the fruit fly Drosophila melanogaster, specifically in adult female heads. It is well recognized that, neuronal tissue is highly susceptible to oxidative stress due to various reasons such as high oxygen consumption, high iron content, relatively low antioxidant defense, PUFA (poly unsaturated fatty acids)-rich nature of the brain, and brain metabolism based generation of peroxides (H2O2). Hence, we strongly believe that chronic hypergravity might be affecting the functioning of specific neuronal clusters via oxidative stress in the fly brain. Therefore there is a strong interest in the lab to study the impact of hypergravity on specific populations of neuronal clusters in adult Drosophila using GAL4:UAS–GFP fly lines.

The expectation is that the research will culminate in a peer-reviewed journal publication. At a minimum a detailed research report will be compiled at the end of each year. Presentation at a scientific conference will also be encouraged depending on the outcome of the research effort.

In a PhD program in molecular biology, neurobiology, cell biology, genetics or a related field. Some experience with Drosophila research would be considered a plus but is not essential for the position.

Desired Student Academic Level

Doctoral

Academic Disciplines

Molecular Biology,
Neurobiology
Cell Biology
Genetics or a related field
Active Wing Shaping Concept Using Lattice-based Digital Materials

Earlier research studies conducted by NASA have proven that active control of wing aeroelasticity in-flight can be effective in reducing aerodynamically induced drag and enhancing lift performance. The analyses showed that through active control of wing twist and deflection at local wing sections the overall aerodynamic efficiency can be improved. The proposed research opportunity presents a revolutionary active wing shape morphing aerostructure control concept that utilizes the advanced composite lattice-based cellular materials to implement continuous shape morphing and improve aerodynamic efficiency for future air vehicles. With placement of distributed actuation and elastic components of varying stiffness, a novel multi-disciplinary and multi-objective flight control system can be developed to achieve light weight, fuel efficient, and aerodynamically effective wing shape morphing for various flight scenarios. Continuous wing shape measurement/estimation through distributed elastic components, hence online modal estimation and in-situ modal control can be realized.

The expectation is that the research will culminate in a peer-reviewed journal publication. At a minimum a detailed research report will be compiled at the end of each year. Presentation at a scientific conference will also be encouraged depending on the outcome of the research effort.


Doctoral

Aerospace Engineering
Instrumentation Engineering
Materials Engineering
Mechanical Engineering

Nanoelectronics: Novel Nanodevices

We have research activities in progress to fabricate and test nanoscale vacuum tubes capable of high frequency performance and radiation-immune operation. Vacuum is better for electron transport than any semiconductor
student assignment): and in nanoscale, the vacuum devices outperform conventional electronics. The fabrication is based entirely on silicon technology and therefore expected to be inexpensive. Efforts are also underway to fabricate sensors on paper substrates including chem, bio and radiation sensors. Opportunities in these projects involve growth of nanomaterials, characterization, device fabrication, device testing and evaluation, failure analysis and reliability studies. These are interdisciplinary projects requiring hands-on skills have exceptional promise not only for Space missions but also for societal applications.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): The expectation is that the research will culminate in a peer-reviewed journal publication. At a minimum a detailed research report will be compiled at the end of each year. Presentation at a scientific conference will also be encouraged depending on the outcome of the research effort.

Student’s Computer and/or Special Skills: Majoring in electrical engineering, Physics, material science, chemistry and other engineering disciplines

Desired Student Academic Level: Doctoral

Academic Disciplines

- Electrical Engineering
- Materials Engineering
- Physics
- Chemistry
- Engineering, general

ARC - 013

Host Center: Ames Research Center - Moffett Field, CA

Opportunity Title: Prognostics and Health Management in Electronics: Remaining Life Estimation and Prognostics Informed Control Applied to Power Electronics Systems

Opportunity Description/Objective (specific student assignment): The development of prognostic methodologies (i.e., the in-situ ability to estimate remaining life of components) for the electronics field has become more important as more electrical systems are being used to replace traditional systems in applications areas like next generation aeronautics, maritime, and automotive applications. However, the development of prognostics methods for electronics faces several challenges due to the great variety of components used in a given system, continuous development of new electronics technologies, and a general lack of understanding of how electronics fail.

DC-DC Power supplies are a critical part of modern avionics systems. Within those, capacitors and MOSFETs are one of the components of concern due
Capacitors are used as filtering elements on power electronics systems. Electrical power drivers for motors require capacitors to filter the rail voltage for the H-bridges that provide bidirectional current flow to the windings of electrical motors. These capacitors help to ensure that the heavy dynamic loads generated by the motors do not perturb the upstream power distribution system. MOSFET’s with the help of switching try to minimize the voltage ripples and maintain the current requirement. These two important components direct the output efficiency of the DC-DC power supply.

OBJECTIVE:

Electrolytic capacitors and MOSFET’s have become critical components in electronics systems in aeronautics and other domains. Due to their low reliability and frequent breakdown, they affect the overall operational efficiency of power supplies and affect crucial systems down the line. The objective of this work will be the development of validated prognostics methodologies at a sub-system level along with component level prognostics. In particular, we develop condition-based health assessment techniques based on physics models. Leveraging knowledge degradation physics at subsystem level to predict remaining useful life as a function of current state of health and anticipated operational and environmental conditions. In addition, the development of new control regimes for power electronics systems, tacking into account the prognostics information from degrading components is to be developed.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

The expected outcome of this fellowship is the following:

- Accelerated life test experiment systems and stress level settings for key failure mechanisms at component level.
- Observe the effect of component aging and degradation on the operational efficiency of the power supply.
- Categorize accelerated aging experiment datasets for key failure mechanisms under different loading and environmental conditions.
- Physics-based degradation models for key failure mechanisms validating with experimental data based on accelerated life test experiments.
- Model validation methodology for developed degradation models, under relevant usage environments like permanent magnet motor power electronics driver.
- Perform remaining useful life prediction algorithms under varying future loading and environmental conditions.
- Validate developed models for remaining useful life prognostics algorithms under a relevant usage environment.
- Develop new prognostics informed methodologies for control of power electronics systems.

All work must be published in conference proceedings and relevant journals. The target publications are two conferences and one journal paper. All relevant technical information like design specification of custom electronics systems must be documented in NASA technical memorandums.

Student's Computer and/or Matlab/Simulink.
**Special Skills:**

**Desired Student Academic Level**
- Masters
- Doctoral

**Academic Disciplines**
- Aerospace Engineering
- Computer Engineering
- Electrical Engineering
- Instrumentation Engineering
- Mechanical Engineering
- Physics
- Computer Science
- Engineering - General

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**ARC - 014**

**Host Center:**
Ames Research Center - Moffett Field, CA

**Opportunity Title:**
In-situ and Ex-situ Damage Assessment Methods to enable Prognostics of Composite Structures

**Opportunity Description/Objective (specific student assignment):**
This opportunity is towards developing in-situ and ex-situ methods for the delamination detection of composite laminates. Delamination is one of the key damage modes in composite laminates. Delamination can simultaneously occur in multiple layers, which compromises composite integrity in different ways. Therefore, accurately characterizing the delamination is critical in predicting structure's fatigue life. This method will allow collecting ground truth information on delamination damage without removing the specimen from fatigue test rig, which would provide key information towards validating prognostic algorithm development for composite structures in aerospace applications. Composite materials are increasingly being used in a variety of applications, including aircraft structures. NASA is currently investigating prognostics technology within the context of the System Wide Safety Assurance Technologies (SSAT) and Integrated Vehicle Health management (IVHM) projects as part of the Aviation Safety Program. This opportunity will enhance the understanding of how internal damage can be measured via in-situ and ex-situ methods. Further, data collected from this work will be valuable resource in developing prognostics technology for composite structures. One of possible methods to be explored is infrared thermography. Infrared thermography is widely utilized for two-dimensional damage detection. The temperature difference caused by the invisible damage can be captured by the visible infrared images from the material surface. As a result, the internal damage, such as delamination, can be detected using certain image processing techniques. The objectives are to investigate the feasibility of the thermography damage detection technique and explore appropriate data...
Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Expected outcome of this research would be damage measurement methods applicable in-situ and ex-situ to collect ground truth information about delamination damage, which is internal to composite structures and often invisible from surface. The study will also generate composite coupon fatigue data that will be relevant for prognostic algorithm development and also towards guiding future research efforts in this area.

Student’s Computer and/or Special Skills:
Matlab/Simulink, Labview, basics of signal processing, experience with MTS or equivalent load cycling equipment, basic knowledge about material fatigue, and composites. This project will involve lab experiment set up and conducting multiple experiments to identify best design to collect relevant data. May involve some travel to lab facilities outside ARC campus.

Desired Student Academic Level
Masters
Doctoral

Academic Disciplines
Aerospace Engineering
Computer Engineering
Electrical Engineering
Instrumentation Engineering
Structural Engineering
Electronics
Comp Science
Engineering - General

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ARC - 015
Host Center: Ames Research Center - Moffett Field, CA
Opportunity Title: Synthesis of Novel Materials for Nanotechnology-enhanced Energy Generation and Storage

Opportunity Description/Objective (specific student assignment):
Novel nanotechnology enhanced devices can be used for energy generation using piezoelectric metal oxide nanowires for harvesting electrical energy from ambient mechanical vibrations and growth of graphene for its potential applications involving improved energy storage devices, such as with better batteries. Critical to these advancements is the materials development involving Chemical Vapor Deposition (CVD) and integration into device structures within the field of Nanotechnology. The project will involve growth of the nanomaterials used for energy generation and/or energy storage applications. Specifically, we will investigate the growth parameters' impacts on material properties and subsequent effect on nanotechnology device performance.

Expected opportunity outcome
Expected outcome involves synthesis of nanomaterials with optimized
**Opportunity Title:** Piezoelectric Nanowires for Nanotechnology-enhanced Power Devices

**Opportunity Description/Objective (specific student assignment):**
Piezoelectric metal oxide nanowires can be used for harvesting electrical energy from ambient mechanical vibrations. These Nanotechnology-based nanowires could be incorporated into shoes, clothes, etc. and generate power from simple movement. Critical to this is the growth of piezoelectric nanowires and subsequent integration into a device structure to extract power. Project involves both growth of piezoelectric nanowires using Chemical Vapor Deposition and integration into device structures in the Nanotechnology processing facilities.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**
Expected outcome involves a detailed research report at the end of the internship in addition to possible poster and/or oral presentation, depending on the scheduling.

**Student's Computer and/or Special Skills:**
Hands-on laboratory experience with chemistry, physics, and materials background.

**Desired Student Academic Level**
Masters  
Doctoral

**Academic Disciplines**
Chemical Engineering  
Electrical Engineering  
Materials Engineering  
Chemistry  
Physics  
Nanotechnology
Host Center:  
Ames Research Center - Moffett Field, CA

Opportunity Title:  
Uncertainty in Prognostics and Health Management

Opportunity Description/Objective (specific student assignment):
Prognostics and health management deal with predicting the behavior of complex engineering systems and making risk-informed decisions regarding the operations of such systems. There are several sources of uncertainty that affect their performance; therefore, it is important to quantify and effectively manage these sources of uncertainty, and estimate their overall effect on prognostics in order to provide meaningful information for decision-making. The student will be responsible for developing computational approaches and algorithms that address and rigorously account for the various effects of uncertainty on prognostics and health management. It is important to develop metrics that assess the performance of such algorithms, assist system verification and validation, and guide decision-making activities such as design optimization, fault mitigation, fault recovery, path planning, mission re-planning, etc. Possible areas of application include, but not limited to, aerospace systems such as planetary rovers, unmanned aerial vehicles, rotorcrafts, etc., electrical and electronic components such as lithium-ion batteries, capacitors, etc., mechanical systems consisting of motors, valves, actuators, etc., and structural composites used in aerospace, mechanical, and civil engineering.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Expected outcome involves a detailed research report at the end of the internship in addition to possible poster and/or oral presentation, depending on the scheduling.

Student's Computer and/or Special Skills:
The student is expected to have fundamental technical knowledge in the field of prognostics, and statistics and probability. Further, the student needs to be familiar with MATLAB or equivalent mathematical tools that are necessary for implementing different types of computational methods and algorithms.

Desired Student Academic Level:
Masters  
Doctoral

Academic Disciplines:
Aerospace Engineering  
Civil Engineering  
Computer Engineering  
Electrical Engineering  
Industrial Engineering  
Materials Engineering
Mechanical Engineering
Nuclear Engineering
Structural Engineering
Applied Mathematics
General Mathematics
General Engineering

ARC - 018

Host Center: Ames Research Center - Moffett Field, CA

Opportunity Title: Advanced Life Support Water Recycling

Opportunity Description/Objective (specific student assignment): Advanced life support systems include all systems and technologies required to keep astronauts alive in space. They include water recycling, air recycling, waste treatment and energy systems. This fellowship is primarily focused on water recycling. Although research into all innovative water recycling technologies are solicited, a particular emphasis this year will be placed on research into the development of anion and cation separation membranes for electrodialysis and ammonia fuel cell applications. Research should focus on development and testing of new membranes that offer improved resistance to fouling, ion flux, and stability. but is cognizant that an optimized system will include integration with air and waste systems, so proposal in these areas are also solicited. Also of interest is systems that recover energy from wastes or disequilibrium processes. In situ resource utilization in spacecraft and on planetary surfaces is also of interest. Or primary interest is in innovative, out of the box, concepts. Incremental improvements to existing space flight hardware is not the primary objective of this research.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Expected outcome involves a detailed research report at the end of the internship in addition to possible poster and/or oral presentation, depending on the scheduling. Additional outcomes include flight experiments, ground based prototype hardware, and flight hardware.

Student's Computer and/or Special Skills: Innovation is the only skill required. This internship is designed to train the next generation of NASA employees how to innovate and to develop the next generation of space flight systems that will enable the human exploration and colonization of the Solar System.

Desired Student Academic Level: Doctoral

Academic Disciplines: Biomedical Engineering
Chemical Engineering
Environmental Engineering
Polymer Engineering
Biology
Host Center: Ames Research Center - Moffett Field, CA

Opportunity Title: The Role of Depressed Metabolism in Adaptation to Spacelight Environment

Opportunity Description/Objective (specific student assignment):

With the growing interest for long haul flights and colonization of solar system, it becomes important to develop organism self-regulatory control system which would allow to meet the requirements of extraterrestrial environments rather than providing an Earthly environment in space. A better mechanistic understanding of metabolism offers a means for sustaining astronauts in long-duration missions beyond the low Earth orbit. Recent data obtained from several research reports have shown that metabolic suppression could protect biological organisms from damaging effects of space radiation and microgravity. The ability to drastically reduce and suspend metabolism appears to be closely tied to the unique survival of bacteria and some invertebrates (e.g., tardigrades) after a prolonged exposure to cosmic vacuum and radiation. Remarkably, many animals including human-size bears, which are largely inactive during 6 to 8 months of hibernation, show no loss in bone mass and less muscle atrophy than would be anticipated over such a prolonged period of physical inactivity. This suggests that in suppressed metabolic state animals have unique natural mechanisms to prevent disuse muscle and bone atrophy. It is possible that there is a monophyletic origin for this adaptation at the molecular level among a variety of different organisms. The molecular mechanisms underlying these important adaptations are not known. Our ultimate goals are to demonstrate proof-of-principle for metabolic suppression as means to reduce the negative effects of spaceflight environmental, such as radiation and microgravity. In order to demonstrate the potential application of the metabolic control technology the PI's laboratory at NASA Ames Research Center has engineered a hypo-metabolic chamber with a range of life-monitoring equipment for high-throughput testing of hypo-metabolic parameters and conditions that enable reversible induction of a state of suspended animation in non-hibernating animals.

Expected outcome involves a detailed research report at the end of the internship in addition to possible poster and/or oral presentation, depending on the scheduling.

Student's Computer and/or Special Skills: Student should be willing to work with animals. He/she should have basic knowledge of metabolism, have basic laboratory skills and technical
knowledge for conduction of well planned experiments. Strong analytical and organizational skills; Interest in biology; Interest in data analysis. Senior undergraduate at junior/senior level or higher preferred.

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<th>Desired Student Academic Level</th>
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<th>Academic Disciplines</th>
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<td>Biomedical Engineering</td>
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**ARC - 020**

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<td>Ames Research Center - Moffett Field, CA</td>
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<th>Opportunity Title:</th>
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<td>Chemical Dynamics Modeling of Hydrocarbon Polymerization under Cold, Isolated Space Conditions</td>
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<th>Opportunity Description/Objective (specific student assignment):</th>
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<td>Our research looks at how molecules react in cold, isolated space environments such as the interstellar or circumstellar mediums. We are particularly interested in how hydrocarbons are ionized from stellar or cosmic radiation and then react with other hydrocarbons to form larger molecules under these environments. We study this in the laboratory and with computational models to understand the processes in space. The project is looking for a student that will help model these reactions, under these very distinct conditions. The student will also work with international collaborators to look at the effects that the plasma has on the reaction processes of hydrocarbons. The student will work closely with astrophysicists and experts on the reaction of molecules in space environments to analyze the results and to connect the laboratory work with astronomy observations and models.</td>
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<td>It is expected that the student will contribute to advancing the field of molecular interactions in space. Data output using chemistry and modeling codes is expected and summaries that may lead to publications in professional science journals from this data need to be delivered in a timely manner.</td>
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<td>Student needs to be familiar with chemical reaction theory, and/or the use of modelling codes for astrophysics/astrochemistry or chemistry applications. Matlab experience is beneficial but not required. Languages</td>
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such as C, Java, or Fortran are also a plus.

**Desired Student Academic Level**
- Masters
- Doctoral

**Academic Disciplines**
- Chemical Engineering
- Nuclear Engineering
- Polymer Engineering
- Applied Mathematics
- Astronomy
- Chemistry
- Physics
- Computer Science

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**ARMSTRONG FLIGHT RESEARCH CENTER**

**AFRC-001**

**Host Center:**
Armstrong Flight Research Center – Palmdale, CA

**Opportunity Title:**
Developing an Integrated Information Architecture Framework

**Opportunity Description/Objective**

NASA Armstrong is seeking novel ways to design an infrastructure for managing its vast amounts of data and information to improve user access, efficiency, and retention. The NASA environment is perhaps unique in the scope of its information operations. The range of internal (NASA and other federal agencies) and external (academia, industry, and international) stakeholders and the degree to which business operations are tightly integrated with scientific research result in a complex information management environment. Users generate and require access to a variety of data types including test (ground and flight), programmatic, operations, organizational, and multimedia data that typically have multiple, independent storage, access and retrieval solutions. Successful flight research requires the access of multiple data sources. It requires research data in the form of flight data, tests cards, instrumentation lists, sensor information, pilot comments, weather data, and audio and video data. Successful flight research is also dependent on operational data that includes project, maintenance, scheduling, facility, and resource data. This dependence demonstrates the tight integration of operations and scientific research. A single information architecture framework is critical to successful research operations and the continued availability of the valuable data to researchers in the future. This fellowship will consist of a case study to explore the research question: “to what degree can a single information architecture framework satisfy both business and research operations information requirements?” Specifically, the student will evaluate the current Armstrong information environment, select a suitable information architecture framework, assist in its implementation, and evaluate research
and business operations in the new information paradigm.

This Opportunity aligns with the mission of the NASA Chief Information Officer. The findings of this study will be relevant in a variety of government and corporate contexts including federal agencies, national labs, federally funded research and development centers (FFRDC), pharmaceutical corporations, research universities, and others.

Student researchers will have access to the information resources associated with operations and flight research at the Armstrong Flight Research Center. Subject matter experts will be available for various aspects of operations and research. Student researchers will also have the opportunity to observe flight research operations, support operations, and IT operations.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

A detailed report describing an integrated Information Architecture solution, concept of information management operations to support both operations and research, and functional assessment.
Oral presentation and possible Poster (typically during summer sessions)

Student’s Computer and/or Special Skills:

Student researcher must have a strong academic background in information management and information architecture

Desired Student Academic Level

Masters or Doctoral

Eligible Academic Disciplines:

Data Science
Computer Science
Information Management/Architecture

AFRC-002
Host Center: Armstrong Flight Research Center – Palmdale, CA
Opportunity Title: Aeroservoelastic Control using Distributed Sensing Fellowship

Opportunity Description/Objective (specific student assignment):

ARMD and other work related to advanced stability and control of aeroservoelastic systems in uncertain environments. The ability for flexible motion control will help in opening the design space for lighter weight airplanes which will increase fuel efficiency and help with noise reduction. The increased flexibility creates an airplane that is more susceptible to aeroelastic phenomena such as flutter, divergence, gust loads and maneuver loads. The ability to control the flexible motion would allow the control system to suppress the aeroelastic and aeroservoelastic instabilities and improve performance. Distributed sensing allows for more localized control for general aeroservoelastic systems. Distributed sensing, identification, modeling, and control for aeroservoelastic systems with potential application on the NASA Armstrong X-56A aircraft using sensors such as fiber optic displacement sensors, accelerometers, and hot-films (for critical
aerodynamic flow feature indicators, CAFFI, and aero loads). The overall goal of the proposed research is to develop adaptive and robust control methods for uncertain and potentially nonlinear aeroelastic and aeroservoelastic systems in the presence of adverse conditions (i.e., wind gust and maneuver loading, unsteady aerodynamic forcing such as flutter, and unknown dynamics or disturbance). The proposed research is concurrent with current efforts at NASA Armstrong and can broadly be divided into a set of four objectives: OBJECTIVE 1: Develop algorithms for the distributed sensor systems such that the distributed measurements can be transformed into observable states for feedback control. Before sensor information can be utilized for feedback control, the signals will have to be properly altered and understood such that an algorithm can convert the data information into usable state information. OBJECTIVE 2: Use an adaptive robust feedback controller to attenuate the aeroelastic responses via active actuation. Using the aerodynamic and structural state information gathered from the sensors, develop a closed loop active controller that can alleviate the flexible dynamics caused by gust loading and flutter resonance forcing. OBJECTIVE 3: Combine the previous aeroservoelastic alleviation controller into a flight dynamics controller. The objective is to suppress unwanted vibration dynamics while simultaneously tracking flight state trajectories. OBJECTIVE 4: Using simulation studies, develop stability margins for the proposed control scheme and develop bounds for the initial system condition requirements. Using both the structural vibration alleviation and flight controllers, study the requirements of gain tuning and evaluate the overall performance. Evaluate the optimality of the control design with respect to some cost function (i.e., control input versus tracking error).

Expected opportunity outcome (i.e., research, final report, poster presentation, etc.): The proposed research effort builds on previous research at NASA AFRC. To achieve the objectives, the following tasks will be pursued. TASK 1: Modeling and identification of distributed sensed aeroelastic systems. Identify appropriate aeroelastic models that can be used in conjunction with online parameter identification and subsequent control design. TASK 2: Adaptive control development using distributed aeroservoelastic sensing. Using active and adaptive control, alleviate flutter phenomena as well as gust and maneuver loading. TASK 3: Simulations study for these active/adaptive aeroservoelastic control algorithms and systems. Examine the transient performance characteristics, control gain designs, allowable initial conditions, and optimality based on a meaningful cost function. TASK 4: Experimental results with possible application to NASA X-56A aircraft. Validate theory and simulation results. Perform data acquisition and analysis and make any require modifications in the control design. All expected work products, milestones and outcomes: Algorithms for distributed sensed aeroservoelastic systems; Active/adaptive control using distributed aeroservoelastic sensing; Simulation of these aeroservoelastic systems Application to the NASA X-56A aircraft;

Student's Computer and/or Special Skills: Modeling and identification of distributed sensed aeroelastic systems; Active/adaptive control developments using distributed sensing and control; Simulation for active/adaptive control of aeroservoelastic systems;

Desired Student Academic Level Masters

Eligible Academic Engineering - Aerospace Eng.
Engineering - Mechanical Eng.
Mathematics - Applied Mathematics
Technology - Information Technology

GLENN RESEARCH CENTER

GRC-001

Host Center: Glenn Research Center - Cleveland, OH

Opportunity Title: Aviation Fuel Characterization

Opportunity Description/Objective (specific student assignment): The NASA Fundamental Aeronautics Fixed Wing Project has ongoing interest in the thermal stability characterization of alternative fuels and has collected data using a Hot Liquid Process Simulator to make Jet Fuel Thermal Oxidation Tester (JFTOT) measurements, per American Society for Testing and Materials (ASTM) D3241. This standardized test method is limited by the qualitative test results, and we are interested in providing more quantitative results in the area of thermal stability research. The objective of this project is to successfully determine the film thickness and profile of oxidative fuel deposits on JFTOT heater tubes of various metal substrates. The award recipient will be given the opportunity to use NASA’s current instrument, a Horiba Scientific Auto Spectroscopic Ellipsometer (SE). The student will also have access to Horiba model developers for technical assistance on model development and instrument functionality, as well as various technical experts at NASA for guidance. If the award recipient has time and is capable/interested, the idea to incorporate predictive models could be useful.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills: Experience or interest in Optics/Ellipsometry; Chemistry background and/or experience with chemical reactions, fuel decomposition; and Materials background and/or interest, specifically stainless steel and aluminum surface

Desired Student Academic Level: Masters/Doctoral

Academic Disciplines: Physics, Chemical Engineering, Mechanical Engineering, Materials Science

GRC-002

Host Center: Glenn Research Center - Cleveland, OH
Opportunity Title: Fundamental Aerodynamic Studies of 3D Ice Accretion on Swept Wings

Aircraft icing research at NASA is supported under Aeronautics Research Mission Directorate (ARMD) programs. Airframe icing is a key challenge whose aim is to develop improved computational and experimental simulation tools for swept wings operating in atmospheric icing including freezing drizzle and freezing rain. The objective of this research is to develop a fundamental understanding of how highly three-dimensional, scallop-shaped ice accretions affect the aerodynamics of a modern, realistic swept wing near stall. This includes identifying key flowfield features and the importance of geometric fidelity of the simulated ice accretion. An understanding of the important aerodynamic features is critical to determining the accuracy to which the scallop geometry must be replicated in computational or experimental models. For example, if the key aerodynamic features are not critical to the iced-swept wing aerodynamics, then much more simplified geometric models could be used in place of the highly 3D geometry. This could be an important simplification resulting in accurate simulation tools at reduced cost. There is very little data available in the published literature that has addressed this problem for modern, realistic swept-wing geometries. Fundamental studies are needed to investigate the details of the three-dimensional flowfield.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills: Sufficient experimental or computation research experience to accomplish the objectives described in the topic.

Desired Student Academic Level: Masters/Doctoral

Academic Disciplines: Aerospace Engineering, Mechanical Engineering, Aeronautical Engineering, Theoretical and Applied Mechanics

GRC - 003

Host Center: Glenn Research Center - Cleveland, OH

Opportunity Title: Ice Crystal Breakup Study with Applications for Engine Icing Supporting Air-Breathing Propulsion

Aircraft jet engine ingestion of ice crystals can cause, at operation conditions, loss of thrust due to ice accretion or accumulation and possible subsequent ice shedding in the engine core. The ice accretion and shedding can affect the performance of the compressors leading to surging or stalling and in some cases causing permanent damage to the units. It is a serious in-flight safety problem. NASA is currently making significant research investments to better understand the fundamental physics of ice-crystal
icing processes. The project will involve the study of ice particle impacts and accretion physics on engine components. Specifically, we will investigate the main parameters involved and how to model the impacts using computational tools.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills: N/A
Desired Student Academic Level: Masters/Doctoral
Academic Disciplines: Aerospace Engineering, Mechanical Engineering, Applied Mathematics, Physical Science

GRC - 004
Host Center: Glenn Research Center - Cleveland, OH
Opportunity Title: Impact/Dynamic Modeling of Advanced Composite Aerospace Components
Opportunity Description/Objective (specific student assignment):
Analysis methods to enable the impact and transient dynamic analysis of aerospace components composed of polymer matrix composite materials with complex material architectures, structural geometries and loading conditions are a research area of interest. Specific application areas of interest include engine containment structures subject to blade-out conditions, fan blades subjected to bird strikes, and rotating drive system components such as shafts, couplings, and gears. Specific research problems of interest include analyzing thick composites with complex fiber architectures, improving analysis methods in general for simulating the response of composites with complex fiber architectures, analyzing composites with local material defects and irregularities such as fiber angle changes and design discontinuities such as ply drops, and modeling the interface between the composite and non-composite components of the structure. The research is expected to utilize commercially available transient dynamic finite element codes, and to employ material models and methods either currently available within the codes or under development.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Composite mechanics, finite element analysis, Nonlinear continuum mechanics including plasticity and/or damage mechanics, familiarity with
Special Skills: commercial transient dynamic finite element codes preferably LS-DYNA.

Desired Student Academic Level: Masters/Doctoral

Academic Disciplines: Aerospace Engineering, Civil Engineering, Mechanical Engineering

GRC - 005

Host Center: Glenn Research Center - Cleveland, OH

Opportunity Title: Experimental Superconducting / Cryogenic Power System for Electric and Hybrid Aircraft

Opportunity Description/Objective (specific student assignment): Novel configurations and operational concepts for both vertical lift and fixed wing aircraft are enabled by more electric/hybrid electric aircraft power/propulsion systems. The benefits of integrating these new systems can include reduced emissions, higher efficiency, reduced noise, and increased system reliability. The highest efficiencies and lowest weight power system components are achieved by operating at cryogenic temperatures. This includes conventional and superconducting electric machines, power electronics, and superconducting electrical distribution. A complex power system providing primary propulsion must be robust and fault tolerant, particularly for vertical lift applications. A modular, reconfigurable test rig is being built at GRC for testing novel superconducting and cryogenic components, materials, and system characteristics at the 10-20 kW scale. Areas of interest include, but are not limited to cryogenic power system protection devices, fault detection and recovery, operational stability and control methodologies, degraded state system performance, and fault tolerant control algorithms. Potential projects may involve design or formulation of new components and/or control methods, fabrication of prototype components, system integration, and testing. Successful applicants will work closely with the research team during test rig build up and testing, including implementation of the applicants' research objectives.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills: Programming, electronics, data acquisition, modeling and simulation

Desired Student Academic Level: Masters/Doctoral

Academic Disciplines: Electrical Engineering, Applied Math, Physics, Engineering
**Host Center:**
Glenn Research Center - Cleveland, OH

**Opportunity Title:**
Process Modeling and Testing of Advanced Composite Aerospace Components

**Opportunity Description/Objective (specific student assignment):**
Analytical and experimental methods to enable the impact and transient dynamic analysis of aerospace components composed of polymer matrix composite materials with complex material architectures, structural geometries and loading conditions are research areas of interest. Specific application areas of interest include engine containment structures subject to blade-out conditions, fan and rotor blades subjected to bird strikes, and rotating drive system components such as shafts, couplings, and gears. Research problems of interest include: (1) improving the predictive capability of numerical simulations through better characterization of material properties and through better representation of material and process variations in structural analysis; (2) development of efficient material and structural element level test approaches; and (3) development of material approaches for improved structural performance. Particular areas of interest include, but are not limited to: (1) improved methods for characterizing compressive strength and through-thickness properties; (2) simulation of the effects of material and process variation on structural performance, particularly for thick composite sections, structures of complex shape, and structures made from advanced preforms; and (3) material toughening approaches suitable for the application areas mentioned above. The research is expected to utilize commercially available composites process modeling codes and finite element codes and to utilize composites processing and testing facilities at NASA GRC.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**
Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

**Student's Computer and/or Special Skills:**
N/A

**Desired Student Academic Level**
Masters/Doctoral

**Academic Disciplines**
Opportunity Title: Atmospheric Propagation

Description/Objective (specific student assignment):
As NASA Networks continue their transition to Ka-band and future transitions to higher frequency allocations (e.g., for the next generation Space Based Relay), GRC propagation data collection will influence SCaN Network architecture design through optimal understanding of margin requirements and compensation of existing assets to enhance Network operational availability. The focus of this opportunity will be in research and development to improve statistical understanding of atmospheric effects (e.g., attenuation, phase stability, etc.) at Ka-Band using single or distributed ground based antennas at current and potential future NASA operational sites. Also to improve the accuracy of atmospheric models (e.g., gaseous absorption, cloud attenuation) at current and future frequency allocations of interest in the mm-wave (e.g. V/W-band). Finally, to collect passive atmospheric measurements (e.g. weather, clouds, attenuation, etc.) for model validation, systems planning and Space Based Relay architecture studies. Emphasis is on developing advanced capabilities for measurement and modeling of the contribution of clouds in atmospheric loss and the statistical characterization of cloud attenuation.

Expected opportunity outcome
(i.e. research, final report, poster presentation, etc.): Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills: N/A

Desired Student Academic Level: Masters/Doctoral

Academic Disciplines

GRC - 008

Opportunity Title: ThermoElectric Materials

Description/Objective (specific student assignment):
Radioisotope power systems provide electricity and heat that can enable spacecraft to undertake scientific missions to environments beyond the capabilities of solar power, chemical batteries and fuel cells. The increased power requirements for future space missions, combined with the reduced availability of radioisotope fuel, has prompted the development for a higher specific power/higher efficiency thermoelectric converter. New materials are critical in achieving higher conversion efficiency. The project will involve identifying potential materials, material synthesis and fabrication, and measurement of thermoelectric properties. Specifically, the research will
focus on the effect of nano-structuring on thermoelectric performance.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills:
Good knowledge of solid state physics and thermodynamics. Familiar with experimental methods for materials processing/characterization and thermoelectric property measurement. Competency in computer software and automation for data logging.

Desired Student Academic Level
Masters/Doctoral

Academic Disciplines
Physics
Chemistry
Materials Science

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GRC - 009

Host Center:
Glenn Research Center - Cleveland, OH

Opportunity Title:
Solid State Battery

Opportunity Description/Objective (specific student assignment):
Rechargeable lithium ion batteries with higher energy capacities (>400 Wh/Kg) and improved safety/abuse tolerance are needed for future NASA missions. Current electrochemical materials and battery design limit energy capacity and pose significant safety risks. The flammable and toxic nature of the organic electrolytes provide a large driving force for the replacement with a chemically inert, mechanically stable solid-state electrolyte. Solid state battery can potentially provide higher energy capacity and mitigate safety issues. Solid state electrolyte based on Li-containing garnets have been identified as candidate materials that exhibits high ionic conductivity and electrochemical stability. The goal of the project is to develop a solid state Li ion battery technology. The project will involve electrolyte synthesis and fabrication, and electrochemical testing. Specifically, the research will focus on technology to reduce cell impedance which has a direct impact on energy capacity and cycle life.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills:
Knowledgeable of battery technology. Familiar with experimental methods for materials processing/characterization and measurement of ion transport. Competency in computer software.
Desired Student Academic Level: Masters/Doctoral
Academic Disciplines: Chemistry, Materials Science

GRC - 010

Host Center: Glenn Research Center - Cleveland, OH
Opportunity Title: Next-Generation Woven Composite Materials

Opportunity Description/Objective (specific student assignment):

Woven composite materials are becoming more prevalent in aerospace, and other, applications due to the high specific strength, high specific stiffness, improved damage tolerance, and relatively low manufacturing cost of these materials. Furthermore, many woven fiber composites are not susceptible to delamination, a major damage mechanism in uni-directional laminates. With advanced weaving techniques, next-generation 3-D woven composites can be tailored specifically to the application of interest leading to design optimization that has been previously unachievable. However, robust numerical tools do not presently exist for predicting the non-linear behavior of woven composite structures. The response of woven composites is highly dependent on the fiber-tow architecture, but it is difficult to include the architectural effects directly into a structural scale model while maintaining the tractability of the analysis. Moreover, the unique weaving signature introduces unique paths and processing flaws may significantly affect the performance and must be included in the modeling efforts. Thus, this project will focus on the development of manufacturing, experimentation and multi-scale modeling techniques for next-generation 3-D woven composite structures.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student’s Computer and/or Special Skills: N/A
Desired Student Academic Level: Masters/Doctoral
Academic Disciplines: Chemistry, Materials Science

GRC - 011
Host Center: Glenn Research Center - Cleveland, OH

Opportunity Title: Modeling of a Liquid Acquisition Device for Advanced In-Space Cryogenic Propulsion Systems in Microgravity

Opportunity Description/Objective (specific student assignment):

NASA maintains a strong desire to develop technology that will enable future in-space cryogenic propulsion systems. Of particular interest is the cryogenic propellant depot, which is the primary candidate to enable long duration human and robotic space missions outside Low Earth Orbit (LEO). The location of the liquid/vapor (L/V) interface within the propellant tank varies with the changing thermal and gravitational conditions of space. The purpose of a liquid acquisition device (LAD) is to separate this interface inside of the depot propellant tank before transferring liquid to the transfer line. Screen channel LADs use capillary flow and surface tension forces for acquiring and maintaining single phase flow to the engine. Screen channel LADs use fine mesh screens to withhold liquid inside micron sized pores, which act as a barrier to vapor ingestion. Vapor free liquid supply is required throughout every stage of every mission. Therefore understanding LAD capabilities, their drawbacks, and improving their fundamental performance is vital to the success of current as well as future NASA missions. LADs are applicable to fluid transfer for future in-space depots, rocket engines, life support systems, fuel cells, in-space resource utilization (ISRU) systems, cooling, refrigeration, and liquefaction systems.

Several screen channel LADs were recently tested in various cryogenic propellants. Fundamental modeling efforts are needed to develop suitable analytical tools which may be used to match the data, as well as predict behavior in future space based cryogenic propellant tanks for engines and propellant depots. The areas where modeling efforts are required include the following:

1. Developing an analytical model based off first principles to solve the mass, momentum, and energy equations for a porous screen channel LAD in low gravity. The model would be a solution to the 2D incompressible Navier-Stokes equation for a cryogenic fluid which can handle turbulent channel flow, non-zero slip velocity at the screen, and solve for temperature, pressure, and velocity fields inside the channel in 1-g.

2. Developing accurate codes to predict the location of the ullage bubble and ullage bubble growth rate as a function of gravitational conditions as the tank is drained. This can be modeled in either Matlab or Surface Evolver.

3. Use the analytical models to perform a design trade study to determine parameters such as LAD dimensions and mass, tank expulsion efficiency, optimal screen type, etc. for multiple different gravitational and thermal environments.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.
Student's Computer and/or Special Skills: It is preferred that the assigned student have already taken 2 semesters of undergraduate level Thermodynamics, Fluid Mechanics, and Heat Transfer. Transport Phenomena can be substituted. Knowledge of partial difference equations is required. Student must be proficient with all basic Microsoft Office programs, specifically Powerpoint, Word, and Excel. Knowledge of Matlab (or equivalent data processing/numerical code) is required. Student should also have familiarity with basic numerical integration and differentiation, curve fitting techniques, optimization schemes, and root solving methods, such as the RK method, finite differencing, finite volume, etc. A basic background in statistics is also desirable but not required.

Desired Student Academic Level: Masters/Doctoral

Academic Disciplines: Applied Mathematics, Mathematics, Chemical Engineering, Physics, Aerospace Engineering, Mechanical Engineering

GRC - 012

Host Center: Glenn Research Center - Cleveland, OH

Opportunity Title: Quantum Communications

Opportunity Description/Objective (specific student assignment): Entangled photons with linked quantum states can be used to provide unconditionally secure communications. However entangled photons are very sensitive to electromagnetic noise and can easily become un-entangled through decoherence. In this project, we will be exploring a new form of secure quantum communications, quantum illumination, which is resilient to noise. We will be investigating methods to increase the secure data rate and to insure security from active eavesdropper attacks.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills: Coursework in optics and quantum mechanics

Desired Student Academic Level: Masters/Doctoral

Academic Disciplines: Electrical Engineering, Optical Engineering, Physics

GRC-013

Host Center: Glenn Research Center - Cleveland, OH

Opportunity Title: Composite Material/Structural Multiscale Modeling
### Opportunity

#### Description/Objective (specific student assignment):

The Aviation Safety program in the Aeronautics Research Mission Directorate and Aeroscience program are investigating the development of prognosis methods to allow for the prediction of damage initiation and progression in aircraft structures composed of both metallic and composite materials subjected to thermomechanical static and impact loads. A significant part of the development of prognosis methods is the development of appropriate material constitutive equations to compute the deformation and damage response of the aircraft materials. As most advanced material systems being currently researched and evaluated are for high temperature airframe and propulsion system applications, the required constitutive models must account for both reversible and irreversible time-dependent deformations. NASA Glenn is leading the development of validated durability, damage, and life prediction models for these unique high temperature materials and for structures composed of both Polymer Matrix Composites (PMCs) and Ceramic Matrix Composites (CMCs). Towards this end, a number of methods are being evaluated in terms of their capabilities and practicality for modeling the linear and nonlinear behavior of composites subjected to static and dynamic loads, particularly at elevated temperatures. There is a pressing need to understand and quantify the capabilities and limitations of these varying approaches for modeling PMCs and CMCs, especially in the context of nonlinear effects such as time-dependent creep, progressive damage, and cyclic fatigue damage.

#### Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

#### Student's Computer and/or Special Skills:

Knowledge of mechanics of materials, constitutive modeling, micromechanics, finite element. Familiarity with Windows office automation packages such as Microsoft Excel, Word, and Powerpoint. Familiarity with Matlab, fortran, C and/or C++

#### Desired Student Academic Level

Masters/Doctoral

#### Academic Disciplines

Civil Engineering, Mechanical Engineering, Structural Engineering

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### GRC-014

#### Host Center:

Glenn Research Center - Cleveland, OH

#### Opportunity Title:

Control of Interfacial Instability and Mixing in Supersonic Combustion and in Rocket Ignition

#### Opportunity Description/Objective (specific student assignment):

Spontaneous supersonic combustion is characterized by the formation of shock waves followed by an interface separating the unburned fuel-air mixture from the surrounding ambient. The instability of this interface determines the combustion efficiency and the emission pollution. The same
phenomenon plays a key role during rocket ignition or in the formation of fireballs resulting from accidental explosions. Experiments have shown that for the spherical case the interface forms a cellular structure corresponding to a certain wave number. The particular form of this structure is attributed to the interfacial instability known as the Rayleigh-Taylor instability. It is believed that the observed most amplified wave number is controlled by the presence of solid particles and its mass diffusivity. As such, the objective of this research is to explore the effect of solid particles and mass diffusivity on the development of the flow instability leading to mixing and the generation of turbulence.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills:
Expert in FORTRAN, Novice in C++

Desired Student Academic Level:
Masters/Doctoral

Academic Disciplines:
Aerospace Engineering, Mechanical Engineering

GRC-015
Host Center: Glenn Research Center - Cleveland, OH

Opportunity Title: High Efficiency Ka-band Gallium Nitride (GaN) Solid-State Power Amplifiers (SSPAs) for Near-Earth and Deep Space Applications

Opportunity Description/Objective (specific student assignment):
The Space Communications and Navigation (SCaN) Office supports the research and development of high efficiency Ka-band solid-state power amplifiers at NASA Glenn. At NASA Glenn, we have initiated an effort to develop high efficiency, high linearity power amplifiers in the frequency range of 25.25 to 27.5 GHz and 31.8 to 32.3 GHz for communications from satellites located in near-Earth and in deep space, respectively. The goal of this research project is to advance the state-of-the-art of linear Ka-band GaN solid-state power amplifier technologies through laboratory demonstrations and publication of results. The proposal should address a research topic that can advance Ka-band GaN solid-state power amplifier technologies for Near Earth and Deep Space applications. These topics include but are not limited to monolithic microwave integrated circuit (MMIC) device development and characterization, RF power combining architectures, linearity improvement techniques, demonstration of the capability to handle waveforms that are bandwidth or spectrum efficient, reliability, radiation hardness, thermal effects, and packaging.
Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills:

coursework in advanced electromagnetic wave theory, microwave circuit analysis and design, microwave solid-state devices, hands-on experience in the use of microwave test and measurement equipment such as RF probe stations and network analyzers

Desired Student Academic Level

Masters/Doctoral

Academic Disciplines

Electrical Engineering

GODDARD SPACE FLIGHT CENTER

GSFC -001

Host Center: Goddard Space Flight Center – Greenbelt, MD

Opportunity Title: Suborbital Tests of Inflationary Cosmology

Opportunity Description/Objective (specific student assignment):

Measurements of the cosmic microwave background (CMB) provide a critical test for cosmology. Gravitational waves excited during an inflationary epoch in the early universe impart a characteristic signature in the linear polarization of the CMB. Detecting this signal would have a profound impact on both cosmology and high-energy physics. It would establish inflation as a physical reality, provide a direct, model-independent determination of the relevant energy scale, and test physics at energies a trillion times beyond those accessible to particle accelerators. The fundamental importance of CMB polarimetry is recognized by the New Worlds, New Horizons Astrophysics Decadal Study and is reflected in NASA’s strategic planning, both of which call for a vigorous program of CMB polarization measurements. The Primordial Inflation Polarization Explorer (PIPER) is a balloon-borne instrument to search for the inflationary signal. PIPER uses kilo-pixel arrays of superconducting transition-edge bolometers fed by dual telescopes cooled to 1.5 K to achieve unprecedented sensitivity. Graduate fellowship opportunities include development and deployment of the cryogenic telescope and superconducting detector arrays, as well as data analysis from a series of flights from northern and southern hemisphere sites. Fellows have access to nanofabrication facilities, 100 mK cryogenic test stations, and a fully equipped laboratory and high bay.
Expected opportunity outcome (i.e. research, final report, poster presentation):

Results from the mission will be of the highest scientific importance and will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student’s Computer and/or Special Skills:

The project involves the development, flight, and analysis of data from millimeter-wave instruments on a high-altitude balloon payload.

Desired Student Academic Level:

Masters/Doctoral

Eligible Academic Disciplines:

Physics
Astronomy
 Astrophysics

GSFC -002

Host Center:

Goddard Space Flight Center – Greenbelt, MD

Opportunity Title:

Novel Instrumentation for Cosmic Microwave Background Polarimetry

Opportunity Description/Objective (specific student assignment):

Measurements of the cosmic microwave background (CMB) provide a critical test for cosmology. Gravitational waves excited during an inflationary epoch in the early universe impart a characteristic signature in the linear polarization of the CMB. Detecting this signal would have a profound impact on both cosmology and high-energy physics. It would establish inflation as a physical reality, provide a direct, model-independent determination of the relevant energy scale, and test physics at energies a trillion times beyond those accessible to particle accelerators. The fundamental importance of CMB polarimetry is recognized by the New Worlds, New Horizons Astrophysics Decadal Study and is reflected in NASA's strategic planning, both of which call for a vigorous program of CMB polarization measurements. The Primordial Inflation Explorer (PIXIE) is developing novel instrumentation to measure CMB polarization. PIXIE combines multi-moded bolometers with Fourier transform spectroscopy to provide a unique combination of sensitivity, spectral coverage, and rejection of instrumental effects. Multi-moded detectors provide background-limited sensitivity while reducing detector sound by $2\sim3$ orders of magnitude compared to single-moded arrays. The resulting reduction in instrument complexity opens a new window for far-IR instrumentation. Graduate fellowship opportunities include development of the polarization-sensitive detectors as well as research into the ability of multi-moded systems to characterize expected astrophysical foregrounds. Fellows have access to nanofabrication facilities, 100 mK cryogenic test stations, and high-end computer facilities.
Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Results from detector characterization or computer simulations will be published in the refereed literature. The fellow will additionally present a detailed research report upon conclusion of the effort. This shall include a poster and oral presentation.

Student's Computer and/or Special Skills: Detector testing requires measurements at cryogenic temperatures (0.1 K). Familiarity with low-noise analog electronics is desirable, as is experience with nanofabrication.

Desired Student Academic Level: Masters/Doctoral

Eligible Academic Disciplines: Physics, Astronomy, Astrophysics

GSFC -003
Host Center: Goddard Space Flight Center – Greenbelt, MD
Opportunity Title: X-ray studies of galaxies near and far Fellowship

Opportunity Description/Objective (specific student assignment): This opportunity covers studies of X-ray emission from star-forming galaxies. This X-ray emission, which is studied via analysis of X-ray datasets from NASA and other space-based instruments, including emission from neutron star and black hole populations and the hot interstellar medium. We will study the connection between the X-ray properties of these various components of galaxies and galaxy parameters such as stellar mass, metallicity, and overall star formation rate. The work involves datasets from missions and instruments developed at or in collaboration with the NASA GSFC X-ray astrophysics laboratory, including microcalorimeters, X-ray optics and other technology.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): The student will produce a report each year and is expected to give oral and final presentations. It is expected the student will aid in the publication of the data in refereed journals. We routinely present results at major astronomical conferences and the student would have such an opportunity if the work goes well.

Student's Computer and/or Special Skills: Experience with UNIX-based operating systems (including Mac OS) is highly beneficial as is experience with writing computer programs in a language such as Python, C. Previous astronomical data analysis experience would also be highly beneficial.

Desired Student Academic Level: Doctoral

Eligible Academic Disciplines: Astronomy, Physics
GSFC -004

Host Center: Goddard Space Flight Center – Greenbelt, MD

Opportunity Title: Aerosol Modeling and Data Assimilation Fellowship

Opportunity Description/Objective (specific student assignment):

General research in aerosol modeling and data assimilation. This either involves 1) developing new modeling and assimilation capabilities in our flagship GEOS-5 earth system model and data assimilation system, or 2) applying our existing tools for addressing general problems in aerosol science such as aerosol forcing of climate, aerosol-cloud interactions and use of advancing data assimilation techniques for maximizing the impact of satellite data on aerosol forecasting.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Successful candidates are expected to present results of research in national/international meetings and to submit peer reviewed publications.

Student's Computer and/or Special Skills:

Familiarity with scientific data analysis in Python, Matlab or IDL is required for all candidates. Familiarity with a low level language such as Fortran or C/C++ is required for those candidates engaged in model/data assimilation development.

Desired Student Academic Level

Master's
Doctoral

Eligible Academic Disciplines:

Applied Mathematics
Earth Sciences
Environmental Sciences
Physical Science

GSFC -005

Host Center: Goddard Space Flight Center – Greenbelt, MD

Opportunity Title: Observing System Simulation Experiments (OSSEs) for the Pre Aerosol-Cloud-Ecosystem (PACE) Mission Fellowship

Opportunity Description/Objective (specific student assignment):

A model-based Observing System Simulation Experiment (OSSE) is a framework for numerical experimentation in which observables are simulated from fields generated by an earth system model, including a parameterized description of observational error characteristics. Simulated observations can be used for
sampling studies, quantifying errors in analysis or retrieval algorithms, and ultimately being a planning tool for designing new observing missions. This opportunity involves general research on the development of observing system simulators based on our flagship GEOS-5 earth system of relevance for the Pre Aerosol-Cloud-Ecosystem (PACE) Mission (http://decadal.gsfc.nasa.gov/pace.html). This work involves utilizing very high global simulations of the atmosphere and ocean biogeochemistry and advanced radiative transfer modeling to simulate PACE measurements. Furthermore, this opportunity involves the design of OSSEs aimed at improving retrieval algorithms and maximizing the overall impact of the mission for ocean ecology, carbon cycle and climate science in general.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Successful candidates are expected to present results of research in national/international meetings and to submit peer reviewed publications.

Student’s Computer and/or Special Skills:
Familiarity with scientific data analysis in Python, Matlab or IDL is required for all candidates. Familiarity with a low level language such as Fortran or C/C++ is required for those candidates engaged in retrieval algorithm development.

Desired Student Academic Level
Master’s
Doctoral

Eligible Academic Disciplines:
Applied Mathematics
Earth Sciences
Environmental Sciences
Physical Science

GSFC -006
Host Center: Goddard Space Flight Center – Greenbelt, MD
Opportunity Title: Observations and Model Fitting for Exoplanet Characterization
Opportunity Description/Objective (specific student assignment):
The selected student will be expected to learn and eventually improve on existing data analysis methodologies for observations of transiting extrasolar planets. The student will also develop algorithms for retrieval of atmospheric properties from these data sets, based on current state-of-the-art methodologies in the literature and in collaboration with the mentor and other researchers.

Expected opportunity outcome (i.e.):
The expected outcome is a suite of data analysis tools with which to analyze observations of transiting exoplanets, and also a preliminary analysis of existing data.
<table>
<thead>
<tr>
<th>Student's Computer and/or Special Skills:</th>
<th>IDL programming, astronomical statistics, general astrophysics background</th>
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<tbody>
<tr>
<td>Desired Student Academic Level</td>
<td>Doctoral</td>
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<tr>
<td>Eligible Academic Disciplines:</td>
<td>Astronomy, Computer Science</td>
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| GSFC -007                                 | Goddard Space Flight Center                                               |
| Host Center:                              |                                                                            |
| Opportunity Title:                        | Analysis of Near-Infrared Spectroscopy of Gas in Protoplanetary Disks     |
| Opportunity Description/Objective (specific student assignment): | The student will use existing software tools to analyze existing observations of circumstellar disks from the CRIRES near-infrared spectrograph on the VLT telescope, in order to search for emission from water and organic molecules. The student will also work with collaborators to develop the modeling software tools needed to determine the temperature and quantity of the molecular gas. |
| Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): | The expected outcome is a set of software tools to aid in interpretation of observations of gas in circumstellar disks. The student will also write or aid in writing a scientific journal article on the results of the analysis. |
| Student's Computer and/or Special Skills: | IDL, astronomical statistics, general computer programming skills        |
| Desired Student Academic Level           | Doctoral                                                                  |
| Eligible Academic Disciplines:           | Astronomy, Physical Science, Computer Science                             |
**Opportunity Title:** Lidar Remote Sensing

**Opportunity Description/Objective (specific student assignment):**

The Laser Remote Sensing Laboratory at NASA Goddard Space Flight Center is considered a leader in the development and application of airborne and spaceborne laser altimetry. Members of the Laser Remote Sensing Laboratory developed and operate the Land, Vegetation, and Ice Sensor (LVIS). LVIS is used as an airborne prototype for future spaceborne measurement approaches, science applications, and instrument technologies. This sensor has been used to collect extensive datasets of wide-swath surface altimetry over the Greenland and Antarctic ice sheets including mapping of several complete glaciers for monitoring surface elevation change, as well as large-area datasets of vegetation structure in several regions of the US and Costa Rica. Further, NASA has recently selected the GEDI (Global Ecosystem Dynamics Investigation) Lidar mission to fly on the International Space Station (ISS) starting in 2018. GEDI utilizes the same full-waveform lidar measurement technique used by LVIS. The project involves the assembling of various air- and space-borne data sets and the development of algorithms and models to analyze surface parameters in order to evolve our understanding of the current state of the cryosphere, ecosphere or hydrosphere, and how they are changing over time. Developing interactive visualization tools for exploring the Earth's surface is also a priority including the combination of high-resolution imagery with lidar waveforms to increase accessibility to data sets. Engineering and software development opportunities also exist to support instrument design, build, and real-time and post mission software modules.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**

Results would likely be presented at a scientific conference as a poster or oral presentation. The project ideally leads to a published paper, or is included in a paper published as part of the student’s thesis results.

**Student's Computer and/or Special Skills:**

Experience with programming in IDL, Matlab, Fortran or C.

**Desired Student Academic Level:**

Masters, Doctoral

**Eligible Academic Disciplines:**

Earth Science
Physical science
Engineering – General
Study of Planetary Atmospheres With ALMA

ALMA - the Atacama Large Millimeter/Submillimeter Array - is a network of 66 antennas in the desert of northern Chile, that is currently being completed and commissioned as a major international observatory. Already, preliminary data from ALMA is providing the first maps of planets such as Uranus, and moons such as Saturn's moon Titan, in the millimeter/submillimeter wavelength range that exhibits the microwave emissions from a host of atmospheric gases such as CO and HCN. The first maps of Titan and Uranus were recently unveiled in the Fall of 2014, and curious new seasonal patterns in the molecular distributions are being discovered. This project is a three-year, doctoral level investigation that will see the PhD student reduce, analyze and model the molecular spectra to map and quantify the amounts and locations of multiple gases. Titan's molecular population is especially exciting, since its atmospheric photochemistry seems to be creating very complex molecules, that could provide clues to the link between chemistry and the origins of biological molecules such as amino acids. A likely timeline is: YEAR 1 - download ALMA data for Titan. Learn how to reduce the data, and run the spectral modeling software (NEMESIS) and garner initial results, updating previous studies in 2014 by GSFC workers. YEAR 2 - continue to search in further datasets for new molecules, and to map the seasonal changes for Titan molecules. YEAR 3 - finalize Titan results, and work on Uranus/Neptune data.

The student should be able to produce ~1 first author scientific paper per year, given that the tools and methods are already highly developed. The student will likely be a co-author on several further papers. The final outcome will be the student's PhD dissertation. The student will also present numerous times at conferences and workshops.

The student should have a very strong background in physics, including thermodynamics, electromagnetism and basic quantum theory applied to atoms and molecules. Some knowledge of chemistry is desirable, but not required. The student should have some programming experience (preferably FORTRAN, or python) and experience with reduction of astronomical data and use of standard data analysis packages (IDL, Matlab etc) is helpful.

Doctoral
*This opportunity is for a multi-year PhD research project* The Cassini spacecraft arrived at Saturn in 2004, and has now been orbiting the planet for nearly ten years, making nearly 100 close flybys so far of the giant moon, Titan. Titan is a fascinating and unique object: the only moon in the solar system with a substantial atmosphere, which has many similarities (such as bulk composition, N2) but also important differences to that of the Earth (no free oxygen, and much colder.) Cassini’s Composite Infrared Spectrometer (CIRS), built and operated by NASA’s Goddard Space Flight Center, is a very important tool for probing Titan’s atmosphere, since the infrared spectrum contains important information about the gas composition, temperatures, aerosol particles, winds, clouds and other physical and chemical phenomena. Modeling the spectrum using a radiative transfer code is used to infer these quantities, and help to answer key questions about the moon, such as: where did the atmosphere come from? Is it stable now or changing rapidly? What physics and chemistry is occurring there, and what level of organic complexity is reached? The proposed PhD project takes the following initial format, which may be adjusted based on the outcome of the ongoing research: YEAR 1 - learn about the instrument and dataset, including how to extract and average the spectral data, compute the noise level, and run the radiative transfer simulation code (NEMESIS). Initial modeling of trace gas emissions would be performed, to check isotopic ratios and search for new gas species. YEAR 2 - detailed modeling would be performed to derive the isotopic ratios: D/H, 12C/13C, 14N/15N and 16O/18O in multiple gas species, including methane (CH4) and CO2. These would be compared to previous results. In addition, abundances or upper limits for other trace gases would be computed. YEAR 3 - time evolution of the 13C/12C and D/H isotopic ratios would be modeled, to infer the lifetime (prior age) of the atmosphere. Comparison with other solar system bodies (planets, comets) would be made to shed insight on Titan’s origin, evolution and fate.

The expected research outcomes are: each year, 2 or more presentations of research at workshops, conferences or other scientific meetings, depending on availability of travel funding. Years 2 and 3: submit and publish research papers in astronomical journals. Year 3+: write PhD dissertation/thesis and graduate with PhD degree.

The student should have a very strong undergraduate background in physics, especially thermodynamics, electromagnetism (EM radiation) and preferably quantum physics of atoms and molecules. In addition, applied mathematical skills (calculus) are essential, while knowledge of computer programming, and any
prior experience with astronomical observing or data reduction would be helpful.

**Desired Student Academic Level**

Doctoral

**Eligible Academic Disciplines:**

Science - Astronomy  
Science - Physical Science  
Science - Physics  
Science - General

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**GSFC -011**

**Host Center:** Goddard Space Flight Center – Greenbelt, MD

**Opportunity Title:** Exploring the Heating and Dynamics of the Solar Corona

**Opportunity Description/Objective (specific student assignment):**

How the solar corona is heated to over a million degrees is a central and longstanding problem of solar physics. This is an opportunity to use temperature, density, and velocity diagnostics in the spectra of a successful sounding rocket instrument (EUNIS), together with coordinated observations from other space- and ground-based instruments, to explore the spatial and temporal variability of solar coronal structures and to test theories of coronal heating such as the nanoflare mechanism. The Extreme Ultraviolet Normal Incidence Spectrograph (EUNIS) is a sounding rocket instrument that has made three successful flights, most recently in April 2013. There is also an opportunity to work on the EUNIS instrument in the laboratory, depending on the fellow's interest.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**

The outcome of this research is expected to be one or more publications in refereed scientific journals as well as oral or poster presentations.

**Student's Computer and/or Special Skills:**

Fluency with computer-based data analysis is expected.

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**Desired Student Academic Level**

Master's  
Doctoral

**Eligible Academic Disciplines:**

Mathematics - Applied Mathematics  
Science - Astronomy  
Science – Physics
GSFC -012

Host Center: Goddard Space Flight Center – Greenbelt, MD

Opportunity Title: Optical Metrology for Free-Flying Test Masses

Opportunity Description/Objective (specific student assignment):
The mentor and his colleagues are developing technologies for future space-based detectors of gravitational waves. A key capability is the measurement of the position and angle of a free-flying test mass using optical interferometry. The fellow will work with the group to develop a laboratory prototype of a 3-axis optical metrology system measuring a test mass dummy mirror that is actuated using piezo-electric motors.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
- Detailed research report
- Poster and/or Oral Presentation
- Journal Publication(s) resulting from work

Student's Computer and/or Special Skills:
- Lab experience preferred
- Experience with MATLAB
- Experience with LabVIEW

Desired Student Academic Level: Masters or Doctoral

Eligible Academic Disciplines:
- Physics
- Aerospace Engineering

GSFC -013

Host Center: Goddard Space Flight Center – Greenbelt, MD

Opportunity Title: Data Analysis for LISA Pathfinder

Opportunity Description/Objective (specific student assignment):
LISA Pathfinder (LPF) is an upcoming mission (launch in 2015) to demonstrate key technologies for the detection of gravitational waves in space. The student will work with the mentor and a post doctoral researcher to develop analysis routines for interpreting data from various experiments conducted on LPF and apply those routines to both simulated and operational data.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
- Detailed research report
- Poster and/or Oral Presentation
- Journal Publication(s) resulting from work
Lab experience preferred
• Experience with MATLAB highly desired

Masters or Doctoral

Physics
Aerospace Engineering

GSFC -014

Research Opportunities for Space-based Gravitational-wave Observatories

Gravitational Waves promise to open the first new window on the Universe in a
century. Gravitational waves are propagating disturbances in space-time
predicted by all theories of gravity and produced most efficiently by the rapid
motions of massive compact objects. Observation of gravitational waves will
provide a powerful new tool for understanding these objects, their environments,
and the underlying physics of gravity itself, including detailed tests of General
Relativity in the strong field limit. The group has two main efforts: Numerical
Relativity and the Space-based Gravitational-wave Observatory technology
development. The Numerical Relativity effort has achieved breakthroughs in the
study of merging black holes, as well as developing data analysis methods for
gravitational wave detectors that incorporate numerical waveforms. The
technology development projects include lasers, telescopes, photo receivers, and
high precision bonded optical benches. Research opportunities in the
gravitational wave astrophysics group include (1) design and development of
space-based gravitational wave instrument technology, (2) development of data
analysis techniques and estimation of LISA’s measurement performance, (3)
prediction of source waveforms using both numerical relativity and analytic
approximation methods, and (4) astrophysics of LISA-observable systems.

Research results, detailed research report, poster and oral presentation, and
possible publication or conference presentation

Knowledge of numerical relativity, data analysis, and general scientific
programming techniques is helpful. Experience with Matlab, Mathematica, or a
and/or Special Skills: similar scientific computing software package is helpful.

Desired Student Academic Level
Masters
Doctoral

Eligible Academic Disciplines:
Aerospace Engineering
Instrumentation Engineering
Mechanical Engineering
Applied Mathematics
Astronomy
Physics
Systems Engineering/Design
Computer Science

GSFC -015
Host Center: NASA Goddard Space Flight Center – Greenbelt, MD
Opportunity Title Radar remote sensing of planetary surfaces
Opportunity Description/Objective (specific student assignment):
Radar remote sensing provides unique information about the stratigraphy and surface properties of planetary surfaces. For this project, the student will work with Dr. Lynn Carter and others in the Planetary Geodynamics Lab on a project utilizing remote sensing data (particularly radar) that is related to the student’s chosen thesis topic. Current research topics encompass a wide range of planetary surface processes including volcanism, impact cratering, regolith development, and comparative climatology.

Graduate student research projects could include, for example, analysis of lunar radar data to study volcanoes or regolith properties, studies of the Martian surface and stratigraphy using sounding radar, radar imaging to determine asteroid surface properties, studies of Venus volcanology or cratering, ground-penetrating radar fieldwork, or development of new radar techniques and instrumentation. These projects would generally involve cross-comparison of radar remote sensing data with other data sets. Common sources of comparison include infrared data, optical imaging, topographic data, earth imaging radar, and terrestrial analog fieldwork. The Planetary Geodynamics Lab is particularly strong in volcanology, so proposals to work on some aspect of planetary volcanism are especially encouraged because there would be opportunities to collaborate with multiple Goddard scientists. The Lunar Reconnaissance Orbiter is also managed at Goddard, and so there is a strong lunar science program with access to multiple types of data in addition to radar.

It is expected that the student proposal will identify the preferred topic (e.g. Moon, Venus, comparative volcanology, instrumentation) and discuss the
relevance of a radar remote sensing project to their thesis (e.g. to determine surface roughness, investigate stratigraphy, model surface properties, detect differences in volcanic eruption styles, compare multiple wavelengths of remote sensing data). Focused projects are desirable; for example, a study of small number of asteroids, or a focus on volcanoes or craters in a specific size range, or having a subset of properties of interest to the student.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

For the chosen project, students would be responsible for processing and analysis of relevant radar data, and it is likely that results could be presented at major conferences. Ideally the project will lead to a published paper, or be included in a paper published as part of the student’s thesis results.

Student's Computer and/or Special Skills:

Use of Macintosh or Linux systems and at least one data analysis package such as IDL or USGS ISIS. Basic programming or scripting knowledge would be very helpful.

Desired Student Academic Level

Masters/Doctoral

Academic Disciplines

Planetary Science
Astronomy
Geology
Physics

GSFC -016

Host Center: Goddard Space Flight Center – Greenbelt, MD

Opportunity Title: Multiwavelength Studies of X-ray Sources Using Archived Data from Swift, Kepler and Other Observatories

Opportunity Description/Objective (specific student assignment):

NASA’s astrophysics data archives contain an enormous and growing amount of rich multiwavelength light curves that capture variability of stellar and extragalactic sources at a variety of timescales. X-ray binaries are double star systems containing a neutron star or black hole. Archived data exist on many of these objects spanning timescales from milliseconds to decades. Using archived X-ray and ultraviolet data from Swift and optical photometry from Kepler, and combining with data from GALEX and ground-based observatories, dozens of bright and variable X-ray sources in the Kepler field-of-view can be investigated. X-ray sources include stellar rapid rotators and flare stars, as well as active galaxies. Virtually continuous uninterrupted Kepler light curves will allow detailed investigations of stellar rotation, star spot evolution and flaring on sunlike stars. Using archived X-ray and ultraviolet data from RXTE, Suzaku, XMM and Swift...
satellites, several bright and variable neutron star and black hole X-ray sources can be investigated. The goal will be to create and utilize a suite of automated analysis scripts that will query the data archives to locate, reduce and analyze data for spectral and timing characteristics, and in particular to search for correlations between low-energy and high-energy variability.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**

Various: refereed publications, poster or oral presentations at professional meetings, preparation and submission of observing proposals.

**Student's Computer and/or Special Skills:**

Ability to write detailed analysis scripts in Python or Perl to chain together existing analysis tools to develop a specialized pipeline for processing the large volume of data.

**Desired Student Academic Level:**

Masters or Doctoral

**Eligible Academic Disciplines:**

Astrophysics
Physics
Computer Science
Mathematics

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**GSFC -017**

**Host Center:**

Goddard Space Flight Center – Greenbelt, MD

**Opportunity Title:**

Testing and characterization of custom mixed-signal ASICs for science instruments

**Opportunity Description/Objective (specific student assignment):**

The Mixed-Signal ASIC Group (MSAG) in Code 564/Instrument Electronics Development Branch is dedicated to the design of analog and mixed-signal Application Specific Integrated Circuits (ASIC) for space instruments. The group’s function is to integrate analog/digital circuits onto silicon chips which reduce power, mass and volume of instrument electronics while providing radiation hardness and inherent reliability. This opportunity would include the testing and characterization of mixed-signal integrated circuits such as data converters detector readout electronics and will provide experience working with custom mixed-signal ASIC designs to support the next generation of science instruments.

**Expected opportunity outcome (i.e. research, final report, etc.):**

(1) Test and verification of mixed signal integrated circuits, (2) Test procedure and Verification documentation, (3) Weekly Status Reports, (4) Attendance at relevant training courses, (5) Detailed Final Research Report and (6) Poster and Oral
Opportunity Title: Analog and mixed-signal ASIC design for science instruments miniaturization

Opportunity Description/Objective (specific student assignment):
The Mixed-Signal ASIC Group (MSAG) in Code 564/Instrument Electronics Development Branch is dedicated to the design of analog and mixed-signal Application Specific Integrated Circuits (ASIC) for space instruments. The group’s function is to integrate analog/digital circuits onto silicon chips which reduce power, mass and volume of instrument electronics while providing radiation hardness and inherent reliability. We are seeking a student interested in the design of mixed-signal integrated circuits such as data converters and the design of readout electronics for micro-well detectors, silicon photomultipliers and solid state detectors for particle instruments and x-ray telescopes in the Heliophysics, Astrophysics and Cross Cutting lines of business. This opportunity will provide experience designing custom mixed-signal ASIC designs to support the next generation of science instruments.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
(1) Design, implement and test of a fully functioning ASIC device on a test board, (2) Develop user manual and test procedure documentation, (3) Weekly Status Reports, (4) Attendance at relevant training courses, (5) Detailed Final Research Report and (6) Poster and Oral Presentation

Student’s Computer and/or Special Skills:
Knowledge of microelectronics, analog and mixed-signal IC design. Some knowledge of microelectronics and EDA software (e.g. Cadence) is recommended.

Desired Student Academic Level
Master’s or Doctoral

Eligible Academic Disciplines:
Electrical Engineering
**Opportunity Title:**
Using passive remote sensing to study aerosol/cloud interactions

**Opportunity Description/Objective (specific student assignment):**
Aerosols and clouds are highly interdependent within the climate system. In recent years, NASA has invested in improving our tools for monitoring aerosols and clouds, which include orbital (e.g. satellite) and suborbital (e.g. aircraft) remote sensing. However, due to the fractal nature of clouds, what may appear as clear sky in a lower resolution view, may in fact be thin cloud filaments in a higher resolution view. This "twilight zone", made up of humidified aerosol, mixed with tiny clouds, and illuminated with artifacts of viewing geometry, is very difficult to characterize. Our research team is responsible for maintaining and improving the algorithms and products of the well-known "dark-target" aerosol retrieval, originally developed for the Moderate resolution Imaging Spectroradiometer (MODIS). To perform global retrieval of aerosol optical depth (AOD) at 10x10 km resolution, the MODIS retrieval relies on its ability to find clear-sky (non-cloud) scenes to process. Out of the 400 MODIS 500 meter "pixels", within a 10x10 km scene, most can be designated as "clear", or "cloudy" but the rest are somewhere in between (the "twilight zone"). In the new version of our algorithm, we not only report aerosol parameters based on the pixels believed to be cloud-free, but also a new parameter which describes the average distance to the nearest cloud. At the same time as performing retrievals with MODIS data, we have adapted the algorithm to work on other datasets (including aircraft observations) to provide similar parameters but at much finer resolution. Together, we expect that the combination of retrieved AOD and cloud distance will help to answer some remaining research questions about processes within aerosol/cloud fields. We desire a student fellow to help analyze this new cloud distance parameter within the framework of the well-characterized dark-target aerosol products. The student will explore this new MODIS product for specific case studies, and move on towards regional and global statistics. At the same time, the student will analyze some of the specific cases observed by the high-resolution, MODIS-like sensor on aircraft, and determine how the aerosol/cloud relationship applies at finer spatial scales.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**
This research effort will lead to a report, and a presentation to interested researchers at Goddard. Depending on results, it may lead to public presentation (at AGU or similar).

**Student's Computer and/or Special Skills:**
1) General understanding of relationships between aerosols and clouds 2) Ability to interpret remote sensing datasets 3) Can perform analysis/visualization with software such as IDL.
Desired Student Academic Level: Masters/Doctoral

Eligible Academic Disciplines:
- Atmospheric Science
- Meteorology
- Geography/remote sensing

GSFC -020
Host Center: Goddard Space Flight Center – Greenbelt, MD
Opportunity Title: Balloon Experimental Twin Telescope for Infrared Interferometry (BETTII): Graduate Fellowships

Opportunity Description/Objective (specific student assignment):

We are developing a new experiment for flight on a high-altitude balloon, the Balloon Experimental Twin Telescope for Infrared Interferometry (BETTII). BETTII will be an 8-meter long system with two telescopes, designed to provide high angular resolution measurements in the far-infrared. Graduate students with an interest in astronomical instrumentation, including interferometry, far-infrared instrumentation, or detectors are particularly encouraged, but we welcome applications from all candidates. Ultimately, a successful candidate will have the opportunity to work on an innovative new experiment that will provide unique new scientific data, and will gain a broad understanding on the development of missions and the system-level problems that must be solved to make these missions successful.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

A successful candidate will have the opportunity to carry out original work related to BETTII, far-infrared instrumentation, and/or far-infrared astronomy. We anticipate that this work would lead to a doctoral dissertation.

Student's Computer and/or Special Skills:
Experience with software development, computer modeling, design software, etc., are all of value, but we will happily work with candidates with a wide range of skills.

Desired Student Academic Level: Master's

Eligible Academic Disciplines:
- Aerospace Engineering
- Computer Engineering
- Electrical Engineering
- Mechanical Engineering
- Astronomy
- Physical Science
- Physics
- Software Eng.
GSFC -021

Host Center: Goddard Space Flight Center – Greenbelt, MD

Opportunity Title: Energetic Particles in the Heliosphere

Opportunity Description/Objective (specific student assignment):
The Energetic Particle Laboratory in the Heliospheric Physics Laboratory (Code 672) has a wide range of solar energetic particle projects that could support a student intern. This includes data analysis for the ACE/CRIS and SIS instruments, STEREO/IMPACT/HET, PAMELA, the CERES cubesat and FERMI, and also design, construction and testing of particle instruments for future missions. Exact tasks can be tailored to skills and interests of student.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Final report and poster presentation expected. Publishable research is possible depending upon summer tasks.

Student's Computer and/or Special Skills:
Basic computer and programming familiarity required. More advanced programming, including c or Labview or IDL is desired.

Desired Student Academic Level
Master's
Doctoral

Eligible Academic Disciplines:
Aerospace Engineering
Computer Engineering
Electrical Engineering
Mechanical Engineering
Astronomy
Physical Science
Physics
Software Engineering
Systems Engineering/Design
Computer Science
General Engineering

GSFC - 022

Host Center: Goddard Space Flight Center – Greenbelt, MD
Opportunity Title: Cognitive Radio (CR) algorithms for space communications systems in the NASA/GSFC Telecommunications and Technology Branch

Opportunity Description/Objective (specific student assignment):
Perform design and development of a cognitive radio (CR) algorithms for wideband spectrum knowledge acquisition. It should be implemented in Software Defined Radio (SDR) platforms at GSFC and at their home institution. The SDR radio should allow supporting multiple systems, protocols and interfaces by changing software programs. The reconfigurable software define radio will be able to sense environment and change the configuration based on the sensing. Focus will be on signal processing methods used at physical level telecommunications to both analyze (e.g. adaptive mode identification, MISM methods) and decision making (e.g. adaptive MIMO beam-forming techniques) within an embodied radio framework.
Distributed estimation and decision methods will be studied within the context of application of CR to telecommunication systems using advanced wide band modulation techniques like OFDM, MC-CDMA, CDMA.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
- Detailed research report upon conclusion
- Poster and Oral presentations.
- Multiple journal and conference publications

Student's Computer and/or Special Skills: Basic Matlab Skills, knowledge of digital communications, analog communications, coding and modulation background. Ability to perform mathematics of communications engineering at a high level. Experience with Software Defined Radios.

Desired Student Academic Level: Doctoral preferred

Eligible Academic Disciplines: Electrical Engineering and other relevant disciplines

GSFC-23
Host Center: Goddard Space Flight Center – Greenbelt, MD
Opportunity Title: CubeSat communication systems in the NASA/GSFC Telecommunications and Technology Branch
Opportunity Description/Objective (specific student assignment):
Design and Simulation work for CubeSats. This will require small, compact, low cost, efficient, reliable, and robust communication system designs with stable electrical and radiation characteristics in harsh space environments to compensate for typical limitations such as power and physical size/shape. The project will offer invaluable experience and insight working on Cube Satellite communication system design including transceivers, antenna performance characterization, cube satellite dynamic/static link budget calculations and deep
knowledge on current NASA Communication Networks.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
- Detailed research report upon conclusion
- Poster and Oral presentation.
- Multiple journal and conference publications

Student's Computer and/or Special Skills:
- Basic Matlab Skills, 3D EM tools, Satellite Link Budget Calculations especially Satellite Tool Kit.

Desired Student Academic Level
Doctoral preferred

Eligible Academic Disciplines:
Electrical Engineering and other relevant disciplines

JET PROPULSION LABORATORY

JPL-001
Host Center: Jet Propulsion Laboratory – Pasadena, CA
Opportunity Title: Mobile Augmented Reality Vulcanology Link (MARVL) 3461- YL14 Fellowship

Opportunity Description/Objective (specific student assignment):
Smartphone apps for a variety of purposes have been developed. Work has begun on an app to support data collection in the field. The app monitors location, records data, and directs teams to the next sampling location. Future work includes augmented reality components to assist in the process. This project will continue the development of an Android app for supporting scientific fieldwork in vulcanology, earthquakes, and other earth sensing applications. Of initial interest is the improvement of an app to aid fieldworkers in collecting samples for ground truth for airborne and orbital observations. Additional work in augmented reality aspects will be highly desirable.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Research, final report, final presentation

Student's Computer and/or Special Skills:
**Desired Student Academic Level**  
Master’s/Doctoral

**Academic Disciplines**  
Science - Earth Sciences  
Technology - Comp Science

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**JPL-002**

**Host Center:** Jet Propulsion Laboratory – Pasadena, CA

**Opportunity Title:** Robotic Control for Automated Cargo Handling 3460

**Opportunity Description/Objective (specific student assignment):**
The ATHLETE and triATHLETE robots are generally teleoperated. However, some operations can be enabled with autonomous behavior. In this case, we wish to utilize the onboard cameras and gripper to automatically build command sequences to operate the robot to identify and pick up cargo containers, as well as manipulate tools and perform docking. This task involves improving software for identifying fiducial markers on cargo items through stereo image processing and generating commands to a robot to actuate its limbs and pick up the specified cargo item. The task will continue work done in 2009 thru 2013 in the area. The overall goals of the software are to identify the fiducial markers visible in imagery taken by the robot, locate the position and orientation of the cargo from the fiducial in the imagery, and then generate a series of commands to the robot to align its gripper with the cargo's lift point and pick up the cargo. Most of the development and testing will be performed in the computer lab but some data collection and testing will be performed hands-on using the triathlete robot.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):** Research, final report, poster presentation

**Student's Computer and/or Special Skills:** This task requires significant experience with C++ programming and object-oriented software development as well as strong mathematics skills.

**Desired Student Academic Level**  
Master’s/Doctoral

**Academic Disciplines**  
Technology - Comp Science

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**JPL-003**

**Host Center:** Jet Propulsion Laboratory – Pasadena, CA

**Opportunity Title:** Intelligent Computer Vision & Parallel Processing
Opportunity Description/Objective (specific student assignment): The Intelligent Sensor Processing Object Recognition & Tracking Systems (iSports) Lab in Bio-Inspired Technologies & Systems Group (3492) is conducting testing and optimization of the automatic object recognition for parallel processing and FPGA implementation. The research is directly applicable to autonomous guidance of spacecraft landing/docking/rendezvous and hazardous avoidance. We are interested in sponsoring 2 intern students in the Minority student internship program for the Intelligent Computer Vision projects. The candidates will help to train intelligent computer programs to automatically detect, recognize, and track objects from CCD/CMOS imaging cameras. The autonomous target recognition (ATR) system helps the robots and autonomous vehicles to understand the environment, and perform autonomous maneuvers.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Research, final report, final presentation

Student's Computer and/or Special Skills: Critical thinking, creativity, curiosity, good communication skills, C/C++, Matlab programming, Labview, Verilog and FPGA; Courses: normal undergraduate math, electrical and computer engineering. Useful, but not required: knowledge of image processing, neural networks, computer vision.

Desired Student Academic Level: Master’s/Doctoral

Engineering - Electrical Eng.

JPL-004

Host Center: Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title: Telemetry-based ranging analysis 3427

Opportunity Description/Objective (specific student assignment): NASA determines the range (distance) to a spacecraft with a specially formatted uplink signal, which the spacecraft echoes back. Using the delay between the transmitted and received signals on the ground, the range can be computed. The new telemetry-based ranging eliminates the downlink range signal, and allows the range to be computed directly from the
telemetry (data bearing) signal. The goal of this project is to develop new technology to determine the range of a spacecraft directly from its telemetry (data carrying) signal, instead of using a specialized ranging signal which carries no science data. This involves a study of the limits of the accuracy of the various tracking loops involved on the spacecraft and ground receivers, a signaling protocol, and an analysis of the system.

<table>
<thead>
<tr>
<th>Expected opportunity outcome</th>
<th>Research, Final report, Poster presentation</th>
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<tr>
<td>(i.e. research, final report, poster presentation, etc.):</td>
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<tr>
<td><strong>Student’s Computer and/or Special Skills:</strong></td>
<td>Required: Digital communications, probability, stochastic processes, signal processing Desired: information theory, coding theory, tracking loop analysis, programming skills</td>
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<tr>
<td><strong>Desired Student Academic Level</strong></td>
<td>Master’s/Doctoral</td>
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<tr>
<td><strong>Academic Disciplines</strong></td>
<td>Engineering - Electrical Eng. Mathematics – General</td>
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**JPL-005**

**Host Center:** Jet Propulsion Laboratory – Pasadena, CA

**Opportunity Title:** Cubesat Orbital Debris Removal Mission Development

**Opportunity Description/Objective (specific student assignment):** A growing amount of debris, or space garbage, is accumulating in both low-Earth orbit and geosynchronous orbit. These pieces of debris pose a risk to current satellites and spacecraft that are operating nearby. To clear these pieces of debris, they must be either pushed up into the graveyard orbit (super-GEO) or nudged down into a decay orbit so that burn up on reentry will occur. However, doing this effectively for the variety of debris types and at a reasonable cost are both challenging problems. A growing amount of debris, or space garbage, is accumulating in both low-Earth orbit and geosynchronous orbit. These pieces of debris pose a risk to current satellites and spacecraft that are operating nearby. To clear these pieces of debris, they must be either pushed up into the graveyard orbit (super-GEO) or nudged down into a decay orbit so that burn up on reentry will occur. However, doing this effectively for the variety of debris types and at a reasonable cost are both challenging problems. This project will investigate the feasibility of de-orbiting a piece of debris using a cubesat derived architecture. The student will perform a system study and provide analysis of the available components to execute such a mission. Small-sat alternatives will also be examined and traded with the CubeSat systems.
### Expected opportunity outcome
(i.e. research, final report, poster presentation, etc.):

Research, final report, final presentation

### Student’s Computer and/or Special Skills:

Strong system engineering background. Strong mathematical skills.

### Desired Student Academic Level

Master’s/Doctoral

### Academic Disciplines

Engineering - Aerospace Eng.

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**JPL-006**

**Host Center:** Jet Propulsion Laboratory – Pasadena, CA

**Opportunity Title:** Extraterrestrial and Terrestrial Terrain Mechanics

**Opportunity Description/Objective (specific student assignment):**

Performance of mechanical systems such as tools, wheels, legs, plumes from rockets etc on unknown terrains (sand, snow, ice, grass, mud etc) in terrestrial and extra-terrestrial applications is strongly dependent on the nature of their interactions with the terrain. Unfortunately, there are only few good models with limited functionality to understand and design these interactions. This task will develop and use ground-breaking methods and tools on High Performance Computing systems to develop models of such interactions with an overall goal of enabling better design of space robotic vehicles with potential to impact terrestrial applications. The proposer will use existing tools to run detailed simulations on HPC of the interactions between terrain and mechanical systems. The proposer will analyze the results and develop surrogate analytical models using various continuum approaches. The proposer will also develop new tools by either writing functionality or coupling different tools. The proposer will develop a new methodology for designing systems with interactions with terrain.

### Expected opportunity outcome
(i.e. research, final report, poster presentation, etc.):

Research, final report, final presentation

### Student’s Computer and/or Special Skills:

This is a mulch-disciplinary problem and proposers with strong academic and research background are strongly encouraged to apply even if they do not meet all the background requirements below. Applied Mechanics or Computational Chemistry, Continuum mechanics, granular mechanics and/or DEM, High Performance Computing or GPU based computing, C++ and Python coding expertise, Numerical Methods for Scientific Computing. Ability to work independently and conduct research on personal motivation.
Desired Student Academic Level: Master's/Doctoral

Academic Disciplines:
- Engineering - Chemical Eng.
- Engineering - Computer Eng.
- Engineering - Mechanical Eng.

JPL-007

Host Center: Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title: Dynamics, Control and Simulation of Planetary Vehicles

Opportunity Description/Objective (specific student assignment):
Space mission applications including landers and surface exploration make extensive use of vehicle and environment models within their simulation test beds. JPL's DARTS lab develops physics-based modeling, simulation and visualization tools for space missions and robotic platforms such as surface planetary rovers, entry/descent/landing and aerial vehicles, cruise/orbiter spacecraft etc. Space mission applications including landers and surface exploration make extensive use of vehicle and environment models within their simulation test beds. JPL's DARTS lab develops physics-based modeling, simulation and visualization tools for space missions and robotic platforms such as surface planetary rovers, entry/descent/landing and aerial vehicles, cruise/orbiter spacecraft etc. Multiple projects on physics based modeling, simulation and visualization of space vehicles and planetary environments are available at the DARTS Lab (http://dartslab.jpl.nasa.gov) at JPL. The projects range from participating in the development of models for new vehicles, conducting analyses using these simulations, 3D graphics visualization, user interface development etc. There are also opportunities in the development and application of the basic multibody dynamics and control algorithms used in these real-time simulations.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Research, final report, final presentation

Student's Computer and/or Special Skills:
- Must be currently enrolled as a graduate student pursuing a Ph.D. degree in Aerospace, Electrical, or Mechanical Engineering, Computer Science, or Applied Mathematics.
- Completed coursework with exposure to standard principles, theories, concepts and techniques in system dynamics, structural dynamics, feedback control systems.
- Knowledge and experience with Matlab, Python, C++ programming is highly desirable.

Desired Student Academic Level: Master's/Doctoral
Academic Disciplines

Engineering - Aerospace Eng.
Engineering - Electrical Eng.
Engineering - Mechanical Eng.

JPL-008

Host Center: Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title: CubeSat Database and Modeling to Support Team X for CubeSats

Description/Objective (specific student assignment):
CubeSats are a high priority at NASA and there are many CubeSat class proposal call that need support. In addition, the emerging Team Xc (for CubeSats) needs CubeSat component and mission data. An authoritative database and we tool to enable searching, designing, analyzing, and verifying candidate designs is needed to make this a reality. CubeSats are a high priority at NASA and there are many CubeSat-class proposal call that need support. In addition, the emerging Team Xc (for CubeSats) needs CubeSat component and mission data. An authoritative database and we tool to enable searching, designing, analyzing, and verifying candidate designs is needed to make this a reality. We are currently leading the development of a CubeSat database that will house authoritative spacecraft, instrument and LV ride sharing information for Formulators to rapidly develop new mission concepts (and support proposal development). Longer-term, this site will be a website that will enable mission conception, analysis, collaboration, and support proposal development to be used by people from academia, industry, government, and the public. The current database lives in an extensive Excel spreadsheet, and we are moving this data into a JPL internal website. We've been working closely with website experts at JPL to develop the website architecture for our envisioned system, which is currently found here, although this is still in the development phases. The system is being designed in coordination with the Office of Export Control to ensure all requirements and regulations are met. This project will consist of continuing to research and populate the database with relevant CubeSat missions and components. The interns will also assist in improving the website front end and user experience of the website. They will be engaged in Team Xc activities to understand the larger impact of their work on concept development, concurrent engineering efforts and proposals.

Expected opportunity outcome
Research, final report, poster presentation

Student's Computer and/or Special Skills: None required. Desired: CubeSats, space systems, computer science, database, website development, etc. We are particularly interested in someone with experience automatically reading data from public websites and populating databases.

Desired Student Academic Level Master’s/Doctoral

Academic Disciplines
- Engineering - Aerospace Eng.
- Engineering - Computer Eng
- Technology - Systems Eng./Design

JPL-009

Host Center: Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title: Frequency Metrology and Sensor Technologies

Opportunity Description/Objective (specific student assignment):
The research activities will be carried out in the JPL Quantum Sciences and Technology group at JPL. The primary focus of our R&D is in developing new enabling technologies in the area of atomic frequency standards and sensors that can be used in space for fundamental sciences and practical applications. The research activities will be carried out in the JPL Quantum Sciences and Technology group at JPL. The primary focus of our R&D is in developing new enabling technologies in the area of atomic frequency standards and sensors that can be used in space for fundamental sciences and practical applications. Research activities range from basic concept studies, proof-of-principle demonstrations in the laboratory, and instrument implementation. We develop novel frequency standards and clocks, high-performance oscillators, and related precision sensor technologies. Strong technological synergy exists between frequency metrology and sensors; both of them are related to precision frequency, phase, and time measurements. An exemplary case is the cold atom clock and atom interferometry inertial sensors. Current research areas include: 1) atomic clocks including compact space optical clocks, micro and chip sized atomic clocks, and other novel approaches to atomic clocks; 2) Atomic inertial sensor development with the focus on measuring gravity and tests of fundamental physics; 3) coherent laser technology that include optical frequency comb generation, laser stabilization, optical phase control, and optical links; and 4) optical sensors and photonics that include photonic oscillators, NIR and MIR lasers and spectrometers, as well as micro resonator-based photonics. Opportunities also exist in the technology development of the trapped ion microwave...
Expected opportunity outcome
(i.e. research, final report, poster presentation, etc.):
Research, final report, final presentation

Student’s Computer and/or Special Skills:
Preparatory graduate level courses in atomic physics, laser and optics, and photonics.

Desired Student Academic Level
Master’s/Doctoral

Academic Disciplines
Engineering - Electrical Eng.
Science - Physics

JPL-010

Host Center: Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title: Optical/Digital Pattern Recognition

Opportunity Description/Objective (specific student assignment):
The Intelligent Sensor Processing Object Recognition & Tracking Systems (iSports) Lab in Bio-Inspired Technologies & Systems Group (3492) is conducting testing and optimization of optical/digital pattern recognition and high-speed electronic interface system for next generation data storage research. The research is directly applicable to spacecraft on-board image understanding and data storage. We are interested in sponsoring a graduate student for digital/optical computer vision and data storage projects. The candidate will help to design algorithms and FPGA firmware to optimize the pattern recognition systems.

Expected opportunity outcome
(i.e. research, final report, poster presentation, etc.):
Research, final report, final presentation

Student’s Computer and/or Special Skills:
Critical thinking, creativity, curiosity, good communication skills, C/C++, Matlab programming, Labview, Verilog and FPGA programming; Courses:

space clock and fundamental physics and sciences enabled by advanced clocks.
normal undergraduate math, electrical and computer engineering, FPGA design. Useful, but not required: knowledge of image processing, neural networks, computer vision.

**Desired Student Academic Level**: Master’s/Doctoral

**Academic Disciplines**: Engineering - Computer Eng  
Engineering - Electrical Eng.  
Technology - Comp Science

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**JPL-011**

**Host Center**: Jet Propulsion Laboratory – Pasadena, CA

**Opportunity Title**: Analysis and Stochastic Modeling of Design, Cost, & Risk of Early Mission Concepts

**Opportunity Description/Objective (specific student assignment)**: JPL relies on two mission formulation teams to select and refine mission ideas, concepts, and designs. The A-Team is an early formulation service designed to quickly explore a mission trade space within small, facilitated groups of subject matter experts. Team X is an in depth cross-functional multidisciplinary team of engineers that utilizes concurrent engineering methodologies to complete rapid design, analysis and evaluation of mission concept designs. Both teams are developing state-of-the-art tools that enable rigorous, robust, and efficient analysis and optimization of the engineering trade space. JPL relies on two mission formulation teams to select and refine mission ideas, concepts, and designs. The A-Team is an early formulation service designed to quickly explore a mission trade space within small, facilitated groups of subject matter experts. Team X is an in depth cross-functional multidisciplinary team of engineers that utilizes concurrent engineering methodologies to complete rapid design, analysis and evaluation of mission concept designs. Both teams are developing state-of-the-art tools that enable rigorous, robust, and efficient analysis and optimization of the engineering trade space. The fellow chosen will participate in a variety of space system design and modeling activities in support of A-team and Team X. Of particular need is the data collection, analysis, and modeling of the interaction between system engineering design trades and the resulting cost, schedule, and risk for evaluation of various spacecraft design options. Patterns in cost, risk, and schedule impacts must be extracted and modeled from a relatively small dataset of unique historical space missions. Multiple models will be developed to assess various spacecraft subsystems, instrument payload, and operations costs and risks. Once complete, they will be linked and cons assess an end-to-end mission. While still converging on a point design, these models will be used to perform cost-informed design trades and then ultimately predict space mission cost, schedule and risk posture consistent with NASA costing policy and procedure.
Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Research, final report, poster presentation

Student's Computer and/or Special Skills:

This task is a cross disciplinary task that requires a background and/or interest in aerospace engineering, mathematics, and computer science. The ideal candidate will be pursuing a degree in one of these fields with an interest and knowledge in the other fields. It is required that they have strong math, statistics, and programming skills. He or she should have a global interest in inspecting, transforming, and modeling data with the goal of discovering useful information, suggesting conclusions, and supporting decision-making.

Required skills: Familiarity with one or more statistical packages (such as R, SAS, Matlab, or JMP), Familiarity with a data mining package such as Weka. Programming and modeling experience (any language) Coursework or professional experience in a majority of the following methods: multivariate linear and nonlinear regression, Bayesian modeling and analysis, Markov chain Monte Carlo techniques, small sample statistics, data mining and cluster analysis, optimization, model validation methods (e.g. cross validation, bootstrap), uncertainty propagation, and probability theory. Ideal skills (but not required): Knowledge of MySQL, database construction, and other end-to-end information systems.

Desired Student Academic Level

Master’s/Doctoral

Academic Disciplines

Engineering - Aerospace Eng.
Mathematics - General
Technology - Information Technology
Technology - Systems Eng./Design

JPL-012

Host Center: Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title: Team X Model-Based Systems Engineering

Opportunity Description/Objective (specific student assignment):

Team X utilizes concurrent engineering methodologies and co-located teams consisting of cross-functional Multidisciplinary, experienced engineers, technologists and scientists. These advanced design teams quickly generate point designs of space missions in the early formulation phase. Team X is exploring new methods to introduce model-based systems engineering methods within the design process of early formulation. Team X utilizes concurrent engineering methodologies and co-located teams consisting of cross-functional multidisciplinary, experienced engineers, technologists and scientists. These advanced design teams quickly generate point designs of space missions in the early formulation phase. Team X is exploring new
methods to introduce model-based systems engineering methods within the design process of early formulation. At JPL, considerable expertise exists in the early conceptual design of a variety of space missions. One of the primary design groups, called Team X, is composed of -20 subsystem engineers that architect a new conceptual design over the course of 1-3 weeks. Currently, this team primarily uses Excel workbooks to design the subsystem hardware and communicate this design across the team. The research task is assessing this process, evaluating whether portions can be automated, and then implementing a series of prototypes to demonstrate alternative solutions. These solutions may use Excel, Python, Java, and/or specific applications (e.g. STK/Solidworks/ModelCenter) to construct an integrated model. As part of our task, we will need help from interns to design and think through some of the requirements for this new integrated environment.

**Expected opportunity outcome**
(i.e. research, final report, poster presentation, etc.):
Research, final report, final presentation

**Student’s Computer and/or Special Skills:**
It is recommended that applicants are familiar with the spacecraft design and process, along with familiarity with several types of software applications. Applicable coursework includes: Space Systems Engineering Design, Spacecraft Mission Design, Applied Orbital Mechanics, Attitude Dynamics, Spacecraft Dynamics, Spherical Astronomy, Astrophysics, Celestial Mechanics, Linear System Analysis, Low/high Speed Aerodynamics, Propulsion. Software background is desired.

**Desired Student Academic Level:**
Master’s/Doctoral

**Academic Disciplines:**
Engineering - Aerospace Eng.
Engineering - Computer Eng.
Technology - Comp Science

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**JPL-013**

**Host Center:**
Jet Propulsion Laboratory – Pasadena, CA

**Opportunity Title:**
Actuation, drilling and sampling via piezoelectric mechanisms

**Opportunity Description/Objective (specific student assignment):**
The student will work with the JPL’s scientists of the Advanced Technologies Group and its Nondestructive Evaluation and Advanced Actuators (NDEAA) Technologies lab, JPL. The student will be involved with innovative research and development (R&D) for space applications and technology transfer to other fields. The core technology that is being used is based on piezoelectric actuators. The student will work with the JPL’s scientists of the Advanced Technologies Group and its Nondestructive Evaluation and Advanced Actuators (NDEAA) Technologies lab, JPL. The student will be involved with...
innovative research and development (R&D) for space applications and technology transfer to other fields. The core technology that is being used is based on piezoelectric actuators. The student will be working on mechanisms related to actuation, drilling and sampling via piezoelectric stacks. The student will perform analyze, design, construct and test of piezoelectric actuated devices.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Research, final report, poster presentation

Student’s Computer and/or Special Skills:
The student needs to major in mechanical related discipline.

Desired Student Academic Level:
Master’s/Doctoral

Academic Disciplines:
Engineering - Electrical Eng.
Engineering - Mechanical Eng.
Science - Physics

JPL-014
Host Center:
Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title:
Human-Computer Interaction for Fast-Moving Design Teams

Opportunity Description/Objective (specific student assignment):
JPL supports its advanced concepts work through the use of "concurrent engineering" teams, which involve many engineers in the same room working a problem using interconnected computer tools and facilitated brainstorming techniques. These teams are employed on a fast turnaround, full contact basis to work design problems and flesh out early concepts to feed into funding proposals or to understand problems of strategic importance to the laboratory. For many years, the Team X concurrent environment has been based on Excel workbooks exchanging data through first a custom VBA framework (ICEMaker) and then a database-facilitated exchange system (NExSys / xlDEA). A revitalization effort is underway to upgrade the tooling platform for the concurrent teams significantly. JPL supports its advanced concepts work through the use of "concurrent engineering" teams, which involve many engineers in the same room working a problem using interconnected computer tools and facilitated brainstorming techniques. These teams are employed on a fast turnaround, full contact basis to work design problems and flesh out early concepts to feed into funding proposals or to understand problems of strategic importance to the laboratory. For many years, the Team X concurrent environment has been based on Excel workbooks
exchanging data through first a custom VBA framework (ICEMaker) and then a database-facilitated exchange system (NExSys / xlDEA). A revitalization effort is underway to upgrade the tooling platform for the concurrent teams significantly. The summer project would involve working with the alpha/beta version of parts of the new engineering platform to develop small tools that are useful to engineers in concurrent engineering. These tools would accelerate basic functions - finding data from previous studies, doing basic calculations, working with analogies.

Expected opportunity outcome
(i.e. research, final report, poster presentation, etc.):
Research, final report, poster presentation

Student's Computer and/or Special Skills:
Required skills: - Web development (knowledge of at least one framework like Java Server, Pages, Spring framework, etc.) - Human Interface Design (understanding of design principles, user testing, etc.)
Suggested / preferred skills: - Minor or having taken enrichment classes in a physical engineering field like mechanical, electrical, aerospace

Desired Student Academic Level: Master’s/Doctoral

Academic Disciplines: Any relevant disciplines

JPL-015

Host Center: Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title: Analysis of Infrared Observations of Jupiter and Saturn

Opportunity Description/Objective (specific student assignment):
Images and spectra of Jupiter and Saturn from infrared instruments are sensitive to temperatures, abundances of a major condensate (ammonia), opacity of clouds, 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 (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. Images and spectra of Jupiter and Saturn from infrared instruments are sensitive to temperatures, abundances of a major condensate (ammonia), opacity of clouds, 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 (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. 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 and final tweaks to the data, combined with their interpretation to be put immediately into a publication in the open literature.

b. 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.

c. 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.

d. For Saturn, besides the long-term response to seasonal variations of radiation, we are investigating the appearance of thermal wave trains in the atmosphere.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Research, final report, poster presentation

Student's Computer and/or Special Skills:
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

Desired Student Academic Level

Master’s/Doctoral

Academic Disciplines

Science - Astronomy
Technology - Comp Science
Host Center: Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title: ISAAC - FPGA-based Instrument Computing/Control Platform

Opportunity Description/Objective (specific student assignment):
The research work will be undertaken on a highly capable, reusable, and modular FPGA-based computing and control platform for instrument avionics that combines state-of-the-art microelectronics technology with a few innovative ideas. The research work will be undertaken on a highly capable, reusable, and modular FPGA-based computing and control platform for instrument avionics that combines state-of-the-art microelectronics technology with a few innovative ideas. The intern students will conduct research with the mentor to: (1) develop a Java-based GUI software toolkit that streamlines the FPGA-based digital system development process from high-level modeling/simulation to RTL-level Firmware implementation; (2) develop a flexible, modular, configurable Python-based software kit that allows control and monitoring of FPGA-based digital systems of various instruments, and acquisition and display of science and engineering telemetry of digital systems; (3) develop and implement DSP algorithms on the ISAAC-based platform, including system architecture exploration and design, algorithm design and implementation, integration and testing, and benchmarking.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Research, final report, poster presentation

Student’s Computer and/or Special Skills:
Critical thinking, creativity, curiosity, good communication skills, self motivation, desire to having fun with exploring, and ability to work on a team. Preferred: Demonstrated ability in design of digital systems using Verilog/VHDL RTLs and software systems in C/C++/Java or any other popular scripting languages such as Python/PERL. Good knowledge in Linux kernel, Linux systems, and low-level hardware/software interface, DSP, Matlab.

Desired Student Academic Level: Master’s/Doctoral

Academic Disciplines:
Engineering - Computer Eng.
Engineering - Electrical Eng.
Technology - Comp Science
Opportunity Title: Zintl Phases for Cryogenic Thermoelectric Applications

Opportunity Description/Objective (specific student assignment):

For the past 50 years the National Aeronautics and Space Administration (NASA) has utilized radioisotope thermoelectric generators (RTGs) to reliably power many deep space and exploration science missions such as Voyager, Cassini and the recent Mars mission, Curiosity. RTGs are ideally used when photovoltaics are not optimal such as for deep space probes where the solar flux is too low or on missions to the moon or Mars where the settling of dust or day and night cycles hamper the efficiency of photovoltaics. However, despite the reliability of thermoelectric generators, the thermal-to-electric conversion efficiency of these devices is still quite low. Currently, NASA employs RTGs containing silicon-germanium alloys (Si0.8Ge0.2) or lead telluride based materials (PbTe/TAGS), which result in generator conversion efficiencies of only -6.5%. Improvements of a factor of two or more in the conversion efficiency are necessary in order to support future space missions. Higher efficiency RTGs would translate into a significant reduction in the required amount of prohibitively expensive radioactive fuel, and would allow for an increase in the available power and/or scientific payload for a given mission. These are improvements are necessary in order to support future space missions. For the past 50 years the National Aeronautics and Space Administration (NASA) has utilized radioisotope thermoelectric generators (RTGs) to reliably power many deep space and exploration science missions such as Voyager, Cassini and the recent Mars mission, Curiosity. RTGs are ideally used when photovoltaics are not optimal such as for deep space probes where the solar flux is too low or on missions to the moon or Mars where the settling of dust or day and night cycles hamper the efficiency of photovoltaics. However, despite the reliability of thermoelectric generators, the thermal-to-electric conversion efficiency of these devices is still quite low. Currently, NASA employs RTGs containing silicon-germanium alloys (Si0.8Ge0.2) or lead telluride based materials (PbTe/TAGS), which result in generator conversion efficiencies of only -6.5%. Improvements of a factor of two or more in the conversion efficiency are necessary in order to support future space missions. Higher efficiency RTGs would translate into a significant reduction in the required amount of prohibitively expensive radioactive fuel, and would allow for an increase in the available power and/or scientific payload for a given mission. These are improvements are necessary in order to support future space missions. In order to achieve a high thermal-to-electric conversion efficiency a material must possess a combination of properties: a low metal-like resistivity, a high insulator-like Seebeck coefficient, and a low glass-like thermal conductivity. High ZT values have been achieved in complex Zintl phases such as Yb14MnSb11. The high ZT in these materials, which often possess small band gaps, is attributed to inherently low glass-like lattice thermal conductivity brought by structural complexity and unique covalent bonding. The electronic properties of these materials can be tuned via structural modifications or by chemical substitutions. Although, many
other complex Zintl crystal structures are known, the thermoelectric properties of these materials remain relatively unexplored. The aim of this project is to investigate and model the thermoelectric transport properties of new novel Zintl phases.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Research, final report, poster presentation

Student's Computer and/or Special Skills:
General chemistry, general physics, solid state chemistry, inorganic chemistry, intro to materials science

Desired Student Academic Level
Master's/Doctoral

Academic Disciplines
Engineering - Chemical Eng.
Engineering - Materials Eng.
Science - Chemistry
Host Center: Jet Propulsion Laboratory – Pasadena, CA

Opportunity Title: Foundry IT architecture modernization

Opportunity Description/Objective (specific student assignment):
The JPL Innovation Foundry Program coordinates and provides leadership for all JPL activities associated with the development and capture of business opportunities. To accomplish its goals for world-wide leadership in mission formulation, the Foundry has developed concurrent engineering capabilities that integrate methods, tools, and domain experts that span the mission concept lifecycle. The JPL Innovation Foundry Program coordinates and provides leadership for all JPL activities associated with the development and capture of business opportunities. To accomplish its goals for world wide leadership in mission formulation, the Foundry has developed concurrent engineering capabilities that integrate methods, tools, and domain experts that span the mission concept life cycle. The Foundry IT architecture modernization task will enhance current mission concept and design capabilities. This will be achieved through a series of investments that will replace current solutions with contemporary IT architectures modern software technologies, the introduction of model based system engineering practices, and improvements in concurrent engineering processes.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Research, final report, poster presentation

Student’s Computer and/or Special Skills: Computer science, software engineering, systems engineering, web-applications development, information/data modeling, database development.

Desired Student Academic Level: Master’s/Doctoral

Academic Disciplines:
- Engineering - Computer Eng.
- Technology - Information Technology
- Technology - Software Eng.
**JSC-001**

**Host Center:** Johnson Space Center - Houston, TX

**Opportunity Title:** Integrating Inference and Complex Event Processing for Autonomous Logistics Management

**Opportunity Description/Objective (specific student assignment):**
The high level objective of this project is to research and develop statistical learning (data mining, inference, and prediction) models and integrate these models with a Complex Event Processing (CEP) engine for use in an Autonomous Logistics Management (ALM) system.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):** Results from this project will be demonstrated and integrated with the Advanced Exploration Systems (AES) Logistics Reduction and Repurposing Project’s Autonomous Logistics Management (ALM) testbed. These demonstrations will showcase how the statistical learning models (data mining, inference, and prediction) developed during the project and integrated with the CEP engine are used to address core operational concepts and needs for an ALM system.

**Student's Computer and/or Special Skills:** Experience in machine learning, information theory, relational database management systems (RDBMS), and data mining is desired. Proficiency in Python, Java C++, or another modern object-oriented language is required. Ideally the candidate will be familiar with the GNU development toolchain and is comfortable developing software in a UNIX/Linux environment. Experience with software development using web frameworks and web applications is a plus.

**Desired Student Academic Level**

**Academic Disciplines**
- Computer Engineering
- Electric Engineering
- Software Engineering
- Computer Science

**JSC-002**

**Host Center:** Johnson Space Center - Houston, TX

**Opportunity Title:** Robotics Algorithms Engineer

**Opportunity Description/Objective (specific student assignment):**
The student will be involved in implementing algorithms for Robonaut 2 (R2). This will involve writing code, using and interpreting sensor data, running tests, operating robots, and learning...
Opportunity Title: Space Suit Assembly engineer

Opportunity Description/Objective (specific student assignment):
The intern will serve as a member of the space suit assembly technology development team. We have a dynamic environment in which task priorities change rapidly, but the intern could expect to work on a task(s) similar to those listed below: -- Space suit helmet CO2 washout least planning, performance, and data analysis -- Space suit joint cycle tester Fabricate and test space suit components -- Determine the joint torque incurred from various suit cover layer/environmental protection lay-up -- Evaluate liquid cooling garment configurations -- Fabricate and test portable air rig or portable air backpack -- Investigate vehicle and other external interfaces to the space suit.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Deliverables could include: test plan, test report, completed test readiness review, completed hardware build-up

Student's Computer and/or Special Skills:
The most successful applicants will have good programming skills as well as knowledge of robotics and control theory.

Desired Student Academic Level:
Masters/Doctoral

Academic Disciplines:
Computer Engineering
Electrical Engineering
Mechanical Engineering
Applied Mathematics
Software Engineering
Computer Science
Student's Computer and/or Special Skills: Helpful, but not mandatory: LabView, CAD. sewing, machining

Desired Student Academic Level Masters
Doctoral

Academic Disciplines Aerospace Engineering
Biomedical Engineering
Electrical Engineering
Materials Engineering
Mechanical Engineering

JSC-004
Host Center: Johnson Space Center - Houston, TX

Opportunity Title: Habitation Systems

Opportunity Description/Objective (specific student assignment): Habitation systems in space must be sustainable for longer durations as exploration missions extend farther from Earth. In general, this will mean recycling and reusing as many waste products as possible (see "Mission Benefits Analysis of Logistics Reduction Technologies" by Ewert and Broyan. AIAA 2013-3383). Of particular interest to NASA are methods of recovering water from human wastes and trash. Three technologies under development are a Universal Waste Management System (i.e. toilet), a Heat Melt Compactor (i.e. trash compactor with water recovery) and Trash-to-gas systems (i.e. methane fuel from trash) Thus far, they have not been integrated together, so systems engineering could provide some benefits. At a minimum, human factors must be considered if waste products are to be transferred into any device for processing analysis. Design concepts and possibly testing are desired to create an end-to-end system for reusing waste products in the volume-constrained, micro-gravity environment of future space exploration missions.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): The student will conduct research on the habitation systems waste reuse topic in collaboration with NASA JSC researchers. Opportunities for laboratory testing of concepts will likely be available. Concepts, analysis and test results will all be documented in a technical paper and presentations to peers.

Student's Computer and/or Special Skills: Microsoft Office skills are desirable.

Desired Student Academic Level Master's
Academic Disciplines

- Systems Engineering
- Human Factors
- Environmental Sciences
- Environmental Engineering

JSC-005

Host Center: Johnson Space Center - Houston, TX

Opportunity Title: Active Response Gravity Offload System Design and Development

Opportunity Description/Objective (specific student assignment):

In preparation for returning to the moon, Mars or Near Earth Orbit, a means must be developed to allow astronauts to practice performing tasks in a reduced gravity environment, and engineers to evaluate systems, such as space suits and tools, used in the performance of these tasks. Robotic hardware can also be tested in the facility. To these ends, the Active Response Gravity Offload System (ARGOS) Project is being developed. ARGOS will use electro-mechanical devices and sensors to compensate for the difference between earth and lunar gravity, while keeping the actuation point above the center of gravity during translations. This system is a large robotic system that will follow the test participant. Since mass constraints could result in lunar transport vehicle suspension systems that do not function in earth's gravity, it would be beneficial if ARGOS, or a similar system, could be used to perform "test drives" of development hardware. Of interest to NASA is a control algorithm that would allow multiple gravity compensation devices to work in tandem to support a large mobile system. The development opportunities include control theory design and testing along with mechanical and electrical engineering design. The task is hands on and interns will be developing, deploying, and testing design ideas. The area of system modeling and model verification is a primary area of development.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

- Functional improvements to the ARGOS system

Student's Computer and/or Special Skills:

- Mechanical engineers will be using the Pro-E software package for designs. Electrical engineers will be using Altium for designs. A Matlab or computer programming would be needed for the control theory modeling and simulation.
| Desired Student Academic Level | Master's  
Doctoral |
|--------------------------------|-----------------|
| Academic Disciplines          | Aerospace Engineering  
Computer Engineering  
Electrical Engineering  
Instrumentation Engineering  
Mechanical Engineering  
Structural Engineering  
Engineering, General |

**JSC-006**

**Host Center:**  
Johnson Space Center - Houston, TX

**Opportunity Title:**  
Exercise Countermeasures

**Opportunity Description/Objective (specific student assignment):**  
The Biomedical Research and Environmental Sciences (BR&ES) Division laboratories at NASA Johnson Space Center are responsible for research focused on understanding the normal human response to spaceflight; and developing, testing and delivering countermeasures to improve crew health during and after spaceflight missions. BR&ES is made up of a variety of life sciences disciplines including: Anthropometry and Biomechanics, Biostatistics, Bone Physiology, Cardiovascular Physiology, Exercise Physiology, EVA Physiology, Immunology, Microbiology, Neurosciences, Nutritional Biochemistry, Pharmacotherapeutics, Radiation Biophysics, Toxicology, and Water. The student applying to this opportunity should refer to the Human Research Roadmap (http7/humanresearchroadmap.nasa.gov/Risks/) and the Risk of Impaired Performance Due to Reduced Muscle Mass. Strength and Endurance to see the research NASA is performing to reduce the risk associated with long duration spaceflight.

**Expected opportunity outcome**  
(i.e. research, final report, poster presentation, etc.):  
Final report, presentation

**Student's Computer and/or Special Skills:**  
Experience with exercise physiology research on human subjects Particular skills include exercise testing (VO2max, isokinetic strength, muscle power), imaging of skeletal muscle (MRI, ultrasound), implementation of exercise training studies (rowing, running, cycling, resistance exercise), data analysis (graphing, reporting data), and biomechanics (load sensing, gait and exercise form evaluation).

| Desired Student Academic Level | Doctoral |
Academic Disciplines

Biology
Life Sciences
Science - General

JSC-007

Host Center: Johnson Space Center - Houston, TX

Opportunity Title: Cardiovascular Physiology Laboratory

Opportunity Description/Objective (specific student assignment):
The Biomedical Research and Environmental Sciences (BR&ES) Division laboratories at NASA Johnson Space Center are responsible for research focused on understanding the normal human response to spaceflight; and developing, testing and delivering countermeasures to improve crew health during and after spaceflight missions. BR&ES is made up of a variety of life sciences disciplines including; Anthropometry and Biomechanics, Bio statistics, Bone Physiology, Cardiovascular Physiology, Exercise Physiology, EVA Physiology, Immunology, Microbiology, Neurosciences, Nutritional Biochemistry, Pharmacotherapeutics, Radiation Biophysics, Toxicology, and Water. The student applying to this opportunity should refer to the Human Research Roadmap (http://humanresearchroadmap.nasa.gov/Risks/) and the Risk of Spaceflight-Induced Intracranial Hypertension/Vision Alterations and/or Risk of Cardiac Rhythm Problems to see the research NASA is performing to reduce the risk associated with long duration spaceflight.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Final report, presentation

Student's Computer and/or Special Skills:
Students should have a good understanding of human physiology. Excellent Microsoft Office skills and MatLab skills are desired.

Desired Student Academic Level: Doctoral

Academic Disciplines

Biology
Life Sciences
Science - General

JSC-008
Host Center: Johnson Space Center - Houston, TX

Opportunity Title: Bone & Mineral Laboratory

Opportunity Description/Objective (specific student assignment):
The Biomedical Research and Environmental Sciences (BR8ES) Division laboratories at NASA Johnson Space Center are responsible for research focused on understanding the normal human response to spaceflight; and developing, testing and delivering countermeasures to improve crew health during and after spaceflight missions. BR8ES is made up of a variety of life sciences disciplines including: Anthropometry and Biomechanics, Biostatistics, Bone Physiology, Cardiovascular Physiology, Exercise Physiology, EVA Physiology, Immunology, Microbiology, Neurosciences, Nutritional Biochemistry, Pharmacotherapeutics, Radiation Biophysics, Toxicology, and Water. The student applying to this opportunity should refer to the Human Research Roadmap (http://humanresearchroadmap.nasa.gov/Risks/) and the Risk of Bone Fracture and Risk Of Early Onset Osteoporosis Due To Spaceflight to see the research NASA is performing to reduce the risk associated with long duration spaceflight.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Final report, presentation

Student's Computer and/or Special Skills: Desire doctoral student with an understanding or capability to understand any of the following related physiological systems, endocrinology, radiology, orthopedics, dental specialties, pharmacology, physical medicine and rehabilitation and/or rheumatology. In addition, an understanding of bone cell biology, biochemistry, histology, anatomy, biomechanics, bioengineering, bone epidemiology and physiology is desired.

Desired Student Academic Level: Doctoral

Academic Disciplines: Biology, Life Sciences, Science - General
during and after spaceflight missions BR&ES is made up of a variety of life sciences disciplines including: Anthropometry and Biomechanics, Bio statistics, Bone Physiology, Cardiovascular Physiology, Exercise Physiology, EVA Physiology, Immunology, Microbiology, Neurosciences, Nutritional Biochemistry, Pharmacotherapeutics, Radiation Biophysics, Toxicology, and Water. The student applying to this opportunity should refer to the Human Research Roadmap (http://humanresearchroadmap.nasa.gov/Risks/) and the Risk of Bone Fracture and Risk Of Early Onset Osteoporosis Due To Spaceflight to see the research NASA is performing to reduce the risk associated with long duration spaceflight.

Microgravity alters global gene expression patterns and protein levels in cultured cells or animals. It has been suggested that packaging of chromatin fiber in the interphase nucleus is closely related to genome function, and the changes in transcriptional activity are tightly correlated with changes in chromatin folding. In human cells that contain 46 chromosomes, chromatin undergoes extensive degrees of folding, with a total length of 5 cm of the chromatin fiber arranged like beads on a string that packs in a volume of only 5-20 μm in diameter. Furthermore, data obtained using modern molecular techniques by various research groups, including our own team, have provided increasing evidences that local chromatin folding is associated with the transcriptional activity and the gene density. However, no data is available currently on chromosomal conformation changes in micro-G and the impact of such changes on the cellular function, differentiation and development.

**Expected opportunity outcome**
(i.e. research, final report, poster presentation, etc.):
Final report, presentation

**Student's Computer and/or Special Skills:**
Basic techniques of mammalian cell culture Basic techniques of genetic analysis, such as DNA/RNA isolation and polymerase chain reaction (PCR) Ph. D. candidate preferred

**Desired Student Academic Level**
Doctoral

**Academic Disciplines**
Biology
Life Sciences
Science - General

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**JSC-010**

**Host Center:** Johnson Space Center - Houston, TX

**Opportunity Title:** Microbiology Laboratory
### Opportunity Description/Objective (specific student assignment):

The Biomedical Research and Environmental Sciences (BRSES) Division laboratories at NASA Johnson Space Center are responsible for research focused on understanding the normal human response to spaceflight, and developing, testing and delivering countermeasures to improve crew health during and after spaceflight missions. BR&ES is made up of a variety of life sciences disciplines including: Anthropometry and Biomechanics, Biostatistics, Bone Physiology, Cardiovascular Physiology, Exercise Physiology, EVA Physiology, Immunology, Microbiology, Neurosciences, Nutritional Biochemistry, Pharmacotherapeutics, Radiation Biophysics, Toxicology, and Water. The student applying to this opportunity should refer to the Human Research Roadmap (http://humanresearchroadmap.nasa.gov/Risks/) and Risk of Crew Adverse Health Event Due to Altered Immune Response and Risk of Adverse Health Effects Due to Alterations in Host-Microorganism Interactions to see the research NASA is performing to reduce the risk associated with long duration spaceflight.

### Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Final report and presentation

### Student's Computer and/or Special Skills:

Desired Student Academic Level

Basic understanding of microbiology

Familiarity with aseptic technique

### Academic Disciplines

Biology

Life Sciences

Science - General

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**JSC-011**

**Host Center:** Johnson Space Center - Houston, TX

**Opportunity Title:** Neurosciences Laboratory

**Opportunity Description/Objective (specific student assignment):**

The Biomedical Research and Environmental Sciences (BRSES) Division laboratories at NASA Johnson Space Center are responsible for research focused on understanding the normal human response to spaceflight, and developing, testing and delivering countermeasures to improve crew health during and after spaceflight missions. BR&ES is made up of a variety of life sciences disciplines including: Anthropometry and Biomechanics, Biostatistics, Bone Physiology, Cardiovascular Physiology, Exercise Physiology, EVA Physiology, Immunology, Microbiology, Neurosciences, Nutritional Biochemistry, Pharmacotherapeutics, Radiation Biophysics, Toxicology, and Water. The student applying to this opportunity should refer to the Human Research Roadmap (http://humanresearchroadmap.nasa.gov/Risks/) and Risk...
of Impaired Control of Spacecraft. Associated Systems and Immediate Vehicle
Egress Due to Vestibular/Sensorimotor Alterations Associated with Space
Flight to see the research NASA is performing to reduce the risk associated
with long duration spaceflight.

Expected opportunity outcome
(i.e. research, final report, poster
presentation, etc.):
Final report and presentation

Student’s Computer and/or
Special Skills:
Students should have a good understanding of human physiology

Desired Student Academic Level
Doctoral

Academic Disciplines
Biology
Life Sciences
Science - General

JSC-012
Host Center:
Johnson Space Center - Houston, TX

Opportunity Title:
Solid Oxide Electrolysis and Fuel Cell Power

Opportunity Description/Objective (specific student assignment):
Student will advance solid oxide fuel cell and electrolysis technology for
spacecraft applications. Such applications range from fuel cell power integrated
with oxygen/methane propulsions systems to electrolysis of carbon dioxide
from the Martian atmosphere. Fellow opportunities include analytical
studies of system performance, development of system performance
models, test validation of models, and system design.

Expected opportunity outcome
(i.e. research, final report, poster
presentation, etc.):
Outcomes expected include poster presentations and conference
publications/presentations

Student’s Computer and/or
Special Skills:
Beyond normal office applications, MATLAB and ProEngineer capability are
desired, along with chemical kinetics packages.

Desired Student Academic Level
Master’s
Doctoral
**JSC-013**

**Host Center:** Johnson Space Center - Houston, TX

**Opportunity Title:** Thermoelectric and Thermionic Power Conversion

**Opportunity Description/Objective (specific student assignment):**
Student will advance thermoelectric and thermionic materials and energy conversion systems for spacecraft applications. Such applications focus on multi-kW to multi-MW nuclear power systems for m-space power and propulsion. Fellow opportunities include materials investigations, analytical studies of system performance, development of system performance models, test validation of materials and system models, and prospective system design.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**
Outcomes expected include poster presentations and conference publications/presentations.

**Student’s Computer and/or Special Skills:**
Beyond normal office applications, MATLAB and ProEngineer capability are desired, along with chemical kinetics packages.

**Desired Student Academic Level:**
- Master’s
- Doctoral

**Academic Disciplines:**
- Chemical Engineering
- Materials Engineering
- Nuclear Engineering
- Power Engineering

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**JSC-014**

**Host Center:** Johnson Space Center - Houston, TX
Opportunity Title: Aneutronic Fusion Plasma Confinement and direct energy conversion

Opportunity Description/Objective (specific student assignment):
Student will advance the understanding of (1) the confinement of high beta, non-Maxwellian plasma for the purpose of harnessing aneutronic nuclear fusion reactions for power and (2) methods for direct conversion of fusion product energy into electric power and propulsive thrust. Research will be applied to multi-MW power for spacecraft propulsion. Fellow opportunities include computer simulation of plasma confinement and direct conversion systems, development of system performance models, experimental validation of computer simulations, and spacecraft system design studies.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Outcomes expected include poster presentations and conference publications/presentations.

Student's Computer and/or Special Skills:
Beyond normal office applications, proficiency with MATLAB, plasma analysis tools such as COMSOL, and particle-in-cell analysis codes is required.

Desired Student Academic Level
Master’s
Doctoral

Academic Disciplines
Electrical Engineering
Nuclear Engineering
Power Engineering
Mathematics - Applied Mathematics
Physics

JSC-015

Host Center: Johnson Space Center - Houston, TX

Opportunity Title: Exploration Flight Test 1 Reentry Data Reduction & Analysis

Opportunity Description/Objective (specific student assignment):
NASA plans to fly Orion/MPCV Exploration Flight Test #1 during the fall of 2014. This flight test will collect an unprecedented volume of data related to the entry aerodynamic and aerothermodynamic environment. The qualified student would work in conjunction with NASA researchers to reduce the flight data and then compare to state-of-the-art analysis computational fluid dynamics tools.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
The opportunity should result in novel research results suitable for publication in archival, peer reviewed journals.
Student's Computer and/or Special Skills:
The student should be proficient with parallel high-performance computing in the context of computational fluid dynamics analysis.

Desired Student Academic Level:
- Master’s
- Doctoral

Academic Disciplines:
- Aerospace Engineering
- Mechanical Engineering
- Applied Mathematics

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JSC-016

Host Center: Johnson Space Center - Houston, TX

Opportunity Title: Nanosensors for Health Monitoring

Opportunity Description/Objective (specific student assignment):
The Nanomaterials Group at JSC has interest in nanosensing, smart materials and small sensors for structural health monitoring. The challenge of space exploration is the vast distances of travel and long duration missions required by future vehicles, so health monitoring capabilities need to be significant where vehicle health is instantaneously assessed and reported back. Also, real-time monitoring of space vehicles enable optimization of operation, identification of required maintenance, identification of system and part failures, the optimized modification of operation in the event of failure, and the monitoring of vehicle safely and life. Future human missions will likely see space vehicles and habitats sent to a destination in space or on a planet (e.g. Mars) prior to sending the astronauts, where the vehicle or habitat functionality and health can be assessed prior to the human departure. In order to achieve this vision of future space exploration smart materials and sensors are required for all systems of the spacecraft. The objective of the Fellowship is to develop new and novel sensors, sensing materials, and smart structures with the supporting systems. The reading of the sensors can be accomplished optically, electrically or other means which are amenable for structural health monitoring systems. One approach of particular interest is the accumulation of information optically. Where a monochromator sends a specific wavelength out over the composite and nanomaterials within the structure reflect back a response which is read from the structure. The wavelength of interest is 300-2100 nm. Some of the properties of interest for sensing are stress/strain, temperature, pressure (surface), resistivity, and voltage, along with other properties required to ensure space vehicles and habitat health. Some interests are below:

- Fabricate sensing materials, smart structures and small sensors.
- Functionalize nanomaterials to form the sensing materials.
- Develop algorithms which detect impact and/or failure - e.g. delamination and microcracks in composites.
- Develop health systems which minimize mass of
composite vehicles and space habitats -Utilize multifunctional materials where the sensing materials can be used not only for structural health after manufacturing but to monitor the health during manufacturing and fabrication. Develop structural health monitoring system for the collection and processing of the information, which is robust and reliable. The end product should be concise yet informative data easy to communicate. Develop a platform that can easily be modified for various sensing capabilities: stress, temperature, viscosity, voltage, optical properties, etc. Fabricate sensors that can be connected to or printed with microprinted RF devices and embedded in structures.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**

The expected outcome will be research and development of new sensing materials, smart materials and/or sensors. We would like to see a demonstrated application of these sensors which will be included in a final report.

**Student's Computer and/or Special Skills:**

Experience is needed in nanotechnology, chemistry, and materials (composites). Basic computer skills are also needed.

**Desired Student Academic Level**

- Master’s
- Doctoral

**Academic Disciplines**

- Aerospace Engineering
- Biomedical Engineering
- Chemical Engineering
- Civil Engineering
- Computer Engineering
- Construction Engineering
- Ecological Engineering
- Electrical Engineering
- Environ Engineering
- Industrial Engineering
- Instrumentation Engineering
- Integrated Engineering
- Materials Engineering
- Mechanical Engineering
- Nuclear Engineering
- Optical Engineering
- Polymer Engineering
- Power Engineering
- Safety Engineering
- Structural Engineering
- Space Mathematics
- Structure Mathematics
- Chemistry
- Life Sciences
- Physics
- Nanotechnology
- Biological Eng.
- Engineering - General
JSC-017

Host Center: Johnson Space Center - Houston, TX

Opportunity Title: Simulation of the Thermodynamics and Mass Transport of Brine Recovery

Opportunity Description/Objective (specific student assignment):

Recovering potable water from wastewater is a critical enabling technology for future human exploration missions. Many water processing technologies (distillation, reverse osmosis) create a brine of wastewater concentrated on the order of 10x more than the original wastewater. Brine recovery technologies seek to remove the last of the useful water from these streams, and must deal with complicated chemical interactions, multi-phase (solid, liquid and gas) behavior in microgravity, and are still trying to optimize the system for minimal mass, volume, power, and cooling requirements. NASA engineers at the Johnson Space Center have a concept called the Coiled Brine Recovery Assembly, an innovative brine recovery system to meet these challenges. But to actually design and operate it, they need information on the dynamics of heat and mass transfer that would occur on the system. NASA is seeking an engineer with a computer simulation background who can help establish design parameters (dimensions, materials, operation) for a new technology concept for brine recovery involving heat transfer and phase change, porous foams expandable/variable-volume bladders, and non-symmetric geometry. The ability to explore the design’s behavior in Earth gravity, partial gravity, and microgravity environments is desirable. Proposals should focus on abilities to manage the challenges of simulating a system with all of the listed processes dynamic behavior, and not on proposing a new technology.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

A simulation of the new brine technology which will provide design insight to NASA. Such a simulation is likely to provide sufficient material for a thesis, journal publication, or conference publication depending on the student’s work.

Student’s Computer and/or Special Skills:

Student needs to be proficient with at least one simulation program capable of modeling heat transfer and mass transfer, or implementing those relationships in an equation based program. NASA may or may not be able to easily provide software to fit the student’s expertise depending on the program selected. Background in thermodynamics, heat transfer, phase change, mass transfer, and numerical simulation.

Desired Student Academic Level

Master’s
Doctoral
JSC-018

Host Center: Johnson Space Center - Houston, TX

Opportunity Title: Orion Cockpit Development and Testing

Opportunity Description/Objective (specific student assignment):
The Orion Project is working to fly astronauts in to Deep Space around 2021. The fellow will be asked to lead the design and development of several critical pieces of test hardware needed for human in the loop testing to assess the latest spacecraft design. They will also help lead the effort to define the human in the loop testing that will be required to prove the spacecraft meets the requirements, which must be performed to certify the spacecraft for human flight.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
The Proposal from the student shall indicate their willingness and skills to design and build hardware. Also, the student shall research what methods are being used by the Commercial Crew program to man-rate their spacecraft for human spacecraft and propose a high-level approach for human-in-the-loop testing for Orion.

Student's Computer and/or Special Skills: CAD (Pro-E preferred, but others are acceptable)

Desired Student Academic Level: Junior

Academic Disciplines

- Aerospace Engineering
- Biomedical Engineering
- Civil Engineering
- Mechanical Engineering
- Structural Engineering
- Engineering - General
**JSC-019**

**Host Center:**  
Johnson Space Center - Houston, TX

**Opportunity Title:**  
Flight Deck of the Future - Google Glass Implementation for spaceflight use

**Opportunity Description/Objective (specific student assignment):**  
The student will have one main task to design and implement a concept for using Google Glass, or another eye mounted display, for regular use by astronauts on ISS or on a Deep Space mission. In addition, the student will have other opportunities to help mature other human interfaces technologies being assessed for future spacecraft.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**  
For the proposal, the student will identify a use case that would show clear benefits to using an eye-mounted technology on orbit to increase efficiency and improve performance and health. They will then provide a detailed description of the implementation plan, including what the solution will look like and how it can be developed. When the student is at JSC, they will write the software and configure the hardware to bring to life their concept.

**Student's Computer and/or Special Skills:**  
Software programming to complete the described task.

**Desired Student Academic Level**  
Masters  
Doctoral

**Academic Disciplines**  
Aerospace Engineering  
Biomedical Engineering  
Computer Engineering  
Electrical Engineering  
Engineering - General

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**JSC-020**

**Host Center:**  
Johnson Space Center - Houston, TX

**Opportunity Title:**  
Spacesuit Portable Life Support System Research and Development

**Opportunity Description/Objective (specific student assignment):**  
The graduate student will support the research and development being accomplished by the Spacesuit Portable Life Support System (PLSS) NASA at the Johnson Space Center is pursuing technology development of an Advanced Extravehicular Mobility Unit (AEMU) which is an integrated assembly made up of primarily a pressure garment system and a PLSS. The
PLSS is further composed of an oxygen subsystem, a ventilation subsystem, and a thermal subsystem. One of the key functions of the ventilation system is to remove and control the carbon dioxide delivered to the crewmember. Carbon dioxide washout is the mechanism by which CO2 levels are controlled within the spacesuit helmet to limit the concentration of CO2 inhaled by the crew member. CO2 washout performance is a critical parameter needed to ensure proper and robust designs that are insensitive to human variabilities in a spacesuit. A Suited Manikin Test Apparatus (SMTA) is also being developed to augment testing of the PLSS ventilation loop in order to provide a lower cost and more controlled alternative to human testing. The CO2 removal function is performed by the regenerative Rapid Cycle Amine (RCA) within the PLSS ventilation loop and its performance is evaluated within the integrated SMTA and Ventilation Loop test system. Particularly, the graduate student will assist with the RCA performance assessment performing various tests including an RCA ball valve life test, assessing those tests, providing a report of the results.

**Expected opportunity outcome** (i.e. research, final report, poster presentation, etc.):

There will be laboratory research including test, analysis, reporting of the results, and providing a presentation of those results.

**Student's Computer and/or Special Skills:**

It would be helpful to have basic computer skills and familiarity with any of aerospace, industrial, civil, mechanical or environmental engineering skills. Also, a person who has a desire to obtain hands on experience in a research laboratory would be beneficial.

**Desired Student Academic Level**

- Masters
- Doctoral

**Academic Disciplines**

- Aerospace Engineering
- Chemical Engineering
- Computer Engineering
- Environmental Engineering
- Industrial Engineering
- Integrated Engineering
- Mechanical Engineering
- Engineering – General

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**JSC-021**

**Host Center:** Johnson Space Center - Houston, TX
Opportunity Title: US Spaceluit Knowledge Capture Engine

Opportunity Description/Objective (specific student assignment):
This assignment is specifically for the advancement and enrichment of the US Spaceluit Knowledge Capture program. An engineer is requested to technically and administratively manage the production and electronic archival of U.S. Spaceluit Knowledge Capture events. This includes closely working with subject matter experts such as astronauts and engineers to capture lessons learned and other valuable technical information about spacesuits so that current and future developers as well as the public can learn about one of our nation’s most valuable assets. The NASA U.S. spacesuit knowledge capture (KC) program has been in operations since the beginning 2008. The program was designed to augment engineers and others with information about spacesuits in a historical way. A multitude of seminars have captured spacesuit history and knowledge over the last six years of the programs existence Subject matter experts have provided lectures and were interviewed to help bring the spacesuit to life so that lessons learned will never be lost As well, the program concentrate in reaching out to the public and industry by making the recorded events part of the public domain through the NASA technical library via You Tube media. The US spacesuit KC topics have included lessons learned from some of the most prominent spacesuit experts and spacesuit users including current and former astronauts The events have enriched the spacesuit legacy knowledge from Gemini, Apollo, Skylab, Space Shuttle and International Space Station Programs As well, expert engineers and scientists have shared their challenges and successes to be remembered The last few years have been some of the most successful years of the KC program program’s life with numerous recordings and releases to the public It is evidenced by the thousands that have view the recordings online. This U.S. Spaceluit Knowledge Capture engineering opportunity includes the following 1) Production of Knowledge Capture events associated with Spacesuit Lessons Learned and other pertinent in-house technical training 2) Collaboration with the studio, camera crew, and technical experts for event productions: 3) Archival of all productions: 3) Coordination of Knowledge Capture requests from EVA Projects Office Engineering Academy, Crew and Thermal Systems Division, and the Space Suit and Crew Survival Systems Branch: 4) Participation in knowledge capture events as required: 5) Review knowledge capture content and materials: 60 Process knowledge capture events for export control. 7) Status reporting and cataloging of events.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Products Produced. Videos and presentation material per event Knowledge Capture Schedule and Database An event synopsis per event Export control documentation (Form 1676 and supporting material) to be submitted into the NASA DAA system for approval Quarterly Status and reports individual Releases for presenters and individuals being interviewed. Status reporting and cataloging of events.

Student’s Computer and/or Special Skills:
This opportunity requires a basic college-level knowledge in computers, any general engineering background, good communication skills, desire to learn spacesuit history, and an understanding of data archiving with venues such as You Tube
This will be an awesome opportunity to meet and work with extraordinary
subject matter experts such as astronauts and project leaders who worked on programs such as Gemini, Apollo, Skylab, Space Shuttle and International Space Station.

Desired Student Academic Level
Master’s

Academic Disciplines
Aerospace Engineering
Chemical Engineering
Computer Engineering
Mechanical Engineering
Environmental Engineering
Biomedical Engineering
Civil Engineering
Construction Engineering
Electrical Engineering
Hydraulic Engineering
Instrumentation Engineering
Integrated Engineering
Materials Engineering
Industrial Engineering
Optical Engineering
Polymer Engineering
Quality Engineering
Safety Engineering
Structural Engineering
Engineering, General

JSC-022

Host Center: Johnson Space Center - Houston, TX

Opportunity Title: IEEE 802.11-2012 (WiFi) mesh implementation in OpenWRT

Opportunity Description/Objective (specific student assignment): Mobile ad-hoc mesh networking protocols allow WiFi enabled devices to communicate collaboratively without direct connection to Access Point wired infrastructure 802.11-2012 absorbed 802.11s and OpenWRT at least partially implements 802.11s A more complete, better-performing implementation is needed.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Rebuilt open software implementation of 802 11-2012 mesh features for incorporation into OpenWRT or other operating systems Participation in a paper describing the product.

Student's Computer and/or Linux, IP-based networking
Special Skills:

Desired Student Academic Level
- Master’s
- Doctoral

Academic Disciplines
- Electrical Engineering
- Computer Engineering
- Computer Science

JSC-023

Host Center:
- Johnson Space Center - Houston, TX

Opportunity Title:
- Knowledge model for Automatic Test Markup Language (ATML)

Opportunity Description/Objective (specific student assignment):

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
- Objective is RDF which can relate ATML information to model information. This is a pilot, so an acceptable outcome is a report or presentation of a roadmap identifying difficult obstacles and areas of easy progress.

Student's Computer and/or Special Skills:
- Familiarity with XML, RDF, OWL, Protege. Familiarity with inference engines could help

Desired Student Academic Level
- Master’s
- Doctoral

Academic Disciplines
- Computer Engineering
- Instrumentation Engineering
- Information Technology
- Software Engineering
- Systems Engineering/Design
- Computer Science
**KENNEDY SPACE CENTER**

**KSC -001**

*Host Center*  
Kennedy Space Center - Florida

**Opportunity Title**  
Controlled Environment Research with Plants and Crops for Human Life Support

**Opportunity Description**  
Student would conduct graduate research in controlled environment agriculture or plant production. Areas of particular interest to NASA include selection of crops for space-based life support applications, including tests with dwarf or shorter species, crop responses to lighting (including current LED technologies), CO2, nutrient/water management, and other aspects of closed or controlled environments. Research could also include plant microbial interactions and relationships that might occur in controlled environment settings.

**Expected Opportunity Outcome**  
Research report, poster, and oral presentation at the end of each CBRE; Student will be expected to present findings in departmental seminars and at appropriate professional meetings as research data becomes available. The ultimate objective will be to publish the research findings in peer reviewed journals.

**Student’s Computer and/or Special Skills**  
Student is expected to have an undergraduate degree with basic computer skills to support writing, data compilation and analysis, and graphical presentations.

**Desired student academic level**  
Masters or Doctoral

**Academic Disciplines**  
Biology  
Life Sciences  
Biological Engineering, and other related fields of study

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**KSC -002**

*Host Center*  
Kennedy Space Center - Florida

**Opportunity Title**  
Data Mining and Knowledge Discover

**Opportunity Description**  
Data mining uses pattern based queries, searches, or other analyses of one or more electronic databases in order to discover or locate a predictive pattern or anomaly indicative of lessons learned, or system failures. Throughout NASA, hundreds of data systems are designed and tailored to serve specific engineering and business needs. Many of these systems use relational algebra with structured query language to categorize and retrieve data. In these systems, data analyses are limited and require prior explicit knowledge of metadata and database relations; lacking exploratory data mining and discoveries. The purpose of this project is to infuse data mining techniques, methods and algorithms to improve data evaluations and analyses in NASA Data Systems.

**Expected Opportunity**  
Research report, poster, and oral presentation at the end of each
**Outcome**

CBRE

**Student's Computer and/or Special Skills**

Proficiency in computer programming in such languages as C++, Java, Visual Basic, C#

**Desired student academic level**

Masters or Doctoral

**Academic Disciplines**

Computer Engineering
Software Engineering
Electrical Engineering
Systems Engineering
General Engineering
Computer Science
Information Technology

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**KSC -003**

Host Center

Kennedy Space Center - Florida

**Opportunity Title**

Development of Multifunctional Smart Coatings for Corrosion Detection and Control

**Opportunity Description**

The NASA Corrosion Technology Laboratory at KSC is interested in developing environmentally friendly smart coatings for corrosion detection and control, and for the self-healing and repair of mechanical damage. These coatings will be used to insure the longevity of spaceport materials in launch structures, ground support equipment, and facility infrastructures to increase safety and reliability, and reduce maintenance costs. The Corrosion Science and Technology capability at KSC has evolved from the need for a better understanding of the corrosion processes that affect materials exposed to the highly corrosive marine environment at KSC and the acidic exhaust from solid rocket boosters. Over the years, numerous materials failures have been attributed to these conditions. To address these issues, the Corrosion Technology Laboratory conducts applied research to identify materials and develop technologies that will prevent such failures. Current research efforts are focused on the development of innovative technologies in support of NASA's vision for space exploration.

**Expected Opportunity Outcome**

Research report, poster, and oral presentation at the end of each CBRE; research paper for a peer-reviewed technical publication

**Student's Computer and/or Special Skills**

Organic chemistry (including polymer chemistry), analytical chemistry, and microscopy. Familiarity with corrosion and coatings is desired but not required.

**Desired student academic level**

Masters or Doctoral

**Academic Disciplines**

Chemistry
Chemical Engineering
Materials Science/Engineering
**KSC -004**
**Host Center**
Kennedy Space Center - Florida

**Opportunity Title**
Evolvable Optimal Work Flow and Power Management for In Situ Resource Utilization

**Opportunity Description**
This Fellowship seeks highly scientific data analysis and software development research relating to evolvable optimal work flow and power management behavior in an autonomous, robotic system operating in environments where tele-operation and human intervention is not generally possible. The final goal will be demonstration of results in simulation and in a physical robotic system with a goal of mean time between interventions (MTBI) of zero. The benefit of the project is adaptation to many types of multi-agent, robotic systems and continuing KSC’s role as a world leader in extra-planetary robotics and surface resource utilization.

**Expected Opportunity Outcome**
Research report, poster, and oral presentation at the end of each CBRE; Final report documenting analysis and software development conducted. The final goal will be demonstration of results in simulation and in a physical robotic system with a goal of mean time between interventions (MTBI) of zero.

**Student’s Computer and/or Special Skills**
Computer Science or Computer Engineering

**Desired student academic level**
Masters or Doctoral

**Academic Disciplines**
Computer Science  
Computer Engineering

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**KSC-005**
**Host Center**
Kennedy Space Center - Florida

**Opportunity Title**
Examining the Impacts of Long-Duration and Recurring K-12 Hands-On STEM Education Projects

**Opportunity Description**
NASA manages and executes a diverse portfolio of STEM education programs, projects, and activities (PPAs) for students and educators in K-12, in both formal and informal education settings. NASA’s PPAs are designed to achieve three major goals: (1) strengthen NASA and the Nation’s future workforce, (2) attract and retain students in STEM, and (3) engage the public in NASA’s mission. This fellowship seeks to characterize and evaluate the impacts of long-duration hands-on projects and those that entail a series of engagement activities with the same participants over a significant period of time. The projects of interest are center-specific, managed and executed by the Education team at the Kennedy Space Center (KSC), and facilitated to the local education community. The purpose of this research is to determine the effectiveness of these types of engagement in fostering interest in and pursuit of STEM fields in higher education and careers.
Expected Opportunity Outcome: Research report, poster, and oral presentation at the end of each CBRE; The fellow will prepare a final report presenting the findings of the study, including the methodology for gathering, measuring, and evaluating the data.

Student’s Computer and/or Special Skills: Experience or interest in analytical methodologies in education research; Effective written and oral communication.

Desired student academic level: Masters or Doctoral.

Academic Disciplines: Science Education or other Education Majors desired.

KSC-006 Host Center: Kennedy Space Center - Florida.

Opportunity Title: Lunar Advanced Volatile Analysis (LAVA): Water Vapor Generation and Analysis.

Opportunity Description: The extraction and processing of space resources into useful products is known as In Situ Resource Utilization (ISRU). These resources can have a substantial effect on individual missions and mission architecture concepts. Knowing that useful resources, such as water, carbon monoxide, and hydrogen are available on the lunar surface and other locations around the solar system is important; however, questions remain to be answered before in situ utilization of these resources is practical. Specifically, it is necessary to know (1) what volatiles are present and in what quantities, (2) how they are distributed on and under the surface, and (3) what material characteristics and operating environments could influence future ISRU designs. The Lunar Advanced Volatile Analysis (LAVA) Subsystem of the Regolith and Environment Science & Oxygen and Lunar Volatiles Extraction (RESOLVE) Project will be designed to answer these questions as the next logical step toward human exploration of the solar system. The LAVA Subsystem will provide identification and quantification of the volatile resources available on the lunar surface. The main resource of interest is water, with hydrogen, helium, carbon monoxide and carbon dioxide also of high importance. The LAVA subsystem encompasses the Gas Chromatograph-Mass Spectrometer (GC-MS), the Water Droplet Demonstration (WDD) unit, and the Fluid Subsystem (FSS) used to transport the effluent gas stream. The fellow will be involved in the design of the verification and validation experiments and procedures that will be run to characterize the GC-MS instrument. It is a challenge to reproduce the samples expected from the mission scenario; therefore the team must use innovative methods to test the system and try to replicate the behavior of the lunar soil that will be analyzed during this mission. The experiments will involve both the generation of high concentration water vapor standards for delivery into the system, as well as the evolution of water vapor from lunar simulant for quantification with the associated LAVA hardware. The GC-MS will be operated in a high vacuum chamber with flight-like software.

Expected Opportunity: Research report, poster, and oral presentation at the end of each
<table>
<thead>
<tr>
<th>Outcome</th>
<th>CBRE; successful implementation may result in publication(s)</th>
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<tbody>
<tr>
<td><strong>Student's Computer and/or Special Skills</strong></td>
<td>MS Word and Excel, knowledge of standard laboratory practices, familiarity with Gas Chromatograph-Mass Spectrometry</td>
</tr>
<tr>
<td><strong>Desired student academic level</strong></td>
<td>Masters or Doctoral</td>
</tr>
<tr>
<td><strong>Academic Disciplines</strong></td>
<td>Chemistry, Chemical Engineering</td>
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| **KSC -007**                                                                         | Kennedy Space Center - Florida                                |
| **Host Center**                                                                      |                                                             |
| **Opportunity Title**                                                                | Numerical Investigation of the Rigid Body Dynamic (RBD) Simulations of Launch Vehicles During Stage Separation: Research in Meshfree Method |
| **Opportunity Description**                                                          | KSC is developing a modeling and simulation capability based on meshfree method with purpose to implement in the design process of future launch vehicles. This project involves numerical investigation of the Rigid Body Dynamic (RBD) simulations of launch vehicles during first stage separation, development of a radial basis function meshfree method to model the motion and flow field, and validation of the results with other traditional numerical methods and/or experimental data. The proposed meshfree method, while requiring less effort in problem preparation in comparison to other traditional numerical methods, is known to have issues with conservation laws and computational costs. These problems will be investigated in the study. KSC possesses a Linux workstation, called the "beast". It is equipped with the best graphical processing unit (GPU) cards available for this research. The beast is behind the KSC firewall and not available for remote access. Students have to be onsite to perform simulations. Other research work can be done remotely. |
| **Expected Opportunity Outcome**                                                    | Research report, poster, and oral presentation at the end of each CBRE; submit and present results at AIAA CFD conferences |
| **Student's Computer and/or Special Skills**                                        | Students must know Fortran and C++ computer programming. Knowledge of computational fluid dynamics (CFD) is required. Familiarity with Meshfree or Meshless method and GPU/CUDA parallel programming would be preferable but not required. |
| **Desired student academic level**                                                  | Masters or Doctoral                                          |
| **Academic Disciplines**                                                            | Aerospace Engineering                                        |
|                                                                                     | Civil Engineering                                            |
|                                                                                     | Mechanical Engineering;                                      |
|                                                                                     | Applied Mathematics                                           |
Opportunity Title: Small Payload Development

Opportunity Description:
Since their inception in 1999, the use and numbers of cubesats have exploded. (The term "CubeSat" was coined to denote picosatellites that adhere to the standards described in the CubeSat design specification.) Work is being done across universities, government and private industry to develop cubesats and technologies that can be demonstrated using cubesats. NASA needs higher performance, higher reliability, longer duration CubeSat/SmallSats to enable future low-cost missions and expand functionality to inter-planetary missions. This research project is to survey the current state-of-the-art in cubesat technologies and design a prototype capable of lunar orbit. Some technology areas of interest are RF transmission, power distribution and consumption, mission duration, battery size, solar cell absorption and configurations, embedded systems, and sleep/wake strategies to extend battery life and mission duration. The student may choose to focus on a single technology area. The cubesat would have to meet the cubesat standards to launch from the poly-picosatellite orbital deployer (P-POD).

Expected Opportunity Outcome:
Research report, poster, and oral presentation at the end of each CBRE; The result of this project would be a report detailing the results of the technology survey, selection of the best technologies for a prototype cubesat (or major subsystem), and a proposed high level design of a cubesat (or major subsystem) capable of lunar orbit.

Student's Computer and/or Special Skills:
General, Systems, Design Engineering

Desired student academic level:
Masters or Doctoral

Academic Disciplines:
General Engineering
Systems Engineering
Design Engineering

Opportunity Title: Wearable Device: Artificial Intelligence Via Voice Recognition

Opportunity Description:
The Systems Hardware Engineering Branch in the Engineering and Technology Directorate at Kennedy Space Center is searching for a graduate student to investigate and develop an artificial intelligence system with a voice recognition interface for the Integrated Display and Environmental Awareness System (IDEAS) project. IDEAS is a wearable computer with an optical head-mounted display providing various means of communication and augmented reality data to its user.

Purpose: To develop a voice recognition interface and artificial intelligence to provide location and situation aware applications for the IDEAS wearable heads-up display.

Background: Current wearable technologies are limited by the
interfaces and processors that can be integrated without compromising battery life and weight. Some wearables provide an easy-to-use interface for interacting with the device in the form of a linear track pad and limited voice commands, however this approach limits the feature set of the device. Other devices have separate interface devices that disrupt the hand-eye coordination and make the devices unintuitive to use. Creating and maturing new interfaces to interact intuitively with wearable devices is a rapidly emerging and an important consideration for developing future wearables.

**Expected Opportunity Outcome**

Research report, poster, and oral presentation at the end of each CBRE; The student is required to document the research, development, and operation of the system for use by NASA personnel and turn over the system documentation at the end of his or her term. The student will also demonstrate the system at this time.

**Student’s Computer and/or Special Skills**

Must be currently enrolled in a graduate degree program in computer science or electrical and computer engineering programs with focus on machine-learning, artificial intelligence, voice recognition interfaces, digital signal processing, and programming. Preferred Skills: Proficiency in Linux, Windows, and familiarity with voice recognition development tools such as Nuance Dragon voice recognition development kit. Prior experience with machine learning and artificial intelligence systems preferred.

**Desired student academic level**

Masters or Doctoral

**Academic Disciplines**

Electrical Engineering
Computer Engineering;
Computer Science

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**MARSHALL SPACE FLIGHT CENTER**

**MSFC-001**

**Host Center:** Marshall Space Flight Center – Huntsville, AL

**Opportunity Title:** Design and Performance Modeling of Large Space Telescopes

**Opportunity Description/Objective (specific student assignment):**

Future astrophysics science missions require 15 to 30 meter class space telescopes. Such systems have a multitude of technical challenges such as: how to assemble and/or deploy in space large-aperture thermally-stable optically-precise contamination-free telescopes; model and control the dynamic stability/jitter of large telescope systems to maintain sub arc-second pointing stability and diffraction limited wavefront for 4500 minutes; model and characterize the thermal response of large telescope systems to changing slew and role attitude of up to 60 degrees in 60 minutes; how
to actually slew or roll a large space telescope 60 degrees in 60 minutes; design, tolerance and package a wide field of view optical telescope system; etc.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**

Student will be expected to write a final report which fully documents their activity; prepare a project poster presentation; and if appropriate write one or more journal papers.

**Student's Computer and/or Special Skills:**

Given the breadth of this research project, a successful applicant will only work on a small piece of the overall problem. Successful Applicant must persuade mentor that they have a 'systems' perspective (i.e. they understand how their specific technical expertise impacts the system level performance of a large aperture space telescope); they have the necessary preparation and skills to address one of the above listed representative problems or they can define a related problem which needs to be solved. Successful candidate will have proficiency in using as many of the following as possible: ANSYS, PRO-E, PATRAN or NASTRAN; Thermal Desktop; Solid Edge, Solid Works, etc.

**Desired Student Academic Level:**

Masters or Doctoral

**Eligible Academic Disciplines:**

Engineering - Aerospace Eng.
Engineering - Mechanical Eng.
Engineering - Optical Eng.
Engineering - Structural Eng.
Science - Astronomy
Science - Physical Science
Technology - Systems Eng./Design

**MSFC-002**

**Host Center:**
Marshall Space Flight Center – Huntsville, AL

**Opportunity Title:**
Large Space Telescope Integrated Structural Thermal and Optical Performance (STOP) Modeling

**Opportunity Description/Objective**
Future astrophysics science missions require 15 to 30 meter
class space telescopes. Such systems have a multitude of technical challenges such as: how to assemble and/or deploy in space large-aperture thermally-stable optically-precise contamination-free telescopes; model and control the dynamic stability/jitter of large telescope systems to maintain sub arc-second pointing stability and diffraction limited wavefront for 4500 minutes; model and characterize the thermal response of large telescope systems to changing slew and role attitude of up to 60 degrees in 60 minutes; how to actually slew or roll a large space telescope 60 degrees in 60 minutes; design, tolerance and package a wide field of view optical telescope system; etc. To solve these problems requires integrated STOP modeling and analysis. Specific questions which could be studied include: (1) Structural and Thermal design optimization as a function of nanometer-level Optical Performance Sensitivity; (2) Tools to model and predict dynamic Optical Performance as a function of mechanical and thermal stimuli; and (3) Fault tolerant performance prediction tools.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):

Student will be expected to write a final report which fully documents their activity and write one or more journal papers.

Student's Computer and/or Special Skills:

Successful Applicant must persuade mentor that they have a 'systems' perspective (i.e. they understand how their specific technical expertise impacts the system level performance of a large aperture space telescope); they have the necessary preparation and skills to address one of the above listed representative problems or they can define a related problem which needs to be solved. Academic preparation in geometrical optics and optical design would be very useful. Successful candidate will have proficiency in using as many of the following as possible: ANSYS, PRO-E, PATRAN or NASTRAN; Thermal Desktop; Solid Edge, Solid Works, etc. Additionally, familiarity with an optical design code such as Zemax or Code V, etc. would be helpful.

Desired Student Academic Level

Masters or Doctoral

Eligible Academic Disciplines:

Engineering - Mechanical Eng.
Engineering - Optical Eng.
MSFC-003

Host Center: Marshall Space Flight Center – Huntsville, AL

Opportunity Title: Technology Management at Marshall Space Flight Center

Opportunity Description/Objective (specific student assignment):
Assist with technology management efforts in the Office of the Chief Technologist at Marshall Space Flight Center, to raise awareness in the workforce. Projects include (1) development of technology displays, (2) support of SharePoint and IdeaLab technology databases, (3) support of Chief Technologist and Deputy Chief Technologist in technology portfolio assessments and technology reports, and (4) participation in Innovation and Technology Information Exchange meetings. Also help develop innovation strategies to help MSFC become a more broadly innovative and creative organization.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
Internship will culminate in a final report and presentation, and potentially includes technology displays, products for the MSFC ExplorNet site, and other.

Student's Computer and/or Special Skills:
Experience with PowerPoint, Excel, Word, Adobe, Photoshop, and similar graphics software tools is beneficial. Website development experience and blogging can be useful also.

Desired Student Academic Level
Junior
Master’s

Eligible Academic Disciplines:
Engineering - Integrated Eng.
Technology - Systems Eng./Design
Business - Business Admin
Business - Public Affairs
Engineering - General
Science - General
Technology - General
Business - General

MSFC-004

Host Center: Marshall Space Flight Center – Huntsville, AL
**Opportunity Title:** System Engineering Modeling

**Opportunity Description/Objective (specific student assignment):**
Explore the use of System Modeling Language (SysML) and Lifecycle Modeling Language (LML) in the modeling of system engineering flows.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**
Development of a model of a space system engineering flows. Identification of techniques using the modeling language to produce a space system model, documented in a final report.

**Student's Computer and/or Special Skills:**
Student should be able to learn SysML, LML in a short period of time. Prior experience with UML, SysML, or LML is good, not mandatory.

**Desired Student Academic Level:**
Masters or Doctoral

**Eligible Academic Disciplines:**
Engineering - Computer Eng
Engineering - Industrial Eng.
Engineering - Integrated Eng.
Technology - Software Eng.
Technology - Systems Eng./Design
Technology - Comp Science
Engineering - General

**MSFC-005**

**Host Center:** Marshall Space Flight Center – Huntsville, AL

**Opportunity Title:** Welding Process Modeling Center

**Opportunity Description/Objective (specific student assignment):**
Modeling opportunities exist in welding. The Friction Stir Welding (FSW) process is a new (British patent 1991) solid state welding process originally applied to low melting aluminum alloys. It is currently being extended in various directions; higher melting alloys, metal matrix composites, higher tool rotation speeds, supplemental vibrations or heating, new tool designs, etc. Deeper understanding through modeling applicable to extension and improvement of the FSW process is of interest. Information is available through
contact on other weld process modeling studies of potential interest.
Research, progress reports and presentations, thesis, degree. We have supported several doctoral candidates through past student education grants.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): Research, progress reports and presentations, thesis, degree.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):
The expected outcome of the research is a reproducible methodology for generating the accurate prediction or measurement under investigation. Documentation of this technique in a peer-reviewed journal article would also be expected.

Student's Computer and/or Special Skills:
Continuum Mechanics (Plasticity theory. Dislocation theory useful, but not required). Heat transfer.

Desired Student Academic Level:
Masters or Doctoral

Eligible Academic Disciplines:
Engineering - Materials Eng.
Engineering - Mechanical Eng.
Student's Computer and/or Special Skills: MATLAB and/or Mathematica, Finite element software

Desired Student Academic Level: Masters or Doctoral


MSFC-007

Host Center: Marshall Space Flight Center – Huntsville, AL

Opportunity Title: Laboratory Experiments and Analysis in Support of Carbon

Opportunity Description/Objective (specific student assignment): Students will conduct laboratory experiments that support the development of Carbon Dioxide Removal Systems for Life Support Applications and analyze the results. Other activities may include computer modeling and simulation of carbon dioxide removal processes and computer-aided design of test apparatus.

Expected opportunity outcome (i.e. research, final report, poster presentation, etc.): The outcome of the internship is a final report and/or poster presentation.

Student's Computer and/or Special Skills: The student is expected to be proficient in standard computer programs such as Microsoft Word and Excel. Expertise in computer-aided design and computer modeling and simulation tools is also desirable but not required.

Desired Student Academic Level: Senior, Masters, Doctoral

| **MSFC-008** |  |
| **Host Center:** | Marshall Space Flight Center – Huntsville, AL |
| **Opportunity Title:** | Investigation of GPS Algorithms for High-G, High-Mach Application |

**Opportunity Description/Objective (specific student assignment):**

Future NASA robotic and manned missions to the moon and Mars would greatly benefit from improved navigation capabilities. These missions will use navigation aids such as GPS, combined with an Inertial Navigation System (INS). Current state-of-the-art GPS receiver hardware and algorithms have not been optimized for space applications. An urgent research need is to optimize GPS hardware and algorithms for high-G, high-Mach space environments. Research shall also provide realistic simulation tests using programmable GPS receivers using real-time flight test data.

**Expected opportunity outcome (i.e. research, final report, poster presentation, etc.):**

Research, presentations, software codes

**Student’s Computer and/or Special Skills:**

None

**Desired Student Academic Level**

Masters or Doctoral

**Eligible Academic Disciplines:**

Engineering - Engineering Aerospace Eng.

Electrical Eng.