MARSHALL SPACE FLIGHT CENTER
NASA FACULTY FELLOWSHIP PROGRAM (NFFP)
RESEARCH/TASKS AVAILABLE FOR SUMMER 2004

Space Transportation Directorate

TITLE OF RESEARCH/TASK
Development of CFD Multiphysics Tool

BRIEF DESCRIPTION OF RESEARCH/TASK
TD03 is interested in supporting a faculty researcher for the summer of 2004. Said researcher would support TD03 activities in propulsion system and vehicle subsystem modeling and integration. A background in advanced solar, chemical and/or nuclear propulsion systems is a must. An understanding of computational fluid dynamics with applications to neutron transport or magnetohydrodynamics or plasma dynamics is a definite plus. The researcher would assist in TD03's efforts to develop a low level multiphysics CFD tool capable of modeling the physical processes underlying nuclear, thermal and electromagnetic propulsion concepts.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Computational Fluid Dynamics, Numerical Methods, Magnetohydrodynamics or Nuclear Physics, FORTRAN programming

MSFC SPONSOR

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DEPARTMENT
TD03/ Advanced Concepts and Planning

TITLE OF RESEARCH/TASK
MXER Tether Dynamic Analysis

BRIEF DESCRIPTION OF RESEARCH/TASK
A continuation of the development of dynamic modeling capability for MXER tethers with specific emphasis on internal tether dynamics. The purpose of this work is to improve the predictive capabilities of orbital propagation codes involving tethers, which will allow the tip of an MXER tether to rendezvous with an orbital payload and "catch-and-throw" it to a higher orbit.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Dynamic analysis, structures, orbital mechanics, solid mechanics

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DEPARTMENT
In-Space Propulsion Technologies Program (TD05)

TITLE OF RESEARCH/TASK
Zenor Diode Analysis Study

BRIEF DESCRIPTION OF RESEARCH/TASK
The individual will be responsible for reviewing the current zenor diode calibration data in search of a pattern that maybe related to cosmological or other natural effects.
A report is to be prepared on the findings.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Solid State Physics or General Physics

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Dr. Ray Lewis	TD40	256-544-2420	Raymond.A.Lewis@msfc.nasa.gov

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Ron Litchford	TD40	256-544-1740	ron.litchford@nasa.gov

DEPARTMENT
Propulsion Research/TD40

TITLE OF RESEARCH/TASK
High-Power Electric Propulsion Thrust Stand

BRIEF DESCRIPTION OF RESEARCH/TASK
The faculty fellow will lead the background research and design of a high power electric propulsion thrust stand. The stand will be capable of measuring up to 10 N of thrust with 100 mn resolution, and will support thrusters weighing up to 250 kg.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Mechanical Engineering

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DEPARTMENT

Propulsion Research Center

TITLE OF RESEARCH/TASK

Diagnostics Development for Plasmoid Propulsion

BRIEF DESCRIPTION OF RESEARCH/TASK

Research is needed to support development of a new “Plasmoid” propulsion system involving fully ionized plasmas such as Field Reversed Configuration (FRC) or Spheromak plasmas. This kind of thruster works by inductively accelerating these plasmoids to high velocities (up to 100 km/sec) and ejecting them. Supporting research will be conducted in one or more of the following categories:

1. Ultra high speed imaging of compact toroid plasmas using gated-intensified framing and streak cameras to determine plasma velocity, density, spatially resolved structure and process of formation.
2. Spectroscopy of plasmas to determine temperature, density and magnetic field in helium, argon or hydrogen gases.
3. X-ray/XUV photography/spectroscopy of candidate plasmas to determine plasma temperature and magnetic field. Data analysis software may be written or hardware may be built using XUV filtered diodes. Data reduction algorithms using a computed plasma emission data base is also needed.
4. Development of system to determine plasma momentum and mass for evaluation of system specific impulse and performance. A diagnostic to determine cold gas versus plasma mass loading ratio is needed.
5. Development of reliable high-power, high duty-cycle spark-gap switches. This will include design, fabrication, and testing of such switches, and/or diagnostics used for testing.
6. Development of novel probes for magnetic field determination is also desired.

The particular topic chosen will depend on the background and relevant experience of the applicant.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Physics, Electrical Engineering, Aerospace Engineering

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Richard Eskridge	TD40	256-544-7119	richard.eskridge@msfc.nasa.gov

DEPARTMENT

Propulsion Research Center / TD40

TITLE OF RESEARCH/TASK
Molten-Salt Reactors for Space Power Systems

BRIEF DESCRIPTION OF RESEARCH/TASK
Molten-salt reactors have many desirable attributes for a space power system—high neutronic efficiency, inherent safety, simplified operation, high temperature/low pressure operation—but have never been seriously examined for this application. It is desired to examine this problem in greater depth and discover whether the numerous positive aspects of a molten-salt reactor could be transferred into a useable space power system.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Nuclear reactor design, dynamics and operation, space systems

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DEPARTMENT
Propulsion Research Center (TD40)

TITLE OF RESEARCH/TASK
Superconductor Permanent Magnet (SCPM) Fabrication Study

BRIEF DESCRIPTION OF RESEARCH/TASK
The individual will be responsible for reviewing the current literature related to the fabrication of superconductor permanent magnets, typically those fabricated using the seeded-melt textured growth technique (SMTG). However, other techniques that warrant investigation may also be investigated.
Samples of the various techniques are to be fabricated to test the flux pinning and levitation properties of the samples using the techniques reported in literature.
A report is to be prepared on the various techniques investigated and others that may warrant investigation.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Superconductor Fabrication, Materials Fabrications, Solid State Physics, or General Physics

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Ron Litchford	TD40	256-544-1740	ron.litchford@nasa.gov

DEPARTMENT

TITLE OF RESEARCH/TASK
Case Studies of Space Transportation Problems

BRIEF DESCRIPTION OF RESEARCH/TASK
Develop a series of NASA related cases studies in the area of space transportation. These studies should provide interactive learning experiences in which MSFC managers and engineers learn to think and make decisions based on real-world space transportation related problems. These cases should be appropriate for small teams facilitated by a Marshall manager. They should include opportunities to diagnose problems, analyze alternatives and make decisions. Feedback on the actual outcome of the case and the likely outcome of proposed alternatives should be included.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Organizational Management
Aerospace and Mechanical Engineering

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Marc Neely	TD51	256-544-7062	marcus.a.neely@nasa

DEPARTMENT
TD50 / Vehicle and Systems Development Department

TITLE OF RESEARCH/TASK
Propulsion System Architecture and Health Management Design

BRIEF DESCRIPTION OF RESEARCH/TASK
Perform studies of new space propulsion system architectures and develop health management system designs. Identify propulsion system failure modes and associated signatures, identify state-of-health monitoring and health management requirements to control these failure modes, and recommend simulation testing needs. Perform analyses to determine failure detection, isolation, and recovery scenarios for health management opportunities considering the timing constraints and failure propagation predictions.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Physics, Electrical and/or Mechanical Engineering, Computer Science, Chemistry

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John Butas	TD52	256-544-7057	John.P.Butas@nasa.gov

DEPARTMENT

Vehicle and Systems Development

TITLE OF RESEARCH/TASK

Aerospace Trajectory Simulation Conversion to C++

BRIEF DESCRIPTION OF RESEARCH/TASK

The Guidance, Navigation and Control Group at MSFC developed a generic aerospace vehicle trajectory simulator called MAVERIC (Marshall Vehicle Representation in C) that is widely used to assess guidance, navigation and control techniques and vehicle performance. It is developed in a modular style using (mostly) C. It is desired to improve the maintainability and extensibility of the simulation by taking advantage of the object oriented programming features of C++ as well as, for example, operator overloading. Portions of the sim will have to interface with C or FORTRAN modules to accommodate model developers that use those languages. The task will involve getting familiar with the existing sim and helping to identify those portions of the sim where object-oriented programming will most improve maintainability and extensibility, and then demonstrating the expected benefits by converting those portions from C to C++.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

Flight mechanics, computer science, C and C++ programming experience

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John Hanson	TD54	256-544-2239	john.m.hanson@nasa.gov

DEPARTMENT

Guidance, Navigation and Control

TITLE OF RESEARCH/TASK

Powered Flight Guidance Using Parameter Optimization

BRIEF DESCRIPTION OF RESEARCH/TASK

Recent research (Dukeman 2002-2003, Lu 2002-2003, Calise 1995-2003) into ascent guidance has involved indirect methods. Indirect methods, while more accurate and efficient than direct methods, are more prone to sensitivity and often have smaller regions of convergence. Also, constraints are more difficult to implement in indirect methods. Michael Ross recently has developed a transcription method referred to as the spectral method which appears to be efficient and robust. Combined with an efficient parameter optimizer, this could be a viable way of performing real-time ascent guidance. Note that the faculty member is free to use his/her own

ideas for how to parameterize/transcribe the problem. The trick is to use clever parameterization of the problem along with state of the art parameter optimizer that can efficiently solve constrained problems.
Another area of interest is to use parameter optimization to solve the 2- or 3-burn orbital transfer problem. Assuming linear steering (i.e., thrust direction = (At + B) / norm (At + B)), each burn could be sufficiently parameterized with 5 steering parameters. For the 3-burn transfer, 5 engine switching times need to be determined. This gives a total of 20 optimizable parameters to minimize fuel consumption and satisfy end conditions (e.g., apogee, perigee, inclination, etc.). Again, the key is to use an efficient parameter optimizer and also take advantage of any closed-form solutions available for vacuum flight.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK

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DEPARTMENT
Guidance, Navigation and Control

TITLE OF RESEARCH/TASK
Acoustic Response of Three Dimensional Volumes of Distributed Property Real Fluid or Gas

BRIEF DESCRIPTION OF RESEARCH/TASK
The proposed activity involves formulating the Navier-Stokes equation to solve for sound wave propagation in a real fluid and in a gas. The solution should be extended to non-symmetric three dimensional volumes where the acoustic properties vary throughout the analysis region. To properly resolve the acoustics the solution should provide fourth order accuracy in space and second order accuracy in time. The formulation should retain fluid viscosity and heat conduction terms so that transmitted pressure varies due to geometric boundaries.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Partial differential equations, fluid dynamics, hydraulics, and signal analysis

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DEPARTMENT
Subsystem & Component Development Department

TITLE OF RESEARCH/TASK
Application of the Aardvark and Phantom Analyses to Turbopump Design

BRIEF DESCRIPTION OF RESEARCH/TASK
The Aardvark (2D) and Phantom (3D) analyses are the new turbomachinery analyses codes being used by TD64. These in-house developed codes have been validated on several unsteady test cases, but need to be optimized for running large-scale design parametrics. The task will include optimizing the speed of the codes for steady-state simulations, improving/organizing the output data, and applying the codes to a relevant design.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
CFD, aerodynamics, turbomachinery

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DEPARTMENT
Subsystems and Components

TITLE OF RESEARCH/TASK
Contemporary Sensor and Data Analysis Techniques Applied to Propulsion Testing Related Measurements

BRIEF DESCRIPTION OF RESEARCH/TASK
Sensor development and data analysis techniques have advanced faster than their application in many fields of science and engineering. Digital techniques developed for diverse applications in fields such as astrophysics and acoustics are showing up in other areas and are constantly being evaluated for use in interpreting data. Rocket motor data contains a wealth of acoustic and vibration data that is mostly ignored in favor of mechanical engineering test that produce a single data point such as the thrust or specific impulse. The task of the summer faculty will be to explore the acoustic and vibration signals in real rocket motor tests to determine what else can be known about the performance of the motor and determine the sensors needed to detect the signals that might contain this information. Related tasks may include development of the fundamental physics of sensors that are needed but as yet do not exist. Such a sensor might include a noncontact device that can determine the level of a cryogenic liquid in a tank.

DISCIPLINARY FIELDS REQUIRED/APPLICABLE FOR RESEARCH/TASK
Ph.D. in Physics with experience in optics, signal analysis and sensor development

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DEPARTMENT

Test Technology