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ABSTRACT

In 1980, the National Aeronautics and Space Administration (NASA) initiated the Graduate Student Researchers Program in order to cultivate additional research ties to the academic community and to support promising students pursuing advanced degrees in science and engineering. Section I of this handbook summarizes the program and lists the research areas in headquarters and eight NASA field centers. Section II describes administrative procedures and provides instructions for proposal preparation. The last section presents specific areas of research activities at each of the NASA facilities. (YP)

Graduate Student Researchers Program 1989/90

Educational Affairs Division
Office of External Relations
NASA Headquarters
Washington, DC 20546

NASA
National Aeronautics and
Space Administration

Preface

In 1980, NASA initiated the Graduate Student Researchers Program in order to cultivate additional research ties to the academic community and to support promising students pursuing advanced degrees in science and engineering. Since then, approximately 800 students have completed the program's requirement while making significant contributions to the nation's aerospace efforts. Universities have also benefitted as their research capabilities have been strengthened.

This year, NASA will select approximately 80 new students for the opportunity to receive stipends and to work at the unique national laboratories. Areas of research and application procedures are fully described in this book. We are pleased to offer this program and hope students and faculty will continue to benefit.

Contents

Section I — Introduction

Program Summary

The NASA Graduate Student Researchers Program (GSRP) awards up to $18,000 in individual grants yearly to promising U.S. graduate students whose research interests are compatible with NASA's programs in space science and aerospace technology. Each year we select approximately 80 new awardees based on competitive evaluation of their academic qualifications, their proposed research plan and/or plan of study, and their planned utilization of NASA research facilities. Fellowships are awarded for one year and are renewable, based on satisfactory progress, for up to three years. Approximately three hundred graduate students are thus supported by this program at any one time. Students may apply any time during their graduate career or prior to receiving their baccalaureate degrees. An application must be sponsored by the student's graduate department chair or faculty advisor; other eligibility requirements are described in the Administrative Procedures section of this book.

The Graduate Student Researchers Program is managed at NASA Headquarters by the University Programs Branch, Educational Affairs Division. Forty of the 80 new awards each year are sponsored by the Headquarters Office of Space Science and Applications (OSSA) in the fields of astrophysics, Earth science, life sciences, solar system exploration, space physics, and microgravity science. Students applying for these fellowships are competitively evaluated on their academic qualifications and plan of research by NASA discipline scientists and an external peer review group. *OSSA fellows carry out research or a plan of study at their home universities* and attend a two- or three-day annual symposium at NASA Headquarters in Washington, D.C. The symposium provides an opportunity for GSRP fellows to exchange ideas, discuss progress, and learn more about space science and applications at NASA. OSSA's research opportunities are described in the Areas of Research Activities at NASA Facilities section of this book.

The remaining 40 new awards are distributed through NASA field centers. *Fellows selected by centers must spend some period of time in residence at the center, taking advantage of the unique research facilities of the installation and working with center personnel.* The projected use of center expertise and facilities is a factor, along with academic qualifications and research plans, in the selection of center fellows.

Students applying for a Center Fellowship are strongly urged to contact the NASA researcher identified at the end of each research description prior to developing a proposal. Students applying to the Headquarters Office of Space Science and Applications should contact Mr. Joseph Alexander's office. See Section II.

Summary of NASA Research Areas

NASA Headquarters (HQ), Office of Space Science and Applications (OSSA)

Astrophysics
Earth science and applications
Life sciences
Solar system exploration
Microgravity science and applications
Space physics

Ames Research Center (ARC)

Aeronautics
Experimental aerodynamics
Computer vision
Flight research
Human factors
Rotorcraft and powered lift flight projects
Aircraft conceptual design
Rotary wing aeromechanics
Engineering and technical services
Telecommunications
Knowledge engineering
Intelligence systems technology
Aerothermodynamics
Aerothermal materials and structures
Computational materials science
High-speed computer architectures
Three-dimensional computer graphics
Wind tunnel automation
Wind tunnel performance enhancement
Wind tunnel composites applications
Control algorithm for wind-tunnel support systems
Computational fluid dynamics
Turbulence physics
Computer graphics workstations
Advanced instrumentation
Advanced adaptive wall wind tunnel instrumentation
Rotor blade aerodynamics
Applied computational fluid dynamics
Hypersonics
Space sciences
Space human factors
Infrared astronomy and astrophysics
Infrared astronomy projects and technology development
Theoretical astrophysics
Solar system exploration projects and technology development
Planetary and earth atmosphere sciences
Airborne science
Life sciences
Advanced development
Space biology
Ecosystem science and technology
Search for extraterrestrial intelligence
Neurosciences
Space physiology
Solar system exploration
Planetary biology

Hugh L. Dryden Flight Research Facility (DFRC)

Advanced digital flight control
Flight systems
Flight dynamics
Flight test measurement and instrumentation
Fluid mechanics and physics
Propulsion/performance
Structural dynamics
Aircraft automation
Integrated test systems and aircraft simulation

Goddard Space Flight Center (GSFC) including Goddard Institute for Space Studies (GISS)

Laboratory for high-energy astrophysics
Laboratory for astronomy and solar physics
Laboratory for extraterrestrial physics
Laboratory for terrestrial physics
Solid Earth geophysics
Geology and geophysics
Hydrology/water resources
Biosphere studies
Laboratory for atmospheres
Space data and computing
NASA space and Earth sciences computing center
National space science data center
Science information systems center
Data flow technology office
Laboratory for oceans
Ocean data systems office
Oceans and ice branch
Observational science branch
Standards and calibration office
Experimental instrumentation branch
Microwave sensors and data communication branch

At GISS:

Causes of long-term climate change
Planetary atmospheres
Biogeochemical cycles
Interdisciplinary research
Data systems technology
Flight dynamics
Optics laboratory

Jet Propulsion Laboratory (JPL)

Space flight programs
Solar system exploration
Earth observations
Astronomy/astrophysics
Graduate Student Researchers Program
Systems division
Mission design
Spacecraft system engineering
Navigation systems
Mission profile and sequencing
Mission information systems engineering
Systems analysis
Tactical information
Earth and space sciences division
Oceanography
Earth atmosphere
Planetary atmospheres
Earth geoscience
Planetology
Space physics
Astrophysics
Telecommunications science and engineering division
Radio science
Gravitational wave studies
Planetary atmospheres and interplanetary media
Planetary dynamics
Asteroid dynamics
Geodynamics
Hypercube
Information theory and coding
Optical communication
Frequency standards research
Planetary radar astronomy
Radar remote sensing of the Earth
Electronics and control division
Mechanical and chemical systems division
Information systems division
Institutional computing and mission operations division
Observational systems division
Imaging systems
Infrared and analytical instrument systems
Microwave observational systems
Image processing applications and development
Optical sciences and applications

Lyndon B. Johnson Space Center (JSC)

Engineering
Advanced programs
Avionics systems
Crew and thermal systems
Propulsion and power
Structures and mechanics
Systems development and simulation
Tracking and communications
Mission support
Artificial intelligence
Safety, reliability, and quality assurance
Risk management
Space and life sciences
Biomedical sciences
Biomedical studies
Biological processing in weightlessness
Pharmacokinetics research
Space biomedical research institute
Man-systems
Biodynamics
Computer science
Lunar base technology
Ecological life support studies
Space life support development
Planetary materials analysis
Space science
Orbital debris
Space radiation

Langley Research Center (LARC)

Aeronautics directorate
Fluid physics
Propulsion
General aviation
Low-speed aircraft
High-speed aircraft
Advanced aircraft systems
Transport aircraft
Electronics directorate
Advanced sensor systems
Measurement science and instrumentation technology
Materials characterization technology
Advanced computational capability
Flight systems directorate
Controls and guidance
Human factors
High-speed aircraft
Transport aircraft
Computer science
Space controls and guidance
Materials and structures
Electromagnetics, antennas, and microwave systems
Electronics and information system
Advanced control/display technology
Optical data storage
Transportation systems
Spacecraft systems technology
Space directorate
Entry fluid physics
Power and propulsion
Transportation systems
Space systems technology
Space technology experiments
Climate research program
Tropospheric air quality research program
Upper atmospheric research program
Nimbus 7/LIMS and SAM II data processing, analysis and interpretation studies
Measurements of air pollution from satellites (MAPS)
Stratospheric aerosol and gas experiment (SAGE)
Earth radiation budget experiment (ERBE)
Structures directorate
Structures—space
Structures—aeronautics
Aeroacoustics

Lewis Research Center (LERC)

Aeropropulsion analysis
Aircraft propulsion systems
Instrumentation and controls technology
Instrumentation
Controls technology
Internal fluid mechanics
Computational fluid mechanics
Experimental fluid mechanics
Computational technolgoy
Aeronautical propulsion systems
Aircraft icing
Propeller aerodynamics and acoustics
Aircraft power transfer technology
Turbine engine technology
High performance aircraft propulsion technology
Hypersonic propulsion technology
Materials
Metal matrix and intermetallic matrix composites
Polymers and polymer-matrix composites
Ceramics and ceramic-matrix composites
Microgravity meterials science
Tribology
Structures
Structural analysis and life prediction
Structural dynamics
Structural integrity
Probabilistic structural mechanics
Advanced composite mechanics
Space propulsion technology
Liquid rocket propulsion
Low thrust propulsion fundamentals
Electric propulsion
Power technology
Photovoltaic space systems
Electrochemical space and storage
Space power management and distribution technology
Power systems technology
Thermal management for space power conversion systems
Stirling dynamic power systems
Space environmental interaction
Electronic device materials for space power
Space experiments
Microgravity science and applications
In-space technology experiments
Space communications technology
Space communications systems analysis
Space communications components
Satellite communications systems technology
Aerospace applications of high temperature superconductivity
Advanced space analysis
Space mission models

George C. Marshall Space Flight Center (MSFC)

Information and electronic systems
Electrical systems
Electronics, sensors, robotics
Optical systems
Software and data management
Materials and processes laboratory
Space environmental effects on materials
Metallic materials research
Nonmetallic materials research
Processing engineering research
Propulsion laboratory
Systems division
Component development division
Combustion devices and turbomachinery
Control mechanisms
Test division
Space science laboratory
Magnetospheric and plasma physics
Aeronomy
Solar physics
X-Ray astronomy
Gamma ray astronomy
Cosmic ray research
Infrared astronomy
Cryogenic physics
Low-gravity science
Biophysics
Structures and dynamics
Pointing control systems
Controls for vehicles
Liquid propulsion dynamic analysis
Structural dynamics
Structural assessment
Vibroacoustics
Structural design
Thermal analysis: liquid propulsion systems
Thermal analysis: solid rocket motor
Thermal/environmental computational analysis
Closed loop life support
Computational fluid dynamics
Earth sciences
Measurement and modeling
Fluid dynamics
Systems analysis and integration
Space station workstations
Hubble space telescope (HST) system design
Payloads
Space shuttle systems
Knowledge-based systems
Hubble space telescope system requirements
Configuration management
Test laboratory
Structural and dynamic testing
Systems and components test and simulation
Crystal growth in fluid field and particle dynamic evaluation
Alloying metals and vapor crystal growth evaluations
Safety, reliability, maintainability, and quality assurance office
Reliability engineering
Quality engineering
Systems safety engineering

Section II — Administrative Procedures

Program Management and Administration

The NASA Graduate Student Researchers Program is managed at the agency level by the University Programs Branch, Educational Affairs Division, Office of External Relations, Code XEU, NASA Headquarters, Washington, D.C. 20546.

Elaine Schwartz
Branch Chief

Jackie Counts
GSRP Program Administrator
(202) 453-8344

The Office of Space Science and Applications at Headquarters and eight field centers participate in the program. Local Program Administrators are:

Mr. Joseph K. Alexander
Assistant Associate Administrator (Science and Applications)
Office of Space Science and Applications, Code E
National Aeronautics and Space Administration
Washington, DC 20546
(202) 453-1430
For inquiries call:
(202) 453-1523

Ms. Meredith Moore
Ames Research Center
Mail Stop AHT–241–3
National Aeronautics and Space Administration
Moffett Field, CA 94035
(415) 694-5624
Hugh L. Dryden Flight Research Facility
Edwards Air Force Base CA 93523
(Program administered by Ames Research Center)

Dr. Gerald Soffen
Associate Director for Program Planning
Goddard Space Flight Center
National Aeronautics and Space Administration
Code 600
Greenbelt, MD 20771
(301) 286-9690

Dr. Harry I. Ashkenas
Jet Propulsion Laboratory
Mail Stop 180-900
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-8251

Dr. Moustafa T. Chahine
Chief Scientist
Jet Propulsion Laboratory
Mail Stop 180-904
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-6057

Dr. Stanley H. Goldstein
Director, University Programs
Lyndon B. Johnson Space Center
Mail Code AHU
National Aeronautics and Space Administration
Houston, TX 77058
(713) 483-4724

Dr. Samuel E. Massenberg
University Affairs Officer
Langley Research Center
Mail Stop 105-A
National Aeronautics and Space Administration
Hampton, VA 23665
(804) 865-2188

Dr. Francis J. Montegani
Chief, Office of University Affairs
Lewis Research Center
Mail Stop 3-7
National Aeronautics and Space Administration
21000 Brookpark Road
Cleveland, OH 44135
(216) 433-2956

Ms. Ernestine K. Cothran
University Affairs Officer
Marshall Space Flight Center
Mail Stop DS01
National Aeronautics and Space Administration
Marshall Space Flight Center, AL 35812
(205) 544-0997

Administrative Procedures

Selection of Proposals

Graduate students are selected for participation in this program by NASA Headquarters, individual NASA Centers, or by the Jet Propulsion Laboratory for participation on the basis of (a) the academic qualifications of the student; (b) the quality of the proposed research or plan of study and its relevance to NASA's programs; (c) except at NASA Headquarters, the student's proposed utilization of Center research facilities; and (d) the availability of the student to accomplish the defined research.

Awards

Awards are made initially for a 1-year period and may be renewed annually for up to 3 years, based on satisfactory progress as reflected in performance evaluations by the faculty advisor. Renewals must also be approved by NASA installation Program Administrators and technical supervisors.

Eligibility

Full-time (as defined by the university) graduate students from an accredited U.S. college or university are the only persons eligible for program awards. *They must be citizens of the United States.* Students may enter the program at any time during their graduate work or may apply prior to receiving their baccalaureate degrees. All applications must be sponsored by the student's graduate department chair or faculty advisor. Those selected will usually receive support until they receive an advanced degree, a maximum of three years in most cases. An individual accepting this award may not concurrently receive other federal funds, including that from other federal fellowships, traineeships, or federal employment.

Equal Opportunity

No applicant shall be denied consideration or appointment as a NASA Graduate Student Researcher on grounds of race, creed, color, national origin, age, or sex.

Obligation to the Government

A student receiving support under the Graduate Student Researchers Program does not thereby incur any formal obligation to the government of the United States. However, the objectives of this program will clearly be served best if the student is encouraged to actively pursue research or teaching in aeronautics, space science or space technology after completion of graduate studies.

Funding

The total award per graduate student cannot exceed $18,000. In addition to the $12,000 student stipend, an allowance of $6,000 ($3,000 for the student allowance and $3,000 for the university allowance) may be requested to help defray tuition costs or to provide a per diem and travel allowance for the student and faculty advisor. Student participants and their advisors participating in the Headquarters OSSA program should plan to attend a two- to three-day symposium in Washington, D.C., in the spring of each year. Specific details regarding this conference will be communicated after awards have been made.

The student allowance may also be used to help defray living expenses during periods of center residency. Students currently living close to the center to which they apply should request only a nominal amount for this purpose.

The university allowance may be used by the faculty advisor for supervision of the student's work and for travel to the NASA facility to oversee the student's progress. It may also be used for student tuition. Alternative uses for this allowance may be requested but must be consistent with the intent of the program.

Preparation and Submission of Proposal

Unsolicited Proposal Requirements
Proposals must be written by the student. NASA does not prescribe a specific proposal format. All proposals must be specific in nature and include the information outlined in the following eight items.

1. Proposal Cover Sheet
This page is to be filled out and signed by the graduate student and advisor and included with the proposal. Cover sheet forms appear in the back of this section.

2. Abstract
A short summary describing the objectives of the plan of study and/or the proposed research and the methodology to be used.

3. Description of Proposed Research and/or Plan of Study
A full statement prepared by the student that identifies and relates the key elements of the proposed research and/or plan of study. Length should not exceed five pages.

4. Schedule
The proposed starting and completion dates for the graduate student's plan of study and/or research program. The approximate periods the student and faculty advisor expect to be at the NASA center to conduct activities, if applicable. Include a detailed schedule and plan in all new proposals.

5. Facilities and Resources (Center Applicants Only)
A description of the NASA facilities and resources the student wishes to use in support of the research and/or plan of study, including an estimate of any computer time required.

6. Personnel
Faculty advisor should submit a short biographical sketch that includes name, current position, title, department, university address, phone number, and principal publications. The graduate student should submit a short summary of education, training, and accomplishments. The student's statement should mention the proposed research and how the Graduate Student Researchers Program would address these objectives.

7. Budget
A twelve-month budget must include the following: (a) student stipend —$12,000 basic stipend for twelve months; (b) student allowance —$3,000. Cost estimates for tuition expenses and/or anticipated travel and living expenses for the student at a NASA facility; and (c) university allowance —$3,000. Cost estimates for travel of faculty advisor to a NASA facility to coordinate and oversee the work of the graduate student. If necessary, student tuition may also be charged against this allowance.
Note — If requesting a renewal, include in this section the expected amount of unused funds remaining on the ending date of the annual grant..

8. Approval
Approval of proposed research and/or plan of study by (1) the faculty advisor; (2) the department head; and (3) the university official responsible for committing the institution for sponsored research (e.g., Director of Research Administration, Director of Sponsored Research). Proposals are not processed without the appropriate university approval signa-tures. Telephone numbers should be included for each approving individual.

Disposition of Unused Funds
If a student terminates the Graduate Student Researchers Program earlier than anticipated, the student stipend is prorated and terminated. Any unused student/university allowances are returned to NASA.

Submission of Proposal
Applicants should submit five copies of all materials *by February 1 of each year* to the appropriate NASA facility, addressed to the attention of the Program Administrator listed in the Program Management and Administration section of this book. Headquarters OSSA proposals should be submitted to:
Graduate Student Researchers Program
Code EPM-20
NASA Headquarters
Washington, DC 20546

Applications will be reviewed in February of each year for selection in March and April. Proposed starting dates for new awards will be July 1 or after. In general, it is expected that tenure will begin with normal semester or quarter dates.

Submission for Renewal
Proposals for renewal are to be submitted to the appropriate Program Administrator *by February 1*. Applicants should submit five copies of all materials. The proposal for renewal should include items 1, 2, 4, 7, and 8, listed on the preceding page, as well as a brief statement outlining progress and status of the plan of study or research, documentation of accomplishments and grades, and letter(s) of recommendation from faculty personnel. The starting date for renewals should be on the anniversary of the original grant.

Final Administrative Report
A report on the student's research and academic progress must be submitted by the faculty advisor upon completion of the student's study and research program. Information to be furnished includes the degree granted, the employment plans of the student, and other important results of the student's experience (e.g., thesis title, papers published other than thesis, presentations made, awards, honors). This report should be submitted to:
GSRP Administrator
University Programs Branch, Code XEU
Educational Affairs Division
National Aeronautics and Space Administration
Washington, DC 20546

A copy should also be sent to the appropriate NASA Program Administrator.

Inquiries
Questions concerning the preparation and submission of proposals and the administration of this program are to be directed to the Program Administrator listed in Section II.

PROPOSALS DUE BY FEBRUARY 1

Submit proposals to:

Field Centers
Send to applicable NASA Facilities
Program Administrator
(for addresses, see beginning
of this section).

Headquarters
Graduate Student Researchers Program
Code EPM-20
NASA Headquarters
Washington, DC 20546

Proposal Cover Sheet, NASA Graduate Student Researchers Program

1. GRADUATE STUDENT'S NAME Mr./Ms._____
LAST FIRST MI

BIRTH DATE _____ BIRTH PLACE _____ PHONE NO. _____
Mo/Day/Yr

ADDRESS _____

2. UNIVERSITY _____

ADDRESS _____

_____

TEL _____

3. GRAD ADVISOR _____

DEPT _____

TEL _____

SIGNATURE/DATE _____

4. TARGET DEGREE _____

DISCIPLINE _____

EXPECTED COMPLETION DATE (Mo/Yr) _____

5. UNDERGRADUATE GPA _____ OUT OF _____

DISCIPLINE _____

6. GRAD GPA (If applicable) _____ OUT OF _____

7. IS THIS SUBMISSION NEW ___ OR A RENEWAL? ___ DESIGNATE GRANT NO. NGT- _____

8. PROPOSED STARTING OR RENEWAL DATE _____
MO DAY YR

9. AREA OF STUDY OR PROPOSED THESIS OR DISSERTATION TOPIC _____

_____

10. NASA FACILITY TO WHICH THIS PROPOSAL IS BEING SUBMITTED
CHECK ONLY ONE:

- ❑ HEADQUARTERS
- ❑ AMES/DRYDEN
- ❑ GODDARD
- ❑ JOHNSON
- ❑ JPL
- ❑ LANGLEY
- ❑ LEWIS
- ❑ MARSHALL

11. PROPOSED NASA TECHNICAL ADVISOR (CENTER PROGRAM ONLY) _____

12. I CERTIFY THAT I AM A CITIZEN OF THE UNITED STATES, AND AM OR WILL BE A FULL-TIME GRADUATE STUDENT AT THE UNIVERSITY DURING THE PERIOD COVERED IN THE ATTACHED PROPOSAL.

_____
SIGNATURE/DATE

PROPOSALS DUE BY FEBRUARY 1

Submit proposals to:

Field Centers
Send to applicable NASA Facilities Program Administrator (for addresses, see beginning of this section).

Headquarters
Graduate Student Researchers Program
Code EPM-20
NASA Headquarters
Washington, DC 20546

Proposal Cover Sheet, NASA Graduate Student Researchers Program

1. GRADUATE STUDENT'S NAME Mr./Ms. _____
LAST FIRST MI

BIRTH DATE _____ (Mo/Day/Yr) BIRTH PLACE _____ PHONE NO. _____

ADDRESS _____

2. UNIVERSITY _____

ADDRESS _____

_____

TEL _____

3. GRAD ADVISOR _____

DEPT _____

TEL _____

SIGNATURE/DATE _____

4. TARGET DEGREE _____

DISCIPLINE _____

EXPECTED COMPLETION DATE (Mo/Yr) _____

5. UNDERGRADUATE GPA _____ OUT OF _____

DISCIPLINE _____

6. GRAD GPA (If applicable) _____ OUT OF _____

7. IS THIS SUBMISSION NEW ___ OR A RENEWAL? ___ DESIGNATE GRANT NO. NGT- _____

8. PROPOSED STARTING OR RENEWAL DATE _____
MO DAY YR

9. AREA OF STUDY OR PROPOSED THESIS OR DISSERTATION TOPIC _____

_____

10. NASA FACILITY TO WHICH THIS PROPOSAL IS BEING SUBMITTED
CHECK ONLY ONE:

- ❑ HEADQUARTERS
- ❑ AMES/DRYDEN
- ❑ GODDARD
- ❑ JOHNSON
- ❑ JPL
- ❑ LANGLEY
- ❑ LEWIS
- ❑ MARSHALL

11. PROPOSED NASA TECHNICAL ADVISOR (CENTER PROGRAM ONLY) _____

12. I CERTIFY THAT I AM A CITIZEN OF THE UNITED STATES, AND AM OR WILL BE A FULL-TIME GRADUATE STUDENT AT THE UNIVERSITY DURING THE PERIOD COVERED IN THE ATTACHED PROPOSAL.

_____
SIGNATURE/DATE

Section III — Areas of Research Activities at NASA Facilities

NASA Headquarters Office of Space Science and Applications

Program Administrator

Mr. Joseph K. Alexander
Assistant Associate Administrator (Science and Applications)
Office of Space Science and Applications, Code E
National Aeronautics and Space Administration
Washington, DC 20546
(202) 453-1430
For inquiries contact:
Dolores Holland
(202) 453-1523

The NASA Headquarters Office of Space Science and Applications (OSSA) supports the nation's research program in space sciences and the application of space techniques to terrestrial use. The OSSA research program includes the development of major new space flight programs such as the Space Telescope and the Jupiter orbiter and probe mission (named Galileo), as well as the support of laboratory research, analysis of data from prior NASA space missions, and theoretical studies of space phenomena. The scientific and applications disciplines currently being supported under the fellowship program are astrophysics, earth science and applications, life sciences, solar system exploration, space physics, and microgravity science and applications. A brief description of these programs follows.

Astrophysics

Research in astrophysics involves a broad program in space-based astronomy, relativity, and high-energy astrophysics. Both experimental and theoretical astrophysics research is supported. Research in astronomy and relativity is intended to aid in the understanding of the origin and evolution of the universe. Research is supported on cosmology, galaxies and quasi-stellar objects, galactic structure, the interstellar medium, and star formation and evolution. This office also supports research in relativity and gravitational wave physics, as well as laboratory research in support of the interpretation of space observations. High-energy astrophysics involves research in all phases of astrophysics involving high-energy processes. Typical of those phenomena are X-ray and gamma-ray emissions from compact binary systems with black hole or neutron star companions, galactic and extragalactic processes that produce high-energy quanta, nucleosynthesis processes, and processes leading to reproduction of primary cosmic ray particles.

Earth Science and Applications

Earth science and applications involves a global, integrated, and interdisciplinary program of research to study the Earth's physical and biological processes that govern the solid Earth, its oceans and atmosphere, and its life forms. Particular emphasis is being placed on understanding processes that affect the Earth's habitability, that is, its biological productivity and air and water quality. The program involves coordinated observational, theoretical, modeling, and experimental investigations, and the development of future observing technologies. These activities are complementary and together form a balanced program of system and process studies. The observational investigations usually require use of a variety of instruments

making both remote and *in situ* measurements from several locations. Both active and passive techniques are used for remote sensing and covering the electromagnetic spectrum from ultraviolet through the radio wavelengths. Instruments are flown on aircraft, balloons, rockets, orbiting spacecraft, and the Space Shuttle.

Life Sciences

Research in the life sciences is a multidisciplinary program established to study questions related to life in space. In the medical sciences, research is conducted to maintain the health and well-being of spacecraft crews in support of achieving a permanent human presence in space. Emphasis is placed on medical care, understanding physiological effects, and developing life support systems in the space environment. In the biological sciences NASA's capabilities and technology are used to understand fundamental questions about the origin and distribution of life in the universe, the effect of the space environment on terrestrial life forms, and the ability of terrestrial life to modify the environment on a global scale. Areas of emphasis include exobiology, biospherics, and gravitational biology. In addition to ground-based research programs, a vigorous flight program to develop and use appropriate equipment and instruments for human, animal, and plant experiments onboard the Shuttle, in Spacelab, and on other Earth-orbiting spacecraft is being conducted.

Solar System Exploration

Research in solar system exploration is comprehensive and aimed at understanding the present state of the solar system and, ultimately, its origin and evolutionary processes. The research also aims at elucidating the chemical history of the solar system toward a better understanding of how life originated on Earth. Research takes the form of astronomical observations, laboratory experimentation, space mission data analysis, modelling, and theory. The solar system objects of interest include the terrestrial planets, the giant outer planets with their rings and moons, the asteroids, and the comets. The analysis of meteorites, presumably originating from the asteroids, the Moon, and even possibly Mars, is an essential part of the program. Such analysis now also includes cosmic dust (believed to originate in comets). Astronomical studies span all parts of the spectrum from the ultrviolet to radio and radar. Data analysis includes Viking Mars data, Voyager outer planet data, and data from ground- and space-based telescopes. Data analysis, modelling, and theory encompass all aspects of planetary science including the chemistry, physics, and meteorology of planetary atmospheres; the controlling processes and stratigraphy of planetary surfaces; the internal chemistry and structure of planetary bodies; the dynamics and evolution of planetary ring systems; and cosmology. Most recently, with the advent of new astronomical techniques, research includes the search for planetary systems around other stars.

Microgravity Science and Applications

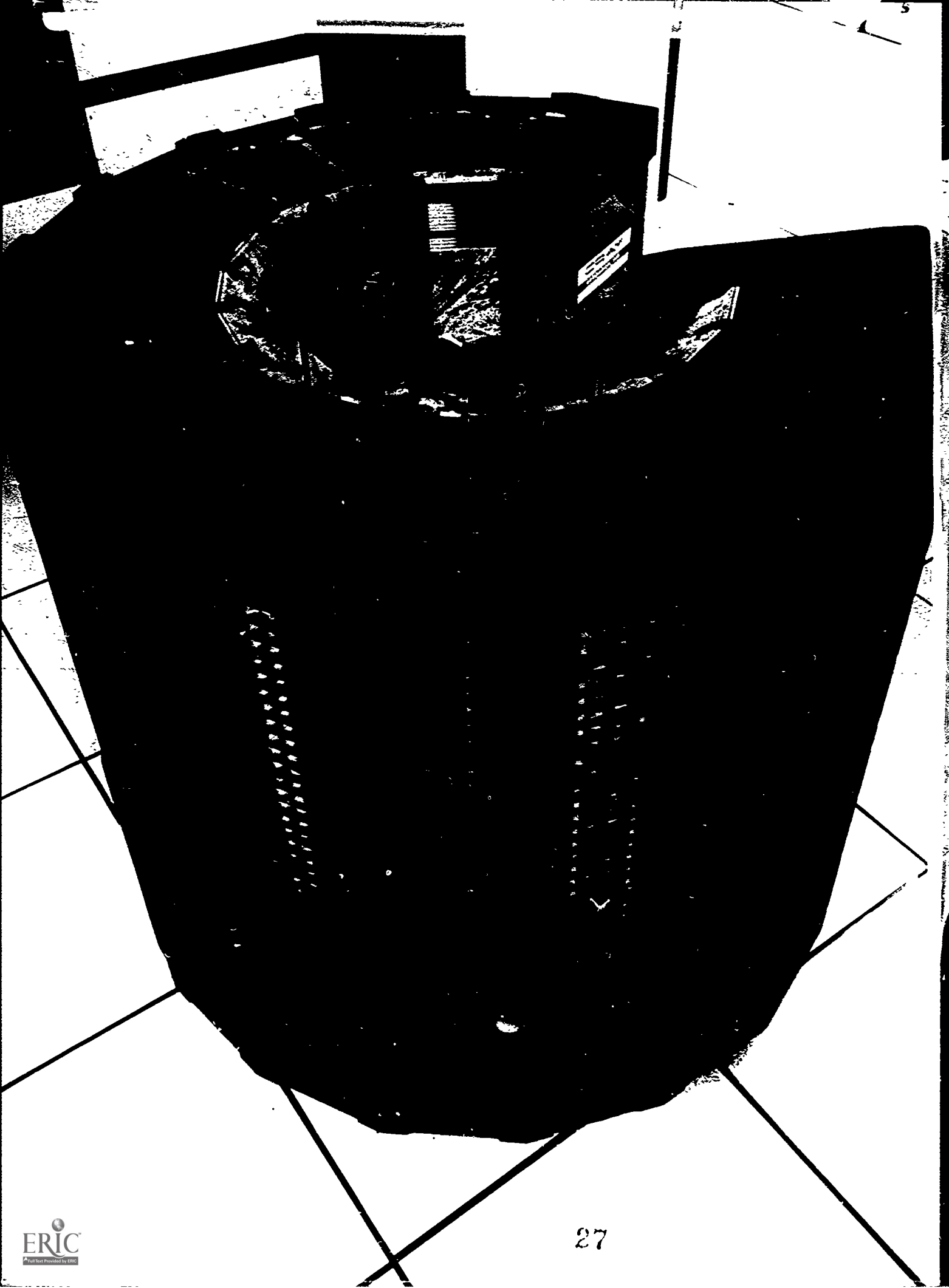
The objective of the Microgravity Science and Applications program is to develop near-Earth space as a national resource to explore the effects of microgravity on physical and chemical processes and pheonomena. This objective includes the establishment of a permanent National Microgravity Laboratory capability in low-Earth orbit to provide a flight facility for conducting long-duration microgravity research. The ongoing research program emphasizes three areas: fundamental science, materials science, and biotechnology.

In fundamental science, research includes the study of fluid behavio: and transport phenomena in microgravity, as well as experiments that make use of the enhanced measurement precision possible in microgravity to measure physical properties that enable scientists to challenge contemporary theories of relativity and to study condensed matter physics. Research in materials science includes the processing of electronic and photonic materials; metals, alloys, and composites; glass and ceramics; and polymers. The primary focus of the microgravity program in biotechnology is to study the effects that occur in living organisms and the growth of protein and other macromolecular crystals in the virtual absence of gravity. The investigations are conducted by university, industry, and government reserachers using both ground-based and flight experiments.

Space Physics

The space physics program involves investigations into the origin and evolution of plasmas, electromagnetic fields, and energetic particles in a variety of space plasmas. Its studies are focused on the Sun, both as a star and as a source of energy, plasma, and energetic particles; on the heliosphere, in both its steady state and dynamic configurations; on planetary and cometary ionospheres and magnetospheres; and on the acceleration, transport, and propagation of solar and galactic cosmic rays. These studies are based on measurements of space plasma systems and plasma processes which are obtained from *in situ* probes and through remote sensing and are complemented by active plasma experiments performed in both the laboratory and in space. Measurements are made from a wide variety of platforms including stratospheric balloons, sounding rockets, Earth-orbiting satellites, missions in orbit around other planets, as well as the Sun itself, and deep space probes which are approaching the boundary of the Solar System. Theory and computer simulations are used to synthesize these measurements into the general understanding of space physics phenomena which is the goal of the program.

Submit proposals to:
Graduate Student Researchers Program
Code EPM-20
NASA Headquarters
Washington, DC 20546



Ames Research Center

Program Administrator

Ms. Meredith Moore
Mail Stop AHT: 241-3
NASA Ames Research Center
Moffett Field, CA 94035
(415) 694-5624

The Ames Research Center conducts research activities, technology programs, and flight projects to advance the nation's capabilities in both civil and military aeronautics, space sciences, and space applications. This diverse program at Ames is organized into aeronautics, aerophysics, space research, and life sciences.

In preparing a proposal for a fellowship at Ames Research Center, prior collaboration with an Ames researcher is mandatory. A suggested point of contact is listed with each research topic for which a student may apply.

Aeronautics

In aeronautics, Ames concentrates on rotorcraft and powered lift aircraft technology, short-haul aircraft and helicopter technology, fluid mechanics, experimental aerodynamics, flight simulation, flight systems research, and human factors. The following are active areas of aeronautical research.
Contact: Don Ehrreich
(415) 694-5067

Experimental Aerodynamics — Low-speed wind-tunnel testing, analysis and development of computational/empirical prediction methods for powered lift and conventional lift configurations. Prediction and analysis of acoustic characteristics of aircraft configurations and wind-tunnel facilities. Development and application of non-intrusive measurement techniques. Contact studies using 40- x 80-, 80- x 120-, and 7- by 10-foot wind tunnels.
Contact: Vic Corsiglia (415) 694-6677

Computer Vision — Computer vision and image understanding techniques are being applied to the autonomous navigation of rotorcraft during low-altitude flight. The techniques are quite general and can be used in the autonomous guidance of other types of vehicles.
Contact: Banavar Sridar
(415) 694-5450

Flight Research — Simulation investigations, guidance and navigation, aircraft automation, flight dynamics, advanced control theory (helicopter V/STOL applications). Contact:
Dallas Denery
(415) 694-5427
Guidance & Navigation Automation Research
Vic Lebacqz
(415) 694-5009
Flight Dynamics and Controls Research

Human Factors — Crew performance, aviation safety, aircraft operating systems, advanced spatial displays and instruments, virtual environments, high-fidelity simulation-based human performance assessment, operator interfaces to intelligent systems and advanced automation.
Contact: Mike Shafto (415) 694–6170

Rotorcraft and Powered Lift Flight Projects — Flight research aircraft design, development, wind tunnel, simulation and flight test experiments; identification of advanced aircraft concepts, technology, and systems integration.
Contact: Bill Snyder (415) 694–6570
Rotorcraft

Aircraft Conceptual Design — Development of aircraft design synt techniques that incorporate optimization routines, expert system concepts, and graphical user interfaces on a system of networked computer workstations. Studies are broad in nature, encompassing the subsonic to hypersonic speed ranges, and including such concepts as lighter-than-air, rotorcraft, fixed-wing, and transatmospheric vehicles. Analyses include a total transportation systems approach and consider markets and economics.
Contact: Thomas L.Galloway
(415) 694–6181

Rotary Wing Aeromechanics — Experimental and theoretical research programs to improve performance, vibration, and noise of advanced rotorcraft are performed. Studies include basic investigations of the aerodynamics, dynamics, and acoustics of rotor systems for helicopters, tilt rotors, and other advanced configurations. Experiments are performed in the Ames 7- by 10-foot wind tunnel and in the National Full-Scale Aerodynamics Complex, including the 40- by 80- foot wind tunnel.
Contact: William Warmbrodt
(415) 694–5642

Engineering and Technical Services —In engineering and technical services, Ames concentrates on facility engineering, telecommunications, and administrative computing.

Telecommunications — Engineering and advanced systems capability for voice, video, data communications, and computer networking; networking research.
Contact: Jim Hart (415) 694–6251

Aerophysics

Knowledge Engineering — Knowledge engineering is the art and science of developing and implementing knowledge-based technologies to solve real world problems. At Ames the emphasis is on space-borne and airborne applications, with research conducted on topics such as artificial intelligence, machine learning, cooperating intelligent agents, automation demonstration projects, photonic processors, neural networks, and distributed processing systems. An outstanding computer center supports the research and includes a CRAY-XMP, DEC 8800, and state-of-the-art AI machines from major AI equipment manufacturers.
Contact: Donald McKellar
(415) 694–4162

Intelligent Systems Technology — The research objective is to develop the methodologies for integrating space borne complex symbolic and algorithmic systems into an effective, robust, and evolvable real-time system. Taking existing systems architecture design methodologies as a point of departure, several knowledge-based techniques such as advanced distributed heterogeneous computational systems, software engineering and open-architecture concepts will be developed specifically for advanced highly automated intelligent systems to address NASA's

future space mission requirements. The laboratory includes a multiprocessing computer system, distributed processor simulation software, and a space facility mockup.
Contact: Donald McKellar
(415) 694–4162

Aerothermodynamics — Provides aerothermodynamic flow-field computational capability to analyze and design advanced space transportation concepts. Also provides the analytical and turbulence chemistry models required to compute the viscous/finite-rate flow field and to predict radiation heating to conceptual aero-assisted orbital vehicles.
Contact: George S. Deiwert
(415) 694–6198

Aerothermal Materials and Structures — Develops lightweight reusable ceramics and carbon-carbon Thermal Protection Systems (TPS) for transient, high-velocity atmospheric penetration and develops expendable TPS for planetary probes.
Contact: Howard E. Goldstein
(415) 694-6103

Computational Materials Science — Develops verified methods for predicting material properties and reactions by extending interaction models of interatomic and molecular behavior to the macroscopic level.
Contact: David M. Cooper
(415) 694–6213

High-Speed Computer Architectures — Current advances in high-speed computation are coming from novel computer architectures such as parallel processors, data flow architectures, systolic arrays, LISP/PROLOG architectures. The suitability of these architectures to solving problems of interest to NASA and the development of new architectures that efficiently solve these problems is the objective of this research. Of particular interest is the investigation of architectures to solve problems arising in computational fluid dynamics as governed by the Navier-Stokes equations, problems in computational chemistry as governed by the Schroedinger equation, and problems in automation and robotics such as "expert systems." These investigations could include software issues as well as hardware issues because the ultimate goal is to provide the user the greatest computational resources possible. Facilities available to the researcher at Ames and at its resident Research Institute for Advanced Computer Science (RIACS) include a CRAY 2, CRAY X-MP/48, and CYBER 205 supercomputers, Sequent, ELXSI, and IPSC parallel processors, and numerous superminis and workstations.
Contact: Kenneth Stevens, Jr.,
(415) 694–5949

Three-Dimensional Computer Graphics — Advances in computational resources have made three-dimensional fluid flow calculations and complex computational chemistry calculations possible and future advances will permit even more complex physical phenomenon to be calculated. The objective of this research is to develop advanced computer graphics techniques, software, and hardware to permit researchers to visualize and understand the complex physics which is being calculated. Graphics facilities include IRIS and SUN workstations, fram buffers, and film recorders. Computational facilities include CRAY 2, CRAY X-MP/48, and CYBER 205 supercomputers; Sequent, ELXSI, and IPSC parallel processors; and numerous VAXes. This work will be done in conjunction with computer science and computational physics researchers at Ames and at its resident Research Institute for Advance Computer Science (RIACS).
Contact: Arsi Vaziri (415) 694–4799

Wind Tunnel Automation — To support an automation project encompassing the automatic control of model positioning, Mach number, Reynolds number, and system safety monitoring, a computer model of the wind tunnel circuit response to various inputs is needed. The model must be generic in structure

with easily tailored modules to achieve the required specificity. The task will include surveying industry for applicable programs before full development is undertaken. The code will allow the user to input the dynamic response of various inputs (i.e., rotal pressure, drive system, model positioning).
Contact: Daniel Petroff
(415) 694–5850

Wind Tunnel Performance Enhancement — The recent interest in hypersonic aerodynamics has kindled an interest in increasing the maximum Mach number of the Ames 8- by 7-foot Supersonic Wind Tunnel from 3.5 to 4.5. Preliminary experimental results and analysis indicate a feasibility for accomplishing the increased performance without an increase in drive power. Further studies are needed to evaluate the risk and perform the conceptual design for budget preparation. The design approach involves injector pumping of the test section and a variable second throat, matched to operate within the envelope of the existing compressor. An opportunity exists to use an existing compressor code to optimize the existing 11-stage axial-flow compressor for performance increase.
Contact: Daniel Petroff
(415) 694–5850

Wind Tunnel Composites Applications — Transfer to composite technology to specific application for the Aerodynamics Division wind tunnels. Areas of application include: axial flow compressor blading, gaging for model support assemblies, and siting assemblies for model supports. Research opportunity exists to develop a computer design code for evaluating and tailoring composite structures to the specific application. Opportunity also exists in developing fabrication and QA techniques.
Contact: Daniel Petroff
(415) 694–5850

Control Algorithm for Wind Tunnel Support Systems — Develop and verify the control algorithm and software for a six-degree-of-freedom Captive Trajectory System. The system will be used in wind tunnel testing to evaluate the aerodynamics of separating vehicles. The task involves using existing support systems to accurately and safely position the vehicles for acquisition of data, specifying the control hardware, writing the software, and verifying the software.
Contact: Daniel Petroff
(415) 694–5850

Computational Fluid Dynamics — Theoretical research in fluid dynamics using the Euler and the Navier-Stokes equations, both compressible and incompressible. Includes research on basic equation formulations, algorithm development, and code efficiency, as well as the physics of laminar and turbulent flow fields.
Contact: Thomas H. Pulliam
(415) 694–6417

Turbulence Physics — Study of the fundamental physics of turbulent and transitional flows through numerical simulations. Studies include developing numerical algorithms suitable for direct and large-eddy simulations of turbulent flows, developing tools for analyzing computer-generated databases, and developing turbulence models for engineering applications.
Contact: John Kim (415) 694–5867

Computer Graphics Workstations — High-performance computer graphics workstations applied to the visualization and understanding of both experimental aerodynamic flow fields and computer-generated solutions of aerodynamic flow fields.
Contact: Val Watson (415) 694–6421

Advanced Instrumentation — Instrumentation techniques are being developed to measure both mean and fluctuating quantities in complex turbulent flow fields. These include three-dimensional LDV systems, rapid scanning LDV systems, multiple hot wire arrays for special and time-dependent data, and holography and

methods to measure surface skin friction.
Contact: Joseph G. Marvin
(415) 694–5390

Advanced Adaptive Wall Wind Tunnel Instrumentation — Development of adaptive wall wind tunnels for interference-free transonic flows are being developed. This effort includes development in new laser-doppler velocimetry and computer and experimental integration.
Contact: George Lee (415) 694–5861

Rotor Blade Aerodynamics — Theoretical methods based on potential Euler and Navier-Stokes methods are being developed for rotor-blade configurations. Free-wake models of the rotor wakes are a companion effort being pursued.
Contact: I.C. Chang (415) 694–6396

Applied Computational Fluid Dynamics — This area deals with the development of new computational methodology involving aerodynamic and/or fluid dynamic applications associated with incompressible, subsonic, transonic, or supersonic flight speeds. Computer codes are constructed and evaluated for applications associated with aircraft or aircraft component aerodynamics, rotorcraft aerodynamics, high angle of-attack flows, unsteady flows, and flows with aeroelastic effects.
Contact: Terry L. Holst
(415) 694–6032

Hypersonics — This area deals with the development of new computational methodology involving aerodynamic and/or fluid dynamic applications associated with hypersonic flight speeds. The physical aspects of this flight regime require emphasis on algorithms/codes with accurate heat transfer prediction capabilities, strong shock capturing abilities and chemical equilibrium and nonequilibrium models for air.
Contact: Terry L. Holst
(415) 694–6032

Space Sciences

In space science, Ames concentrates on research directed at enhancing understanding of the origins, evolution, and current state of the universe, the solar system, the Earth, and life. Principle efforts focus on a multidisciplinary approach to research activities in space science and life science. As a federal research laboratory with strong ties to the universities and other government laboratories, Ames brings to the task a small research team approach that applies the skills and interests of the broader science community to these fundamental issues. Particular emphasis in space science is placed on infrared astronomy and astrophysics, stellar and planetary system formation, planetary atmospheric science and climatology, Earth airborne sciences, and the development and application of selected flight projects and areas of space technology relevant to those research needs. The following are ongoing areas of space science research.

Space Human Factors — Operator interfaces to automated and non-automated systems; computational human performance modeling, habitability, and crew performance research; space suit and portable life support system design.
Contact: Everett Palmer
(415) 694–6073
Bruce Webbon
(415) 694-5385
Suits and Life Support

Infrared Astronomy and Astrophysics — Properties of solar system, galactic, and extragalactic objects using their infrared spectra to determine constituents and processes. Development of instrumentation for observations from ground sites and airborne and spaceborne platforms. Conducts laboratory research in support of this science.
Contact: David Black
(415) 694-4912

Infrared Astronomy Projects and Technology Development — Research and development is conducted on a wide variety of airborne and space telescopes.

Designs are under development for the Space Infrared Telescope Facility (SIRTF), Stratospheric Observatory for Infrared Astronomy (SOFIA), and the Astrometric Telescope Facility (ATF). Opportunities exist in both hardware development and computer simulation. Advanced mirror materials are studied in a unique low-temperature facility, which allows for interferometric measurements on optical surfaces at helium temperatures. Flight technology experiments are conducted.

The program focuses on multi-element infrared detector arrays and cryogenics. The detector array activity pushes the sensitivity and wavelength response of doped silicon and germanium devices for enhanced scientific return. The cryogenics activity aims to provide spaceworthy, high-efficiency cooling and liquid helium transfer techniques. Both experimental and simulation studies are performed on optical coatings for stray radiation suppression. Extensive computer facilities (CRAYS, VAX, and other workstations), as well as state-of-the-art software design tools are utilized to simulate telescope subsystems, including structures, optics, thermal cryogenics, and guidance and control. Current research is focused on the integration of the design tools to allow full system simulation of space telescopes prior to launch.

Contact: Walter Brooks
(415) 694–6547
Craig McCreight
(415) 694–6549

Theoretical Astrophysics — Star formation, galactic formation and interaction, interstellar grains, planetary formation, planetary atmospheres, radiative transfer, and computational astrophysics and atmospherics to model these processes are but a few of the research issues here.
Contact: Pat Cassen (415) 694–5547

Solar System Exploration Projects and Technology Development — Development of systems and instrumentation to conduct in-situ and remote science measurements for missions to observe and explore space. This includes ongoing operation of the *Pioneer* family of spacecraft, management and flight operations of the *Galileo* probe to Jupiter, development of the Comet Nucleus Penetrator, development of the Astrometric Telescope Facility (for extrasolar planetary detection), and the study and advocacy of penetrators, atmospheric probes, and science instruments for future missions.
Contact: Joel Sperams
(415) 694–5706

Planetary and Earth Atmosphere Sciences — Research in this area includes study and development of general circulation models, use of airborne platforms and spacecraft, study of the interaction of the stratosphere with the troposphere, trace gas measurements, spectroscopy, aerosol detection and propagation, and the effects of materials in the atmosphere on the weather.
Contact: Phil Russell (415) 694–5404

Airborne Science — Needs research in the use of airborne platforms for diverse scientific measurements and observations, aircraft-based IR astronomy, and atmospheric sampling.
Contact: Phil Russell (415) 694–5404

Life Sciences

In life sciences, Ames concentrates on biomedicine (the effects of the space environment on man and other organisms), extraterrestrial research, and biosystems (the ability to support man in the space environment).

Advanced Development — Advanced program development is focused on defining the science objectives and requirements for future life science space missions, particularly those involving nonhuman experiments, and for identifying the necessary facilities and equipment to support those

objectives. Advanced program planners work with both in-house and outside scientists to develop the scientific rationale for space flight experiments requiring long-term exposure to microgravity. They define the facilities and equipment complement needed for such experiments and conduct focused scientific engineering studies to assess the technologies and techniques required.
Contact: Roger Arno (415) 694–6640

Space Biology — Space biology research uses the space environment, particularly weightlessness, and ground-based space flight simulations to investigate basic scientific questions about the role of gravity in present-day terrestrial biology and the role it has played during the evolution of living systems. The research is divided into the disciplinary areas of biological adaptation, gravity sensing, and developmental biology. Experiments are carried out at the subcellular, cellular, tissue, organ, and system levels in differing organisms of the five kingdoms of life.
Contact: Emily Holton (415) 694–5471

Ecosystem Science and Technology – Interdisciplinary research in ecosystem science and technology looks at the role of life in modulating the complex cycling of materials and energy throughout the biosphere. Intact ecosystems, with particular emphasis on temperate and tropical forests, are examined by remote sensing from aircraft and spacecraft and by field site visits, with subsequent laboratory and computer analysis of the data gathered. Research results may help answer specific environmental questions from outside collaborators as well as contribute to an overall understanding of the couplings among land, water, and atmosphere and the life therein.
Contact: Jim Lawless (415) 694–5900

Search for Extraterrestrial Intelligence — The Search for Extraterrestial Intelligence has as its goal the detection of intelligent life elsewhere in the universe. The approach is to examine portions of the radio spectrum, using state-of-the-art search systems to detect and confirm signals of extraterrestrial intelligent origin. The present research and development phase of this program is largely concerned with the design of the signal processing hardware and algorithms that will permit us to sift through thousands of megahertz of bandwidth in search of artifact signals that may be only a few hertz wide. The fields of digital signal processing, VLSI design microcoding, and statistics are all germane to this effort.
Contact: Bernard Oliver (415) 694–5166

Neurosciences — Experimental studies in neurosciences examine how the nervous system adapts to environmental conditions encountered in space, how adaptive processes can be facilitated, and how human productivity and reliability in space can be enhanced. In its efforts to elucidate mechanisms underlying adaptation to space, neurosciences research includes the areas of neurochemistry, neuroanatomy, neurophysiology, vestibular physiology, psychophysiology, and both experimental and physiological psychology. Available state-of-the-art research facilities include human and animal centrifuges, linear motion devices, an animal care and use facility, a human bedrest research facility, and NASA's Vestibular Research Facility.
Contact: Mal Cohen (415) 694–6441

Space Physiology — Space physiology studies investigate the effects of space flight on major physiological systems other than the cardiovascular and the central nervous systems. Emphasis is placed on understanding how the human body regulates muscle and skeletal mass in the absence of gravitational loading. Nutritional, neurohormonal, cellular, electrophysical, biomechanical, and biochemical factors involved in the structure and function of the musculoskeletal system are studied to predict the changes expected during prolonged spaceflight, understand the mechanisms involved, and develop ways to control the deleterious aspects of the

changes and expedite recovery upon return to terrestrial gravity.
Contact: Alan Hargens
(415) 694–5746

Solar System Exploration — Solar system exploration research defines flight experiments and related data bases and develops analytical concepts and prototype flight instrumentation for the extraterrestrial study of exobiology (history of the biogenic elements, chemical evolution, and origin and early evolution of life). Particular emphasis is placed on the biogenic elements (C, H, N, O, P, S) and their compounds as they relate to the composition and physical characteristics of the various bodies and materials of the solar system, such as cometary nuclei and comas and planetary atmospheres and surfaces. Experiment and instrument definition studies for Mars, Titan, interplanetary dust particles, and comets are currently being conducted.
Contact: Glenn Carle (415) 694–5765

Planetary Biology — Interdisciplinary research in planetary biology is aimed at understanding the factors in cosmic, solar system, and planetary development that have influenced the origin, distribution, and evolution of life in the universe and the course of interaction between biota and Earth's surface environments. Hypotheses are formulated and tested by two major approaches: (1) analysis of samples, such as cosmic dust, planetary materials, ancient and recent rocks and sediments, and extant microorganisms, and (2) use of simulation, ranging from laboratory experiments to computer modeling. Research is also carried out to establish the scientific basis for a bioregenerative life support system, i.e., a system for use outside the Earth's environment that uses photosynthetic organisms in the regeneration of air, water, and food.
Contact: Sherwood Chang
(415) 694–5733

Hugh L. Dryden Flight Research Facility

Program Administrator

Ms. Meredith Moore
Mail Stop AHT 241-3
NASA Ames Research Center
Moffett Field, CA 94035
(415) 694-5624

The research program at the Dryden Flight Research Facility, Edwards Air Force Base, CA, is administered by the Ames Research Center. The program includes most engineering disciplines in aeronautics, with emphasis on flight systems integration and flight dynamics. The following descriptions identify the current activities relevant to the Dryden program for which qualified students may apply.

Advanced Digital Flight Control — Modeling, simulation, and flight test of distributed control systems. Design criteria and methods for unconventional vehicles, including decoupling of asymmetrical airplanes and stabilization of highly unstable airframes.
Contact: Kevin Petersen
(805) 258-3189

Flight Systems — Engineering aspects of the formulation, design, development, fabrication, evaluation, and calibration of flight control, avionic, and instrumentation systems used on board complex, highly integrated flight research vehicles. Work with fault tolerant redundant microprocessor-based control systems; microprocessor-based measurement systems; transducers; actuators; techniques for system safety; and hazard analysis.
Contact: Jim Phelps (805) 258-3117

Flight Dynamics — Pilot/aircraft interaction with advanced control systems and displays, assessing and predicting aircraft controllability, developing flying qualities criteria, parameter estimation, and mathematical model structure determination.
Contact: Don Berry (805) 258-3140

Flight Test Measurement and Instrumentation — Laser-based flow measurement, skin friction drag, fuel flow, integrated vehicle motion measurements, space positioning, airframe deflection, sensor and transducer miniaturization, digital data processing.
Contact: Rodney Bogue
(805) 258-3193

Fluid Mechanics and Physics — Laminar and turbulent drag reduction configuration aerodynamics, experimental methods, wing/body aerodynamics, full-scale Reynolds number test technology, high angle of attack aerodynamics, applied mathematics and atmospheric processes.
Contact: Robert Meyers
(805) 258-3707

Propulsion/Performance — Propulsion controls, integrated propulsion/airframe systems, vehicle performance measurement.
Contact: Larry Myers (805) 258–3698

Structural Dynamics — Aerostructural modeling, vibration and flutter analyses/predictions, aircraft flutter, flight envelope expansion, ground vibration and inertia testing, aeroservo/elasticity, active control of structural resonances, advanced flight test technique development.
Contact: Mike Kehoe (805) 258–3708

Aircraft Automation — Knowledge-based systems development, verification and validation of knowledge-based systems, neural networks, heuristic controllers, knowledge-based acquisition/implementation, maneuver controllers, performance optimization, guidance, pilot-vehicle interface, robotic aircraft.
Contact: Lee Duke (805) 258–3802

Integrated Test Systems and Aircraft Simulation — Development of Integrated System Test equipment including aircraft/simulation interface equipment, automated test equipment and applied artificial intelligence techniques for diagnosis and control. Flight simulation development for advanced aircraft systems in aerodynamic, propulsion and flight control modeling.
Contact: Dale Mackall
(805) 258-3408

Goddard Space Flight Center

Program Administrator

Dr. Gerald Soffen
Associate Director for
Program Planning
NASA Goddard Space
Flight Center, Code 600
Greenbelt, MD 20771
(301) 286-9690

The Goddard Space Flight Center has a variety of programs and activities in pursuit of space exploration. Included are space science, space and terrestrial applications, space research and technology, space transportation systems, space tracking and data systems, and the payload operations control centers for Earth orbital operations of free-flyer payloads. The three major areas of Goddard research where the Graduate Student Researchers Program is conducted are in the Space and Earth Sciences Directorate, the Engineering Directorate, and the Mission Operations and Data Systems Directorate. The following is a brief description of research programs for which qualified graduate students may apply.

Laboratory for High Energy Astrophysics

High energy astrophysics is the study of those physical processes in an astronomical setting that typically occur at energies in excess of the few million degree temperatures characteristic of stellar photospheres. Continuum X-ray and gamma ray emission is produced by the interaction of charged particles with matter and electromagnetic fields, so that the study of such radiation is the study of these interactions in remote settings, while cosmic ray studies sample the charged particle distributions locally. Discrete lines in the X-ray and gamma ray spectra can be related to extreme environments in compact objects (ultra-high magnetic fields, for example), and can trace nucleosynthesis through nuclear or atomic transitions. In the Laboratory for High Energy Astrophysics, a broad program of experimental and theoretical research is conducted in all phases of astrophysics that deal with cosmic particles and the high energy quanta that their interactions produce. Experiments that measure cosmic X-rays, gamma rays, and charged particles are designed, built, and flown on balloons, rockets, Earth satellites, and deep space probes. The resulting data are analyzed and interpreted by laboratory scientists and their associates. In so studying the physics of solar, stellar, galactic, and metagalactic high energy processes, theoretical models of the origins and histories of these particles and quanta are developed. Contact:

C. E. Fichtel
(301) 286-6281
High Energy (>20 MeV)
Gamma Rays

T. L. Cline (301) 286-8375
Low Energy (.02-20 MeV)
Gamma Rays

E. A. Boldt
(301) 286-5853
X-rays (.2-20 keV)

J. F. Ormes
(301) 286-5705
Cosmic Rays

Laboratory for Astronomy and Solar Physics

The Laboratory for Astronomy and Solar Physics conducts a broad program of research in observational and theoretical astronomy and solar physics. Observational programs, including technology and instrumentation development, span the spectral range from X-ray to radio wavelengths. Astrophysical phenomena of the Sun and stars are studied with emphasis on their structure, origin, and evolution. Investigations on the gross dynamics and transient properties of the atmospheres of the Sun and other stars are carried out, emphasizing phenomena revealed by spectroscopic observations made above the Earth's atmosphere and correlated with ground-based observations. The interstellar medium is studied, both on a large scale to elucidate the distribution of mass and luminosity in the Galaxy and in individual clouds to probe processes of stellar formation, grain characteristics, and cloud chemistry. The Milky Way galaxy, other galaxies, quasars, and radio galaxies are studied, with special emphasis on those parameters bearing on the present structure of the universe as well as on its origin, age, and future fate. The cosmic microwave and infrared background radiations are also studied to probe the early history of the universe. Additional research includes investigations of the chemical history of the Solar System and the nature of the solar wind interaction with comets. Data of interest to laboratory scientists are currently being obtained from the *International Ultraviolet Explorer* (IUE) and the *Solar Maximum Mission* (SMM); archival data from these missions and the *Infrared Astronomical Satellite* (IRAS) are extensively used. The laboratory's High Resolution Spectrograph on the Hubble Space Telescope, as well as the Ultraviolet Imaging Telescope on the Astro Mission, will yield additional data for analysis. Three experiments under development for the *Cosmic Background Explorer* (COBE), to be launched in 1989, will provide dramatic new data for cosmological and local astrophysical studies. The Space Telescope Imaging Spectrograph (STIS) will provide diffraction-limited spectral imagery when installed in the Hubble Space telescope in the mid -1990s. Two missions, Lyman Explorer and High Resolution Solar Observa-tory are being studied. Conceptual and technology studies for an Infrared Array Camera on the *Space Infrared Telescope Facility* (SIRTF) are in progress. Active suborbital observing programs are carried out from ground-based, airborne, balloon-borne, and rocket-borne instruments. Contact:

Theodore Gull
(301) 286-8701
Interstellar Medium

Michael Hauser
(301) 286-8701
Infrared Astronomy

David Leckrone
(301) 286-8904
UV-Optical Astronomy

Stuart Jordan
(301) 286-8811
Solar Physics

Laboratory for Extraterrestrial Physics

This laboratory performs research on the physical properties and dynamical processes active in solar, planetary, and stellar objects, and interplanetary and interstellar media. The chemistry and physics of comets, planetary atmospheres, magnetospheres, and condensed Solar System matter, including meteorites, asteroids, planets, are studied. A major effort is the analysis of data from *Voyagers* 1 and 2, the one remaining *International Sun Earth Explorer* spacecraft and the two *Dynamics Explorer* spacecraft, including magnetic field, radio wave, electron and ion plasma in the Jovian and Saturnian magnetospheres, Io plasma torus, and Titan.

Infrared spectra of Jupiter, Saturn, Uranus, Io, and Titan are also studied to deduce atmospheric properties. *Voyager* 2's encounter with Uranus in January 1986 and *Giotto's* with Comet Halley in March 1986 produced another influx of new data, as will *Voyager* 2's encounter with Neptune in 1989. In infrared astronomy, the laboratory studies molecular astronomy, galactic infrared sources, as well as solar and planetary infrared astronomy. Instrumentation includes various diode laser heterodyne spectrometers and in-house developed instruments for use on the gound, in aircraft, and on balloons. Work is continuing on the scientifc aspects of the International Solar Terrestrial Physics Program, the joint ESA-NASA Ulysses Solar Polar mission to be launched in October 1990, and the Shuttle Infrared Telescope Facility instruments. Studies on molecules and chemical reactions of astrophysical and aeronomic interest are also conducted in the special facilities of the laboratories. Contact:

Daniel N. Baker
(301) 286-8112
Solar Terrestrial Studies

John Hillman
(301) 286-7974
Infrared Spectroscopy
& Molecular Structures

Louis Stief
(301) 286-7529
Chemical Kinetics

Keith Ogilvie
(301) 286-5904
Fields and Particles

Michael J. Mumma
(301) 286-6994
Planetary Atmospheres

Laboratory for Terrestrial Physics

The Laboratory for Terrestrial Physics performs research directed at advancing the state of knowledge in the Earth sciences and the management of the resources of the Earth through the use of space technology.

These efforts include solid Earth geophysics, geology, hydrology and the study of the biosphere.

Objectives are the complete, fruitful utilization of data of the Earth obtained from satellites and the development of future satellite systems that will enable deeper understanding of the Earth system.

Activities include laboratory and field investigations, acquisition and use of data gathered aboard spacecraft and aircraft, and numerical simulation and modelling.

Applicants should discuss potential research programs with the appropriate point of contact.

Solid Earth Geophysics — Research topics include the structure and composition of the Earth's interior through geodetic studies of the gravity field and rotational parameters of the Earth and planets and the dynamics of the measurement of sea surface topography with altimeters and studies of mesoscale oceanography crustal movements.
Contact: D. Smith, Code 621
(301) 286-8555

Geology Geophysics — Research is directed at studies of the Earth's crust through the use of remote sensing and the measurement of crustal magnetic anomalies, as well as at the understanding of the generation of the Earth's main magnetic field.
Contact: J. Heirtzler, Code 622
(301) 286-5213

Hydrology/Water Resources — Activities address the use of remote sensing through advanced numerical and analytical models to measure and define the abundance of water, ice and snow on land surfaces and the exchange of water between soil, biosphere, and atmosphere.
Contact: R. Gurney, Code 624
(301) 286-5480

Biosphere Studies — These include research on the interaction of electromagnetic radiation with plant canopies that permits the measurement

of biomass and vigor and the study of phenomena such as deforestation and acid rain.
Contact: J. Smith, Code 623
(301) 286-3532

Laboratory for Atmospheres

This laboratory performs a comprehensive theoretical and experimental research program dedicated to advancing our knowledge and understanding of the atmospheres of the Earth and other planets. The research program is aimed at advancing our understanding of the structure, dynamics, and radiative and chemical properties of the troposphere, stratosphere, and mesosphere, determining the role of natural and anthropogenic trace species on the ozone balance in the stratosphere, and advancing our understanding of the physical properties of the atmospheres and ionospheres of the Earth and other planets. The laboratory identifies problems and requirements for observations of atmospheric processes by satellite and other techniques. A broad program of laboratory research, including instrument development of mass spectrometers and remote sensing laser detectors, supports the program to observe the Earth and the planets. Extensive computer facilities and interactive processing systems are available for data processing. Contact:
Marvin Geller
(301) 286-5002
Global Modeling and Simulation
Albert Arking
(301) 286-7208
Climate and Radiation
Franco Einaudi
(301) 286-6786
Severe Storms
Larry Brace
(301) 286-8575
Planetary Atmospheres
Robert Hudson
(301) 286-5485
Stratosphere Chemistry and Dynamics
Eugene Maier
(301) 286-4425
Solar Radiation
Hasso Niemann
(301) 286-8706
Mass Spectrometry
Harvey Melfi
(301) 286-7024
Remote Sensing

Space Data and Computing Division

The Space Data and Computing Division provides comprehensive research, development, and support in data handling and computing for space and Earth science research programs. The division manages and operates a NASA Supercomputing Center, a National Space Science Data Center, the Goddard Space Flight Information and Image Analysis Center, and a Network Planning Office all in support of space and Earth sciences. The increasing complexity, variety, and volume of data needed for research in Earth and space sciences require the development and integration of advanced computing tools and techniques.
Contact: Jaylee Mead (301) 286-8543

NASA Space and Earth Sciences Computing Center

The center is engaged in the applications of advanced system architectures, such as the CYBER 205 vector processor, to supporting extensive numerical modelling and simulation studies of physical processes occurring in space and Earth sciences. Specific research opportunities exist for the optimization of numerical analysis techniques for scientific applications on multi-vector processors.
Contact: Fred Shaffer (301) 286-8 30

National Space Science Data Center

The center offers exceptional opportunities for computer scientists

seeking to apply advanced data systems concepts to NASA's challenging space data problems. Areas of interest include Data Base Management Systems (DBMS) heterogeneous multisource data bases, transaction management, and data base logic.
Contact: Barry Jacobs (301) 286–5661

Research is conducted on advanced data systems for scientific data management, using expert systems, data base machines, digital optical disk technology, and computer visualization. Contact:
Bill Campbell
(301) 286–8785
Expert Systems
Regina Brown
(301) 286–6595
Data Base Machines
Joseph King
(301) 286–7355
Optical Disks
Lloyd Treinish
(301) 286–9884
Computer Visualization

Developing interactive scientifc data systems integrating data archiving, catalogue, retrieval, data and image manipulation, and transmission techniques into distributed systems, e.g., NASA Climate Data System (NCDS) and Pilot Land Data System (PLDS).
Contact: Blanche Meeson
(301) 286-9282

Science Information Systems Center

In general, this center conducts research in applied computer sciences and information sciences, engineering and integrating results into the data and information systems of advanced space and Earth science satellite sensor missions. Topic areas include the investigation of expert systems approaches to data analysis and information extraction; development of computer perception; development of parallel/concurrent processing algorithms and software and implementation of parallel computing machines such as the Massively Parallel Processor; and application of georeferenced/geocoded information systems techniques to Earth sciences data. Research is also conducted in image data understanding and image data correction methodologies.
Contact: Robert Price (301) 286–9041

Investigation of expert systems approaches to data analyses and information extraction, particularly space remotely sensed image data.
Contact: James Tilton (301) 286–9510

Development of computer graphics techniques for scientific data visualization and information perception.
Contact: James Strong (301) 286–9535

Development of parallel/concurrent processing algorithms and software, and implementation on parallel computing machines such as the Massively Parallel Processor.
Contact: John Dorband (301) 286–9419

Development of image data processing techniques, including image data correction and georeferencing/geocoding of Earth observed image data.
Contact: H. Ramapriyan (301) 286–8744

Data Flow Technology Office

This office conducts advanced research in the development of network control management systems, computer communications architecture, fiber optics, network computer simulation, and high-speed LAN and WAN network development.
Contact: Sol Broder (301) 286–7088

Laboratory for Oceans

The laboratory performs research to expand our knowledge of the Earth's oceans, especially emphasizing those areas (biology, ice, dynamics, waves, and transport) that can be assisted by space observation. Also conducts research necessary for the development and spaceflight of Earth-observation sensor systems.
Contact: Erik Mollo-Christensen
(301) 286–6171

Ocean Data Systems Office

This office performs research and development of advanced direct readout data acquisition systems, and designs, builds, and organizes large interrelated data bases to increase their usefulness to researchers in the areas of oceans, weather, earth resources, and climate and hydrology. Develops and manages major projects for the remote sensing of the Earth and its environment and implements these projects in support of NASA, NOAA, and USAID programs.
Contact: Charles Vermillion
(301) 286-5111

Oceans and Ice Branch

This branch conducts oceans and ice research to enhance understanding of these systems and their relationships with other elements of the biosphere and the geosphere. Works with the scientific community on problems in biological, physical, and polar oceanography; glaciology; and marginal ice zones and air-sea interactions. Pursues interdisciplinary studies, together with atmospheric and terrestrial scientists, on problems such as those involving the biomass, productivity, nutrient distributions, carbon fluxes, geostrophic and thermohaline circulations, and upwelling and ice sheets. Employs theoretical and numerical modelling methods, develops algorithms and interpretations, and participates in sensor development. Demonstrates, through flight programs and analyses, the uses of remote sensing in research on the Earth environment, global habitability, global biogeochemical cycles, and global change.
Contact: Nancy Maynar
(301) 286-4718

Observational Science Branch

This branch conducts theoretical and experimental research on observational systems and techniques for oceanic remote sensing. Develops and operates research facilities (i.e., wave tank, laboratory field standards, aircraft remote sensors), ground-based ozone and wind sensors to obtain scientific data and develop new sensors.
Contact: Dave Clem (804) 824-1515

Standards and Calibration Office

This office develops, maintains, and operates centralized facilities for calibration of measurement systems used in the Space and Earth Sciences Directorate. Develops techniques to ensure that long-term repeatability of measurements is maintained.
Contact: Bruce Guenther
(301) 286-5205

Experimental Instrumentation Branch

This branch performs the engineering design, fabrication, testing, calibration, and integration of scientific instrumentation capable of measuring parameters related to the state of the oceans, atmosphere, and Earth surfaces. Provides mechanical, electronic, and optical engineering support for scientific instrument development, integration, field measurements, and data acquisition.
Contact: Jack Bufton (301) 286-8591

Microwave Sensors and Data Communication Branch

This branch performs research and development on advanced microwave sensing systems and data collection systems directed at providing remote and *in situ* data for research in the areas of the oceans, weather, climate, and hydrology. Performs basic laboratory and field studies that elucidate the interaction of electromagnetic radiation with the environment to improve our understanding of remote sensing systems.
Contact: Thomas Wilheit
(301) 286-9831

Goddard Institute for Space Studies (New York, NY)

The Institute for Space Studies conducts comprehensive theoretical and experimental research programs in four major areas.

Causes of Long-Term Climate Change — Basic research on the nature of climate change and climatic processes, including the development of numerical climate models. Primary emphasis is on decadal or end-of-century global-scale simulations, including studies of humanity's potential impact on the climate. Climate sensitivity and mechanisms of climatic change are investigated in global paleoclimatic research, specifically from the comparison of pollen and glacial data with paleoclimatic model simulations. In addition to their use for climate simulations, the global models are used to simulate the transport of atmospheric constituents and thus study their global geochemical cycles. The program also includes development of techniques to infer global cloud and surface properties from satellite-radiance measurements as part of the International Satellite Cloud Climatology Project, and analysis of the role of clouds in climate. Contact:

Anthony Del Genio
(212) 678-5588
Convection and Clouds

James Hansen
(212) 678-5619
Greenhouse Effect

Dorothy Peteet
(212) 678-5587
Paleoclimate, Pollen Studies

David Rind
(212) 678-5593
Climate Dynamics, Stratosphere

William Rossow
(212) 678-5567
Global Cloud Properties

Planetary Atmospheres — Concerned with investigations of Jupiter, Saturn, Venus, and the Earth. The observational phase of the program includes imaging and polarization measurements from the *Pioneer Venus Orbiter* and radiation budget, temperature-sounding, photometric, and polarization measurements from the *Galileo Jupiter Orbiter*. The theoretical phase of the program includes interpretation of radiation measurements of planets to deduce bulk atmospheric composition and the nature and distribution of clouds and aerosols, and modeling of atmospheric thermal structure and dynamics using both numerical and analytical models. Emphasis in the theoretical program is on analysis of physical processes in terms of general principles and models applicable to all planets. Contact:

Michael Allison
(212) 678-5554
Atmospheric Dynamics

Larry Travis
(212) 678-5599
Radiative Transfer

Biogeochemical Cycles — Research on global biogeochemical cycles involving the study of chemically and radiatively important trace gases. The aim is to improve our understanding of the cycles of CO_2, CH_4, N_2O, CFC_s, O_3, NO_x, OH, and other trace compounds. Many trace gases are observed to be increasing in the atmosphere and are expected to affect climate and air quality in the near future. The research involves three-dimensional chemical tracer models, which are essential for determining the sources and sinks of these gases and for predicting future atmospheric composi-tion. Central to the program is the investigation of the role of the biosphere, terrestrial and oceanic, in the global carbon cycle using a combination of satellite measurements and modeling. This research is being carried out in cooperation with Harvard University, and with the Applied

Mathematics Pro-gram and Lamont-Doherty Geological Observatory of Columbia University. Contact:
Inez Fung
(212) 678–5590
Carbon Cycle, Ocean Modeling
Michael Prather
(212) 678–5625
Atmospheric Chemistry

Interdisciplinary Research — Interdisciplinary research ranges from theoretical studies of the origin of the solar system to relationships between the Sun, terrestrial climate, geological processes, and biology. One phase of the program involves the structure and evolution of accretion disks, especially the primitive solar nebula, using models of large-scale turbulence. Another topic is the calculation of molecular properties of atmospheric and astrophysical interest. A third area concerns the evolution and pulsation of bright stars, which may be analogs of the Sun. A biological question of special interest concerns how terrestrial vegetation will change during the next 50 years, when climate and atmospheric CO2 are expected to be changing. Contact:
Vittorio Canuto
(212) 678–5571
Large-Scale Turbulence
Sheldon Green
(212) 678–5562
Molecular Calculations
Richard Stothers
(212) 678–5605
Stars, Climate Studies
Dorothy Peteet
(212) 678-5587
Biology

Data Systems Technology Division

This division is responsible for applying and evaluating advanced technology and systems architecture concepts to support the development of future communications and data systems for free-flying satellites, attached Shuttle payloads, and the Space Station. This is accomplished through development of prototypes with other divisions responsible for specific spacecraft control, data processing, and network subsystems. Major technology areas include development of VLSI-based modular components for data capture and preprocessing; development of high performance mass storage subsystems for mission data management; application of expert systems for spacecraft control, scheduling, and fault isolation; prototyping of advanced software engineering environments to reduce development costs and provide a reusable software base; and prototyping of distributed systems and user interfaces for remote investigator control of experiments. A state-of-the-art test bed has been assembled to support this development, including a VLSI design workstation, an optical disk subsystem, IRIS graphics workstations, Symbolics LISP workstations, knowledge-based systems tools, user interface prototyping tools, and Ada language systems. Contact:
David Howell
(301) 286–6373
VLSI Systems and Prototyping
Dolly Perkins
(301) 286–6887
Expert Systems & Software Engineering

Flight Dynamics Division

Research is conducted toward the development of algorithms and techniques to support flight dynamics mission requirements. Areas of particular interest are spacecraft orbit and attitude dynamics modeling and the development of dynamics simulators, planning of launch and maneuver parameters to tailor spacecraft trajectories for specific missions such as the *International Cometary Explorer* (ICE) mission, analysis and evaluation of advanced sensor and actuator hardware including the characterization of error

sources, and development of efficient and robust algorithms for the estimation of spacecraft attitude and orbit parameters. This research depends on contributions from astrodynamics, linear and nonlinear estimation theory, system identification, linear and nonlinear dynamic system analysis, and applied mathematics.

Another significant area of research is in systems and software engineering. This research is conducted for the purpose of applying results to the mid- to large-scale software/systems development activities that also take place within the division.

Through experimentation and empirical studies in the flight dynamics software productive environment, numerous development technologies and approaches are studied. Effects of available practices are studied by quantitatively assessing their impact on cost reliability, and general quality of newly developed flight dynamics systems. Major experiments are currently active or planned in the following disciplines:

- Ada, as a development language and overall design discipline
- Reusable software concepts and approaches
- Structured methodologies such as the "Clean Room" approach
- Sofware development environments
- Software maintenance tools and techniques

Research in the systems engineering disciplines includes:

- Development of advanced graphics techniques for flight dynamics problems
- Application of expert system technology to flight dynamics.

Contact: Frank McGarry
(301) 286-6846

Optics Laboratory

The Optics Branch conducts research and development programs in the optical sciences to support flight experiment development in the areas of high energy astrophysics solar and stellar astronomy, atmospheric sciences, and to a lesser extent with ocean and terrestrial sciences. Specific research and development objectives include optical property characterization of solids and thin films, diffraction grating technology, optical system design and analysis, and advanced optical fabrication and testing techniques. Modern laboratory facilities are equipped for optical property studies in the far-infrared to the extreme ultraviolet, generation of holographic diffraction grating, and optical fabrication and testing. In addition, extensive computer facilities are available to support optical design and analysis studies.

Contact: John Osantowski
(301) 286-6706

Jet Propulsion Laboratory

Program Administrators

Dr. Harry I. Ashkenas
Mail Stop 180–900
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354–8251

Ms. Carol L. Snyder
University Affairs Office
Mail Stop 180-900
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-3274

The primary role of the Jet Propulsion Laboratory within the NASA family is the exploration of the solar system, including planet Earth, by means of unmanned, autonomous spacecraft and instruments.

In addition, an active community of JPL scientists, technologists, and engineers is engaged in Earth atmosphere and geosciences, oceanography, planetary (including asteroid and comet) studies, and solar, interplanetary, interstellar, and astrophysical disciplines

The Graduate Student Researchers Program is concentrated in the areas of science, research, and advanced development.

Space Flight Programs

During the thirty years of its association with NASA, JPL's primary focus has been the accomplishment of unmanned space flight projects. The array of activities encompasses spacecraft systems, flight science instruments and experiments, flight operation, data analysis and the science, research, and advanced development activities on which they are based. All three primary areas of space science and applications are heavily represented: solar system exploration, Earth observations, and astronomy/astrophysics.

Solar System Exploration

The JPL *Voyager* spacecraft, after more than 10 years in space and earlier encounters with Jupiter, Saturn, and Uranus is now proceeding outward to a 1989 encounter with the planet Neptune.

A yet larger and more sophisticated endeavor, the *Galileo* mission, is scheduled for launch in 1989 to carry out an in-depth exploration of Jupiter and its satellites. This will include a probe, launched from the spacecraft 150 days prior to encounter, to descend into the atmosphere for *in situ* measurements. The spacecraft itself will carry out a 22-month tour of the Jupiter system, obtaining closeup images and other data as it passes each of the satellites of the planet, as well as providing the first long-term continuous observation of the giant planet.

Also coming up is the *Ulysses* mission, a joint European Space Agency (ESA) and NASA project, for which JPL carries NASA implementation responsibility. Utilizing Jupiter gravity assist, the spacecraft will be boosted out of the plane of the ecliptic into an orbit that carries it over the poles of the Sun. A complement of both European and U.S. instruments will monitor many aspects of solar activity from this new vantage point, overcoming for the first time the limitations of observing the

Sun only from the plane of Earth orbit.

Mars will be revisited in the early 1990s by the Mars Observer spacecraft, the first U.S. mission to that planet since the Mariner and the Viking projects of the 1960s and the 1970s. This mission will provide long-term monitoring of the entire planet from close orbit to determine seasonal and other variations in both atmosphere and surface.

The surface of Venus, shrouded from visual observation by its opaque cloud cover, will be mapped from orbit by an imaging radar on the Magellan spacecraft. Images showing surface features as small as 150 meters across will aid in understanding the geological processes that formed the surface and processes that may still be active in the planet's interior. A radar altimeter will provide accurate topographic measurements and, together with the images, will give the first clear and detailed look at the entire surface.

Earth Observations

The Earth-orbiting satellite Ocean Topography Experiment (TOPEX), like the pioneering Seasat spacecraft of the 1970s, will use a radar altimeter to measure ocean surface height variations. From this data, the circulation of the world's oceans can be mapped. Information gathered over 3 to 5 years will help determine average behavior of the global ocean and its general trends, as well as time fluctuations and small-scale changes. Greater understanding of specific phenomena, such as the El Niño ocean-warming cycle, will be sought. With its remarkable accuracy of 14 centimeters, TOPEX will allow determination of currents, eddies, and other circulation features. Planned for launch in the 1990s, the mission will be jointly sponsored by NASA and the French national space agency CNES.

The NASA Scatterometer (NSCAT) is being developed by JPL for flight in the early 1990s. Utilizing a multiple antenna design, this instrument measures radar backscatter from the ocean at several azimuth angles, from which wind vectors can be determined. A global map of ocean wind field can be obtained every 2 days. These winds not only generate ocean waves and affect upper ocean mixing, but they also strongly influence the transfer of kinetic energy, heat, and moisture, which have crucial impact on the Earth's weather and climate.

As the designated lead agency for investigating the potential destruction of Earth's protective ozone layer by both natural and human activities, NASA sponsors a large field measurement and laboratory experiment program at JPL. One of the field units is the Atmospheric Trace Molecule Spectroscopy (ATMOS) instrument, which first flew on Spacelab 3 in April 1985 and is scheduled for a series of reflights over the next decade. It is an infrared interferometer that observes vertical distributions of upper atmosphere trace constituents via their absorption spectra as it sights on the Sun through the intervening atmosphere at orbital sunrise and sunset. Many of these species take part in, and/or are intermediate products of the multitude of gaseous chemical reactions involved in the complex ozone problem. A smaller version of this instrument has been used on an aircraft and in uplook mode from the ground to provide essential data on the Antarctic ozone hole phenomenon.

Another of the JPL atmospheric field instruments is the Microwave Limb Sounder (MLS), which obtains vertical profiles of upper atmosphere constituents from observation of their thermal emission spectra in selected microwave bands. The MLS is being developed for flight on the NASA Upper Atmosphere Research Satellite (UARS) in the 1990s. A balloon-borne version of this instrument has already flown successfully from the National Scientific Balloon Facility in Palestine, Texas.

Pointing to the future of NASA Earth observation activities, an enormous step forward is now in the planning stage—the Earth Observational System (EOS). This is to be a very large polar orbiting vehicle, an element of the Space Station complex, that will provide continuous long-term monitoring of the entire globe with a variety of advanced instrumentation. It will provide for the first time a cohesive data source for Earth system science, the study of Earth as a total system of interacting elements and of the processes governing their interaction. Among the JPL contributions to EOS will be a multispectral synthetic aperture radar system and a visible/infrared imaging spectrometer; both will be greatly enhanced versions of instruments that have already flown on aircraft and on the Shuttle.

Astronomy/Astrophysics

JPL has for many years provided strong support to the NASA astronomy and astrophysics programs and the NASA centers that lead them. The most recent project activity involves the *Infrared Astronomical Satellite* (IRAS), which orbited the Earth during 1983 surveying 96 percent of the celestial sphere for infrared radiation sources; 245,839 sources were catalogued.

JPL has been responsible for the data gathering and processing, and now operates the Infrared Processing and Analysis Center (IPAC) at the Caltech campus where scientists from around the world gain access to the data. Spectacular results have come from this activity, including the discovery of cool material around many stars suggestive of planetary formation, massive quasar energy emission in the infrared, nonuniformity in galaxy distribution, and possible observation of accreting protostars.

The NASA Hubble Space Telescope, promising an enormous leap forward in observational astronomy by dint of its location above the interference of the Earth's atmosphere, will carry the JPL-developed Wide-Field/Planetary camera as its largest instrument. This two-camera system will provide both extraordinarily detailed images of individual objects and wider field survey for object detection. Targets will range from planets, comets, and asteroids in our solar system to galaxies and quasars in deepest space. Objects 100 times fainter than those visible from ground-based observatories will be detectable, with 100 times greater resolution.

In a joint program with NASA's Ames Research Center, prototype instrumentation and techniques are being developed for the Search for Extraterrestrial Intelligence (SETI) program. The Deep Space Network antennas, along with other radiotelescopes, will be used to conduct microwave searches of the sky for possible radio signals from beyond the solar system. The key component, recently achieved, is a 65,000-channel spectrum analyzer with variable resolution and on-line processing. Development of a much greater capability unit is contemplated.

Graduate Student Researchers Program

Opportunities for Graduate Student Researchers exist in all eight technical divisions of JPL. These technical divisions, organized by general discipline area, encompass almost the whole of JPL engineering and science resources; it is here that the programs described above are actually carried out. Within each technical division is contained the planning, design, development, engineering, and implementation functions relevant to its discipline area. Fundamental to the structure of JPL is the location of the related research, science and advanced technology efforts in close contact with these engineering functions. Following is a brief resume of the activities of each technical division as a guide to identifying specific Graduate Student Researcher opportunities.

Systems Division

The Systems Division performs systems engineering and design integration for all the major projects undertaken by JPL. It also conducts specialized analyses in many disciplines to support these projects.
Contact: Christopher Carl
(818) 354-3017

Mission Design — Includes interplanetary spacecraft trajectory design, planning mission sequences to accommodate science requirements, launch vehicle trajectory analysis, studies of advanced interplanetary scientific missions, and software development to support mission design and analysis.

Spacecraft System Engineering — Supports JPL flight projects by providing design integration of the total spacecraft system, including its interfaces with the launch vehicle and with its scientific instrument payload. It also conducts studies and analyses of advanced future spacecraft designs and analyzes the performance of spacecraft in flight.

Navigation Systems — Develops the capability to determine very precisely the position and velocity of scientific spacecraft in interplanetary space through radiometric and optical techniques, designs propulsive maneuvers to place spacecraft on correct trajectories, develops complex software to solve the equations of motion, and conducts scientific studies of relativistic gravity, planetary orbital dynamics gravitational radiation and planetary mass and gravity fields using spacecraft radio tracking data.

Mission Profile and Sequencing — Develops the detailed sequences to be executed by interplanetary spacecraft, plan the commands required to carry out the sequences, and develop the software that keeps track of the command sequences and ensures the commands will safely perform the desired functions.

Mission Information Systems Engineering — Plans for the operation of interplanetary spacecraft in flight, including design of ground computers and software that process the data, design integration of the end-to-end data systems from the spacecraft instruments to the scientist receiving the data, and development of large data systems for other ground-based applications.

Systems Analysis — Performs economics, operations research, costing, and mission analyses for a broad spectrum of unmanned and manned space projects and military and civilian ground-based programs.

Tactical Information — Performs system level design integration and develops computer hardware and software for a large military data merging system. Disciplines in the division include traditional electrical, mechanical, aeronautical, and aerospace engineering, along with computer science, operations research, economics, and the physical sciences.

Earth and Space Sciences Division

The Earth and Space Sciences Division conducts a wide-ranging program of research in oceanography, the atmospheres, and solid bodies of the Earth and other planets, planetary satellites, asteroids, comets, interplanetary medium, the search for extraterrestrial intelligence (SETI), and selected solar, stellar, and interstellar phenomena. Ground-based observations from the visible through radio frequencies are conducted from a variety of facilities including the NASA/JPL Table Mountain Observatory. Active and passive remote sensing experiments covering ultraviolet through radio wavelengths are flown on aircraft, balloons, and rockets as well as Earth-orbiting and planetary spacecraft. X-ray, gamma-ray, magnetic field, and solar wind measurements are also carried out with spacecraft instruments.

Extensive laboratory and theoretical research efforts and significant technology development work support these observational programs. Data analysis, interpretation, and modeling are central endeavors in all areas of activity. Summaries of the most significant current efforts are given below.
Contact: Clifford Heindl
(818) 354-4603

Oceanography — Altimetry for determining currents and tides; air-sea interactions including fluxes of mass, momentum, energy, and chemicals between ocean and atmosphere; determination of marine biomass and ocean productivity; sea ice dynamics and influence on climate variability; global surface temperature measurements; surface driving forces and wave propagation derived from radar observations.

Earth Atmosphere — Laboratory research, field measurements and data analysis to understand the chemistry of stratospheric ozone; monitoring of long-term trends in important minor and trace constituents; extraction of meteorological parameters from satellite data including temperature profiles, humidity, clouds, winds, and pressure.

Planetary Atmospheres — Observations from ground-based telescopes and analysis of spacecraft data to determine composition, structure and dynamics; long-term study of seasonal and interannual variability; global mapping; synthesis of information to determine physical processes and state of the atmospheres.

Earth Geoscience — Characterization of exposed rocks, sediments and soils on the Earth's surface to understand evolution of the continents; examine state and dynamics of biological land cover for assessment of the role of biota iln global processes; tectonic plate motion; volcanology; paleoclimatology.

Planetology — Observations of the surface of the inner planets, satellites and rings of the outer planets, asteroids and comets across the spectral range from ultraviolet through active and passive microwave; studies of meteorites and cosmic dust; theory and modeling relevant to the origin and evolution of the solid bodies of the solar system; development of approaches to the detection and characterization of solar systems around other stars.

Space Physics — Mapping of the magnetic fields of the Sun and planets and their time variations; structure and dynamics of the solar wind; interactions of solar fields and particles with the magnetic fields and outer atmospheres of Earth and planets.

Astrophysics — Variability of the solar constant; sky survey of infrared sources; composition and chemistry of interstellar clouds, identification of gamma-ray sources within the galaxy and beyond; observations of supernova 1987A; studies of gravitational wave detection utilizing spacecraft.

Telecommunications Science and Engineering Division

Astrophysics — Observational and theoretical research into the nature of radio emission from quasars, galaxies, and stars.
Contact: Robert Preston
(818) 354–6895

Radio Science

Gravitational Wave Studies — Algorithm development and data analysis of spacecraft tracking data for the detection of very-low-frequency gravitational waves predicted by general relativity and other theories of gravity.
Contact: John Armstrong
(818) 354–3151

Planetary Atmospheres and Interplanetary Media — Experimental and theoretical research investigations based on the use of spacecraft radio signals to probe planetary atmospheres and the interplanetary/solar plasma.
Contact: Richard Woo
(818) 354–3945

Planetary Dynamics — Determination of orbital, rotational, or atmospheric motions of planets by tracking of spacecraft or balloons associated with the planets.
Contact: Robert Preston
(818) 354–6895

Asteroid Dynamics — Study orbital evolution of main belt and planet crossing asteroids, resonances, and asteroid families.
Contact: James Williams
(818) 354–6466

Geodynamics — Experimental and theoretical investigations of global and regional phenomena using the modern space geodetic techniques of lunar laser ranging, Very Long Baseline Interferometry (VLBI) and the Global Positioning System (GPS).
Contact: Jean Dickey
(818) 354–3235

Hypercube — Experimental and theoretical research investigations involving application of the Hypercube concurrent computer to computational intensive problems such as astrophysics, geophysics, graphics and image processing, data base management, and artificial intelligence.
Contact: David Rogstad
(818) 354–3573

Information Theory and Coding — Theoretical research into information theory and coding with special emphasis on very noisy channels and some interest in fading and bandlimited channels.
Contact: Laif Swanson
(818) 354–2757

Optical Communication — Theoretical and experimental research involving free space laser communications systems, components, and techniques, and including such items as lasers, detectors, modulators, signal design, large telescope design, spatial and temporal acquisition and tracking, detection strategies, and channel coding.
Contact: James Lesh
(818) 354–2766

Frequency Standards Research — Experimental investigations including ultra-high resolution spectroscopy to support development of stable sources of microwave and optical frequencies.
Contact: Lute Maleki
(818) 354–3688

Planetary Radar Astronomy — Experimental and theoretical research in planetary surface, atmospheres, and rings (including geology, spin dynamics, and scattering properties of rings and cometary debris swarms) using the ground based Goldstone radar system to form images of terrestrial planets, asteroids, and comets.
Contact: Raymond Jurgens
(818) 354–4974

Radar Remote Sensing of the Earth — Experimental and theoretical investigations in remote observation of the Earth's surface through radar scattering properties, for example, polarization and interferometry to determine the structure and motion of regions of interest.
Contact: Howard Zebker
(818) 354–8780

Electronics and Control Division

The division's activities encompass a broad spectrum of disciplines in applied research and technology development for both space and terrestrial applications. These include work in guidance and control and automated systems, which include sensors, actuators, target trackers, dynamics, fault management, man-machine systems, teleoperators, robotics, and computer vision. Opportunities are also available in solar cell development in advanced photovoltaics, conventional terrestrial photovoltaics, and lightweight, high-power-density photovoltaic arrays for space. Emerging areas with high scientific and technical content include electron tunnelling spectroscopy, semiconductor interface studies, submillimeter and infrared radiation detection, and deposition of semiconductors by molecular beam

epitaxy and chemical vapor deposition. Power research and engineering topics of interest are nuclear thermal-to-electric space power, electrochemical power (high-energy batteries), and automated power systems management. Electronics research includes semiconductor materials and devices, field-effect vacuum devices, amorphous metals, and associative computer memories.
Contact: Henry Stadler
(818) 354–3556

Mechanical and Chemical Systems Division

The Mechanical and Chemical Systems Division carries out research in a number of areas related to structures, materials, and thermal sciences. Research opportunities exist in polymeric materials with unique electronic and optical properties, use of active members in large flexible space structures, cryogenic cooling by sorption methods, adiabatic demagnetization cooling using magnetic flux pumping, advanced composites for large space structures, electric propulsion, high-temperature superconductors and autonomous mobility, and sample acquisition.
Contact: Donald Rapp (818) 354–4031

Information Systems Division

The Information Systems Division performs a variety of research and development and system implementation activities. Primarily concerned with ground-based processing, the division's R&D disciplines range from computer science through software engineering. Implementation activities include the development of the information system orchestrating the Deep Space Network, which are facilities for spacecraft communications and data acquisition, spacecraft and link monitoring and controlling, and distribution of telemetry data. The Deep Space Network, with tracking complexes in Canberra, Australia, Madrid, Spain, and Goldstone, California, and the Space Flight Operations Center, in Pasadena, California, form a worldwide, real-time, highly dynamic, and interactive system capable of reaching beyond the edge of the solar system. Specific research and development areas include (1) application of expert systems to spacecraft and ground data system event scheduling and failure identification, isolation, and recovery; (2) development and application of computer graphics and simulation techniques to knowledge fusion, scientific visualization and education; (3) investigation into effective distributed, failure-resistant information networks; (4) integration of humans into complex information systems; (5) research into the engineering processes involved in producing and maintaining software in order to improve productivity and reliability; (6) numerical analysis including the development of large portable mathematical tool sets and the use of concurrent processors in numerically intensive problems; (7) use of large interactive and distributed data bases for oceanographic analysis; and (8) use of artificial intelligence to aid in the process of coding software.
Contact: Robert C. Tausworthe
(818) 354–2773

Institutional Computing and Mission Operations Division

This division is primarily responsible for flight mission operations and institutional computing. In this role, the division provides planning and operations of the Mission Control Center with the associated computer systems for space flight projects, and the large-scale, general purpose communication and computer networks in support of the general JPL user. The division is also responsible for assembly, test, and integration of spacecraft prior to launch; microprocessor hardware and software applications; computer science education; ground test data acquisition and control systems; electronic, electrical, optical, and physical

measurements; and measurement standards.
Contact: Kris Blom (818) 354-0119

Observational Systems Division

The Observational Systems Division is responsible for the conception, design, engineering development, and implementation of a variety of scientific instrumentation for space flight applications. A key element in the division is digital image processing research and development for space science and environmental and earth resources applications.
Contact: Kane Casani
(818) 354–4040

Imaging Systems — Design, development, and implementation of imaging and spectrographic systems used in space exploration. Having developed imaging systems for the *Voyager, Galileo*, and Space Telescope projects, the section is on the forefront of development of CCD sensors. With their wide spectral band (X-ray, ultra violet, and visible and shortwave infrared) these sensors will enhance development of the next generation of imaging systems for science applications.
Contact: Robert Lockhart
(818) 354–6350

Infrared and Analytical Instrument Systems — Conception, design, advanced development, and implementation of scientific instrumentation for remote sensing in the infrared and in situ analyses of chemical species using mass spectrometry and scanning electron microscopy. Missions addressed include planetary exploration, Earth remote sensing, and astrophysics.
Contact: John Wellman
(818) 354–7696

Microwave Observational Systems — Conception, advanced technology, design, implementation, and calibration of observational systems in the microwave through submillimeter wavelength regions. Also development of opportunities for new microwave observational systems with the user community. They also develop theoretical models describing the interaction of microwave and atmospheric and surface parameters.
Contact: Paul Swanson
(818) 354–3274

Image Processing Applications and Development — Develops and applies image processing techniques to the display, analysis, and interpretation of image and image-related data. Utilizing engineering and artificial intelligence to develop automated and semi-automated schemes for data interpretation. Performs research and development in image processing. Also develops and applies specialized software, hardware, and system architectures to increase the speed of computationally intensive functions on large data sets. Provides image processing and analysis support to the flight projects, imaging teams, and the science community.
Contact: Ray Wall (818) 354–5016

Optical Sciences and Applications — Basic and applied research in advanced optics technologies. Uses unique computational tools for optical design and system analysis to support development of various remote sensing systems for astrophysics and earth and interplanetary scientific measurements. Large mirror advanced optical materials, adaptive optics, thermal infrared optics, ultra-low scattered light optics, electro-optics,hyperspeed image correlators, and sensor systems for the Thousand Astronomical Unit (TAU) exploration are examples of study areas. Development of advanced spaceflight hardware optical systems for use in the visible, infrared, ultraviolet, and submillimeter spectral regions for science applications take place in this section.
Contact: James Breckinridge
(818) 354–6787

Lyndon B. Johnson Space Center

Program Administrator

Dr. Stanley H. Goldstein
Director, University Programs
Mail Code: AHU
NASA Lyndon B. Johnson Space Center
Houston, TX 77058
(713) 483-4724

The Johnson Space Center is involved in a wide range of activities dealing with manned spaceflight and space exploration. Areas of research available for Graduate Student Researchers are in the Engineering and Development Directorate and the Space and Life Science Directorate. Additional information concerning the following opportunities may be obtained from the program administrator.

Engineering

Advanced Programs — Research and engineering efforts are directed toward the definition, analysis, and characterization of a wide variety of space-related activities, including advanced space transportation systems, evolution of the Space Station, future lunar efforts, and planetary missions. Research opportunities exist in advanced mission characterization, concept development, systems analysis, system design, performance, flight dynamics, aerodynamics/aerothermodynamics, computational fluid dynamics, and microgravity fluid dynamics. Opportunities also exist for computer systems programming, network management, development of software for aerospace applications, and the integration of analytical methods with existing modeling tools.
Contact: Robert C. Ried
(713) 483-6606
Warren L. Brasher
(713) 483-6604

Avionics Systems — Responsibilities exist for the definition, development, implementation, integration, and verification of all avionics systems for manned spaceflight programs assigned to the center. These avionics systems include guidance and control, navigation, onboard and ground checkout, instrumentation, electrical power distribution and control, and onboard data management. To accomplish program responsibilities, an advanced technical base is maintained involving a number of test and laboratory facilities and include the engineering support necessary for providing technical direction to associated development and production contractors. Overall coordination, assembly, and integration of avionics hardware/software requirements schedules, development plans, ground and flight

test plans and objectives, and associated analyses of project management functions are also provided.
Contact: Edward Chevers
(713) 483-8225

Crew and Thermal Systems — Projects involve analyzing, developing, and testing environmental/thermal control and life support (ETC/LS) systems for spacecraft and extravehicular crewmen.

Engineering expertise is provided along with management capability for advancement of ETC/LS technologies to meet the requirements of current and future space missions. Responsibilities involve operating simulated spacecraft cabins, thermal vacuum chambers and associated laboratories for manned and unmanned testing and evaluation of ETC/LS components and systems, as well as maintaining state-of-the-art computational capabilities for design and analysis of ETC/LS components and systems.

Future space missions will require regenerative environmental control and life support to eliminate expendable that must be resupplied from the Earth, and low-cost, reliable thermal management of heat dissipated by high power space systems. Research opportunities exist in the areas of (1) advanced regenerative and closed-loop life support technologies for air revitalization, water reclamation, and solid-waste management; (2) two-phase fluid and high flux-density heat collection, transport, and rejection technologies; (3) advanced extravehicular activity (EVA) systems including astronaut space suit, portable life support and maneuvering, and airlocks and support equipment for higher EVA safety and productivity; and (4) artificial intelligence systems for monitoring.
Contact: Chin Lin
(713) 483-9126

Propulsion and Power — Electrochemical energy conversion systems are studied with emphasis on fuel cells and water electrolysis systems. Opportunities are also present for research on nickel-hydrogen and lithium battery systems. Significant increases in photovoltaic and solar dynamic power system (i.e., those that utilize rotating or reciprocating machinery) technologies are required for successful utilization of solar energy for electrical power generation. New power management and distribution schemes must be conceived and validated. High-temperature thermal energy storage technology must be advanced. Development work is needed in cryogenic fluid management, specifically on-orbit transfer techniques and low-gravity fluid behavior. Contact:
Cecil Gibson
(713) 483-9041
Power
Ralph Taeuber
(713) 483-9002
Propulsion

Structures and Mechanics — Capabilities exist in fracture mechanics, electron and optical microscopy, nondestructive examination, and failure analysis. Current research activities are mostly related to theoretical and experimental work in fracture mechanics. Numerical solutions are derived for stress-intensity factors; methods are being improved for fatigue crack growth analyses and experimental work is being conducted to better understand crack growth behavior.
Contact: Royce Forman
(713) 483-8926

Systems Development and Simulation — Responsibilities exist for the simulation, test, and evaluation of integrated multi-

disciplined systems; research, development, and application of teleoperated robotics systems, artificial intelligence methodologies for systems autonomy and intelligent autonomous robotic systems; crew displays and controls; and associated generic technology. In addition, computational support is provided to the Engineering Directorate for selected engineering analysis and design tasks.

In the area of simulation, real-time, man, and/or hardware-in-the-loop simulation support is provided to the JSC space program for engineering design, development, analysis, validation, and verification. Integrated simulated systems include but are not limited to Shuttle, Space Station, Manned Maneuvering Unit, Orbital Maneuvering Unit, Orbital Transfer Vehicle, robotics and manipulators, payloads, artificial intelligence, and expert systems with subsystems required for particular tasks.

Teleoperations and robotics research and development is active in the Advanced Systems Development Laboratory for advanced flight displays, controls, manipulators, and flight robotics sensors, actuators, and controllers. In addition, systems engineering focus is provided for all teleoperations, manipulator, display/control, and robotics activities of the Engineering Directorate.

Artificial Intelligence (AI) projects involve the development, maintenance, and operation of the Intelligent Systems Laboratory for research, design, and development of machine intelligence and robotics for system autonomy and intelligent robotics including knowledge-based systems, expert systems, causal modeling, neural network architectures, computer and robotic sensor perception processing, and machine learning.

Research opportunities exist in the areas of teleoperations, robotics, and machine intelligent applications in space. Additional research opportunities include expert systems applications to real-time spacecraft simulations.

Contact:
James Lawrence
(713) 483-1553
Simulations
Charles Price
(713) 483-1532
Teleoperations
Kathleen Healey
(713) 483-47[illegible]
Artificial Int[illegible]nce

Tracking and Communications — Future permanent presence in space and resulting operations involve construction activities, satellite servicing, manufacturing, Earth and orbit transfer of people and cargo, scientific and engineering experiments, power generation and distribution, communications services, rendezvous and docking, and Earth and space monitoring; these activities will require multiple access, secure, multichannel information transfer with a wide range of characteristics and simultaneous functions. Innovative expert system implementations are envisioned for the control and monitoring of these complex communications and tracking systems. Additionally, noncontact vision will be required for autonomous operations involving robotics and automation systems. Research opportunities exist in many communications, tracking, and noncontact vision system development areas, including efficient multiaccess secure communication systems, voice recognition systems for control operations, television- and laser-based vision systems, optical processing, laser/optical communications, MMIC distributed array antennas, and expert systems for control and monitoring of communications/tracking systems. Research is also conducted on end-to-end integrated systems models and simulation for secure, packetized, and compressed data transfer and processing.

Contact. Kumar Krishen
(713) 483-0207

Mission Support

Artificial Intelligence — Responsibilities for developing, evaluating, assessing, and implementing artificial intelligence (AI) applications in support of Space Shuttle and Space Station operations. A numer of ongoing research projects offer the potential for major contributions to the integration of AI technology with robotics, image and speech analysis, training, software development, flight design and control, intelligent data base technology, machine learning, and intelligent man-machine interfaces.

Current efforts include research into the development of general-purpose intelligent training systems; expert assistants for flight controllers; neural networks for robotics simulation, machine learning and image/speech recognition (as well as speech generation); implementation of expert systems on parallel/distributed systems; and verification/validation techniques for expert systems. Work is supported by a laboratory equipped with six Symbolics 3600-series Lisp machines, a VAX 11/780, a Flex computer with six co-processors, an Inmos parallel computer with 40 transputers, a large number of personal computer workstations, and access to a Cray supercomputer. In addition to traditional languages (C, FORTRAN, and ADa) and tools (MACSYMA and SMP), a wide range of AI software is available, including Lisp (Symbolics, VAX, HP, and personal computer versions), ART, KEE, OPS5, Nexpert Object, and CLIPS (a production system developed by the AI Section.
Contact: Robert T. Savely
(713) 483-8105

Safety, Reliability, and Quality Assurance

Risk Management — Complex space programs with long lead times and high costs demand advanced risk management techniques which dynamically integrate the functions of hazard identification, the potential for occurrence, and the level of program impact. Opportunities exist for research in the development and implementation of both quantitative and qualitative techniques to identify the parameters of a comprehensive risk management program for complex space systems and facilities which provide for accurate assessment of the human interfaces in each area. Approaches to be considered in such a comprehensive program include, but are not limited to, statistical modeling of failures and their effects; probabilistic risk assessment; fault tree, event tree, or decision tree analysis; and the dynamic integration of element hazards arising from both ground and mission phases. The objective of the research is to develop an approach which successfully melds hazard control and fault tolerance criteria, risk management techniques, systems performance, and human performance in a dynamic continuum of mission activities which will support the achievement of a corresponding level of dynamic risk measurement aned appraisal which lead sound risk management decisions.
Contact: Richard Holzapfel
(713) 483-4290

Space and Life Sciences

Biomedical Sciences

Biomedical Studies — Provides biochemical and endocrinological support to manned spaceflight operations. Prolonged space missions and the need to monitor and correct biochemical changes in flight necessitate the development and refinement of techniques for electrolyte and hormone assays suitable for use in zero-gravity environments. The laboratory is actively pursuing (1) development of analytical procedures for routine determination of hormone-binding proteins; (2) refinement of

existing techniques of radioimmuno assays for vitamin D, antidiuretic hormone, atrial natriuretic factor (ANF), and parathormone; (3) development of analytical methods for hormones and vasoactive agents implicated in renal physiology; (4) development and field testing of new concepts of automated biochemical analysis; and (5) testing of analytical procedures in simulated and actual spaceflight for simplicity of use, accuracy, reproducibility, and noninvasiveness.
Contact: Nitza Cintron
(713) 483-7165

Biological Processing in Weightlessness — Microgravity can be used to enhance the separation or synthesis of medically important biologicals from suspension-cell cultures. In weightlessness, liquids and gases exhibit novel behavior, convective mixing is virtually absent, and immiscible mixtures can remain stable for prolonged periods. Various gravity-dependent processes have been examined to determine whether, in the absence of gravity, significant improvements in process technology can be achieved. Shuttle flight experiments demonstrate that both free-flow and static electrophoretic systems can achieve better separations of certain cells in weightlessness than is possible on Earth. Researchers are also examining different physical phenomena and the resulting effects on fluid mechanics in the weightless environment of space. Theoretical and experimental work will assess the significance of these physical changes to biological systems. The major thrust of this program is to explore improvement in biological separations and cell-culturing techniques under microgravity conditions. Continuous flow electrophoresis and recirculating isoelectric focusing of cells and proteins are being compared, or new candidates for flight experiments are being evaluated. The bioprocessing laboratory is developing a prototype microcarrier bioreactor for conducting cell-culture experiments in microgravity and provides biological laboratory support for electrophoresis of kidney, pituitary of flow cytometry, cell sorting, hybridoma production of specific antibodies, enzyme-linked immunosorbent assays, and cell growth on microcarrier beads. Research associates also can collaborate with scientists at the Bioprocessing Research Center at the University of Texas Health Science Center, which is under contract to JSC.
Contact: Clarence Sams
(713)483-7160

Pharmacokinetics Research — Pharmacokinetics of drugs administered to crew members during flight are subject to variability as a result of exposure to weightlessness. Identification and evaluation of these changes in the pharmacokinetic behavior of therapeutic agents is essential for designing and developing effective treatment regimens for space flight-induced pathophysiologic conditions like space motion sickness.

The biochemistry research laboratories conduct research in the areas of clinical pharmacokinetics and biopharmaceutics. The special areas of our interest are development of simple and noninvasive drug monitoring methods that are flight suitable; evaluation of pharmacokinetic changes of drugs during antiorthostatic bedrest; identification of physiologic changes that influence drug disposition, such as a hepatic and renal function, gastro-intestinal physiology, and changes in protein binding of drugs, using simulation models. Our group is also involved in a numb[illegible] nflight pharmacokinetics r[illegible].ch projects. Research in the area [illegible] physi[illegible]logic-pharmacokinetic model development is also actively pursued.

Clinical facilities and staff to conduct human research are provided by collaborating institutions and inhouse contractor personnel. Fully equipped, inhouse analytical laboratories are

available to support pharmacokinetics research. An inhouse computer facility with a wide range of statistical software packages is also available for pharmacokinetic data analysis and modeling.
Contact: Nitza Cintron
(713) 483-7165

Space Biomedical Research Institute — Medical research to investigate the physiologic changes associated with space flight. Human and nonhuman subjects are used in basic and applied research programs. Emphasis is on human investigations under actual or simulated space flight conditions. Particular areas of interest include cardiovascular physiology, neurosensory adaptations, musculoskeletal regulation, biobehavioral mechanics, and environmental factors such as dysbarism. The understanding of the scientific principles that underlie the adaption to weightlessness is further utilized in the development and testing of countermeasures. On-site facilities are enhanced by close working relationships with local and national universities. Manages the life sciences detailed supplementary objective (DSO) flight program.
Contact: John Charles
(713) 483-7224

Man-Systems

Biodynamics — Developing computerized models of human strength and body motion. To further these models, extensive data is needed giving the strength capabilities of healthy adults for various body positions. Opportunities exist for collecting some collaborative data in simulated zero-gravity, neutral buoyancy (under water), and parabolic flight, where periods of up to 30 seconds of weightlessness are created.
Contact: Barbara Woolford
(713) 483-3701

Computer Science — Comprehensive research, development and operations support provided to life sciences activities by computer facilities housing various midrange systems, the majority of which are DEC/VAX machines. Major applications include CAD/CAM, graphics and organization support applications. The increased complexity of the hardware and software needed for research requires better integration of the advanced systems, networks, and tools, along with higher reliability, serviceability and availability of computer resources. Areas of interest include application of advanced operations techniques to the ADPE environment. Research is needed on advanced systems for data management, data systems integration, advanced networking performance analysis, and advanced architecture to solve ADPE problems. Investigations would include software and hardware issues. Advanced systems capabilities include integration of voice, data communications, computer networking, and networking research.
Contact: Lou Fadula
(713) 483-5968

Lunar Base Technology

Ecological Life Support Studies — Investigation of *in-situ* planetary regolith as a solid support medium for the growth of higher plants as part of a Controlled Ecological Life Support System (CELSS). Focus is on obtaining basic data on plant toxicities to planetary materials and their amelioration to provide a long-term productive plant growth substrate.
Contact: Donald Henninger
(713) 483-5034

Space Life Support Development — Interdisciplinary research in life support science and technology to sustain human life on planetary mission and settlements in space. The aim is to find self sufficient means to support human, plant, and animal life in closed, controlled volumes.

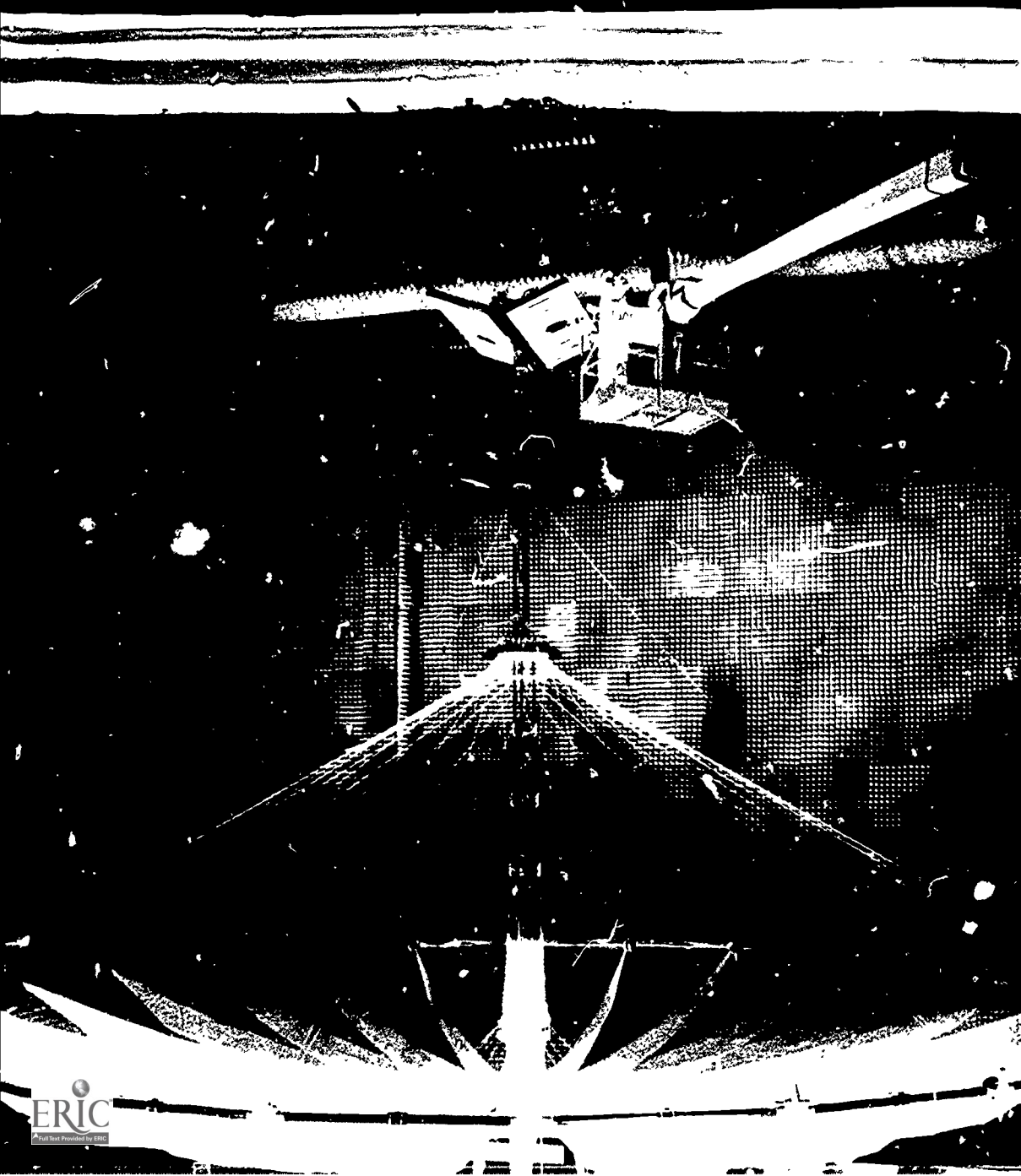
Research projects will attempt to answer specific questions related to human life support or to an overall understanding of human-centered biosystems in space.
Contact: Hatice Cullingford
(713) 483-8402

Planetary Materials Analysis — Laboratory analyses of lunar rocks, terrestrial rocks, meteorites, and cosmic dust particles are conducted to unravel the early geochemical history of solid matter in the solar system and the geologic evolution of planets and rocky protoplanetary objects, including comets. Cometary studies by remotely sensed data of Earth and other planetary bodies are also used for these same objectives. Determinative mineralogy employs electron microscopy and microprobe analysis, as well as X-ray and electron diffraction analyses. Trace element concentrations are determined by instrumental neutron activation analysis. Isotopic data is gathered by solid source and gas source mass spectroscopy. Light elements are analyzed by chromatography and quadropole mass spectroscopy. Interactions of water and planetary materials are studied by low-temperature differential scanning calorimetry and by computation of mineral-fluid reaction relationships.
Contact: William Phinney
(713) 483-4464

Space Science

Orbital Debris — Theoretical and experimental research in fields related to the orbital debris program. Includes research on the orbital mechanics of space debris in both low Earth orbit and geosynchronous orbit, measurement of orbital debris by optical, infrared, and radar techniques, and laboratory and experimental research on hypervelocity impact phenomena.
Contact: Donald Kessler
(713) 483-5313

Space Radiation — Theoretical and experimental research in space radiation, with emphasis on aspects related to radiation biology. Includes applied research on radiation dosimetry and basis research on modeling and measurement of the radiation environment in low Earth orbit.
Contact: Adrei Konradi
(713) 483-5059



Langley Research Center

Program Administrator

Dr. Samuel E. Massenberg
University Affairs Officer
Mail Stop 105A
NASA Langley Research Center
Hampton, VA 23665–5225
(804) 865–2188

(After October 1988, the Langley Research Center telephone system will be undergoing changes. To obtain telephone numbers for contact personnel, you may call the Langley Research Center Operator at (804) 864-1000 or the University Affairs Office at (804) 864-4000.

The research program of the Langley Research Center is very broad and includes activities in aeronautics, space, space science, atmospheric science, and applications. The following topics identify the current disciplines relevant to the Langley program. Specific research activities associated with each discipline are also included

Aeronautics Directorate

The goal of the aeronautics research program is to establish a solid foundation of aeronautical technology and provide a wellspring of ideas for advanced aeronautical concepts. This program includes the following disciplines and specific research activities.

Fluid Physics — Subsonic aerodynamics, transonic aerodynamics, high-speed aerodynamics, computational fluid dynamics, turbulent drag and noise reduction, airfoil aerodynamics, advanced test techniques, full scale Reynolds number test technology, and flight reasearch measurement techniques. Contact:

Joseph W. Stickle
(804) 865–2037
Subsonic Aerodynamics

Percy J. Bobbitt
(804) 865–2961
Transonic Aerodynamics

Robert A. Jones
(804) 865–3783
High-Speed Aerodynamics

Ajay Kumar
(804) 865–3171
Computational Fluid Dynamics

Dennis M. Bushnell
(804) 865–4546
Turbulent Drag Reduction

William D. Harvey
(804) 865–2631
Airfoil Aerodynamics

Robert A. Kilgore
(804) 865–3713
Advanced Test Techniques

Lawrence E. Putnam
(804) 865-2601
Full-Scale Reynolds No. Test Tech.

Bruce J. Holmes
(804) 865-3274
Flight Research Measurement Techniques

Propulsion — Propulsion integration, hypersonic propulsion research, advanced turboprops (noise reduction). Contact:

William Henderson
(804)865–2676
Propulsion Integration

Griffin Y. Anderson
(804) 865-3772
Hypersonic Propulsion Research
William P. Henderson
(804) 865-2676
Advanced Turboprops
(Noise Reduction)

General Aviation — Aerodynamics and handling qualities, drag reduction, separated flow control (stall/spin). Contact:
Joseph L. Johnson
(804) 865-2184
Aerodynamics and Handling Qualities
H. Paul Stough
(804) 865-3274
Stall/Spin
Bruce J. Holmes
(804) 865-3274
Drag Reduction

Low-Speed Aircraft — Rotorcraft structures, vibration aeroelasticity, and acoustics, natural laminar flow. Contact: Bruce J. Holmes
(804) 865-3274

High-Speed Aircraft — Flight dynamics and rocket-borne, small-scale flight research. Contact:
Joseph L. Johnson
(804) 865-2184
Flight Dynamics
Bruce J. Holmes
(804) 865-3274
Rocket-borne, Small-scale Flight Research

Advanced Aircraft Systems — Aerodynamics, structures, acoustics of advanced flight systems. Contact:
Wallace C. Sawyer
(804) 865-2658
Advanced Military A/C and Missiles
Samuel M. Dollyhigh
(804) 865-3294
Advanced Aircraft Systems

Transport Aircraft — Aviation meteorology research-heavy rain effects, lightning, severe storms, wake vortex minimization, laminar-flow control, high Reynolds number research, configuration aerodynamics. Contact:
R. Earl Dunham, Jr.
(804) 865-3611
Heavy Rain Effects
Bruce D. Fisher
(804) 865-3274
Lightning, Severe Storms
George C. Green
804) 865-4546
Wake Vortex Minimization
Richard D. Wagner
(804) 865-2045
Laminar-Flow Control
Lawrence Putnam
(804) 865-2601
High Reynolds No. Research and Configuration Aerodynamics

Electronics Directorate

The mission of the Electronics Directorate is to pioneer and provide technology, systems, and services in the areas of instrumentation, scientific computing, and simulation to sustain Langley's continued research preeminence; and to manage the Center's major aerospace flight research projects. The following items represent active research disciplines within the directorate purview.

Advanced Sensor Systems — Solid-state laser technology, and semiconductor detector technology. Contact:
Charles E. Byvik
804) 865-3761
Solid-State Laser Development
William E. Miller
(804) 865-3761
Semiconductor Detector Technology

Measurement Science and Instrument Technology — Far infrared technology, electromechanical sensors, digital data systems, nonintrusive optical/laser measurements, optical/laser spectroscopy, mass spectrometry/gas chromotography, thermal measurements, structural dynamics/acoustics measurements, optical interferometry/photogrammetry techniques, and electronics applications. Contact:

Ira G. Nolt
(804) 865–3761
Far Infrared Sensor Technology

Stewart L. Ocheltree
(804) 865–2791
Nonintrusive Measurements

Glenn R. Taylor
(804) 865–3541
Advanced Electronics Systems

Harlan K. Holmes
(804) 865–3483
Electronmechanical Sensors and Structural Dynamics/Acoustics Measurements

Robert L. Krieger, Jr.
(804) 865–2031
Digital Data Acquisition

Reginald J. Exton
(804) 865–2791
Optical/Laser Spectroscopy

George M. Wood, Jr.
(804) 865–2466
Mass Spectrometry/Gas Chromotography

S. Franklin Edwards
(804) 865–2466
Thermal Measurements

John C. Hoppe
(804) 865–3234
Optical Interferometry/Photography

Materials Characterization Technology — Ultrasonic propagation and scattering in composites, ultrasonic arrays, signal processing, image analysis; thermal wave and diffusion analysis, nonlinear acoustics, electron microscopy, microstructural physics, elastic behavior, X-ray tomography, fiber optic sensors, and electronics reliability. Contact:

Eric I. Madaras
(804) 865–3249
Ultrasonic Propagation and Scattering in Composites

Patrick H. Johnson
(804) 865–4928
Utrasonic Arrays, Signal Processing, and Image Analysis

William P. Winfree
(804) 865-4928
Thermal Wave and Diffusion Analysis

John H. Cantrell
(804) 865–3036
Nonlinear Acoustics, Elastic Behavior, Electron Microscopy, and Microstructural Physics

Min Namkung
(804) 865–3036
X-Ray Tomography for Stressed Solids

Robert S. Rogowski
(804) 865–3036
Fiber Optic Sensors for Structural Dynamics

Joseph S. Heyman
(804) 865–3036
Electronics Reliability Sciences

Advanced Computational Capability — Piloted simulation, computer-generated and enhanced graphics, image processing, grid generation, and numerical techniques. Contact:

Billy R. Ashworth
(804) 865–3874
Piloted Simulation

John E. Hogge
(804) 865–3547
Advanced Computer Graphics

Robert E. Smith
(804) 865–3978
Grid Generation and Numerical Techniques

Flight Systems Directorate

The goal of the Flight Systems Research Program is to provide, through basic and applied multidiscipline research activities, advanced technology needed to

develop and implement future aerospace flight systems. Research activities include the following disciplines and specific research activities.

Controls and Guidance — Fault-tolerant systems, theoretical dynamics and control, crew station technology, and applied control concepts.
Contact:
Charles Meissner
(804) 865–3681
Fault-Tolerant Systems
Jarrell Elliott
(804) 865–3291
Theoretical Dynamics and Control
Applied Control Concepts
Jack Hatfield
(804) 865–3917
Crew Station Technology

Human Factors — Flight management technology, advanced crew interface/intelligent cockpit aids research, and pilot workload/performance research. Contact:
Sam Morello
(804) 865–3621
Flight Management Technology
Advanced Crew Interface Research
Kathy Abbott
(804) 865–3621
Intelligent Cockpit Aids Research
Randall Harris
(804) 865–3917
Pilot Workload/Performance Research

High-Speed Aircraft — Aspects of navigation, guidance, and control relative to high-speed aircraft. Contact:
Jarrell Elliott
(804) 865–3291
Flight Dynamics and Control

Transport Aircraft — Advanced ATC/Aircraft interaction, airborne detection of wind shear research, advanced controls, guidance, and flight management research. Contact:
Bill Howell
(804) 865–2224
Advanced ATC/Aircraft Interaction
Roland Bowles
(804) 865–3621
Airborne Detection of Wind Shear Research
Bill Howell
(804) 865–2224
Advanced Controls, Guidance, and Flight Management Research

Computer Science — Concurrent processing, highly reliable computing, information and data base management, graphics, and image processing.
Contact: Wayne Bryant
(804) 865–3535

Space Controls and Guidance — System identification and adaptive control of large flexible space structures, teleoperator/robotics system technology, and robust/failure-accommodating control design methodology for advanced spacecraft. Contact:
Claude Keckler
(804) 865–4591
System Identification/Adaptive Control of Large Flexible Space Structures
Al Meintel
(804) 865–2489
Teleoperator/Robotics System Technology
Claude Keckler
(804) 865–4591
Robust/Failure Accommodating Control Design Methodology for Advanced Spacecraft

Materials and Structures —
Contact:
Al Meintel
(804) 865–2489
Automated Construction of Large Space Structures

Electromagnetics, Antennas, and Microwave Systems — Electromagnetic analysis methods, spacecraft, and aircraft antenna technology, far-field and near-field antenna measurements, compact range technology, and microwave remote sensing technology for aircraft and spacecraft applications.
Contact: Tom Campbell
(804) 865–3631

Electronics and Information System — Laser sensing technology, optical data processing, solid-state memory technology, and very high-speed information processing.
Contact: Harry Benz (804) 865-3777

Advanced Control/Display Technology —
Contact: Jack Hatfield (804) 8 5-3917

Optical Data Storage —
Contact: Thomas Shull (804) 865-3541

Transportation Systems — Studies leading to algorithms for on-board, real-time guidance, navigation, and control of space transportation systems through launch, aeromaneuvering, and entry: robust and adaptive guidance schemes that allow for unknown and changing atmospheric conditions; simplified and autonomous mission planning.
Contact: Doug Price (804) 865-4591

Spacecraft Systems Technology —
Contact:
Harry Benz
(804) 865-3777
Semiconductor Material Growth in Low-G Environment

Space Directorate

The goal of the space and atmospheric science research and technology base is to establish and maintain a solid foundation of technology embracing all of the disciplines associated with space and atmospheric science and to provide a wellspring of ideas for advanced concepts. This program includes the following disciplines and specific research activities.

Entry Fluid Physics — Spacecraft aerothermodynamics and configuration technology, planetary mission support technology, aerodynamic/aerothermodynamic flight data analysis, detailed aerothermal loads.
Contact: Kenneth Sutton
(804) 865-3031

Power and Propulsion — Laser power generation, transmission, and photovoltaic conversion in space.
Contact: Edmund J. Conway
(804) 865-4275

Transportation Systems — Future space vehicle concept development, operations research, computer-aided design.
Contact: Delma C. Freeman
(804) 865-3912

Space Systems Technology —
Advanced technology space stations, advanced spacecraft systems, low Earth-orbital microgravity research, satellite servicing, and system conceptual designs for planet Earth geostationary platforms, lunar bases, and Mars missions.
Contact: L. Bernard Garrett
(804) 865-3667

Space Technology Experiments —
Shuttle entry air data system, Shuttle infrared leeside temperature sensing, shuttle upper atmosphere mass spectrometer.
Contact: Kenneth Sutton
(804) 865-3031

Climate Research Program —
Theoretical, laboratory, and field investigations of the chemical and radiative properties of natural volcanic and man-made aerosols and assessment of their impact on regional and global climate, remote and *in situ* observations of cloud properties and radiation balance components and theoretical studies of the role played by clouds in the Earth radiation balance.
Contact: John T. Suttles
(804) 865-2977

Tropospheric Air Quality Research Program — Assess and predict human impact on the troposphere on the regional-to-global scale, define chemical and physical processes governing the global geochemical cycles by performance of empirical and analytical modeling studies, laboratory measurements, technology developments, and

field measurements, exploit unique and critical role that space observations can provide.
Contact: James M. Hoell, Jr.
(804) 865–4779

Upper Atmospheric Research Program — Application of Langley's capabilities to expand the scientific understanding of the Earth's stratosphere and the ability to assess potential threats to the upper atmosphere, development of empirical and theoretical models, formulation of new instruments and techniques, performing laboratory and field measurements, and performing data analysis and interpretation studies to increase civilization's understanding of atmospheric processes.
Contact: Robert K. Seals, Jr.
(804) 865–2576

Nimbus 7/LIMS and SAM II Data Processing, Analysis and Interpretation Studies — Stratospheric constituents and aerosols successfully measured with the Nimbus 7 satellite instruments.
Contact:
Edward M. Sullivan
(804) 865–4784
LIMS
Leonard R. McMaster
(804) 865–2065
SAM II

Measurements of Air Pollution From Satellites (MAPS) — An instrument developed to provide global measurements of tropospheric carbon monoxide on aircraft, Shuttle STS-2, and subsequent Shuttle flights.
Contact: Harry G. Reichle, Jr.
(804) 865–2576

Stratospheric Aerosol and Gas Experiment (SAGE)— Analysis and interpretation of atmospheric aerosols, ozone, nitrogen dioxide and water vapor measured from SAGE II (1979–1981) and SAGE II (1984–present) satellite instruments.
Contact: Leonard R. McMaster
(804) 865–2065

Earth Radiation Budget Experiment (ERBE) — Experiment for flight on one or more satellites to provide measurements of the Earth's radiation budget, measurement interpretation to provide basis for assessing climate impact of human activities and natural phenomena as well as a better understanding of atmospheric and oceanic circulation. Contact:
Bruce Barkstrom
(804) 865–2977
Earth Radiation Budget Experiment
Edward M. Sullivan
(804) 865–4784
Halogen Occultation Experiment
Kelli Willshire
(804) 865–4834
Human Factors
George F. Lawrence
(804) 865–4830
Power and Electric Propulsion
Barry D. Meredith
(804) 865–4830
Electronics and Information Systems and Space Systems Technology
Roger Breckenridge
(804) 865-4834
Flight Experiments and Shuttle Payloads
Ray Hook
(804) 865–4469
Space Station

Structures Directorate

The goals of the Structures Directorate cover a wide range of space and aeronautical disciplines. This program includes the following activities.

Structures (Space) — Materials and structures-materials for advanced space structures, thermal protection systems for space transportation systems, space structural design methods, space vehicle dynamics, high-temperature space structures, fatigue and fracture of metal and composites, composites for advanced space transportation systems.
Contact:
Brantley R. Hanks
(804) 865-3054
Spacecraft Structural Dynamics, Advanced Flexible Space Structures, Control of Large Flexible Structures
James H. Starnes
(804) 865-2552
Composite Structures for Advanced Space Transportation Systems, Rotorcraft Structures
Martin M. Mikulas
(804) 865-2551
Concepts for Advanced Space Structures Construction of Large Space Structures, Robotic Construction of Large Space Structures
Donald R. Rummler
(804) 865-2422
Thermal Protection Systems for Space Transportation Systems, High-Temperature Space Structures
Robert H. Tolson
(804) 865-2887
Integrated Multidisciplinary Analysis Capability for Large Space Structures
Terry L. St. Clair
(804) 865-4194
High-Performance Polymer Concepts, Tough Composite Matrices, Composites Processing and Adhesive Bonding
Charles E. Harris
(804) 865-3013
Fatigue and Fracture of Metals and Composites
Bland A. Stein
(804) 865-2125
Composite Materials and Coatings, Concepts for Applications in Space Structures
Barry W. Lisagor
(804) 865-2036
Processing and Joining Methods for Lighter Weight, Lower Cost Aerospace Structures

Structures (Aero) — Materials and structures-structural, composites and adhesives, advanced aircraft structures, loads, aeroelasticity and structural dynamics, aeronautical structural design methods, high-temperature aeronautical structures, structural material alloys, fatigue and fracture of metals and composites. Contact:
James H. Starnes
(804) 865-2552
Advanced Composite Structures, Computational Structural Mechanics
John A. Tanner
(804) 865-2796
Aircraft Safety and Crash Survivability
Donald R. Rummler
(804) 865-3451
Aero-Space Plane Propulsion and Airframe Structural Concepts, Thermal Structural Analysis Techniques
Allan R. Wieting
(804) 865-3423
Integrated Fluid-Thermal Structural Analysis Techniques, Aerothermal Loads Experimentatio

John W. Edwards
(804) 865-4236
Theoretical and Experimental Aerodynamics Aeroelastic Analysis, Unsteady Aerodynamics

Rodney H. Ricketts
(804) 865-2960
Aircraft Aeroelasticity, Rotorcraft Aeroelasticity, Rotorcraft Structured Dynamics

Robert H. Tolson
(804) 865-2887
Multidisciplinary Synthesis Methods for Aerospace Vehicles

Charles E. Harris
(804) 865-3013
Fatigue and Fracture of Metals and Composites

Bland A. Stein
(804) 865-2125
High Temperature-Structural and Thermal Protection Materials, Advanced Composite Materials for Rotorcraft and Aircraft Structures, Thermal Protection Materials

Barry W. Lisagor
(804) 865-2036
Advanced Light Alloy and Metal Matrix Composites, High-Temperature Thin Gage Metal and Metal Matrix Composites

Clemans A. Powell
(804) 865-3561
Interior Noise Control, Acoustic Response and Sonic Fatigue

Aeroacoustics — Supersonic/hypersonic Dynamic Loads, High-speed Rotorcraft Noise, Advanced Turboprop, Computational Methods.

Contact:

S. Paul Pao
(804) 865-2645

David Chestnutt
(804) 865-3841
Helicopter Acoustics, Propeller Noise, Laminar Flow Acoustics, Noise Propagation

Robert J. Huston
(804) 865-4301
Low-Speed Aircraft.Rotorcraft Structural Dynamics, Structural Acoustics, Material Applications, Aeroelasticity, Aerodynamics, Aeroacoustics, and Unsteady Aerodynamics

Lewis Research Center

Program Administrator

Dr. Francis J. Montegani
Chief, Office of University Affairs
Mail Stop 3-7
NASA Lewis Research Center
Cleveland, OH 44135
(216) 433–2956

The Lewis Research Center has a broad research program embracing aeronautical propulsion, space propulsion and power, and space communications. Brief descriptions of some of the major research activities at Lewis follow:

Aeropropulsion Analysis

Aircraft Propulsion Systems Analysis —

Advanced propulsion concepts are analyzed to estimate performance for typical flight vehicle applications, determine relative merits compared with alternative propulsion systems, and derive optimum designs of systems integrated with a vehicle. Also conduct propulsion system sensitivity studies to identify deficiencies in existing technologies to guide the development of new NASA technology programs.
Contact: Daniel C. Mikkelson
(216) 433–5637

Instrumentation and Controls Technology

Instrumentation —

Instrumentation is developed for aerospace propulsion R&D requirements. Emphasizes laser techniques for nonintrusive flow and structures measurements, thin film sensor technology for temperature and strain, optical and electro-optical sensors and systems for control applications, and advanced transducers and measurement systems for clearance, pressure, heat flux, smoke, particles, and droplets. Silicon carbide-based solid-state electronic device technology for high temperature application is also being developed.
Contact: Norman C. Wenger
(216) 433–3730

Controls Technology —

Advanced digital electronic controls and systems for both airbreathing and rocket engines, motivated by increased performance and durability requirements. Included in the scope of the research are control theory applications, system dynamics, real-time propulsion system simulation, integrated flight/propulsion controls, fiber-optic and electro-optical control components, and robust fault tolerant controls and systems. Applications of artificial intelligence/expert systems

and neural networks to controls is an active research area.
Contact: Norman C. Wenger
(216)433–3730

Internal Fluid Mechanics

Computational Fluid Mechanics

New techniques for analysis of subsonic, supersonic, and hypersonic aerospace propulsion system flows associated with inlets, nozzles, compressors, turbines, combustors, augmentors, and rocket systems. Behavior of fluids in microgravity is also investigated. Emphasis is on numerical methods with greater accuracy and significantly increased convergence rates. Of increasing importance are computational strategies using such concepts as multiblock grids and zonal approaches combining two or more numerical methods. Pacing items for advanced applications are three-dimensional complex geometry mesh generation techniques, grid lattice construction, and solution-adaptive mesh clustering. Three-dimensional turbulent flow fields with emphasis on turbulence models are of continuing interest. The application of advanced architectures, expert systems, innovative graphics, and scientific data-base structures is expected to have a major impact on this work.
Contact: Brent A. Miller
(216) 433–5815

Experimental Fluid Mechanics

Experiments to verify selected fluid mechanics computations and to advance understanding of flow physics, heat transfer, and combustion processes fundamental to aerospace propulsion. Experimental data are analyzed to aid development of aerothermodynamic models embracing combustion thermodynamics, reaction chemistry, and turbulence. State-of-the-art experimental facilities, instrumentation, and data acquisition, reduction, and analysis methods and facilities are employed.
Contact: Brent A. Miller
(216) 433–5815

Computational Technology

Development and application of advanced computer hardware and software to the simulation of flows associated with aerospace propulsion components and systems. Included in the scope of the research are the synthesis and benchmarking of parallel computer architectures and algorithms for solving 3-D steady and unsteady flow problems, the use of expert systems as intelligent interfaces to large computer codes, the use of parallel processing and interactive graphics techniques for on-line visualization of analytical and experimental data, and improved data handling software for distributed computing environments.
Contact: Brent A. Miller
(216) 433-5815

Aeronautical Propulsion Systems

Aircraft Icing

Analytical and experimental efforts devoted to developing novel concepts for aircraft ice protection. Fundamental experiments to understand and model the physics of ice formations. Changes in aircraft performance with ice build-up on unprotected components are quantified. Extensive aerodynamic and thermodynamic numerical models are developed and utilized. Interdisciplinary efforts are devoted to developing instruments to characterize icing cloud properties, measure ice accretion on surfaces, and detect changes in aircraft performance in icing conditions. Experimental research is conducted with a specially equipped Twin Otter aircraft and in the Lewis Icing Research Tunnel, the largest refrigerated icing tunnel in the world.
Contact: John J. Reinmann
(216) 433–3900

Propeller Aerodynamics and Acoustics

Analytical and experimental investigations of the aerodynamics and acoustics of advanced propellers for flight Mach numbers to 0.8. Advanced lifting line and finite difference lifting surface methods are applied to the prediction of the flow fields and performance. Noise predictions are made using time and frequency domain acoustic analogy models in conjunction with aerodynamic predictions. New propeller concepts are evaluated analytically, and the more promising are evaluated experimentally for performance and noise characteristics.
Contact: John F. Groeneweg
(216) 433–3945

Aircraft Power Transfer Technology

Power transfer technology for advanced propulsion drive systems having higher power-to-weight ratio, longer life, higher reliability, lower noise, and higher efficiency. Areas under study include design optimization, new gear arrangements and tooth forms, materials, lubrication, and cooling. New analytical tools for stress analysis, vibration, lubrication, and high speed gears are being developed. A full-scale helicopter transmission test rig is available as are facilities for fundamental studies of lubrication, endurance, efficiency, noise of spur and bevel gears, and planetary gear sets
Contact: John J. Coy
(216) 433–3915

Turbine Engine Technology

Research to advance gas turbine engine technology for wide range of civil and military applications. Areas addressed include advanced cycles involving regenerators and recuperators, advancement of compressors, combustors, and turbines, and application of ceramic materials. Involved are flow visualization, computer code development, performance modeling, and thermal and mechanical technologies.
Contact: Clavin L. Ball (216) 433–3397

High Performance Aircraft Propulsion Technology

Research on propulsion systems for advanced high performance aircraft including highly maneuverable fighters and short takeoff/vertical landing fighters. Included are theoretical analyses and experimental investigations of individual components and complete systems. Highly integrated flight/propulsion control systems are a special area of investigation. Novel propulsion concepts are evaluated and research performed to develop key technologies. Research includes analytical studies, application of advanced design codes, and planning and execution of experimental programs.
Contact: Peter G. Batterton
(216) 433–3912

Hypersonic Propulsion Technology

Analytical and experimental research directed at the aerodynamic design of hypersonic propulsion systems and their integration with the airframe. Work includes analysis and test of inlets, nozzles, combustors and other critical components. Experimental efforts include design of models and instrumentation. New theoretical flow analyses, which include 3-D shock/boundary layer interactions, are applied to the design and evaluation of experiments.
Contact: Robert E. Coltrin
(216) 433–2181

Materials

Metal Matrix and Intermetallic Matrix Composites

Advanced materials, such as intermetallic compounds and refractory metals, coupled with innovative processing concepts, such as rapid solidification, arc spraying, and laser fiber growth, are being developed for application to aerospace propulsion systems and space power systems having improved performance, higher temperatures, greater durability, and lower cost. Microstructure/property relationships are being developed and experimentally verified. Advanced

analytical and microscopy techniques are employed.
Contact: Hugh Gray (216) 433-3230

Polymers and Polymer-Matrix Composites

New generation of composite materials for application to advanced aerospace propulsion systems and airframes, and space power systems and structures. Areas of research include polymer synthesis, fiber characterization, processing, fiber/matrix degradation mechanisms, and environmental effects. The effort spans the range from fundamental inquiry at the molecular level to employment of composite material systems in final applications. The research is supported by facilities for Fourier transform infrared and nuclear magnetic resonance spectrometry, and thermogravimetric and differential thermal analysis.
Contact: Raymond D. Vannucci
(216) 433-3202

Ceramics and Ceramic-Matrix Composites

Structure/processing/property relationships of ceramic-matrix composites for high-temperature, high-reliability requirements for advanced aerospace propulsion and power applications. New processing approaches, including polymer pyrolysis, chemical vapor deposition, and sol-gel processing are being pursued. Properties of interest include flaw distribution, phase morphology, strength, toughness, crack initiation and propagation characteristics, and resistance to environmental attack.
Contact: Stanley R. Levine
(216) 433-3276

Microgravity Materials Science

A fundamental understanding of the effect on materials processing of gravity as it influences convection, buoyancy, sedimentation, and hydrostatic pressure. Central to this effort is the Microgravity Materials Science Laboratory, which is used by visiting scientists to develop experiments for eventual flight on the Space Shuttle. The laboratory contains functional duplicates of flight hardware and supporting equipment for research processing and analysis of metals, ceramics, glasses, and polymers. Areas of research include directional solidification, macro-and microsegregation, undercooling, sol-gel and containerless processing, and crystal growth. A significant portion of this effort is being directed to computational modeling of growth processes as they are influenced by gravity.
Contact: Thomas K. Glasgow
(216) 433-5013

Tribology

Research to gain a fundamental understanding of lubrication, adhesion, and wear phenomena of materials in relative motion that meet increased speed, load, and temperature demands of advanced aerospace propulsion and power systems. Both synthesized liquid lubricants and solid lubricants created by plasma film deposition techniques are under study. Tribological behavior is investigated in situ using a variety of techniques including Auger electron and X-ray photoelectron spectroscopy.
Contact: Stephen V. Pepper
(216) 433-6061

Structures

Structural Analysis and Life Prediction

Structural analysis methods for advanced aerospace propulsion and power systems. Areas of consideration include finite element modeling, aeroelasticity, rotor and structural dynamics, fracture mechanics, life prediction, micromechanics of high temperature fatigue, and damping. Analytical and experimental efforts are devoted to nonlinear constitutive relations for predicting the behavior of materials and components under varying loads and temperatures. Other topics include crack propagation and

fracture criteria for mixed mode loading and variable temperature, transient thermal growth, and thermal bowing and its effects on clearances and unbalance.
Contact: John L. Shannon, Jr.
(216) 433-3211

Structural Dynamics

Fundamental methods for predicting and controlling the dynamic response and stability of aerospace propulsion and power systems. High-speed rotation provides a central focus for much of the work. This includes studies of the aeroelastic response of bladed disk systems, both active and passive methods for controlling the vibration and stability of high speed-rotor-shaft systems, and modal analysis methods for highly damped large scale periodic structures. Actively controlled bearing supports are being developed to allow higher speed and lighter weight aeropropulsion system design. Robotic systems are also being developed for use in microgravity Space Station laboratories. Innovative computational methods that exploit parallel computers and modern computer science principles are being applied.
Contact: L. James Kiraly
(216) 433-6023

Structural Integrity

Research to assure integrity and reliability of aerospace propulsion and power systems and structural components. Areas of emphasis include interrogational methods for avoiding catastrophic fracture, fault-tolerant design, defect assessment, and residual life prediction. Comprehensive life prediction models are sought that incorporate complex stress states, nonlinear material characteristics, microstructural inhomogeneities, and environmental factors. Structural integrity is verified by nondestructive characterization of microstructure, flaw population, material morphology, and other relevant factors. Nondestructive evaluation is carried out using analytical ultrasonics, computed tomography, laser acousto-ultrasonics, and other advanced interrogational technologies. Modern computer science practices are exploited to the fullest, and emphasis is on advanced structural ceramics and composites. Integrated computer programs for predicting reliability and life of brittle material components are generated.
Contact: John P. Gyekenyesi
(216) 433-3210

Probabilistic Structural Mechanics

Research for developing probabilistic structural mechanics, solution/computational algorithms, and requisite computer codes to quantify uncertainties associated with the parameters and variables required for structural analysis and design. Research focuses mainly on developing probabilistic theories and models for coupled thermal-mechanical-chemical-temporal structural behavior of propulsion structures made from high temperature materials and including metal matrix, ceramic matrix, and carbon-carbon composites.
Contact: Christos C. Chamis
(216) 433-3252

Advanced Composite Mechanics

Research for development of theories, computational algorithms, and requisite computer codes for the mechanics, analysis, and design of propulsion structures made from high temperature composites. Of interest are polymer matrix, metal matrix, ceramic matrix, and carbon-carbon composites. Research focuses mainly on specialty finite elements for micromechanics and laminate theory, improved theories for life and durability prediction, probabilistic composite mechanics, and integrated computer programs for component specific analysis and design, progressive fracture, and high-velocity impact. Selective experimental research is conducted in support of theoretical developments.
Contact: Christos C. Chamis
(216) 433-3252

Space Propulsion Technology

Liquid Rocket Propulsion

Research devoted to a better understanding of the basic physical and chemical processes involved in liquid rocket engines in order to provide technology for the next generation of liquid-fueled space propulsion systems. Disciplines include high-energy propellant chemistry, ignition, combustion, heat transfer and cooling in thrust chambers, nozzle flow phenomena, and performance. Of particular interest are the fundamentals involved in combustion instability, metallized propellants, planetary *in-situ* propellants, expert system applications to propulsion, and non-intrusive diagnostics. Concepts are evaluated at the system level to determine engine and vehicle performance impact. The work is conducted through detailed analytical and experimental programs to determine feasiblity or applicability and to develop and validate models to describe the processes.

Contact: Carl A. Aukerman
(216) 433–2441

Low Thrust Propulsion Fundamentals

Research on electric and chemical propulsion concepts that are candidates for a broad range of low-thrust, space propulsion functions. The electric propulsion effort includes arcjets and a variety of advanced plasma rockets. The low-thrust chemical propulsion effort is focused on very high-performance storable and hydrogen/oxygen rockets at thrust levels up to about 100 pounds. Efforts are directed toward understanding the fundamental phenomena of the various concepts. State-of-the-art flow visualization, plume diagnostics, and other research tools are used to provide spatially and temporally resolved information on the critical thruster element such as the vortex/plasma flow fields of arcjets, the electrode/plasma relationships of MPD thruster, the combustion/mixing fluid physics and heat transfer of small chemical rockets, and the plumes of all the rocket concepts. In general, the results are used as input to formulation of predictive technology, such as three dimensional Navier-Stokes models. Ultimately, self-consistent models of low-thrust propulsion concepts are desired, which will allow prediction of thruster behavior and stability as a function of configuration and operating condition.

Contact: David C. Byers
(216) 433-2447

Electric Propulsion

Research on electrothermal and electrostatic thruster concepts for primary and auxiliary space propulsion applications. Included are resitojets, DC and pulsed arc jets, and microwave thrusters—all using storable propellants—and ion thrusters using inert propellants. The objectives are to evaluate the feasibility of new concepts; understand the physical processes involved in propellant heating, expansion, ionization, and acceleration; improve thruster performance and life; and optimize thruster power processing and control designs. Emphasis is on programs to develop arcjets suitable for a broad range of space propulsion functions. These thrusters operate at Reynolds numbers of 1500 or less, and employ vortex stabilized electric arcs to add enthalpy to the propellant. Efforts are desired that increase the understanding of the fundamental phenomena controlling arcjet performance. Studies of arc/vortex behavior as a function of inlet propellant conditions, arc power, and nozzle configuration are of interest. Techniques to provide spatially resolved plasma properties, including sheath characteristics, and to be used as input to formulation of three dimensional Navier Stokes models of the arcjet flow fields are particularly

important. Ultimately, a self-consistent model of arcjets is desired to allow prediction of thruster behavior and stability as a function of flow rates, power levels, and configuration.
Contact: Larry A. Diehl
(216) 433–2438

Power Technology

Photovoltaic Space Systems

Research to increase the efficiency and extend the life of solar cells in space. emphasis is on InP, GaAs, and other III-V compound solar cells and amorphous silicon solar cells. Activities include fundamental studies of materials on a microscopic scale; investigation of the effects of radiation damage on cell performance, device design, fabrication, and testing; and study of related component technologies such as interconnects and optical concentrators.
Contact: Dennis J. Flood
(216) 433–2303

Electrochemical Space and Storage

Advanced technology to increase the life and energy density of energy storage systems and fuel cells. Emphasis is on nearer-term nickel-hydrogen and hydrogen-oxygen systems, with exploratory efforts being given to more advanced high-temperature ionic conductor systems. Pre-prototypes of advanced battery systems are being designed, built, and tested.
Contact: Lawrence H. Thaller
(216) 433–6146

Space Power Management and Distribution Technology

Technology to control the generation and distribution of electrical energy in space systems and to define enabling technology for future high-power space systems. The program includes the investigation of advanced electrical power circuits and the fundamental physics of electrical devices (insulators, conductors, and semiconductors). Prototype devices and circuits are fabricated and performance characterized and analyzed Research in system autonomy, system architecture, and fault prediction are important elements of the program.
Contact: Robert W. Bercaw
(216) 433–6112

Power Systems Technology

Technology for efficient, compact, lightweight, long-life nuclear space power systems for a variety of applications over the range from 5 kilowatts to 1 megawatt. Mission application studies for nuclear and solar space power systems are conducted to identify system requirements and technology needs. Analytical and experimental investigations are conducted in the areas of energy conversion, thermal management, power conditioning and control, materials and environmental effects.
Contact: John M. Smith
(216) 433-6130

Thermal Management for Space Power Conversion Systems

Analytical and experimental efforts to develop lightweight space radiator components and to tailor cycle operating conditions to minimize overal system mass. Radiator designs must resist a variety of natural hazards including micro-meteroids and space debris. Concepts under investigation include pumped loop designs, the use of heat pipes with a variety of working fluids and containment materials, and liquid droplet, moving belt, and Curie point radiators.
Contact: Marvin Warshay
(216) 433-6126
Albert J. Juhasz
(216) 433-6156

Stirling Dynamic Power Systems

Technology to exploit the unique potential of the Stirling engine for both space and terrestrial applications. Principal emphasis is on developing the free-piston Stirling engine for high-capacity space-power generation systems. Among the areas of research are oscillatory flow and heat transfer,

advanced instrumentation, heat pipes, high temperature materials, hydrodynamic gas bearings, dynamic balancing systems, and hydraulic and linear alternator power takeoff systems.
Contact: Donald G. Beremand
(216) 433-6110

Space Environmental Interactions

Research on electrostatic and electromagnetic effects induced in space systems and instrumentation by interaction with space plasma and field environments and on the development and characterization of local plasma and field environments around large space systems. Such effects include surface and bulk dielectric charging, plasma sheath development and characteristics, current collection from plasma, arcing, and the stimulation and propagation of disturbances. Research disciplines involved include plasma, solid state, and surface physics, electromagnetism, and fundamentals of space system design.
Contact: Carolyn K. Purvis
(216) 433-2307

Electronic Device Materials for Space Power

Research on thermally conductive high-strength composite materials with either very low or very high electrical conductivity for high-performance applications requiring light weight. New and improved materials are investigated for use as insulators, conductors, semiconductors, dielectrics, thermal radiators, and protective coatings. Research is also conducted to enable fabrication, characterization, and functional evaluation of the materials.
Contact: Bruce A. Banks
(216) 433-2308

Space Experiments

Microgravity Science and Applications

Basic science experiments designed to capitalize on the microgravity environment of the Space Shuttle in the areas of combustion, metals and alloys, fluid physics and transport phenomena, ceramics and glasses, and electronic materials. Science requirements and conceptual designs are developed using ground-based 2.2 second and 5 second drop towers and a Learjet aircraft. Activities culminate in the design, fabrication, and flight of space experiments.
Contact: Fred J. Kohl
(216) 433-2866

In-Space Technology Experiments

In-space experiments to support advancement of the technology base in the areas of fluid management, energy systems and thermal management, and satellite communications. Areas of investigation include on-orbit fuel storage and transfer, low-gravity fluid behavior and thermal processes, instrumentation, and spacecraft fire safety. While ground-based precursor studies are pursued, emphasis is on the definition and development of cost-effective flight projects that yield results otherwise unobtainable through ground-based experiments or analysis.
Contact: Jack A. Salzman
(216) 433-2868

Space Communications Technology

Space Communications Systems Analysis

Studies of advanced space communications systems to [illegible] the future technology requirements. Such studies include investigation of new communications system architectures and networking concepts, comparison of advanced satellite and terrestrial systems, and exploration of new ways to increase the available spectrum/orbit communications capacity. Involved are computer modeling of systems of satellites and simulation of communications links. Laboratory research is conducted on digital coding schemes to reduce bandwidth requirements for information transmission.
Contact: Edward F. Miller
(216) 433-3479

Space Communications Components

Research to establish the technical feasibility of advanced satellite communications components including electron beam devices, solid state devices, and antennas. Electron beam device research is focused on traveling wave tubes operating to 100 GHz and embraces materials and fabrication, electron guns, beam wave interactions, efficiency enhancement techniques, and submillimeter wave sources and components. Solid state device research is focused on monolithic microwave integrated circuit (MMIC) devices for advanced transmitter and receiver modules. Areas of interest include wave transmission media, circuit analysis and synthesis, device modeling, microfabrication technology, and crystal growth techniques. Antenna research includes theoretical and experimental investigation of advanced multibeam systems operating at microwave and millimeter wave frequencies. Work is focused on the use of MMIC modules in multiple feed elements and the use of such feeds to dynamically compensate for distortions by controlling phase and amplitude.
Contact: Denis J. Connolly
(216) 433-3503

Satellite Communications Systems Technology

Advanced satellite communications system and subsystem technology to establish performance and cost data necessary to demonstrate readiness for operational application. Specific technologies being developed include antennas and antenna feeds, low noise amplifiers, RF power amplifiers, IF and RF switching systems, modems, communication processors, and network control techniques.
Contact: James W. Bagwell
(216) 433-3503

Aerospace Applications of High-Temperature Superconductivity

Research to assess the potential payoff for aerospace applications of high-temperature superconductivity (HTS), to define the technology requirements for these applications, and to develop the requisite technology. Emphasis will be placed on the large scale applications generally involving high currents, high magnetic fields, and substantial energy storage or power transmission.
Contact: Denis J. Connolly
(216) 433-3503

Advanced Space Analysis

Space Mission Models

Research to develop advanced analytical models of space transportation, propulsion, power, and communications systems. Models are used to perform assessments and trade-off studies of proposed future space missions. New analytical capabilities are being sought and existing models are under continuing review for areas of enhancement.
Contact: Thomas J. Miller
(216) 433-2867

George C. Marshall Space Flight Center

Program Administrator

Ms. Ernestine K. Cothran
University Affairs Officer
NASA Marshall Space Flight Center
Mail Code DX01
MSFC, AL 35812
(215) 544-0997

The Marshall Space Flight Center offers opportunities for original work in many areas of the physical sciences, mathematics, and engineering. Theoretical and experimental research is greatly enhanced by the ready access to computers, including the Cray XMP.

Before preparing your proposal, prior discussion with a center researcher is recommended. In general, Marshall advisers are interested in collaborative efforts with students and their university advisers and will look favorably on proposals indicating some research time will be spent on-site at the center.

Information and Electronic Systems Laboratory

Electrical Systems

Activities include development of advanced silicon devices utilizing diffusion and ion implantation techniques, high solar concentration photovoltaic systems, and electrical power system automation techniques. Research is conducted in planar and concentrator array development, and improved efficiency photovoltaic cell design, cell modeling, and performance testing. On-site resources include semiconductor processing facilities for cell and material development, and a photovoltaics test laboratory complete with solar simulator and vacuum chamber for simulation of on-orbit conditions. Artificial intelligence approaches are used to support electrical power system automation, address autonomous fault management, dynamic payload rescheduling, intelligent data reduction, autonomous battery management, and enhanced state-of-health monitoring and reporting.
Contact: D. Weeks (205) 544-3309

Electronics, Sensors, Robotics

Research, design and development activities are conducted on electronic control systems and measurement sensors for guidance, navigation, and control of missiles, orbiting spacecraft and planetary exploration vehicles, and on robotics and teleoperated systems. A wide variety of subjects are addressed, such as rate gyros, accelerometers, star trackers, sun sensors, strain gauges, pressure sensors, control moment gyros, reaction wheels, and pointing gimbals. A typical activity related to electronics and sensors research to use charge injection devices for improved tracking applications, robotics is another area of concentration. Rendezvous and docking of vehicles in orbit, both teleoperated and automated modes, is

studied and demonstrated in the flight robotics facility. This facility, a broad-based testbed, is used for concept study, development, and testing in the areas of space orbital and robotics operations. On-orbit servicing is a related effort. Camera placement, force torque sensing, lighting, and robotic vision are all study areas for which the facility is used. Control station work involves research in the use of voice recognition, touchscreens, and stereo vision.
Contact: E.C. Smith (205) 544-3506

Optical Systems
Opportunities exist for research, design, and development of optical, laser doppler, video, and electro-optic image and detection device technology for application in future or proposed missions.
Contact: E. Reinbolt (205) 544-3462

Software and Data Management
An area of high interest is the automatic generation of digital computer code from structured requirements. An area of particular interest is to use knowledge-based systems with Artificial Intelligence (AI) tolls to implement software progressions automatically from requirements phase through code generation for embedded computer systems. Another target area of research and development is AI techniques and tools to aid in fault diagnosis, load management, and scheduling for flight systems and subsystems.
Contact: D. Aichele (205) 544-3721

Materials and Processes Laboratory
Major technology and research efforts are underway in physics and chemistry of materials, both metallic and nonmetallic, and in critical environments at cryogenic to high-temperature levels. Comprehensive research and development activities are pursued in qualification and testing of materials.

Space Environmental Effects on Materials
Evaluation of materials is accomplished in space environmental conditions involving vacuum, temperature, electron/proton, atomic oxygen, and micrometeoroid impact. The effects of outgassing products of materials on weight loss, strength loss, surface properties, and re-deposition and condensation on other items is being studied. Lubrication and surface physics on bearings in space and in rocket propulsion components is under research. Nondestructive evaluation (NDE) research and development in new NDE methods/processes and instrumentation is encouraged.
Contact: R. Gause (205) 544-2508

Metallic Materials Research
Development of alloys for special application such as blades and discs in hydrogen or oxygen turbopumps, fuel tanks, solid rocket motor cases, etc., is an ongoing requirement. Research in metallographic micro-structural analysis methods to determine the condition and history of certain alloys is being accomplished in support of failure analyses and fracture mechanics research. Methods for quantitatively determining the state of corrosion, stress corrosion and hydrogen embrittlement of alloys are being developed.
Research is also directed at characterizing the properties of alloys in simulated service environments and enhancing alloy performance through modifications in chemistry, processing, or surface treatment. Available state-of-the-art research facilities include mechanical testing laboratories; a high pressure, high temperature, gaseous hydrogen, materials testing laboratory; corrosion research laboratories; a foundry and thermal processing laboratory, and a metallurgical and failure analysis laboratory equipped with modern diagnostic systems for microstructural

and surface chemistry analysis.
Contact: P. Schuerer (205) 544-2566

Nonmetallic Materials Research
Opportunities exist to develop and modify pc ners for adhesives insulator., astomers, composite matrices, and molding and extrusion compounds for use in sp ecraft hardware and in special environments. Organic composites such as carbon-carbon or carbon-resin are being developed for structural applications to reduce mass or for high temperatu.e applications such as rocket engine nozzles and leading edges. Ceramics and glasses with special optical properties and high strength and toughness for structural properties in spacecraft are continually sought.
Contact: C. McIntosh (205) 544-2620

Processing Engineering Research
A Productivity Enhancement Center employs new and improved techniques for developing manufacturing processes to produce spacecraft hardware. This center uses graphics computers/terminals to lay-out work by Computer Aided Design, Computer Aided Manufacturing, and Computer Integrated Manufacturing. Remote programming of machines and robots to improve filament winding patterns, automatic weld paths, and foam spray are just a few applications in process. Welding by new techniques, such as the variable polarity plasma arc process on special alloys and use of smart robots to accomplish intricate welds, is being researched. Nonmetallic processing such as filament winding, pultrusion, tape laying, tape wrapping and hydroclave curing to achieve optimum properties in composites is the subject of intensive research and development.
Contact: M. H. Sharpe (205) 544-2714

Propulsion Laboratory
Activities are directed toward the research, technology, and flight hardware development of propulsion systems for launch and space vehicles and support equipment. Areas of activity include liquid and solid propulsion and control systems for the Space Shuttle, space propulsion and support systems, advanced chemical and laser propulsion systems for future launch and space vehicles, and flight experiment and space station mechanisms.

Systems Division
Research and development is ongoing in liquid rocket engines, solid motors, propulsion systems, and reaction control systems. Activities include predicting, analyzing, and evaluating propulsion system and launch vehicle performance, and establishing test, integration, and verification requirements for flight and test bed propulsion systems. There is continuing interest in solid and liquid propellant combustion, performance prediction, engine risk management, launch and space vehicle propellant and pressurization systems, hybrid (solid/liquid) boosters, pressure fed boosters, laser propulsion, and advanced engine control and monitoring subsystems. Special emphasis areas for research are zero- and low-gravity propellant systems and combustion.
Contact: J. Redus (205) 544-7051
G. Platt (205) 544-7106

Component Development Division
Activities involve research and development for mechanical subsystems such as propulsion feedlines, turbomachinery, combustion devices, thrust vector control, auxiliary propulsion, valves, actuators, controls, mechanisms, and environmental control and life-support hardware. Another area of interest is establishing test, integration, and verification requirements for mechanical elements.
Contact: C.S. Cornelius (205) 544-7130

Combustion Devices and Turbomachinery
Investigation of the combustion stability, along with performance and heat

transfer, of large hydrocarbon-fueled rocket engines are of special interest for the development of a new booster engine. Techniques for understanding the failure and wear modes and improving the life of propellant cooled antifriction bearings are needed for reusable rocket engines.
Contact: L. Gross (205) 544-7067

Control Mechanisms
Facilities exist that give unique high-flow/high-pressure hydraulic test capability combined with dynamic load simulators for testing a wide range of electrohydraulic servoactuators and fluid power subsystems. Opportunities exist for research in the design and development of fluid power systems for thrust vector control of rocket engines.
Contact: V.P. Neiland (205) 544-7143

Test Division
Activities include experimental research and development testing of propulsion systems, subsystems, and components for space systems hardware. Current specific areas of interest relate to automated test control systems. A continuing interest exists for new and advanced instrumentation techniques.
Contact: R.C Shaw (205) 544-1244
C.L. Robinson (205) 544-1169

Space Science Laboratory

Magnetospheric and Plasma Physics
Research is centered around study of plasma processes in the Earth's magnetosphere. Particular emphasis is placed on the characteristics of the low-energy thermal plasma of the plasmasphere and ionosphere, medium-energy plasma responsible for auroral phenomena, interactions between these plasma populations, and resulting effects on the upper atmosphere. Activities include design, development, and calibration of flight instrumentation and analysis and interpretation of resulting data.
Contact: T. Moore (205) 544-7633

Aeronomy
Research in this area is aimed at understanding the Earth's middle and upper atmosphere. Experimental programs are underway featuring remote sensing in the vacuum ultraviolet, visible and near-infrared, including instrumentation on Shuttle, satellites, stratospheric balloons, and ground sites. An important aspect is development of advanced optical and focal plane detection systems for exploring the physics and chemistry of this region from space platforms.
Contact: M. Torr (205) 544-7676

Solar Physics
The influence of the magnetic field on the development and evolution of solar atmospheric structure is studied. The primary data are vector magnetograms obtained at Marshall's Solar Observatory. These observations are complemented by theoretical studies to characterize the non-potential properties of these fields. This includes the development of MHD (magnetohydrodynamic) codes designed to simulate both coronal and large scale interplanetary dynamics. Instrument development programs in optical polarimetry, grazing and normal incidence x-ray optics, and imaging detectors are being pursued.
Contact: J. Davis (205) 544-7600

X-Ray Astronomy
Theoretical and experimental research is conducted in the fields of X-ray astronomy and high-energy astrophysics. Specialities include study of neutron stars, active galactic nuclei, and imaging X-ray detectors operating from 1/4 keV to 100 keV. Opportunities include participating in balloon flights of these detectors theoretical studies of physical processes near compact objects, and analysis of data from the Einstein

(HEAO2) and EXOSAT satellites.
Contact: M. Weisskopf (205) 544-7740

Gamma Ray Astronomy
Gamma ray astronomy is performed with balloon-borne and orbiting instruments designed and developed at MSFC. The research includes experiments covering the 30keV to 10 MeV region to study gamma ray bursts and other transient sources, and to study the gamma ray continua from known sources. Present activities include the development of the Burst and Transient Source Experiment to fly on the Gamma Ray Observatory, and balloon-borne observations of SN 1987A and the galactic center region with a high resolution detector system. A study of the local gamma ray background in the atmosphere and on spacecraft is in progress with calculations and with measurements on Spacelab, LDEF, and other spacecraft. Laboratory studies of future detector systems for gamma-ray astronomy are in progress
Contact: G. Fishman (205) 544-7691

Cosmic Ray Research
Cosmic ray research emphasizes the study of the chemical composition and energy spectra of cosmic ray nuclei above 500 billion electron volts. Study of the interactions of heavy cosmic ray nuclei is also carried out above this energy to determine the differences between nucleon and nucleus interactions at very high energies and to search for evidence of new states of nuclear matter (e.g., chiral symmetry restored state). The research is carried out principally with emulsion chambers, occasionally in tandem with electronic counters to select categories of events. The instruments are exposed on balloons at about 4100 m (125,000 feet) for up to 2 weeks. Research includes laboratory work with passive and electronics detectors, data analysis, particle cascade calculations, and correlative accelerator experiments.
Contact: T. Parnell (205) 544-7690

Infrared Astronomy
Astronomical research is carried out in close coordination with the development of IR sensors. The sensors, which span the spectral region between 1 and 30 micrometers are used at major telescopes to produce unique images of comets and regions of star formation in our own and other galaxies. These data provide clues to cometary structure, origin, and long-term evolution.
Contact: C. Telesco (205) 544-7723

Cryogenic Physics
Experimental and theoretical research is conducted on cooled sensors for advanced space science experiments and cooling systems to support the sensors. Stored cryogens and their containment systems are developed, as well as active refrigeration systems extending both to sub-Kelvin temperatures needed by infrared bolometers and conventional superconducting electronic devices, and to higher operating temperatures required by high critical temperature superconducting electronic devices. Sensor research includes conventional and superconducting infrared detectors and arrays for cometary and galactic astronomical observations, and superconducting devices such as cooled gyroscopes, electronic devices, and sensitive accelerometers, in support of gravitational physics program. Well-equipped laboratories exist to suppo research on improved superconducting materials and sensors.
Contact: E. Urban (205) 544-7721

Low-Gravity Science
Theoretical and experimental research is conducted on the effects of gravity on the crystal growth or solidification of materials including semiconductors, metals, alloys, proteins, polymers, model systems, etc. Both the preparation and the characterization of materials are important. The areas of research include

solid-state physics, surface physics, solidification phenomena, separation techniques, fluid modeling, analysis of crystal growth, and characterization techniques such as optical, X-ray, and electron microscopy. In addition to well equipped laboratories for these activities, the division operates a drop tube and drop tower each 100 m high.
Contact: F. Szofran (205) 544-7777

Biophysics
An opportunity exists to conduct research in the separation and purification of biological cells and proteins to develop basic understanding of the separation phenomenon. The proposed research should include analysis of the fundamental behavior of a separation process by theoretical and/or experimental methods. A second activity involves laboratory and space experiments in protein crystal growth. High quality single crystals are required to obtain the three-dimensional structure of the proteins, and Shuttle space experiments confirm the advantages of the microgravity environment. Projects include experiments to define improved crystallization conditions and the analysis of crystals by X-ray diffraction.
Contact: R. Snyder (205) 544-7805

Structures and Dynamics Laboratory

Pointing Control Systems — Anticipated tasks include pointing systems with performance in the order of one milli-arcsecond, the ability to actively control structures with several structural modes below the control frequency, the use of fiducial light systems and unobtrusive sensors/effectors to stabilize large space structures, development of the theory of many control systems working on the same flexible structure, the modeling, controlling, and verification of flexible multibodies that can undergo configuration changes, and momentum exchange control of very large objects.
Contact: H. Waites (205) 544-1441

Controls for Vehicles — Automatic or remote piloted precision recovery of objects from earth orbit, control system development for dynamic objects connected by low-tension tethers, control of aero-assisted tugs, and remote piloted controls for docking with uncooperative, dynamics objects are being investigated.
Contact: N. D. Hendix (205) 544-1451

Liquid Propulsion Dynamic Analysis — Tasks include dynamic analysis, determination of damping methods, analysis of bearings, and dynamic balancing of high speed turbomachinery. Topics of interest in control include rapid recognition of engine failure, detecting incipient failure, automatic reconfiguration of control components, and more accurate means to control propellant mixture ratio.
Contact: P. Vallely (205) 544-1440

Structural Dynamics — Activities of interest are aerostructural modeling, vibration analysis, and load predictions using simulation of all environments, including propulsion, control, aerodynamics and atmosphere. Probabilistic, as well as deterministic, approaches are used on the CRAY to simulate flight and obtain loads data. Enhanced dynamic analysis techniques are pursued.
Contact: W. Holland (205) 544-1495

Structural Assessment — Opportunities exist for research in stress modeling and analysis, fracture mechanics, stability, and fatigue analysis. The CRAY computer is available for analytical analysis in conjunction with CAD/CAM work stations. Structural testing capability is extensive and can be used for

research and development activities.
Contact: C. J. Bianca (205) 544-7182

Vibroacoustics — Mechanically and acoustically induced random vibration design and test criteria and response loads analytically derived using advanced computer techniques. Vibration, acoustic, and transient data from engine static firing and Space Shuttle flights are analyzed and categorized. Research opportunities include improved vibroacoustic environment prediction methods and high frequency vibration data reduction techniques.
Contact: H.J. Bandgren (205) 544-5714

Structural Design — Evaluation, concept selection, and design of composite intertank structure for reusable Heavy Lift Launch Vehicles. Plans are currently in place to fabricate and test subscale models of the resulting structure. Plans are being developed to initiate a similar program for the evaluation, selection, fabrication, and test of both reusable and expendable cryogenic tankage. A significant technology program in the area of spacecraft meteoroid and debris protection is underway. This problem area is of particular concern for large area, long-term on-orbit spacecraft systems such as space station, in a gradually increasing debris environment. As part of NASA's Pathfinder program, we are currently performing concept evaluation, design, and functional testing of heavily loaded joints for on-orbit assembly of large space structures and Lunar/Mars mission vehicles. The challenge is to design joints that can be assembled with minimum or no Extra-Vehicular Activity (EVA).
Contact: P.I. Rodriguez (205) 544-7006

Thermal Analysis: Liquid Propulsion Systems — Opportunities for research exist in thermal analysis of liquid propulsion system components, including integrated thermal/structural analysis of turbine blades and fluid/thermal modeling of bearing systems in high-pressure turbomachinery. Analytical results may be correlated to ground test data.
Contact: J. Owen (205) 544-7213

Thermal Analysis: Solid Rocket Motor — Opportunities are available for research in thermal modeling and analysis of solid rocket motor thermal protection systems. Specific areas include the modeling of ablation processes involving a variety of material surfaces and the determination of heat transfer coefficients in radiative, erosive, and chemically reactive environments.
Contact: K. McCoy (205) 544-7211

Thermal/Environmental Computational Analysis — Research opportunities are available in advanced thermal modeling and analysis techniques based on state-of-the-art graphics systems and software. Research is needed in methods of 3-D graphic modeling of thermal systems which are compatible with computational fluid dynamics and stress modeling.
Contact: J. Sims (205) 544-7212

Closed Loop Life Support — Development of innovative, efficient, and reliable techniques for performing environmental control and life support for future long-duration missions is underway. Emphasis is on improved processes for oxygen and water reclamation. Also of interest is long-life sensing of internal atmosphere state conditions, as well as monitoring of water and air quality conditions from physical, chemical, and microbial viewpoints.
Contact: W. Humphries (205) 544-7228

Computational Fluid Dynamics — Opportunities to develop and apply state-of-the-art computational fluid dynamic (CFD) methods to solve three-dimensional highly turbulent flows for compressible and incompressible fluid states; and to provide benchmark CFD Comparisons to establish code quality

for subsequent application. Research is needed to assess significant aspects of the computational algorithms, grid generation, numerical problem formulation, code efficiency, convergence rate, stability, etc.
Contact: L. Schutzenhofer
(205) 544-1458

Earth Sciences

Measurement and Modeling — Efforts to enhance understanding of the dynamical behavior of the Earth's atmosphere are underway. These activities include supporting basic studies in global and meso-scale atmospheric processes and storm physics. Earth-based aircraft and satellite meteorological observation systems are in various stages of design and application. Laboratory and space experiments are also in progress to supplement theoretical and numerical calculations. Long range activities include planning for satellite based observational systems for measurements of lightning, winds, and precipitation.
Contact: F. Leslie (205) 544-1633

Fluid Dynamics — Analytical, computational, and experimental activities are aimed at understanding and predicting the fluid dynamical behavior of a range of systems. Areas of application include geophysical fluid dynamics, low-gravity fluid dynamics, and turbulent curved and rotational internal flow processes in rocket engines.
Contact: F. Leslie (205) 544-1633

Systems Analysis and Integration Laboratory

Space Station Workstations — High-performance computer workstations utilized to visualize and understand both Space Station subsystem performance and experiment control. Development of innovative concepts focuses on utilizing Space Station breadboards and subsystem simulators to further the technology in the workstation area.
Contact: M. Boyd (205) 544-2472

Hubble Space Telescope (HST) System Design — Opportunities exist to perform failure modes effect analyses, as well as hazard analyses, on all HST equipment. Another activity will be support of the orbital verification simulations for the HST.
Contact: J. Laux (205) 544-2418

Payloads — Systems engineers coordinate activities of NASA and contractor engineers in about 35 technical disciplines to arrive at an integrated design for payloads to fly on Spacelab, Space Station, and other carrier missions. Payloads include experiments in virtually all areas of science, from life sciences to material processing. Current missions include Spacelab J (a joint U.S./Japan payload, focusing on materials science and life sciences), ATLAS (earth observation), and ASTRO (ultraviolet astronomy).
Contact: M. Slayden (205) 544-2391

Space Shuttle Systems — Systems engineering support is provided in numerous areas related to Space Shuttle operations, including development of Reflight Flight Test Requirements, establishing requirements for Development Flight Instrumentation and Operational Instrumentation, identifying Lightning Protection/EMC requirements, technical evaluation of new designs for Solid Rocket Motors, development of Launch Commit Criteria and Flight Rules and Evaluation of flight performance and anomalies. Focus is on the following elements of the Shuttle: the Space Shuttle Main Engines, Solid Rocket Motors, and the External Tank. Ground test activities include the development of test requirements and evaluation of test data.
Contact: P. Hoag (205) 544-2361

Knowledge-Based Systems — Efforts have been initiated to enhance present systems engineering methods by developing applications of knowledge-based systems. A major project has been initiated in support of the Hubble Space Telescope that which is aimed at constructing a very large knowledge base captures not only the design and operation of the HST, but also the expertise used to arrive at the present design and operational plan. Knowledge-based systems utilizing this expertise will be constructed to support both Orbital Verification testing of the HST at launch and its long-term operation on-orbit. The primary goal, however, is to capture the design and engineering expertise built up in HST development and make it directly available to other major NASA projects such as AXAF and Space Station. The implementation of multiuser knowledge based systems is also being investigated to support design activities in the Spacelab and Space Station payload domains.
Contact: M. Freeman (205) 544-5456

Hubble Space Telescope System Requirements — Final technical issues concerning design and operation of the HST are being resolved. A facility composed of hardware and special monitoring and analysis software is being developed to support the launch and initial operation to the HST directly. Another activity in this area is completion of the technical requirements for Advanced X-Ray Astrophysics Facility (AXAF).
Contact: J. Loose (205) 544-2422

Configuration Management — Configuration management is an essential component of any successful engineering activity. Marshall projects tend to be both large and complex, requiring the efforts of teams of both NASA and contractor engineers. The level of control required by manned space flight makes configuration management a critical activity. Automated tools and methods are necessary to support this activity in a timely manner, and improved approaches are continually sought.
Contact: G. Thrower (205) 544-2375

Test Laboratory

Structural and Dynamic Testing
Structural and dynamic testing of aerospace systems and components is ongoing. Development, acceptance, and qualification testing is performed in the disciplines of structural strength and dynamics, including modal, vibration, shock, acoustics, functional, and load. Control dynamics of large structures is also investigated, and various active and passive damping techniques are developed and tested.
Contact: N. Fama (205) 544-1103
C. Kirby (205) 544-1119

Systems and Components Test and Simulation
Opportunities exist for the development, qualification, integration, and flight acceptance testing of space vehicles, payloads, and experiments. Neutral buoyancy simulations for training and development of Extra-Vehicular Activity (EVA) techniques are performed. Thermal vacuum testing is conducted in a variety of chambers with capabilities to 1X10-7 torr and temperature ranges from -300°F. to +400°F. Facilities exist to calibrate X-ray payloads and scientific instruments utilizing a 309-meter evacuated guide tube. Contact:
B. Dickson
(205) 544-1296
Neutral Buoyancy
R. Stephens
(205) 544-1336
Environmental Testing
C. Reily
(205) 544-1298
X-Ray Calibration

Crystal Growth in Fluid Field and Particle Dynamic Evaluation
The Fluid Experiment System (FES) was developed to study low-temperature crystal growth of triglycine sulfate solution in a low-gravity environment. Incorporated into the FES is a laser/optical system for taking holograms of crystal growth, fluid density, and temperature variations. Tasks include applying holographic and digitized image techniques to evaluating these holograms.
Contact: J. Lindsay (205) 544-1301

Alloying Metals and Vapor Crystal Growth Evaluations
Current investigative activities in the General Purpose Rocket Furnace (GPRF) Test Complex include the study of the macro- and micro-structures developed in liquid phase miscibility gap materials such as Aluminum Indium; the microgravity effects on vapor transport and crystal growth properties of electronic materials (germanium selenide and mercury-cadmium-tellurium) utilizing a temperature gradient to induce the necessary vapor transport of the source material; and the dendritic growth of alloys under microgravity conditions. These studies are conducted with samples approximately 3 inches long and .75 inches in diameter which are processed in 1 3-element gradient furnace with each element controlled individually. The furnace capabilities are vacuum or inert gas environment with temperatures up to 950°C.
Contact: J. Lindsay (205) 544-1301

Safety, Reliability, Maintainability, and Quality Assurance Office

Reliability Engineering
Research and analysis are conducted to gain understanding of complex physics of failure mechanisms with the Space Shuttle Main Engine. The use of statistical models, failure mode and effects analysis, and analysis of failure and anomaly reports, as well as applicable generic data, contribute significantly toward the research efforts.
Contact: F. Safie (205) 544-5278

Quality Engineering
Research is performed in areas dealing with software quality control, nondestructive evaluation (radiography, ultrasonic, eddy current), critical process control, use and evaluation of inspection methods, and assessment of critical characteristics in inspection with respect to control of critical items.
Contact: R. Bledsoe
(205) 544-7406
R. Neuschaefer
(205) 544-7382

Systems Safety Engineering
Opportunities exist for research in the development and implementation of quantitative and qualitative techniques directed at the identification, evaluation, and control of hazards associated with complex space systems. This includes probabilistic risk assessment, fault tree analysis and applications, interactive hazard information tracking and closure systems, and the identification of conceptual approaches to establishing mission levels and requirements for various types of space missions.
Contact: J. Livingston (205) 544-0049