NASA research priorities are defined by the Mission Directorates (Aeronautics Research, Human Exploration & Operations, Science, and Space Technology), and NASA's ten Centers. Each Mission Directorate and Center covers a major area of the Agency's research and technology development efforts.

Research Priorities for the Mission Directorates

Aeronautics Research Mission Directorate (ARMD), POC: Tony Springer, tony.springer@nasa.gov

Researchers responding to the ARMD should propose research that is aligned with one or more of the ARMD programs. Proposers are directed to the following:

- ARMD Programs: http://www.aeronautics.nasa.gov/programs.htm
- The National Aeronautics and Space Administration (NASA), Headquarters, Aeronautics Research Mission Directorate (ARMD) Current Year version of the NASA Research Announcement (NRA) entitled, "Research Opportunities in Aeronautics (ROA)" has been posted on the NSPIRES web site at http://nspires.nasaprs.com (select "Solicitations" and then "Open Solicitations").

Detailed requirements, including proposal due dates are stated in appendices that address individual thrust areas. These appendices will be posted as amendments to the ROA NRA and will be published as requirements materialize throughout the year.

Human Exploration & Operations Mission Directorate (HEOMD), POC: Bradley Carpenter, bcarpenter@nasa.gov

Human Research Program

The Human Research Program (HRP) is focused on investigating and mitigating the highest risks to human health and performance in order to enable safe, reliable, and productive human space exploration. The HRP budget enables NASA to resolve health risks in order for humans to safely live and work on missions in the inner solar system. HRP conducts research, develops countermeasures, and undertakes technology development to address human health risks in space and ensure compliance with NASA's health, medical, human performance, and environmental standards.

Space Life Sciences

The Space Life Sciences, Space Biology Program has three primary goals:

- To effectively use microgravity and the other characteristics of the space environment to enhance our understanding of fundamental biological processes;
- To develop the scientific and technological foundations for a safe, productive human presence in space for extended periods and in preparation for exploration;
- To apply this knowledge and technology to improve our nation's competitiveness, education, and the quality of life on Earth.

These goals will be achieved by soliciting research using its three program elements:

- Cell and Molecular Biology and Microbial Biology - studies of the effect of gravity and the space environment on cellular, microbial and molecular processes;
- Organismal & Comparative Biology - studies and comparisons of responses of whole organisms and their systems; and

- Developmental Biology – studies of how spaceflight affects reproduction, development, maturation and aging of multi-cellular organisms, as described in NASA's Fundamental Space Biology Science Plan (PDF, 7.4 MB).

Further details about ongoing activities specific to Space Biology are available at: Space Biosciences website

Physical Science Research

The Physical Science Research Program, along with its predecessors, has conducted significant fundamental and applied research, both which have led to improved space systems and produced new products offering benefits on Earth. NASA's experiments in various disciplines of physical science reveal how physical systems respond to the near absence of gravity. They also reveal how other forces that on Earth are small compared to gravity, can dominate system behavior in space.

The Physical Science Research Program also benefits from collaborations with several of the International Space Station international partners—Europe, Russia, Japan, and Canada—and foreign governments with space programs, such as France, Germany and Italy. The scale of this research enterprise promises new possibilities in the physical sciences, some of which are already being realized both in the form of innovations for space exploration and in new ways to improve the quality of life on Earth.

Research in physical sciences spans from basic and applied research in the areas of:

- Fluid physics: two-phase flow, phase change, boiling, condensation and capillary and interfacial phenomena;
- Combustion science: spacecraft fire safety, solids, liquids and gasses, supercritical reacting fluids, and soot formation;
- Materials science: solidification in metal and alloys, crystal growth, electronic materials, glasses and ceramics;
- Complex Fluids: colloidal systems, liquid crystals, polymer flows, foams and granular flows;
- Fundamental Physics: critical point phenomena, atom interferometry and atomic clocks in space

Implementing Centers: NASA's Physical Sciences Research Program is carried out at the Glenn Research Center (GRC), Jet Propulsion Laboratory (JPL) and Marshall Space Flight Center (MSFC). Further information on physical sciences research is available at http://issresearchproject.nasa.gov/

Engineering Research

- Spacecraft: Guidance, navigation and control; thermal; electrical; structures; software; avionics; displays; high speed re-entry; modeling; power systems; interoperability/commonality; advanced spacecraft materials; crew/vehicle health monitoring; life support.
- Propulsion: Propulsion methods that will utilize materials found on the moon or Mars, “green” propellants, on-orbit propellant storage, motors, testing, fuels, manufacturing, soft landing, throttle-able propellants, high performance, and descent.
- Robotic Systems for Precursor Near Earth Asteroid (NEA) Missions: Navigation and proximity operations systems; hazard detection; techniques for interacting and anchoring with Near Earth Asteroids; methods of remote and interactive characterization of Near Earth Asteroid (NEA) environments, composition and

structural properties; robotics (specifically environmental scouting prior to human arrival and later to assist astronauts with NEA exploration); environmental analysis; radiation protection; spacecraft autonomy, enhanced methods of NEA characterization from earth-based observation.

- Robotic Systems for Lunar Precursor Missions: Precision landing and hazard avoidance hardware and software; high-bandwidth communication; in-situ resource utilization (ISRU) and prospecting; navigation systems; robotics (specifically environmental scouting prior to human arrival, and to assist astronaut with surface exploration); environmental analysis, radiation protection.
- Data and Visualization Systems for Exploration: Area focus on turning precursor mission data into meaningful engineering knowledge for system design and mission planning of lunar surface and NEAs. Visualization and data display; interactive data manipulation and sharing; mapping and data layering including coordinate transformations for irregular shaped NEAs; modeling of lighting and thermal environments; simulation of environmental interactions including proximity operations in irregular micro-G gravity fields and physical stability of weakly bound NEAs.
- Research and technology development areas in HEOMD support launch vehicles, space communications, and the International Space Station. Examples of research and technology development areas (and the associated lead NASA Center) with great potential include:

  - *Processing and Operations*
    - Crew Health and Safety Including Medical Operations (Johnson Space Center (JSC))
    - In-helmet Speech Audio Systems and Technologies (Glenn Research Center (GRC))
    - Vehicle Integration and Ground Processing (Kennedy Space Center (KSC))
    - Mission Operations (Ames Research Center (ARC))
    - Portable Life Support Systems (JSC)
    - Pressure Garments and Gloves (JSC)
    - Air Revitalization Technologies (ARC)
    - In-Space Waste Processing Technologies (JSC)
    - Cryogenic Fluids Management Systems (GRC)

  - *Space Communications and Navigation*
    - Coding, Modulation, and Compression (Goddard Spaceflight Center (GSFC))
    - Precision Spacecraft and Lunar/Planetary Surface Navigation and Tracking (GSFC)
    - Communication for Space-Based Range (GSFC)
    - Antenna Technology (Glenn Research Center (GRC))
    - Reconfigurable/Reprogrammable Communication Systems (GRC)
    - Miniaturized Digital EVA Radio (Johnson Space Center (JSC))
    - Transformational Communications Technology (GRC)
    - Long Range Optical Telecommunications (Jet Propulsion Laboratory (JPL))

- Long Range Space RF Telecommunications (JPL)
- Surface Networks and Orbit Access Links (GRC)
- Software for Space Communications Infrastructure Operations (JPL)
- TDRS transponders for launch vehicle applications that support space communication and launch services (GRC)

- *Space Transportation*
  - Optical Tracking and Image Analysis (KSC)
  - Space Transportation Propulsion System and Test Facility Requirements and Instrumentation (Stennis Space Center (SSC)
  - Automated Collection and Transfer of Launch Range Surveillance/Intrusion Data (KSC)
  - Technology tools to assess secondary payload capability with launch vehicles (KSC)
  - Spacecraft Charging/Plasma Interactions (Environment definition & arcing mitigation) (Marshall Space Flight Center (MSFC))

Science Mission Directorate (SMD), POC: Stephanie Stockman, stephanie.a.stockman@nasa.gov
Detailed information on SMD research priorities is available at the following URLs:

- NASA Science: http://science.nasa.gov
- NASA Science Plan 2010: http://science.hq.nasa.gov/strategy/ and http://science.nasa.gov/media/medialibrary/2010/08/10/2010SciencePlan.pdf.
- NASA's Plan for a Climate-Centric Architecture for Earth Observations and Applications from Space: http://science.nasa.gov/media/medialibrary/2010/07/01/Climate_Architecture_Final.pdf.
- Research Opportunities in Space and Earth Science (ROSES):
- http://nspires.nasaprs.com/external/. Select "Solicitations", "Open Solicitations", and then "Research Opportunities in Space and Earth Sciences (ROSES) – 2010".
- In addition, proposers can visit the following URLs:
- http://nasascience.nasa.gov/big-questions which summarizes the research questions across all four SMD divisions and links to their respective 2007-2016 science strategy.
- http://science.nasa.gov/researchers/sara/advisory-committees/ which provides information on a new planetary decadal survey that was released in the spring of 2011.

Space Technology Mission Directorate (STMD), POC: Joseph Grant joseph.grant-1@nasa.gov
In addition to the key areas of: 1) ISS utilization, 2) MGI, 3) Advanced Manufacturing and 4) Robotics, the Space Technology Mission Directorate (STMD) is responsible for developing crosscutting, pioneering, and transformational new technologies and capabilities, needed by the Agency to achieve its current and future missions. STMD is divided into the following nine programs, representing all levels of technology readiness (TRL) from early stage innovations to mission-ready projects:

- NASA Innovative Advanced Concepts focuses on visionary aeronautics and space system concepts. TRL Range: 1-3

- Space Technology Research Grants focus on innovative research in advanced space technology via range of university grants involving senior researchers, early career faculty and graduate students. TRL Range: 1-3
- Center Innovation Fund stimulates creativity and innovation at the NASA field centers. TRL Range: 1-3
- Centennial Challenges offers incentive prizes to stimulate innovative solutions by citizen inventors and independent teams outside of the traditional aerospace community. TRL Range: 5-9
- Small Business Innovative Research (SBIR)/Small Business Technology Transfer (STTR) engage small businesses in aerospace research and development for infusion into NASA missions and the nation's economy. TRL Range: 2-5
- Game Changing Development focuses on maturing advanced space technologies that may lead to entirely new approaches for the Agency's future space missions. TRL Range: 3-5
- Small Spacecraft Technology develops and demonstrates subsystem technologies and new mission capabilities for small spacecraft. TRL Range: 3-7
- Flight Opportunities facilitates low-cost access to suborbital environments for a broad range of innovators as a means of advancing space technology development and supporting the evolving entrepreneurial commercial space industry. TRL Range: 5-7
- Technology Demonstration Missions seeks to mature laboratory-proven technologies to flight-ready status. TRL Range: 5-7

In addition, Space Technology supports NASA's participation in the following cross-agency partnerships and National initiatives:

- The National Network for Manufacturing Innovation brings together government agencies to collaborate toward modernization of manufacturing, and supports direct investments in small businesses and training for the high-skilled manufacturing workforce. (http://manufacturing.gov/welcome.html)
- The National Nanotechnology Initiative brings government agencies together with a collective interest in understanding and controlling matter at the nanoscale, leading to a revolution in technology and industry that benefits society. (http://www.nano.gov/)
- The National Robotics Initiative brings together government agencies with interest in accelerating the development and use of robots in the United States that work beside, or cooperatively with, people and funds innovative robotics research and applications emphasizing the realization of such co-robots acting in direct support of and in a symbiotic relationship with human partners. (http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503641&org=CISE)
- Materials Genome Initiative is a multi-agency initiative designed to create a new era of policy, resources, and infrastructure that support U.S. institutions in the effort to discover, manufacture, and deploy advanced materials twice as fast, at a fraction of the cost.

Additional information about STMD programs is available at http://www.nasa.gov/directorates/spacetech/home/index.html.

By investing in high payoff, crosscutting and transformational technologies the broad space enterprise cannot tackle today, STMD matures these technologies required for NASA's future missions in science and exploration, while proving the capabilities and lowering the cost for other government agencies and commercial space activities. By pushing the boundaries of aerospace technology and seizing opportunities, investing in space technology allows NASA and our Nation to remain at the cutting edge. NASA's STMD:

- Advances technologies that are broadly applicable to multiple stakeholders
- Employs a portfolio approach to capture the entire spectrum of technology readiness
- Competitively selects research by academia, industry, NASA Centers, and other government organizations based on technical merit
- Coordinates with internal and external stakeholders and leverages the technology investments of our international, other government agency, academic and industrial partners
- Results in new inventions, new capabilities and the creation of a pipeline of innovators aimed at serving future NASA needs and National needs
- Grows the Nation's innovation economy and creates high-technology jobs

STMD programs intentionally push the boundaries of what is possible with a strong focus on innovation. No single effort is guaranteed to succeed and some will fail as novel approaches are attempted. While appropriate safety, design, and verification practices are followed, STMD programs employ a graduated technical risk tolerance approach. More resources, rigor, and greater risk avoidance apply to higher cost and higher technology readiness level (TRL) efforts, such as test articles destined for complex ground tests and/or space flight demonstrations. In all cases, a transparent, informed risk acceptance approach applies.

STMD programs described above fund projects aligned with the Agency's Space Technology Roadmaps (http://www.nasa.gov/offices/oct/home/roadmaps/index.html), which reflect the National Research Council's (NRC's) review and prioritization (http://www.nap.edu/catalog.php?record_id=13354) of these roadmaps.

NASA developed the Space Technology Roadmaps in order to facilitate the development and demonstration of space technologies that address the needs of NASA's exploration systems, earth and space science, and space operations mission areas, as well as those that contribute to critical national and commercial needs in advanced space technologies. Each of the 14 roadmaps focuses on a Technology Area (TA). The roadmaps were initially drafted by NASA and subsequently independently reviewed by the NRC. The NRC's review (link provided above) resulted in findings, recommendations, and priorities – within and across the technology areas – intended to inform NASA's space technology investments. The NRC's final report (http://www.nap.edu/catalog.php?record_id=13354) was released early in 2012.

Applicants proposing Space Technology related content are strongly encouraged to familiarize themselves with the roadmap document most closely aligned with their space technology interests. Links to the individual roadmap documents are provided below along with the NRC's top 16 priorities within their corresponding technology area:

Technology Areas	**NRC Priorities within Technology Areas**
TA01 Launch Propulsion Systems http://www.nasa.gov/pdf/500393main_TA01-ID_rev6-NRC-wTASR.pdf	
TA02 In-Space Propulsion Technologies http://www.nasa.gov/pdf/501329main_TA02-ID_rev3-NRC-wTASR.pdf	(Nuclear) Thermal Propulsion Electric Propulsion (2.2.1)
TA03 Space Power and Energy Storage http://www.nasa.gov/pdf/501328main_TA03-ID_rev7_NRC_wTASR.pdf	Solar Power Generation (Photovoltaic and Thermal) (3.1.3) Fission Power Generation (3.1.5)
TA04 Robotics, Tele-Robotics, and Autonomous Systems http://www.nasa.gov/pdf/501622main_TA04-ID_rev6b_NRC_wTASR.pdf	Extreme Terrain Mobility (4.2.1)
TA05 Communication and Navigation http://www.nasa.gov/pdf/501623main_TA05-ID_rev6_NRC_wTASR.pdf	Guidance Navigation &Control
TA06 Human Health, Life Support, and Habitation Systems http://www.nasa.gov/pdf/500436main_TA06-ID_rev6a_NRC_wTASR.pdf	Radiation Mitigation for Human Spaceflight Long-Duration Crew Health Environmental Control and Life Support Systems
TA07 Human Exploration Destination Systems http://www.nasa.gov/pdf/501327main_TA07-ID_rev7_NRC-wTASR.pdf	
TA08 Science Instruments, Observatories, and Sensor Systems http://www.nasa.gov/pdf/501624main_TA08-ID_rev5_NRC_wTASR.pdf	In-Situ Instruments and Sensors (8.3.3) Optical Systems (Instruments and Sensors) (8.1.3)High Contrast Imaging and Spectroscopy Technologies (8.2.4) Detectors and Focal Planes (8.1.1)
TA09 Entry, Descent, and Landing Systems http://www.nasa.gov/pdf/501326main_TA09-ID_rev5_NRC_wTASR.pdf	Entry Descent and Landing and TPS (see also (TA14)
TA10 Nanotechnology http://www.nasa.gov/pdf/501325main_TA10-ID_rev8_NRC-wTASR.pdf	
TA11 Modeling, Simulation, Information Technology and Processing http://www.nasa.gov/pdf/501321main_TA11-ID_rev4_NRC-wTASR.pdf	

TA12 Materials, Structures, Mechanical Systems, and Manufacturing http://www.nasa.gov/pdf/501625main_TA12-ID_rev6_NRC-wTASR.pdf	Lightweight and Multifunctional Materials and Structures
TA13 Ground and Launch Systems Processing http://www.nasa.gov/pdf/501626main_TA13-ID_rev4_NRC-wTASR.pdf	
TA14 Thermal Management Systems http://www.nasa.gov/pdf/501320main_TA14-ID_rev6a-NRC-wTASR.pdf	EDL and Thermal Protection Systems (see also TA09) Active Thermal Control of Cryogenic Systems