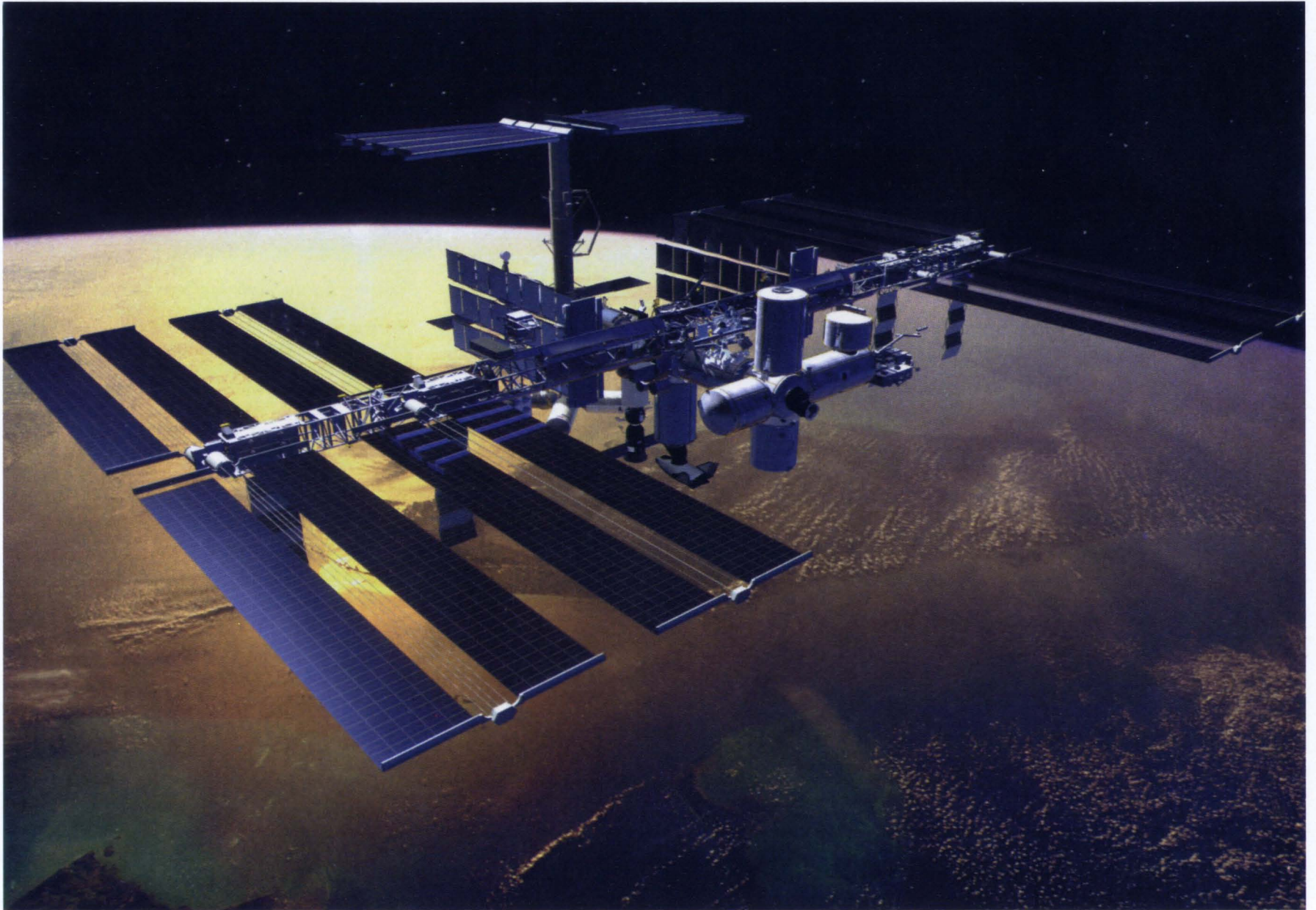




National Aeronautics and
Space Administration

Research on the International Space Station





The **International Space Station (ISS)** will provide an orbital laboratory for long-term research, where one of the fundamental forces of nature—gravity—is greatly reduced. In addition, world class research in biology, chemistry, physics, ecology, and medicine can be conducted using the most modern tools available.

Examples of the types of U.S. experiments that will be performed aboard the ISS include:

Protein crystal studies: Crystals of many proteins have better structure when grown in space rather than on Earth. Analysis of these crystals helps us better understand the nature of proteins, enzymes, and viruses, which could lead to the development of new drugs and a better understanding of the fundamental building blocks of life. Similar experiments have been conducted on the Space Shuttle, although most are limited by the short duration of Shuttle flights. The ISS experiments will lead to studies influencing possible treatments for cancer, diabetes, emphysema, and immune system disorders. This research is an example of studies in the discipline of *Biotechnology*.

Tissue culture: Living cells are grown in a laboratory environment in space where they are not distorted by gravity. NASA already has developed a *Bioreactor* device that is used to grow tissues in 3-D, more like actual tissues in the body. Growing cultures for long periods aboard the ISS will further advance this research. Cultures may be used to test new treatments for cancer without risking harm to patients. This research is also in the field of *Biotechnology*.

Life in low gravity: The effects of long-term exposure to reduced gravity on humans—weakening muscles, called atrophy; changes in workload on the heart, arteries and veins, called *reduced cardiovascular function*; and the loss of bone density; among others—will be studied aboard the ISS. Studies of these effects will lead to a better understanding of the body's systems and similar ailments on Earth. A thorough understanding of such effects and possible methods of counteracting them are needed to prepare for future long-term human exploration of the solar system. This research is

in the field of *Biomedicine*. In addition, studies of the gravitational effects on plants, animals and the function of living cells will be conducted aboard the ISS. A centrifuge, located in the *Centrifuge Accommodation Module*, will use centrifugal force to generate simulated gravitational forces ranging from almost zero to twice that of Earth. This facility can imitate Earth's gravity for comparison purposes; minimize variables in experiments; and simulate the gravity on the Moon or Mars for experiments that can provide information useful for future space travels. This research is in a field called *Gravitational Biology*.

Flames, fluids, and materials in space: Fluids, flames, and materials will be the subject of basic research on the ISS. In a microgravity environment, fluids are not subject to sedimentation and buoyancy-driven convection (gravity induced liquid motion). This environment allows the study of forces that are masked by gravity and the resulting fluid behavior. Research in this field is known as *Fluid Physics*. Flames burn differently without gravity as well. Reduced gravity reduces convection currents—the currents that cause warm air or fluid to rise and cool air or fluid to sink on Earth. This absence of convection alters the flame shape in orbit and allows studies of the combustion process that are impossible on Earth, a research field called *Combustion Science*. The absence of convection allows molten metals or other materials to be studied more thoroughly in orbit than on Earth. Scientists plan to study this field, called *Materials Science*, to create better metal alloys and control materials' properties for applications such as computer chips. The study of all of these areas—*Fluid Physics*, *Combustion Science* and *Materials Science*—may lead to developments that can enhance many industries on Earth.

The nature of matter and space: Some experiments aboard the ISS will take place on the external portions of the ISS modules. Such exterior experiments can be used to study the space environment and how long-term exposure to space, the near vacuum, the temperatures, and micrometeorites and orbital debris affect materials. This research, in the field of *technology and engineering*, can provide engineers and scientists a better under-

standing of the nature of space and enhance spacecraft design. Some scientists may also study the basic properties of matter and space, in a field called *Fundamental Physics*, through experiments which take advantage of microgravity to study forces that are weak and difficult to study when subject to gravity on Earth. Experiments in this field may help explain how many systems, from magnets to weather, function leading to better weather forecasting and stronger materials. Investigations that use lasers to cool atoms to near absolute zero may help develop a new time standard a thousand times more accurate than today's atomic clocks.

Watching Earth: Observations of Earth from orbit can help the study of large-scale, long-term changes in the environment. Studies in this field, called *Earth Science*, will increase understanding of the atmosphere, forests, oceans, and mountains. The effects of volcanoes, ancient meteorite impacts, hurricanes and typhoons can be studied. In addition, changes to Earth that are caused by the human race also can be observed. The effects of air pollution, such as smog over cities; of deforestation, the cutting and burning of forests; and of water pollution, such as oil spills, are visible from space and can be captured in images that provide a global perspective unavailable from the ground.

As part of the *Commercialization* of space research on the ISS, industries will participate in ISS research by conducting experiments and studies aimed at developing new products and services. The results may benefit those on Earth not only by providing innovative new products as a result, but also by creating new jobs to make the products.

Additional Information is available over the World Wide Web at <http://spaceflight.nasa.gov/station/science/index.html>.

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