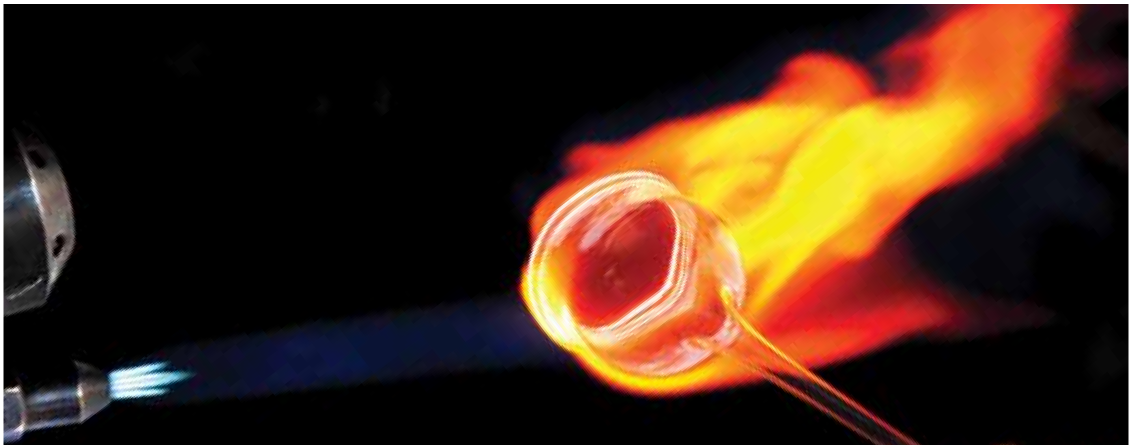
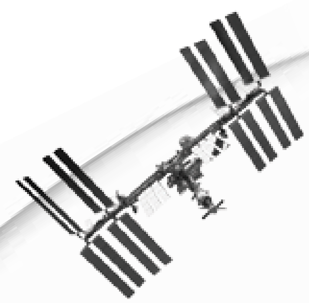
RESEARCHER'S FACT SHEET: *Physical Sciences*

Elucidate and measure processes not accessible on Earth.

Microgravity alters many observable phenomena within the physical sciences, enabling unique opportunities in basic and applied research. For example, complex fluids, soft matter and combustion processes are markedly susceptible to gravity. Other aspects of the space environment and the location of the International Space Station offer unparalleled capabilities to investigate questions regarding the fundamental laws of physics, elusive particles, plasma physics and other critical phenomena—and the capability to elucidate and measure processes with accuracy and precision not achievable on Earth.



Features of space science



Effects of microgravity:

- Loss of density- or buoyancy-driven convection.
- Absence of forces such as hydrostatic pressure gradients in fluids (and related sedimentation or buoyancy convection), affecting fluid and fundamental physics, among other phenomena.
- Surface tension gradients dominate liquid convection.
- No restoring force after interface disturbance between phases of fluid systems.
- Altered flame ignition, propagation and quenching.

Easier in space:

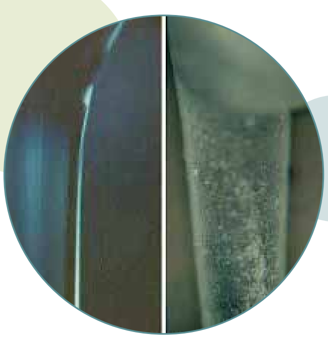
- Research on certain enigmatic particles that cannot be studied on Earth.
- Analysis of plasma crystals, which develop larger 3-D systems in weaker electric fields.
- Certain types of combustion studies (quiescent and slow-flow), some of which are near impossible on the ground.

Novel in the space environment:

- High and ultra-high vacuum, super-high-temperature synthesis (up to 3000K) and extreme temperature cycling.
- The International Space Station is the largest artificial object in Earth's plasma environment.

Exploiting space-specific phenomena

- Observe unmasked phenomena in fluid physics, interface dynamics, coarsening, particle physics, combustion, properties of molten materials, multiphase flows, cryogenics, heat transfer and the solidification process.
- Study underlying processes of pressure-driven flows, capillary flow, diffusion, viscosity, electromagnetic forces and vibration.
- Investigate the internal structure of fluids and the properties of condensed matter on a fundamental, kinetic level.
- Measure precisely the forces in fundamental physical science phenomena.
- Study magnetorheological fluids.
- Study self-assembly in colloid models.
- Apply particle physics observations to increase understanding of climatology, planetary formation and fundamental physics.
- Observe combustion patterns in a diffusion-limited system.
- Augment ground-based theoretical studies and simulations in combustion science.
- Search for antimatter, dark matter and dark energy.
- Study undercooled liquids or high-temperature supercritical fluids in ways not possible on Earth.
- Study structural details of plasma crystals (using less effort to achieve levitation) that are not apparent in ground experimentation.
- Characterize plasma perturbation by large objects.



CASIS™

CASIS™

RESEARCHER'S FACT SHEET: *Physical Sciences*

ISS photos courtesy of NASA.

Relevance & potential market applications

- Development of advanced materials, alloys and semiconductors.
- Creation of metallic alloys with fibrous or multilayer film microstructures.
- Optimization of metallurgical processes.
- Design of high-performance wicks; for example, for use in electronics cooling.
- Improvements in design of ground structures; for example, to better withstand earthquakes.
- Development of "smart materials" or active mechanical systems such as stress transducers, robotics and vibration damping systems.
- Improvement of microcapsules and other drug delivery systems.
- Production of alloys of high-strength glassy metal materials for consumer electronics applications.
- Improvements to "memory shape" technology used in consumer products.
- Improvements in fire safety and environmental impacts of combustion.
- Increased efficiency in ground use of combustion processes (including power generation and propulsion).
- Optimization and increased understanding of various aspects of combustion phenomena (e.g., flame structures, cool flames, soot formation and droplet combustion).
- Optimization of liquid–gas interface dynamics for use in energy production and food processing industries.
- Development of applications of quantum gases.

To learn more, contact CASIS: **info@iss-casis.org**

The Center for the Advancement of Science in Space (CASIS) manages the International Space Station U.S. National Laboratory, supporting space-based research that seeks to improve life on Earth. The National Lab is now open for use by the broad scientific community—and CASIS is the gateway to this powerful in-orbit research platform. For more information, visit **www.iss-casis.org**.

For information on specific experiments in space, including resulting publications and patents, scan the code to your left.