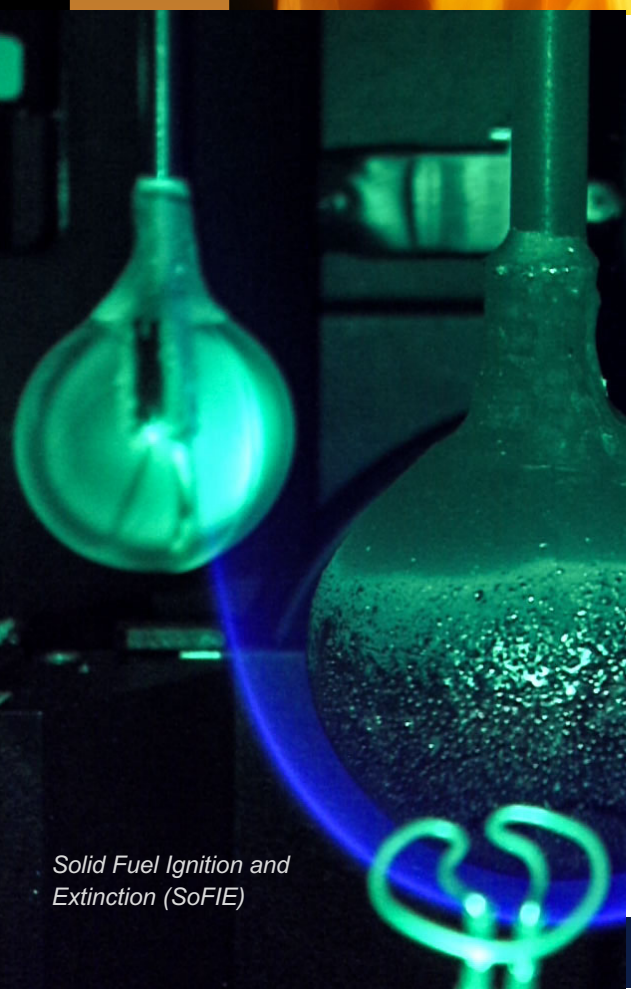
BIOLOGICAL & PHYSICAL SCIENCES

Foundations

Revealing the novel behaviors of fluids, fire, and materials in space

Phenomena familiar to us on Earth can behave very differently in space. NASA's space-based research focuses on understanding how flames, liquids, and materials respond to extreme conditions, such as radiation, varying gravities, and corrosive environments.



Solid Fuel Ignition and Extinction (SoFIE)

NASA research delivers critical insights that inform future space exploration and can improve products and technologies widely used on Earth.

ENABLING SPACE EXPLORATION:

- Fire safety, protecting crew
- Advanced thermal management systems for habitats and spacecraft
- Innovations in recycling/upcycling, sustainability on other worlds
- Space-based manufacturing and processing

BENEFITTING HUMANITY:

- Innovations in materials, new products
- Improved manufacturing processes
- More efficient engineering designs and technologies

MISSIONS ABOARD SPACE STATION INCLUDE:

- ELF (Electrostatic Levitation Furnace)
- EML (Electromagnetic Levitation laboratory)
- FBCE (Flow Boiling and Condensation Experiment)
- SoFIE (Solid Fuel Ignition and Extinction)
- ZBOT (Zero-Boil-Off Tank experiments)

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WHY NASA STUDIES PHENOMENA IN SPACE:

1. **Flammability:** Conditions in space and on other worlds can prove more volatile and pose extreme fire safety risks.
2. **Fluids:** Different gravitational environments affect how fluids flow, impacting a wide range of systems, from cooling equipment and habitats to watering plants to managing fuel transfer.
3. **Crystals and metal alloys:** Understanding how these materials form in space can lead to innovations in space-based manufacturing and repair techniques.
4. **Soft matter:** Novel materials, such as foams, gels, and emulsions, can be affected by gravity and other thermal stresses.
5. **Dusty plasma and other granular media**: Particles found in space, including dusty plasma and regolith, can affect both astronaut health and equipment; exploring how some media could be used in space crops.

MISSION HIGHLIGHTS:

ELF: Used to handle material in a containerless processing technique to reduce imperfections in high-temperature manufacturing of materials including oxides, semiconductors, insulators, and alloys which are only possible in the microgravity environment of space. Could lead to the development of containerless processing technology, benefiting manufacturers and scientists designing new materials. Partnership with JAXA.

EML: Designed to study properties of high-temperature materials and used to develop accurate models of casting, welding, and metal additive manufacturing. Research could lead to more efficient and reliable production of metallic parts for space exploration and commercial applications. Partnership with ESA.

FBCE: Enables researchers to study two-phase flow boiling and condensation. Research could support improvements to important systems on spacecraft, including thermal control systems in space vehicles and planetary habitats, heat pumps for humidity control of crew cabins and habitats, and storage and transfer of cryogenic liquid propellants.

SoFIE: Designed for use within the existing Combustion Integrated Rack (CIR) that enables researchers to study the ignition and flammability of solid spacecraft materials in a microgravity environment. Results could improve our understanding of early fire growth behavior and help determine optimal fire suppression techniques, improving crew safety in future space facilities and providing applications for Earth fire safety as well.

ZBOT: Used to study cryogenic fuel vaporization so that researchers can develop innovative fuel tank pressure control designs. Research is critical to ensure reliable storage of propellant needed to travel to deep-space destinations. Data from studies have been used by commercial space companies to improve propulsion systems.

Probing biological and physical phenomenon under extreme conditions advances the fundamental scientific knowledge required to go farther and stay longer in space, while also benefitting life on Earth.