IMAP

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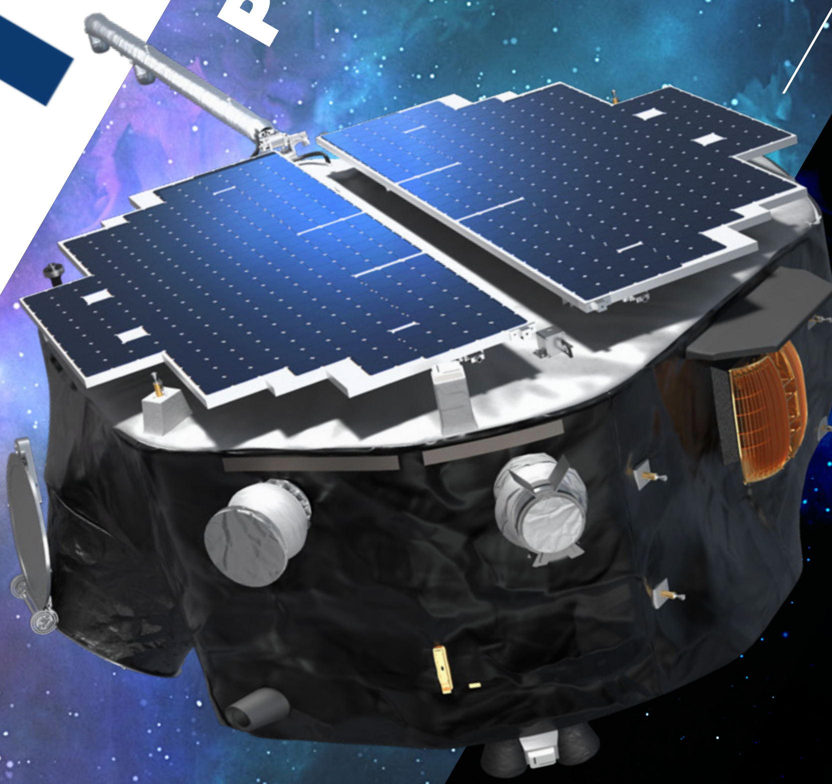

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IMAP Quick Facts

Spacecraft weight: 797 kg (1,757 pounds)

Spacecraft diameter: 8 feet (2.4 meters)

Instruments: 10

Launch: 2025

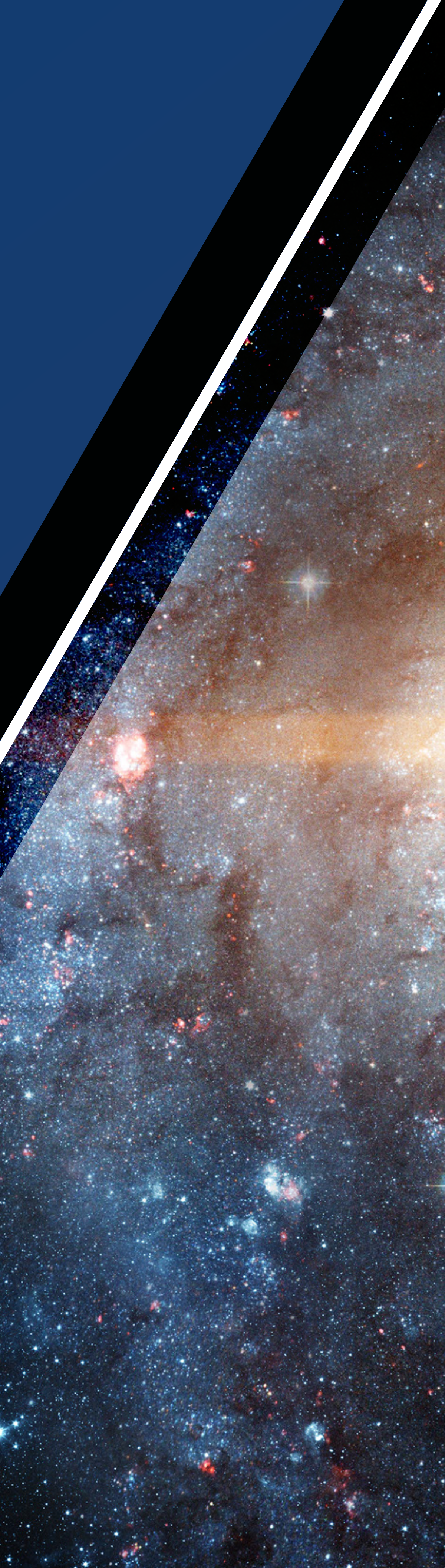
Destination: Earth–Sun Lagrange Point 1 (L1) (1 million miles from Earth toward Sun)

Length of Trip to L1: 108 days

Prime Mission Duration: 2 years

"IMAP is a remarkable mission of discovery and exploration that unlocks secrets of our heliosphere and how it protects Earth and human explorers in our solar system."

Dave McComas,
Principal Investigator,
IMAP

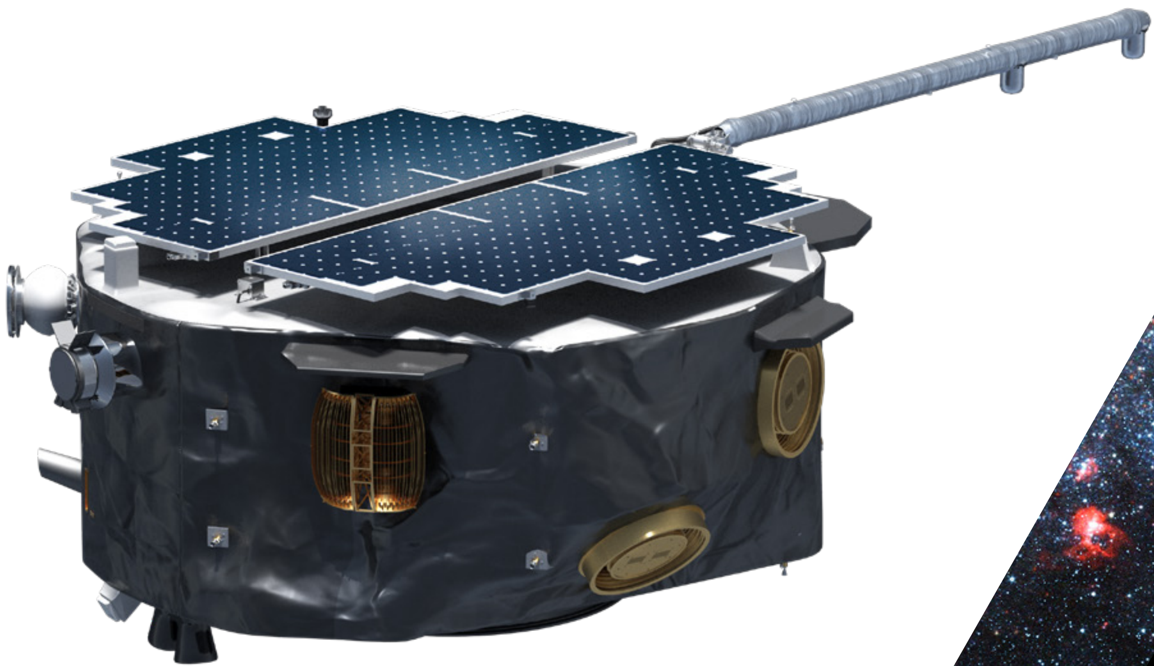


INTRODUCTION

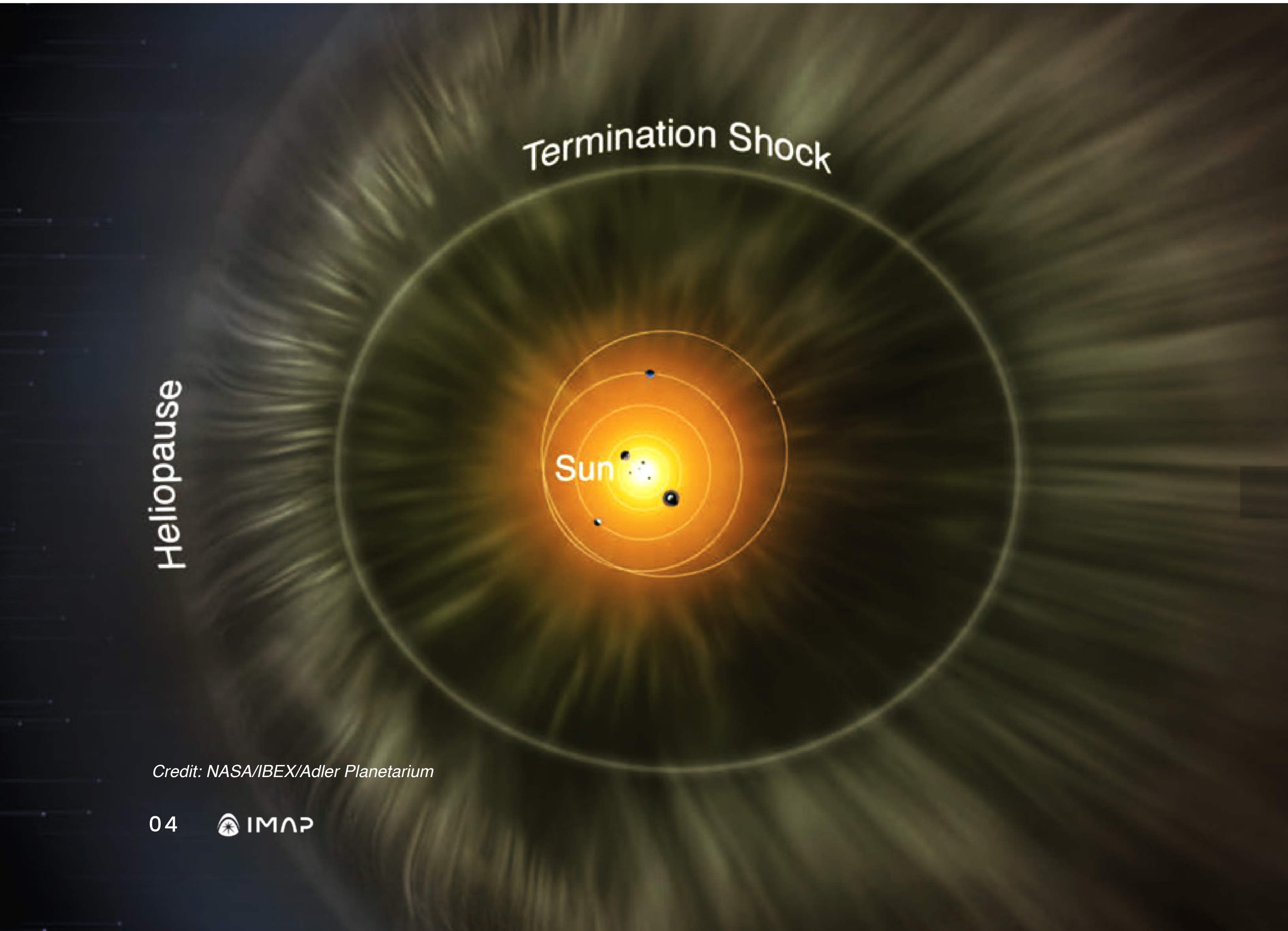
Billions of miles into space, an invisible boundary is formed around our solar system by the interaction between the continual flow of energetic particles from the Sun, known as the solar wind, and the material found between the stars — the interstellar medium. The solar wind streams outward from the Sun into space and carves out a protective bubble around our entire solar system. **This bubble is called the heliosphere.**

Launching in 2025, **NASA's Interstellar Mapping and Acceleration Probe (IMAP) will study the boundary of the heliosphere** from afar to answer several questions about how this boundary protects our solar system.

Built by an international team of 25 partner institutions, IMAP features 10 instruments that are able to capture data on energetic neutral atoms (ENAs), the solar wind, interstellar dust, and more in order to provide a map of our heliosphere. **NASA's IMAP mission collects near-real-time measurements of the solar wind, high-energy particles, and magnetic fields. Scientists can use this data to research space weather, which can harm technologies and astronauts in space.**



IMAP will focus on a region 9 billion miles (14 billion kilometers) **away from Earth,** or around 100 times the distance between Earth and the Sun.



Credit: NASA/IBEX/Adler Planetarium

What Are the **SOLAR WIND** and **THE HELIOSPHERE?**

The solar wind is a stream of charged particles emitted by the Sun that travels beyond all planets in our solar system. As the solar wind flows through space, it brings with it radiation and magnetic fields that shape the space environment around planets.

It also helps form a vast **bubble called the heliosphere that protects our planet** and others within the solar system from cosmic radiation.

The heliosphere is a definable, measurable region in space with a distinct geography of its own. The inner heliosphere is created as the solar wind blows through our solar system in all directions. The solar wind slows down and heats up as it begins to interact with the interstellar medium in a region called the termination shock.

The outermost edge, or heliopause, is formed where the solar wind is fully stopped by the interstellar medium. The edge of this boundary region starts approximately 9 billion miles (14 billion kilometers) away from Earth, or around 100 times the distance between Earth and the Sun. However, this distance from the Sun is not uniform, and the average distance varies with solar activity.

The solar wind is also not evenly distributed, and events such as solar storms are directional and create a ripple effect in the boundary encompassing our solar system. **Parts of the heliopause are 11 billion miles (18 billion kilometers) from Earth, while in other directions, the heliopause is much farther away.** IMAP will help answer fundamental scientific questions about the essential physical processes occurring in this area and its influence on our solar system's evolving space environment.

Mission **OVERVIEW**

The groundbreaking IMAP mission addresses several critical questions by studying the heliosphere boundary from afar.

The spacecraft orbits the Sun at a location 1 million miles (1.6 million kilometers) from Earth toward the Sun, called Lagrange Point 1 (L1). Positioned at L1, **IMAP can provide astronauts and spacecraft near Earth with roughly 30 minutes' warning of incoming harmful radiation**.

IMAP spins once every 15 seconds, allowing the comprehensive suite of 10 instruments to scan every part of the heliosphere. The spacecraft collects near-real-time measurements of the solar wind's high-energy particles and magnetic fields in interplanetary space and also collects, counts, and measures ENAs, which are fast-moving particles formed when charged particles from the solar wind gain or exchange electrons and become neutral, allowing them to travel without being impacted by magnetic fields.

IMAP also continually monitors space weather to protect space explorers and critical space infrastructure.

The collection of data is used to create a comprehensive map of the Sun's influence, an instrumental piece in resolving the fundamental physical processes that control our solar system's evolving space environment and in **answering the following key questions**:

- What are the properties of the local interstellar medium?
- How does the Sun's magnetic field interact with the local interstellar medium?
- How do the solar wind and interstellar medium interact at the boundary of our heliosphere?
- How do parts of the solar wind rapidly accelerate to incredible energies?

The IMAP mission's scientific goals and objectives build on a heritage of findings from past missions that have expanded our knowledge of the heliosphere and its dynamics, dating back to NASA's Voyager program that began in the 1970s. Since 2009, NASA's Interstellar Boundary Explorer (IBEX) mission has imaged the entire sky, giving us a complete global view of the heliosphere's boundary. Combined data from both Voyager and IBEX have helped scientists create a more complete model of the boundary of our solar system. New instruments aboard IMAP collect ENAs over a larger energy range and more frequently than IBEX, allowing better mapping of the heliosphere.

The groundbreaking IMAP mission addresses **SEVERAL CRITICAL** questions by studying the heliosphere boundary from afar.

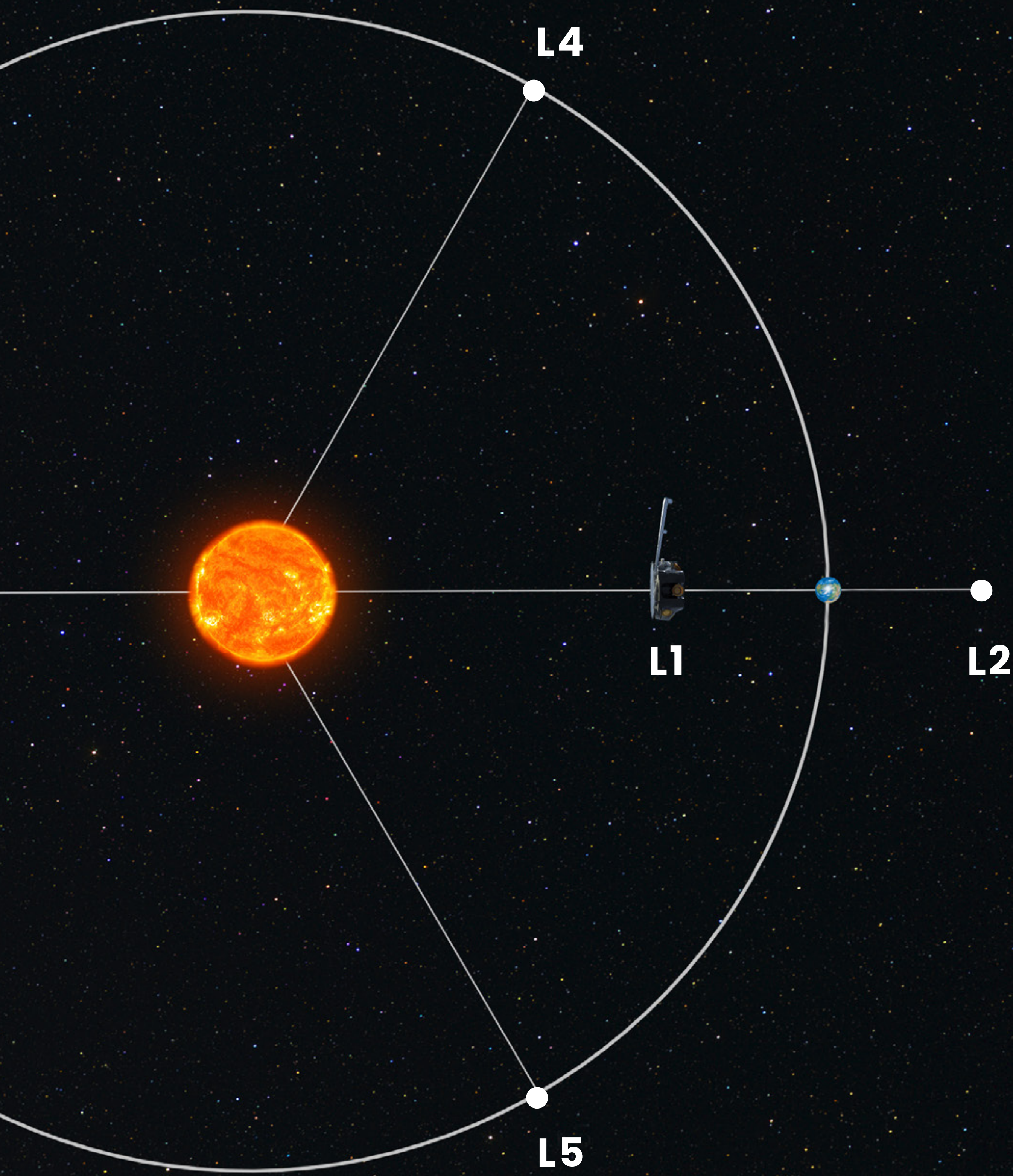
1. What are the properties of the local interstellar medium?
2. How do magnetic fields interact from the Sun through the local interstellar medium?
3. How do the solar wind and interstellar medium interact through the boundaries of our heliosphere?
4. How are particles accelerated to high energies throughout the solar system?

IMAP at L1

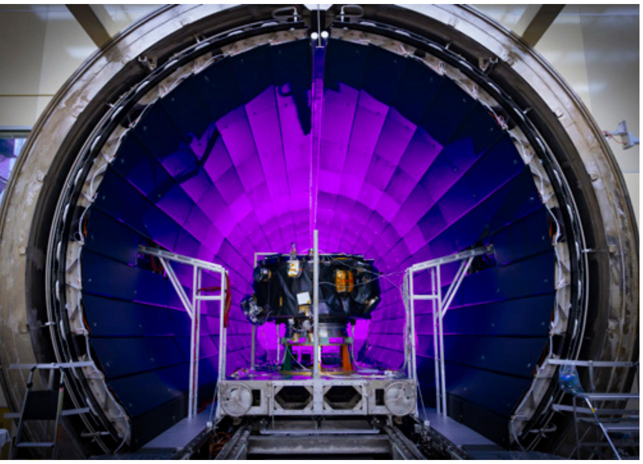
Lagrange points are positions in space where the gravitational forces of Earth and the Sun perfectly balance smaller objects like a spacecraft or satellite. There are five Lagrange points positioned at various locations in space.

IMAP will sit at Lagrange Point 1, or L1, approximately 1 million miles from Earth toward the Sun. Heliophysics missions like IMAP benefit greatly from this position because it provides an unobstructed view of solar activity.

Not to scale.


L4
L1
L2
L5

IMAP **SPACECRAFT**



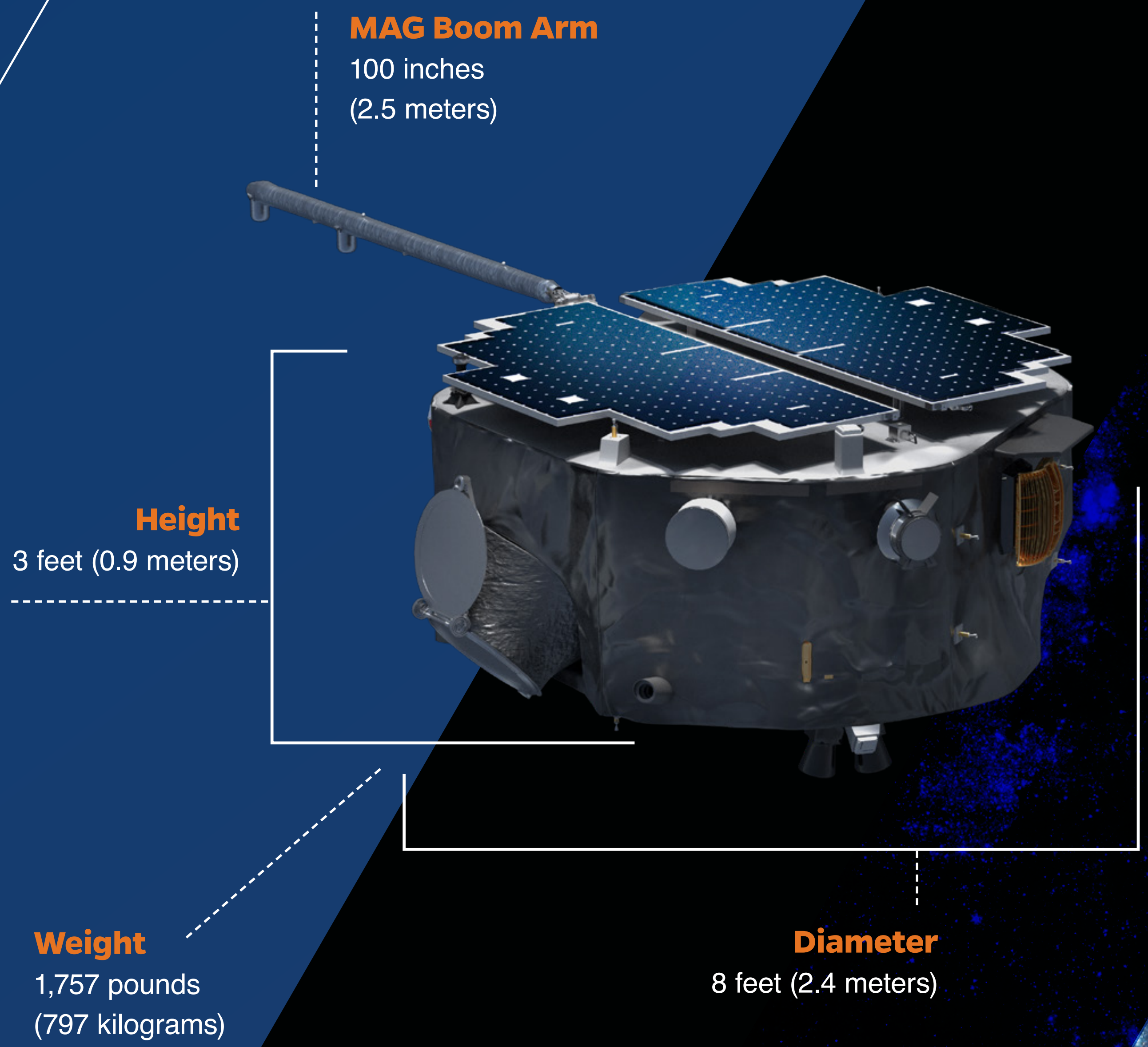
The IMAP spacecraft is shown after installation into the X-Ray and Cryogenic Facility (XRCF) chamber at Marshall Space Flight Center in Huntsville, Alabama. (Credit: NASA/Johns Hopkins APL/Princeton/Ed Whitman)

The IMAP spacecraft is about 3 feet (0.9 meters) tall and 8 feet (2.4 meters) in diameter. The spacecraft's frame is divided into **six bays that hold 12 instrument sensors**, plus one on top. The completed spacecraft, with fuel for the propulsion system, **weighs 1,757 pounds (797 kilograms)**. Careful placement of the instruments around the perimeter of the observatory, and two magnetometers on a deployable boom, allows the instruments to operate without interfering with each other.

IMAP launches on a SpaceX Falcon 9 two-stage rocket from Kennedy Space Center at Cape Canaveral, Florida. In space, IMAP's onboard propulsion system steers the spacecraft to its **final orbit about 1 million miles (1.6 million kilometers)** from Earth toward the Sun, at L1. Solar panels facing the Sun provide the power to run the instruments and other systems during the mission.

IMAP's magnetometer (MAG) is fastened to a boom arm that is folded to fit perfectly between the two sets of solar array panels on the top deck for launch. In space, the boom unfolds, extending the sensors out away from the spacecraft and any magnetic interference caused by the electrical systems.

Emory Toomey and Tyler Radomsky prepare to lift IMAP in the "yoke" fixture to the mass properties machine at the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland. (Credit: NASA/Johns Hopkins APL/Princeton/Ed Whitman)


MAG Boom Arm
100 inches
(2.5 meters)
Height
3 feet (0.9 meters)
Weight
1,757 pounds
(797 kilograms)
Diameter
8 feet (2.4 meters)

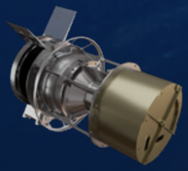
IMAP **INSTRUMENTS**

To capture the extensive data required to map our heliosphere, IMAP hosts a suite of 10 instruments that will measure ENAs, magnetic fields, cosmic dust, and ultraviolet light, and make near-real-time observations of the solar wind and its energetic particles.

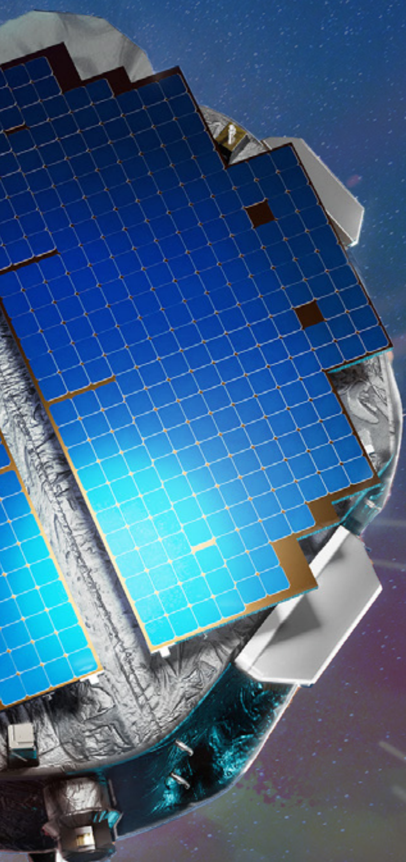
IMAP-Lo
Imager built by the University of New Hampshire (UNH) that measures and maps low-energy ENAs, particles created where the solar wind and interstellar medium meet, as well as interstellar neutral particles from beyond the solar system

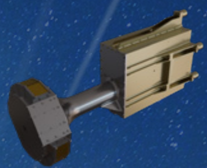
IMAP-Hi
Imager developed collaboratively by Los Alamos National Laboratory (LANL), Southwest Research Institute (SwRI), UNH, and the University of Bern in Switzerland (UBern) that measures and maps medium-range ENAs at the edge of the heliosphere

MAG
Magnetometer built by Imperial that will measure the interplanetary magnetic field that originates from the Sun



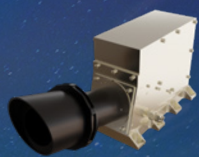
SWAPI
The Solar Wind and Pickup Ions (SWAPI) instrument built by Princeton University that measures ions from the solar wind and particles from beyond the solar system





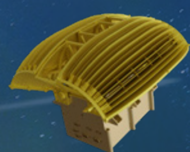
HIT

The High-energy Ion Telescope built by NASA's Goddard Space Flight Center (GSFC) that studies high-energy ions that come from the solar wind and deep space



GLOWS

The GLObal Solar Wind Structure (GLOWS) instrument built by the Space Research Center of the Polish Academy of Sciences (CBK PAN) that investigates the ultraviolet glow created by the solar wind to understand how it evolves over time



IMAP-Ultra

Imager built by APL that measures and maps ENAs at their highest range at the edge of the heliosphere

SWE

The Solar Wind Electron (SWE) instrument built by LANL that is used to measure electrons found in the solar wind

CoDICE

The Compact Dual Ion Composition Experiment (CoDICE) instrument built by SwRI that is designed to measure the mass and electric charge of ions originating from both interstellar space and the solar wind

IDEX

The Interstellar Dust Experiment (IDEX) instrument built by the Laboratory for Atmospheric and Space Physics (LASP) that measures the composition of interstellar and interplanetary dust particles

IMAP sits in the "yoke" fixture on the mass properties machine at the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland. (Credit: NASA/Johns Hopkins APL/Princeton/Ed Whitman)

GLOSSARY

Coronal mass ejections: Events during which solar material bursts away from the Sun into space and possibly toward Earth.

Energetic neutral atoms (ENAs): Fast-moving particles formed when charged particles from the solar wind gain or exchange electrons and become neutral, allowing them to travel without being impacted by magnetic fields.

Energetic particles: Charged particles (electrons, protons, and ions) that move very fast (high energy). If the particles originate at the Sun, they are known as solar energetic particles.

Helioglow: A faint ultraviolet light created when neutral hydrogen atoms from outside the solar system absorb and re-emit energy from the Sun's ultraviolet photons.

Heliopause: The outermost boundary of the heliosphere formed where the Sun's solar wind and the interstellar medium, and their associated magnetic fields, meet.

Heliosphere: The bubble-like region, inflated by the solar wind, that surrounds the solar system and shields it from interstellar radiation.

Interstellar dust: Small particles of solid matter that formed in part by supernova star events, and are the building blocks of stars and planetary systems.

Interstellar medium: The combination of gas, dust, and charged particles that fills the space between stars in a galaxy.

Lagrange point: A position in space where the gravitational forces of the Sun and Earth are balanced enough to allow a spacecraft to stay in a stable position.

Lyman-alpha: A specific wavelength of ultraviolet light emitted by hydrogen atoms.

Pickup ions (PUIs): Neutral atoms that become electrically charged when they interact with the solar wind, allowing the solar wind's magnetic field to carry them along.

Solar cycle: A cycle of activity driven by the Sun's magnetic field every 11 years.

Termination shock: The boundary marking one of the outer limits of the Sun's influence. At the termination shock, solar wind particles slow down as they begin to press into the particles forming the interstellar medium.

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Products and Events

News Releases, Features, and Status Reports

News, updates, and feature stories about the IMAP mission are available at *https://science.nasa.gov/mission/imap/*.

Video and Images

Videos, animations, images, and graphics are available in the mission website's media gallery: *https://svs.gsfc.nasa.gov/*.

Please consult *NASA's image use policy* for guidelines on use of videos, images, or other multimedia.

Additional Resources on the Web

To learn more about the IMAP mission, visit the following websites:

https://imap.princeton.edu/

https://science.nasa.gov/blogs/imap/

https://imap.princeton.edu/public-media-library

Social Media

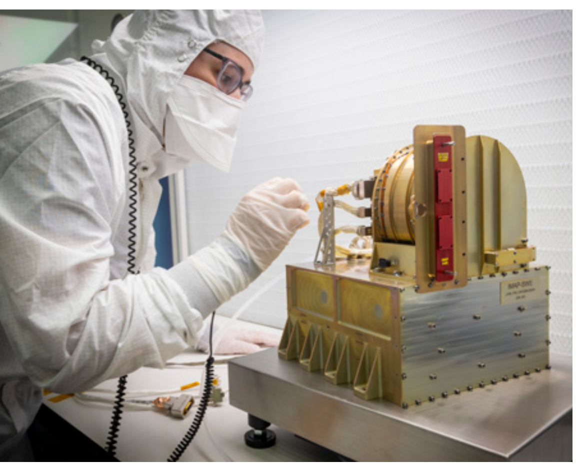
Join the conversation about IMAP by following these accounts and hashtags for the latest mission updates:

X:
@NASA, @NASASolarSystem, @Princeton, @JHUAPL

Facebook:
/NASA, /NASASolarSystem, /Princeton, /JHUAPL

Instagram:
@nasa, @princeton, @johnshopkinsapl

Tim Lippy of the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland, and Marc Miller of the Laboratory for Atmospheric and Space Physics (LASP) install the IDEX instrument to the Interstellar Mapping and Acceleration Probe. Credit: NASA/Johns Hopkins APL/Princeton/Ed Whitman



Jackie Kilheffer inspects the Solar Wind Electron (SWE) instrument before installation to the IMAP spacecraft at the Johns Hopkins Applied Physics Laboratory in Laurel, Maryland. (Credit: NASA/Johns Hopkins APL/Princeton/ Ed Whitman)

Mission MANAGEMENT

Princeton University professor David J. McComas leads the IMAP mission and an international team of 25 partner institutions. The Johns Hopkins Applied Physics Laboratory in Laurel, Maryland, is managing mission development, built the IMAP spacecraft, and is operating the mission. IMAP is the fifth mission in NASA's Solar Terrestrial Probes (STP) Program portfolio of the Heliophysics Division in NASA's Science Mission Directorate. The IMAP mission is made possible through the incredible collaborative efforts of 19 domestic partners and 6 international partners.

NASA Leads

Joe Westlake
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Nicki Rayl
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NASA Heliophysics

Brad Williams
IMAP Program Executive
NASA Heliophysics

Patrick Koehn
Program Scientist
NASA HQ IMAP

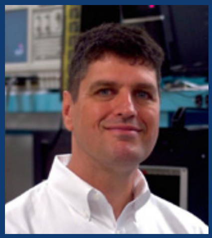
IMAP Leads

David J. McComas

McComas is the principal investigator on the IMAP mission. He is a professor of astrophysical sciences as well as participating faculty in mechanical and aerospace engineering at Princeton University. He also served as vice president of the Princeton Plasma Physics Laboratory from 2016 to 2024. His research interests span nearly all of heliophysics, including the solar corona, solar wind, terrestrial and planetary magnetospheres, interstellar PUIs, and the outer heliosphere and its interaction with the local interstellar medium.

Eric Christian

Christian is deputy principal investigator on IMAP and instrument lead for HIT. He is a senior research scientist and associate lab chief in the Heliospheric Laboratory at NASA Goddard Space Flight Center. His scientific interests are the origin of energetic particles and the design, construction, testing, and data analysis of particle detectors.



Nathan Schwadron

Schwadron is deputy principal investigator on IMAP and lead for the IMAP-Lo instrument. A visiting professor at Princeton University, he serves as a presidential chair and the Norman S. and Anna Marie Waite Professor of Physics at the University of New Hampshire. His research interests include the effects of radiation, acceleration of energetic particles and cosmic rays, and the origins of solar and stellar winds.

Matina Gkioulidou

Gkioulidou is IMAP's project scientist and a space physicist at Johns Hopkins APL. She is also a member of the European Space Agency's JUpiter ICy moons Explorer (JUICE) mission and previously worked on NASA's Van Allen Probes mission. Her scientific interests include energetic particle instrumentation and data analysis, focusing on plasma acceleration processes in planetary magnetospheres and the heliosphere's interactions with the local interstellar medium.

Kieran Hegarty

Hegarty is IMAP's project manager from Johns Hopkins APL. He previously served at NASA's Goddard Space Flight Center and has worked in the spaceflight industry since 2010.

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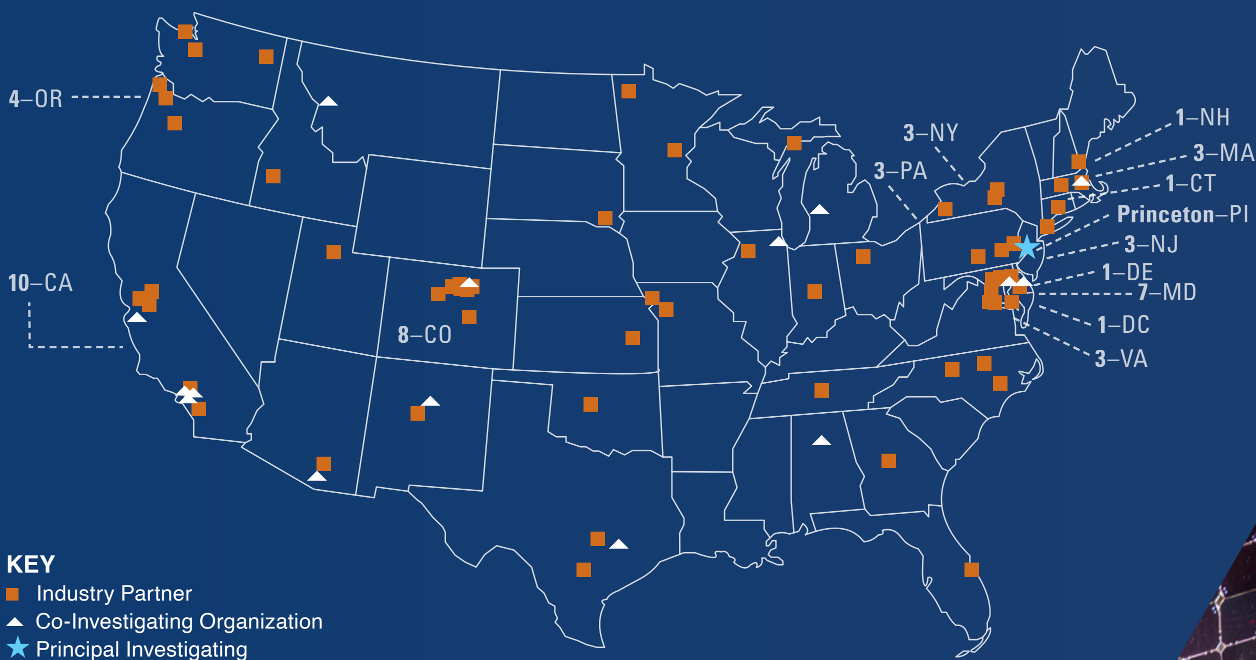
Maciej Bzowski
Instrument Lead, GLOWS
Space Research Center of the
Polish Academy of Sciences

NASA's IMAP mission, led by Princeton University and managed by the Johns Hopkins Applied Physics Laboratory, will study the heliosphere — the Sun's magnetic bubble that shields our solar system — to better understand its protective boundary and provide critical space weather monitoring.



KEY

- ■ Industry Partner
- ▲ Co-Investigating Organization
- ★ Principal Investigating Organization (PI)

35 States

82 U.S. Partners and Co-Investigating Organizations

Major U.S. industry partners include L3Harris, Moog, Northern Machining, Rocket Lab, Sierra Space Corporation, SSC Space US, Teledyne Reynolds, Vantage Systems, and Vertex Aerospace.

IMAP