

Jamie Rankin, Voyager

Heliophysics Investigations by Dr. Hilarie Davis & Christina Milotte 4/1/25



Understanding the Solar System and Beyond!

In 1964 Gary Flandro, an aerospace engineers at JPL, conceptualized a Grand Tour program to take advantage of a planetary alignment that occurs once every 175 years. This alignment would allow a spacecraft to reach all the outer planets using gravity assists. Voyager built on Mariner technology and used gravity assists to go past the heliosphere to interstellar space.

Launched in 1977, the Voyager spacecraft continue and sending back data. The data are still being analyzed and used to guide the development of other missions like IBEX and IMAP.

Framework for Heliophysics Education (FHE)

Developed by NASA HEAT in 2022

<https://science.nasa.gov/learn/heat/big-ideas/>

Structure around NASA's Big Heliophysics Questions

1. What are the impacts of the Sun on humanity?
2. How do the Earth, the solar system, and heliosphere respond to changes on the Sun?
3. What causes the Sun to vary?

FHE has Developed Big Ideas for the NASA Questions

1. What are the impacts of the Sun on humanity?

1.1 The Sun is really big and its gravity influences all objects in the solar system. (PS2, ESS1)

1.2 The Sun is active and can impact technology on Earth via space weather. (PS1, PS2, PS4, ESS2, ESS3)

1.3 The Sun's energy drives Earth's climate, but the climate is in a delicate balance and is changing due to human activity. (PS1, PS2, PS3, LS4, ESS2, ESS3)

2. How do the Earth, the solar system, and heliosphere respond to changes on the Sun?

2.1 Life on Earth has evolved with complex diversity because of our location near the Sun. It is just right! (PS3, PS4, LS1, LS2, ESS2)

2.2 The Sun defines the space around it, which is different from interstellar space. (PS2, ESS1, ESS2)

2.3 The Sun is the primary source of light in our solar system. (PS1, PS2, PS3, PS4, ESS1)

3. What causes the Sun to vary?

3.1 The Sun is made of churning plasma, causing the surface to be made of complex, tangled magnetic fields. (PS1, PS2, ESS1, ESS2)

3.2 Energy from the Sun is created in the core and travels outward through the Sun and into the heliosphere. (PS1, PS2, PS4, ESS1, ESS2, ESS3)

Voyager Connections to the Framework

NASA Heliophysics Question 1: What are the impacts of the Sun on humanity?

Big Idea 1.1 The Sun is really big and its gravity influences all objects in the solar system. (PS2, ESS1)

NASA Heliophysics Question 2: How do the Earth, the solar system, and heliosphere respond to changes on the Sun?

2.2 The Sun defines the space around it, which is different from interstellar space. (PS2, ESS1, ESS2)

Introductory Level Investigation

Launched in 1977, both Voyager spacecraft carry a unique “time capsule” –a Golden Record to communicate a story of our world to extraterrestrials. Why? Why were the specific pictures and sounds chosen? If you were going to make a recording for future or extraterrestrial beings, what would you put on it? Why?

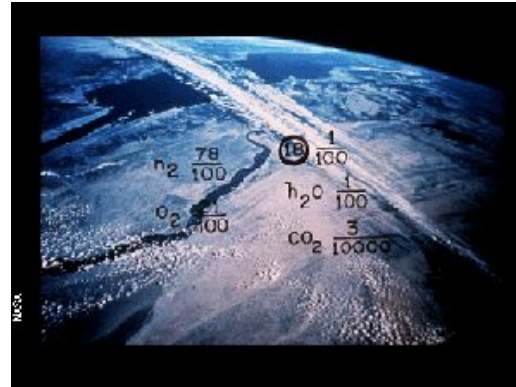


Resources

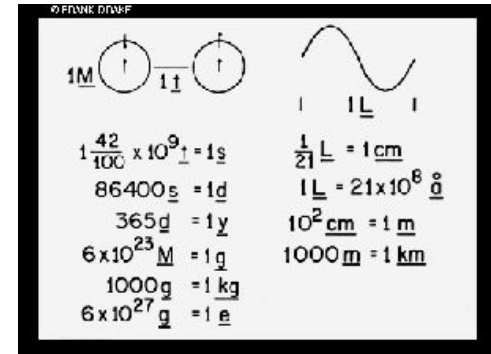
- <https://science.nasa.gov/mission/voyager/golden-record-contents/>
- <https://science.nasa.gov/mission/voyager/voyager-golden-record-overview/>
- <https://science.nasa.gov/mission/voyager/golden-record-contents/images/>



Children with globe



Egypt-Red Sea-Sinai



Physical unit definitions

Intermediate Level Investigation

IBEX and IMAP are also designed to explore interstellar space.

- How are they building on the data from Voyagers 1 and 2?
- How are their instruments different or the same?
- How are they getting all the way out to interstellar space?
- How are their travel plans different than Voyager?
- What more do they hope to learn beyond what was learned from Voyager?

<https://spacephysics.princeton.edu/missions-instruments/ibex>

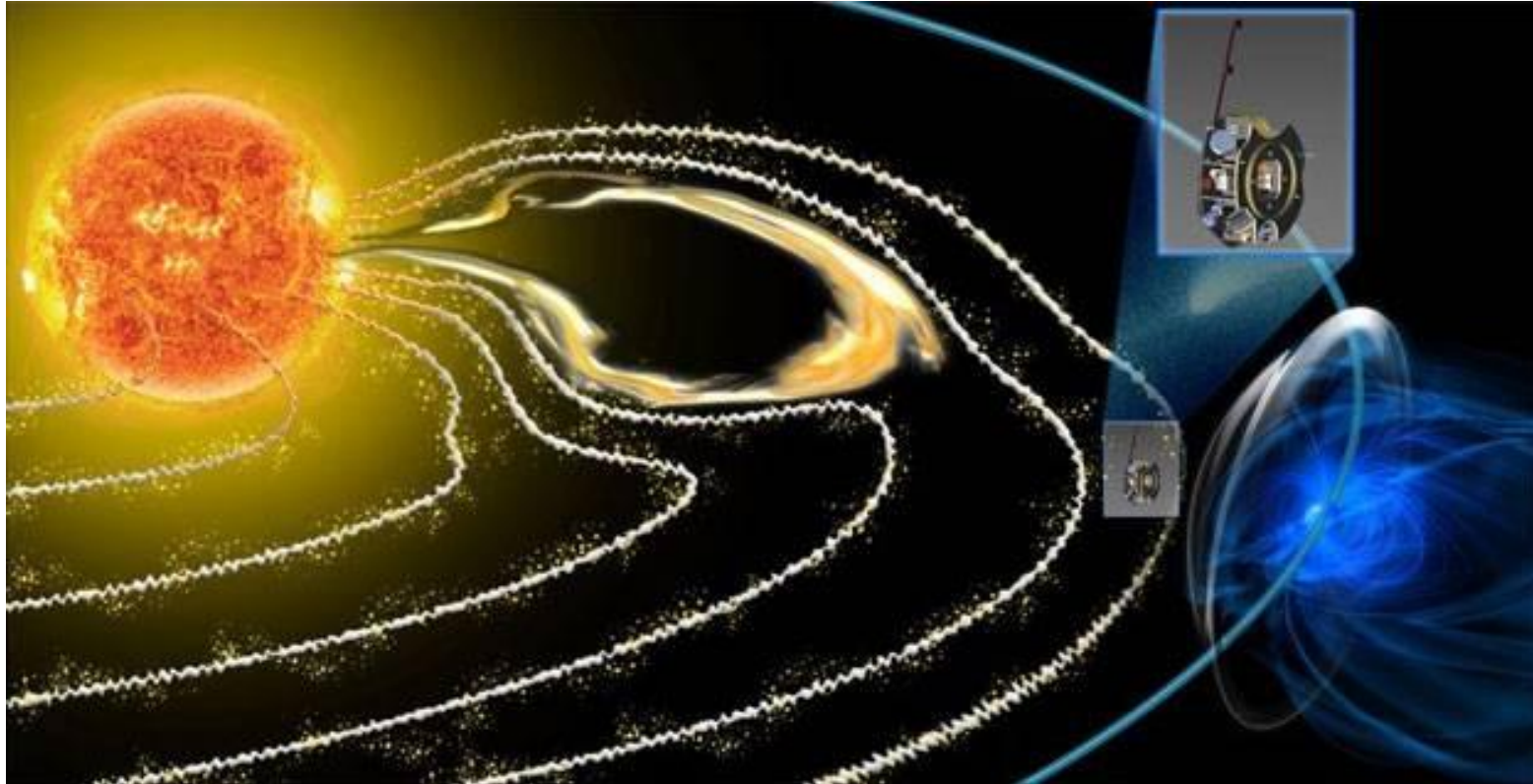
<https://imap.princeton.edu>

https://www.youtube.com/watch?v=c0-7_2Rvqec

<https://blogs.nasa.gov/imap/>

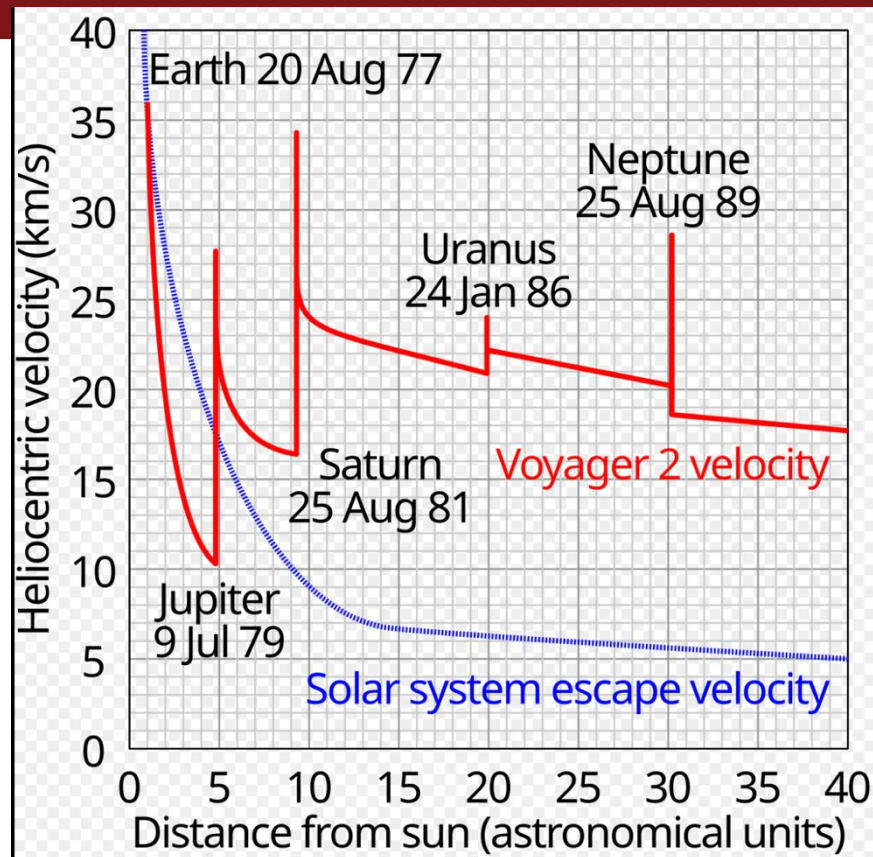
<https://www.princeton.edu/news/2018/07/18/princetons-mccomas-will-lead-imap-nasa-mission-study-heliosphere>

IMAP will orbit the sun at L1, a million miles sun-ward from Earth, where it will be outside the protective envelope of Earth's magnetic field (shown here in blue).



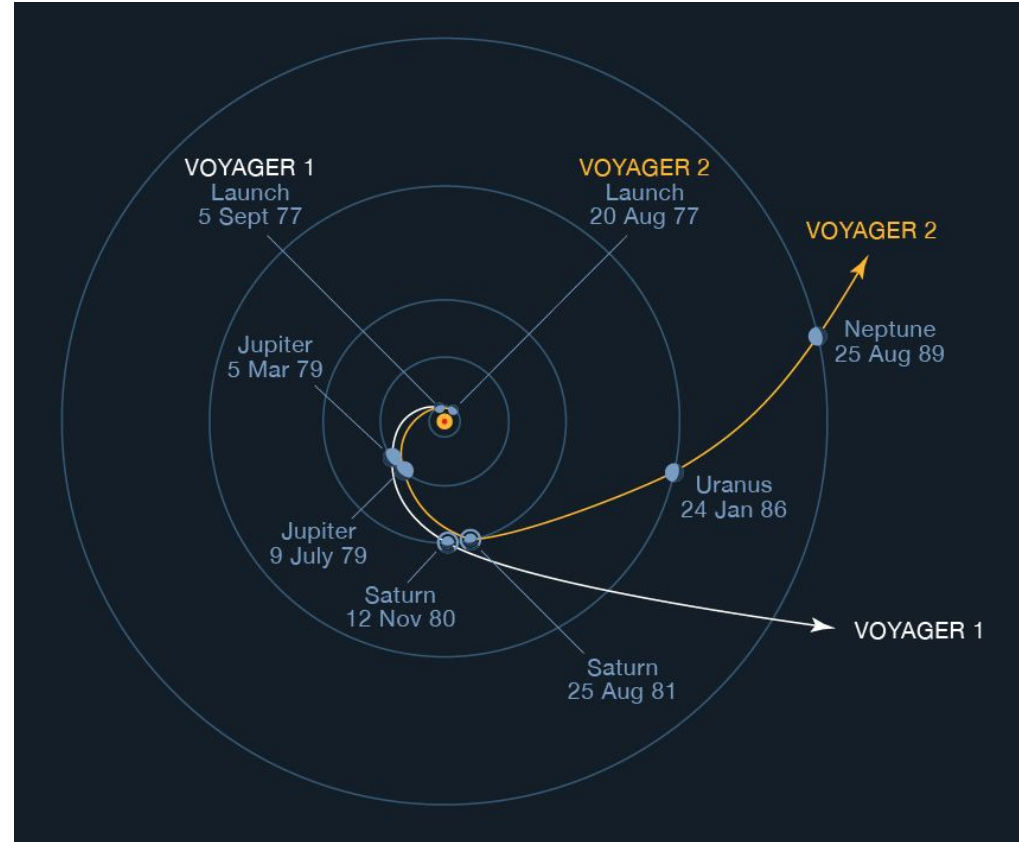
Advanced Level Investigation

How much time and energy did the gravity assists save the Voyager spacecraft?
Are they still used with spacecraft today?



Resources

- <https://science.nasa.gov/learn/basics-of-space-flight/primer/>
- <https://www.youtube.com/watch?v=5Bm9RDp07aQ> (NASA Goddard)
- <https://www.jpl.nasa.gov/edu/resources/teachable-moment/the-n-there-were-two-voyager-2-reaches-interstellar-space/>



For more information on the
Framework for Heliophysics Education

<https://science.nasa.gov/learn/heat/big-ideas/>