What's Going On?

Checking In

Minds on Hello from Earth

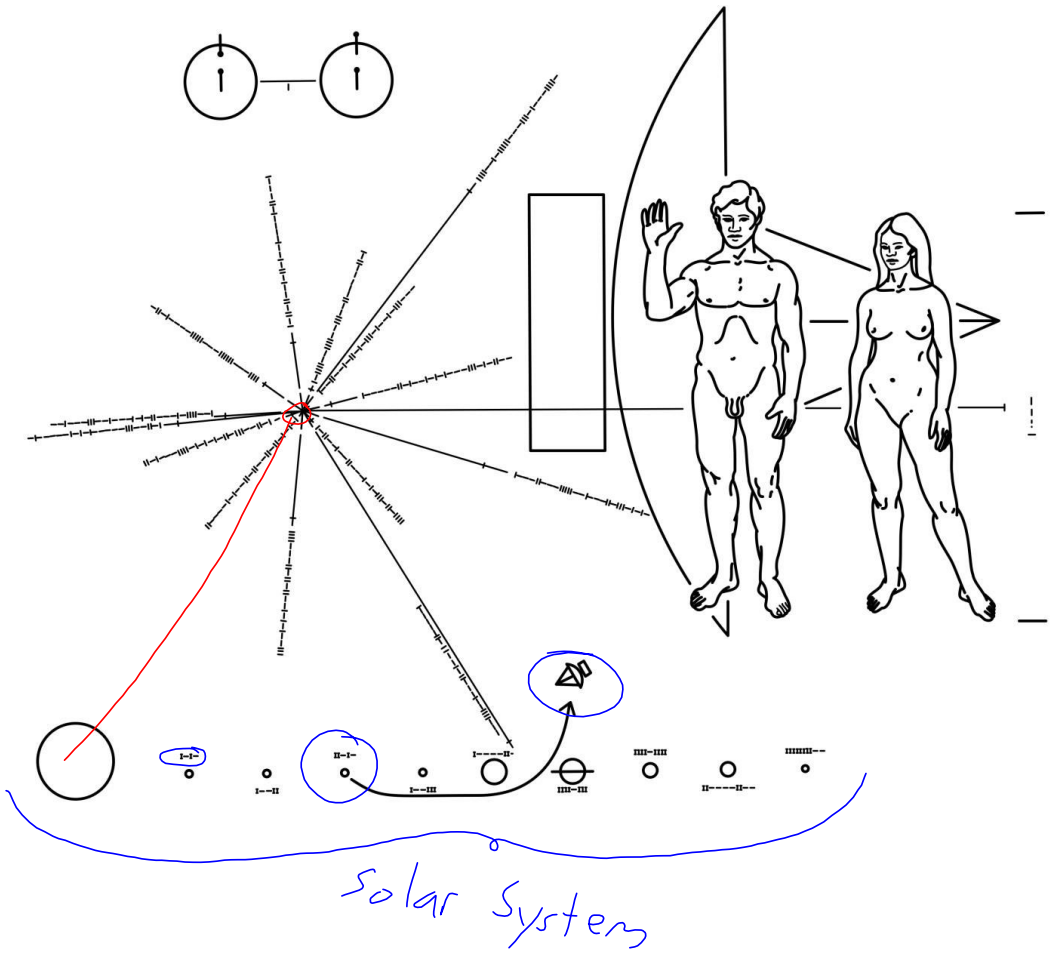
Action! The sun, the earth and the moon.

Consolidation What Do You Think Now?

Learning Goal - I will be able to describe how our understanding of the universe has changed over time.

Minds on

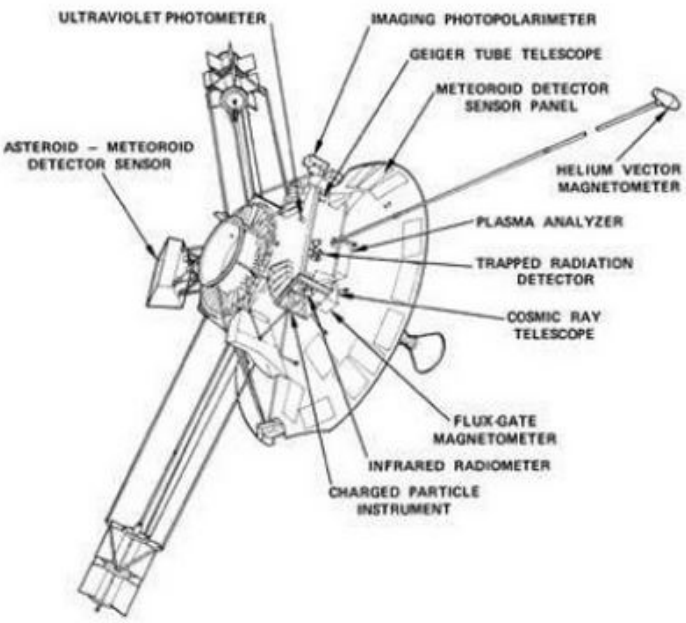
The Pioneer Plaque



With your partner, come up with an explanation for what this thing is.

History

- In 1972 NASA decided that its next spaceprobe, Pioneer 10, would have a message on it that could be read and understood by extraterrestrial life.
- Acknowledging the fact that these lifeforms probably wouldn't speak any earth-based languages, and would have a radically different culture, this became a challenge in universal design.



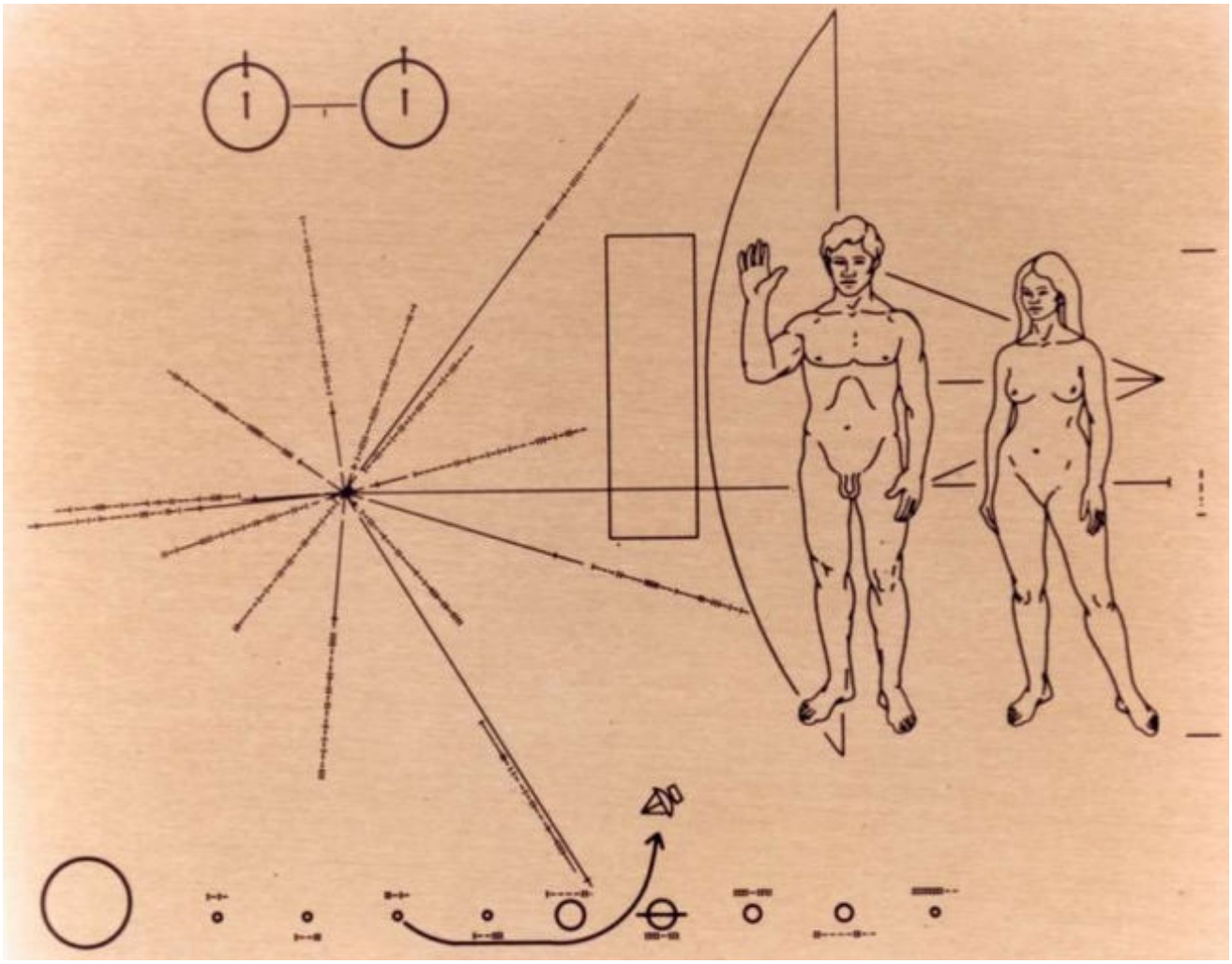
Designers

- Noted American astronomers, Carl Sagan and Frank Drake, were approached to design this message, and with the help of Sagan's then-wife Linda Salzman Sagan (who did the artwork) they designed a plaque.

Carl Sagan

Linda Salzman Sagan

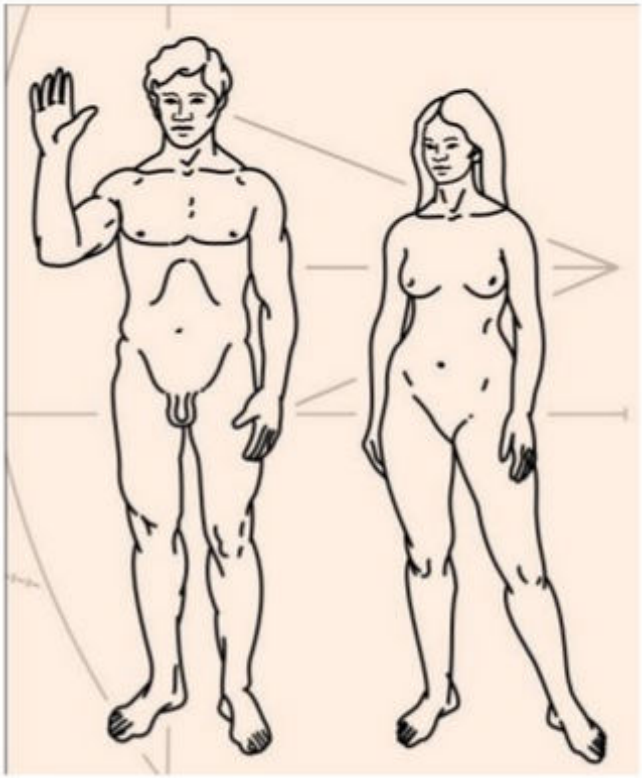
Frank Drake



If you aren't completely clear as to what it all means, don't worry, most of the NASA scientists were a bit confused as well.

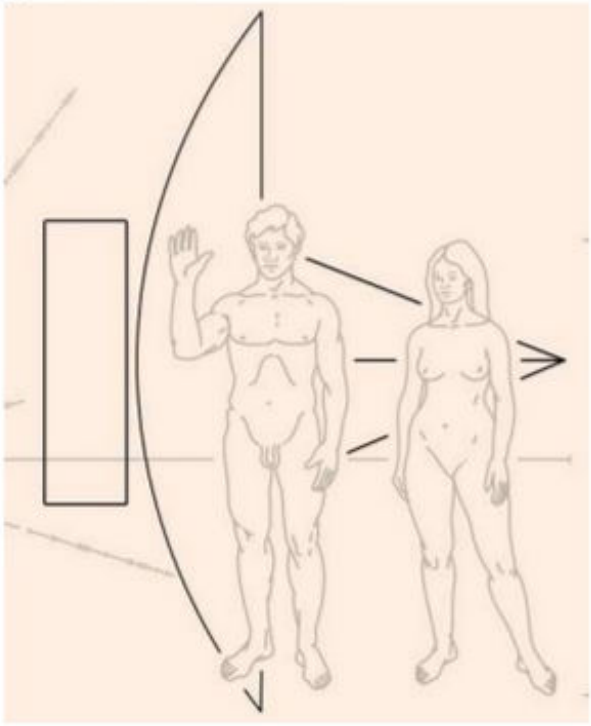
The Human Figures

- Originally Sagan intended for the humans to be holding hands, but soon realized that an extraterrestrial might perceive the figure as a single creature rather than two organisms.
- The right hand of the man is raised as a way to show the opposable thumb and how the limbs can be moved.



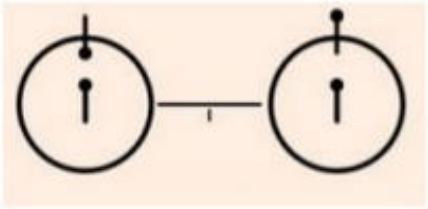
The Pioneer Spacecraft

- Behind the humans stands the silhouette of the Pioneer spacecraft itself.
- It is shown on the same scale as the humans so that the size of the human beings can be deduced by measuring the spacecraft.



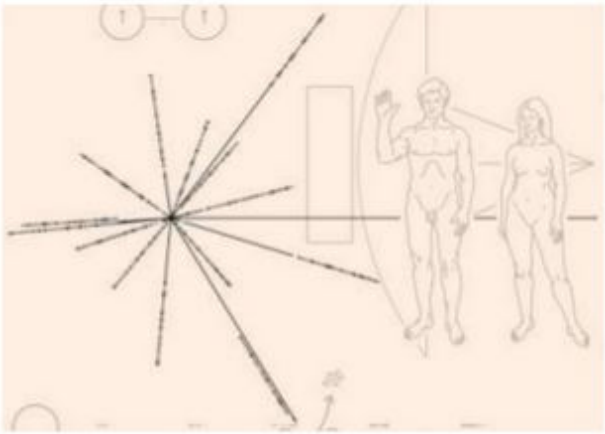
Hydrogen

- At the top left of the plate is a representation of hydrogen, which is the most common element in the universe.
- Below this symbol is a small vertical line to represent the binary digit 1.
- The hydrogen atom can specify a unit of length (wavelength, 21 cm) as well as a unit of time (frequency, 1420 MHz).
- Both units are used as measurements in the other symbols.



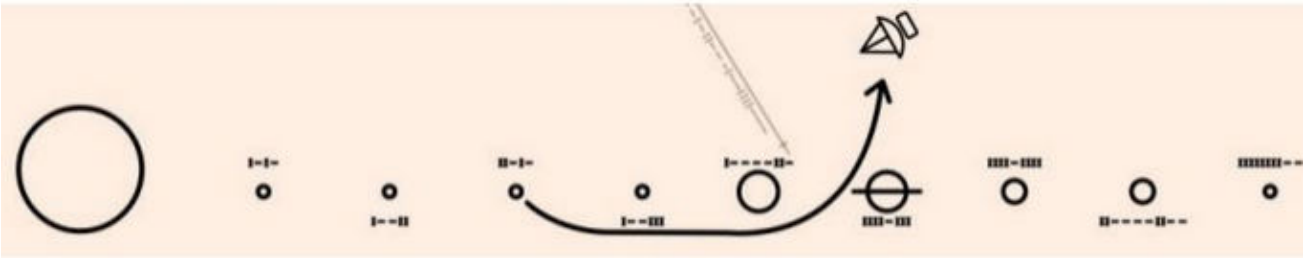
Address of solar system in our Galaxy

- The radial pattern on the left of the plaque shows lines with corresponding long binary numbers, which stand for the periods of pulsars, using the hydrogen spin-flip transition frequency as the unit.
- The lengths of the lines show the relative distances of the pulsars to the Sun.

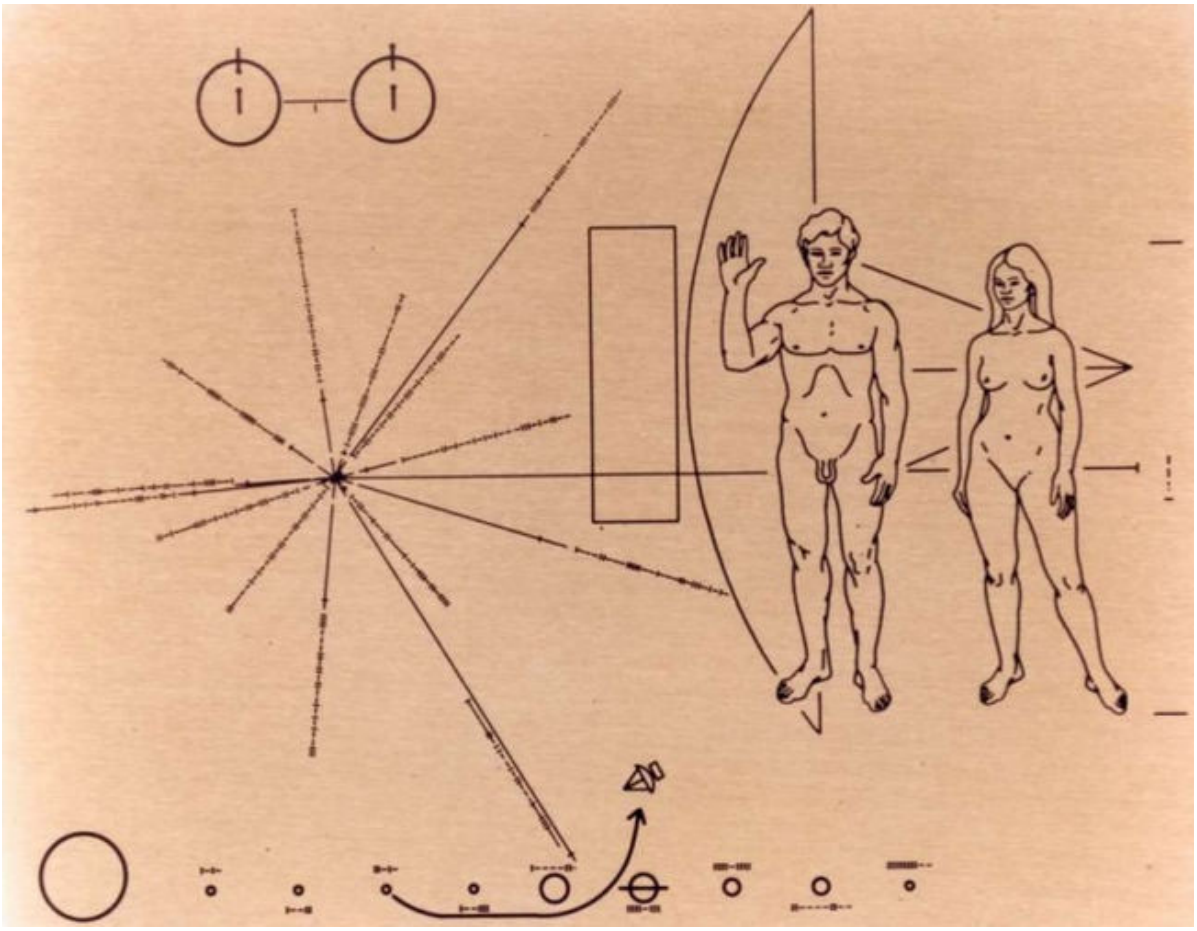


The Solar System

- A map on the bottom of the plaque shows what planet the spaceprobe came from and its approximate trajectory.
- The binary numbers next to the planets show the relative distance to the sun.

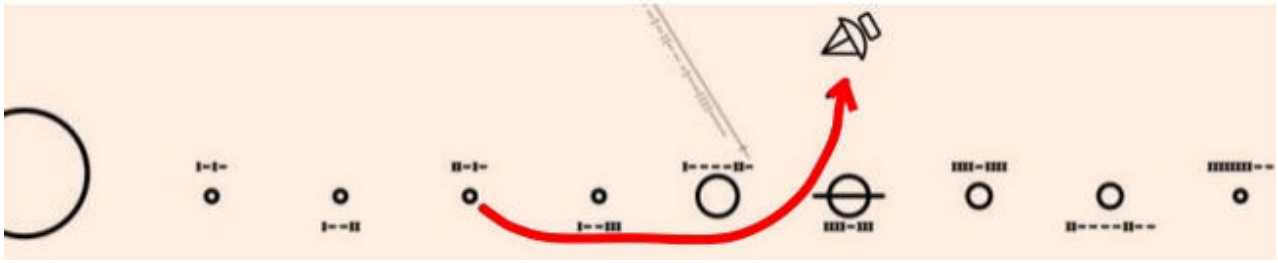


Now, this is interesting, of all the imagery, what part of it do you think the aliens would find most difficult to understand ?



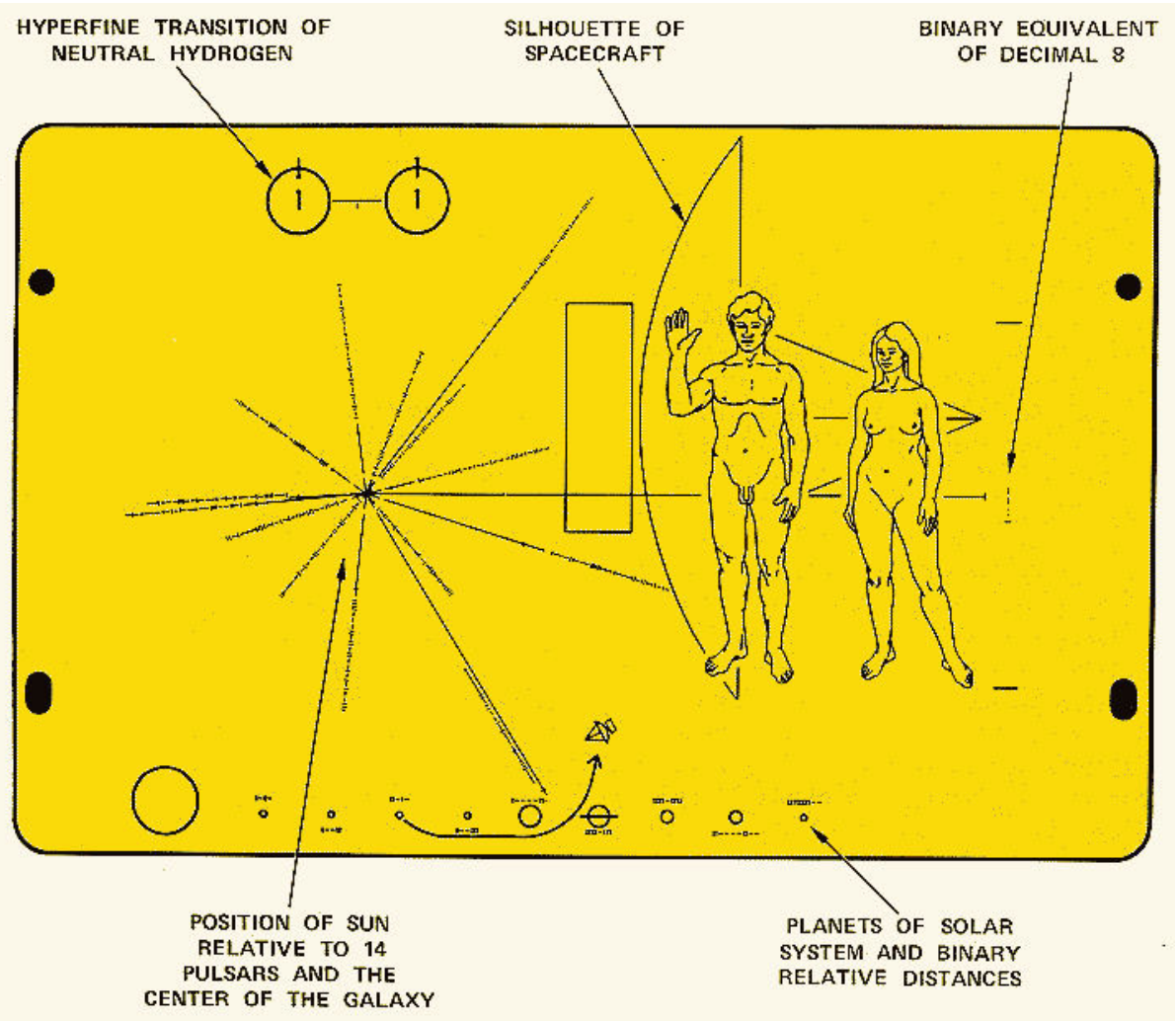
Answer

- It's the arrow !!!
- A 1972 article in Scientific American said that because arrows are an artefact of hunter-gatherer societies like those on Earth; finders with a different cultural heritage may find the arrow symbol meaningless.

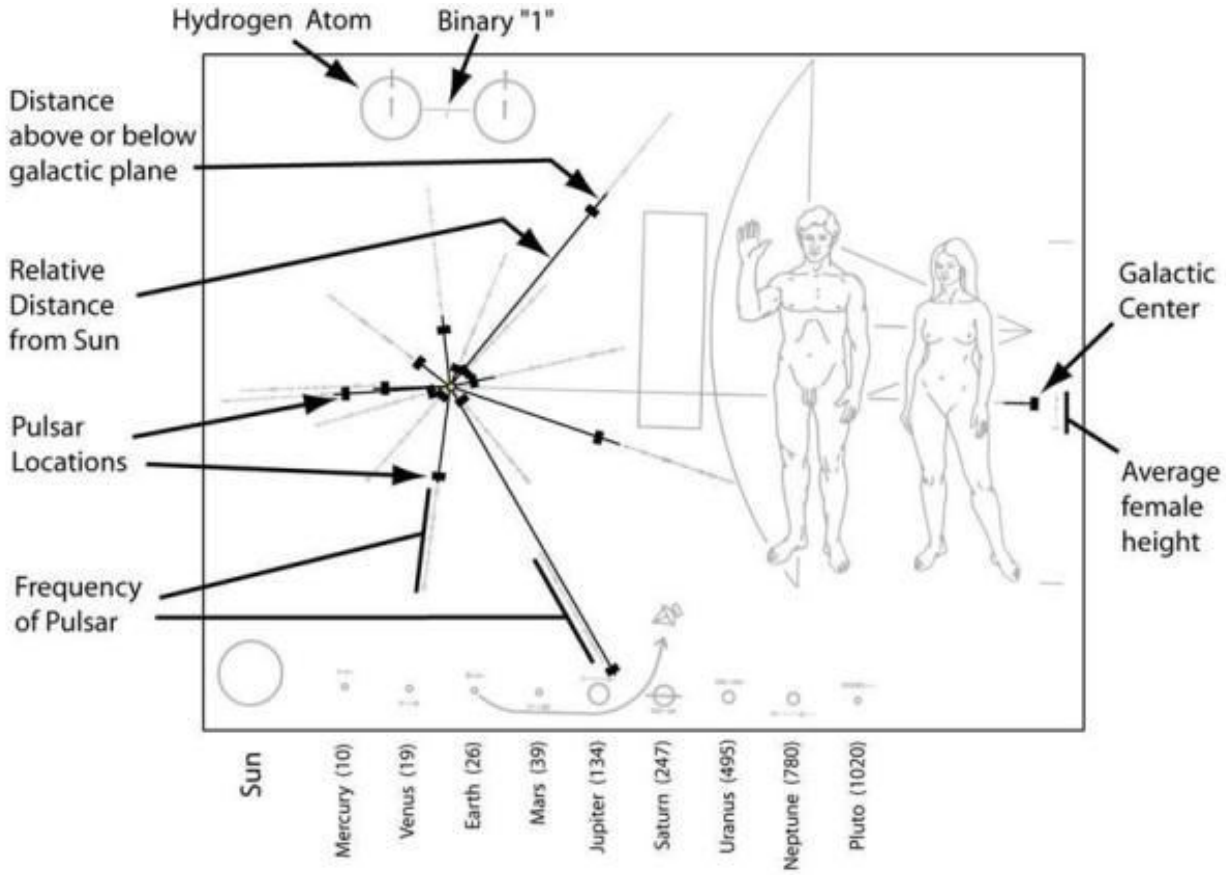


Other Problems

- The raised hand might be an aggressive gesture in some cultures, and could be seen as a message of conquering.
- Feminists felt that the woman being smaller than the man might send a message to the aliens that women were lesser than men.
- We now know that Saturn isn't the only planet with rings, Jupiter, Uranus, and Neptune do also (all Gas giants do).


HYPERFINE TRANSITION OF NEUTRAL HYDROGEN
SILHOUETTE OF SPACECRAFT
BINARY EQUIVALENT OF DECIMAL 8
POSITION OF SUN RELATIVE TO 14 PULSARS AND THE CENTER OF THE GALAXY
PLANETS OF SOLAR SYSTEM AND BINARY RELATIVE DISTANCES

The Pioneer Plaque



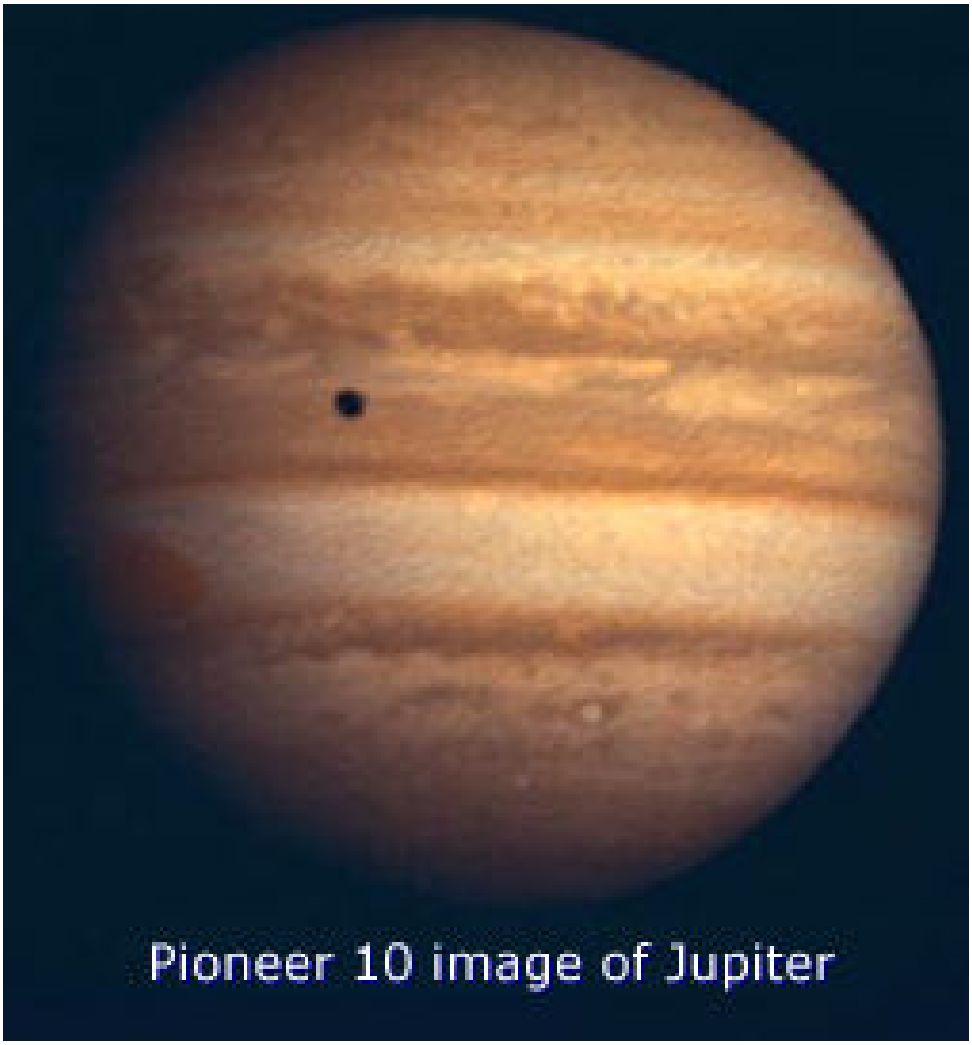
Into Space

Pioneer 10

In 1972, NASA launched the space probe *Pioneer 10.* Its mission was to fly past Jupiter and continue on to the outer solar system.

Pioneer 10 transmitted images of Jupiter back to Earth that humans had never been able to see before.

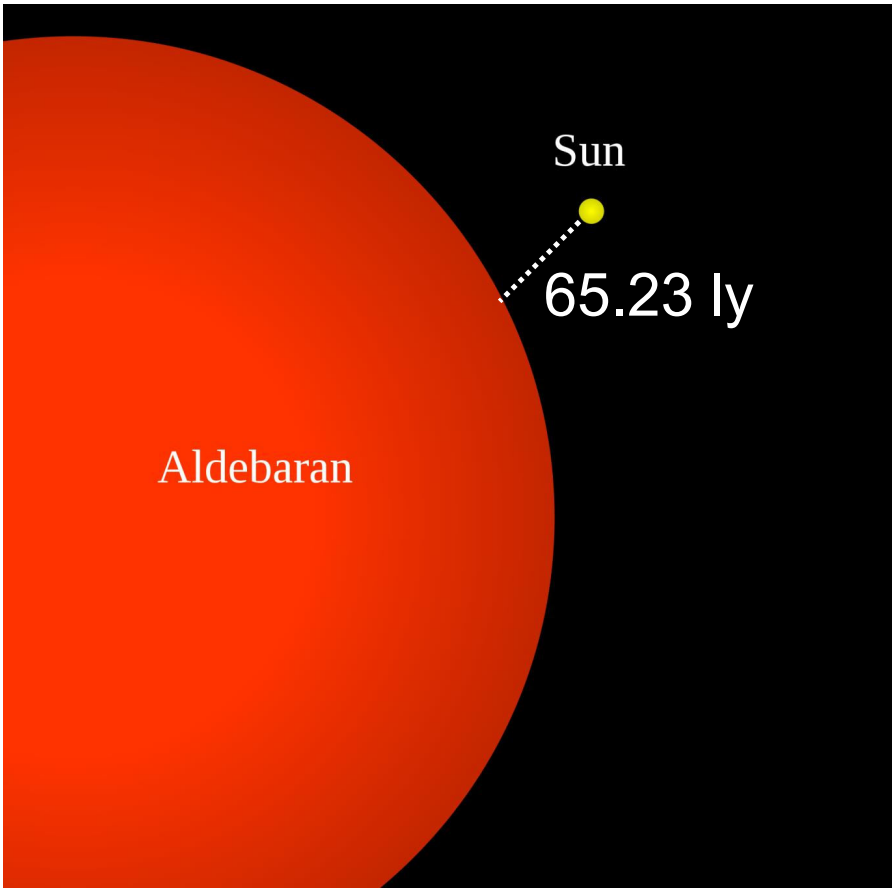
The probe has exited our solar system and continues to travel away, though no signals have been received since January 2003.

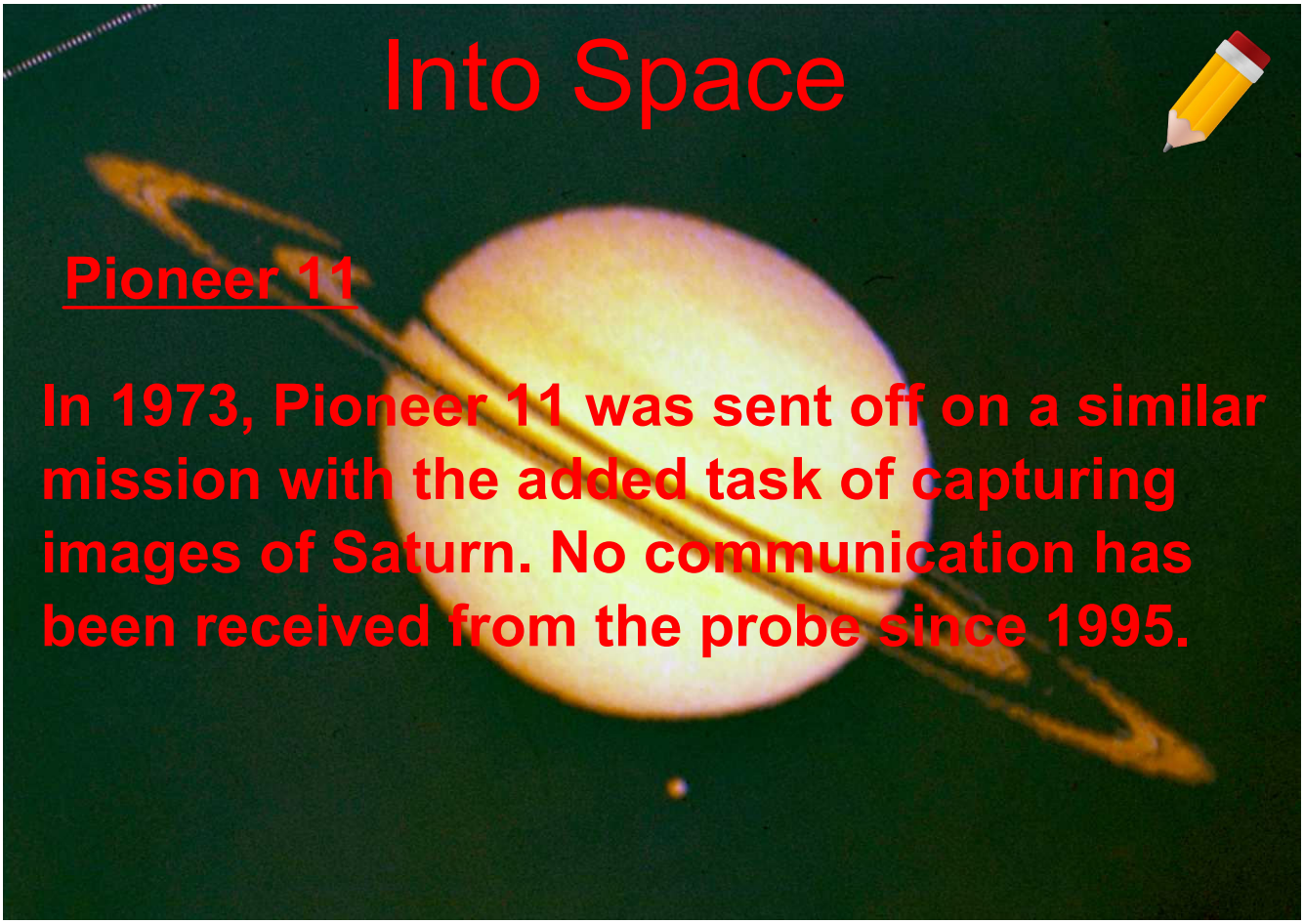

Pioneer 10 image of Jupiter

Into Space

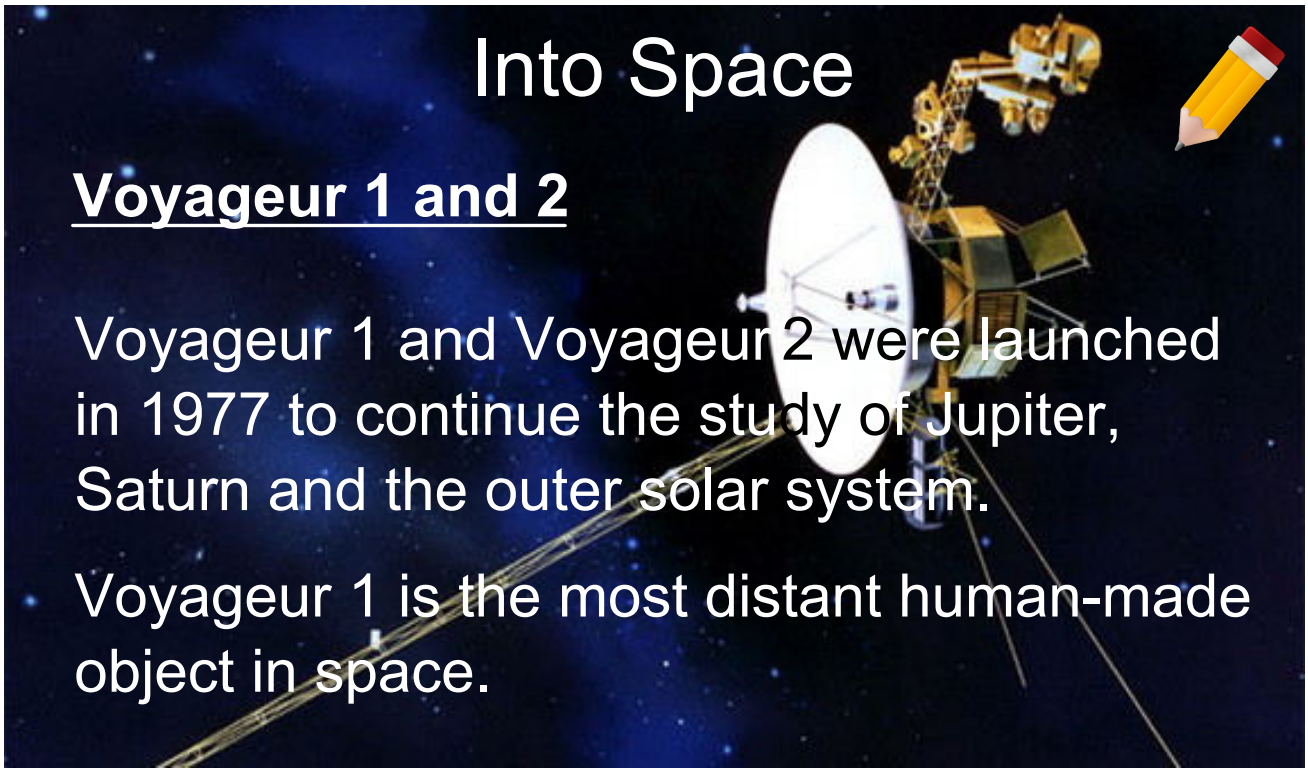
Pioneer 10

By August 2009, Earth-based telescopes tracking Pioneer 10 saw that it was already more than 1000 times farther from the Sun than Earth. If nothing interferes with its progress, it could pass the star Aldebaran in about 2 million years.


Sun
65.23 ly
Aldebaran


Into Space
Pioneer 11
In 1973, Pioneer 11 was sent off on a similar mission with the added task of capturing images of Saturn. No communication has been received from the probe since 1995.

Action!

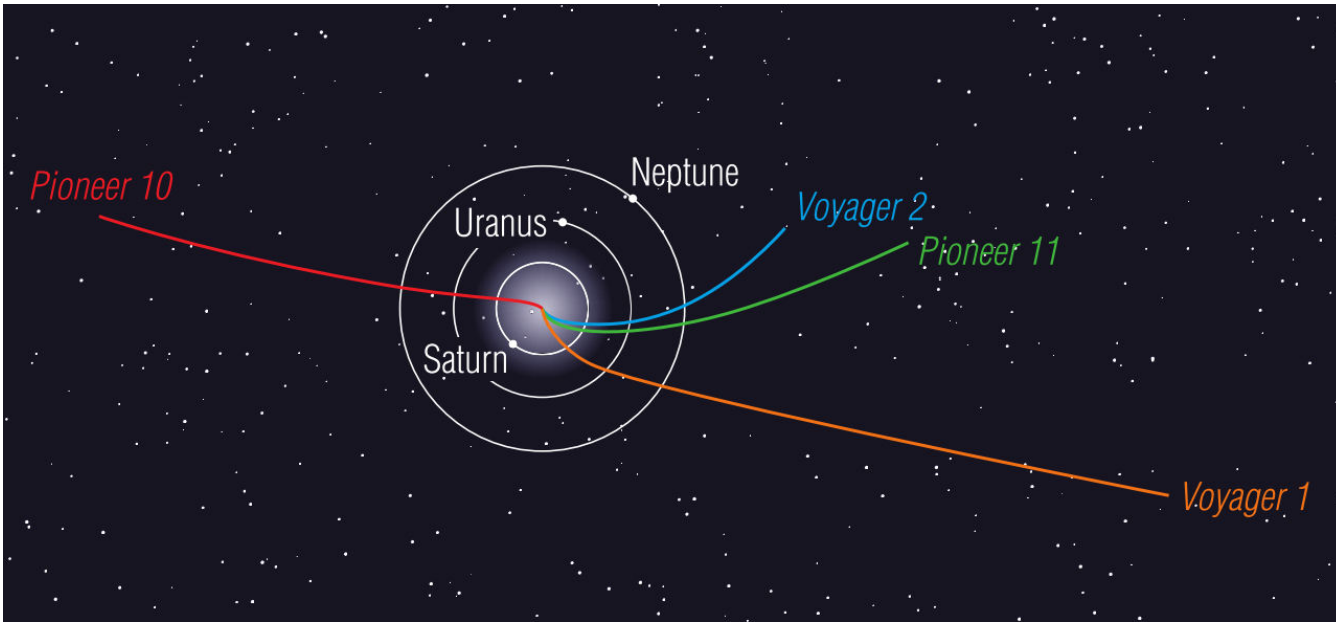

Into Space
Voyageur 1 and 2
Voyageur 1 and Voyageur 2 were launched in 1977 to continue the study of Jupiter, Saturn and the outer solar system.
Voyageur 1 is the most distant human-made object in space.

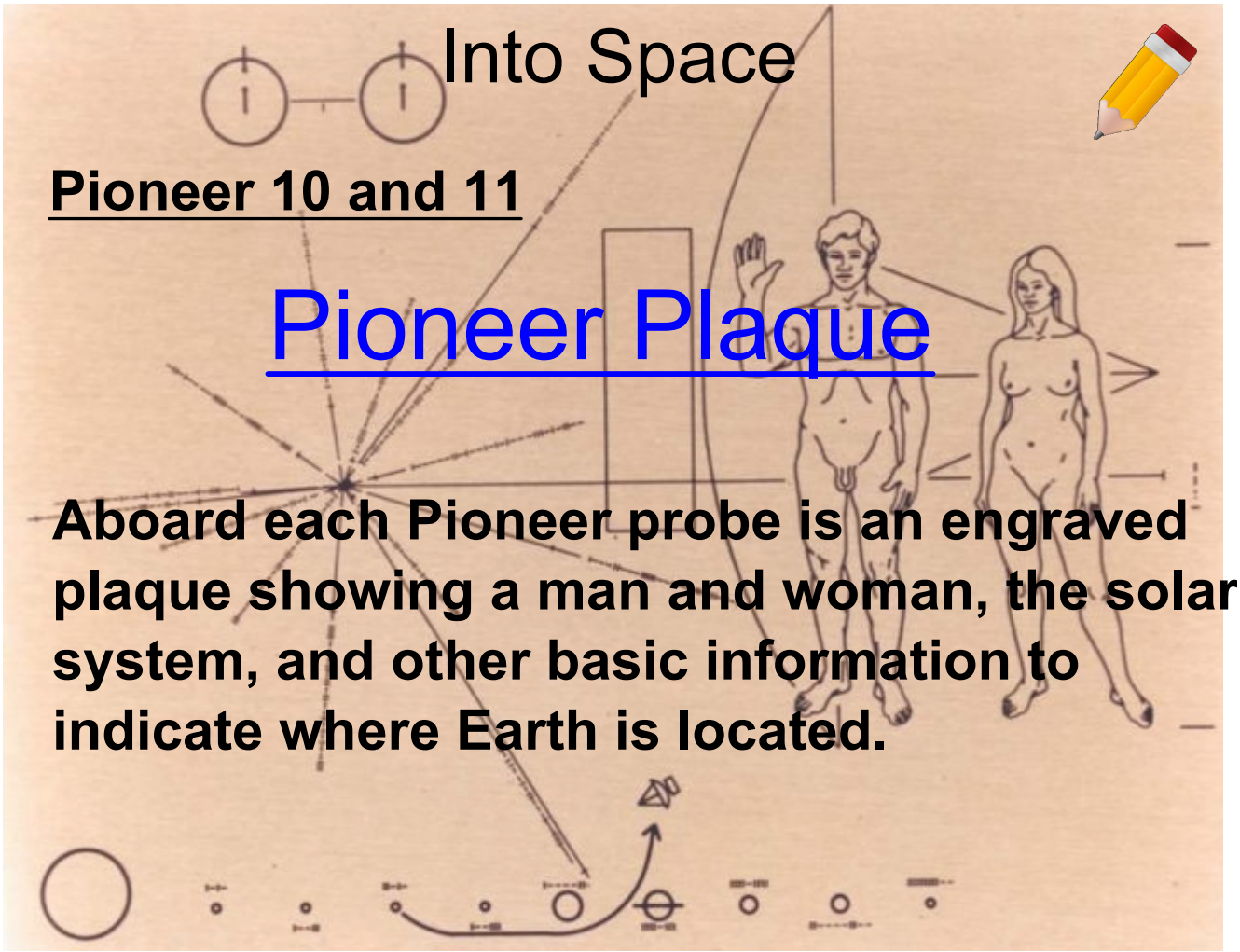
Action!

Pioneer 10 and 11 have both now left our solar system.

The Voyageur craft continue to transmit data to Earth, but their future will be similar to that of the Pioneer probes.

However, the purpose of all four craft has not entirely ended...




Into Space
Pioneer 10 and 11
Pioneer Plaque
Aboard each Pioneer probe is an engraved plaque showing a man and woman, the solar system, and other basic information to indicate where Earth is located.

The Golden Record

Aboard each *Voyageur* probe is a "golden record" with recorded sounds and pictures of Earth.

Action!

Building on Past Knowledge

Action!

Solstices

Two important annual events for our ancestors were the summer and winter solstices.

June 21 marks the summer solstice, the longest period of daylight and the start of summer, in the Northern Hemisphere while December 21 marks the winter solstice, the shortest day of the year and the start of winter.

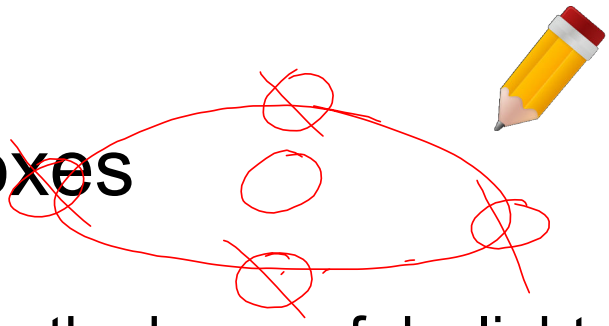
Solstices

Predicting the approaches of summer and winter was important to early peoples and many ancient civilizations built huge monuments to honour beliefs they had related to seasonal changes.

Stonehenge

Action!

Equinoxes



An equinox is a day when the hours of daylight and night are equal.

The Vernal (spring) Equinox occurs about March 21 while the Autumnal (fall) Equinox occurs about September 22.

Action!

Chichen Itza

The Mayans built an enormous cylindrical tower to celebrate the equinoxes.

Action!

Entrance of Khufu

The ancient Egyptians built many pyramids and other monuments to align with the seasonal positions of certain stars.

The entrance passage of Khufu, the Great Pyramid at Giza once lined up with Thuban (the "North Star" in 2700 BC)

Action!

Medicine Wheels

First Nations people in Western Canada built medicine wheels. In these wheels, key rocks were aligned to the bright stars that rose at dawn.

Action!

Medicine Wheels

Other rock installations were used to predict when it was the right time to plant or harvest crops, or to prepare for hunting and fishing.

Action!

Building on Past Knowledge

Action!

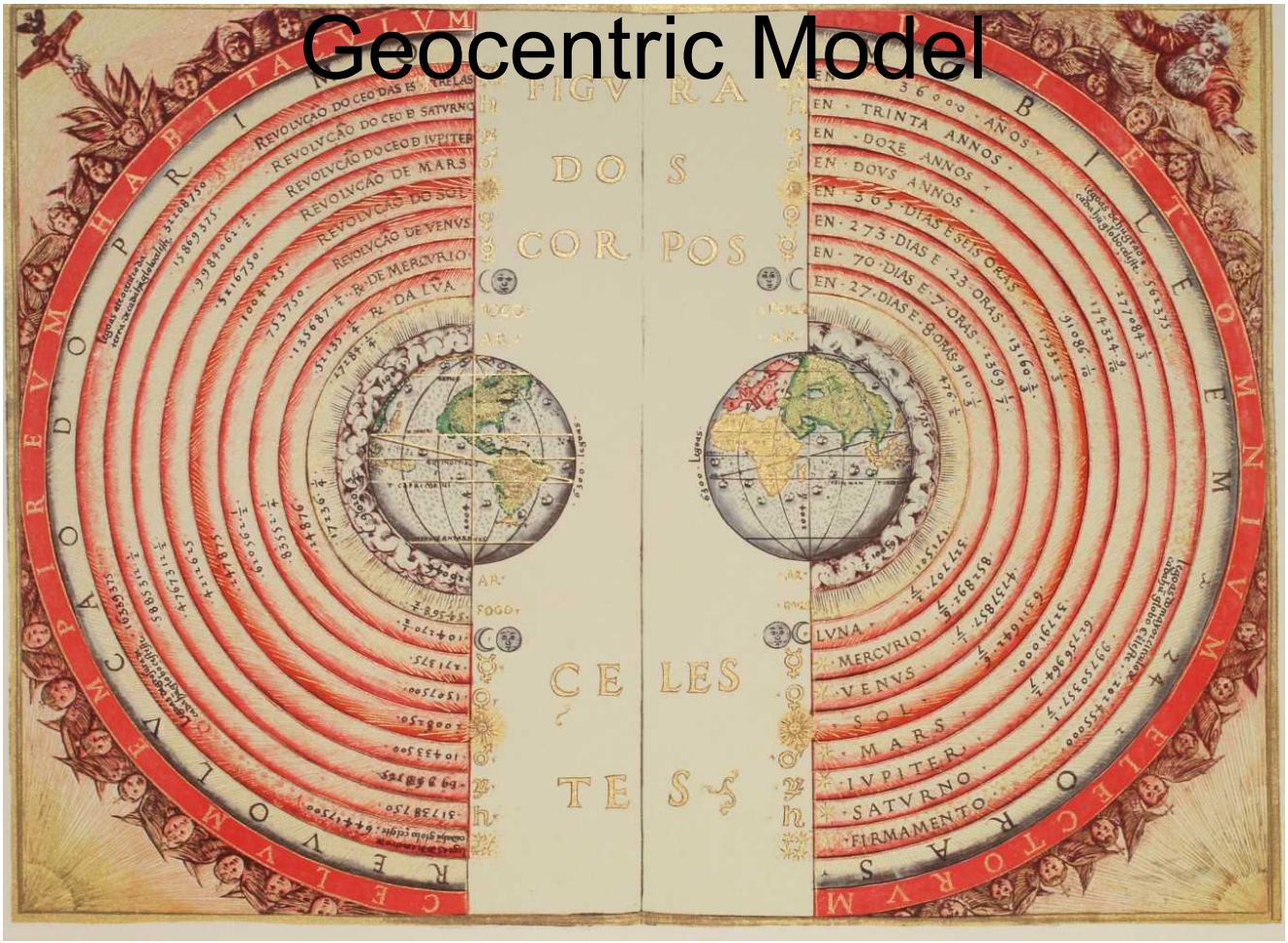
Models of Planetary Motion

Geocentric Model

2000 years ago, it was believed that Earth was the centre of the universe.

Aristotle was the first to describe the Geocentric (Earth-centered) model in an attempt to explain planetary motion.

Geocentric Model



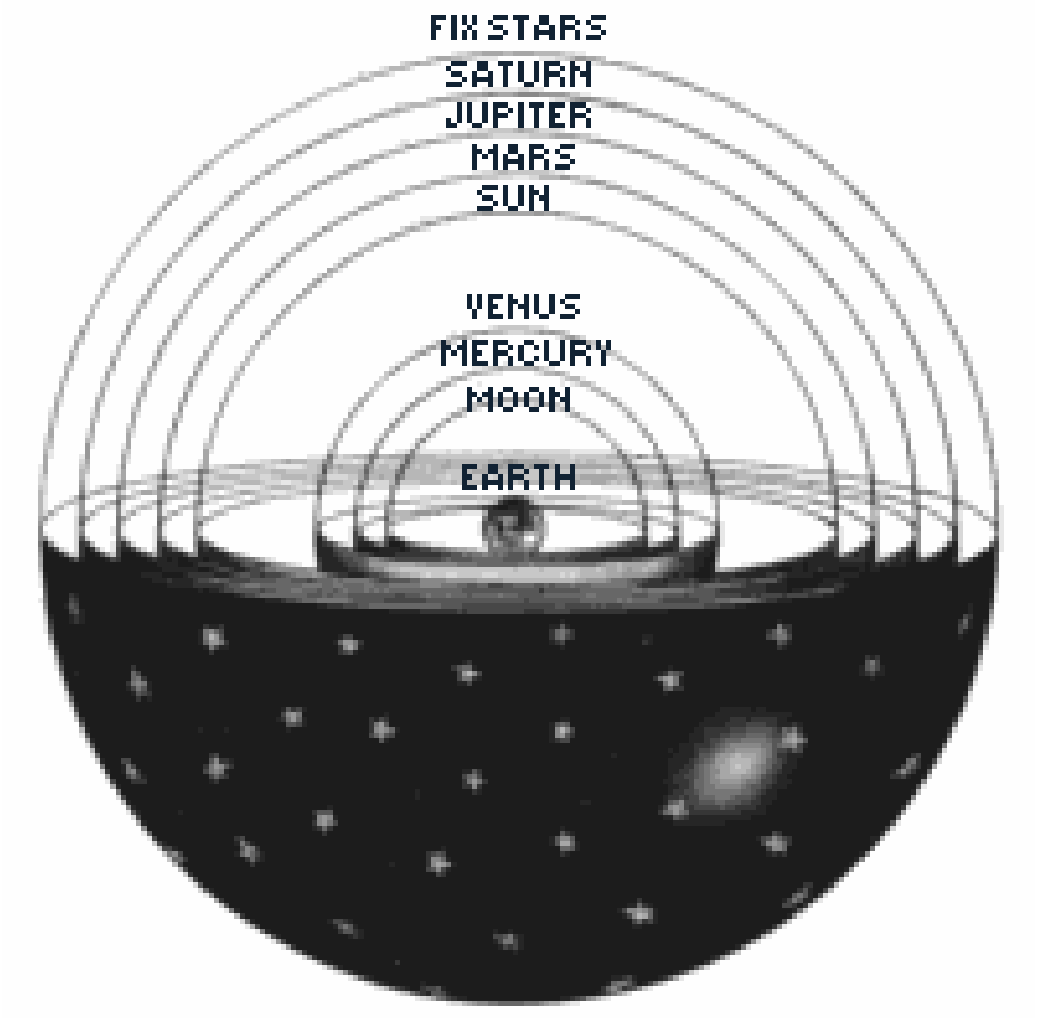
Action!

Models of Planetary Motion

Geocentric Model

In his model, Aristotle showed the Earth with the Sun, Moon and the five known planets revolving around it.

To explain why the distant stars didn't move, Aristotle suggested they were attached to the outer sphere.

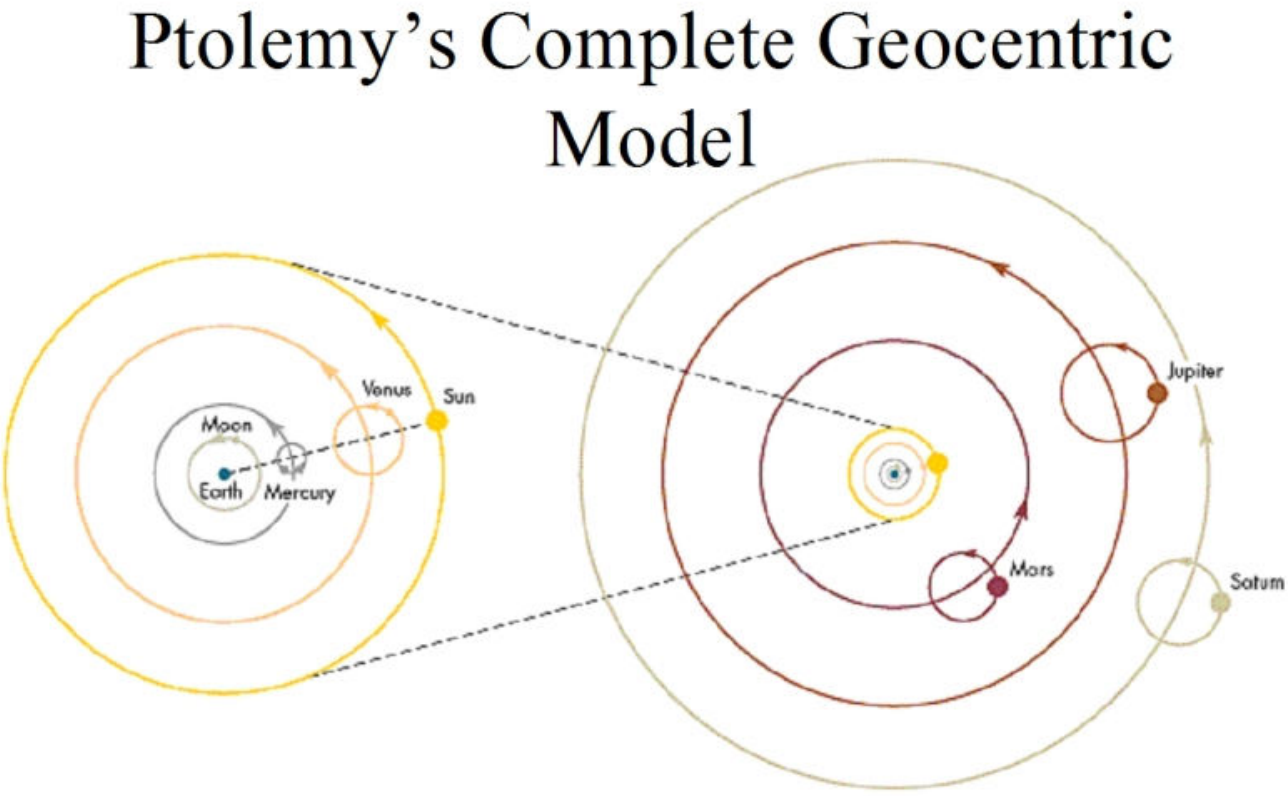


Action!

Models of Planetary Motion

Geocentric Model

Early scientists continued to build on the Geocentric model and Ptolemy adjusted the model and was able to explain the changes phases of the moon.



Action!

Models of Planetary Motion

Geocentric Model

Specifically, Mars, Jupiter and Saturn appeared to loop backward for a few months in their route across the sky.

Action!

Models of Planetary Motion

Geocentric Model

Retrograde Motion

Mars' path over a two month period

Action!

Models of Planetary Motion

Geocentric Model

Retrograde Motion

The apparent reversal of the planets' path relative to the starry backdrop is called retrograde motion.

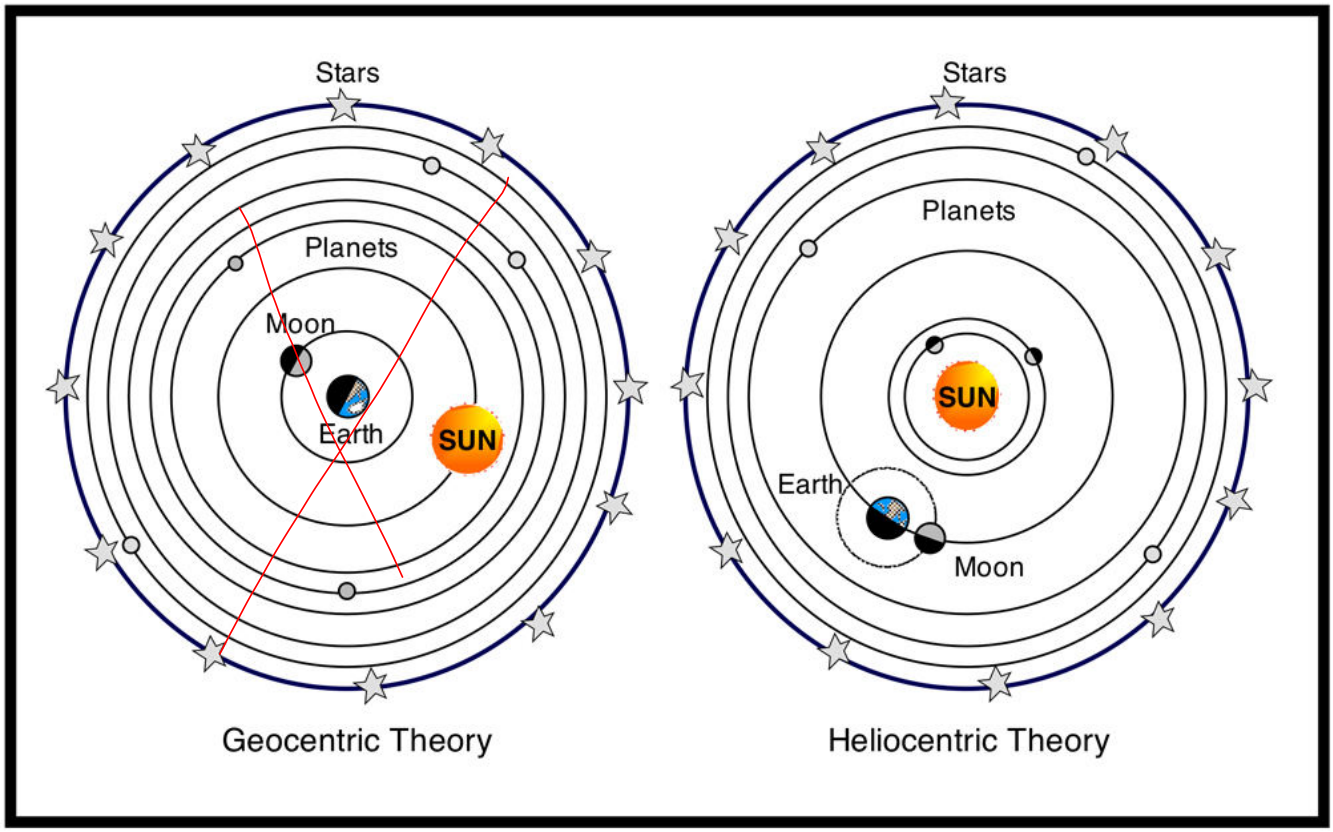
Action!

Models of Planetary Motion

Heliocentric Model

including retrograde motion

After 2000 years with the Geocentric model, many observations and improved technology led to the Heliocentric or Sun-centered model.


Stars
Planets
Moon
Earth
SUN
Geocentric Theory
Stars
Planets
SUN
Earth
Moon
Heliocentric Theory

Action!

Models of Planetary Motion

Heliocentric Model

It was the awareness of two key aspects of planetary orbits that helped add support to this model:

- Orbital Radius
- Elliptical Orbits

Action!

Models of Planetary Motion

Heliocentric Model

Orbital Radius

The orbital radius of a planet is its distance from the Sun.

The shorter the orbital radius, the faster the planet moves in its orbit.

Action!

Models of Planetary Motion

Heliocentric Model

Orbital Radius

This means that Earth orbits the Sun faster than Mars but slower than Venus.

This pattern is even true for asteroids in the solar system.

Action!

Models of Planetary Motion

Heliocentric Model

Orbital Radius

Essentially, the farther an object is from the Sun, the weaker the effect of the Sun's gravity on the object.

Action!

Models of Planetary Motion

Heliocentric Model

Orbital Radius

The differences in orbital speeds explain why Mars, Jupiter and Saturn display retrograde motion relative to Earth.

Basically, Earth is speeding around its course faster than the other three.

Action!

Models of Planetary Motion

Heliocentric Model

Orbital Radius

It's as though you were in a track race and you were passing three other runners, not only because you are faster, but also because you have the inside track.

When you pass them, they appear to be moving backwards.

Retrograde Motion

Action!

Models of Planetary Motion

Heliocentric Model

Orbital Radius

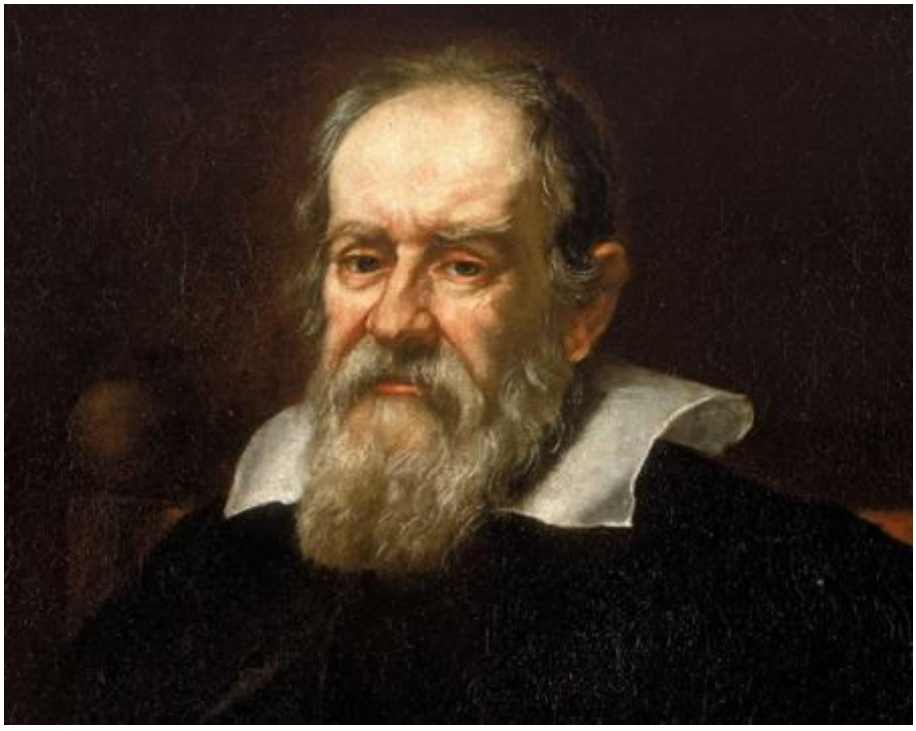
A new generation of scientists provided further evidence for the heliocentric model with the help of the telescope.

In the 1600s Galileo Galilei used a telescope with a strength close to that of today's binoculars to view mountains on the moon, a "bump" on either side of Saturn, spots on the Sun, and moons orbiting Jupiter.

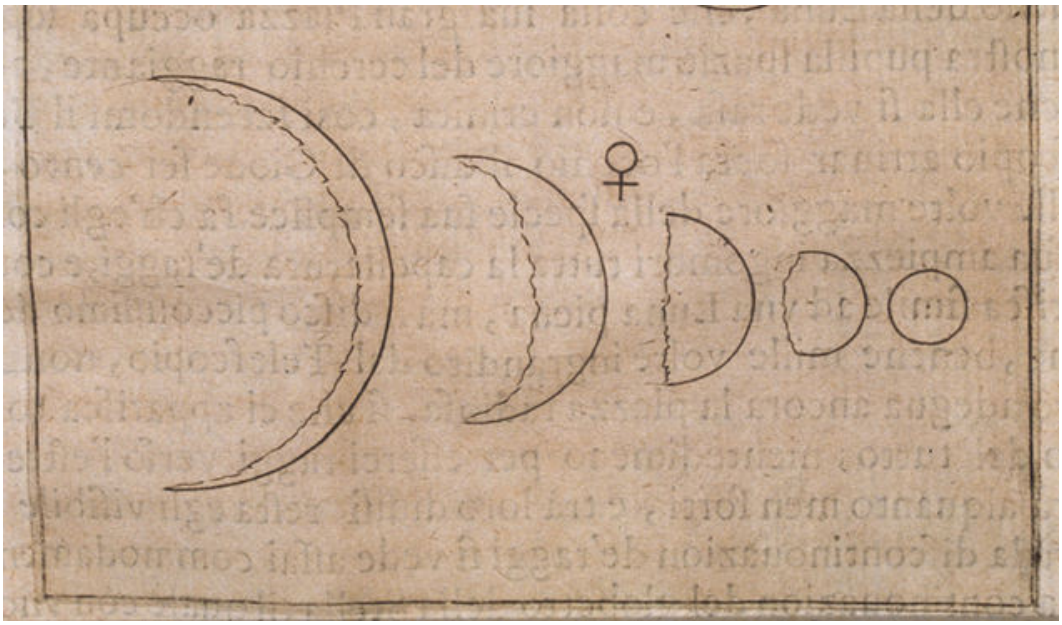
*Not orbiting the Earth!

What do you think those bumps were?

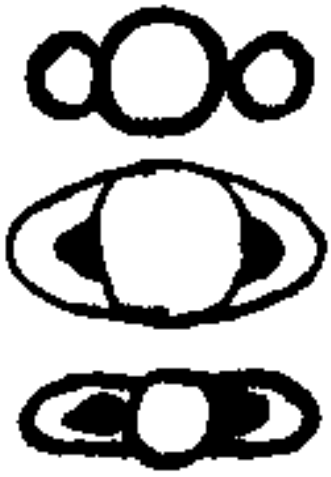
Galileo's Observations



Galileo's Observations

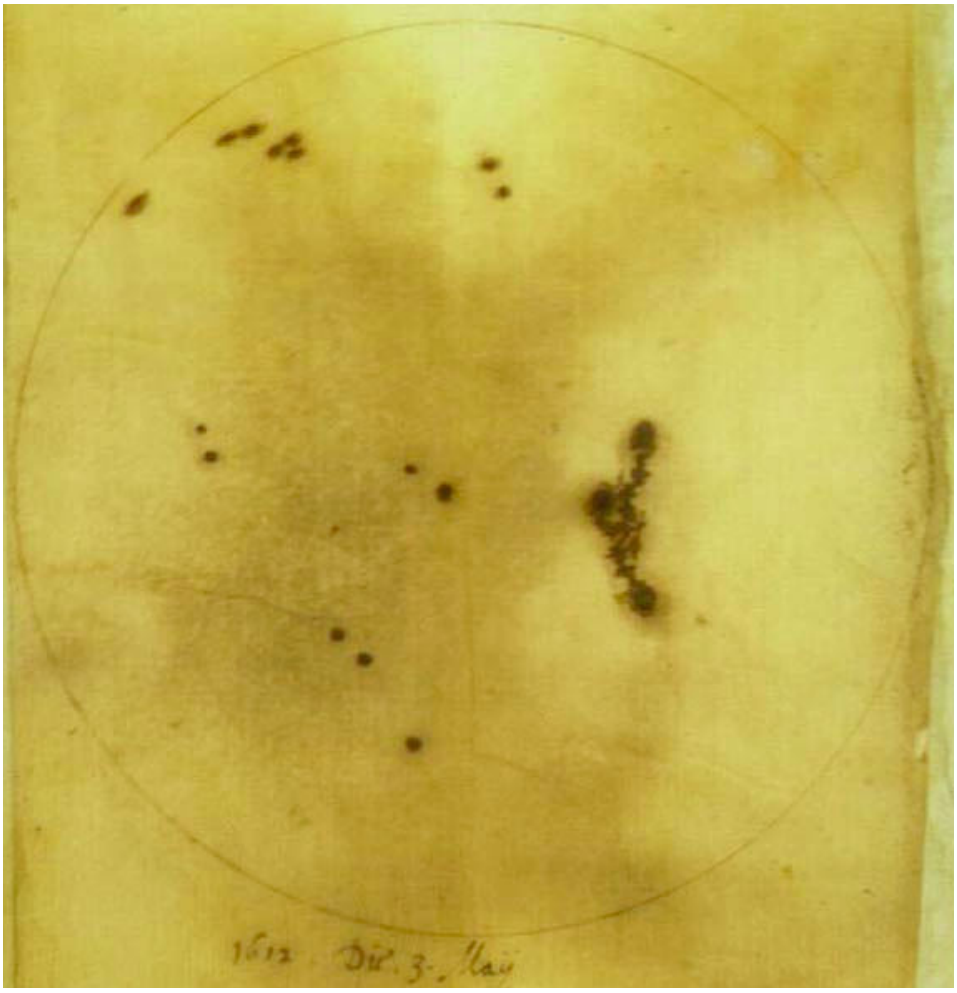


Galileo's Observations

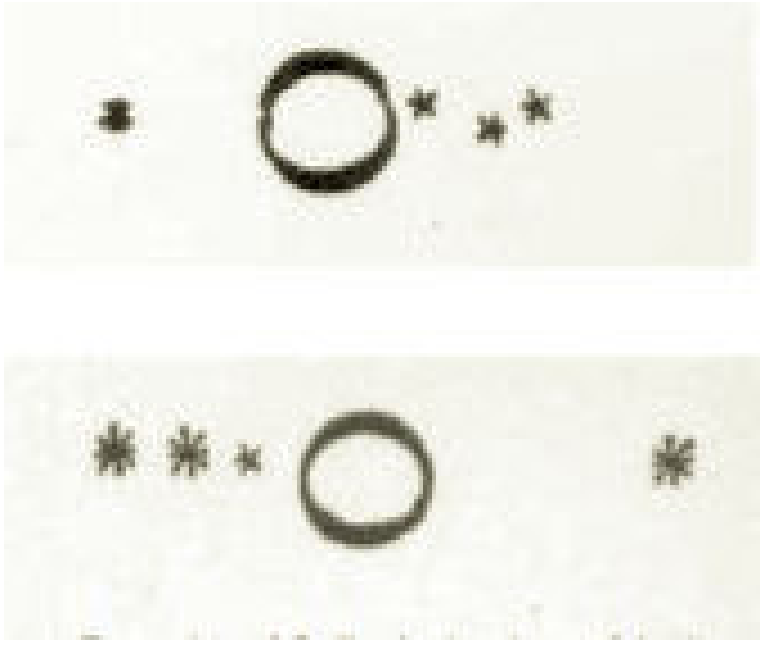


These are sketches of three drawings Galileo made of Saturn through his primitive telescope. ("New Worlds," Couper & Henbest, p.86.)

Galileo's Observations



Galileo's Observations



Action!

Models of Planetary Motion

Heliocentric Model

Elliptical Orbits

Using detailed observations of the movement of the planets, Johannes Kepler discovered the missing piece of the Heliocentric puzzle:

The orbits of the planets were **not** circular, but rather they were **elliptical**!

Today all astronomical observations continue to support the heliocentric model of our solar system.

In fact, it is the guide that we use when studying other star-systems and planet-systems.

Consolidation

Homework

Pg. 351

1 - 5

Read Pg. 345 - 348

(The Evolution of Astronomers' Tools)

Answer Pg. 351: 6, 7, 11

Attachments

- 1 - Z - Intro to Space - How Many Universes.mp4
- 1 - Intro to Space - 1 - Contact Opening Scene.mp4
- Intro to Space - The Beginning of the Universe.mp4
- 1 - Intro to Space - 1 - Celestial Objects.mp4
- 1 - Intro to Space - 2 - How Many.mp4
- 1 - Intro to Space - 4 - What Makes a Planet.mp4
- 2 - 1 - The Solar System - Introduction to Our Solar System.mp4
- 2 - 2 - The Solar System - Is there a Center of the Universe.mp4
- 2 - The Solar System - How fast is the Earth moving.mp4
- 2 - The Solar System Star Size Comparison.mp4
- 2 - X - The Solar System - Helical Model.mp4
- 4 - Earth and Moon - 1 - Basic Rotation.mp4
- 4 - Earth and Moon - 2 - Axis of Rotation.mp4
- 4 - Earth and Moon - 3 - Complex Rotation.mp4
- 4 - Earth and Moon - 4 - Sun Earth Moon Basics.mp4
- 4 - Earth and Moon - 5 - Synchronous Rotation.mp4
- 4 - Earth and Moon - 6 - Detailed Motion.mp4
- 4 - Earth and Moon - 7 - Total Solar Eclipse.mp4
- 4 - Earth and Moon - 8 - Rap.mp4
- B4 (Earth and Moon) - Basic Rotation.mp4
- B4 (Earth and Moon) - Axis of Rotation.mp4
- B4 (Earth and Moon) - Complex Rotation.mp4
- B4 (Earth and Moon) - Synchronous Rotation.mp4
- B4 (Earth and Moon) - Detailed Motion.mp4
- B4 (Earth and Moon) - Total Solar Eclipse.mp4
- B4 (Earth and Moon) - Rap.mp4
- B4 - (Earth and Moon) - Never Setting Sun.mp4
- B4 - (Earth and Moon) - Star Spin Time Lapse.mp4
- B4 (The Moon) - Synchronous Rotation.mp4
- B4 (The Moon) - Detailed Motion.mp4
- B4 (The Moon) - Total Solar Eclipse.mp4

Attachments

- B4 (The Moon) - Rap.mp4
- B4 (The Moon) - Tides in 10.mp4
- B4 (The Moon) - The Tides.mp4
- B4 (The Moon) - The Tides Fundy.mp4
- B4 (The Moon) - The Tides Fundy 2.mp4
- B4 (The Moon) - The Tides Hopewell.mp4
- C1 (Intro. to Space Exploration) - Pioneer Plaque.mp4
- C1 (Intro. to Space Exploration) - Voyageur Golden Record.mp4
- C1 (Intro. to Space Exploration) - Theories of the Universe.mp4
- C1 (Intro. to Space Exploration) - Stonehenge.mp4
- C1 (Intro. to Space Exploration) - Retrograde Motion.mp4
- C1 (Intro. to Space Exploration) - Elliptical Orbit.mp4