A Voyage to the Stars

The New Astronomy

Professor Miguel Angel Moreno, BS., MS., Ph.D., LEED, BPIEA

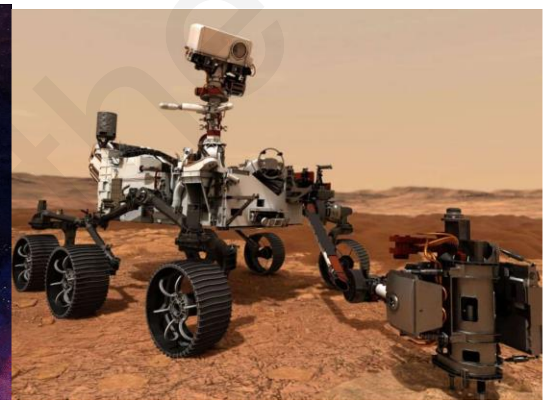
Profesor Miguel Angel Moreno, Ph.D. - View of the Earth from the Moon – Astronauts' Electric Car

Listening and searching for life in the Universe

Delta rocket night launch on its way to Mars

Mars Rover - Spirit

The Hubble Space Telescope



The Mars Science Laboratory: Perseverance Rover

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Atomic and Space Physicist
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Publisher: Cosmic Productions, Co. Los Angeles, California 12th Edition


NASA An artist's conception of a future Mars mission

You are invited to step into the “spacecraft” of Space Science for a voyage of discovery to the planets, the stars and the universe.

About the author

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*Please see a short biography of Dr. Moreno at the end of the book

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Introduction

In writing this book, I attempt to solve several problems; one is the high cost of textbooks. Our students have difficulty paying each semester for four or five textbooks that cost more than $140 each. I hope that this book will cost much less. Another problem we encounter in Astronomy textbooks is that they go beyond the content of introductory solar system astronomy and instead of 20 chapters; they extend to 30 chapters or more with material that is appropriate only for a second semester course.

The scientific method and problem solving skills are an integral part of the learning philosophy of this textbook. I wrote this book to focus it on the contents of an introductory course on Astronomy, specified to meet the university General Education Science requirements. I use scientific visualization to explain physical processes and astronomical facts. The mathematics has been kept to a minimum to facilitate the learning process. The book supplements visits to a planetarium and observatory.

There is ample reference to relevant web sites, computer simulations, visualization and the use of NASA materials. My philosophy is to make science more humanistic and learning of science an enjoyable process as opposed to a burden of stressful assignments. There is a generation of students who have been turned off, lost from science, because they were not inspired or motivated and were disappointed by the lack of humanism in the rigorous strenuous methods of teaching and learning science in the past. This book is an attempt to correct that and to promote a new and inspiring way to learn science.

Another important aspect of the approach to the subject of modern astronomy is to start learning how we learn about the planets and the universe today by use of space technology. We make discoveries about the planets and the universe by use of spacecraft, robots, space telescopes, ground telescopes, observatories in modified high altitude airplanes and more. I find that this is a more motivating and interesting approach to learning this science.

Thus, this book focuses on Solar system astronomy and on the subject of life in the universe and the development of critical thinking skills and technological skills.

I invite you to take this voyage to the stars and the universe and discover the knowledge and insights and the experience of the universe and the space technologies that are helping us to move towards a great future.

CHAPTER I

The Science of Astronomy

Outline

Objectives

To discuss

1. The Science of Astronomy
2. What is Astronomy?
3. Why do we study Astronomy?
4. Astrology – What is Astrology?
5. What is the differences between Astronomy, a science, and Astrology (not valid, not a science)? Review an example of Astronomy and an example of Astrology, a comparison.
6. The Scientific Method
7. A hypothesis. What is a hypothesis?
8. What are the steps of the Scientific Method?
9. A flowchart for the process of the Scientific Method
10. Examples of a hypothesis
11. Examples of the application of the Scientific Method
12. Summary and Conclusions

The Science of Astronomy

What is Astronomy? Astronomy is the science concerned with the study of the universe and with investigating the position, movement, composition, properties, physical states and evolution of celestial objects. Astronomy is a respectable science based on the Scientific Method and the application of Physics.

Some people confuse Astronomy with Astrology. Astrology is not a science and it claims to predict the future of a person, his or her personality and their path in life based on the alignment of the planets at the moment of birth. There are numerous arguments and tests that indicate that astrology is invalid. A typical counter argument is that twins are born essentially at the same time, with the same planetary alignment, yet one twin goes to UCLA and the other to USC, one studies economics and the other political science, their personalities are different and their paths in life are very different. Once in a social gathering a lady said to me "I always wanted to meet and astrologer like you", I smiled and kindly explained to her the difference between Astronomy and astrology. A student recently sent me an email saying that "I need to take your astrology class to meet my General Ed Science requirements". In this course we want to make sure we don't make that mistake and focus on learning the science of Astronomy.

Astronomy comes from the Greek language

"Astro" comes from aster which means star and "nomy" which means the study of

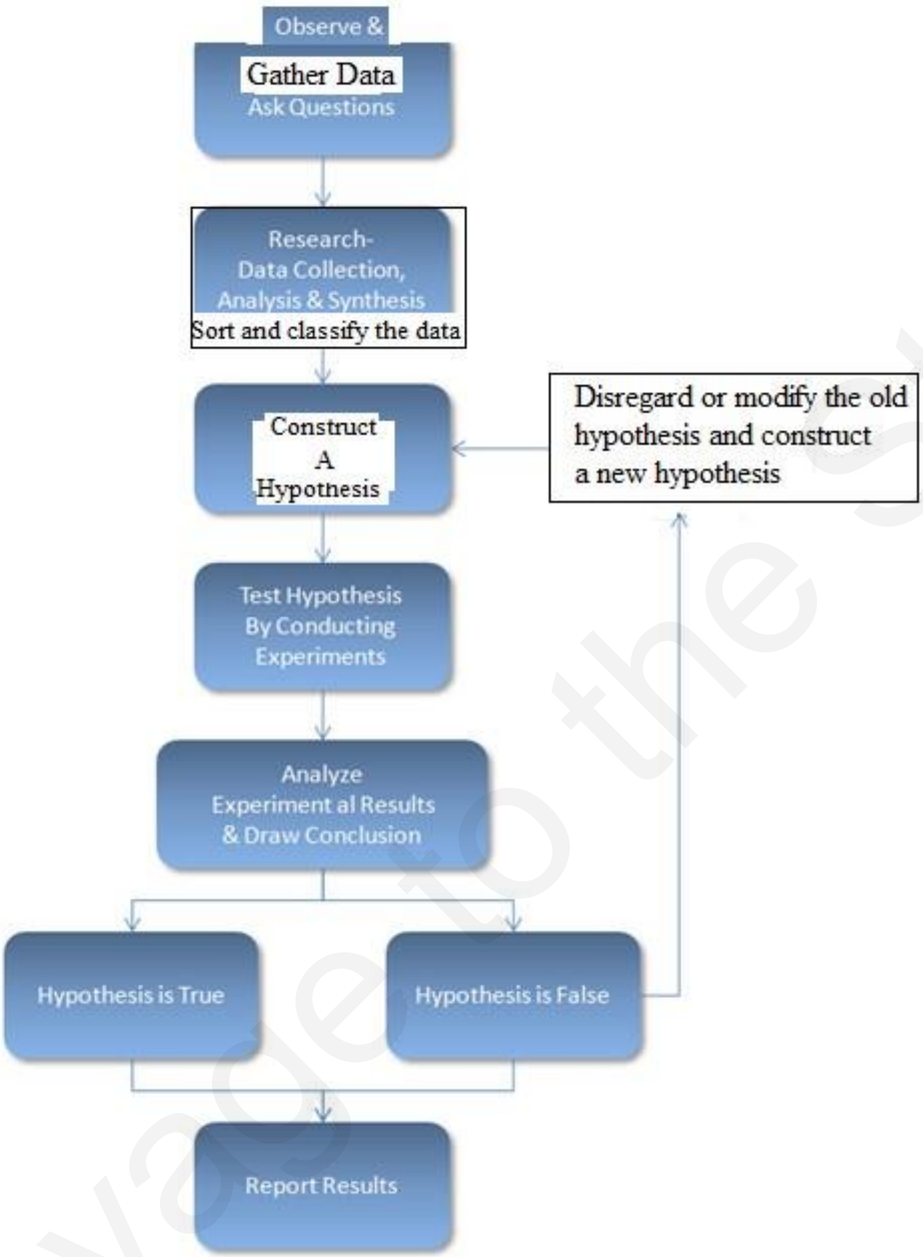
The study of the stars

What is the Scientific relation between you and the Universe?

The chemical elements you are made of were manufactured in a Blue Giant star which became a supernova

The Scientific Method

It is the method by which we derive scientific knowledge in Astronomy and all the sciences.



Examples: Select a topic, gather data, develop a hypothesis, think how you would test the hypothesis and complete the cycle for an application of the Scientific Method.

A cosmic Perspective exercise:

Please go to the following web site and watch this Imax video titled Cosmic Voyage

1. https://www.youtube.com/watch?v=uxq5QUpO_mE

   https://www.youtube.com/watch?v=MjcT7acDzAo

Please go to the following web site and patiently learn about the structure of the universe by sliding the bar and zooming in and out in the Universe to get a perspective from the smallest to the largest structures in the Universe.

2. http://htwins.net/scale2/

Assignments

1. Write a one-page summary (At least two paragraphs) about Chapter 1
2. Write a definition and a description of the science of Astronomy. What is Astronomy?
3. Research the answer to the question:
   What is the difference between Astronomy and Astrology?
4. What is the scientific relation between you and the Universe? (The Chemical elements that you are made of were manufactured in a Blue Giant star that became a supernova)
5. How old are you?
6. Describe the work of an Astronomer
7. Write a one-page summary (at least two paragraphs) about the video (1) above "Cosmic Voyage"
8. Write a one-page summary about the exercise Zoom in Zoom out, Scale of the Universe, with http://htwins.net/scale2/

https://www.sciencealert.com/this-3-minute-animation-will-change-the-way-you-see-the-universe

CHAPTER II

Modern Tools of Astronomy

Objectives

To discuss

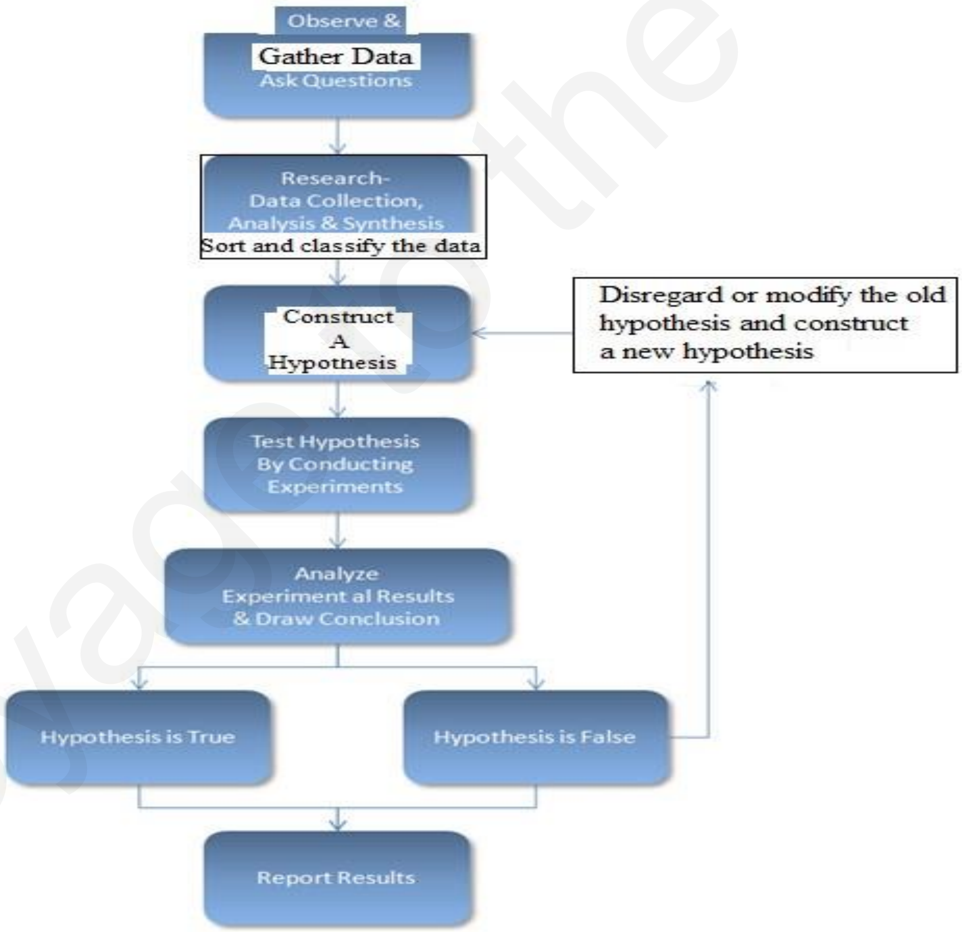
1. What are the modern tools of Astronomy?
2. How did we achieve the Astronomical knowledge we have today?
3. Three thousand years of observations
4. The Laws of Physics
5. The Scientific Method
6. Ground telescopes
7. Telescopes in aircraft, for example NASA's SOFIA
8. Balloons with scientific instruments
9. Rockets, example the Delta II rocket
10. Space telescopes – NASA's Hubble Space Telescope
11. Spacecraft
12. The manned space flights – The Space Station- Astronomical instruments _ For example: A study of dark matter
13. Robotic spacecraft to the planets
14. Mars Viking Missions
15. Mars Rovers
16. Other spacecraft. Example the Kepler mission
17. NASA's Deep Space Network
18. New data storage facilities and analysis capabilities
19. Supercomputers
20. The development of specialized software
21. Computer simulations
22. Research
23. Conclusions

Modern tools of Astronomy

What are the tools we use today to reach the planets and learn about the universe in modern Astronomy? The Scientific Method
Physics
Technology and space exploration, rockets, spacecraft, robots and new telescopes.

The new Astronomy

Tool: The Scientific Method
It is the method by which we derive scientific knowledge in Astronomy and all the sciences.



Examples: Select a topic, gather data, develop a hypothesis, think how you would test the hypothesis and complete the cycle for an application of the Scientific Method.

Advances in Space Technology: How do we learn about the planets and the universe?

Astronomy, as all other sciences, is based on Physics. Physics is the fundamental science, the foundation of the building of scientific knowledge. As a result, I place great importance in understanding the basic laws of Physics, such as the law of Universal Gravitation, the law of conservation of energy, momentum, angular momentum, Newton's Laws of Motion and Kepler's laws of planetary motion.

As an application of Physics we have the development of technology. In this book, I emphasize the use of technology to gain scientific astronomical knowledge. I describe the use of rockets, spacecraft, measuring instruments, computers, microchips, robots, telescopes and other space technologies. Also I describe how things are measured, the measurement technique, how do we arrive to a specific knowledge of the planets and stars? These technologies and techniques are essential to the understanding and development of the new Astronomy.

An example this is the Delta rocket, which delivers spacecraft and robots to the planet Mars. Without this technology we would not accomplish the scientific exploration of Mars.

Life on Mars will be an important test for humans
http://observe.arc.nasa.gov/nasa/gallery/image_gallery/universe/universe_gal5.html

http://www.planetary.org/mars/mer-images.html#spacecraft

Observations with new and more powerful telescopes

The Andromeda galaxy our nearest neighbor

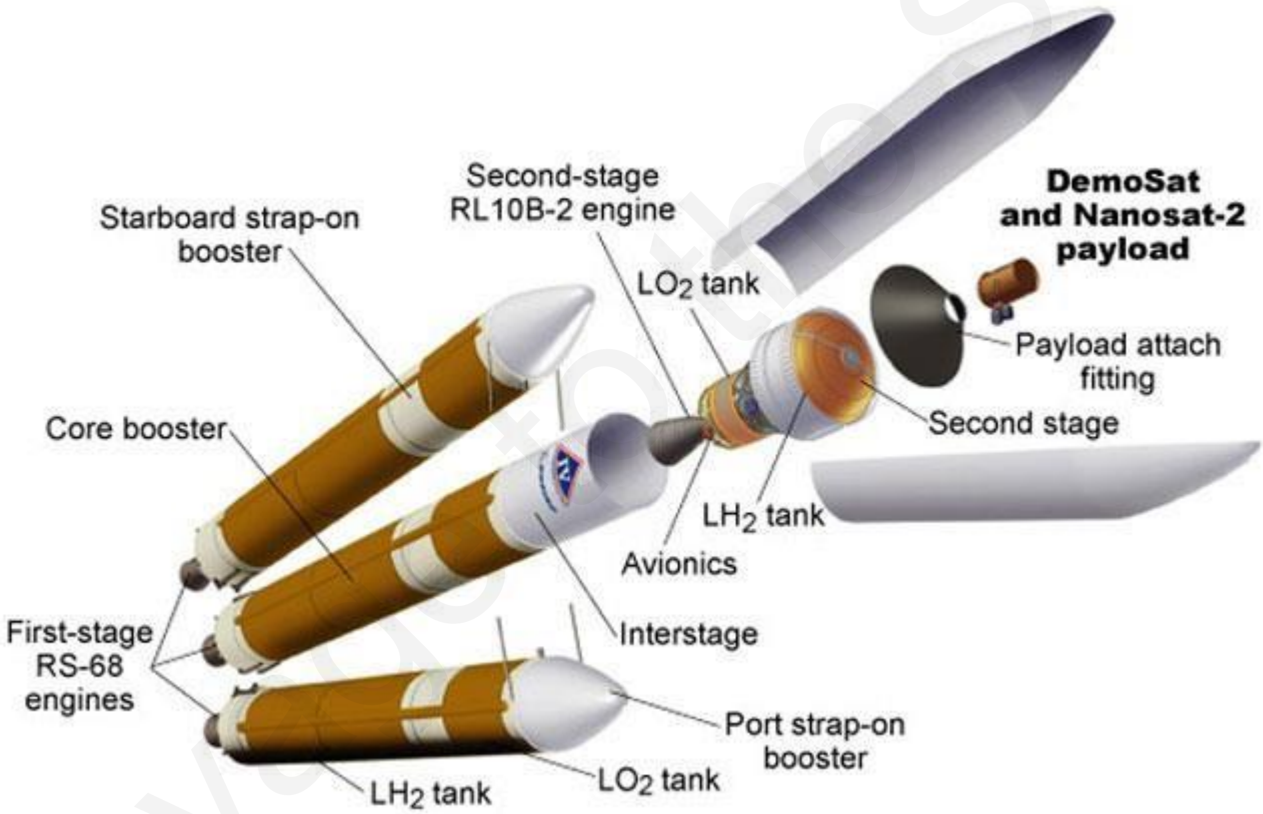
We estimate it is made of one trillion stars
It is located at a distance of two and a half million light years from us

http://observe.arc.nasa.gov/nasa/gallery/image_gallery/universe/graphics/galaxies_page5/072495.jpg

The near future: Exploring Mars with a combination of robots and human astronauts
Image credit: NASA

http://www.space.com/scienceastronomy/solarsystem/mars_humans_001106.htm

Tools of Astronomy. Tools to reach the planets.



Launch of a delta rocket: https://www.youtube.com/watch?v=bVusSxQV5Jo
The multiple stages and payloads of the first Delta 4 Heavy mission are shown here in this diagram. Image Credit: The Boeing Company.
http://www.space.com/php/multimedia/imagedisplay/img_display.php?pic=h_d4h_diagram_02.jpg&cap=The+multiple+stages+and+payloads+of+the+first+Delta+4+Heavy+mission+are+shown+here+in+this+diagram .+Credit%3A+Boeing.

Delta rocket launch at night. On its way to Mars.

The robotic exploration of Mars will search for water and possible microscopic life. It will help prepare the way for human exploration and settlement on the red planet

Image credit: NASA

Robots on the surface of Mars
Image Credit: NASA
NASA image:
http://marsrovers.jpl.nasa.gov/classroom/

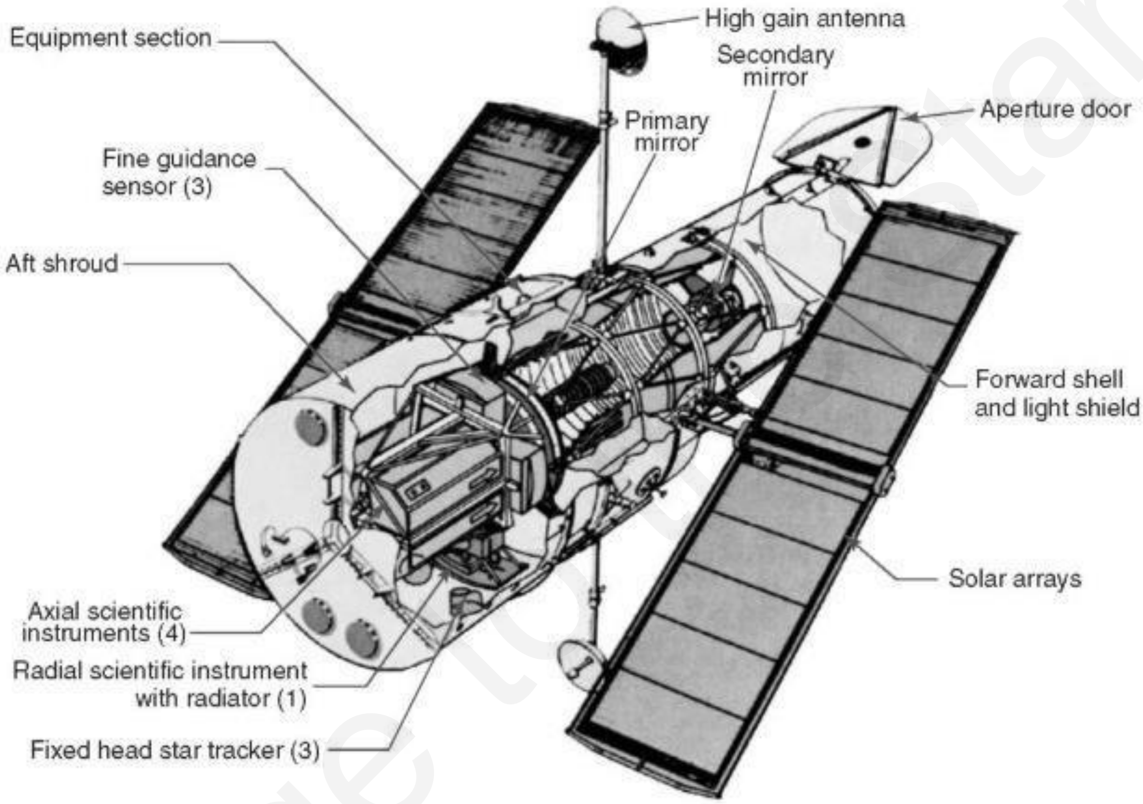
A comparison between Earth and Mars
Studies of the evolution of the Earth as a planet and a comparison with Mars
NASA image: http://marsrovers.jpl.nasa.gov/classroom/

Tools of Astronomy: The Hubble Space Telescope

The Hubble Space Telescope
Image credit: NASA

The Hubble Space Telescope is a space telescope that was launched into low Earth orbit in 1990, and remains in operation. With a 2.4-meter mirror, Hubble's four main instruments observe in the near ultraviolet, visible, and near infrared spectra.

Components and instruments of the Hubble Space Telescope



1. **Orbit height:** 347 miles (559 km)
2. **Launch date:** April 24, 1990
3. **Speed on orbit:** 4.66 miles/s (7.5 km/s)
4. **Power:** 2,800 watts
5. **Cost:** 2.5 billion USD

Tools of Astronomy: The Keck Telescope

The Keck Telescope in Hawaii

Credit: http://www2.keck.hawaii.edu/geninfo/about.phpThe University of Hawaii's Institute for Astronomy manages an 11,600-acre science reserve at the summit. A dozen major research facilities occupy this reserve, representing a capital investment of more than $1 billion and employment for several hundred Big Island residents. More than 80 percent of the combined annual operating costs for all observatories is spent in Hawaii, predominantly on the Big Island. In the year 2004, a dozen major research teams occupied this reserve, representing a capital investment of more than $1 billion and employment for hundreds of Big Island residents. Amid this gathering of telescopes, the Kecks stand alone.

"Great telescopes like the Kecks allow us to explore the river of time back toward its source. The Kecks will allow us, like no other telescope in history, to view the evolving Universe that gave us birth."
-- Astronomer Sandra Faber

Tools of Astronomy: Mauna Kea Hawaii Observatories viewed from the Northeast

Credit: University of Hawaii

In the foreground on the summit ridge, from left to right, are the UH 0.6-meter telescope (small white dome), the Gemini Northern 8-meter telescope (silver, open) and the Canada-France-Hawaii Telescope. On the right are the NASA Infrared Telescope Facility (silver), the twin domes of the W.M. Keck Observatory; behind and to the left of them is the Subaru Telescope. In the valley below are the Caltech Sub millimeter Observatory (silver), the James Clerk Maxwell Telescope (white, open), and the assembly building for the sub millimeter array.

The cinder cone in the center of the photograph is Pu`u Poliahu. In the distance is the dormant volcano Hualalai (altitude 8,271 feet), located near Kailua-Kona.

Tools of Astronomy: The smaller telescopes for Education in Astronomy

The 12 - inch Meade telescope with a GPS tracking system

Image credit: Meade Telescope Company: http://www.meade.com/about/

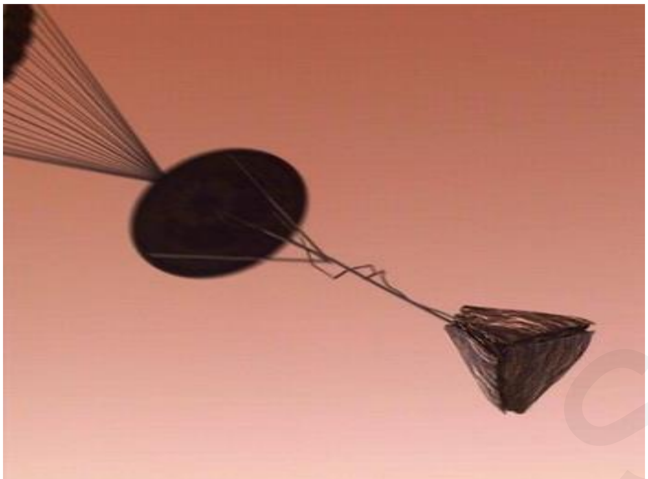
New robotics telescopes with more than 145,000 objects in the computer data base. Also these telescopes make use of the GPS system. This technology represents a new era in modern Astronomy

Tools of Astronomy: Robots on Mars

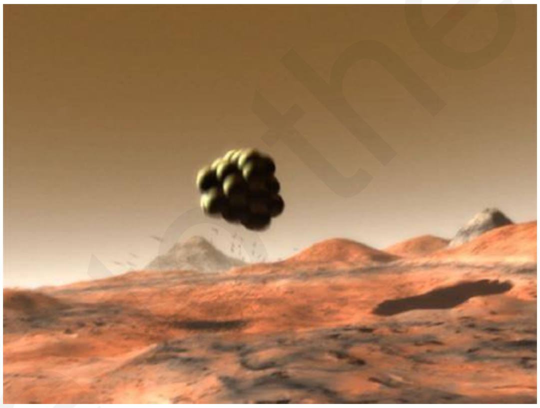
Robotic exploration of Mars, the landing sequence:

https://www.youtube.com/watch?v=CgUGBVzWnIk

Entry into the Martian atmosphere
Six minutes from atmospheric entry to landing



Opening of the parachute system



Cutting of the cables and inflating 12 bags that surround and protect the spacecraft on impact

The airbags with the spacecraft inside bounce up to 40 times before they stop

Image credit: NASA

http://marsrovers.jpl.nasa.gov/mission/spacecraft_edl_airbags.html

https://www.youtube.com/watch?v=lZ9rlYJtP7g

This is an illustration of the bouncing of the air bag system on the surface of Mars to make sure the spacecraft inside has a smooth landing. The system is similar to the air bags in cars that protect people in case of accidents. In this case, the bags protect the spacecraft and the robot inside. This has been the most reliable method of landing on Mars. This technology made it possible to deliver sophisticated robots and scientific instruments to the surface of Mars.

The Space Shuttle

The use of the Space Shuttle technology has enabled us to learn about the response of the human physiology to the space environment, especially the conditions of micro-gravity. The goal is to prepare astronauts to go to Mars, which we expect will take place before 2040. This technological development together with the International Space Station will help provide a platform to find solutions to the problems of space sickness, loss of bone mass, neurological effects and all the physiological effects that represent a barrier to long-term space flight. The physiological and medical studies, such as specific reactions to medications in space will help prepare for the long-term flights necessary to develop manned bases on the Moon and to reach the planets in the future.

The human problem

NASA says that space is the most hostile environment we will ever explore. Even a single five-hour space walk requires months of training, and a vast technical backup to keep it safe. The astronauts and cosmonauts who live aboard the ISS will be there for only a few weeks or months; if we want to travel into deep space it could take years. First we'll have to find out just how long the human body can survive in a weightless environment. In zero gravity, four pints of body fluid rush from the legs to the head where it stays for the duration of the mission. Astronauts often feel as if they have a permanent cold, and disorientation can become a major problem. In space there's no physical sensation to let you know when you're upside down and astronauts have to rely on visual clues from their surroundings. A few hours after reaching orbit, one in three of all astronauts will experience space sickness - a feeling rather like carsickness. And weightless conditions lead to calcium being lost from the bones, and problems with the astronauts' immune systems.

Trillions of rocky fragments - meteoroids - roam our Solar System at speeds of up to 150,000 miles an hour. A meteoroid, no bigger than a grain of salt, at high velocity could pierce a spaceship window. Protection from the extreme hazards of space is going to need some clever technology. Space is also full of lethal radiation – particle radiation, protons, electrons, helium nuclei, X-rays, gamma rays and the highspeed particles called cosmic rays.

Down here on Earth we are protected by the atmosphere and by our planet's magnetic field, but in space astronauts in long duration flights, may suffer no only gradual, but irreversible radiation sickness unless they are carefully shielded. It is expected that the International Space Station, ISS, will help us crack the problems. The ISS is going to answer a number of questions about long range exploration in space.

Tools of astronomy: An electric car to explore the surface and geology of the Moon

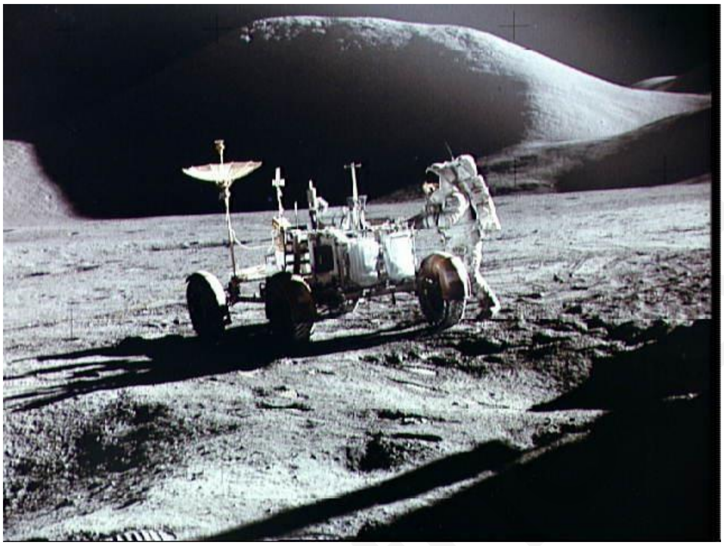


Image credit: NASA. The Earth's Moon and an astronaut about to ride an electric vehicle on the Moon's surface

Similar vehicles will be used in the future bases on the Moon and on the surface of Mars

The development of technological and scientific bases on the Moon, the settlement of small enclosed villages, tourism to space to view the big blue sphere that is the Earth, representing a special view and a special experience of our planet and tourism to the Moon will require detailed scientific knowledge of the long term response of the human body to environments of gravitational acceleration less than that of the Earth as well as environments of micro-gravity. Human accomplishments in space will depend on the development of robotics and on the development of space medicine. **NASA's Plans to go back to the Moon in the 2020's**

Camping out in the cosmos

Mars, for example, doesn't have a strong global magnetic field to deflect radiation particles, and its atmospheric blanket is 100 times thinner than Earth's. These two differences make the radiation dose on the Martian surface about one-third as intense as in unprotected open space, and similar to the surface of the Moon. Future Mars explorers will also need radiation shielding.

Assignments

1. Write a one-page summary of this chapter. What are the main points? The main ideas?
2. Describe the Cassini-Huygens mission to Saturn and its largest moon Titan
3. Describe the robotic exploration of Mars. The Spirit and Opportunity robots
4. Describe the sequence steps for landing on Mars https://www.youtube.com/watch?v=CgUGBVzWnIk
5. How fast does the Space Shuttle travel when it reaches its orbit?
6. Describe the Hubble Space Telescope and its components and use at least one image taken by the Hubble.
7. Describe in one paragraph and with a picture the Kepler Space Telescope as a tool of Astronomy.
8. List the main telescopes of the world.

CHAPTER III
Distances in the Universe

Outline

Objectives

To discuss

1. What is an Astronomical unit? Definition
2. What are the distances to the planets?
3. What is the size of the solar system?
4. Distance to the Kuiper Belt
5. Distance to the Ort Cloud 6. What is the speed of light?
7. What is a Light year? Definition

The distance traveled by light in one year. 6.0 Trillion miles or 10.0 Trillion kilometers

8. Distance to the stars
9. Distance to the nearest star Proxima-Centaury 4.0 light years
10. Diameter of the Milky Way Galaxy
11. Distance from the Sun to the center of the Milky Way Galaxy
12. Distance to the brightest star on the sky Sirius - 8 light years
13. Distance from our home galaxy, the Milky Way Galaxy, to the nearest galaxy, Andromeda
14. Size of the local cluster of galaxies
15. Size of the local super cluster
16. Size of the Universe
17. Distance and time – The farther we look in space the deeper we look into the past
18. Light – minutes. Distance from the Sun to the earth 8 light - minutes (8 minutes and 20 seconds)
19. Distance to Jupiter 42 light-minutes
20. Distance to the dwarf planet Pluto: 5 light- hours and 30 light - minutes
21. The Parsec –Definition 3.26 light years
22. How do we measure distances in the universe?

a. Laser ranging, mirror on the Moon
b. Triangulation
c. Using parallax which varies as 1/distance
d. Using the 1/r2 Illumination Law and Wien's law
e. Using supernovae
f. Examples

23. Summary
24. Conclusions

Review: Scale of the Universe zoom in and out: http://htwins.net/scale2/

The Astronomical Unit

What is an Astronomical Unit? In our daily work it is common to use inches, feet, yards, miles, centimeters, meters, and kilometers. However, when we reach to the planets and the stars, there units are not practical, we need to use different units, different meter sticks. We use the Astronomical Unit, or AU. One AU is the average distance from the Sun to the Earth, or 92,000,000 miles, ninety two million miles.

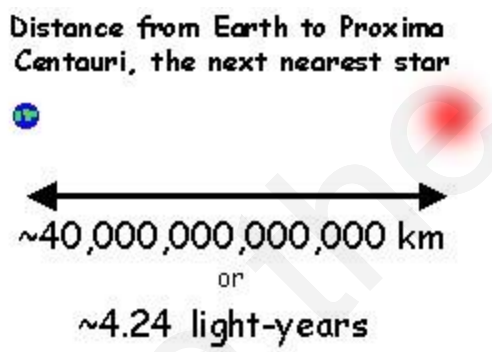
1 AU = 92,000,000 miles

The distances to the planets expressed in AU's are: Mercury 0.38 AU, Venus 0.70, Earth 1.0, Mars 1.52, Ceres 2.8, Jupiter 5.27, Saturn 9.6, Uranus 19.6, Neptune 30.0, Pluto 40.0AU.

Distance to the nearest star, Proxima-Centauri in Astronomical Units: 270,000 AU's

Speed of light and the light year

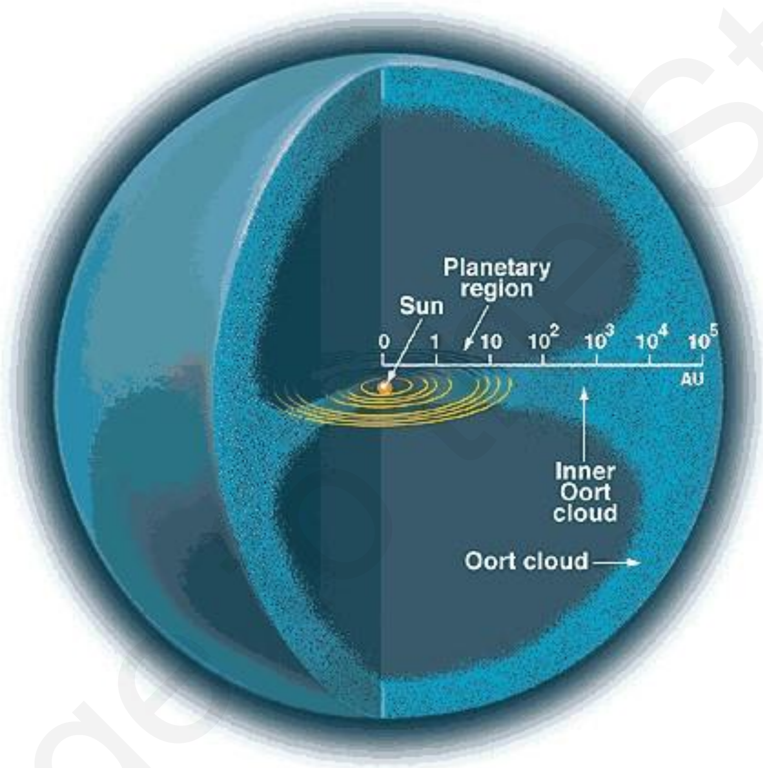
The speed of light in vacuum is 186,000 miles/second or $3x10^8$ meters/second. When we discuss the distance to the stars we use the light year, one light year is the distance traveled by light in one year, which is six trillion miles. The distance to the nearest star is 4.2 light years.



One light year = 6.0 trillion miles or 10 trillion kilometers

The distance between the Sun and the center of our galaxy is 26,000 light years. The diameter of our galaxy is 100,000 light years. The thickness of the disk of the galaxy is 2,000 light years. The distance to the Andromeda galaxy is 2.4 million light years.

Light - Minute, Light-Second. The distance from the Sun to the Earth 8 light-minutes. Light takes 8 minutes to go from the Sun to the Earth. The distance to the Moon is approximately 1.2 light second; it takes approximately 1.2 second for light to go from the Earth to the Moon.



The Kuiper Belt and the Ort Cloud

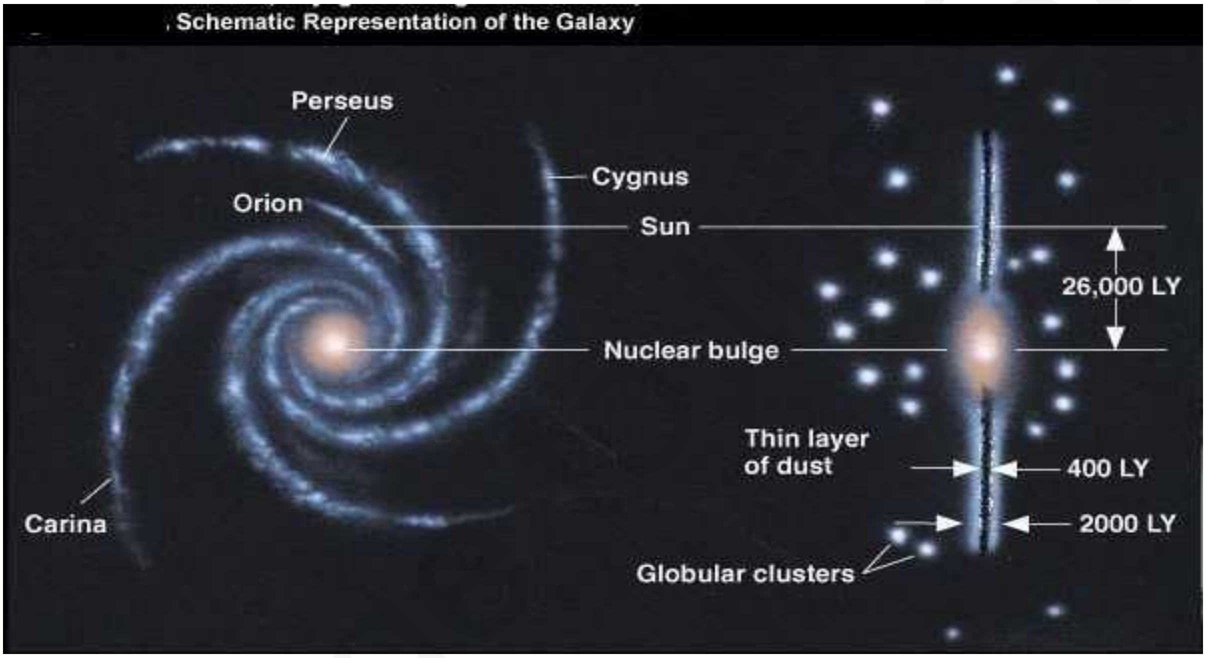
What is the Kuiper Belt? What is the Ort Cloud and how far are they from the Earth?

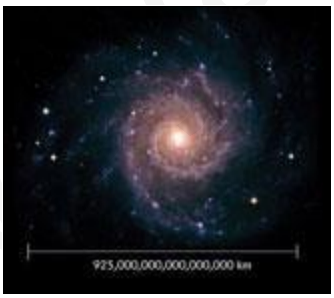
The Kuiper Belt and the Oort Cloud surround our sun, a star. The Kuiper Belt is a doughnut-shaped ring, extending just beyond the orbit of Neptune from about 30 to 55 AU. The Oort Cloud is a spherical shell, occupying space at a distance between five thousand and 100 thousand AUs.

Credit: https://solarsystem.nasa.gov/planets/profile.cfm?Object=KBOs

http://www.astro.rug.nl/~etolstoy/ACTUEELONDERZOEK/JAAR2000/oort/oort_cloud.gif

Distances in the Milky Way Galaxy





Because we dwell within the Milky Way Galaxy, it is impossible for us to take a picture of its spiral structure from the outside. But we do know that our Milky Way has a spiral nature from observations made from within our Galaxy (though whether or not it is a barred spiral is still being debated). To represent this, the beautiful spiral galaxy Messier 74 was used, as it thought to be a similar galaxy to ours.

Image Credit: The Isaac Newton Group of Telescopes, La Palma, and Simon Dye (Cardiff University).

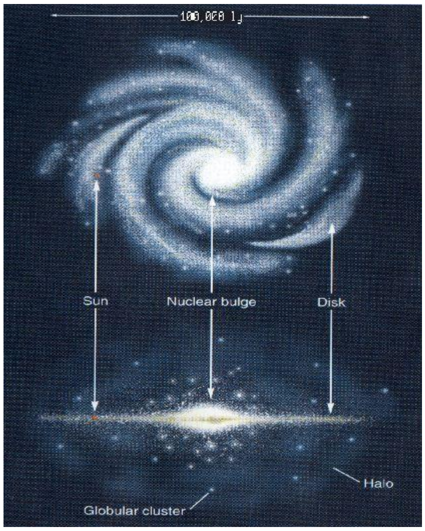
Below is a picture of the real Milky Way taken by the satellite COBE. The disk and center region of our Galaxy are readily recognizable. This image makes the Milky Way appear much more galaxy-like and less like the smudge of stars we see stretching across our night sky. It is possible to imagine what our Milky Way might look like looking down on it from outside.

Image Credit: The COBE Project, DIRBE, NASA

Distance Information

The Parsec. Although the light year is a commonly used unit, astronomers prefer a different unit called the parsec (pc). A parsec, equal to 3.26 light years, is defined as the distance at which 1 Astronomical Unit subtends an angle of 1 second of arc (1/3600 of a degree) When we use the parsec for really large distances, we often put a prefix in front of it - like kiloparsecs (kpc), which are equal to 1000 parsecs - or Megaparsecs (Mpc), equal to a million parsecs.

The Milky Way is about 1,000,000,000,000,000,000 km (about 100,000 light years or about 30 kpc) across. The Sun does not lie near the center of our Galaxy. It lies about 8 kpc from the center on what is known as the Sagittarius arm of the Milky Way.



Andromeda: How far is our nearest neighboring galaxy, the Andromeda Galaxy?

The distance to Andromeda is 2.4 Million light years

Other units for measuring distance in space

Parsec = 3.26 Light year

Kilo Parsec = 1000 Parsecs

Mega Parsec = One million Parsecs, 1,000,000 Parsecs

Chapter III Assignment

Answer the following questions:

1. What is the speed of light? (miles/sec, meters/sec, kilometers/sec)
2. How far is the nearest galaxy to the Milky Way, the Andromeda galaxy?
3. What is an Astronomical Unit?
4. What is a light year?
5. What is a parsec?
6. What is a Kiloparsec, a Megaparsec?
7. How long does a radio message take to reach a robot on Mars?
8. How long does light take to reach the Moon?
9. How long does light take to reach the planet Pluto?
10. How long does light take to reach the nearest star Proxima Centaury?

CHAPTER IV

The Universe: An overview of the Universe

Lecture outline

Objective

To discuss

1. The origins of the Universe. Tracing the universe back to its origin.
2. What is the Big Bang Theory – Author: Georges Lemaître
3. Description
4. Forces that control the Universe
5. Objects in the Universe – What is the Universe made of?
6. Your address in the Universe. Where are you in the universe? What is your address? 7. Description of the Milky Way Galaxy
8. The matter we are made of. Where were the atoms that form the human body made?
9. How old are you?
10. How old is the Universe?
11. How old is the Earth?
12. How many stars are there in the Milky Way Galaxy?
13. How many stars are there in the Universe?
14. Review and perspective
15. What is the time-line from the Big-Bang until now
16. Conclusions

The Big Bang Theory and the evolution of the Universe

Time: 0:00:00:00:00:00

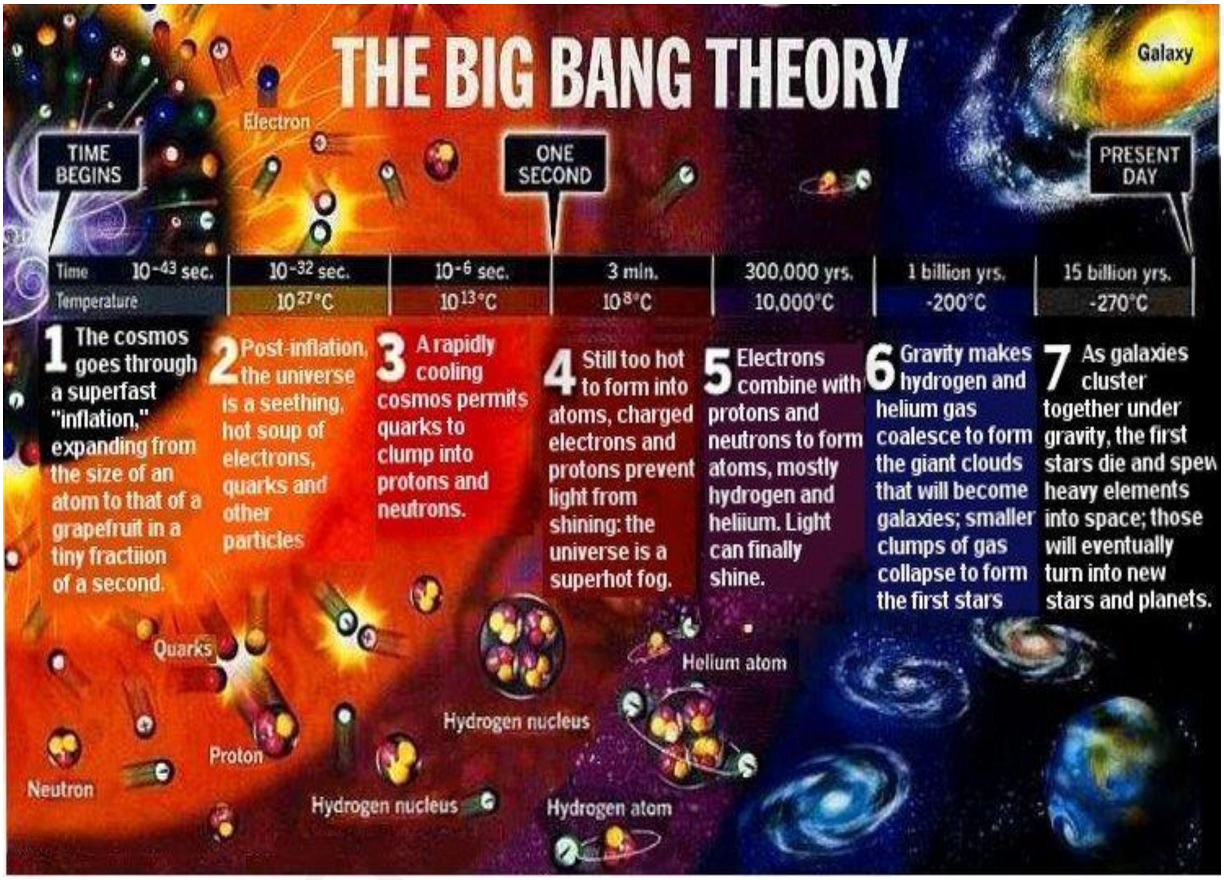
The Universe is created by means of a Big Bang explosion with the laws of Physics built in.
It consists of Energy, subatomic particles, light and the rules.
The Universe is born with a very powerful flash of light.
Sub-atomic particles are formed from light. Matter forms from light
The universe is a small fireball with a temperature of trillions and trillions of degrees No space or time exists outside the fireball there is no outside.

The universe expands through an inflationary process. Energy generates space and time.

Please see the following videos:

https://www.youtube.com/watch?v=LeUcjqqhNxM
https://www.youtube.com/watch?v=uabNtlLfYyU

The Big Bang was an event where space itself “exploded” from a dimensionless point.



View the following simulation of the formation of the Universe

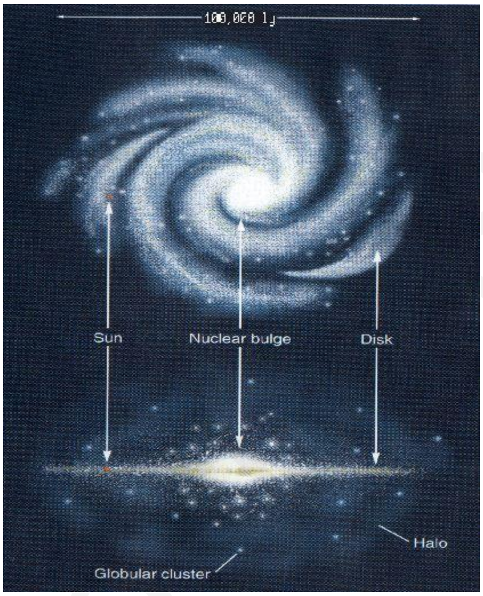
https://www.youtube.com/watch?v=4jXVDeUHMSA

What are the fundamental forces the control the Universe?

1. Gravitational
2. Electromagnetic
3. Nuclear Strong
4. Nuclear weak

In class we will describe and discuss the domain and nature of each fundamental force

Where are you in space? What is your address in the universe?



Images credit NASA and UC Sand Diego
http://cassfos02.ucsd.edu/public/tutorial/MW.html

The Milky Way Galaxy system, our home galaxy, is a spiral galaxy consisting of over 400 billion stars, plus gas and dust arranged into three general components as shown to the left:

- The halo - a roughly spherical distribution of gas and stars which contains the oldest stars in the Galaxy,
- The nuclear bulge and Galactic Center
- The disk, which contains the majority of the stars, including the sun

The Milky Way Galaxy

Image credit: 1. http://www.anzwers.org/free/universe/galaxy.html
2. http://www.astrosociety.org/index.html

This is a drawing of the Milky Way looking down from above. The evidence for this picture is provided below. The Sun is just one of 400 billion stars in this typical barred spiral galaxy that is about 100,000 light-years in diameter.

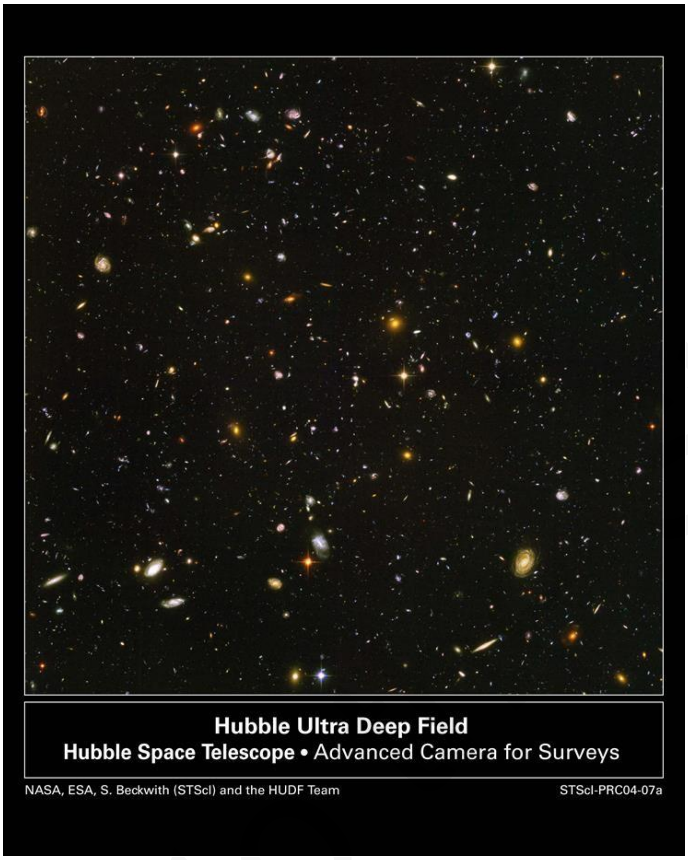
Your address: Earth-solar system-Orion Arm-Milky Way galaxy-local cluster-local super clusters

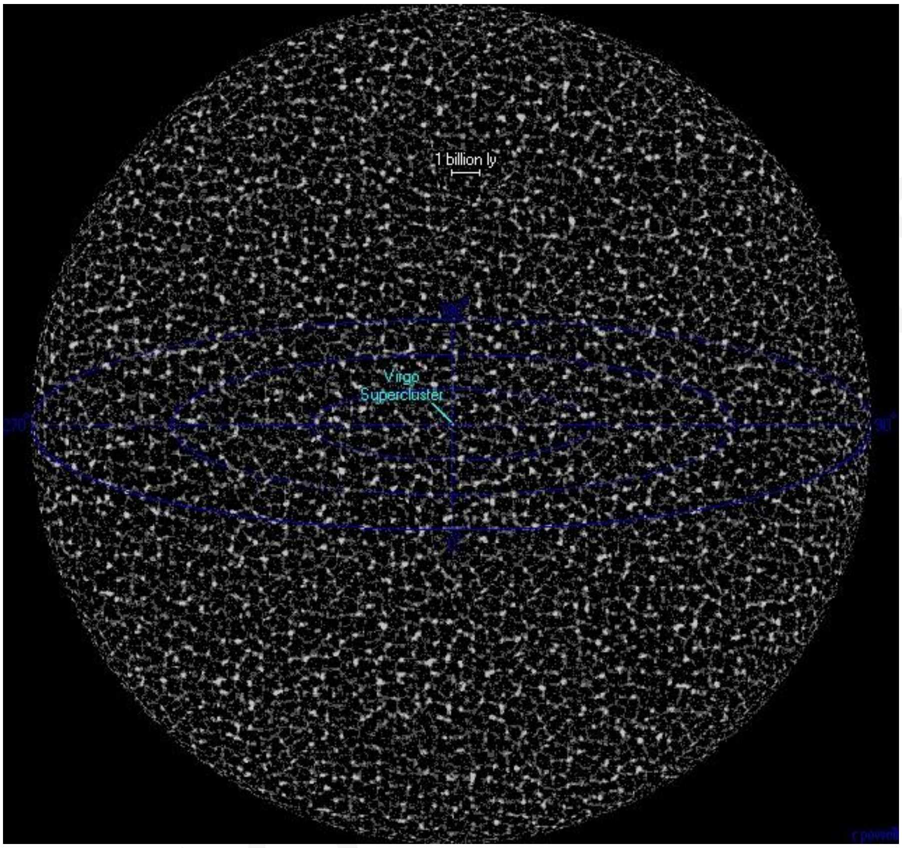
The Size of the Universe

The universe we see is 14 billion years old, therefore with a radius of 14 billion light years.

Observational evidence suggests that the universe we do not see is much larger in mass than the visible universe. There is a large amount of matter that is not observed directly and it has been called dark matter. The universe is expanding at near the speed of light and accelerating faster suggesting that there is an unknown repulsive force. Objects near the visible edge of the universe emitted the light we see 14 billion years ago. The deeper we see into space the deeper into the past we reach. Our visible universe may be a small speck in a much larger reality.

In December 1995, the Hubble Space Telescope was pointed at a blank area of the sky, an area where no objects had been detected before, in Ursa Major for ten days. It produced one of the most famous astronomy pictures of modern times – the Hubble Deep Field Image. Almost every object in the image is a galaxy typically lying 5 to 10 billion light years away. The galaxies revealed here are of all shapes and colors; some are young and blue, whereas others are old, red and dusty. It revealed about 10,000 galaxies.


Hubble Ultra Deep Field
Hubble Space Telescope • Advanced Camera for Surveys
NASA, ESA, S. Beckwith (STScI) and the HUDF Team
STScI-PRC04-07a



This is a representation of the visible universe where every white dot represents a cluster of galaxies formed by up to one million galaxies or more.

A Slice of the Universe

THE VISIBLE UNIVERSE

Each white dot in the image above is a cluster of more than one million galaxies, where each galaxy has up to a trillion stars. There are more stars in the universe than there are grains of sand in all the beaches and deserts of the world. Approximately one centimeter in the figure equals a distance of 2 billion light years.

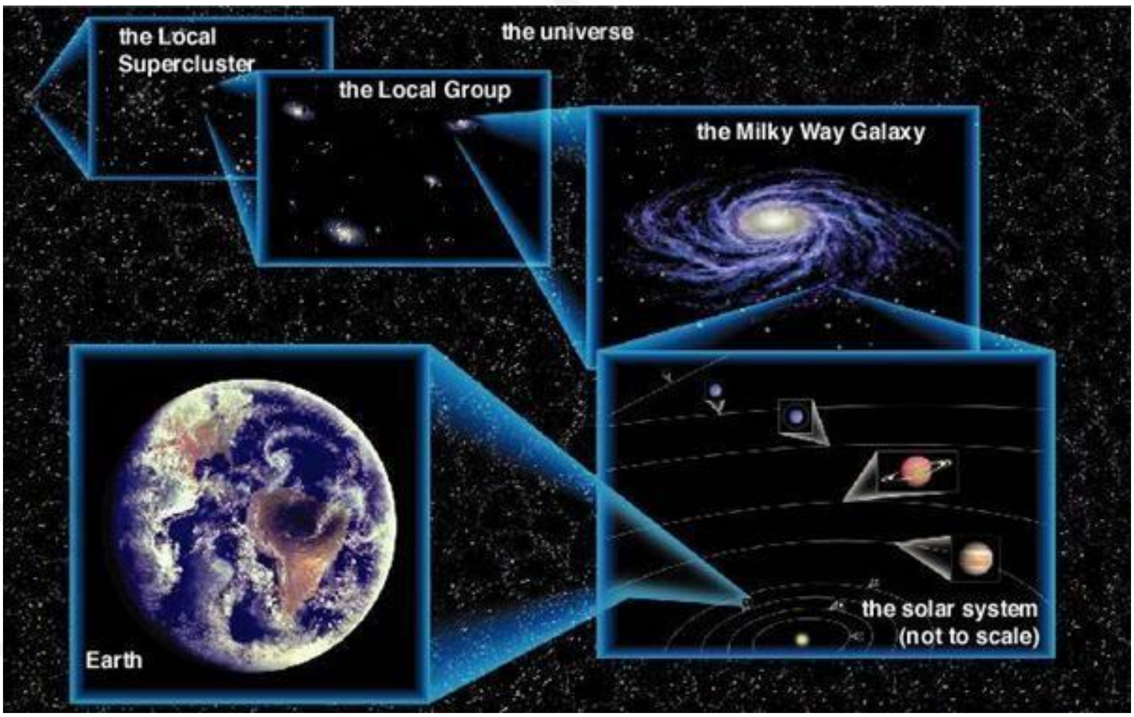
By collecting distances to thousands of galaxies in a narrow strip of the sky galaxies are plotted.

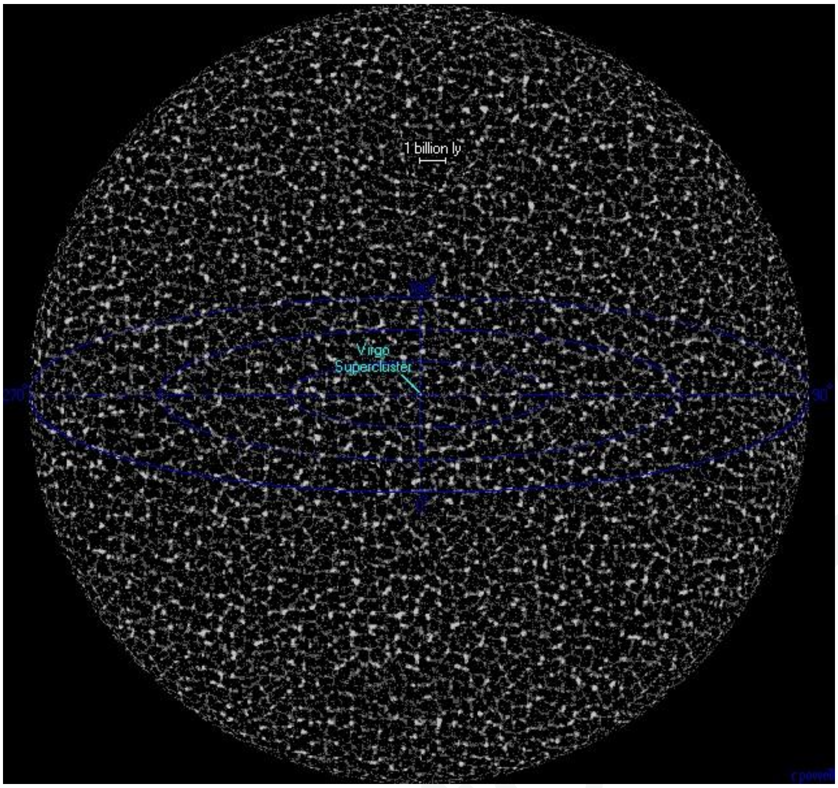
Image credit: http://www.anzwers.org/free/universe/universe.html

Where are you in the Universe?

What is your address in the Cosmos?

Example:
Your address in the universe
Jane Student
LATTC 400 West Washington Blvd
Los Angeles, CA 90015
USA
North America
Earth
Solar System
Orion Arm
Milky Way Galaxy
Local Group
Local Super Cluster
The Virgo Cluster
The visible Universe





The visible Universe and the Virgo Super Cluster

Go to the following web site

http://www.classzone.com/books/earth_science/terc/content/visualizations/es2808/flash/ es2808_galaxy_ g.swf and zoom out from the earth to the universe

Review: Go to the following web site and review your knowledge of the Universe

http://htwins.net/scale2/

What is the Universe made of?

Celestial objects. What kinds of objects do we find in the universe?

A Survey.

Stars. Spherical electrified gas, plasma, made mostly of hydrogen and helium and held together by the force of gravity, and the pressure from the inside due to the heat produced by thermonuclear reactions at the core.

Star clusters. Group of stars up to ten million generally found above and below the galactic disk.

Star superclusters

Planets. Celestial objects that move around a star, example the Sun, and are a part of the original solar system

Moons Celestial objects moving in orbit around a planet

Asteroids. Remnants of the solar system found mainly between the orbits of Mars and Jupiter. They are made mostly of iron and nickel and vary in size from the size of a house to the size of half the state of California

Comets. Icy bodies that originate in a cloud of frozen objects that surrounds the solar system, the Ort cloud and the Kuiper belt.

Gas clouds

Dust clouds

Galaxies

Clusters of galaxies

Super-clusters of galaxies

Stellar winds

Novae

Supernovae

Neutron stars

Black holes

Quasars

Hypervelocity stars

Red giants

Super giants

Blue giants

White dwarfs

Black dwarfs

Dark matter

Dark energy

Pulsars

Magnetars

Review: The forces that control de universe

Gravitational. This force takes place between any two objects in the universe and is directly proportional to the masses of the object and inversely proportional to the square of the distances between the objects. It ranges from the closest distances between subatomic particles to the edge of the universe.

Electromagnetic. This force takes place between all electrically charged particles. It is the force that holds the atoms together and holds you together as a unit.

Nuclear Strong. This is the force that holds the atomic nucleus together, it has a short range it ends at the edge of the nucleus

Nuclear Weak. It is the force that takes place inside the nucleus of an atom and is responsible for the phenomenon of radioactivity

Distances

The Astronomical Unit Examples . The Light Year. Examples

Time - line from the Big Bang to the present. Discussion of the time - line for the Universe

Timeline: Review of a 12 - month representation of the evolution of the Universe from the Big Bang until today.

Assignments

1. Write a one-page summary of this chapter. What are the main ideas and concepts?
2. What is the Big Bang?
3. How old is the Universe?
4. How old is the Milky Way Galaxy?
5. How old is the Sun?
6. How old is the Earth?
7. When did life first appear on Earth?
8. How old are the oceans and the atmosphere of the Earth?
9. Where did the water in the oceans come from?
10. What is the Cambrian explosion of diversity of life and when did it happen?
11. When did plants first form on land?
12. When did the first amphibians move to the land?
13. When did the first dinosaurs appear, developed through evolution?
14. What is Pangea?
15. When did the dinosaurs become extinct?
16. Why did the dinosaurs become extinct?
17. When did the human looking creatures first appear, through the evolutionary process, on Earth?
18. When did modern humans develop?
19. When did humans become an agricultural civilization?
20. How old is modern technological civilization?
21. Select twelve celestial objects listed above and look up their description in an encyclopedia of science
22. Where are you in the Universe?
23. Describe the structure of the universe going from the smallest to the largest objects
24. Describe the US Fermi Lab and the European Large Hadron Collider. Describe how they try to reproduce the conditions of the first seconds of the Big Bang.
25. And how this (24) helps to understand the Big Bang.

CHAPTER V

The History of Astronomy

In order to study the history of astronomy, we divide it into five periods

Periods

1. Pre-historic - Before 5000 BC
2. Ancient – 5000 BC to 500 BC
3. Classical 500 BC to 1450 AD
4. Renaissance 1450 AD to 1650 AD

5. Modern 1650 AD to the Present

    a. Pre-Space Age – Before October 1957.
    b. Space Age – After October 1957

The history of Astronomy is divided into five major periods

1. Pre-historic. Before 5000 BC

http://mars.jpl.nasa.gov/gallery/artwork/neanderthals.html

Example: Artist's rendition of Earth approximately 60,000 years ago

Image credit: NASA

This image shows a family of Neanderthals. The Neanderthals lived in the Northern and Western areas of Eurasia, during the Pleistocene epoch, in the time of the last Ice Age. Neanderthals looked very similar to modern humans. They had slightly more pronounced foreheads, wider noses and larger jaws. They were short and stocky, robust people. The Neanderthals were hunter-gatherers. They created stone tools and weapons, wore garments made of leather and fur. They wore ornamental jewelry and buried their dead ceremonially. Neanderthal also used fire. They lived in Plains, Forest and Mountain areas. Plant foods were only eaten seasonally, so up to 90% of their diet was meat.

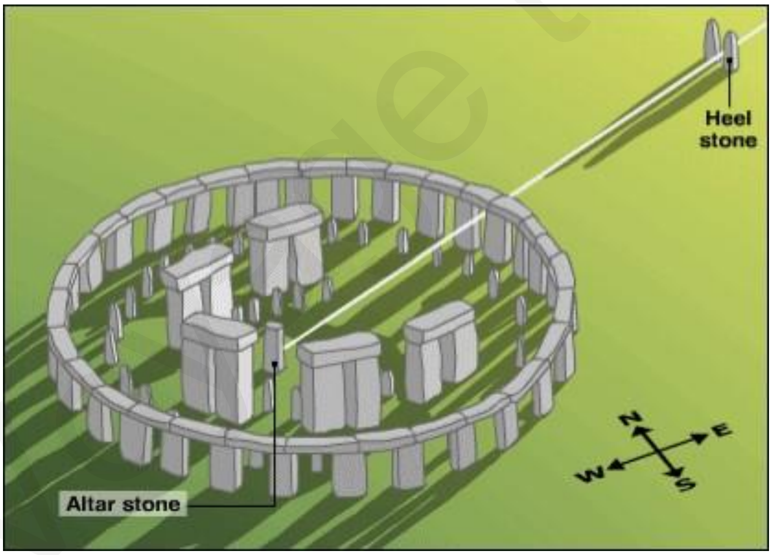
Neanderthal man appears to have "died out" about 40,000 years ago. It is speculated that he was outcompeted by modern man (Cro Magnons). Neanderthals vanished about 12,000 years after contact with Cro Magnon Man.

Many ancient civilizations, such as Egyptian, Chinese, European, native American and Polynesian combined astronomy and astrology and used for navigation and for determining the season to apply it as a management tool for agriculture, guidance for sea voyages and religious ceremonies.

There are caves in France that show paintings of the night sky with identifiable features such as supernova events. These have been dated and represent valuable astronomical information.

2. Ancient, 5000BC to 500 BC

Example: Stonehenge



Alignments of windows and sun light during the morning of the summer solstice

Stonehenge: An observatory, a temple, a seasonal clock, a place of celebrations to mark the start of the seasons. Astronomy- Astrology and Religion and celebrations for the start of the seasons, were all combined together.

Example: Egyptian Astronomy: The alignment of the Pyramids

The Babylonians

(The region of Irak today)

The old Babylonian Astronomy refers to the period of about 2000BC to 500BC.

The Babylonians were the first to recognize that astronomical phenomena are periodic and apply mathematics to their predictions. Tablets dating back to the Old Babylonian period document the application of mathematics to the variation in the length of daylight over a solar year. Centuries of Babylonian observations of celestial phenomena are recorded in the series

of cuneiform. The oldest significant astronomical text that we possess is Tablet 63, which lists the first and last visible risings of Venus over a period of about 21 years.
It is the earliest evidence that planetary phenomena were recognized as periodic.

There are catalogues of stars and constellations as well as schemes for predicting risings and settings of the planets, and lengths of daylight.

There are dozens of cuneiform Mesopotamian texts with real observations of eclipses, mainly from Babylonia.

Old Astronomy in Malaysia, China and India

Example: Uses of astronomy in navigation and

agriculture applications Please see the following web

site

http://en.wikipedia.org/wiki/History_of_astronomy#Ea

rly_history Other examples: **Aztec and Maya**

Astronomy

http://www.astrosociety.org/edu/resources/multi3.

ml

Ancient Astronomy in Africa

https://www.news.uct.ac.za/article/-2014-12-02-

africas-ancient-astronomers-made-their-mark-in-

culture-folklore

https://en.wikipedia.org/wiki/History_of_science_and_

technology_in_Africa#Astronomy

3. Classical period 500 BC to 1450 AD

Focus and Results: Models of the solar system

Plato first proposed that the planets followed perfect circular orbits around the Earth. Later, Heraclides (330 B.C.) developed the first Solar System model; placing the planets around the Earth it was called the geocentric solar system model.

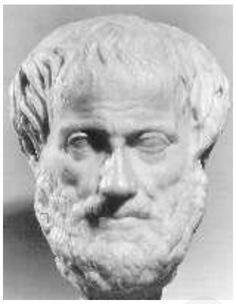
Note that orbits are perfect circles (for philosophical reasons all things in the Heavens were considered "perfect"). Heraclites model became our first model of the cosmology of things outside the Earth's atmosphere.

Aristarchus (270 B.C.) proposed an alternative model of the Solar System placing the Sun at the center with the Earth and the planets in circular orbit around it. The Moon orbits around the Earth. This model became known as the heliocentric model of the solar system.

Classical Period: 500 BC to 1450 AD

Aristotle

(384-322 BCE)

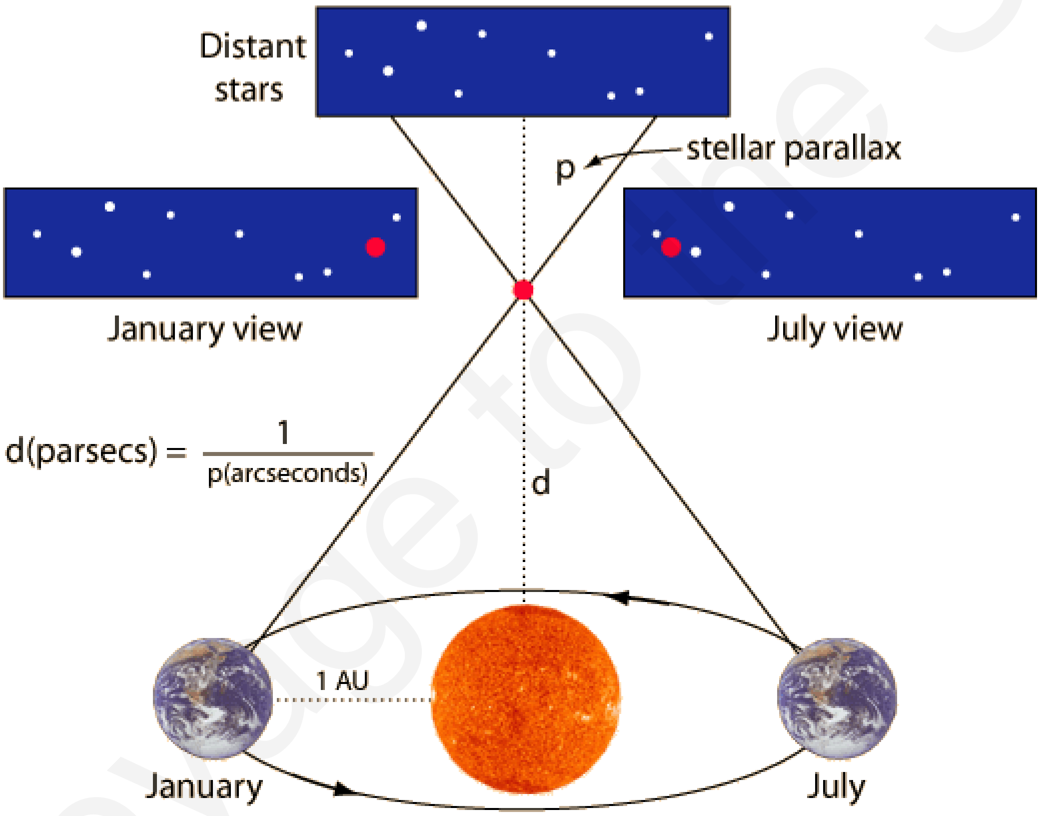


Born in northern Greece, at the city of Stagira, Aristotle was the most notable result of the educational system and program devised by Plato; he spent twenty years of his life studying at Plato’s Academy. When Plato died, Aristotle returned to his native Macedonia, where it is said that he participated in the education of King Philip's son, Alexander the Great. He came back to Athens with Alexander's approval in 335 and established his own school at the Lyceum, spending most of the rest of his life engaged there in research, teaching, and writing. His students acquired the name "peripatetics" from the master's habit of strolling about as he taught. Although the surviving works of Aristotle probably represent only a fragment of the whole, they include his investigations of an amazing range of subjects, from logic, philosophy, and ethics to physics, biology, psychology, politics, and rhetoric. Aristotle appears to have thought through his views as he wrote, returning to significant issues at different stages of his own development. The result is less a consistent system of thought than a complex record of Aristotle's thinking about many significant issues.

Aristotle also determined that the Earth is round by observing the shadow of the Earth on the Moon during a lunar eclipse. He determined that the Earth had a diameter three times larger than the diameter of the Moon. Aristotle argued that the Earth was the center of the solar system because of the absence of an observed parallax Parallax. The concept of parallax will be explained in detail in class.

Aristotle used the observed absence of parallax to argue against the heliocentric model of the solar system proposed by Aristarchus.

Geocentric Model of the solar system and the Universe



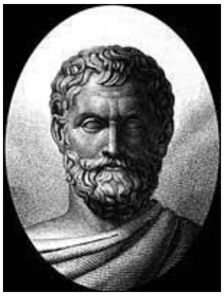
Stellar Parallax

Aristotle's argument: He considered the absence of stellar parallax, as observed with the human eye, as evidence that the Earth was the center of the solar system. We know now that there is stellar parallax, but it is so small that it can't be observed by the unaided human eye.

Aristarchus: The Heliocentric model of the solar system, with the Sun at the center.

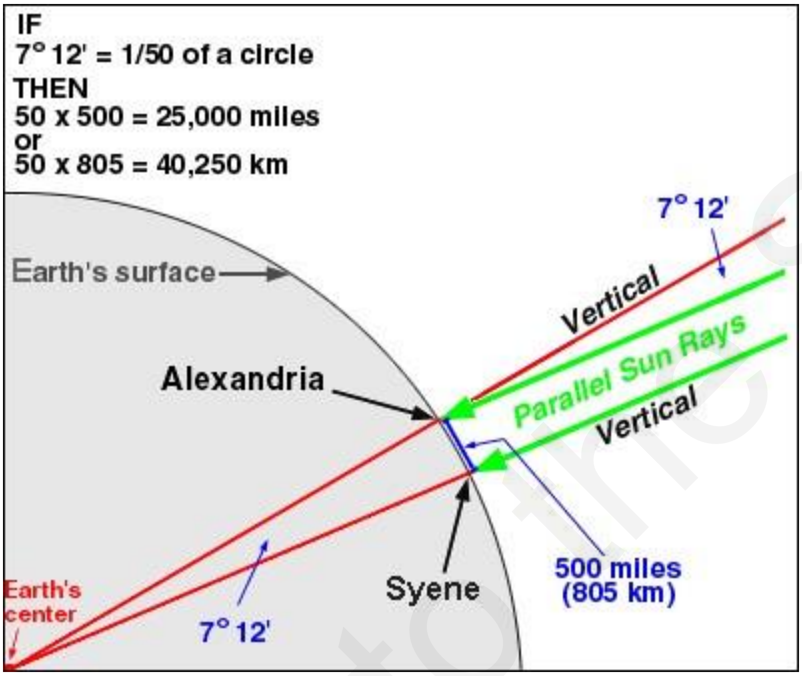
Eratosthenes

Eratosthenes of Cyrene was a Greek astronomer. He was a man of learning, becoming the chief librarian at the Library of Alexandria.
Born 276 BC
Died 194 BC
He was the first to measure the size, the circumference and the diameter of the earth



How did Eratosthenes measure the size, the circumference and radius of the Earth?

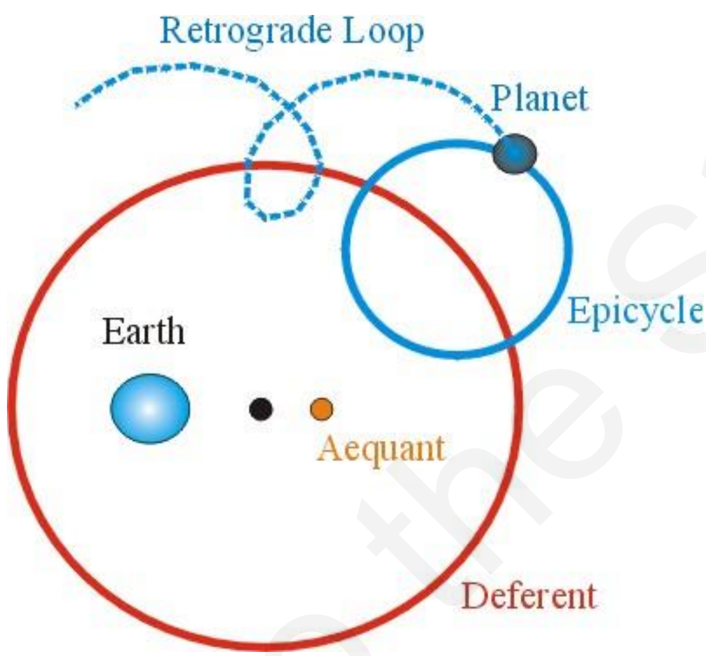
Using the shadows of two sticks at two locations, separated by 500 miles, at noon during the first day of summer and using geometrical principles.



Ptolemy. 90AD - 168 AD

Greek Astronomer, mathematician and geographer from Alexandria

Author of the "theory" of epicycles



To solve the problem of the retrograde motion of Mars he invented the imaginary concept that planets move in small circles, epicycles, within their own orbits.

Retrograde motion simulator https://www.youtube.com/watch?v=1nVSzzYCAYk

http://astro.unl.edu/classaction/animations/renaissance/retrograde.html

To look at a short biography of Ptolemy you can read http://en.wikipedia.org/wiki/Ptolemy

For an animation of Ptolemy's model, please go to the following web site:

http://www.polaris.iastate.edu/EveningStar/Unit2/unit2_sub1.htm

Native American Astronomy

The painting on this rock, made by Anasazi Americans in the 11th century, might depict the rare appearance of a bright explosion of a dying star. The supernova of AD 1054 (of which the Crab Nebula is a result) and the Moon were in this configuration when the supernova was near its brightest. An imprint of a hand at the top signifies that this is a sacred place.

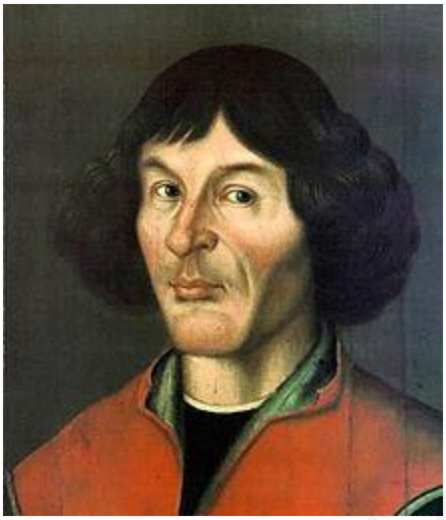
Assignment:

1. Who are the main participants of the Classical Period of Astronomy?
2. How are the models of the solar system of Aristotle, Aristarchus and Ptolemy different and similar?
3. Who was the first astronomer to measure the circumference of the Earth and by what method?
4. What were the numerical results found in question 3 above?

Chapter VI

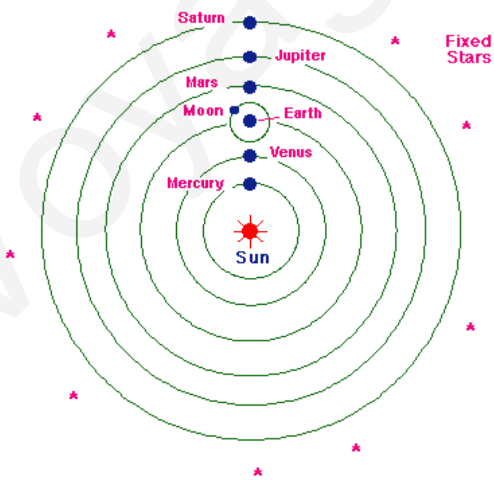
4. The Renaissance Period 1450 to 1650 AD

Nicolaus Copernicus



Portrait, 1580, Toruń Old Town City Hall

Nikolaus Kopernikus; (19 February 1473 – 24 May 1543) was a Renaissance mathematician and astronomer who formulated a heliocentric model of the universe which placed the Sun, rather than the Earth, at the center



Heliocentric Model of the Solar System

Born on Feb. 19, 1473, in Thorn (Torun), Poland, Nicolaus Copernicus was destined to become, through the publication of his heliocentric theory 70 years later, one of the foundational figures in the history of Astronomy. He was the son of a wealthy merchant, he was raised after his father's death by a maternal uncle, who enabled him to enter the University of Krakow, a famous institution for its science, mathematics, philosophy, and especially for its astronomy curriculum. This experience motivated Copernicus to study further liberal arts at Bologna (1496-1501), medicine at Padua, and law at the University of Ferrara, from which he emerged in 1503 with the doctorate in canon law. Shortly afterward he returned to Poland and eventually settled permanently at the cathedral in Frauenberg, less than 100 miles from his birthplace. Through his uncle's influence he had been elected a canon of the church even before his journey to Italy. Copernicus not only faithfully performed his church duties, but also practiced medicine, wrote a treatise on monetary reform, and turned his attention to a subject in which he had long been interested in, Astronomy.

By May 1514 Copernicus had written and discreetly circulated a manuscript, the first outline of those arguments eventually substantiated in De revolutionibus orbium coelestium (On the Revolutions of the Heavenly Spheres, 1543). This classic work challenged the geocentric cosmology that had been dogmatically accepted since the time of Aristotle.

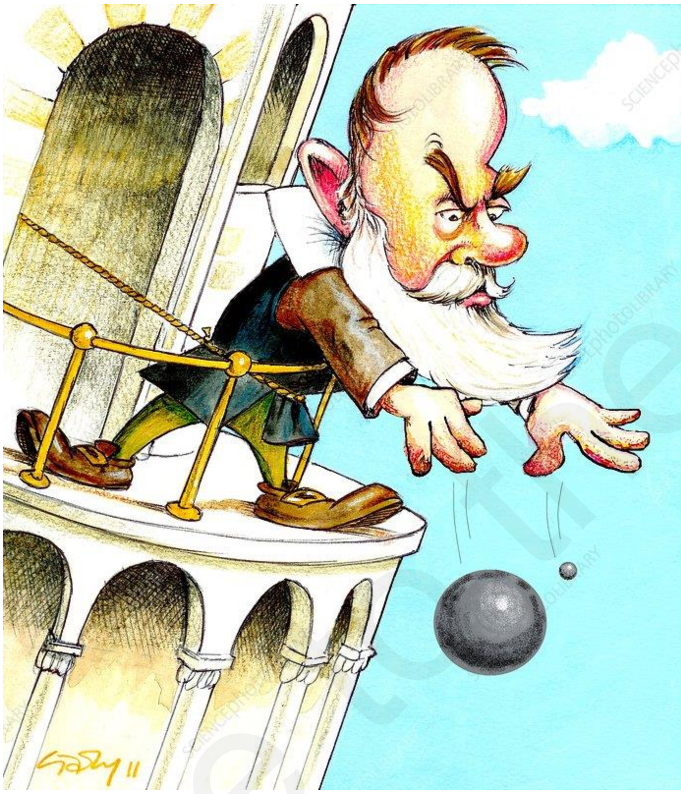
In direct opposition to Aristotle and to the astronomer Ptolemy, who enunciated the details of the geocentric system based on the celestial phenomena, Copernicus proposed that a rotating Earth revolving with the other planets about a stationary central Sun could account in a simpler ways for the same observed phenomena of the daily rotation of the heavens, the annual movement of the Sun through the ecliptic, and the periodic retrograde motion of the planets.

The enunciation of the heliocentric theory by Copernicus marked the beginning of the scientific revolution, and of a new view of the universe. It was a shift away from the comfortable anthropocentrism of the ancient and medieval world which closely matched the theological models and religious concepts. This scientific theory that impacted the perception of humanity was not welcomed by the church, and it was only after the publication (1540) of Narratio prima (A First Account), by an enthusiastic supporter named Rheticus, that the aged Copernicus agreed to commit to print the theory already outlined in 1514. An undocumented, but often repeated, story holds that Copernicus received a printed copy of his treatise on his deathbed. He died on May 24, 1543. One year later his book was published and became a topic of extreme controversy.

Galileo Galilei February 1564 - January 8, 1642

Galileo Galilei was a university professor who carried out many Physics experiments and developed the law of inertia, which Newton integrated into what we now know as Newton’s Laws of Motion. We state the first law of motion as an object at rest will remain at rest for ever unless acted upon by an external force and an object in motion with constant, uniform velocity will remain in motion for ever unless acted upon by an external force.

Galileo learned about the telescope invented by lens makers in the Netherlands and constructed a new telescope with a magnification of 30 and aimed it to the heavens. He studied the Moon, Venus and Jupiter and used these observations to develop arguments to refute Aristotle's claims. In this process, he wrote two books titled Two New Sciences, where he presented his arguments and observations. These publications offended the authorities because they had made Aristotle's statements into theology. They claimed that by offending their theology, Galileo had offended God and that called for severe punishment. He was put on trial and after being forced to deny his scientific discoveries he was made to kneel and show repentance and apologize. It is said that as he stood up, he whispered "but it moves nevertheless". Meaning that the Earth moves around the Sun and it didn't matter what they did to him. What he had discovered was a scientific fact and somebody else would discover it sooner or later. He then was sentenced and placed under house arrest for the rest of his life. For a short biography please read: http://en.wikipedia.org/wiki/Galileo_Galilei



Representation of Galileo in the process of discovering the Law of Falling Bodies

by testing and dropping light and heavy objects from the Tower of Pisa.

All objects fall with the same acceleration (g = 9.81 meters per second squared)

and reach the ground at the same time independent of their masses if we neglect

the force of friction with the air.

A similar experiment on the Moon Apollo Mission

A hammer vs. a feather

https://www.youtube.com/watch?v=KDp1tiUsZw8

Name: **Tower of Pisa, Leaning Tower of Pisa, Bell Tower of Pisa**
→ Italian Name: **Torre Pendente di Pisa**
→ Location: **City of Pisa, Italy.**
→ Construction Year: **started in 1173, finished in 1399**
→ Original Height: **60 m**
→ Actual Height: **56.67m =highest side; 55,86m =lowest side**
→ Stairs: **251 steps**
→ Weight: **14,500 tonnes**

Leaning angle 4 degrees

Summary of Galileo's main contributions

1. The astronomical telescope
2. Observations of the Moon. The Moon has valleys, craters, and mountains. Contrary to Aristotle's idea of a smooth surface.
3. Discovery of the moons of Jupiter. They move around Jupiter; they don't move around the earth as predicted by Aristotle
4. Discovery of the phases of Venus. Evidence that Venus moves around the Sun, not the Earth.
5. Discovery of the Law of Falling Bodies. Objects fall at the same rate, with the same acceleration, contrary to Aristotle's statement that heavy objects fall first.
6. Discovery that the Milky Way was made of many stars
7. Precise, strict, application of the Scientific Method
8. A book titled Two New Sciences

At this point we will watch a video on Galileo and his work on Astronomy
Video: Title: Galileo: Battle for the Heavens

https://www.youtube.com/watch?v=VnEH9rbrIkk
http://www.pbs.org/wgbh/nova
/galileo/
http://www.youtube.com/watch
?v=YgtOX W1s
http://www.youtube.com/watch
?v=GmwAr54L_pM

Tycho Brahe 1546-1601 AD

Tycho Brahe made measurements of the positions and movements of celestial objects for 35 years. These measurements were used by Johannes Kepler to discover the three laws of planetary motion.

Johannes Kepler 1571 – 1630 AD

Johannes Kepler
Mathematician

Johannes Kepler was a German mathematician, astronomer, and astrologer. A key figure in the 17th century scientific revolution, he is best known for his laws of planetary motion, based on his works ... Wikipedia

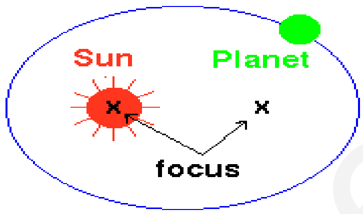
Born: December 27, 1571, Weil der Stadt, Germany
Died: November 15, 1630, Regensburg, Germany
Education: Tübinger Stift (1587–1591)
Parents: Katharina Kepler, Heinrich Kepler
Children: Ludwig Kepler, Heinrich Kepler, Sebald Kepler, More

Kepler discovered three laws of planetary motion based on an extensive analysis of Tycho's observational data.

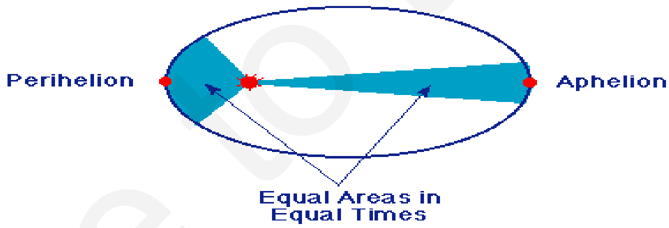
Watch a video on Kepler and his work on Astronomy Karl Sagan's Cosmos series Harmony of the Worlds Episode 3. http://vimeo.com/68345820

Kepler's Laws of Planetary Motion

Law I: Each planet revolves around the Sun in an elliptical path, with the Sun occupying one of the foci of the ellipse.



Law II: The straight line joining the Sun and a planet sweeps out equal areas in equal intervals of time**.**



Law III: The squares of the planets' orbital periods are proportional to the cubes of the semi major axes of their orbits.

$$P^2 = [4\,\pi^2/GM]\;a^3$$

If P is expressed in years and the semi-major axis in Astronomical units, then we can write the 3rd law as:

$$P^2 = a^3$$

Kepler's laws apply not just to planets orbiting the Sun, but to all cases in which one celestial body orbits another under the influence of gravitation -- moons orbiting planets, artificial satellites orbiting the Earth and other solar system bodies, and stars orbiting each other and around the Galaxy.

Assignments:

1. Go to the following web page and see an animation of planetary motion and Kepler's laws:

http://www.drennon.org/science/kepler.htm

http://home.cvc.org/science/kepler.htm

http://www.kepler.arc.nasa.gov/johannes.html

http://astro.unl.edu/naap/pos/animations/kepler.swf

http://www.physics.sjsu.edu/tomley/Kepler12.html

2. Important: Watch the following video **Cosmos episode 3**, Titled "The harmony of the Worlds" by Carl Sagan

   http://vimeo.com/68345820

   And write a short summary

Assignments

1. Write a short summary of Chapter 6
2. Describe the telescope developed by Galileo
3. Write a short biography – At least one paragraph - about Copernicus, Galileo, Tycho Brahe and Johannes Kepler,
4. Describe the work of Galileo Galilei - His contributions to Astronomy
5. Write a short summary of the video: Galileo: Battle for the Heavens

6. Describe Kepler's laws of planetary motion

7. Watch the following video: **Cosmos episode 3**,
   Titled "The harmony of the Worlds" by Carl Sagan **http://vimeo.com/68345820**

Chapter VII

5. Modern Period: 1650 AD to the Present

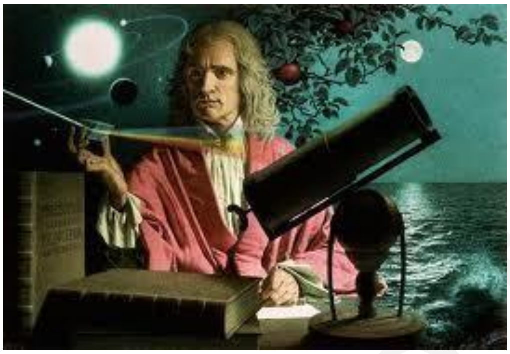
In this book, I have subdivided the Modern period into two major sub periods

a. Pre-Space age
b. Space Age

a. Pre-Space Age

Isaac Newton

The Birth of Astrophysics with Isaac Newton



Newton using Galileo's discoveries and his own experiments and analysis develops what today we call Newton's laws of motion, which apply to all macroscopic motion in the universe. He also studied light and its properties. Also, he developed the first accurate mathematical formulation of the universal law of gravitation. He also invented modern Mathematics.

Watch the following videos

1. https://www.youtube.com/watch?v=X09rtF7WMjI

2. https://www.youtube.com/watch?v=BWY0garE0Q

3. https://www.youtube.com/watch?v=PCxP24qj2UQ

4. https://www.youtube.com/watch?v=UuFAfD7Krhk

5. https://www.youtube.com/watch?v=qNaNyr3GpBQ

Newton's Laws of Motion

1. **1st Law. Law of Inertia**. An object at rest will remain at rest for ever unless acted upon by an outside unbalanced force. An object in motion with constant uniform velocity will remain in motion with constant uniform velocity for ever unless acted upon by an outside unbalanced force.
2. **Second Law. F = m a**

   a = F/m F = Net applied force m = Mass a = Acceleration

   Force equals mass times acceleration

3. **Third Law. Action - Reaction**

   For every action there is an equal and opposite reaction

The Law of Universal Gravitation

M1 = Mass 1

M2 = Mass 2

D = Distance between Masses 1 and 2

F= - $[GM1 \times M2/d^2]$ **r**

The invention of the Calculus and Modern Mathematics

The Reflecting Telescope

A Theory of Light
The application of the Calculus and the Law of Universal Gravitation to explain Kepler's Laws of Planetary Motion.

These accomplishments gave birth to modern Astrophysics

Pierre Simon Laplace: The Nebular Hypothesis

Pierre-Simon, marquis de Laplace was a French Mathematician and Astronomer whose work was pivotal to the development of Mathematics Astronomy and Statistics

Born: March 23, 1749, Beaumont-en-Auge, France

Died: March 5, 1827, Paris, France

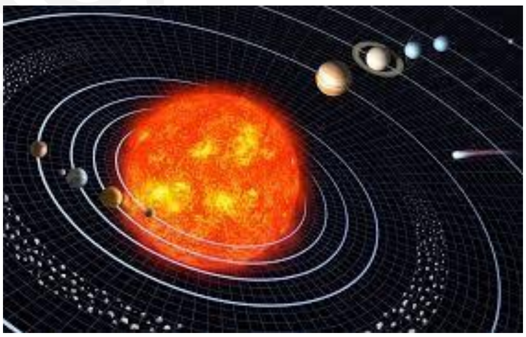
Education: Caen University

Spouse: Marie-Charlotte de Courty de Romanges (m. 1788) **Books:** A philosophical essay on probabilities

Immanuel Kant: The Nebular Hypothesis

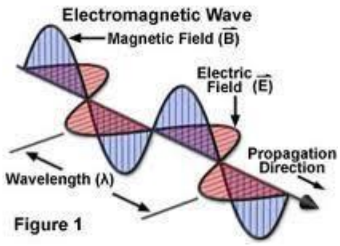
German - Born 22 April 1724, Prussia
Diesd 12 February 1804 (79) , Prussia

The Nebular Hypothesis: The solar systems originated in a nebula, a cloud like this one



Clerk Maxwell 1885

Maxwell explains Electromagnetism. The discovery that light is an electromagnetic wave.



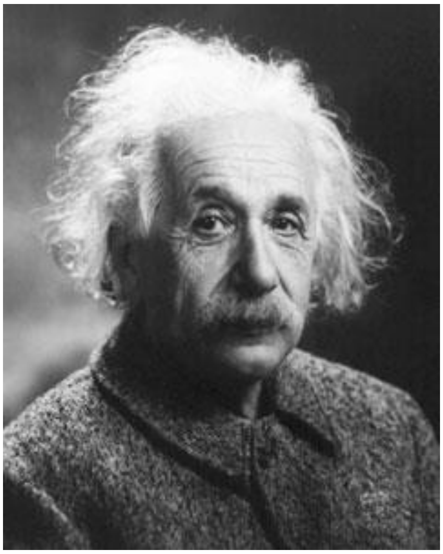
J. J. Thomson 1897

Discovered the electron

Planck 1900

Discovers the Quantum of light. The Quantum of energy.

Albert Einstein 1879 – 1955



Library of Congress public domain image

Developed the Theory of Special relativity
Developed the Theory of General Relativity
Developed the foundations of Quantum Mechanics through the explanation of the Photoelectric Effect

Developed a theory of cosmology. In 1905 he derives the equation

$E = mc^2$ m=

mass c = The

speed of light in

vacuum

E = Energy

It helped explain how stars work

Time and space dilate and contract

Time and space are not separate. They form Space-Time
Gravity is the bending of space-time

E. Rutherford 1909

The discovery of the atomic nucleus

Niels Bohr 1913

Puts all the discoveries together and develops the first quantum model of the atom

De Broglie 1923

Develops the theory of matter waves

Heisenberg 1926

Develops the Theory of Quantum Mechanics

Schrodinger 1926

Develops the Theory of Quantum Mechanics

Le Maitre – The Big Bang Theory 1923

Develops the Theory of the Big Bang

Hans Bethe 1954

Explains nuclear fusion inside stars

Assignment

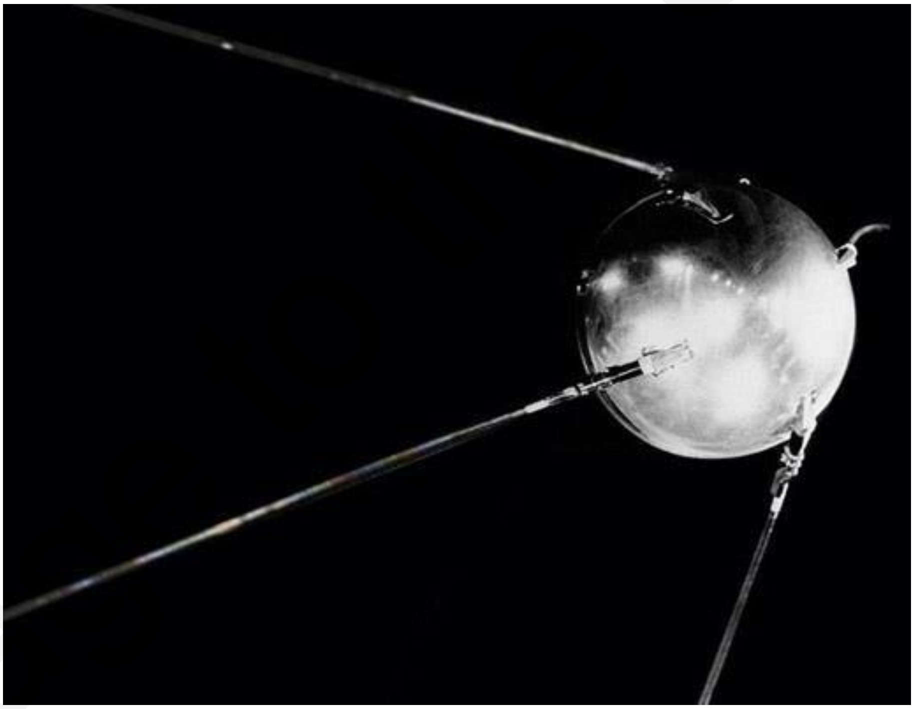
1. Describe the work of Isaac Newton
2. Describe Newton's laws of motion
3. Describe Newton's Law of Universal Gravitation
4. Describe the Nebular Hypothesis
5. Describe the work of Albert Einstein
6. Describe the work of Han Bethe

Chapter VIII. The Space age

The space age initiated by the launch of the Sputnik spacecraft in October 1957 initiated a period of unprecedented astronomical discovery, since astronomers could now overcome the limitations of the atmosphere, which blocked the view of the universe. The launch of satellites and observatories such as the Hubble Space Telescope brought a new era in Astronomy.

Research each spacecraft below and describe it and its mission in one

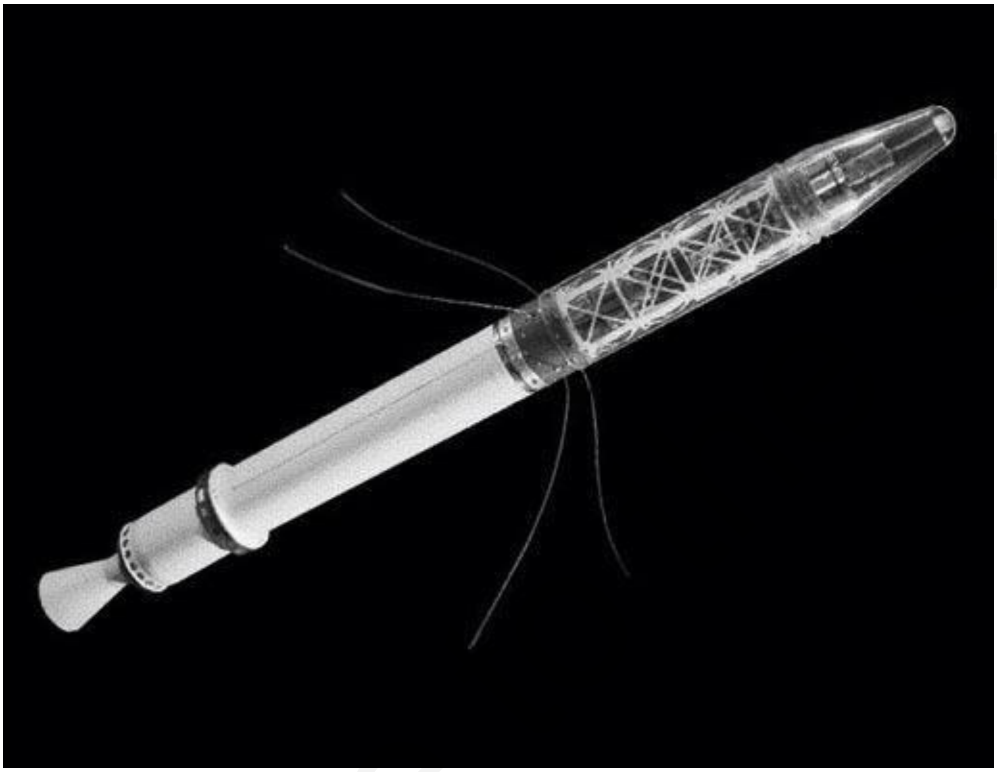
paragraph Sputnik



The Soviet Union launched Sputnik 1 on Oct. 4, 1957. The world's first artificial satellite, Sputnik 1 was a 183-pound beach ball-sized sphere that took about 98 minutes to orbit Earth. The launch of Sputnik marked the start of the space age and the U.S. – U.S.S.R. space race.

Image Credit: NASA

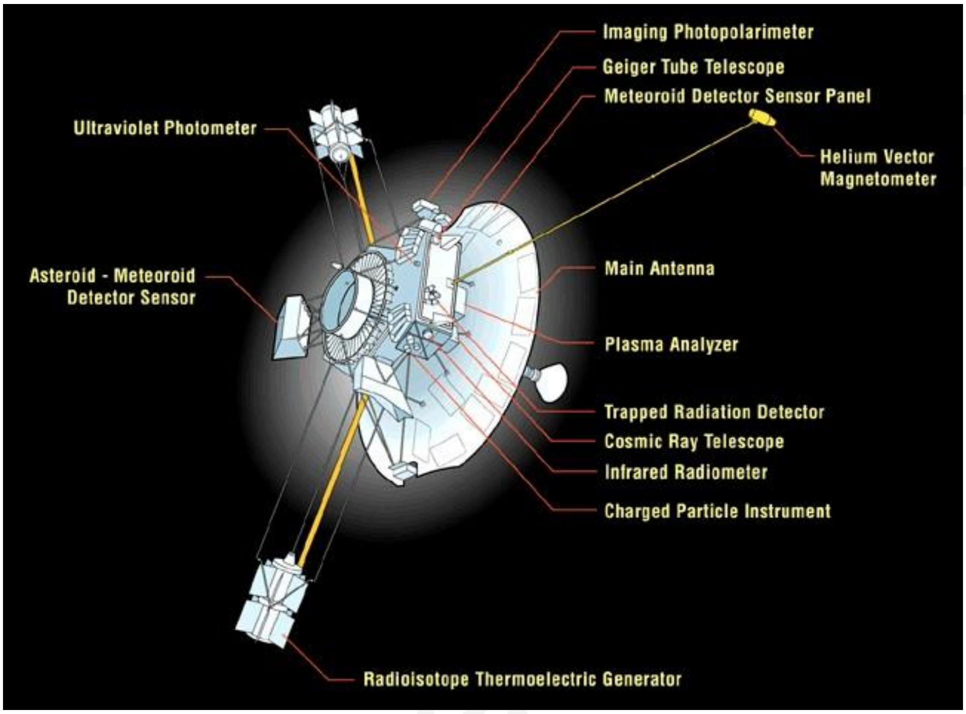
The American Response: Explorer I



Explorer 1 was the first U.S. satellite and the first satellite to carry science instruments. The satellite was launched on Jan. 31, 1958, from Cape Canaveral, Fla.

Explorer 1 followed a looping flight path that orbited Earth once every 114 minutes. The satellite went as high as 2,565 kilometers (1,594 miles) and as low as 362 kilometers (225 miles) above Earth. Credit: NASA

Pioneer 10



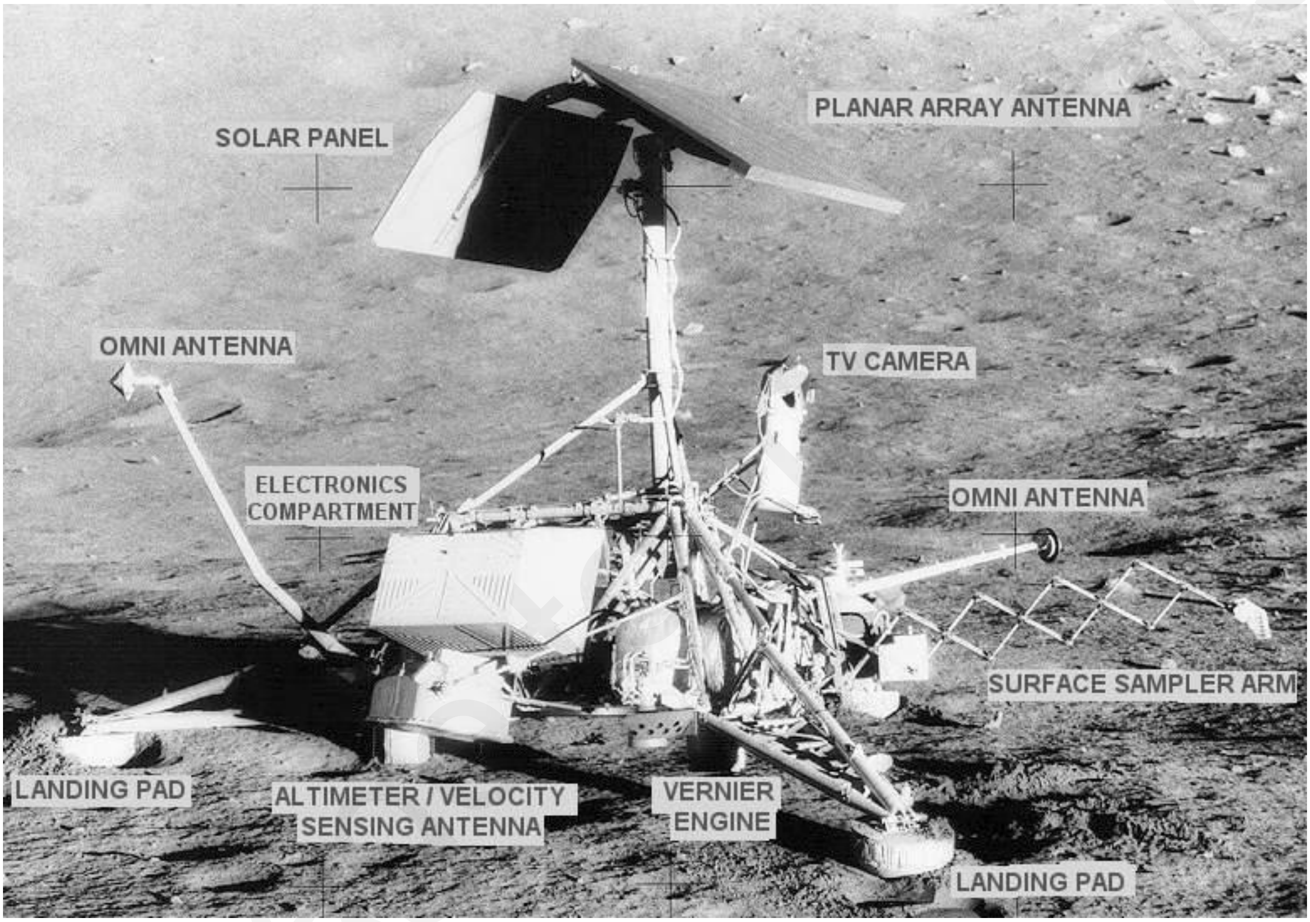
Pioneer 10 was an American robotic spacecraft, weighing 258 kilograms, that completed the first mission

to the planet Jupiter. Pioneer 10 became the first spacecraft to achieve escape velocity from the Solar System.

Surveyor Missions to the Moon

Surveyor 1

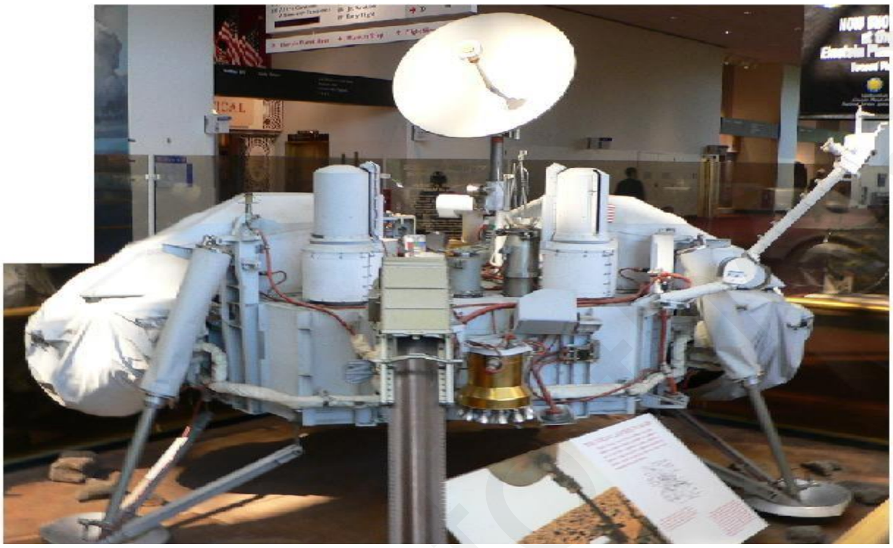
Image credit: NASA/JPL-Caltech



Mission Summary

Surveyor 1, the first of a series of seven robotic spacecraft sent to the moon to gather data in preparation for NASA's Apollo missions, was the first spacecraft to make a true soft landing on the moon. As such, it was one of the great successes of NASA's early lunar and interplanetary program.

Viking 1 and 2
Surface exploration of Mars
The search for life experiment



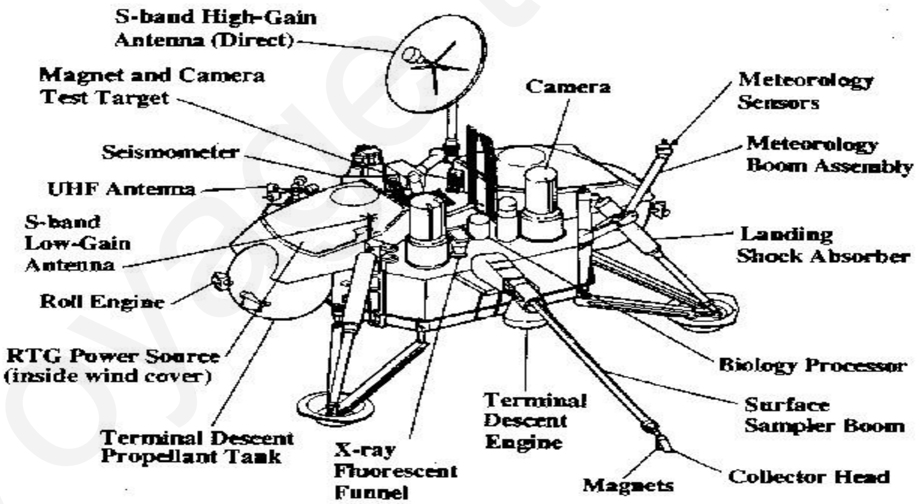
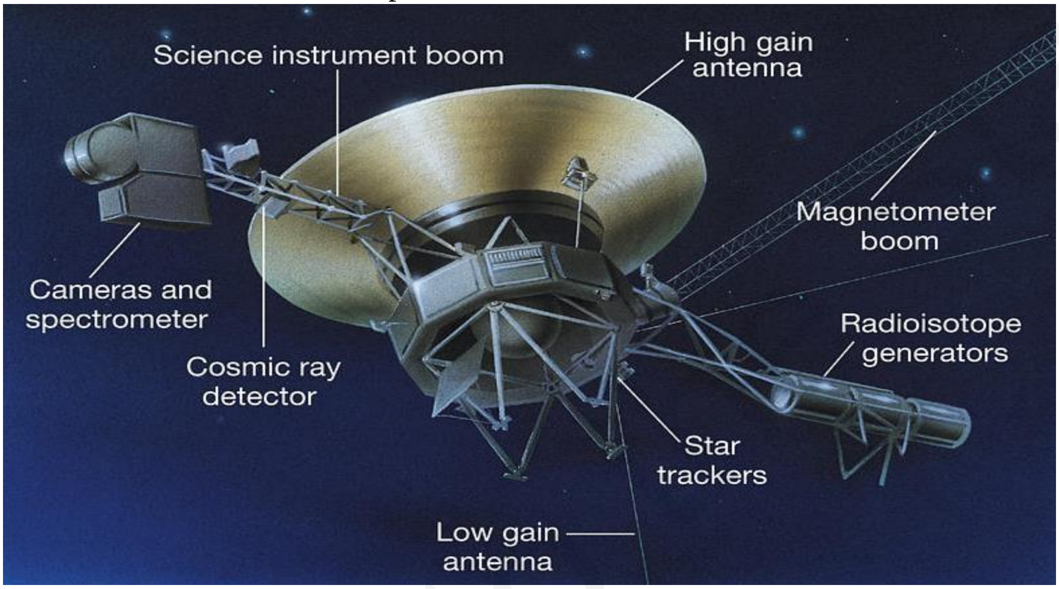
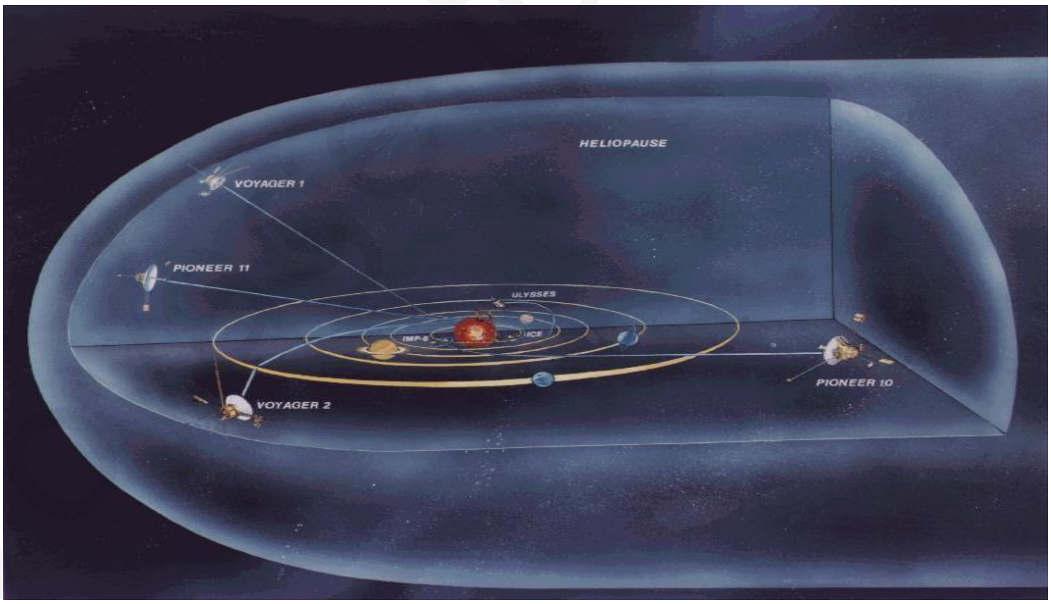


Image Credit: NASA: Viking instruments

NASA: Viking image of the surface of Mars

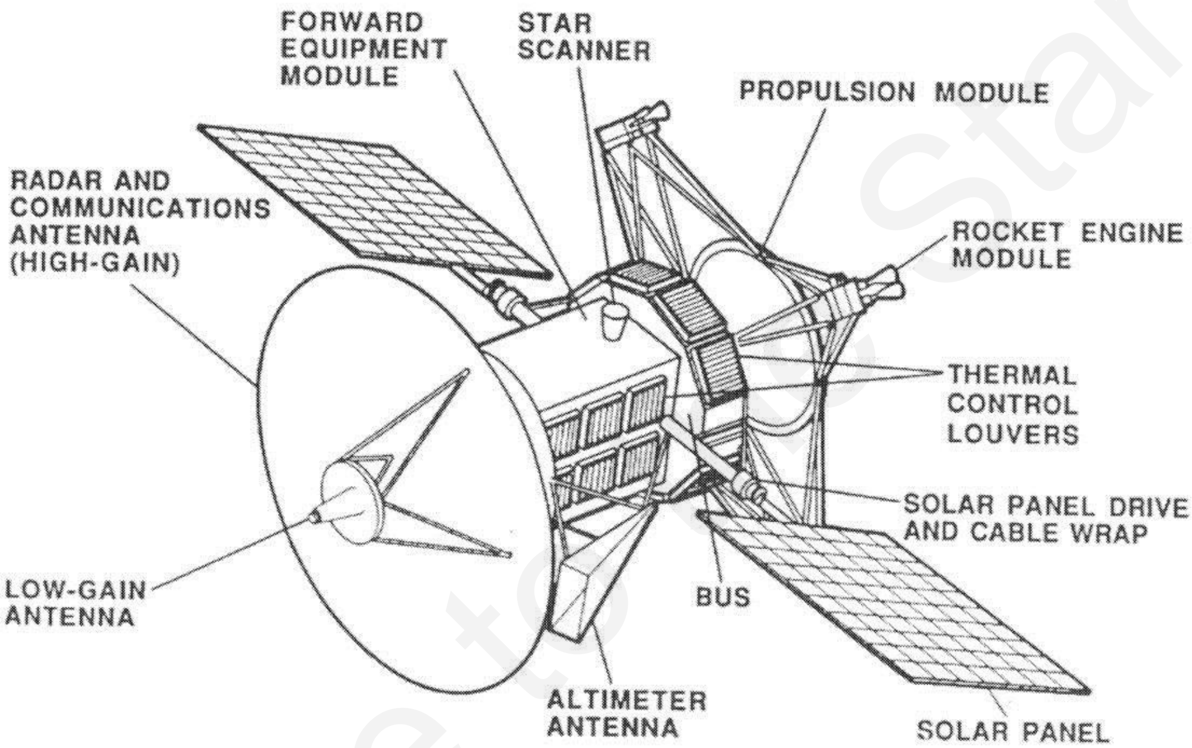
Voyager 1 and 2
Fly by the outer planets
Jupiter – Saturn – Uranus and Neptune



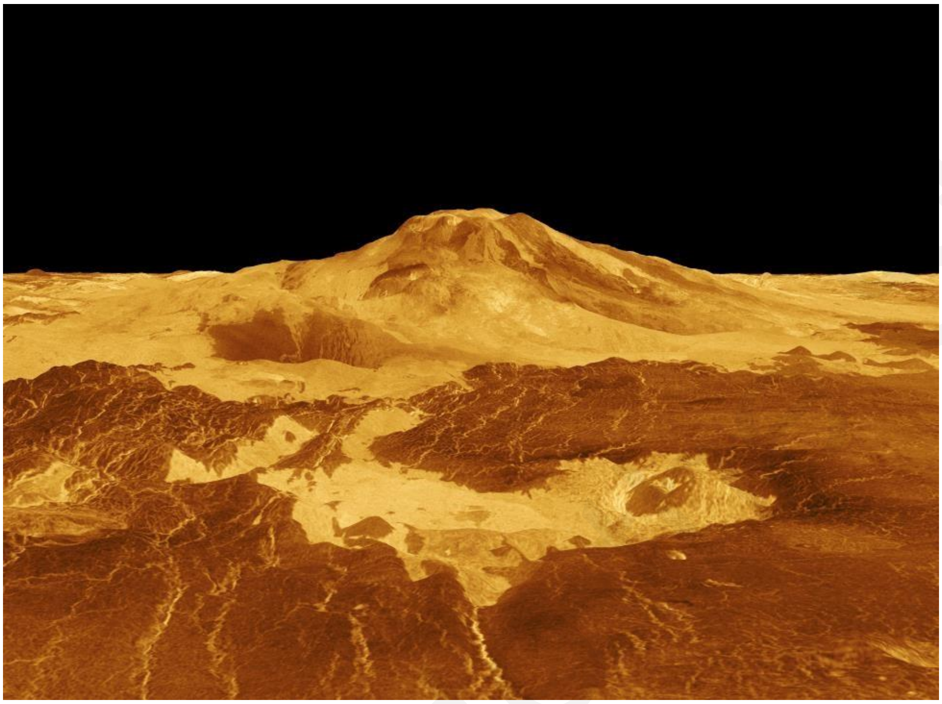


Trajectories of Voyager 1 and Voyager 2 the galactic wind and the Heliosphere

The Magellan Spacecraft

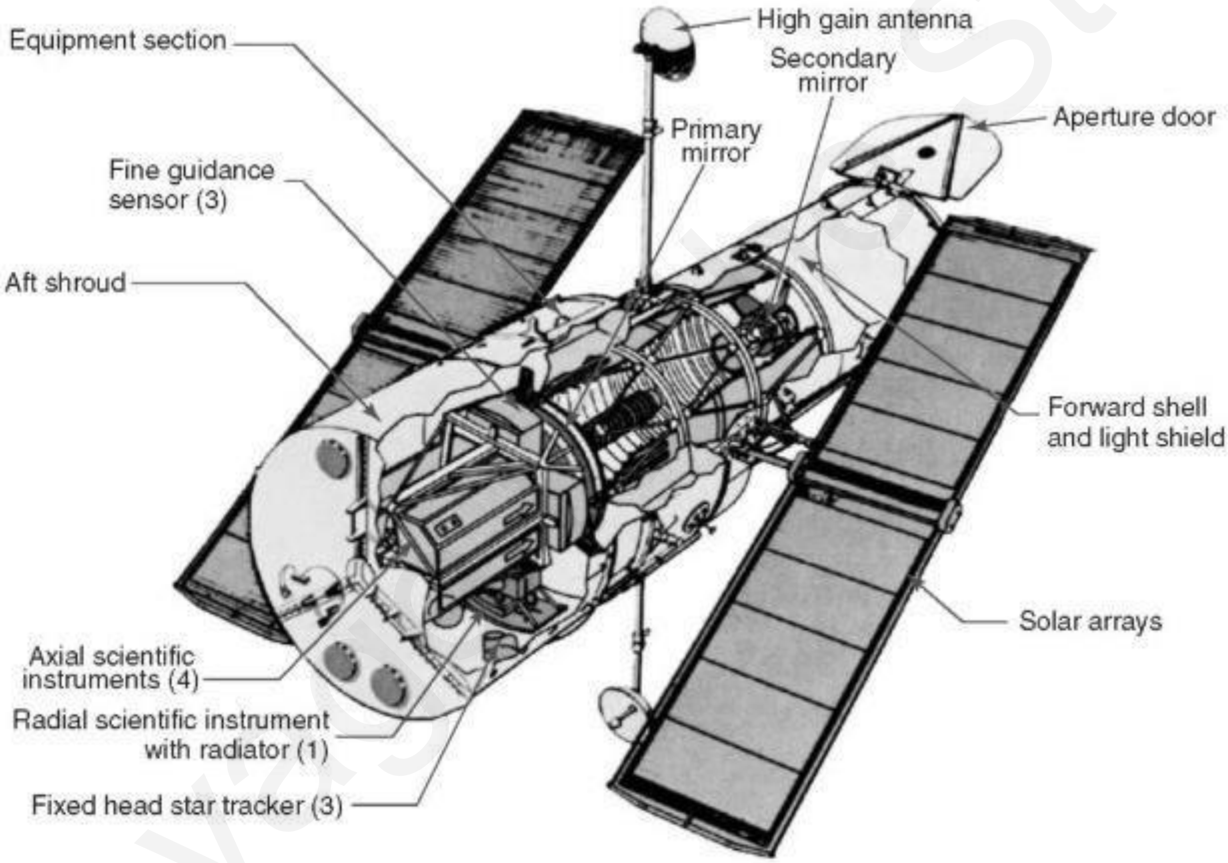


Images credit: NASA



First images of Venus – From Magellan's radar mapping

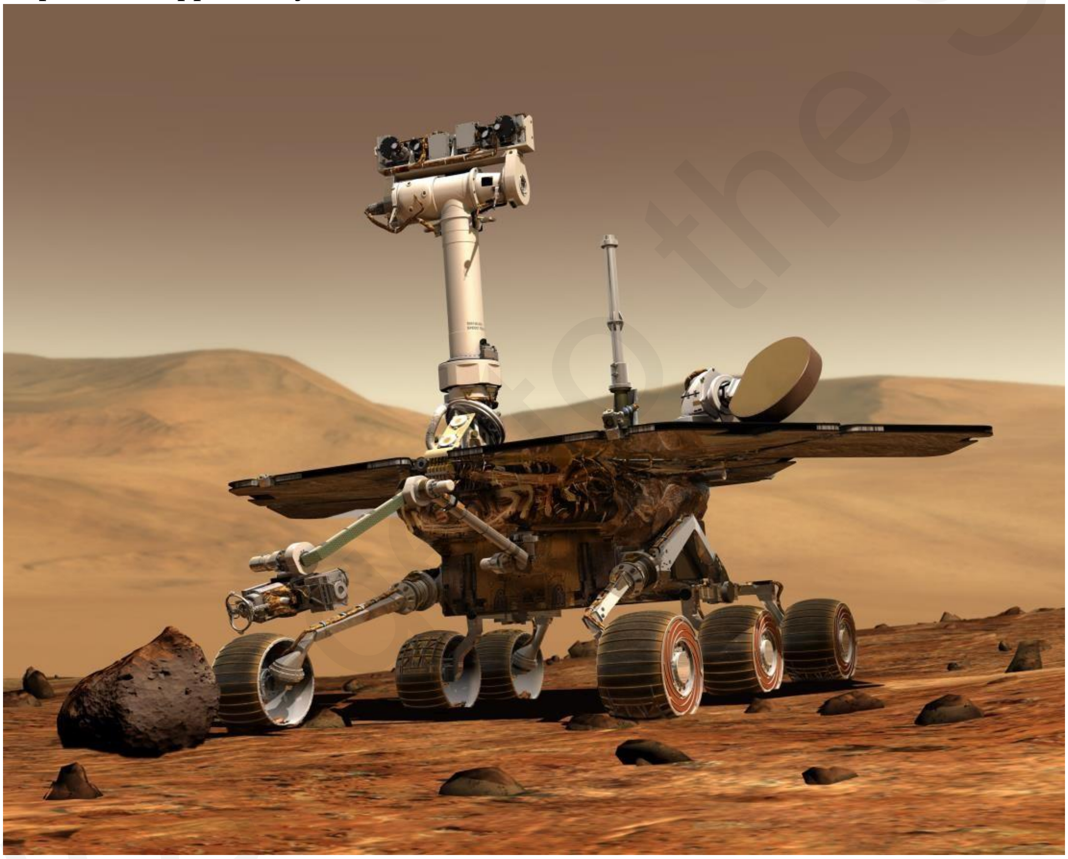
The Hubble Space Telescope



Credit: NASA

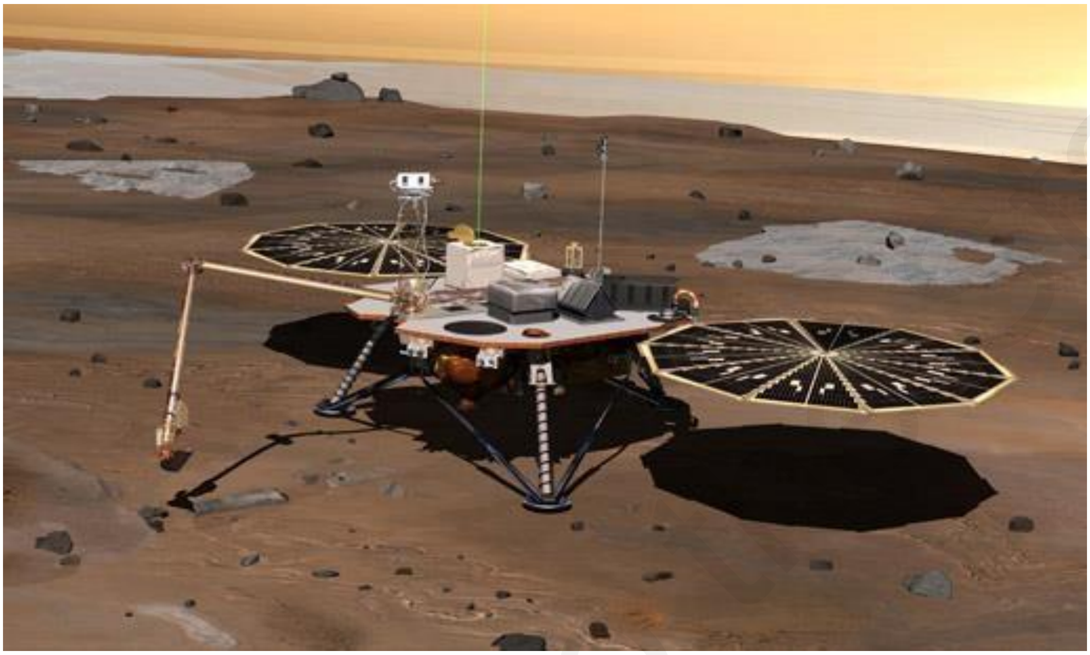
Mars Path Finder

Spirit and Opportunity

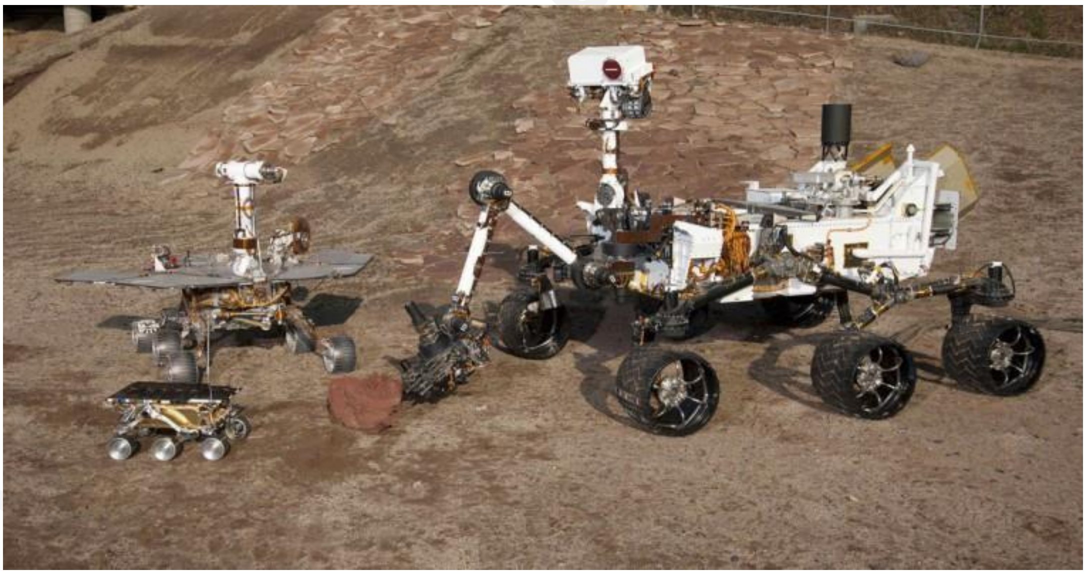


The robotic exploration of Mars

Mars Phoenix Mission



Mars Curiosity

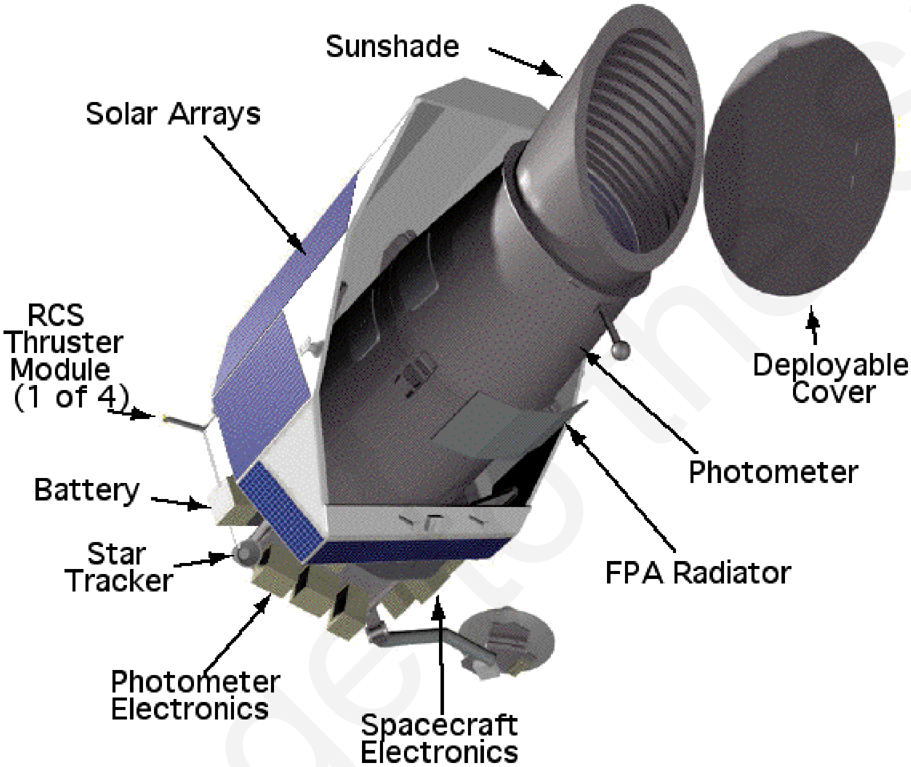


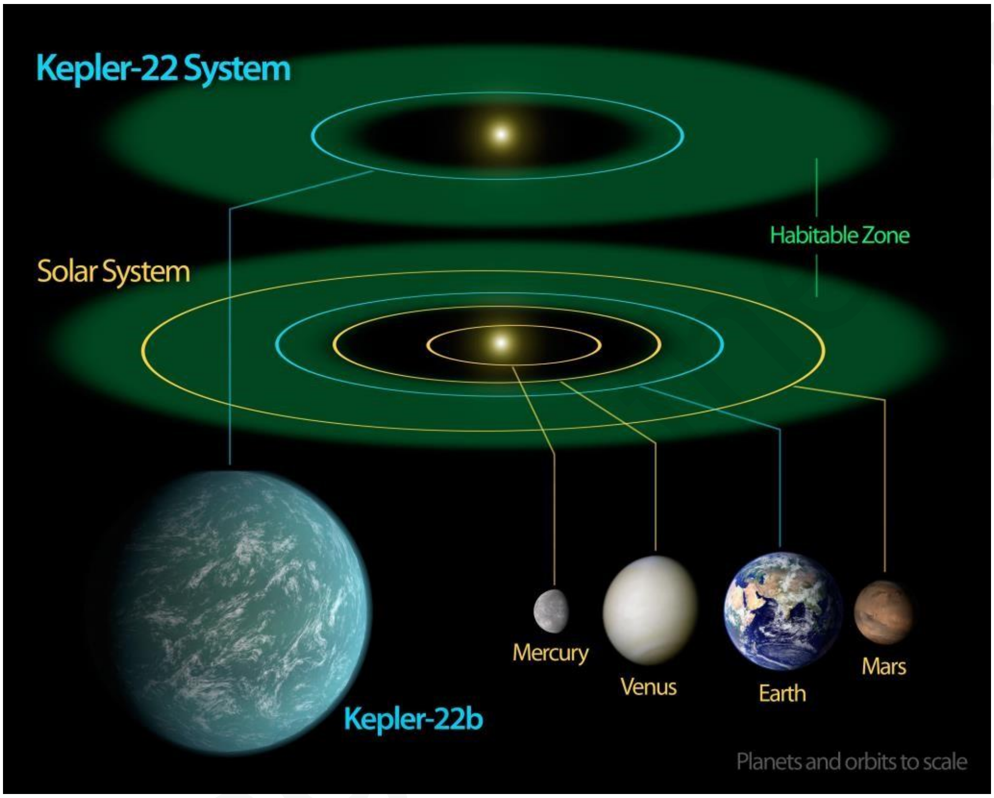
A chemical laboratory on Mars and a robotic geologist

The Kepler Mission
The search for

another Earth

Where is ET?





Kepler 22b an Earth like planet within the habitable zone

CHAPTER IX.

The Night Sky and Diurnal Motion

Motions of the Earth

The Earth spins on its axis once every 23 hours and 56 minutes with respect to the stars and once every 24 hours with respect to the Sun. The rate of rotation produces a speed of close to 1000 miles per hour at the equator. It moves in its orbit around the Sun once every 365 days and six hours at a speed of 68,000 miles per hour. The Earth's spin axis precesses once every 26,000 years. The sun together with the planets moves around the Milky Way galaxy once every 250 million years. The Milky Way galaxy moves towards the Andromeda Galaxy at a speed of two hundred miles per hour. The Earth's spin axis points to the North Star also called Polaris.

Diurnal Motion

The night sky, moves from East to West, due to the rotation of the Earth from West to East.

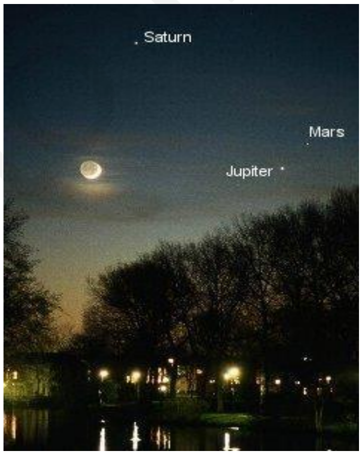


Image credit: NASA

http://science.nasa.gov/headlines/y2004/19mar_planets.htm

Watch the following videos

1. https://www.youtube.com/watch?v=9n04SEzuvXo

2. https://www.youtube.com/watch?v=yyohu4h0Xkg

Circumpolar Motion

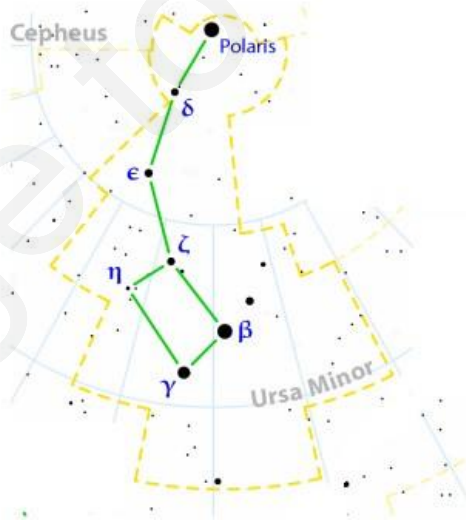
Please go to the following web site

http://www.ioncmaste.ca/homepage/resources/web_resources/CSA_Astro9/files/multimedia/unit1/circumpolar_ motion/circumpolar_motion.swf

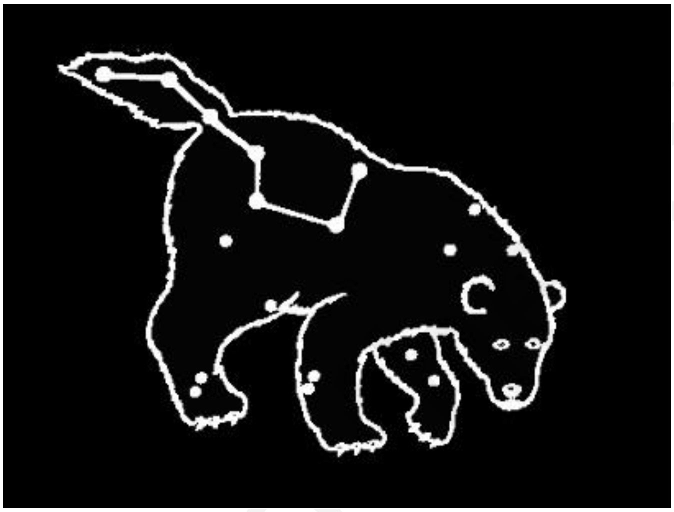
The constellations and Asterisms

http://www.geocities.com/CapeCanaveral/Launchpad/1364/Conste

llations.html The North Star and the Little Dipper



The Ursa Major Constellation



Circum
polar
Star
Trails

Polaris. The North Star is located at a distance of 390 light years from Earth.

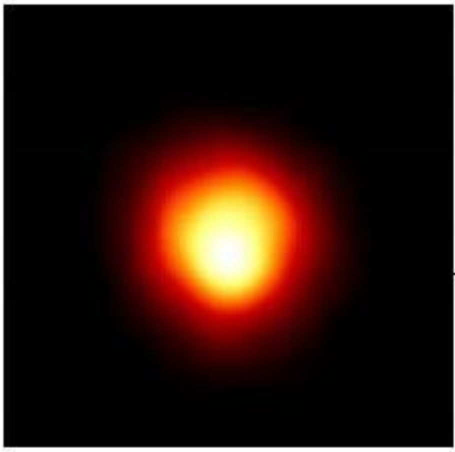
There is an easy way to find your directions at night: The North Star is at the end of the handle of the Little Dipper Asterism. As you face the North Star you will find the east to your right, the West to your left and the South behind you.

The pointer stars of the Big Dipper. They point towards the North Star Polaris

Dubhe and Merak

See the image of the pointer stars in the following web site

http://www.astropix.com/HTML/SHOW_DIG/038.HTM



Star Betelgeuse
Atmosphere of the star as viewed by the Hubble Space Telescope

Constellation: Orion the Hunter

The Celestial sphere

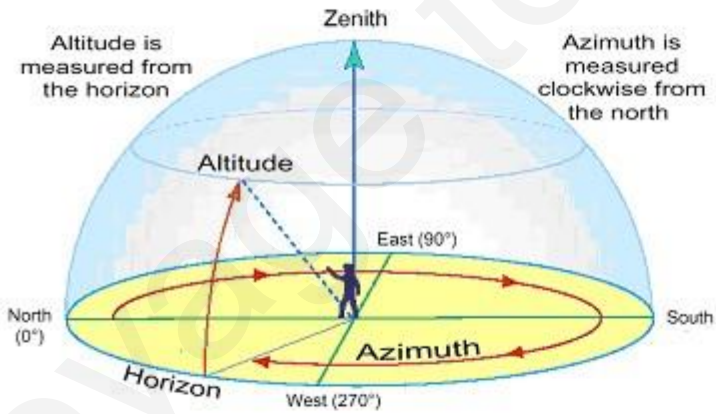
Concepts to study

Latitude and Longitude

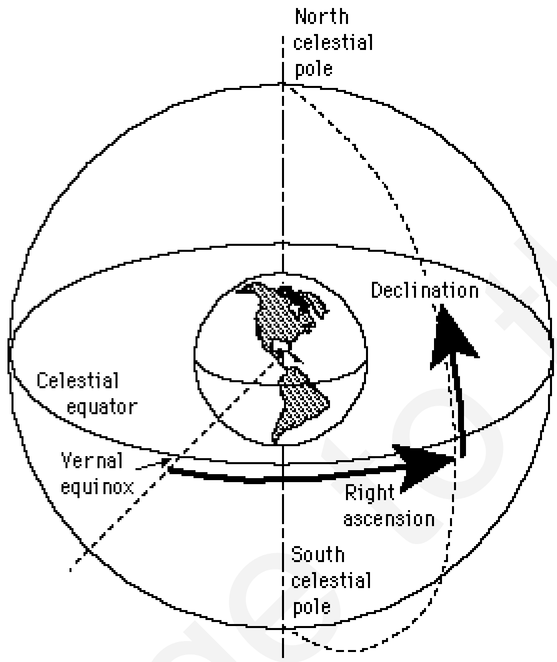
The North Celestial Pole

The South Celestial Pole

The Celestial Equator



Altazimuth Coordinates



The Celestial Sphere

Equinoxes

Solstices

Declination

Right Ascension

Ecliptic Plane

Ecliptic plane: The path of the Sun in the sky

Concepts:

Horizon

Zenith

Altitude

Azimuth

Nadir

Sidereal Day

Solar Day

The study of the Stellarium software Description of the Stellarium software

Stellarium.org

Assignments

1. Select three cities in the Northern Hemisphere and identify their coordinates Latitude and Longitude
2. Select three cities in the Southern Hemisphere and identify their coordinates
3. What are the latitude and the longitude of Los Angeles?
4. Select ten stars and identify their magnitudes
5. Describe what is meant by equinoxes and solstices

6. Write a short summary of the videos about the motions of the Earth

CHAPTER X

Origins of the Solar System and General Description

How did the Solar System start?

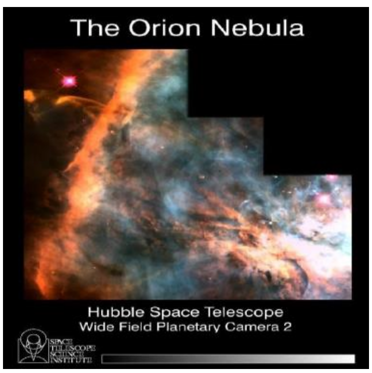
Origins of the Solar System
The Nebular Hypothesis
Watch the following computer simulation about the formation of the solar system starting with

a nebula:

https://www.youtube.com/watch?v=yXq1i3HlumA

Origins of the Nebular Hypothesis of the formation of the Solar System
Kant and La Place

The nebular Hypothesis is a model of a how the solar system was formed. In its original form, it was formulated by Emanuel Kant and Laplace in the 18th century. Now, we describe it as follows: A large cloud of gas, the remnant of a supernovae explosion with all the chemical elements contracts by its own gravitational force and as it contracts it spins faster and faster in a manner similar to an ice skater and as it spins it flattens forming a disk. At the core the temperatures increase as the gas is compressed and as it reaches temperatures higher than 6 million Kelvins it ignites Nuclear Fusion and a star is born. That star was the Sun. The planets formed from small grains formed by condensation and grew at first by electrical attraction and chemical processes and subsequently by gravitational attraction and agglomeration of other objects. This growth process led to the formation of each planet. In many instances the shock wave from the explosion of a nearby supernova compresses the gases in a cloud and triggers the birth of a star or a group of stars out of a group of gas clouds. The star ignition mechanism can be a supernova shock wave or gravitational compression.



The Hubble Space Telescope took these images of stars in the process of formation: Nebulae, a large cloud of gases, a place where stars are formed, they range from two to 17 times the size of our solar system.

Below: Hubble Space Telescope visible spectrum images of proto – planetary disks gas and dust, around young stars. Location: The Orion nebula, at a distance of 1,500 light-years from Earth.

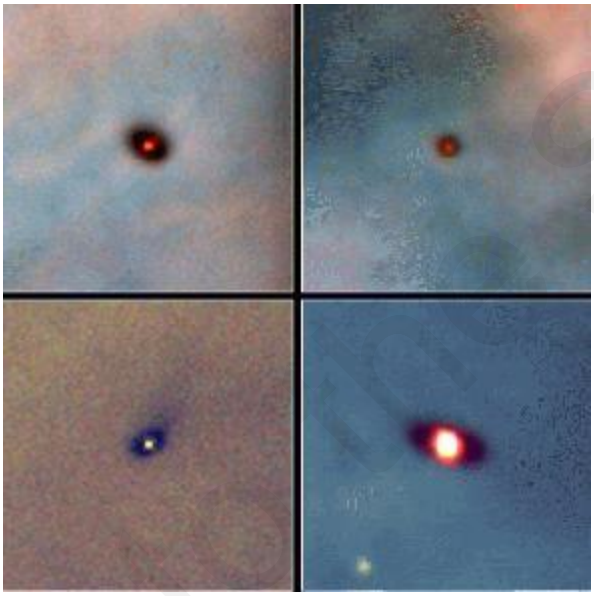


Illustration of the contraction of the Solar Nebula and the formation of a protoplanetary disk

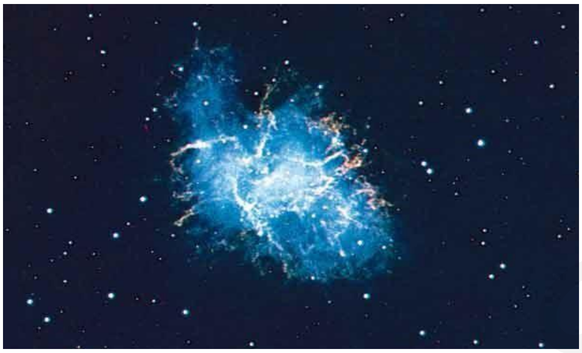


Image of a nebula. NASA Credit.

This is the result of the explosion of a supernova. All the chemical elements of the periodic table were manufactured in the explosion and dispersed in large region t form new stars. The 25 chemical elements that form the human body were manufacture in this manner. So you are made of star material, you are a star.
NASA gives the following broad outline for the nebular hypothesis for the formation of the Solar System Formation of nebula (>1000 atoms/cm3) from diffuse gas of previous nova(s). Nebula collapse -> rotating and contracting disk, and heat production.

- Development of proto star, T-Tauri phase and associated 'wind'. t=100,000 yrs Development of condensates in a particular spatial, temperature-dependent order.
- Gases mostly swept from inner solar system.
- Accretionary development of planets. Significant until 3.6 billion years ago.
- Development of small nebular disks around larger planets and creation of moons. Internal differentiation of the planets (ongoing).

The Chemical Elements

The chemical elements your body is made of come from a supernova, the remnant clouds of a supernova gave rise to the solar system.
To view the planets and solar system from the perspective of space, from a currently active spacecraft go to: http://space.jpl.nasa.gov/

To get a view of planets and moons from a spacecraft as of today please go to the JPL Solar System simulator at http://space.jpl.nasa.gov/

The formation of the Moon

Impact Theory of the Formation of the Moon

Web site to see the formation of the moon Giant Impact Theory of the formation of the Moon computer simulation

http://www.classzone.com/books/earth_science/terc/content/visualizations/es2501/es2501page01.cfm?chapter_ no=visualization

https://www.youtube.com/watch?v=yXq1i3HlumA

Assignment

1. What is a nebula?
2. How was the solar system formed?

   Watch the following computer simulation and summarize it.

   https://www.youtube.com/watch?v=yXq1i3HlumA
3. What is the Nebular Hypothesis?
4. How does a star ignite, light up?
5. Why does the Sun and other stars shine?
6. Where does the energy you use every day to talk to walk, come from?
7. How much weight does the Sun lose per second, fuel that it converts to light?
8. What does E = Mc2 mean?
9. What is a supernova?
10. What is the temperature of ignition, Nuclear Fusion of a Nebula core into a star?

CHAPTER XI. The Earth as a planet

Motions of planet Earth

Rotation on its axis, translation around the Sun, Precession or wobbling, orbit of the solar system around the Milky Way Galaxy. Motion of our Milky Way galaxy towards Andromeda. To be explained in class.

Watch this video about the motions of the Earth

https://www.youtube.com/watch?v=82p-DYgGFjI

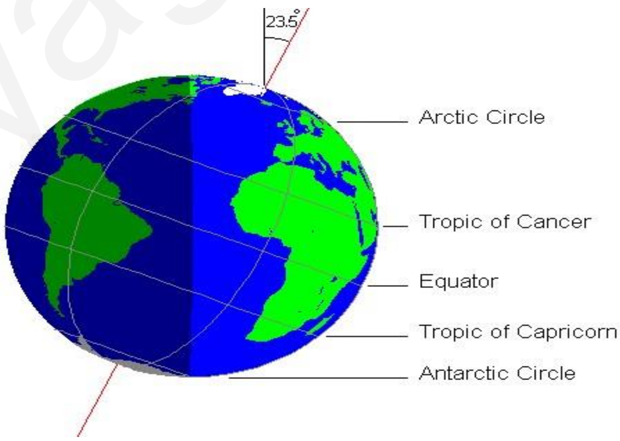
The seasons

Why do we have seasons?

Explore the following answers

a. The Earth is closest to the Sun during the summer
b. The Earth's axis precesses, wobbles, at 23.5 degrees
c. The Earth's spin axis is tilted 23.5 degrees with respect to the perpendicular to the ecliptic plane
d. Global warming causes the seasons

e. Seasonal variability of the Sun's intrinsic brightness. Because the Sun is a variable star



For a computer simulations about the seasons please see the voyager software

http://www.carinasoft.com/

Also you can see an animation in the following web site: http://www.edumedia-sciences.com/en/a63-4-seasons-2

Concepts to study and to discuss in class

Climate systems

El Nino

La Nina

The Ozone depletion problem

Acid rain

Climate Change

Global Warming

Chapter XII. The Moon

Watch the following videos about the Moon:

1. https://www.youtube.com/watch?v=6AviDjR9mmo

2. https://www.youtube.com/watch?v=6MP920xMC0Q

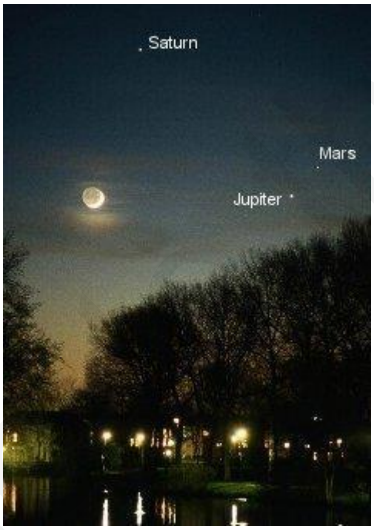


Image credit: NASA

http://science.nasa.gov/headlines/y2004/19mar_planets.htm

Impact Theory of the Formation of the Moon

Web site to see the formation of the moon Giant Impact Theory of the formation of the Moon computer simulation

http://www.classzone.com/books/earth_science/terc/content/visualizations/es2501/es2501page01.cfm?chapter_ no=visualization

The Moon was formed as the result of the impact on the Earth of an Asteroid of the size of Mars 4.5 billion years ago. The same impact caused the tilt of the spin axis of the Earth and gave us the seasons we know today.

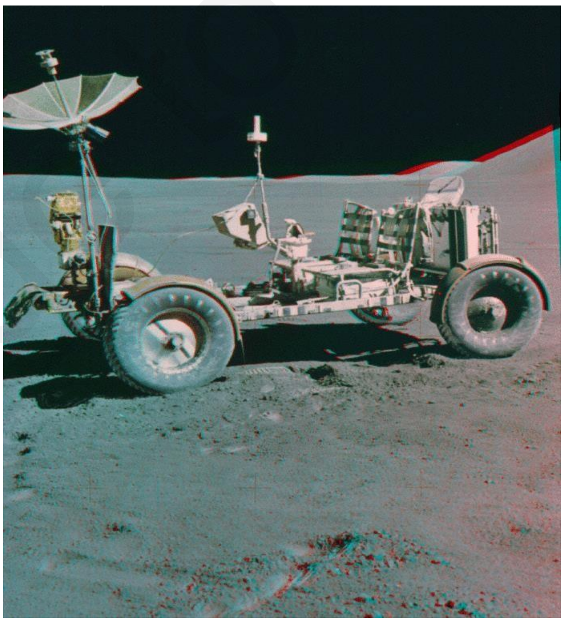
Moon Phases

To learn about the specific moon phases by date and time, please go to NASA's web site http://sunearth.gsfc.nasa.gov/eclipse/phase/phases2001.html

To practice learning about the moon phases and to check your answers please go to NASA's http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level2/moonlight.html

Exploring the surface of the Moon

NASA's new vision calls for a return to the moon, followed by journeys of discovery to Mars and beyond.



Lunar Rover Image credit: NASA

The Lunar Roving Vehicle (LRV), shown in this 3-D Apollo 15 view, was a battery-powered buggy driven by astronauts during the Apollo 15, 16, and 17 missions. The rover permitted astronauts to venture greater distances from the Lunar Module because of its speed and ability to navigate the lunar surface. The maximum speed of the LRV was about 13 kilometers per hour, but for safety reasons, the cruise speed was limited to 6–7 kilometers per hour. The total traverse distance of the Apollo 15 LRV was 28 kilometers.

The rover was equipped with a high-gain antenna (the metallic umbrella seen on the left) for communications between the astronauts and Mission Control in Houston, a television camera (the box in front of the high-gain

antenna), and a low-gain antenna (the aerial antenna located between the seats). The wheels were constructed of flexible woven piano wire. Titanium treads helped provide traction on the lunar surface. Apollo 15 landed at the foot of the Apennine Mountains in July 1971. Credit NASA

In December of 1972, Apollo 17 astronauts Eugene Cernan and Harrison Schmitt spent about 75 hours exploring the Moon's Taurus-Littrow valley while colleague Ronald Evans orbited overhead. Cernan and Schmitt were the last humans to walk or ride on the Moon - aided in their explorations by a Lunar Roving Vehicle. The skeletal-looking lunar rover was just over 10 feet long, 6 feet wide and easily carried astronauts, equipment, and rock samples in the Moon's low gravity (about 1/6 Earth's). In this picture, Cernan stands at the back of the rover which carried the two astronauts in lawn-chair style seats. An umbrella-shaped high gain antenna and TV camera are mounted in the front. Powered by four 1/4 horsepower electric motors, one for each wheel, this rover was driven a total of about 18 miles across the lunar surface. Its estimated top speed was a blazing 8 miles per hour. Credit NASA. **Theory of the formation of the Moon**

Impact Theory.

The Moon Formed by an impact of a Mars-Sized Object on Young Earth.

How did the Earth's Moon originate?

NASA's Lunar Prospector supports evidence gathered some 30 years ago during the Apollo program that the Moon was formed by the impact of a Mars-sized object on the young Earth. The impact ejected large quantities of matter, some of which entered into Earth orbit and collected by self-gravity to form the Moon.

The evidence is based on the following data. Prospector's gravity measurements show that the Moon possesses a very small, iron-rich core that adds up to, at most, about four percent of the Moon's total mass. In comparison, the Earth's core is much larger, amounting to approximately 30 percent of our planet's mass. Prospector also confirmed the Apollo missions' findings that the Moon and Earth have strikingly similar mineral compositions. Furthermore, the lunar surface is almost devoid of water and other volatiles (i.e., easily vaporized materials such as molecular nitrogen and carbon dioxide). Only in polar craters that are in permanent shadow did Prospector discover evidence of water, presumably deposited there by comet impacts after the Moon was formed.

The "giant impact" model for the origin of the Moon explains each of these findings. The impact occurred when the Earth was less than a hundred million years old (its present age is 4.6 billion years), but after most of its iron had sunk toward the center to form the terrestrial core. Hence, the material torn out of our planet's outer layers by the impact, and which subsequently collected to form the Moon, was iron-poor.
Since it was iron-poor, the Moon was able to form only a very small core.
Secondly, since, according to this model, most of the lunar material came from the Earth (some came from the impacting body), the mineral compositions of the Moon and Earth are very similar. Thirdly, because the impact was extraordinarily violent, the ejected material was severely heated (up to nearly 20,000 °F according to numerical simulations of the impact event) and became spread out into a ring that orbited the Earth before collecting into the Moon. Thus, the volatiles were able to escape, which made them rare on the Moon.

Despite the compelling nature of this reasoning, Dr. Alan Binder of the Lunar Research Institute in Tucson, AZ, and principal investigator for the Lunar Prospector takes the conservative view: "Further analysis of Lunar Prospector data to refine the exact size of the lunar core and the amounts of elements like gold, platinum and iridium in lunar rocks--all of which are concentrated with metallic iron--is required. This will do much to pin down for good if the 'giant impact' model of the formation of the Moon is correct, or if the Moon formed in a different manner."

More information

The Lunar Prospector is a $63 million mission that is managed by NASA's Ames Research Center. It was developed under NASA's Discovery Program of lower-cost, highly focused, small scientific spacecraft. For more information on the spacecraft, its mission, and its science discoveries, go to:

http://lunar.arc.nasa.gov/

Following waning crescent is New Moon, beginning a repetition of the complete phase cycle of 29.5 days average duration. The time in days counted from the time of New Moon is called the Moon's "age". Each complete cycle of phases is called a "lunation". Because the cycle of the phases is shorter than most calendar months, the phase of the Moon at the very beginning of the month usually repeats at the very end of the month. When there are two Full Moons in a month (which occurs, on average, every 2.7 years), the second one is called a "Blue Moon". See the article "Once in a Blue Moon" for the story of how the usage of this term has evolved (Ref: Philip Hiscock, Sky & Telescope, March 1999, pp. 52-55.).

New Moon, First Quarter, Full Moon, and Last Quarter phases are considered to be primary phases and their dates and times are published in almanacs and on calendars.

The two crescent and two gibbous phases are intermediate phases, each of which lasts for about a week between the primary phases, during which time the exact fraction of the Moon's disk that is illuminated gradually changes.

The phases of the Moon are related to (actually, caused by) the relative positions of the Moon and Sun in the sky.

For example, New Moon occurs when the Sun and Moon are quite close together in the sky.

Full Moon occurs when the Sun and Moon are at nearly opposite positions in the sky - which is why a Full Moon rises about the time of sunset, and sets about the time of sunrise, for most places on Earth.

First and Last Quarters occur when the Sun and Moon are about 90 degrees apart in the sky.

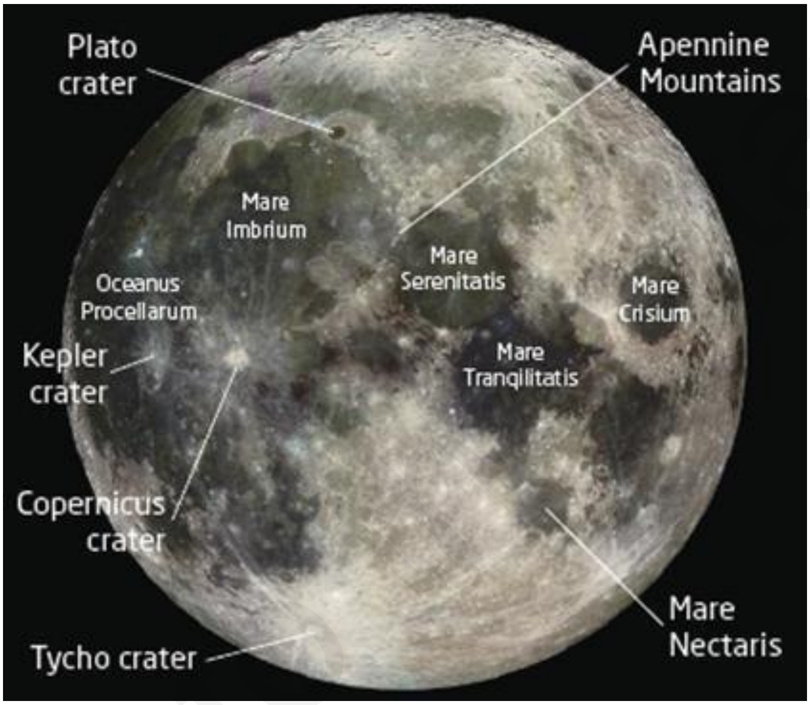
The **percent of the Moon's surface illuminated** is a more refined, quantitative description of the Moon's appearance than is the phase. Considering the Moon as a circular disk, the ratio of the area illuminated by direct sunlight to its total area is the fraction of the Moon's surface illuminated; multiplied by 100, it is the percent illuminated. At New Moon the percent illuminated is 0; at First and Last Quarters it is 50%; and at Full Moon it is 100%. During the crescent phases the percent illuminated is between 0 and 50% and during gibbous phases it is between 50% and 100%.

For practical purposes, phases of the Moon and the percent of the Moon illuminated are independent of the location on the Earth from where the Moon is observed. That is, all the phases occur at the same time regardless of the observer's position.

http://aa.usno.navy.mil/faq/docs/moon_phases.html

http://www.usno.navy.mil/USNO/astronomical-applications/data-services/phases-moon

Moon Map: Surface Features



You can view more lunar surface details at:

Arval Observatory: http://www.oarval.org/MoonMapen.htm

Additional Notes:

The Moon has a surface area of some 37.96 million Km^2, and a diameter of some 3,476 Km.

The directions East (E) and West (W) marked on the graphics, are directions as seen from the Moon; These are opposite of East and West as seen from the Earth.

ARVAL's Moon Map shows the Moon as seen through binoculars or the naked eyes, it does not invert the image in any direction.

Moon/Earth

A Comparison

	Moon	Earth	Ratio (Moon/Earth)
Mass (10^{24} kg)	0.07349	5.9736	0.0123
Volume (10^{10} km^3)	2.1958	108.32	0.0203
Equatorial radius (km)	1738.1	6378.1	0.2725
Polar radius (km)	1736.0	6356.8	0.2731
Volumetric mean radius (km)	1737.1	6371.0	0.2727
Ellipticity (Flattening)	0.0012	0.00335	0.36
Mean density (kg/m^3)	3350	5515	0.607
Surface gravity (m/s^2)	1.62	9.80	0.165
Surface acceleration (m/s^2)	1.62	9.78	0.166
Escape velocity (km/s)	2.38	11.2	0.213
GM (x 10^6 km^3/s^2)	0.0049	0.3986	0.0123
Bond albedo	0.11	0.306	0.360
Visual geometric albedo	0.12	0.367	0.330
Visual magnitude V(1,0)	+0.21	-3.86	-
Solar irradiance (W/m^2)	1367.6	1367.6	1.000
Black-body temperature (K)	274.5	254.3	1.079
Topographic range (km)	16.0	20.0	0.800
Moment of inertia (I/MR^2)	0.394	0.3308	1.191

Atmosphere of the Moon:

What is the very thin atmosphere of the Moon made of?

Estimated Composition (particles per cubic cm):
Helium 4 (^{4}He) - 40,000; Neon 20 (^{20}Ne) - 40,000 ; Hydrogen (H_2) - 35,000
Argon 40 (^{40}Ar) - 30,000 ; Neon 22 (^{22}Ne) - 5,000 ; Argon 36 (^{36}Ar) - 2,000
Methane - 1000 ; Ammonia - 1000 ; Carbon Dioxide (CO_2) - 1000
Trace Oxygen (O^+), Aluminum (Al^+), Silicon (Si^+)
Possible Phosphorus (P^+), Sodium (Na^+), Magnesium (Mg^+)

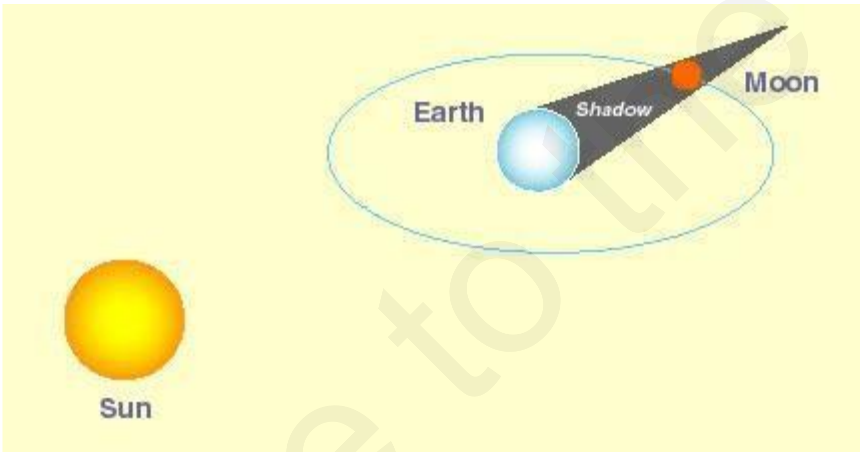
Composition of the tenuous lunar atmosphere is poorly known and variable, these are estimates of the upper limits of the nighttime ambient atmosphere composition. Daytime levels were difficult to measure due to heating and outgassing of Apollo surface experiments.

The tides
To see and animation of the tides please go to:

http://www.pbs.org/wgbh/nova/venice/tides.html#

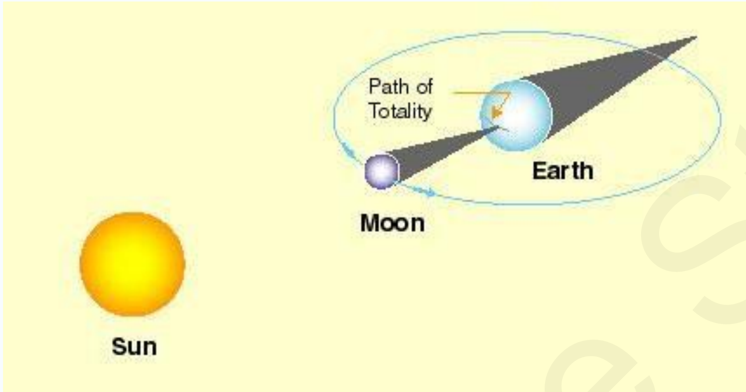
Eclipses

1. Lunar eclipses



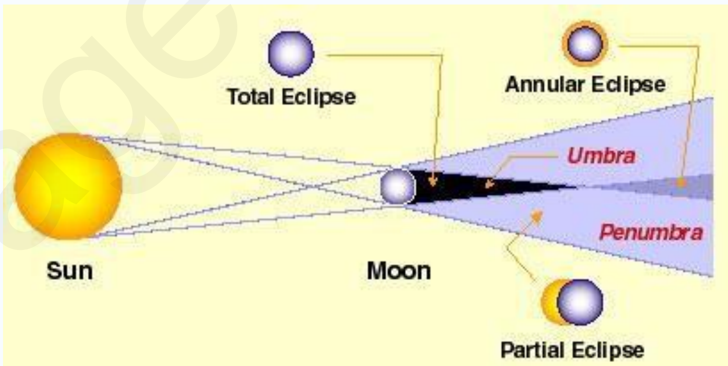
Credit: http://csep10.phys.utk.edu/astr161/lect/time/eclipses_lunar.html

2. Solar eclipses



Credit: http://csep10.phys.utk.edu/astr161/lect/time/eclipses.htm

A total solar eclipse



An annular eclipse

An annular solar eclipse

Credit: http://csep10.phys.utk.edu/astr161/lect/time/eclipses.html

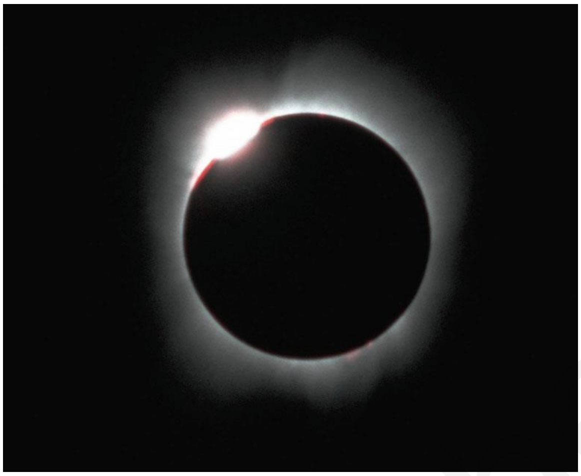
- A hybrid eclipse

  In some areas is viwed as a total eclipse and in other areas as a partial eclipse

- A partial eclipse

A partial solar eclipse

Annular Eclipse



The diamond ring solar eclipse

Assignments

1. Write a one-page summary of this Chapter
2. Sketch and explain lunar eclipses, total and partial lunar eclipses
3. Sketch and explain solar eclipses, total and partial solar eclipses
4. Explain the diamond ring eclipse
5. Use a solar projection scope to identify the dark spots on the SUN
   Warning <u>never</u> look at the Sun directly or through a telescope or through binoculars
6. Indicate the places and dates for the solar eclipses for the next 100 years
7. Indicate the dates for the lunar eclipses in the next 10 years as viewed from Los Angeles
8. Circle and label the main features on the surface of the Moon

Circle and identify the following:

1. Maria
2. Craters
3. Mountains
4. Highlands
5. East, West, North and South
6. Where the astronauts first landed
7. South Pole
8. North Pole
9. Lunar phases
10. Today's lunar phase
11. Describe, explain and sketch lunar eclipses
12. Describe, explain and sketch solar eclipses
13. Describe, explain and sketch the tides
14. Describe The theory of formation of the Moon
15. Describe and sketch the internal structure of the Moon
16. Describe a Moon rock, show an image and describe the properties of a Moon rock compared to a terrestrial rock
17. Regions of the Moon where water may be found
18. Describe the properties of the "atmosphere" of the Moon
19. Describe where Moon rocks have been found on Earth
20. What is the relation between the tilt of the spin axis of the Earth and the formation of the Moon?

CHAPTER XIII

Light, the messenger of the universe

Subjects to discuss the properties of light and atomic line spectra
Properties of light and atoms web page
http://csep10.phys.utk.edu/astr162/lect/light/ionization.html

Exercise 1. Get a classroom Spectrometer with scale. Exercise.

http://scientificsonline.com/product.asp_Q_pn_E_3052521

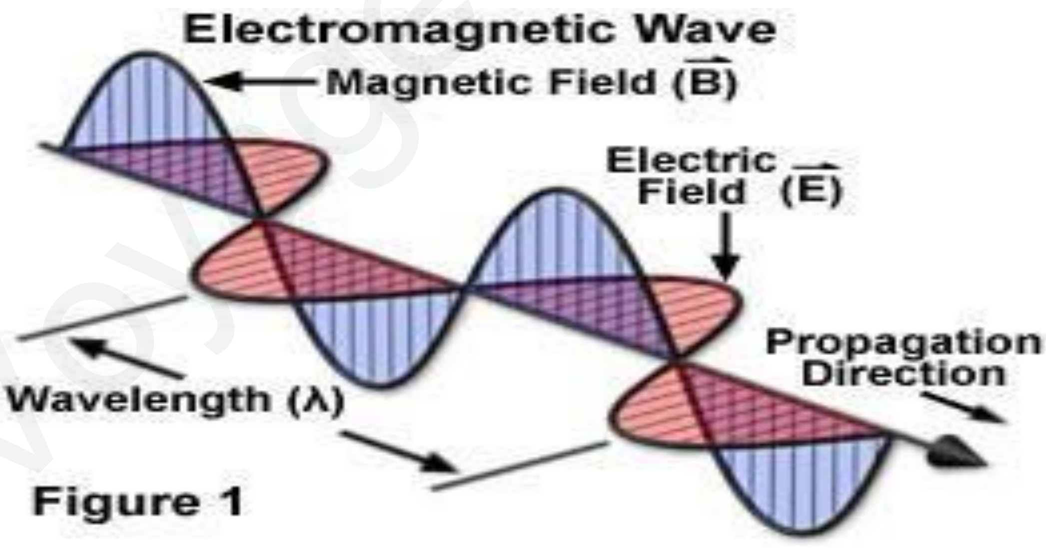
Diagram of an electromagnetic wave, a light wave

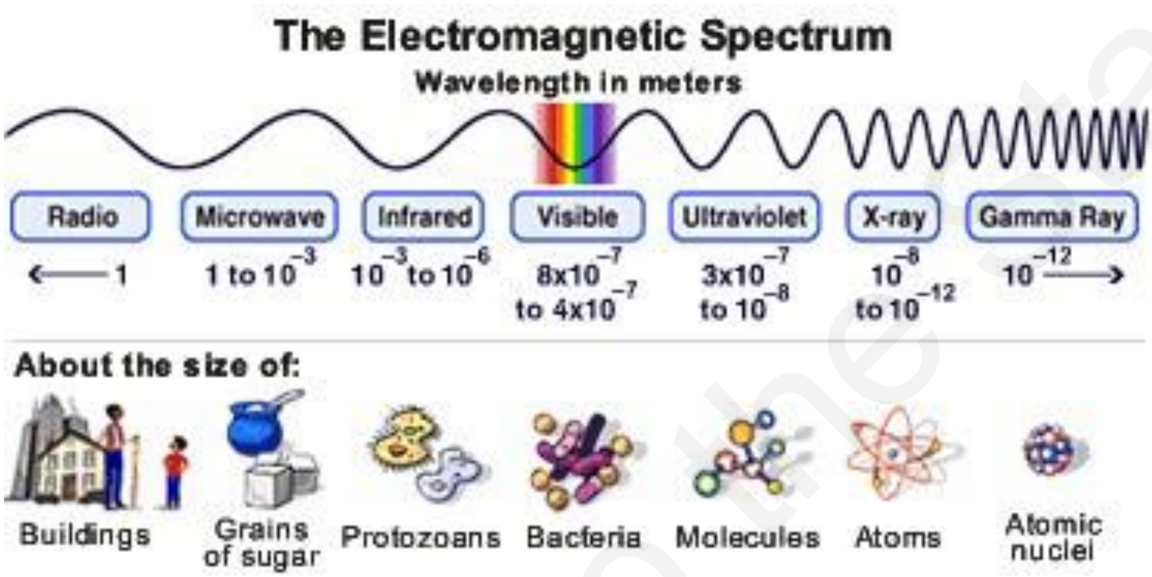
http://www.phy.ntnu.edu.tw/ntnujava/index.php?topic=35

http://www.phys.hawaii.edu/~teb/java/ntnujava/emWave/emWave.html

http://www.walter-fendt.de/ph11e/emwave.htm

For electromagnetic waves **E** and **B** are always perpendicular to each other, and perpendicular to the direction of propagation. The direction of propagation is the direction of **E´B**. Electromagnetic waves are <u>transverse waves</u>.




The Electromagnetic Spectrum
Wavelength in meters
Radio
Microwave
Infrared
Visible
Ultraviolet
X-ray
Gamma Ray
← 1
1 to 10^{-3}
10^{-3} to 10^{-6}
$8x10^{-7}$ to $4x10^{-7}$
$3x10^{-7}$ to 10^{-8}
10^{-8} to 10^{-12}
10^{-12} →
About the size of:
Buildings
Grains of sugar
Protozoans
Bacteria
Molecules
Atoms
Atomic nuclei

Preparation to study telescopes

Subjects to discuss in class

Properties of light

Optics

Mirrors

Lenses

Laws of reflection

Snell's Law of refraction

Examples

Magnifying glass

Lens equation

Lens Maker's Equation

Examples

The optics of a

refracting telescope

The optics of a

reflecting telescope

Assignment

1.What is light?

2.What is the Electromagnet Spectrum?

3. What is the Visible Spectrum of light?

4. What type of light goes through the atmosphere and reaches the surface of the Earth, to be observed

by ground telescopes?

Chapter XIV

Binoculars and Telescopes

Watch the following video about the Hubble Space Telescope

1. https://www.youtube.com/watch?v=ChyLgXVTmxw

2. https://www.youtube.com/watch?v=-nNiULl5_2k

3. https://www.youtube.com/watch?v=073GwPbyFxE

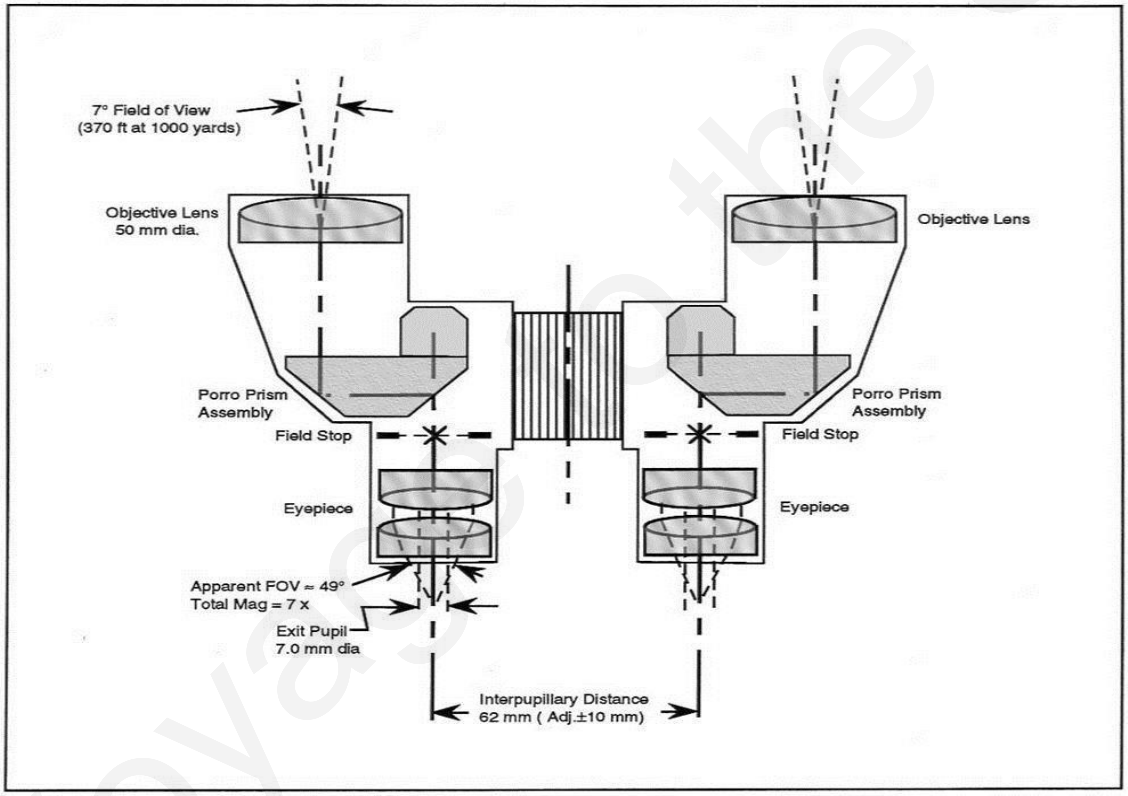
Meade 12 x 50mm TravelView Series Porro Prism Binoculars with Case & Strap

Image credit Meade company

Alpen Binoculars Pro 10x50 Binoculars - Specifications:

Credit: Eagle optics

Optics of Binoculars

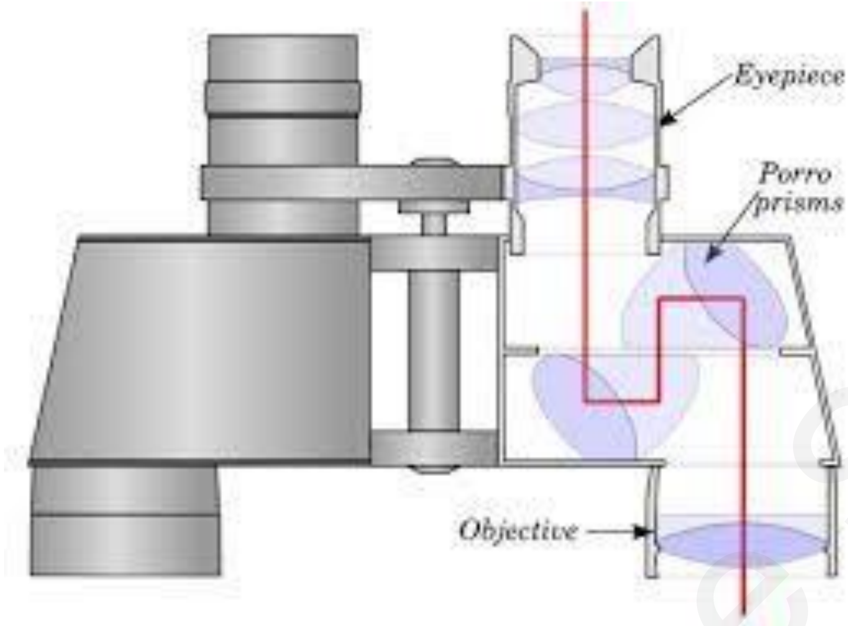


Concepts and terminology to be explained in class

1. Field of view
2. Objective lenses
3. Prisms
4. Prism assembly
5. Eyepiece lenses
6. Inter-pupillary distance
7. Magnification
8. Diameter of the objective lens
9. Apparent FOV
10. Focus
11. Resolving Power
12. Resolution
13. Porro Prism Binoculars
14. Roof Prism Binoculars

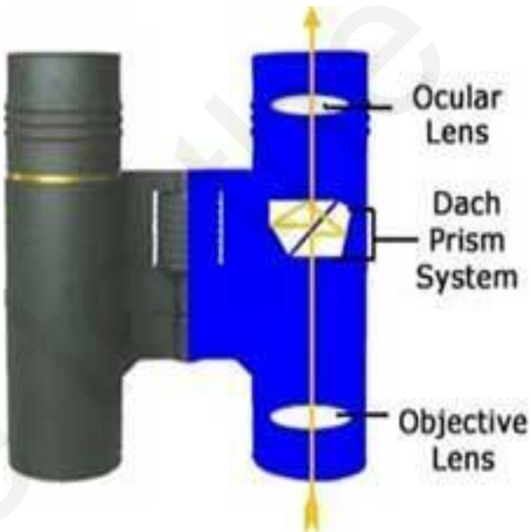
Ray tracing

Porro Prism Binoculars



Roof Prism Binoculars

VORTEX



Ocular Lens
Dach Prism System
Objective Lens

Optics of a telescope

A. Refracting Galilean Type Telescopes

Galileo's Telescope

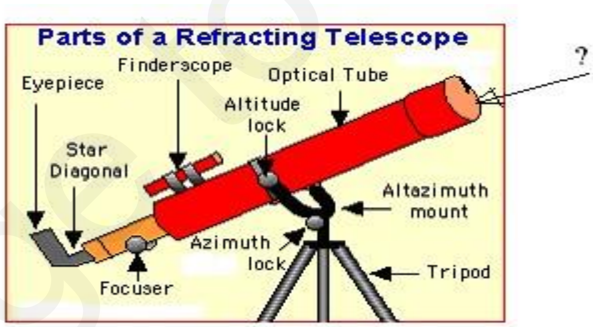
Image Credit: National Geographic

Build your own refracting telescope at a low cost

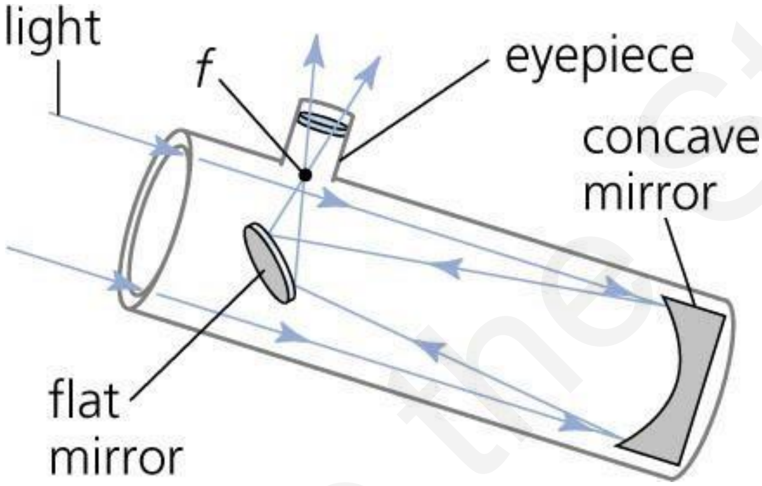
Example: http://www.anchoroptics.com/catalog/product.cfm?id=98

See images of the Yerkes Observatory University of Chicago
http://en.wikipedia.org/wiki/File:Yerkes_40_inch_Refractor_Telescope-2006.jpg

Features and properties of a refracting telescope



B. Reflecting telescopes



Reflecting telescope optics web site

http://spectroscopyonline.findanalytichem.com/spectroscopy/data/articlecolumn//spectroscopy/032005/142103/ article.pdf

Dr. Moreno's Astronomy class at LATTC working with our own Mead 12" Cassegrain Telescope observing the planet Saturn.

Cassegrain- type telescopes: LATTC Students observing the planet Saturn

A combination of Refracting and reflecting telescopes

Assignments

1. Visit the nearest observatory and write a three-page report about your observations
2. Visit the Griffith Observatory and planetarium and write a report
3. Build your own simple refracting telescope
   Example: http://www.anchoroptics.com/catalog/product.cfm?id=98

4. View the following short telescope videos

Telescope basics

1. http://www.youtube.com/watch?v=goL3K_xQzbE

2. http://www.youtube.com/watch?v=msIAdyljrwI

3. Celestron Firstscope
http://www.youtube.com/watch?v=cLKQHfTM9uE
4. How to select and buy your first telescope
http://www.youtube.com/watch?v=ZFJP1RguLXI
5. Comparing the Firstscope to the Funscope
http://www.youtube.com/watch?v=BkgR_307OEo
6. How to make a small simple telescope
http://www.youtube.com/watch?v=msIAdyljrwI
7. How to choose your first telescope
http://www.youtube.com/watch?v=FY74mdoSykw
8. How telescopes work http://www.youtube.com/watch?v=YQP4hB-2l2w
9. How big telescopes work
http://www.youtube.com/watch?v=Muk4F_LvbYs

10. How Telescopes Work
http://www.youtube.com/watch?v=9UQmqTAoBEY

11. How to set up a telescope

    http://www.youtube.com/watch?v=EMcHQRdjbSA

12. How telescopes work
    http://www.watchknowlearn.org/Video.aspx?VideoID=12163

13. How binoculars work: http://www.youtube.com/watch?v=TxEfy66r0G8

    http://www.youtube.com/watch?v=kPBq77PlcAw

Chapter XV

The Planets

As a first step:

Watch the following video for an overview of the planets and the Solar System

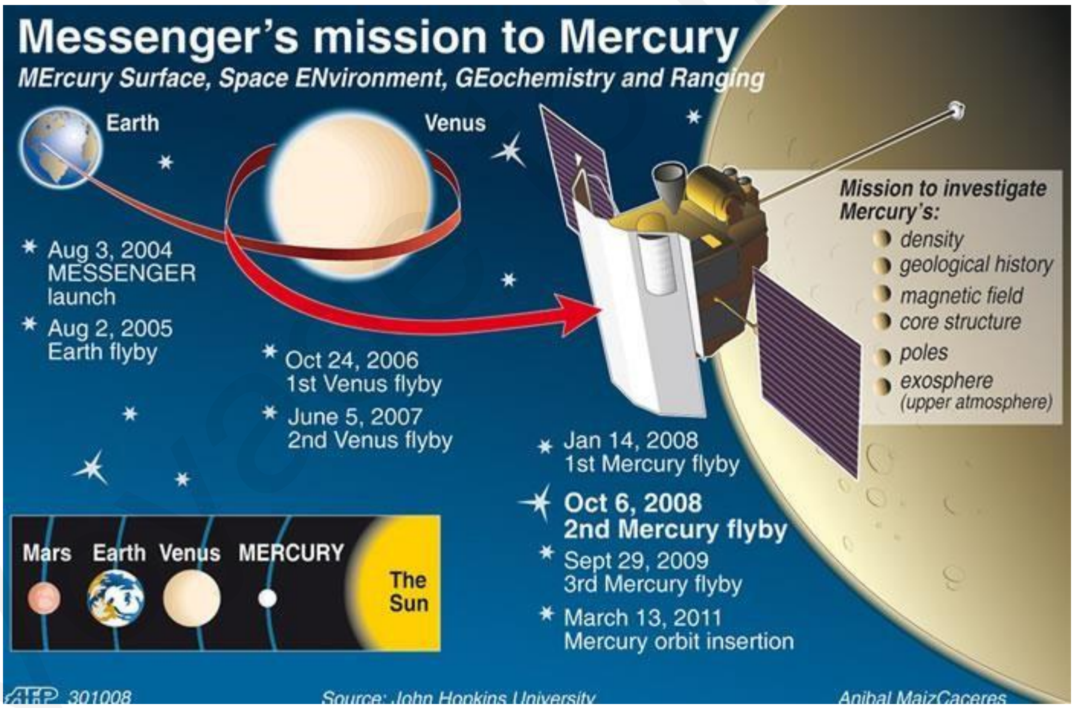
https://www.youtube.com/watch?v=QfOF0bRBFJ4

Mercury video: https://www.youtube.com/watch?v=0KBjnNuhRHs

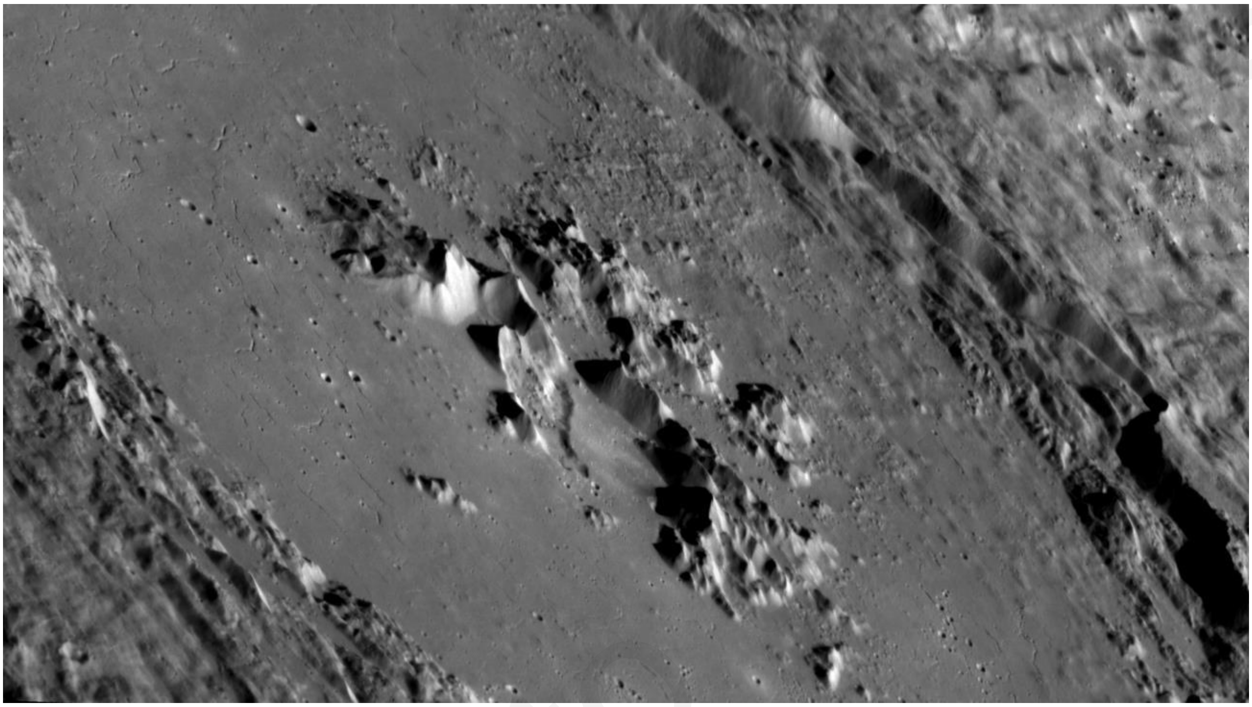
Mercury

The messenger spacecraft

https://www.nasa.gov/mission_pages/messenger/main/index.html



Credit: NASA



NASA - Messenger image of Mercury, mountains, valleys and scarps

NASA's Messenger Spacecraft in orbit around Mercury

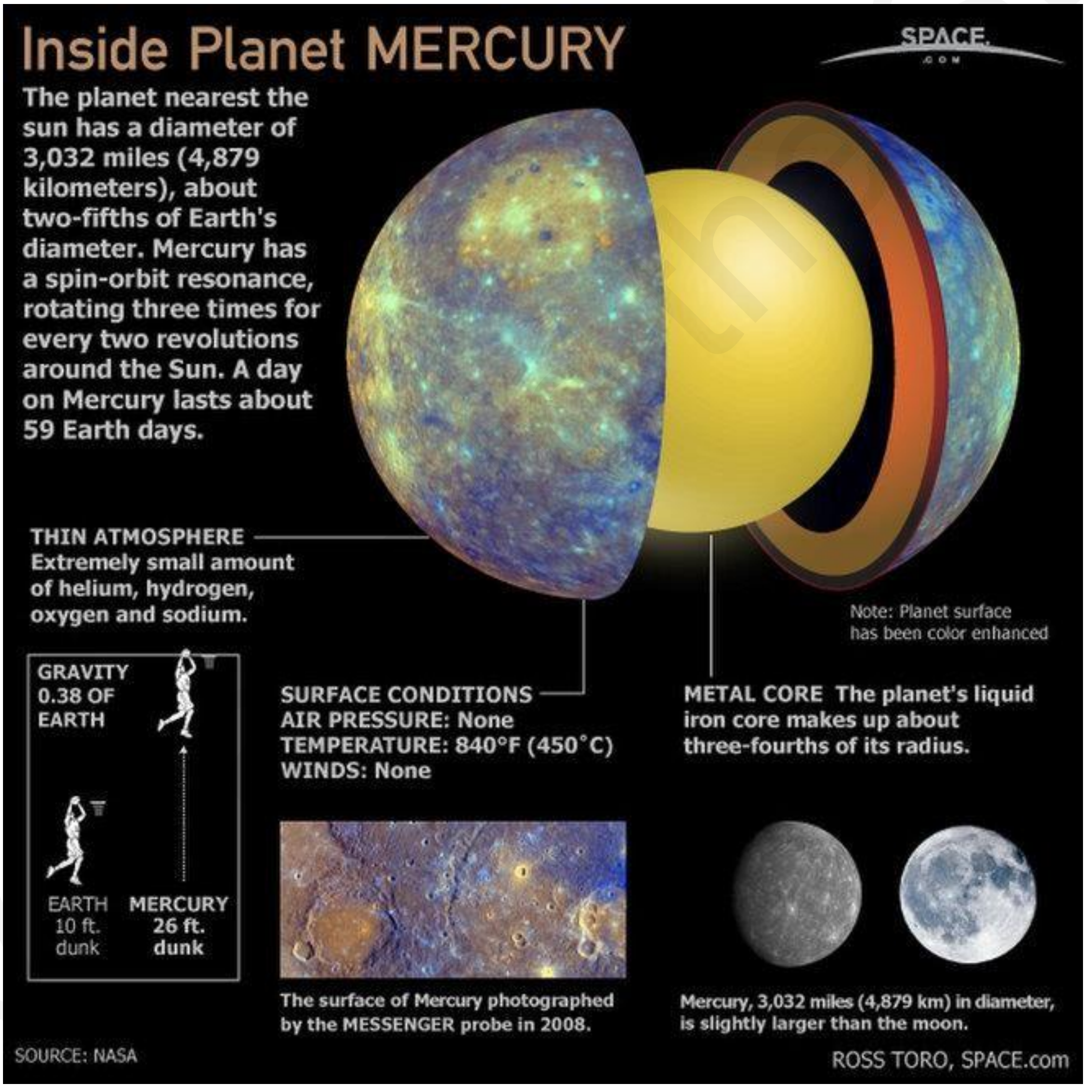


Image Credit: NASA

Orbital characteristics[4]Epoch J2000Aphelion

- 0.466 697 AU
- 69,816,900 km

Perihelion

- 0.307 499 AU
- 46,001,200 km

Semi-major axis

- 0.387 098 AU
- 57,909,050 km

Eccentricity0.205 630[2]
Orbital period

- **87.969 1 d**
- **0.240 846 yr**
- **0.5 Mercury solar day**

Average orbital speed
47.362
km/s[2]
Inclinat
ion

- 7.005° to ecliptic
- 3.38° to Sun's equator

Mean radius

- 2439.7±1.0 km[5][6]
- 0.3829 Earths

Siderealrotation period

- **58.646 d**
- **1407.5 h**[5]

Equatorial rotation velocity
10.892 km/h (3.026 m/s)

Surface area

- 0.147 Earths

Volume

- 0.056 Earths

Mass

- 3.

3022×10^23

kg[5]

0.

055

Earths

Mean density

5.427 g/cm^3[5]

Surface gravity

- 3.7 m/s^2
- 0.38 g[5]

-

Surface temp.	min	mean	max
0°N, 0°W [11]	100 K	340 K	700 K
85°N, 0°W[11]	80 K	200 K	380 K

Angular diameter

4.5–13″[2]

Atmosphere
Surface pressure
Trace Composition by volume

- 42% molecular oxygen
- 29.0% sodium
- 22.0% hydrogen
- 6.0% helium
- 0.5% potassium
- Trace amounts of argon, nitrogen, carbon dioxide, water vapor, xenon, krypton, and neon

Venus

Watch the following videos about Venus:

1. https://www.youtube.com/watch?v=BvXa1n9fjow

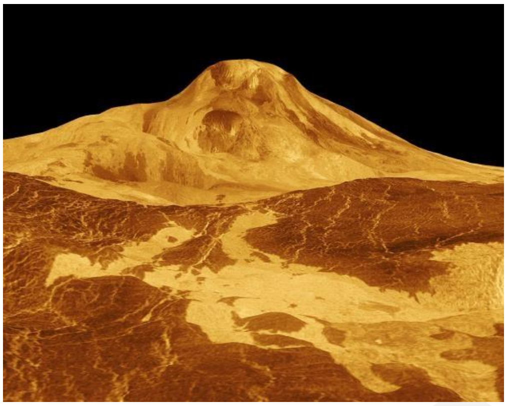
2. https://www.youtube.com/watch?v=fWbKRuKZ6MM

3. https://www.youtube.com/watch?v=xf80fN1Me_c

4. https://www.youtube.com/watch?v=yzqbN6z8ncc

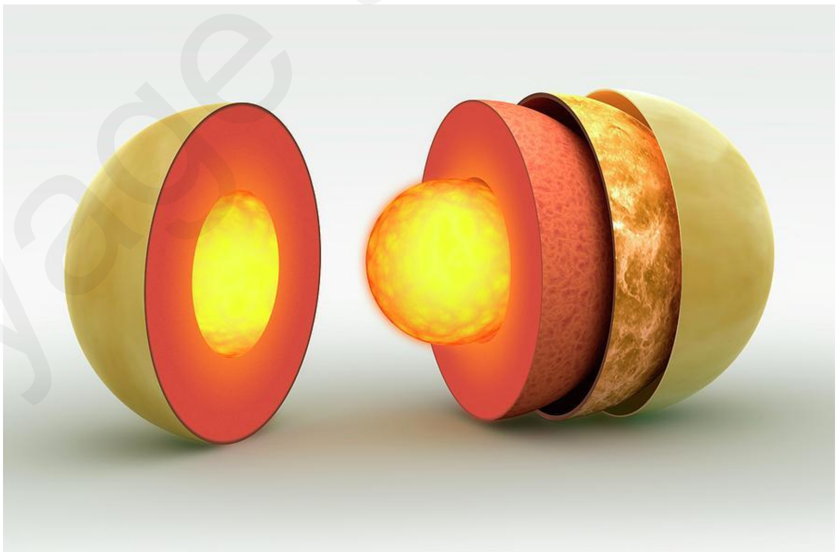
5. https://www.youtube.com/watch?v=3xrMu3jq6P8

http://pds.jpl.nasa.gov/planets/choices/venus5.htm



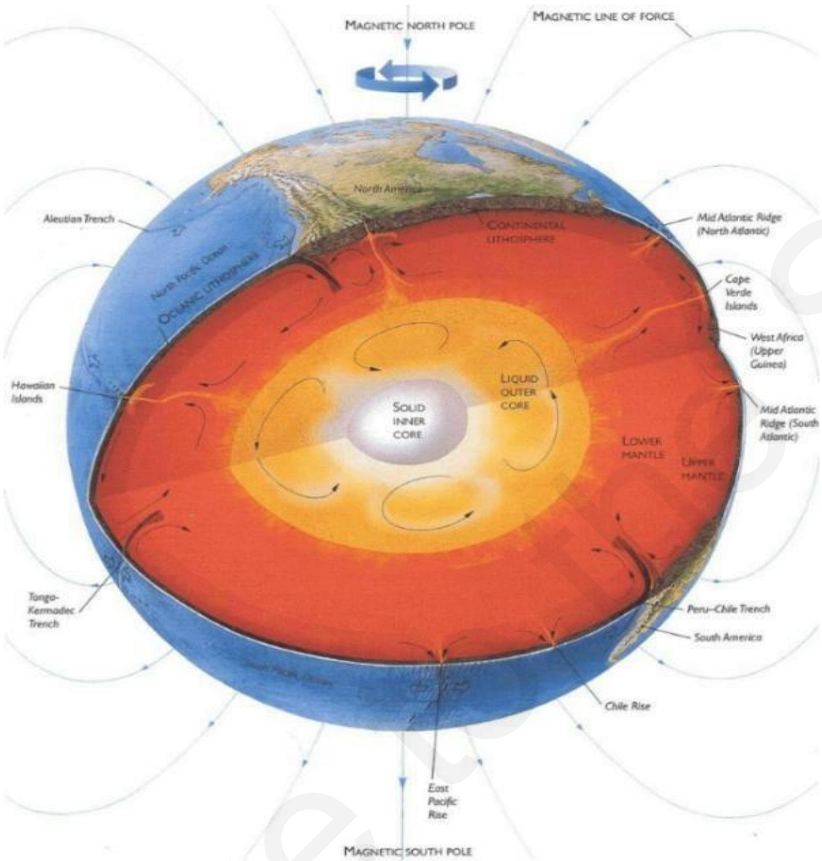
NASA - Planet Venus: Mount Maat – Image from the Magellan spacecraft

Maat Mons is a massive shield volcano. It is the second-highest **mountain**, and the highest volcano, on the planet **Venus**. It rises 8 kilometers (5.0 mi) above the mean planetary radius at 0.5°N 194.6°E, and nearly 5 km above the surrounding plains. It is named after the Egyptian goddess of truth and justice, Ma'at.

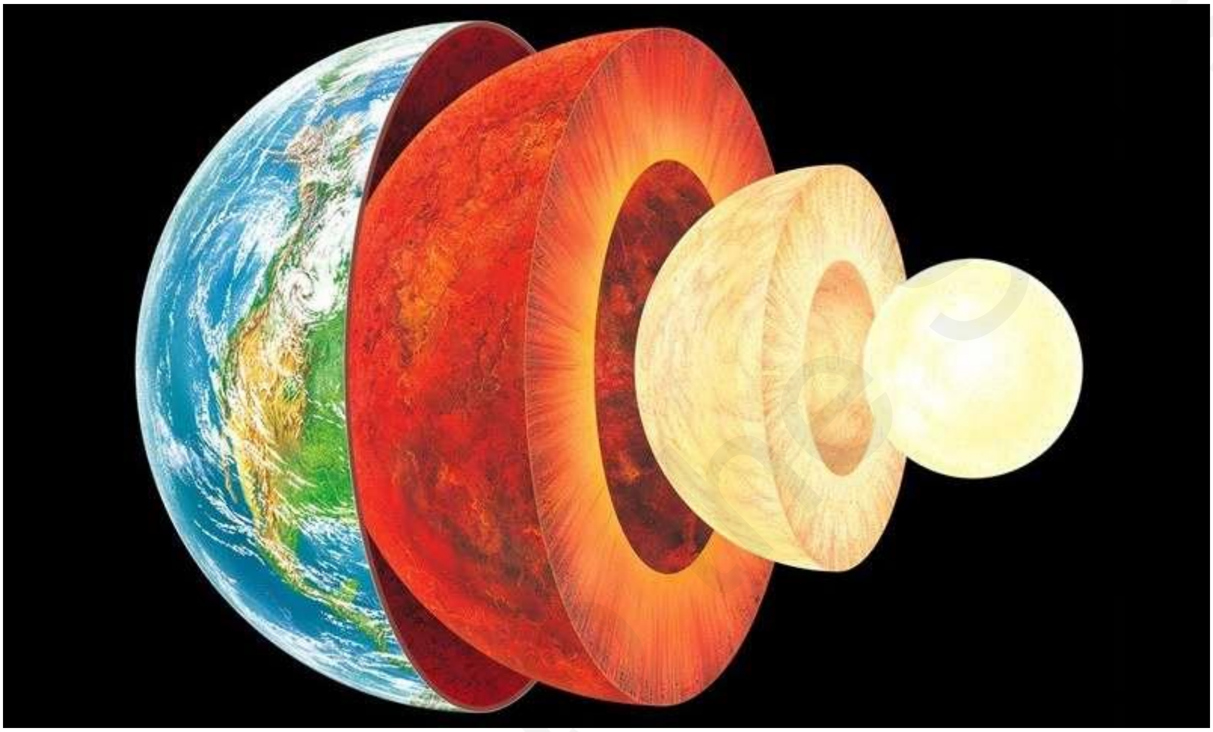


Interior structure of Venus Core, Mantle and two layers of the Crust.

Earth



Internal structure of the Earth



Earth's Interior. Inner Solid Core, Outer Liquid Core, Mantle and Crust

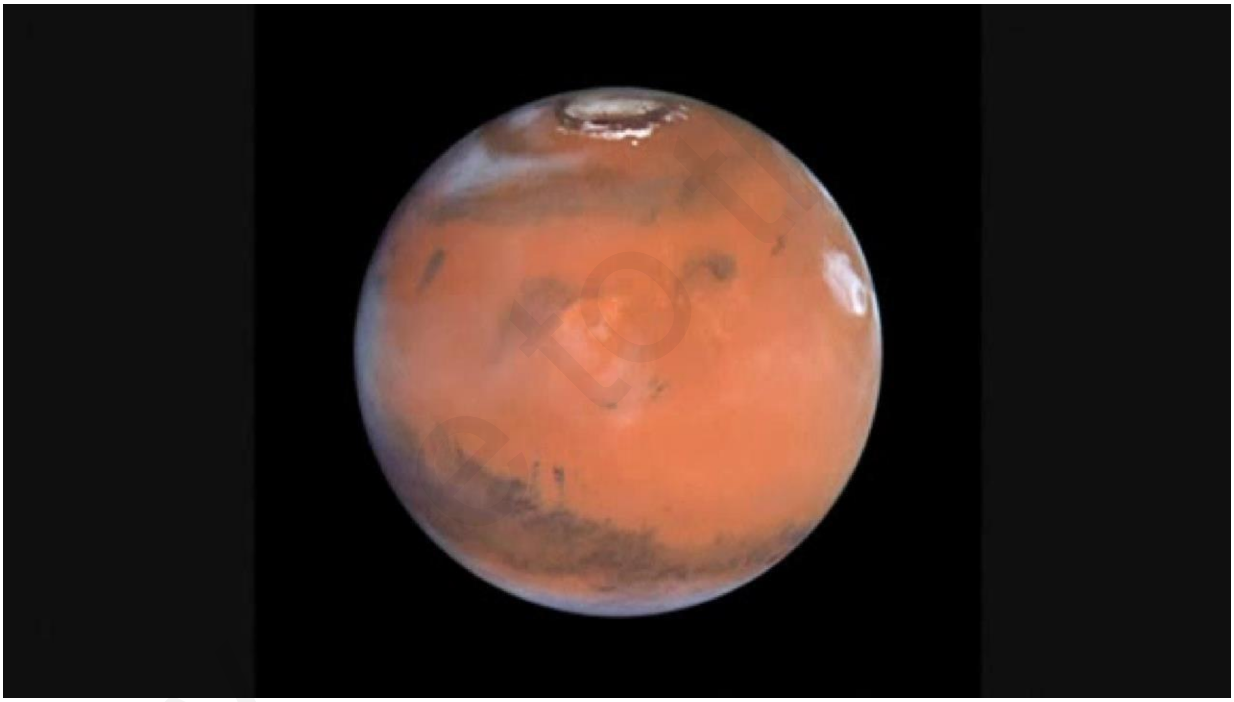
Watch the following videos:

1. https://www.youtube.com/watch?v=HCDVN7DCzYE
2. https://www.youtube.com/watch?v=aU6pxSNDPhs

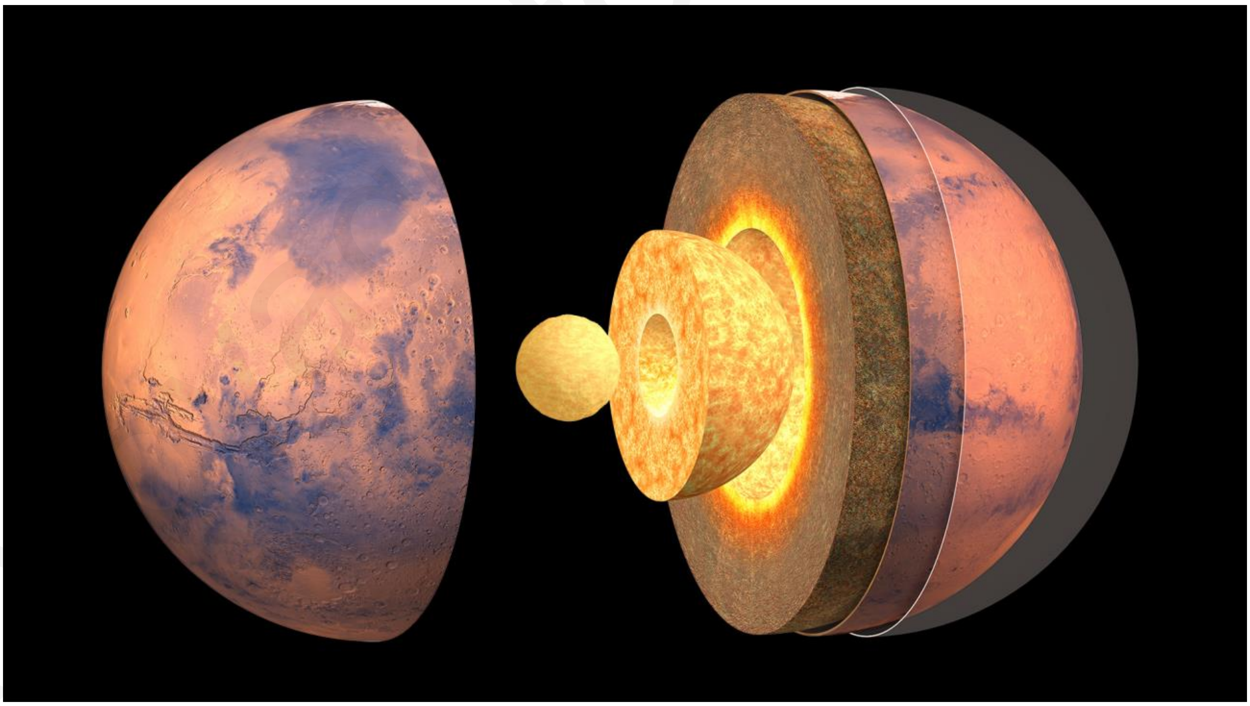
Mars

Watch the following videos about Mars:

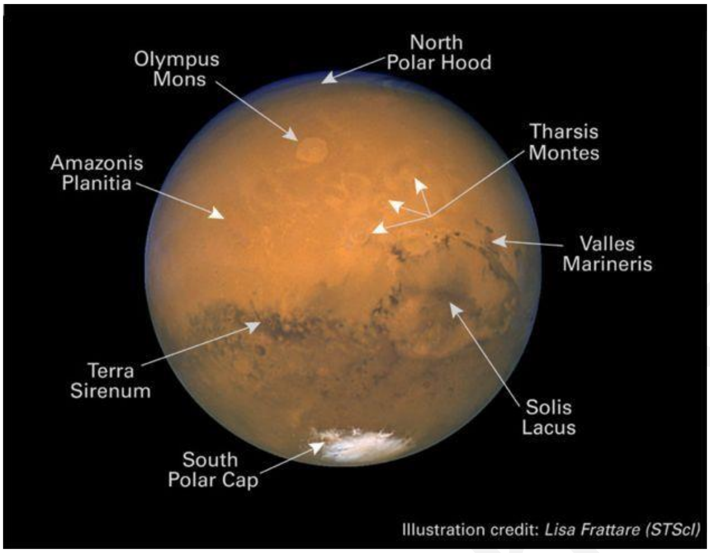
1. https://www.youtube.com/watch?v=D8pnmwOXhoY
2. https://www.youtube.com/watch?v=E-PuUs25rJA
3. https://www.youtube.com/watch?v=CyvsIVtzixw
4. https://www.youtube.com/watch?v=6t3IARmIdOI
5. https://www.youtube.com/watch?v=a_Ljhhtka6c



Viking image of the surface of Mars



Mars' Interior: Solid Inner Core, Liquid Core, Mantle and Crust



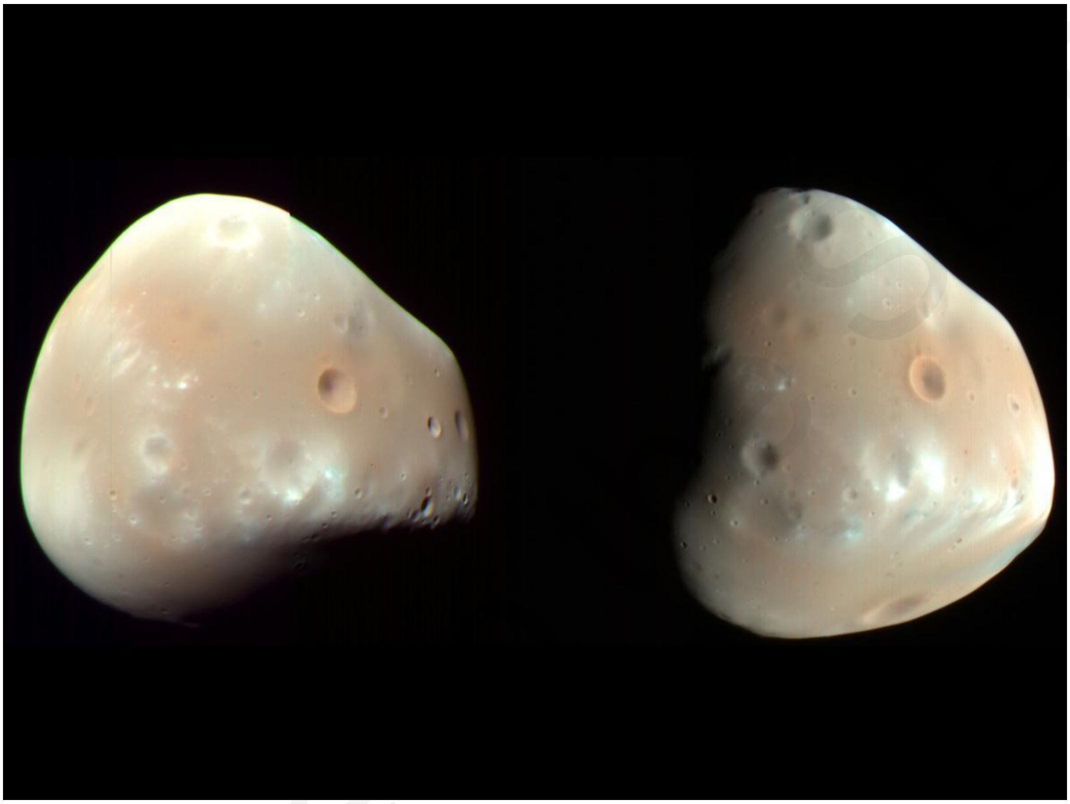
Mars surface features


Representation of the Spirit Rover on Mars

Moon of Mars: Phobos

Moon of Mars: Deimos

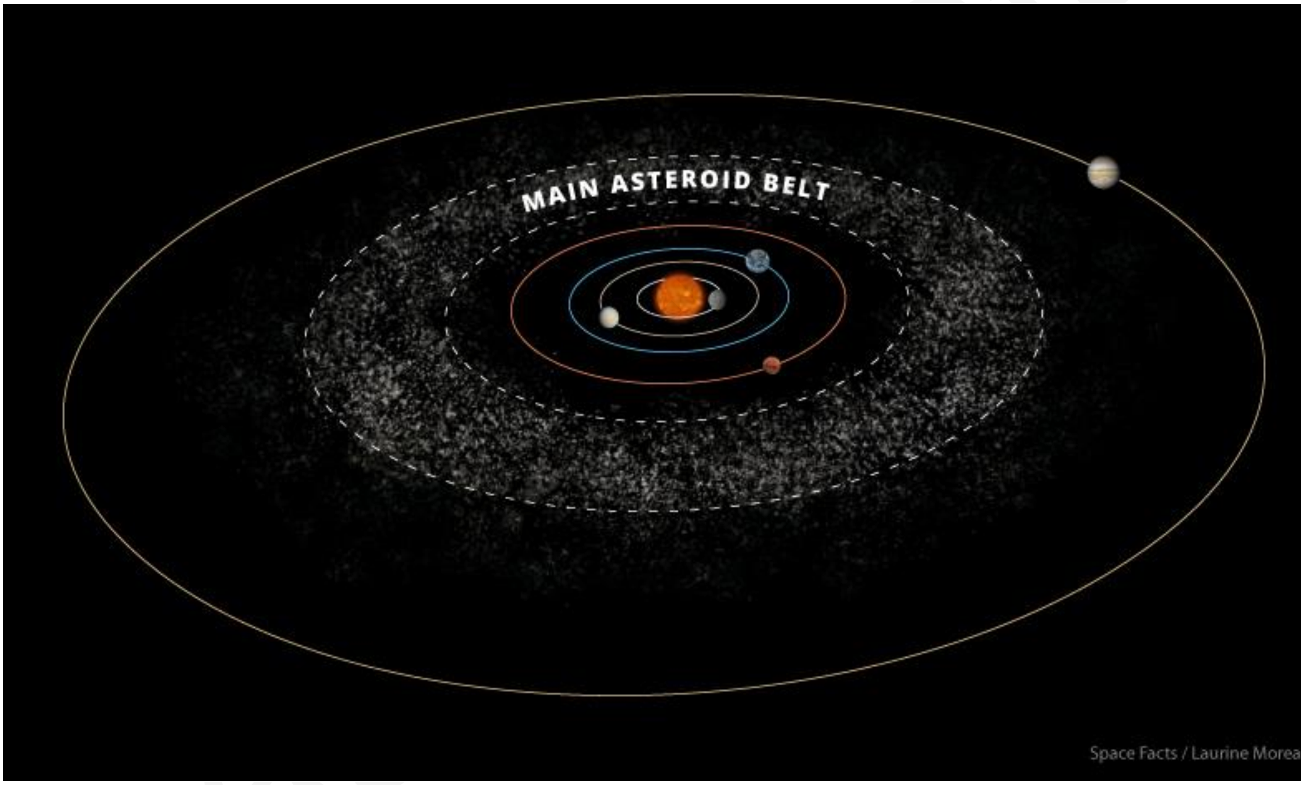
Credit: NASA Image – Phobos

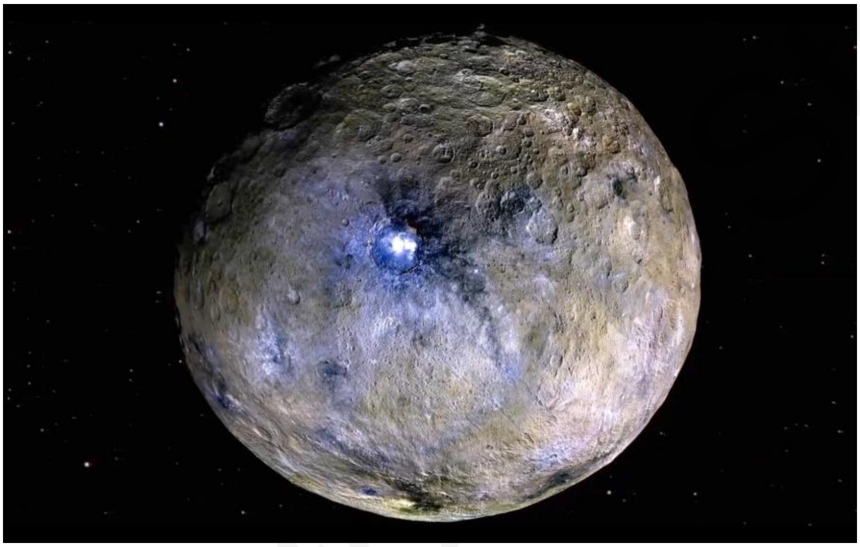


Credit – NASA Image – Deimos

	PHOBOS (fear)	DEIMOS (panic)
Mean distance from Mars (km)	9,377	23,436
Orbital period (Mars days)	0.31891	1.26244
Major axis (km)	26	16
Minor axis (km)	18	10
Mass ($x \ 10^{15}$ kg)	10.8	1.8
Mean density (kg/m^3)	1,900	1,750

Asteroid Belt between Mars and Jupiter





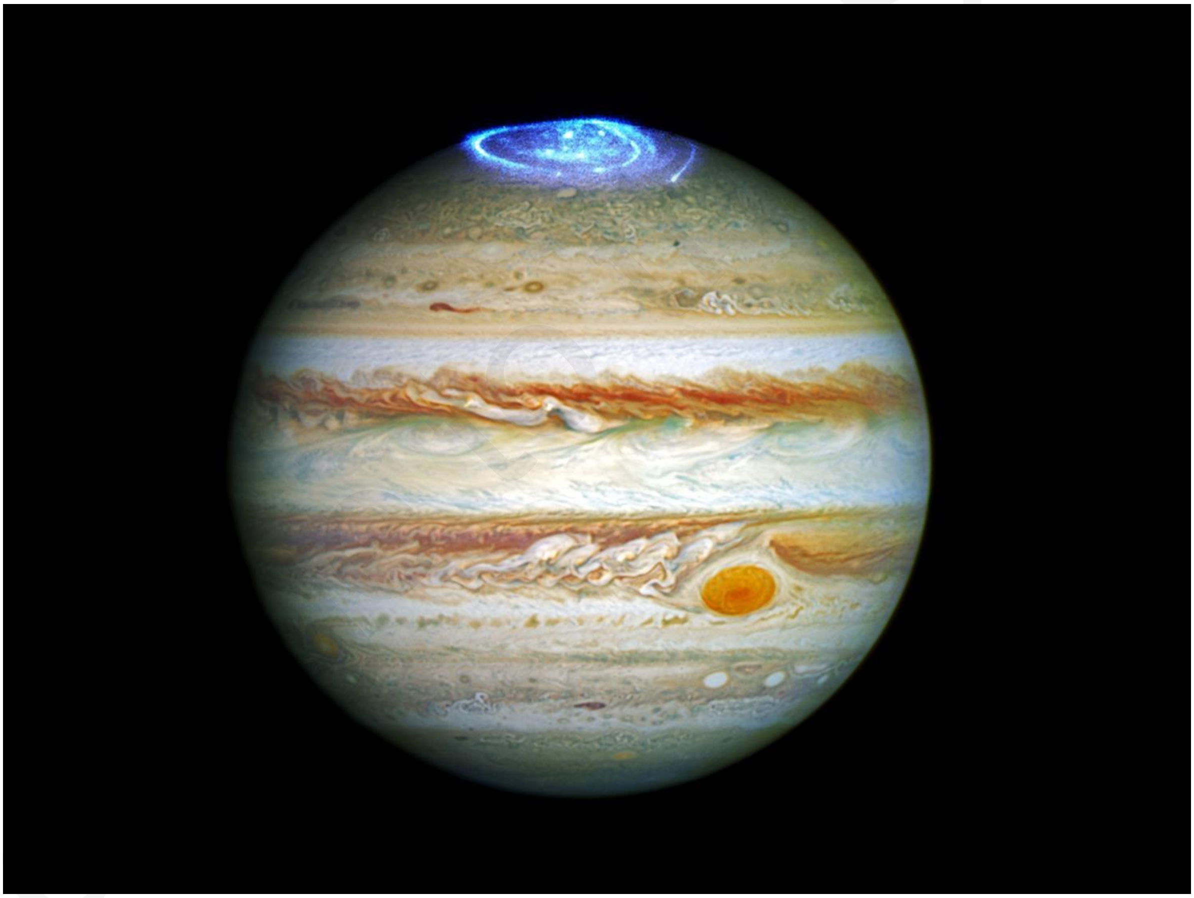
NASA Image. Dwarf planet Ceres in the Asteroid Belt.

https://solarsystem.nasa.gov/planets/dwarf-planets/ceres/overview/

Diameter:	950 km
Mass:	8.96 × 10^20 kg (0.01 Moons)
Orbit Distance:	413,700,000 km (2.8 AU)
Orbit Period:	1,680 days (4.6 years)
Surface Temperature:	-105°C

Discovery Date:	1st January 1801
Discovered By:	Giuseppe Piazzi

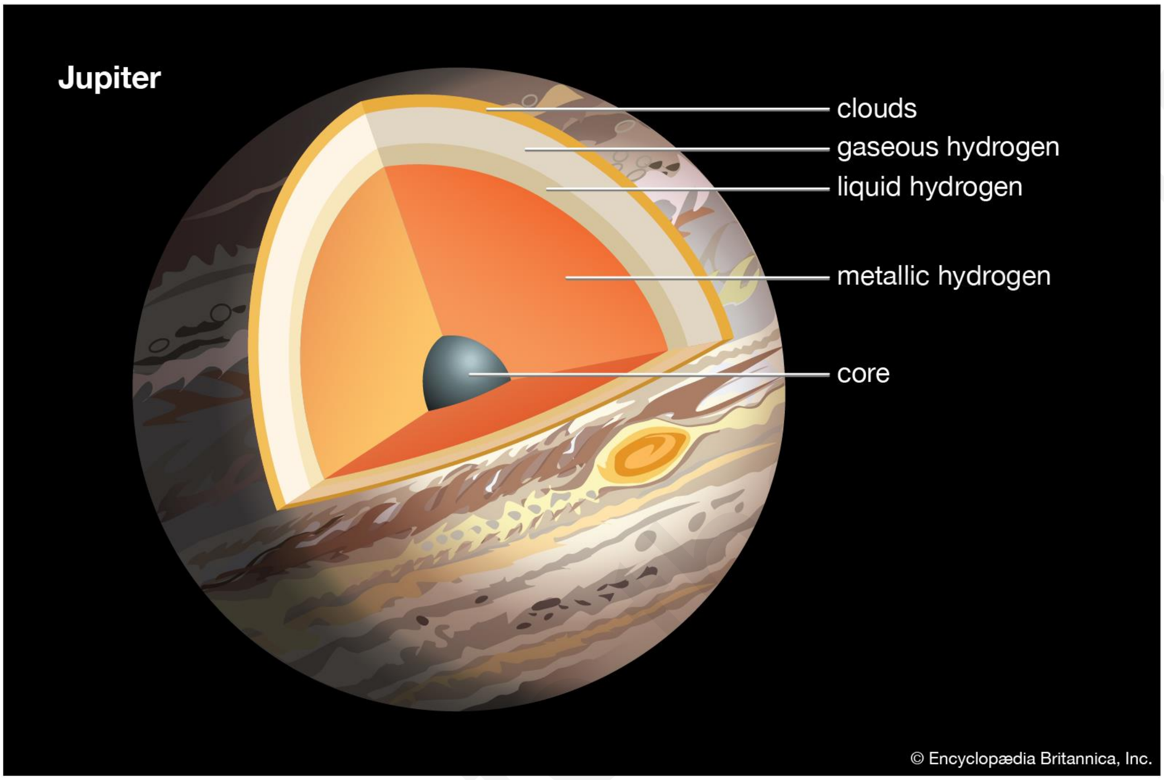
Jupiter

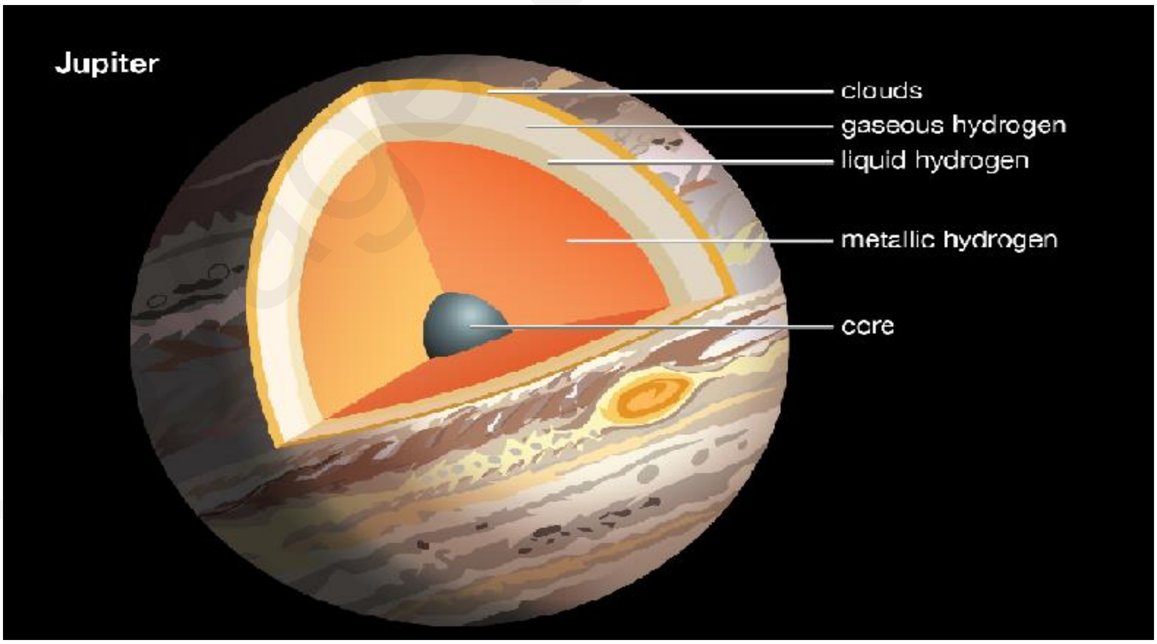


NASA Juno Spacecraft image of Jupiter. Showing the Great red Spot a 400 year Hurricane and the Northern Lights.

Jupiter 101 – National Geographic

https://www.youtube.com/watch?v=PtkqwslbLY8


Jupiter
clouds
gaseous hydrogen
liquid hydrogen
metallic hydrogen
core
© Encyclopædia Britannica, Inc.

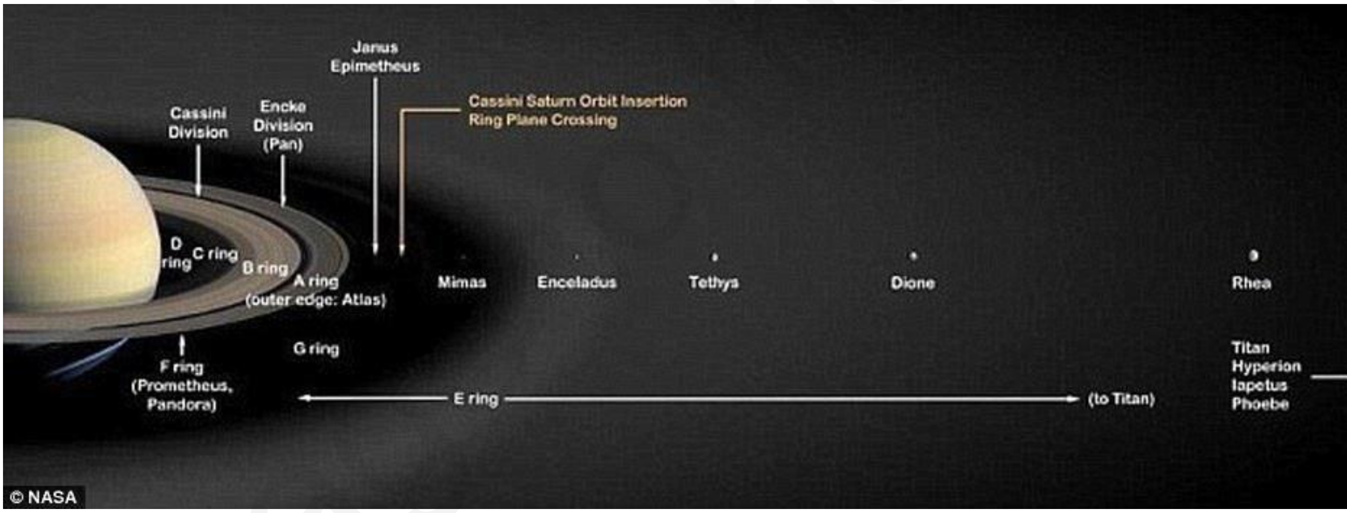

Jupiter
clouds
gaseous hydrogen
liquid hydrogen
metallic hydrogen
core

NASA - Galilean moons of Jupiter: Io, Europa, Ganymede and Callisto

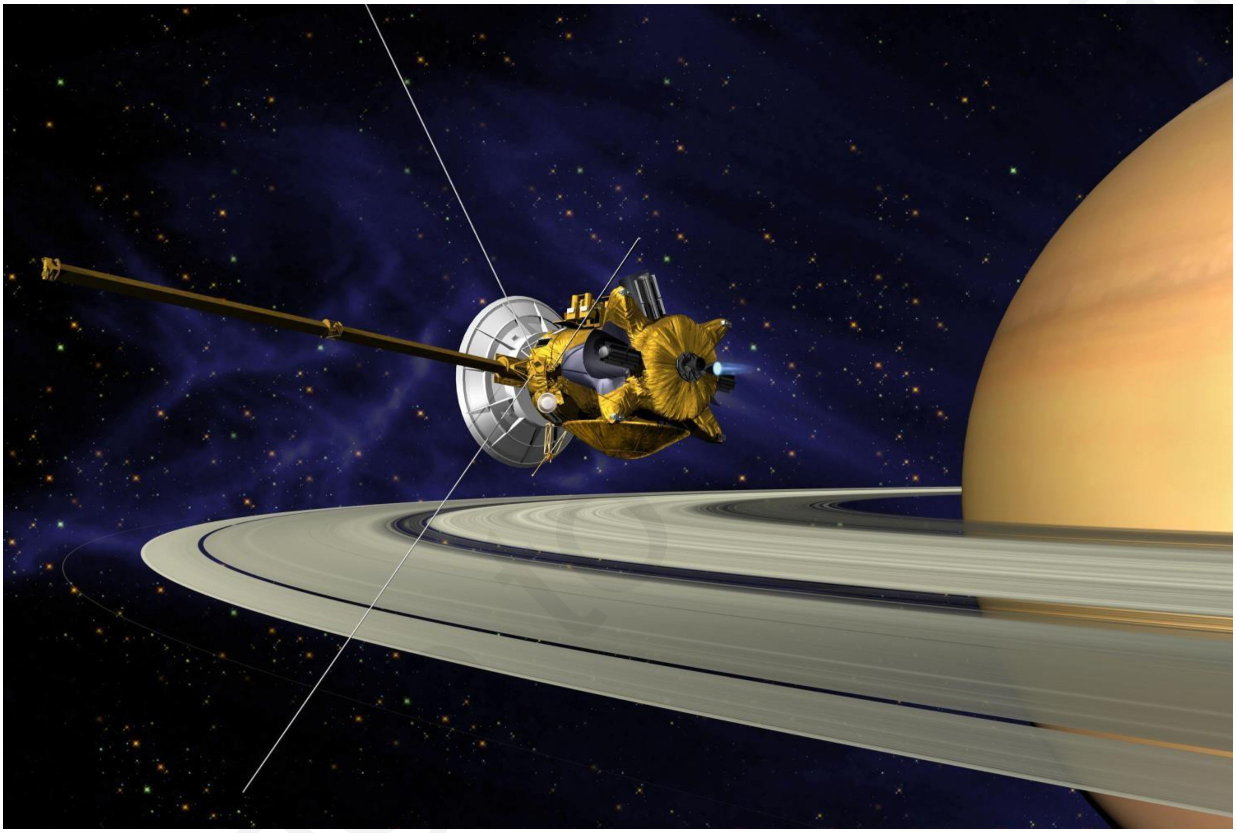
Saturn

Watch the following videos about Saturn

1. https://www.youtube.com/watch?v=epZdZaEQhS0
2. https://www.youtube.com/watch?v=stFJjVGKSWw
3. https://www.youtube.com/watch?v=wVlcNE3A83o
4. Titan Moon of Saturn: https://www.youtube.com/watch?v=uE5POhMnN78
5. Enceladus Moon of Saturn: Water volvanoes
   https://www.youtube.com/watch?v=MjOpZrYLE1U

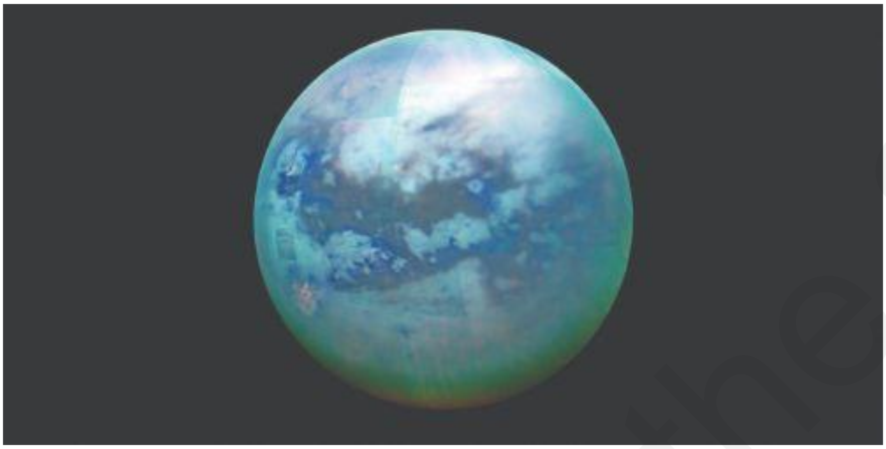


See Cassini Spacecraft Mission to Saturn NASA



NASA

Titan: Moon of Saturn



NASA: Cassini image

The surface of Titan as photographed by the Casinni - Huygens probe

It was determined that Titan has rivers and deep (325 feet) lakes of Methane

NASA/ ESA: On Jan. 14, 2005, ESA's Huygens probe made its descent to the surface of Saturn's hazy moon, Titan.

https://www.jpl.nasa.gov/video/details.php?id=1455

Uranus

https://www.youtube.com/watch?v=m4NXbFOiOGk

Neptune

Neptune National Geographic: https://www.youtube.com/watch?v=NStn7zZKXfE

Pluto

Watch the following video about Pluto:

https://www.youtube.com/watch?v=CnNzpnCj1yo

NASA's New Horizons Mission to Pluto:

https://www.youtube.com/watch?v=6l4kr36TzQ4

Why was Pluto classified as a Dwarf planet?

https://www.youtube.com/watch?v=NStn7zZKXfE

To be described in class with NASA images

Dwarf planet classification

- List of Dwarf Planets: https://www.youtube.com/watch?v=KtDaB-cP_68

Pluto

Cerers

Sedna

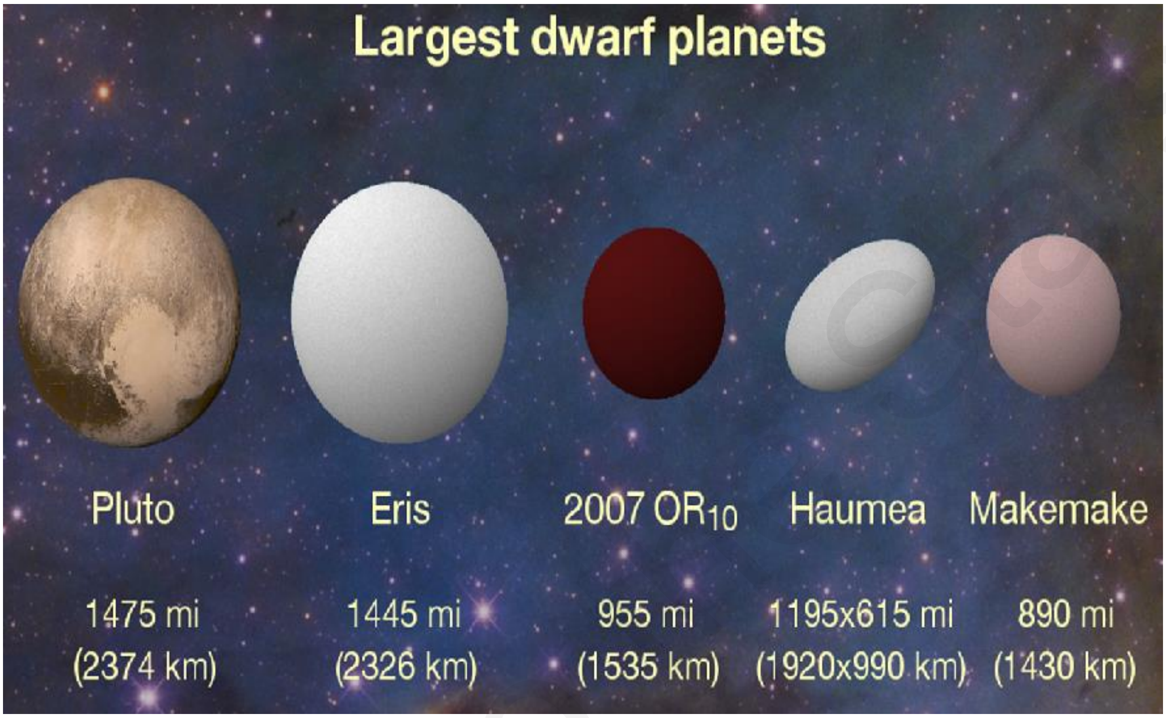
Discussion of each one of the planets in class

A comparison with the Earth

What is a Dwarf Planet?

Dwarf planets are round in shape and orbit the Sun just like the eight major planets. But unlike planets, dwarf planets are not able to clear their orbital path so there are no similar objects at roughly the same distance from the Sun. A dwarf planet is much smaller than a planet (smaller even than Earth's moon), but it is not a moon. The first five recognized dwarf planets are Ceres, Pluto, Eris, Makemake and Haumea and they are all uniquely mysterious.

Credit: NSA/JPL



Credit: JPL - NASA

Assignments:

1. Watch the following video and write a short summary of its contents.
   Planets: https://www.youtube.com/watch?v=QfOF0bRBFJ4

2. Draw the solar system and identify its component planes, asteroid belt, Dwarf planets, Kuiper Belt and the Ort
   Cloud.

Chapter XVI

Our Star: The Sun.

Watch the following videos about the Sun

1. https://www.youtube.com/watch?v=2HoTK_Gqi2Q
2. https://www.youtube.com/watch?v=eknD3g73wr0
3. https://www.youtube.com/watch?v=6tmbeLTHC_0
4. White Dwarfs – The end of the life time of the Sun
   https://www.youtube.com/watch?v=ITD8s-bLXSk

VOCABULARY

- chromosphere
- corona
- photosphere
- solar wind
- sunspot
- Nuclear fusion

The structure of the Sun is determined by the conditions of mass conservation, momentum conservation, energy conservation, and the mode of energy transport.

The Sun is an oblate spheroid, like all the major bodies in the solar system, but in a first simplifying approach to describe the solar structure, the effects of rotation and magnetic fields will be neglected here so that the Sun is taken to be spherically symmetrical. Calculating a solar model means the determination of pressure, temperature and chemical composition as a function of mass or radius through the Sun, (Chandrasekhar 1967; Kourganoff 1973).

Two forces keep the Sun in hydrostatic equilibrium in its current stage of evolution: the gravitational force directed inward and the total pressure force directed outward. Credit: NASA

Internal Structure of the Sun

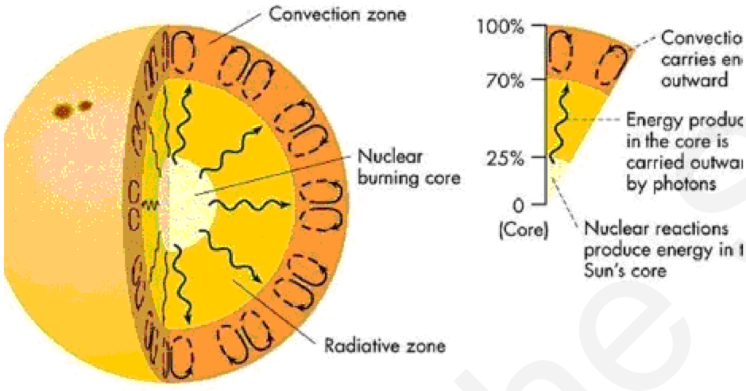
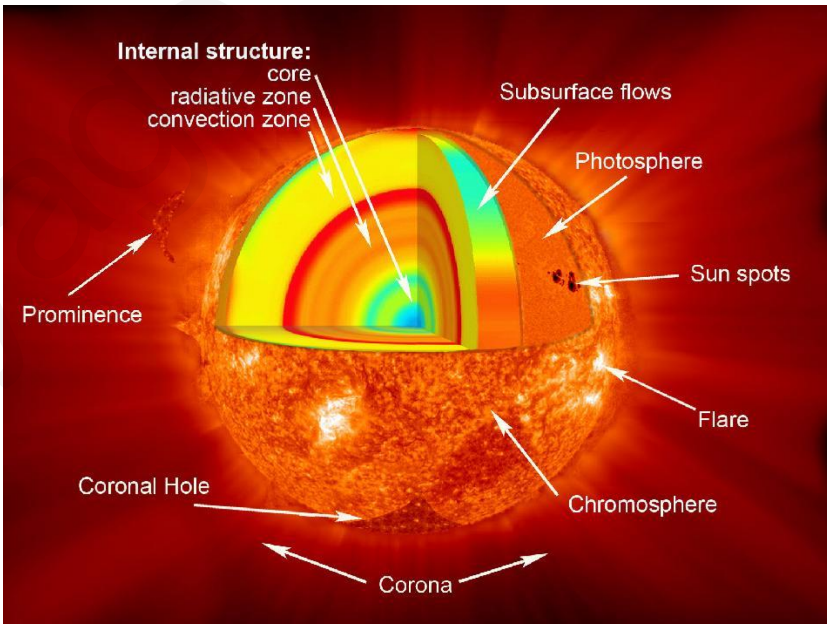
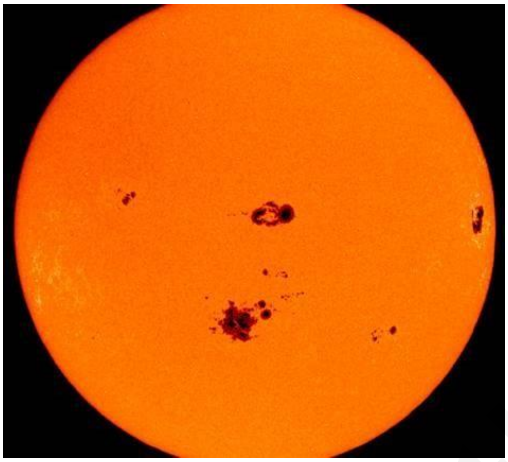


Image credit NASA.

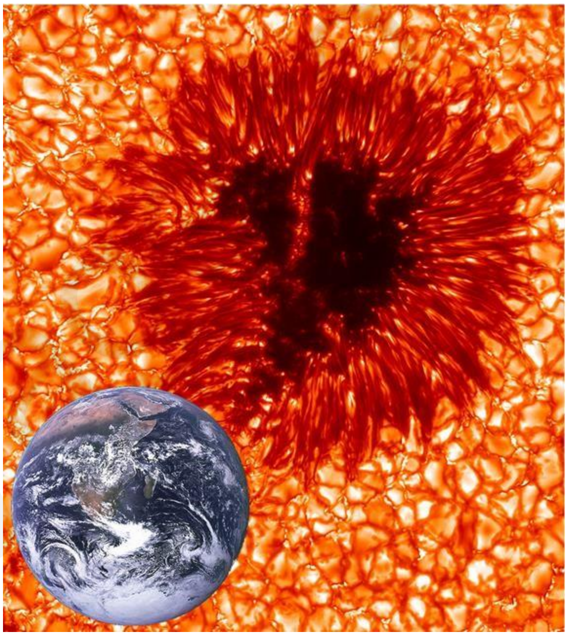
https://www.nasa.gov/mission_pages/sunearth/multimedia/Sunlayers

.html





Sun spots



Comparing a Sun spot to the size of the earth

Animation of the solar wind

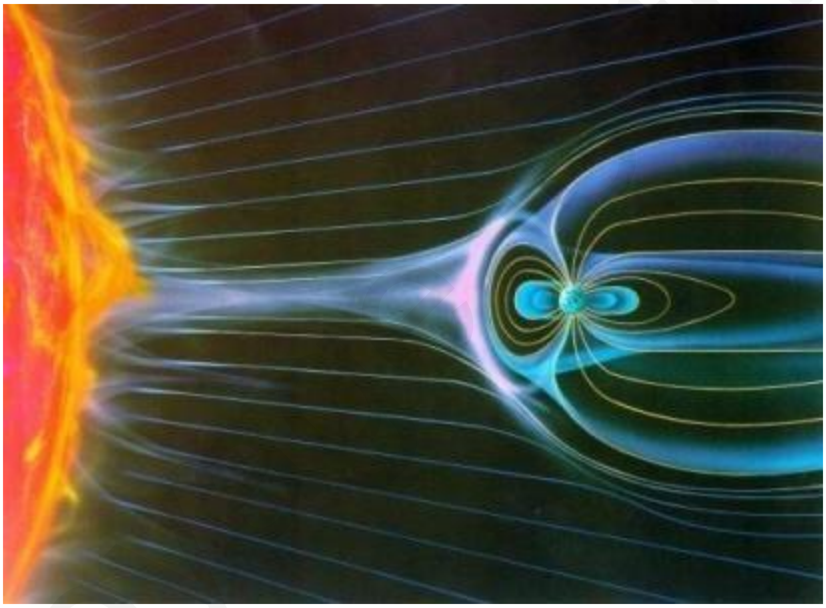
http://techtv.mit.edu/videos/944-span-classhighlightsolarspan-span-classhighlightwindspaninteracting-with-interstellar-medium

http://www.youtube.com/watch?v=a27xQy1b1Cs Magnetosphere of the earth

http://www.youtube.com/watch?v=5SXgOWYyn84&feature=related

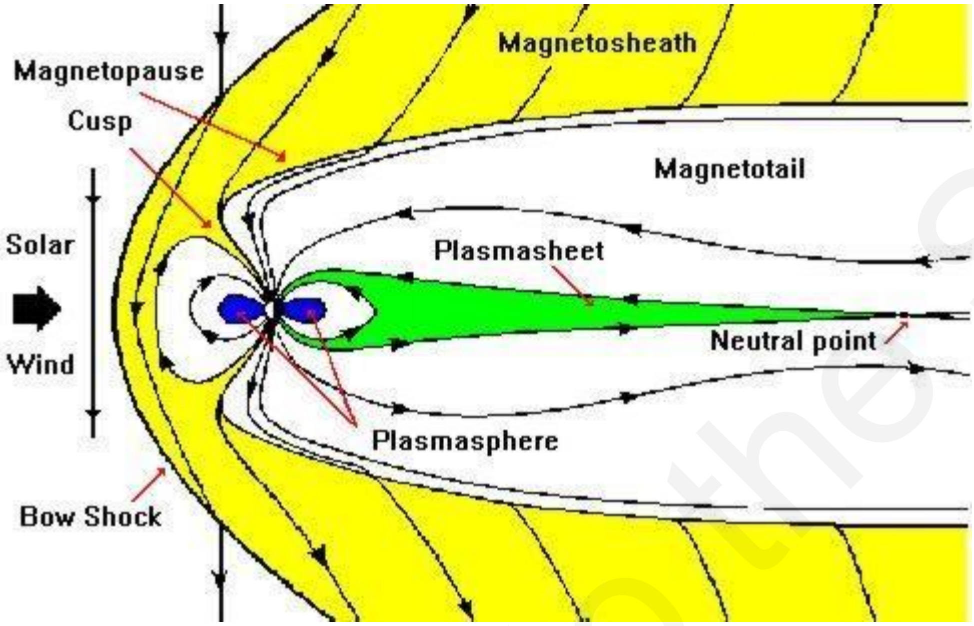
Electric and magnetic storms, effects on communications

Aurora Borealis and Aurora Australis



NASA - Interaction of the solar wind with the Earth's magnetic field, the magnetosphere.

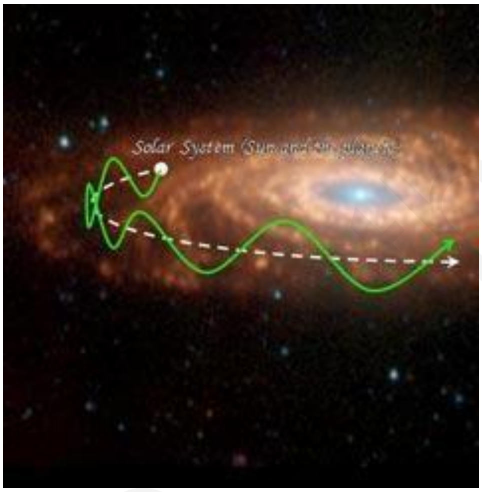
The Magnetosphere of the Earth



Electric and magnetic storms, effects on communications

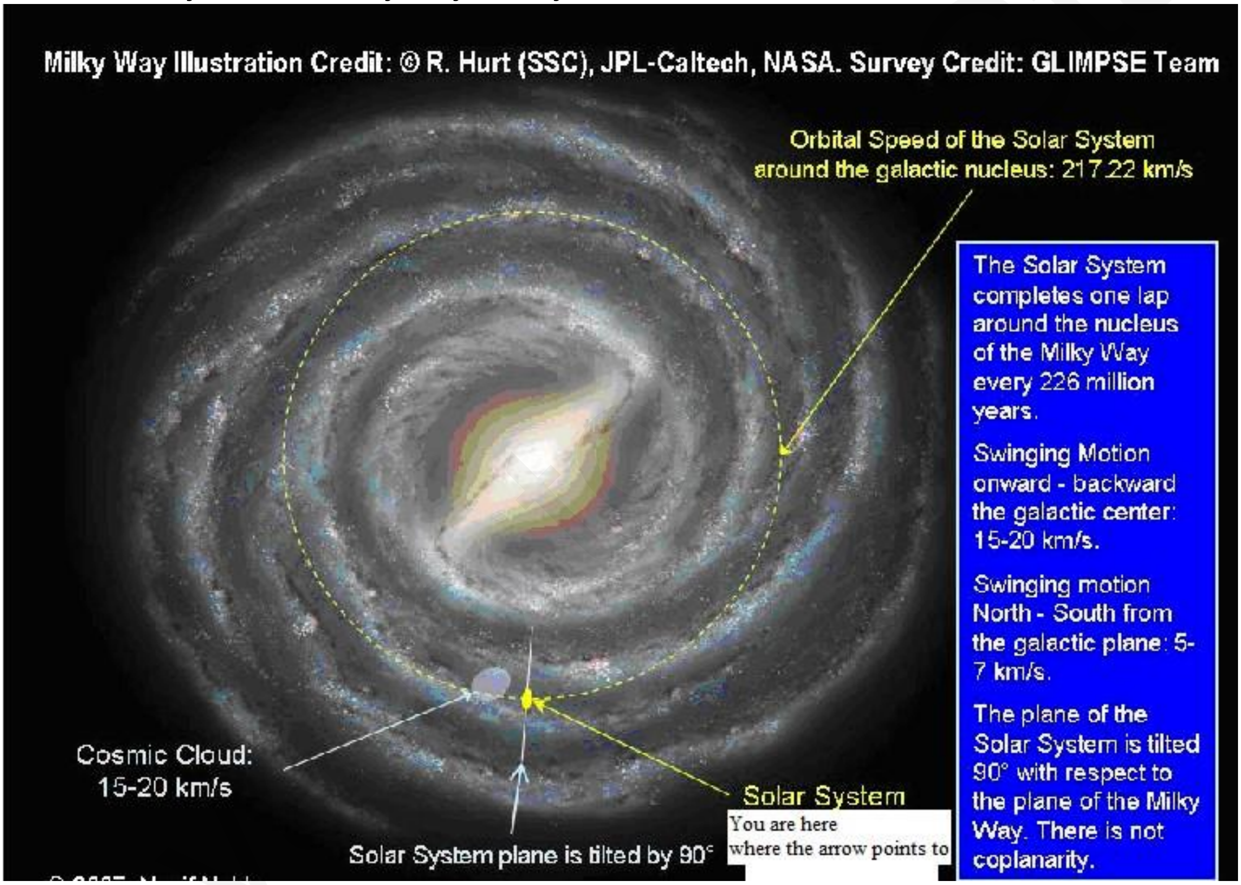
Motion

What are the motions of the Sun?
Rotation: Once every 25 days
Revolution: Around the Milky Way Galaxy: Once every 226 million years



What is the Milky Way?
It is a group of 400 billion stars held together by the force of gravity on a spiral disc. The Sun is one of those stars

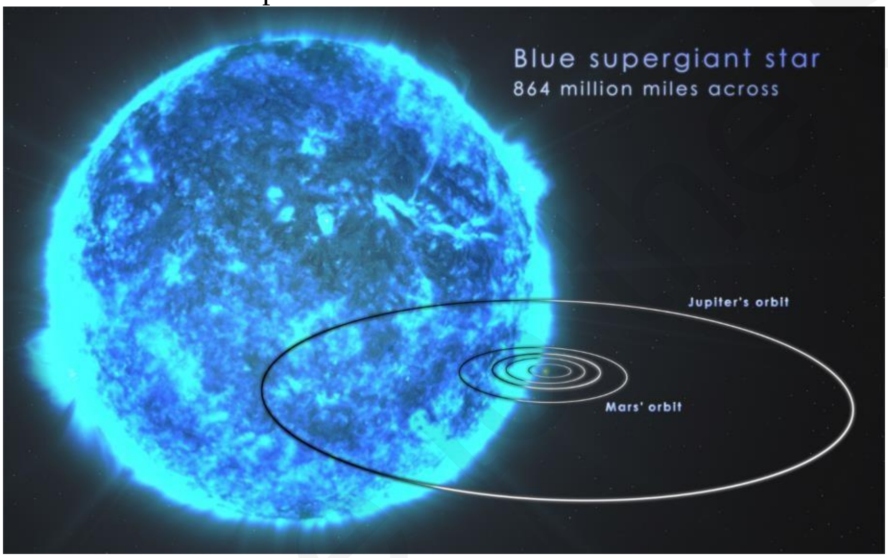
Where is the Sun with the family of planets in the Milky Way? Please see where the arrow is pointing
Where are you in the Milky Way Galaxy?



About 1/3 of the stars in the Galaxy are like the Sun

How does the Sun compare to other stars?

Types of stars: Blue Super Giants, Main Sequence and Red giants and Red Dwarves 1. Blue Super Giants and Blue Giants

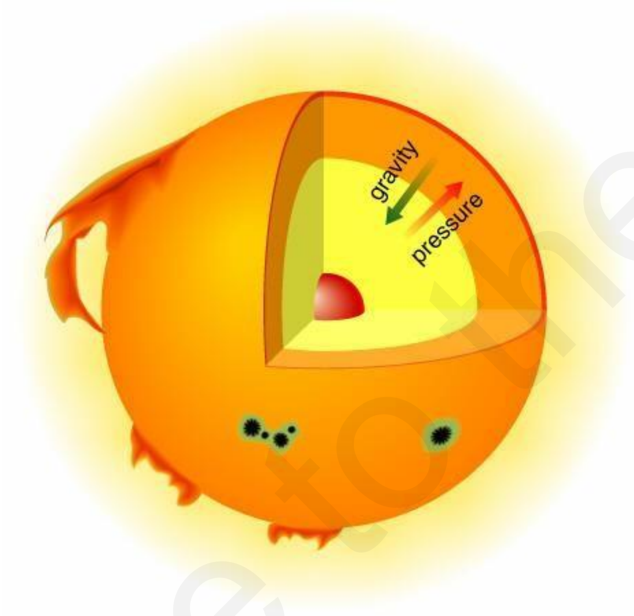


Example: Rigel in the constellation Orion is a Blue Super giant


Orion
The Hunter
Betelgeuse
Bellatrix
Mintaka
Horsehead
Nebula
M43
M42
Rigel

2. Main Sequence Stars

A star like the Sun

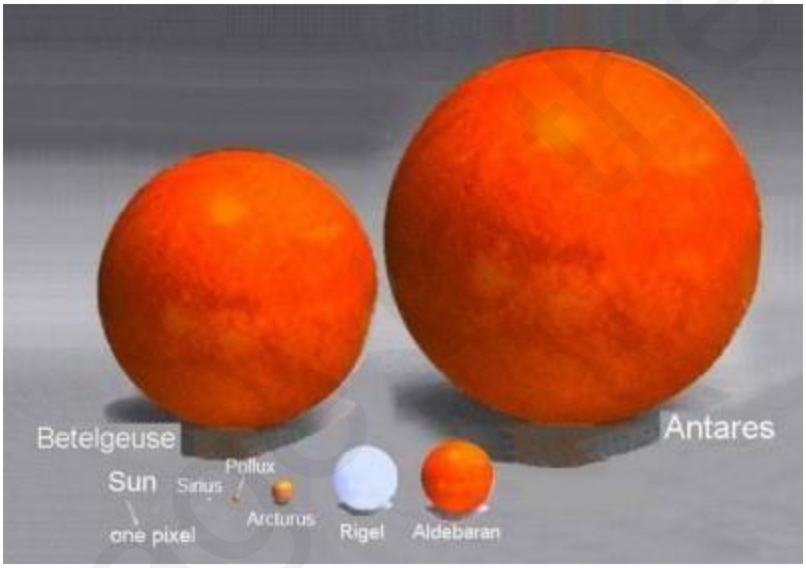


What holds the Sun together?

There is a balance between gravity pulling in and pressure from the heat pushing out.

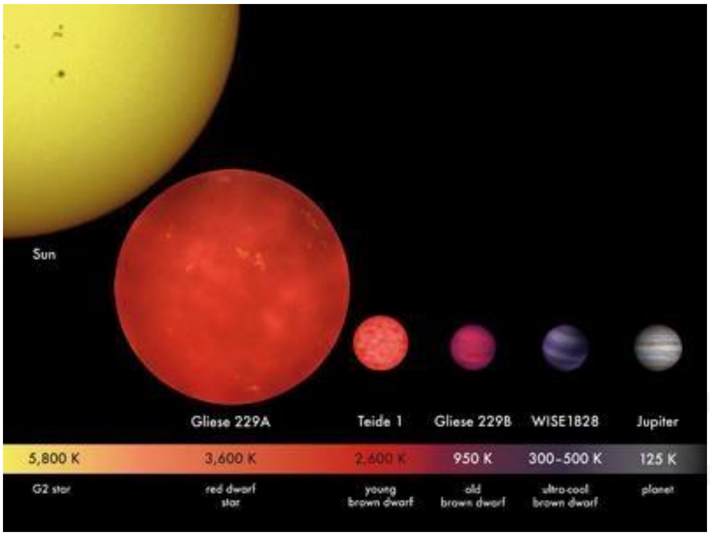
Red stars: Red giants

Comparison with the Sun

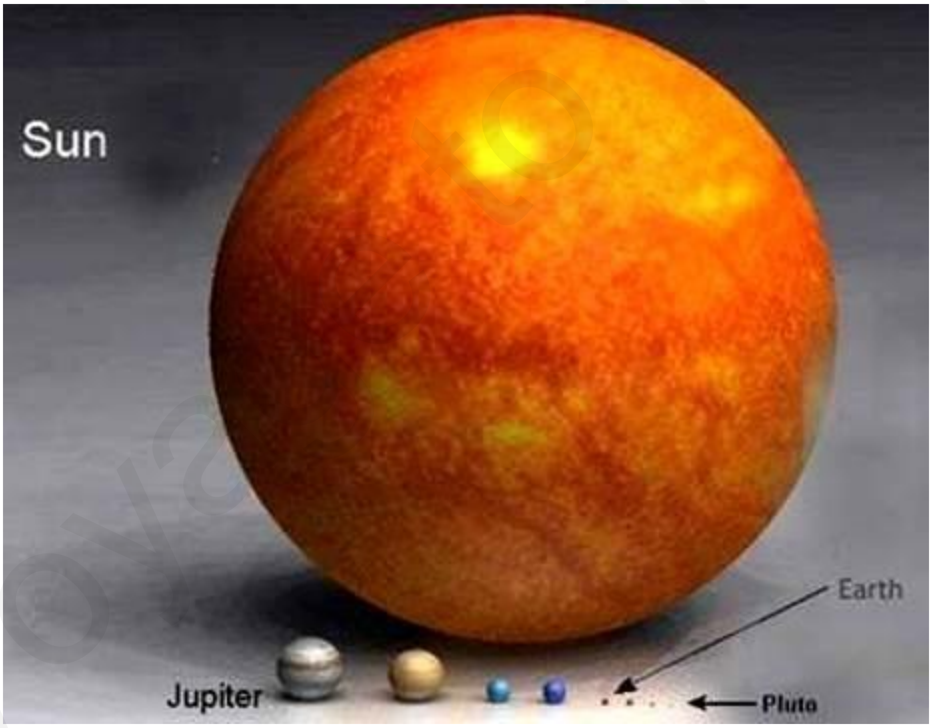


Can you find the Sun in the picture above?

Red dwarves

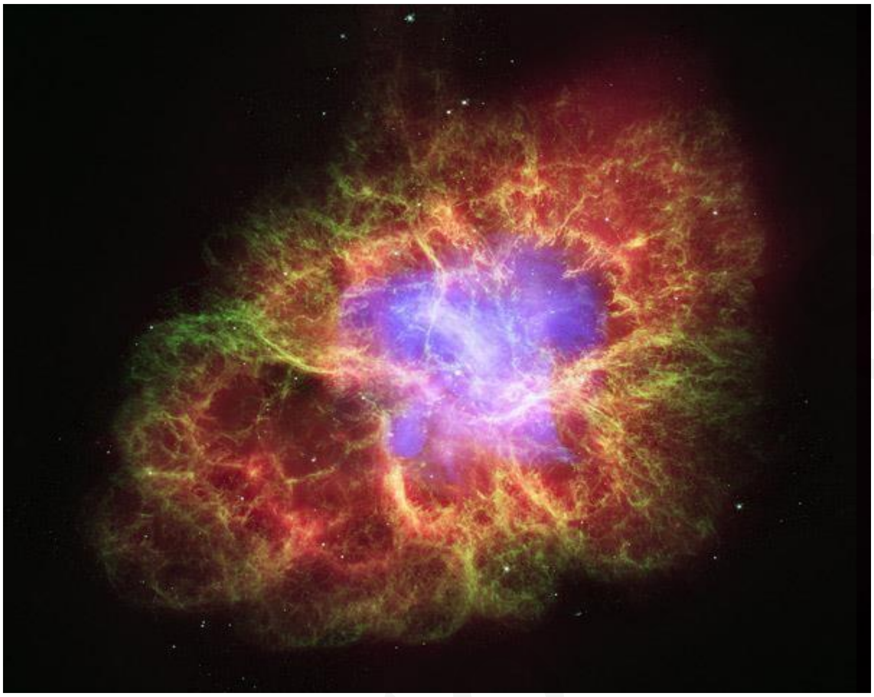


How do the planets compare with the Sun?

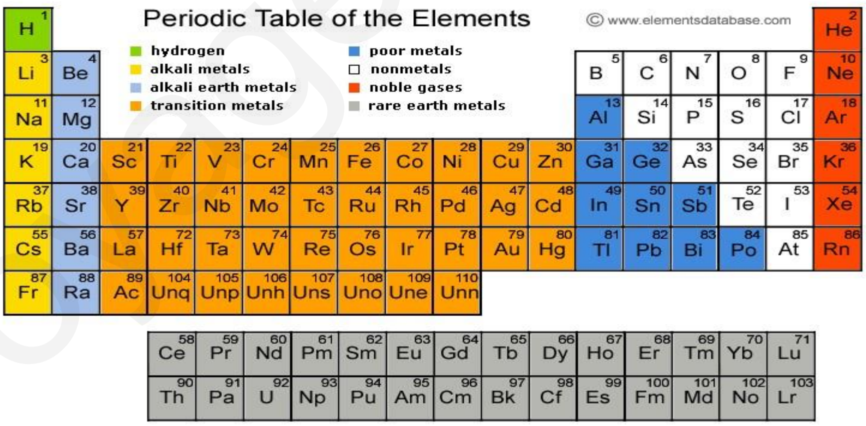


Can you find the earth?
The Sun is more than one million times bigger then the Earth (1.3 million times bigger) What is the result, when a blue supergiant or a blue giant explodes?

A nebula: A big cloud of gas with all the chemical elements



1. The Periodic Table of the Elements

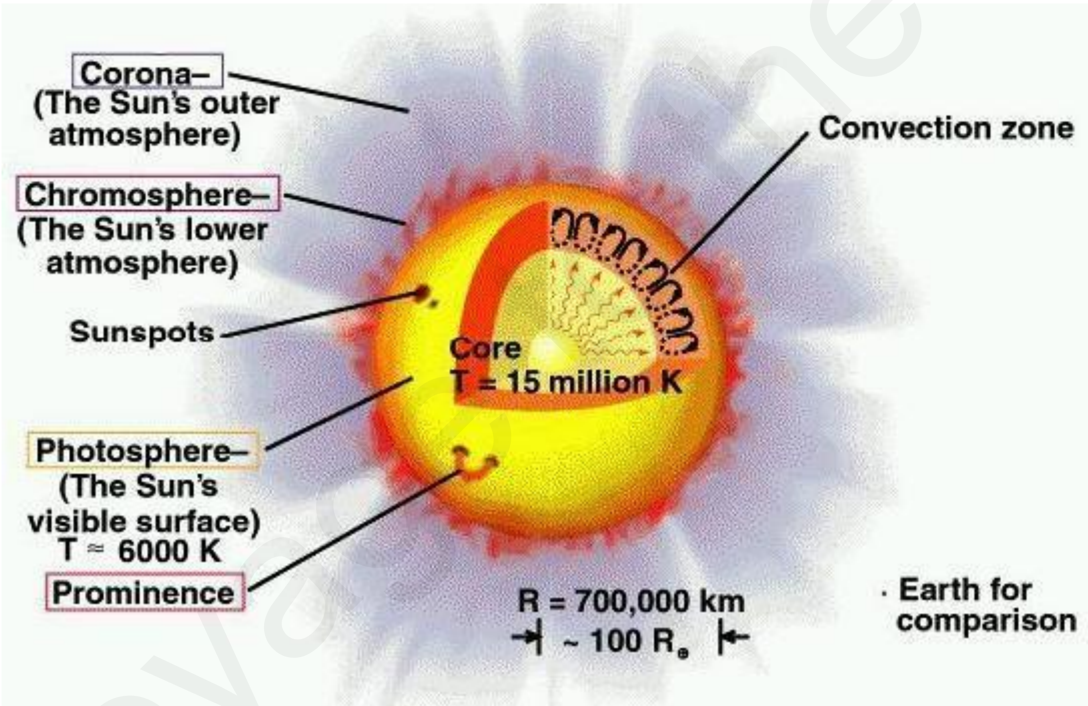


2. A cloud that gives birth to new suns and solar system

   Example: The Sun is the daughter of a Blue Giant

3. Neutron stars and black holes

Let’s go back to the Sun
Structure of the Sun
What is happening inside the Sun?



What is the temperature at the core of the Sun? at the surface?

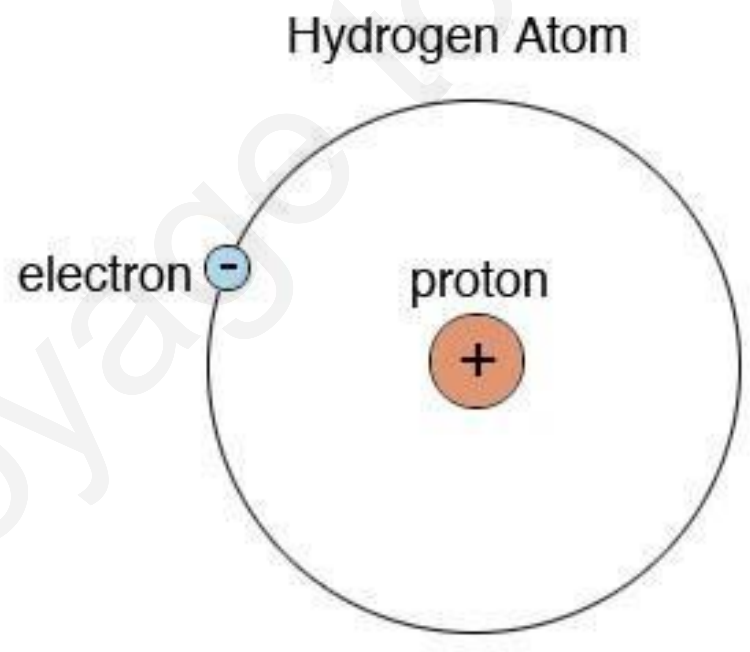
How much would you weigh if you were near the surface of the Sun (protected from the heat)?

Qn: Why does the Sun shine?

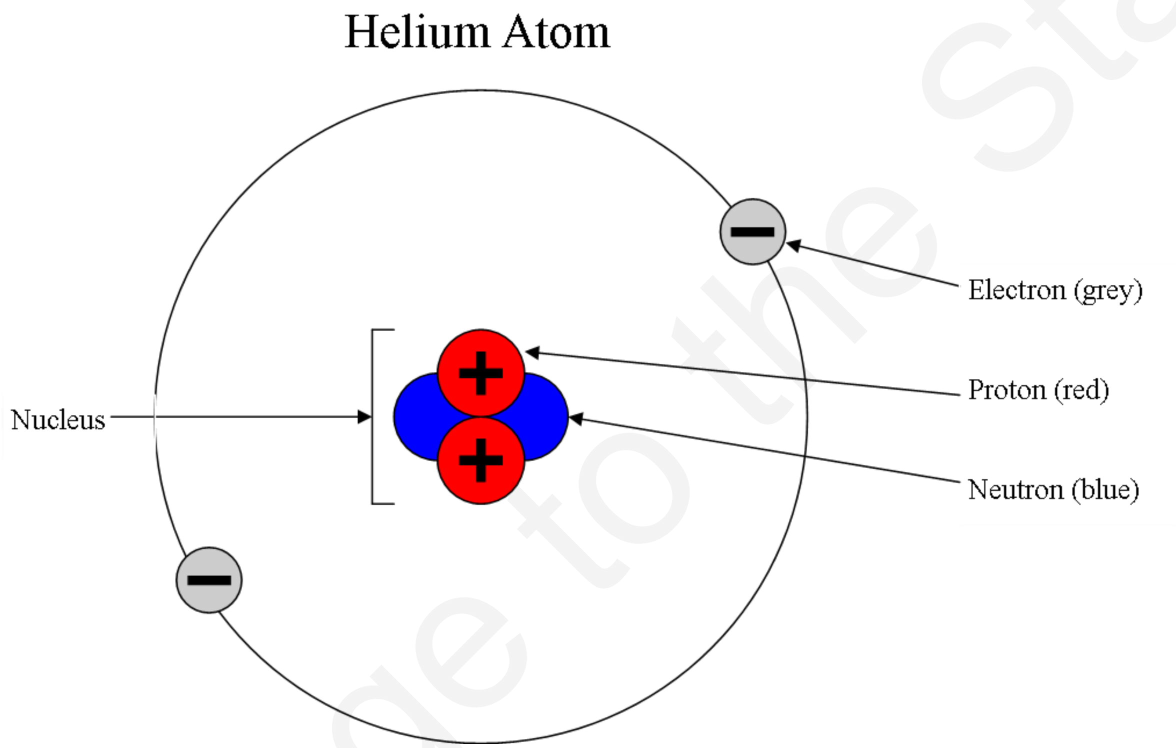
Qn: What is the formula that makes the Sun work?

Atoms:

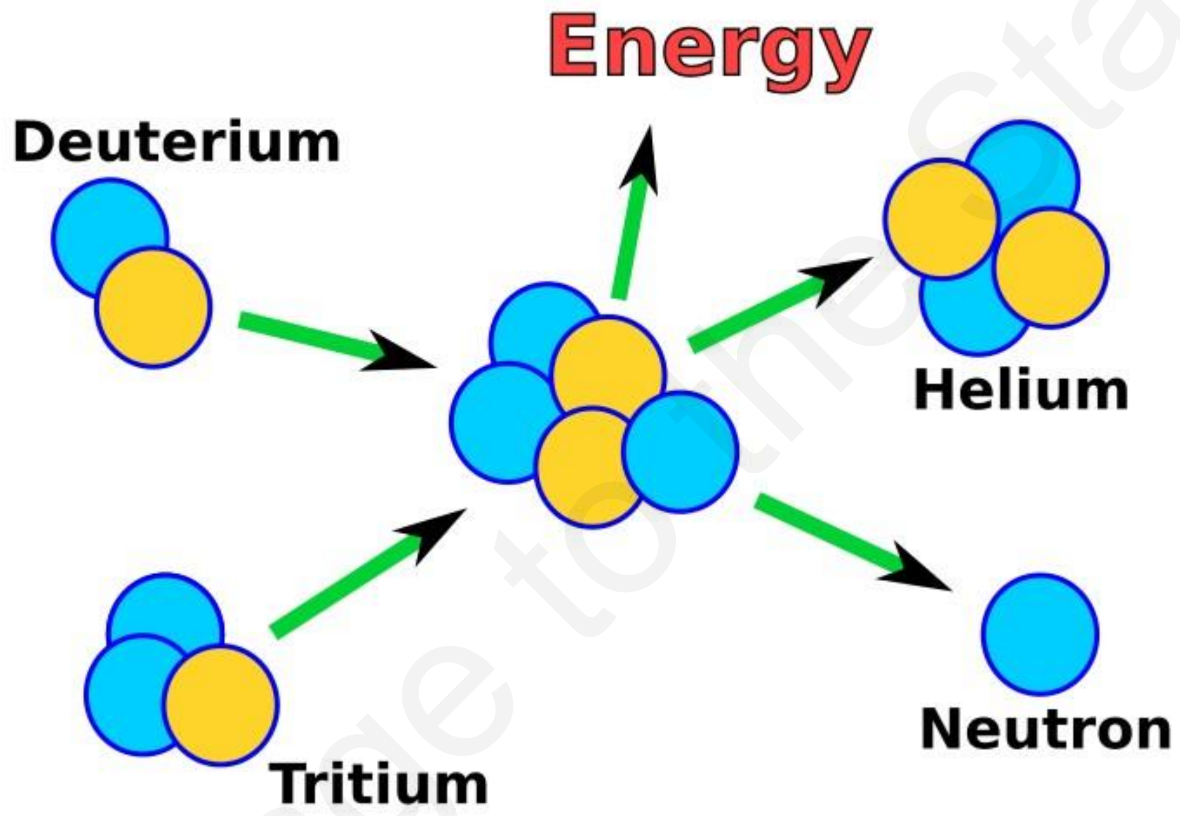
What is a Hydrogen atom?



What is a Helium atom?



Nuclear Fusion
What is Nuclear Fusion?

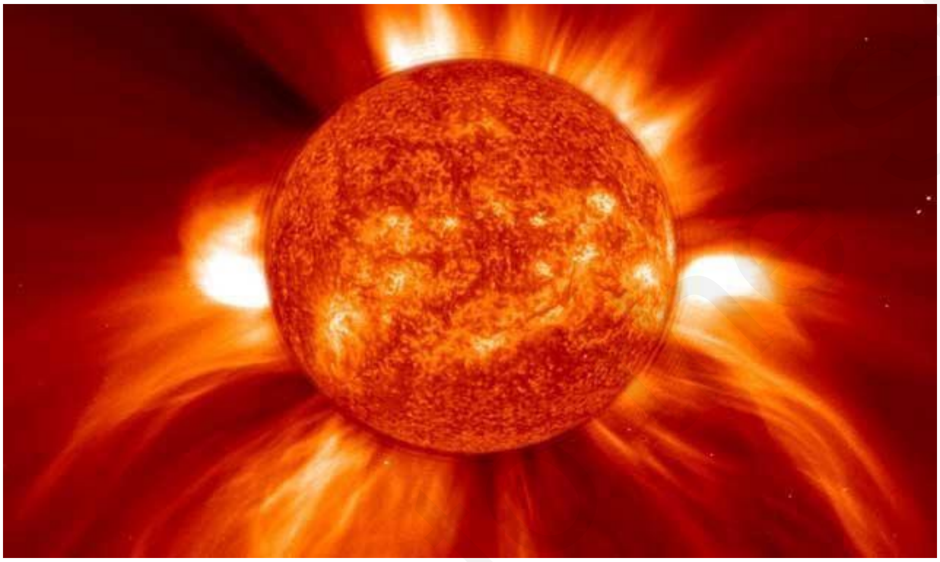


Essentially: 4 Hydrogen atoms combine to form one atom of Helium and the release of energy in the form of

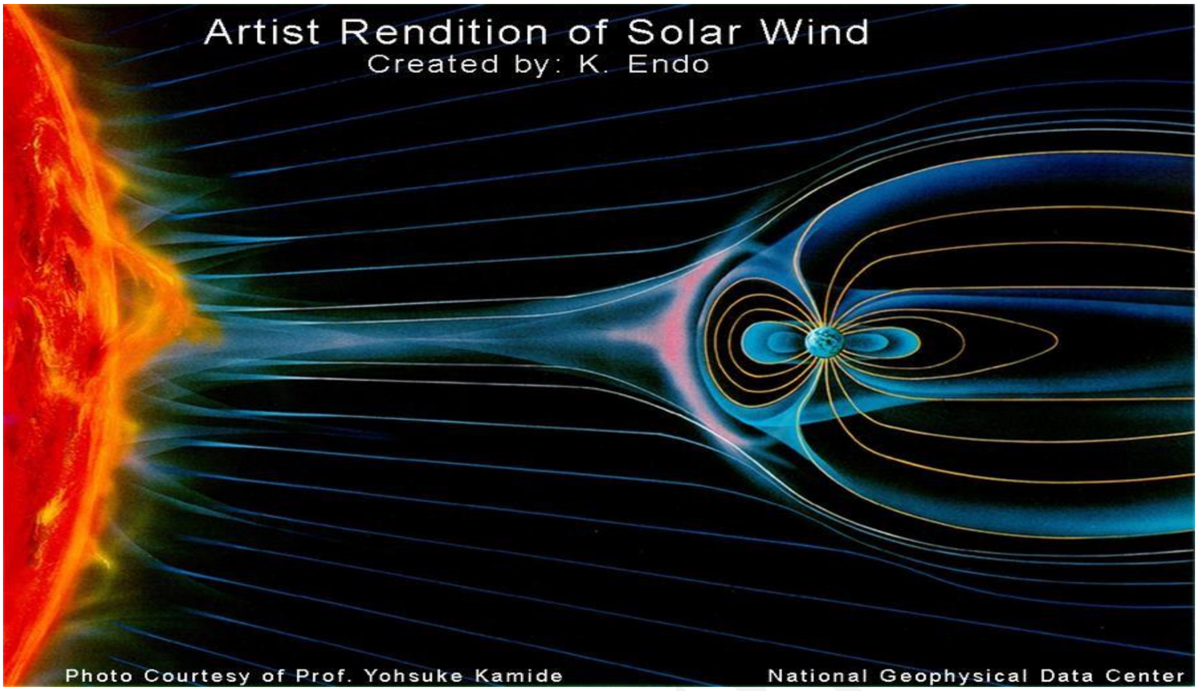
The sun loses weight, how many pounds per second does it lose? 10 billion pounds per second

It converts mass, matter, into light by Nuclear Fusion

The Solar wind



The sun produces a wind made of Helium nuclei, protons and electrons and it moves towards the Earth and other planets at approximately one million miles an hour.



The Solar Wind
Protection for the Earth

The Earth is protected by its own magnet – Its own magnetic field deflects particles – radiation – around the Earth and into space.

Only a small amount goes into the Earth's magnetic poles to produce the northern and southern lights.

Aurora Borealis
Rough It is caused by electrons from the solar wind going through the North and South Magnetic Poles.

Assignment:

Questions:

1. What is the Solar Wind?
2. How are we protected from the Solar Wind?

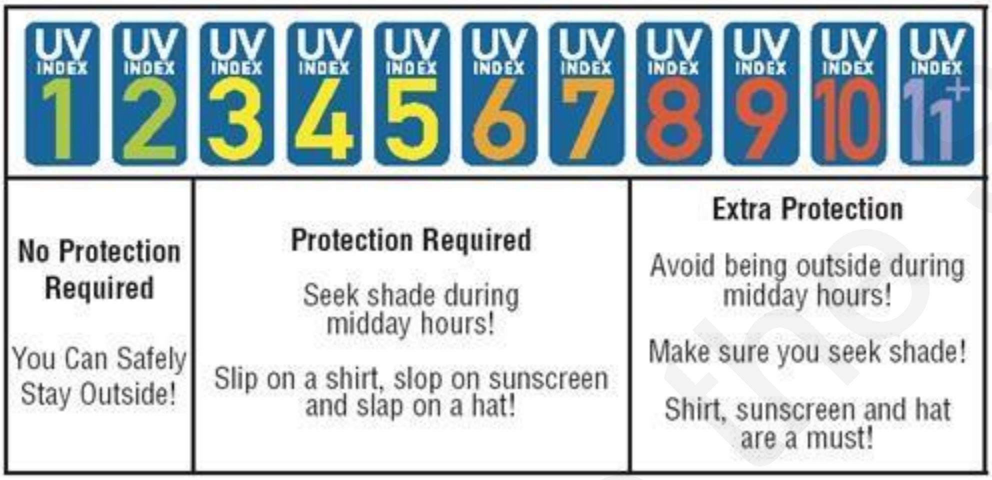
3. What is the Aurora Borealis?

4. What is the Aurora Australis?

5. UV rays from the Sun
The Sun send us light we see and light we do not see
What is an example of light we do not see?
UV light
Can UV light cause
harm to humans? It
can produce a sun
burn How are we
protected?
The Ozone layer
And
A Sun screen
What is the UV Index?
UV Index read in the weather section of the newspaper everyday

Suggestion: Read it before you go outside or to the beach
The UV Index in Los Angeles

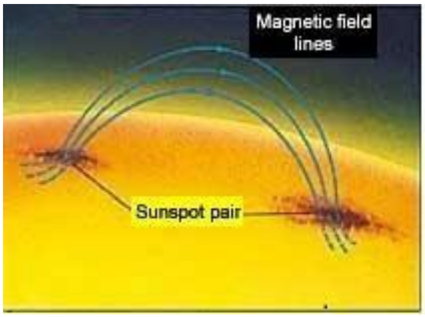
https://uv.willyweather.com/ca/los-angeles-county/los-angeles.html

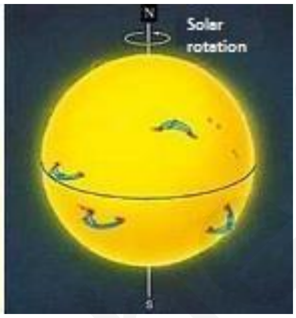


UV INDEX 1 – 2	UV INDEX 3 – 7	UV INDEX 8 – 11+
No Protection Required You Can Safely Stay Outside!	**Protection Required** Seek shade during midday hours! Slip on a shirt, slop on sunscreen and slap on a hat!	**Extra Protection** Avoid being outside during midday hours! Make sure you seek shade! Shirt, sunscreen and hat are a must!

Sun Spots

6. What are Sun spots?

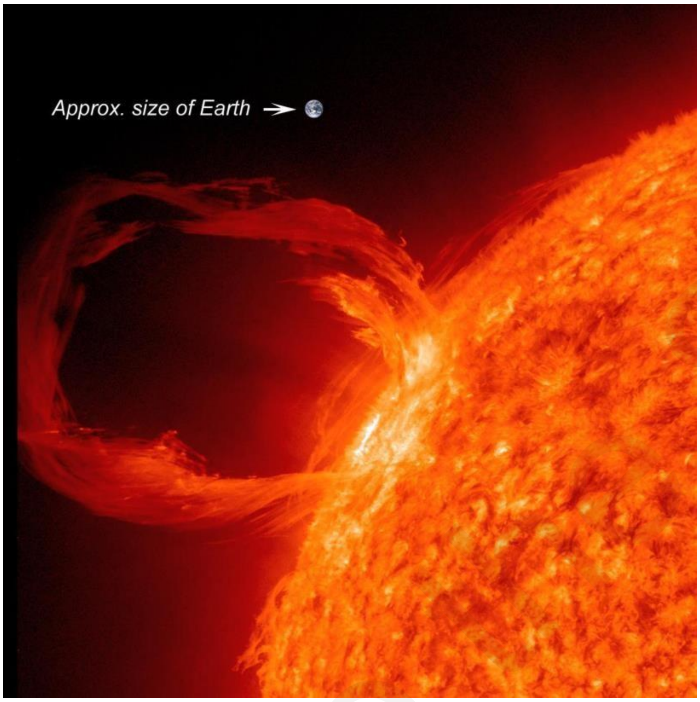




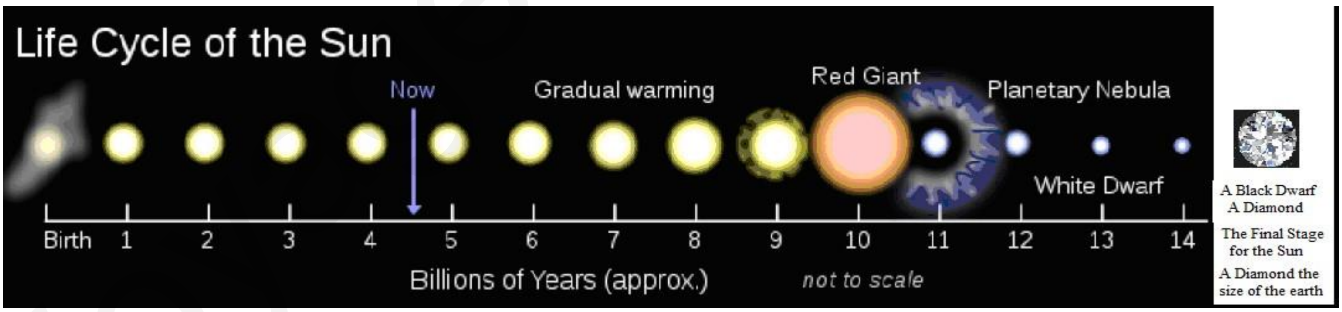
They are at a lower temperature than the rest of the Sun 2000F lower temperature. They work in pairs like a magnet:

One is a North magnetic pole and the other a south Magnetic pole.

What are solar flares?



8. What is the life cycle of the Sun?
How old is it?
How long will it last?



The end of the life cycle of the Sun is a white dwarf and then a black dwarf. The black dwarf is a large diamond the size of the Earth. That will take place five billion years from now.

Assignment

1. Describe the composition and structure of the Sun
2. Describe the solar wind
3. Describe the Aurora Borealis and Aurora Australis
4. Describe the life cycle of the Sun

Chapter XVII

Asteroids

Watch the following videos:

1. https://www.youtube.com/watch?v=ggqEFtp7wxc

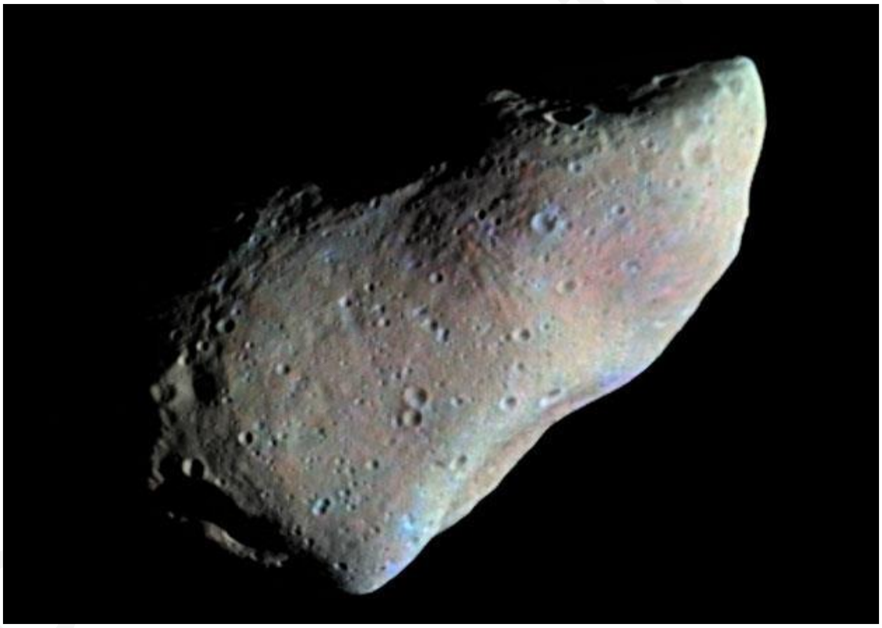
2. https://www.youtube.com/watch?v=tRPu5u_Pizk

3. https://www.youtube.com/watch?v=aiDACZx_VJs

4. https://www.youtube.com/watch?v=vfvo-Ujb_qk

5. https://www.youtube.com/watch?v=UkLBsH6a5b0

Example: Gaspra



Asteroid Gaspra's Best Face Credit: NASA, The Galileo Project,, JPL

Can you find out the dimensions of this asteroid?

Impact simulations

Run these programs from the following web site:

http://www.lpl.arizona.edu/impacteffects/

See how safe you would be if a small asteroid were to hit a populated area 20 miles from where you are.

Run this case in the computer simulation in the web site and see the effects 20 miles away.

Distance from Impact: **32.00 km = 19.87 miles**
Projectile Diameter: **250.00 m = 820.00 ft = 0.16 miles**
Projectile Density: **8000 kg/m^3**
Impact Velocity: **5.00 km/s = 3.10 miles/s**
Impact Angle: **90.0 degrees**
Target Density: **2500 kg/m^3**
Target Type: Sedimentary Rock

The Asteroid that killed the dinosaurs

Effects of the impact of a large asteroid, 10 miles in diameter, on the Earth

Tsunamis or tidal waves

Earthquakes

Acid rain

Craters

Incandescent rocks

The earth covered with a cloud of dust after the impact it becomes dark in one hour

Big asteroids can be extra deadly when they strike the ocean, carving water craters and sending huge waves in all directions. These tsunamis can wreak destruction on shores thousands of miles away. Bad news for people living in coastal areas, but it could be a lucky break for the rest of mankind: The same impact on land would throw dust high into the atmosphere and could block sunlight for many months, possibly causing global starvation and mass extinctions.
Energy transfer and dissipation. Dangerous waves

The surface of water is very good at transferring energy, in the form of waves, across great distances. In 1960, for example, an earthquake near Chile created a series of waves that crossed the Pacific Ocean and killed several hundred people 10,000 miles away in Japan.
Tsunami can travel at around 400 mph in deep water. When they reach shallow water they slow down, and that's when the real danger begins. The front of the wave slows first and the effect is like a pile-up on a freeway, with the rear of the wave catching up to the front. The wave increases in height from this bunching effect. The final height of the wave depends on several factors, but the shape of the sea floor has the greatest impact.

Estuaries, harbors, cliffs, reefs, and the topography of the continental shelf all play a role.
For a typical shoreline, the final tsunami height is usually about three times its height in deep water, but in some locations the ratio (known as "run-up factor") reaches 40. In other words, a 1-foot wave in deepwater can amplify to a 40-foot wave at a shoreline that is exceptionally vulnerable to tsunami, as are some parts of Hawaii.

Splashdown

If an asteroid collides with the Earth there is a good chance it will hit an ocean, simply because two-thirds of the Earth's surface is covered by water. A gigantic explosion occurs and the asteroid is pulverized and vaporized, along with a huge volume of water. This creates a crater in the water surface that quickly fills. The filling process generates a series of tsunamis that radiate across the ocean. The effect is similar to a pebble thrown into a pond, though with a 50,000-mph impact, we're not talking ripples here.
Based on NASA estimates, about once every 2,000 years an asteroid with a diameter of about 100 yards can be expected to hit one of Earth's oceans. Larger asteroids collide with the Earth much less frequently -- a 500yard rock from space might hit an ocean once every 80,000 years and a 1,000-yard (1 k) asteroid perhaps once every 200,000 years.

A Comparison: Atomic bombs and ocean asteroid impacts

The largest aboveground H-bomb test by the United States was like a firecracker compared to an asteroid impact.

The"Bravo" explosion at Bikini Atoll in 1954 was equivalent to fifteen megatons (15 million tons) of TNT but was only about one-thousandth of the energy of a 500-yard asteroid moving at 50,000 mph.

The Bikini Atoll H-bomb tests enabled scientists to develop computer models of the destructive effects (on shipping) of explosions at the water surface. In the early 1990s these models were applied to asteroid impacts. Initial results suggested that even relatively small impacts could pose a grave tsunami threat over large areas of ocean.

More recent computer simulation modeling indicates that the tsunami generated by an asteroid impact tend to dissipate, or die out, rapidly (the computer program, developed by Sandia National Laboratories, accurately predicted the consequences of the plummet of Comet Shoemaker-Levy 9 into Jupiter in 1994).
According to this work, a 500-yard-diameter asteroid is predicted to generate a water crater nearly 3 miles in diameter. At a distance of 10 miles from "ground zero" the resulting deepwater tsunami will be about 200 yards high, but by the time the wave has traveled 100 miles it will be reduced to a height of about 14 yards. After 1,000 miles it will have dropped to less than 1 yard in height. Due to the amplification in shallow water, however, this size tsunami could still become a 120-foot wave at a vulnerable shore.

Credit: Sandia National Laboratory

The Beringer crater in Arizona was caused by an asteroid impact 49,000 years ago

Diameter: 1.186 kilometers (.737 miles)

Rim diameter: 0.875 kilometers (.544 miles); age: 300,000 years

The Beringer Crater

Manicouagan, Quebec, Canada
Rim diameter: ~100 kilometers (62 miles); age: 212 +- 1 million years

The extinction of the dinosaurs

The evidence gathered from throughout the world indicates that the dinosaurs were killed by the environmental effects of an asteroid that struck the Earth 65 million years ago. It is thought that the asteroid had a diameter of 10 miles and that it struck the earth with a velocity of more than 100,000 miles per hour. It caused a crater of 160 miles in diameter in the Yucatan peninsula. It initiated a chain of environmental effects which will be discussed in detail in class.

Assignment

1. Write a one-page report on the cause of the extinction of the dinosaurs
2. Describe Earth crossing asteroids
3. Simulate a dinosaur extinction asteroid impact on the Earth using the simulator above. Describe two Earth orbit crossing asteroids
4. Describe the Beringer crater in Arizona. How big was the object? How fast was it traveling?

Chapter XVIII

Comets

Watch the following videos about comets:

1. https://www.youtube.com/watch?v=R8L_JcXJO4c
2. NASA: https://www.youtube.com/watch?v=0IxM_9AVaXc

What is a comet?
Structure and composition of comets

The Ort cloud: The source of comets

Structure of the solar system with the Kuiper belt and the Ort cloud

http://www.lpl.arizona.edu/faculty/malhotra_preprints/ISP_Nov04/KuiperBelt.jpg

http://startswithabang.com/wp-content/uploads/2009/03/kbos.jpg

http://www.astro.rug.nl/~etolstoy/ACTUEELONDERZOEK/JAAR2000/oort/oort_cloud.gif

http://www.grantchronicles.com/oort_cloud.gif

http://www.spitzer.caltech.edu/Media/releases/ssc2004-05/ssc2004-05v1.shtml

Comet orbit Viewer

http://www.astroarts.com/simulation/cometary-orbit.php

Find out about the Tunguska event of 1908 in Siberia. It is considered that a comet exploded in the air and Destroyed trees in an area with a diameter of 30 miles.

Example

Exploration and landing on comet 67P/Churyumov – Gerasimenko,

November 2014 **The Rosetta Mission**

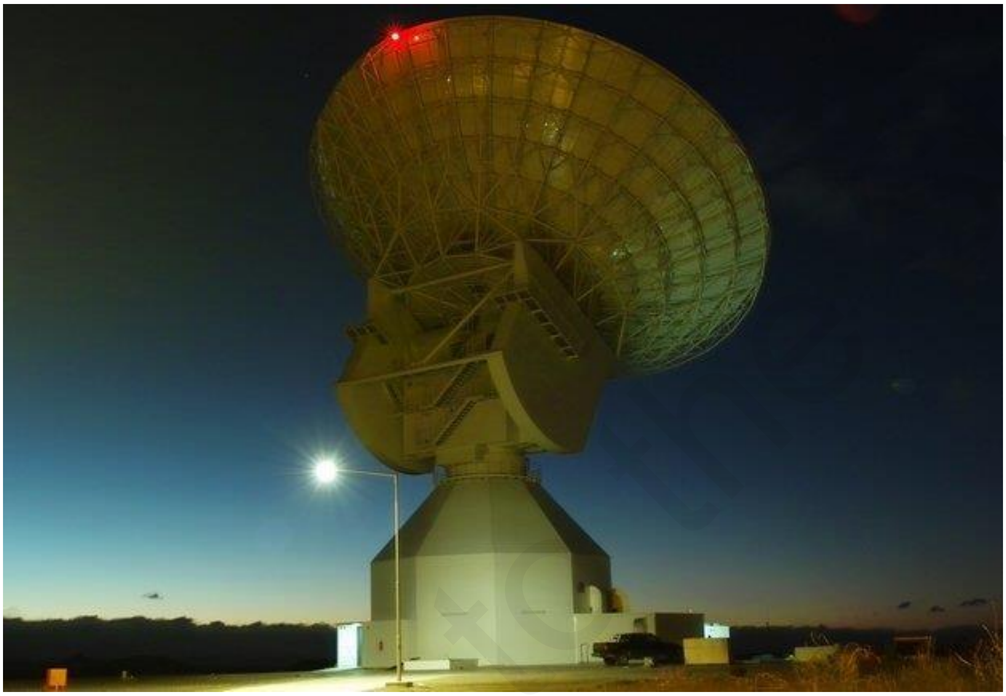
Philae comet surface probe

What is the size of comet 67P?

A comparison with Downtown Los Angeles

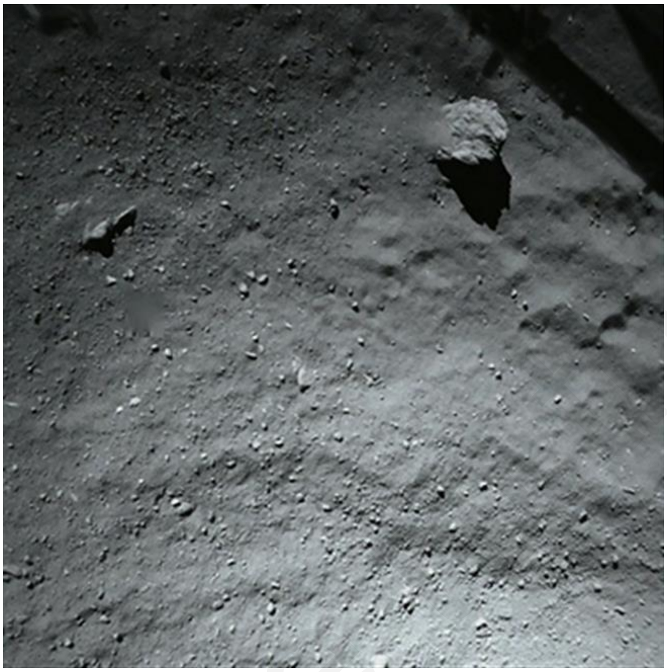
A superposition of real images one is a picture taken by the Rosetta spacecraft and the other a picture of the downtown Los Angeles

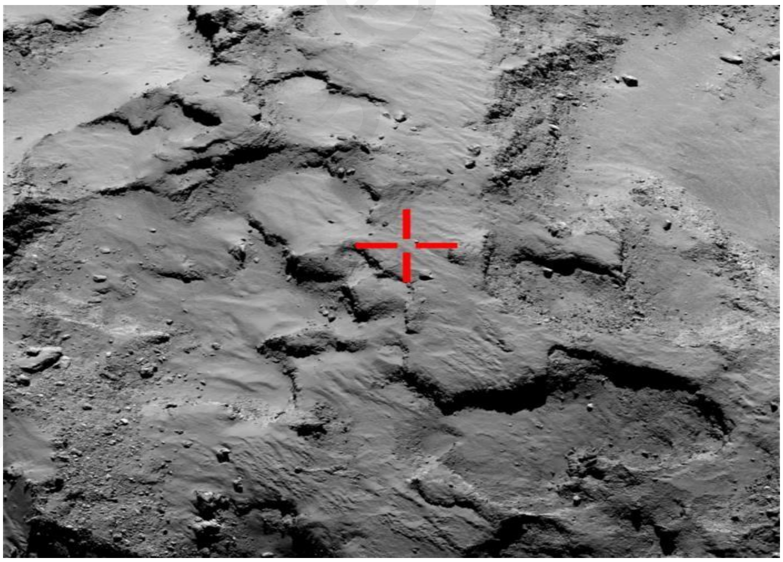
Dimensions 4.1×3.2×1.3 km
Period of rotation 12.4 hours
Time it takes to orbit the Sun: 6.4 years
Located between the orbits of Mars
and Jupiter Surface temperature – 153
Celsius or - 243 F

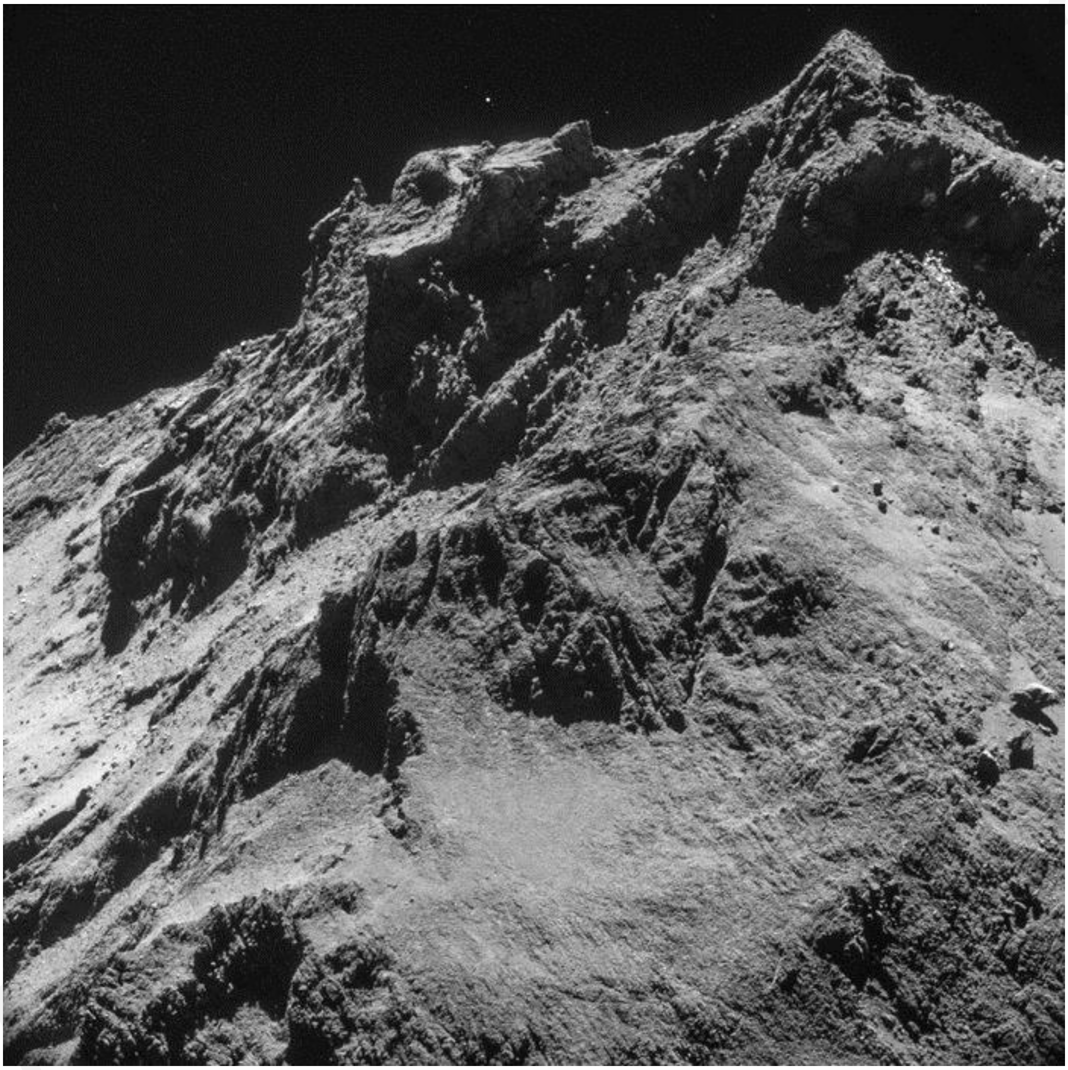


Radio telescope antenna located in Mendoza, Argentina one of a system of antennae used to communicate with the Rosetta spacecraft and its probe Philae.

Transmitted images







A world of water ice, dust and rocks

Analysis – In class- of the water in the ice of the comet, and the water in the oceans of the Earth.

Isotope comparison

A theory: The water in the oceans on Earth came from comets, results and an update.

The subject of aminoacids in comets.

The theory that the basic components for life on Earth came from aminoacids from comets. Discussion in class

CHAPTER XIX

Black Holes

What is a black hole?

How many types of black holes are there?

Check the following web sites and videos

1. https://www.youtube.com/watch?v=EuC-yVzHhMI
2. https://www.youtube.com/watch?v=kOEDG3j1bjs
3. Black hole calculator: http://hyperphysics.phy-astr.gsu.edu/hbase/Astro/blkhol.html#c2
4. What would happen if you fell into a black hole? Spaghettification https://www.youtube.com/watch?v=RMqtoEZBw4c

Here is an artist's conception of the collimated jet of energy being shot out above and below a super massive black hole located in the center of a galaxy. The black hole is called a 'blazar' when the jets happen to be pointed directly at Earth. Click to enlarge.

Below we see a close encounter with another star put the doomed star -- shown by the orange circle -- on a path that took it near a super massive black hole. The enormous gravity of the giant black hole stretched the star until it was torn apart.

Credit: NASA http://www.nasa.gov/home/hqnews/2004/feb/HQ_04061_black_hole.html

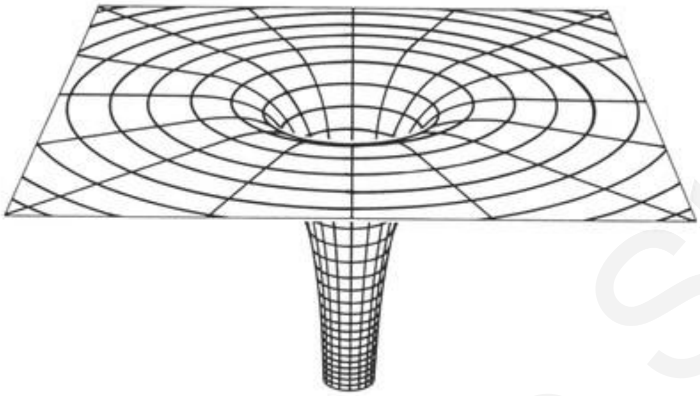
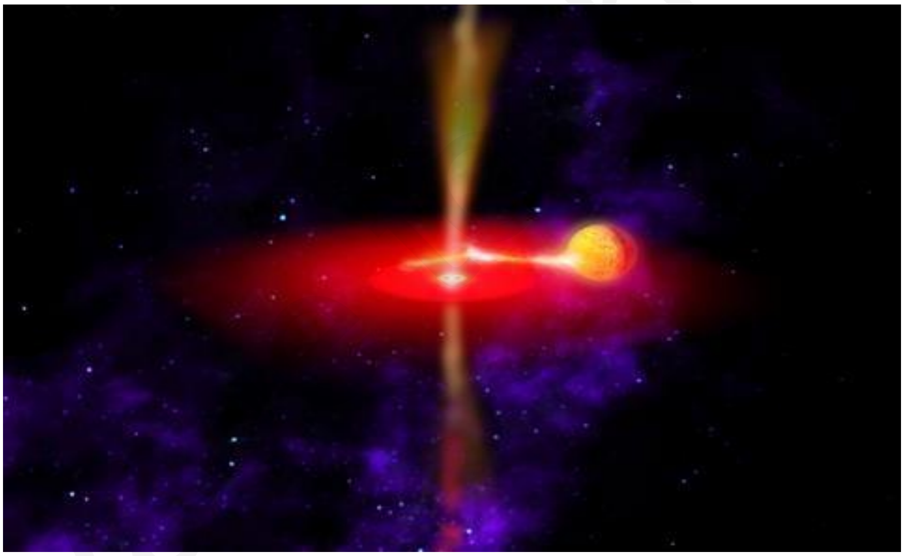


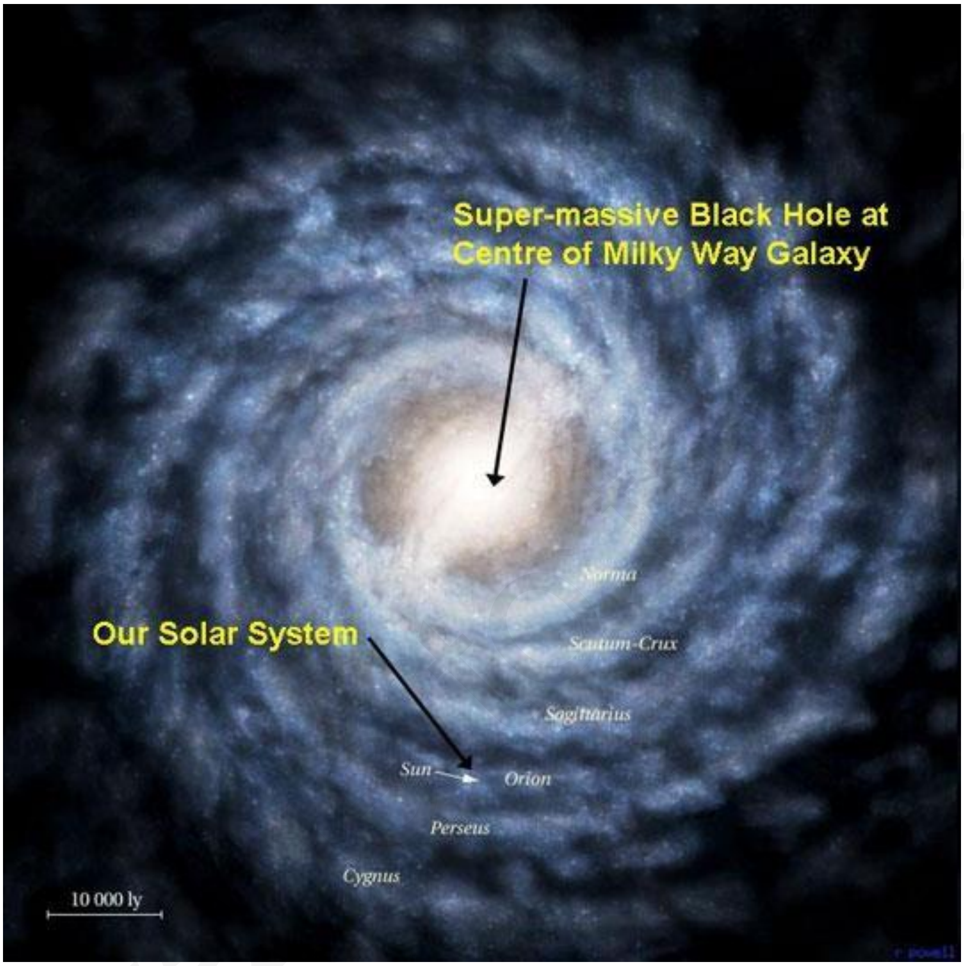
Diagram of the bending of space - time by a black hole

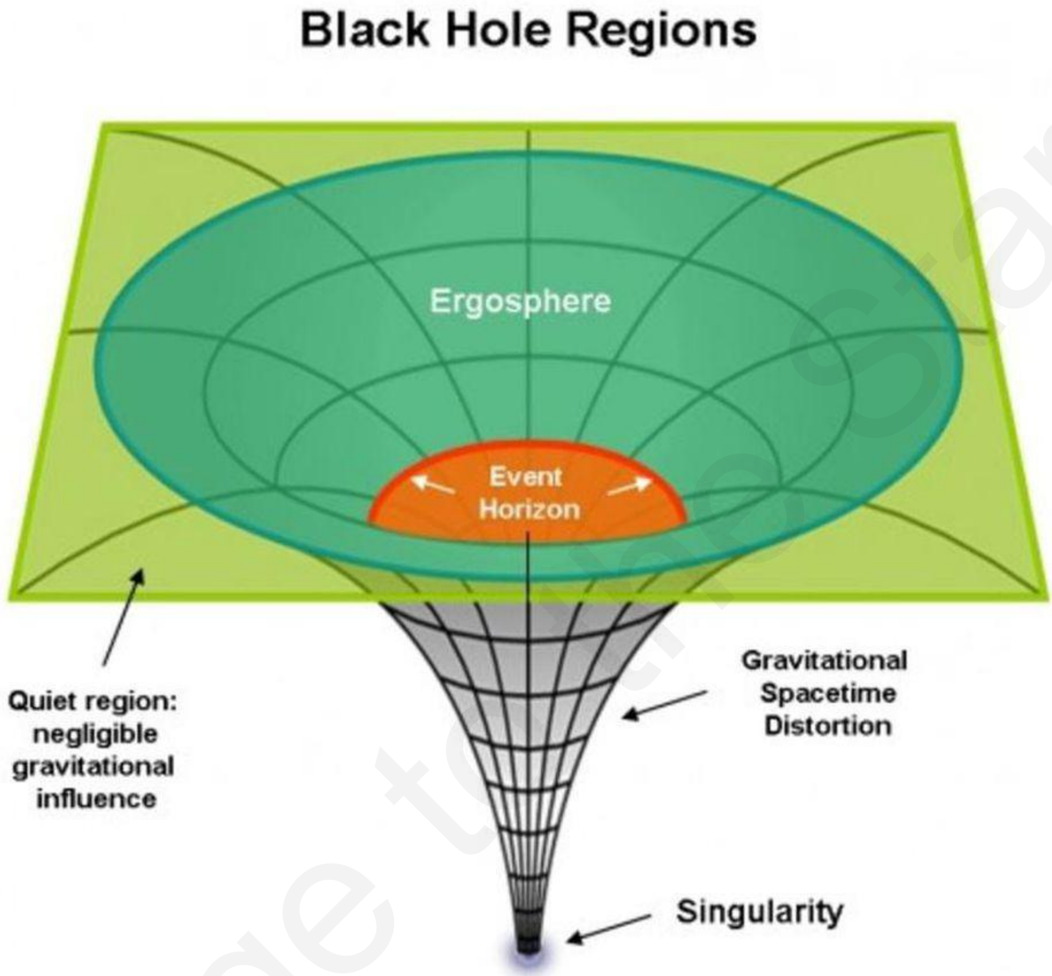


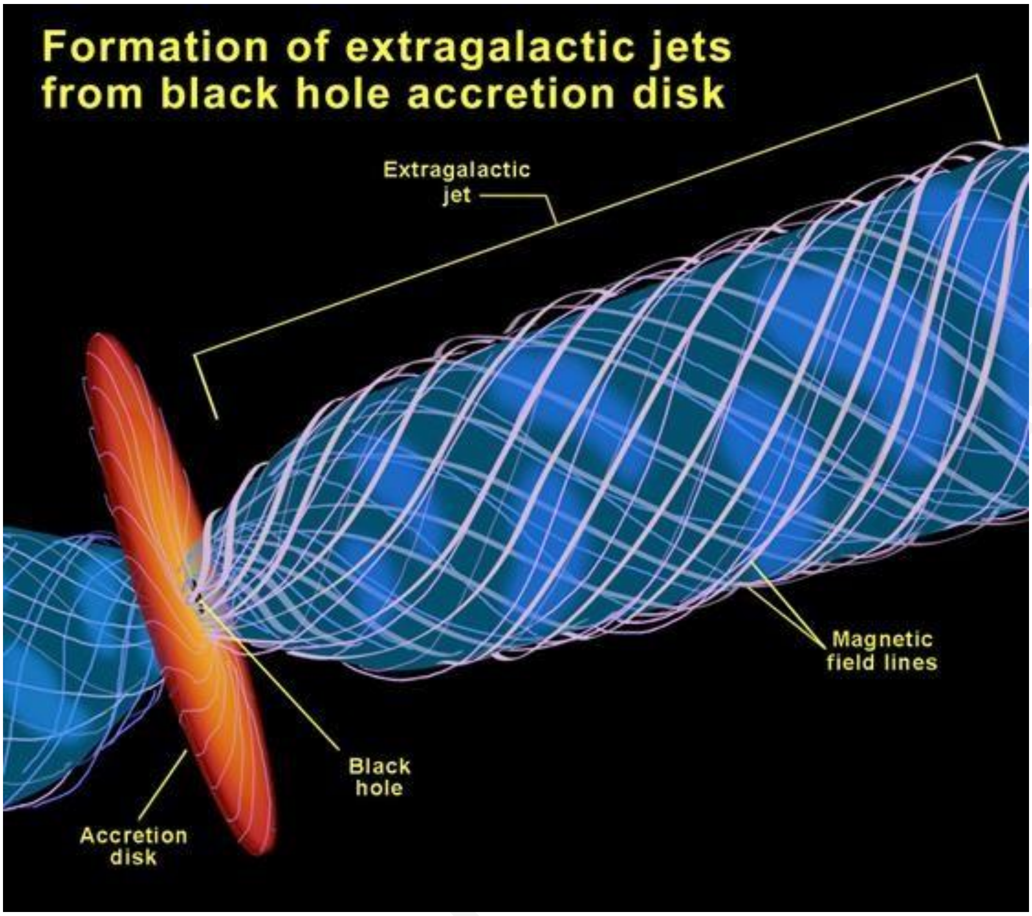
Matter is surfing on the ripples of space time around a

black hole Image credit: NASA

Massive black holes at the centers of galaxies

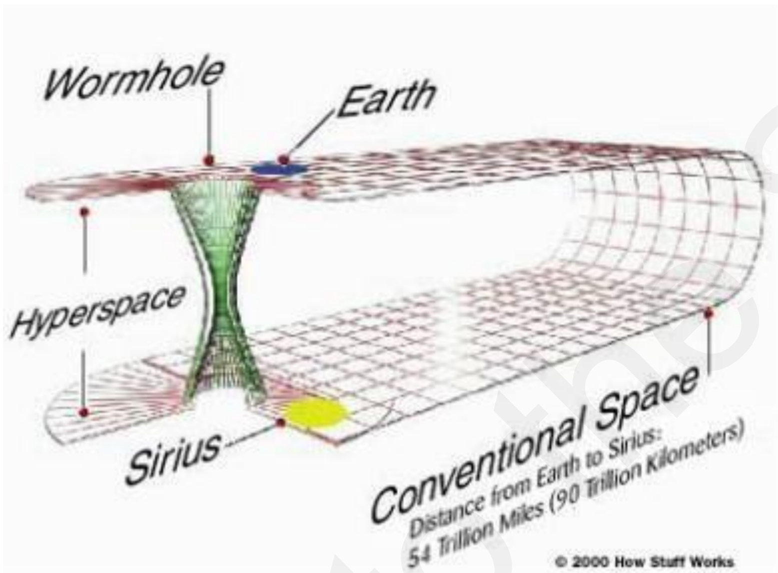



Black Hole Regions
Ergosphere
Event
Horizon
Quiet region:
negligible
gravitational
influence
Gravitational
Spacetime
Distortion
Singularity



To discuss in class: Time travel and black holes

White holes and wormholes



Traveling "faster" than the speed of light

Assignments

1. What is a black hole?

2. What are the different parts of a black hole? Draw a diagram and label it.

3. How many types of black holes are there in the Universe?

4. What would happen is a spaceship were to fall into a black hole?

CHAPTER XX

THE SEARCH FOR LIFE IN THE UNIVERSE

Welcome to Search for Life in the Universe

Where is ET? Listening for a intelligent radio signal

Objective: To discuss the ET Hypothesis; the models and predictions and the search for life in the Universe.

In this Chapter, I review the different methods and programs for the search for life in the Universe, from microorganisms to intelligent technological communicative civilizations. I examine the corresponding tools and technologies, and the results or lack thereof obtained so far from each method.

Context and subjects: In this context, we will consider the following:

1. What are the basic conditions for life? Are they everywhere in the Universe or only here in our Galaxy?

2. What is the possibility of finding life in the universe?

   a. Microbial life

   b. Intelligent, advanced technological life ET

3. The Drake Equation. What is the potential for life in the Milky Way Galaxy? In the Universe?

   The number of galaxies in the universe. The number of stars in a galaxy.

   The Andromeda Galaxy

   The number of stars and solar systems and in the universe

   Results of the Drake Equation

4. The Fermi Paradox

5. Dr. Moreno's theory of the possibility of finding life on Mars, Europa, Titan, Enceladus ?

6. The search for life in the universe. What are the methods for the search for life in the Universe?

7. A scale of possible levels of civilizations

8. Dr Moreno's spectrum of civilizations

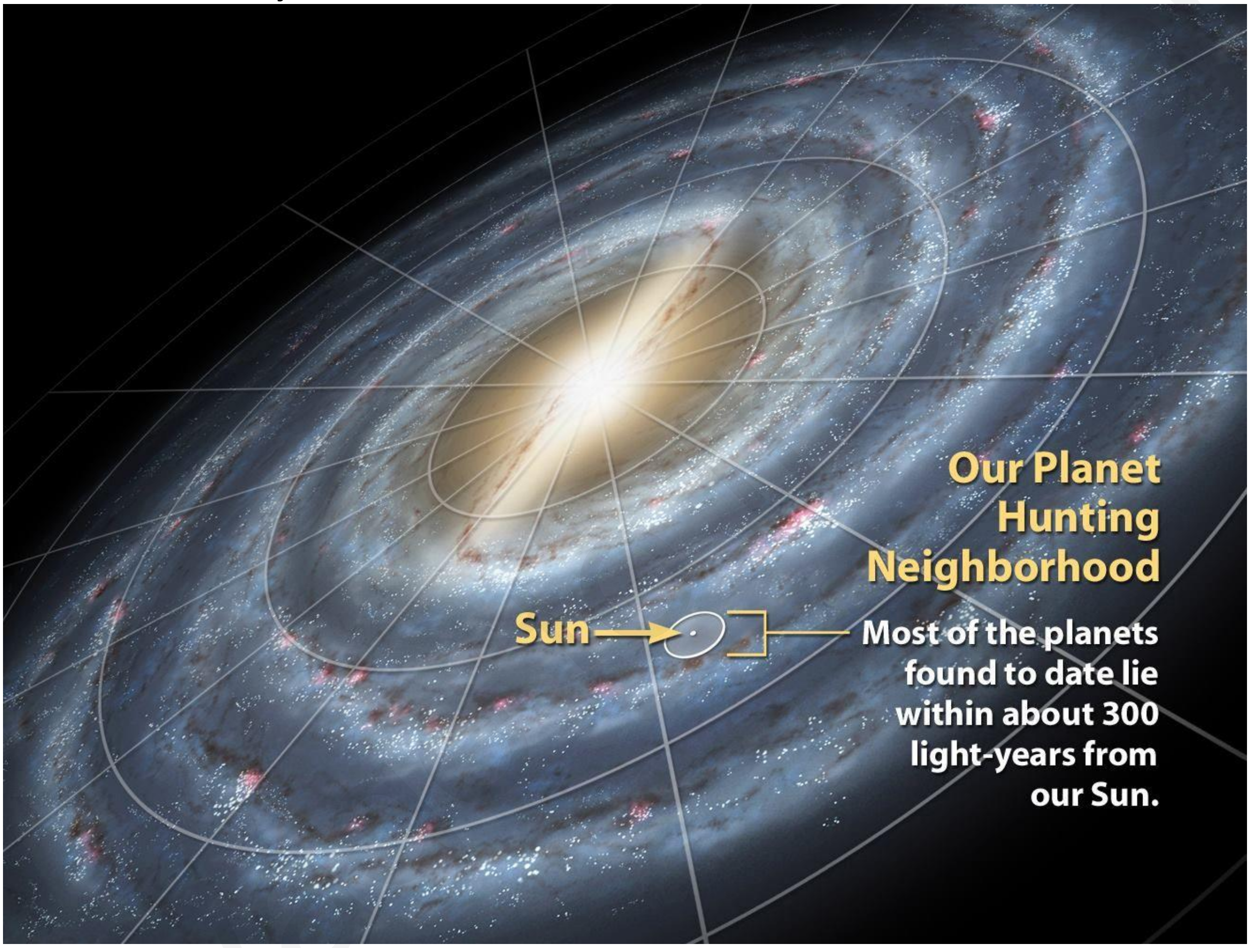
9. Asymmetric flow of information between lower technological civilizations and higher technological civilizations

10. The scientific study of UFOS. The evidence. The results.

Foundations and the rationale: What justifies this effort and research?

The Universe and the Drake Equation

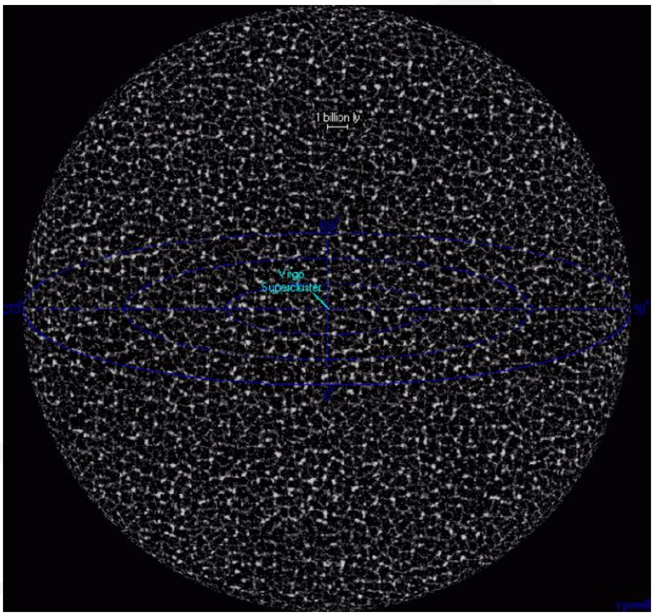
The Milky Way, the Andromeda Galaxy 1.0 Trillion stars – A trillion Galaxies in the Universe 10 trillion solar systems? Billions of Earths?



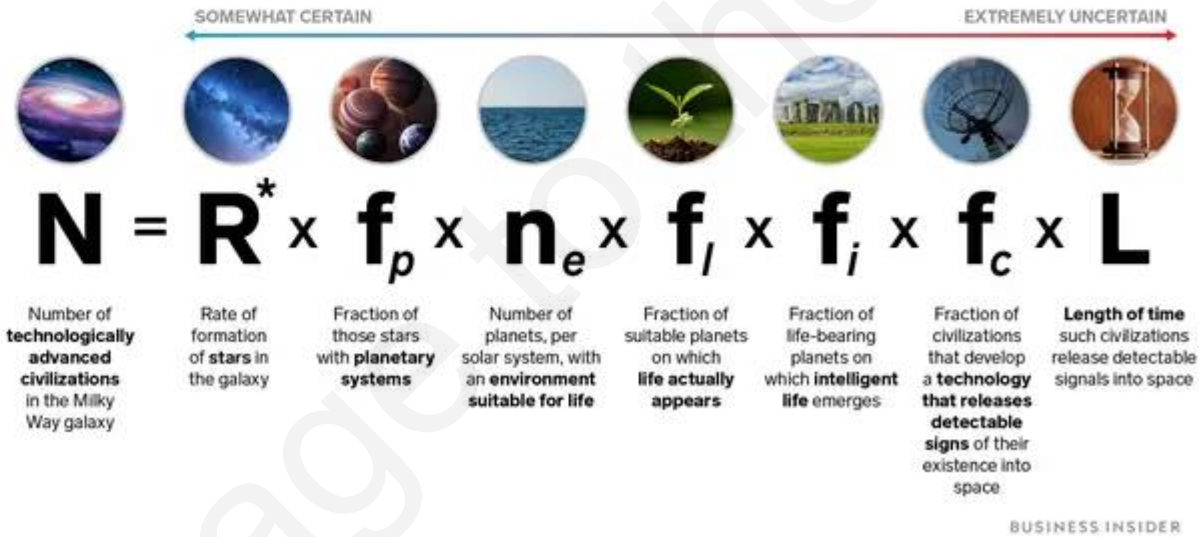
The Milky Way Galaxy with 400 Billion stars, solar systems and the expectation of a trillion planets. With one out of 3,500 an Earth – Like planet.

The Andromeda galaxy with 1trln stars and 10 Trillion planets.

The Universe with a Trillion Galaxies



The Universe with a Trillion Galaxies



Estimates by Professor Drake: 10,000 Technological Civilizations in the Milky Way alone. And we estimate a trillion galaxies in the visible Universe. There exists the possibility of millions of tecnological civilizations in the Universe.

Methods for the search for ET

Method 1. Sending coded radio pulses with information about the Earth and our human civilization. Professor Drake in the early 1960's. Results.

Method 2. Using a disk with information about the location of the Earth and mankind in the Voyager spacecraft. Results.

Method 3. Search in our solar system by sending robots to Mars, Europa, Titan, and Enceladus, comets and asteroids in search for water and microorganisms. Looking for the signs of life. Results.

Method 4. SETI. The search for extraterrestrial intelligence by means of radio – telescopes. Results.

Method 5. Light SETI: Search for the detection of laser pulses in space originating from or sent by a technological civilization. Results.

Method 6. The Kepler Telescope Program. The search for exoplanets, i.e., planets similar to the Earth, in orbit in the habitable zone, around other stars. The study of exoplanets. Results.

.

Method 7. Dr. Moreno's Proposal. This is a proposed search for traces of an ET landing on the Moon. This proposed search covers a period of five million years. Any traces on the Moon would last for 5 million years, since they would only be erased by micrometeorite erosion. Results?

Method 8. Looking for extremophiles here on Earth to identify adaptation of microorganisms in hostile outer space places. And to estimate what ET microbial life may be like. Results.

Method 9. Looking for objects that come to the solar system from other stars and to study them for any signs of ET intelligence, such as non – natural orbits. Large objects that some think may be large ET. spaceships. Results.

Method 10. Search for components of life forms and microbes or microbe fossils in a recovered meteorite that originated from Mars.

Method 11. Future sample return missions to Mars. Future Manned missions to Mars to explore and drill on the rocks and soil and bring samples to Earth to conduct studies and search for microbial life or other life forms.

Method 12. Dr. Moreno's Theory of Life on Mars, Europa and Enceladus, and other moons of the outer planets. Searching for microbial life in Mars and also the moons of the outer planets.

Method 13. The production of synthetic life in the Labs and the search for the possibility of synthetic life in the Universe. Also the possibility of advanced robotic life forms.

Method 14. The scientific study of UFOS. Results. The ET Hypothesis, the evidence, the results.

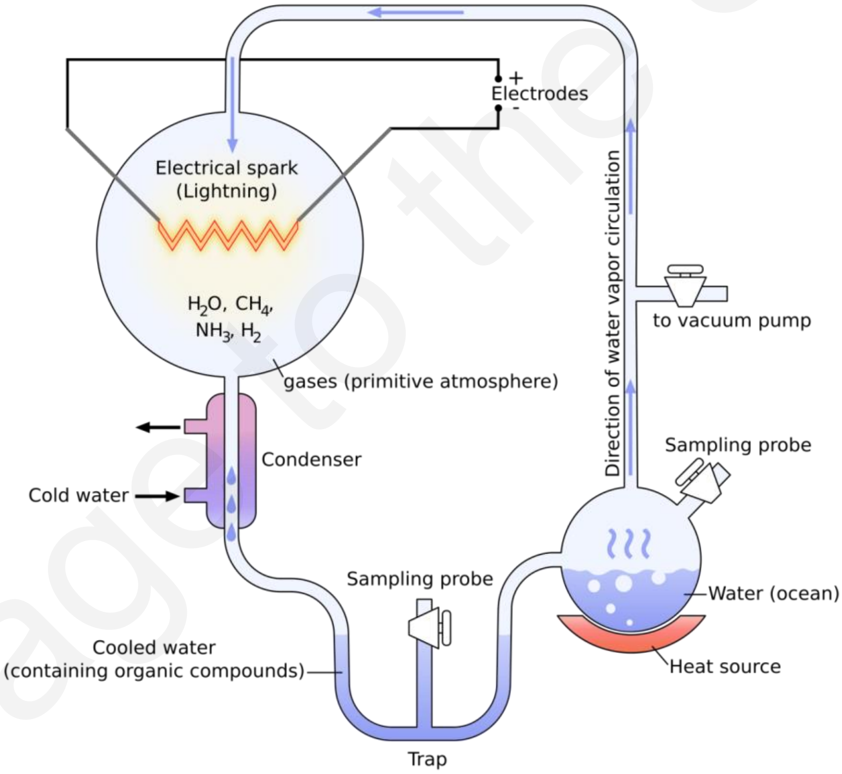
The visible universe, one trillion galaxies with up to a trillion stars, potentially a trillion solar systems each.

The justification for the search for ET

Basic Conditions for Life

The Miller – Urey Experiment: Goals. Results. (1952).

The University of Chicago and The University of California San Diego**.**



A summary explained in class**.** Conclusion: Given the proper conditions with an early Earth environment, the experiment demonstrated how organic components can form amino-acids, which are the basic building blocks of life. This suggests that life originated from inanimate organic compounds and that these conditions may be present in other parts of the solar system, such as Titan the Moon of Saturn and in many other places throughout the Universe given the detection of organic compounds in outer space.

What are the Basic Conditions for Life?

1. A Sun-Like Star –Second or third generation star – with the presence of all the Chemical elements
2. An Earth-like planet
3. An Earth-like planet in a habitable zone
4. A magnetosphere to protect life from space radiation
5. Plate tectonics to bring heavy metals, essential for life, to the surface
6. An Ozone layer for life's UV protection
7. Liquid water
8. Appropriate level of Ph, water acidity
9. The presence of organic compounds that lead to amino-acids, the basic life building blocks
10. Temperature range – Absence of global warming
11. The absence of blue giants – Potential supernovae explosions within 50 light years
12. The absence of major asteroid impacts for at least 50 to 60 million years to allow for evolutionary processes to reach completion towards intelligent life.

It is estimated that these basic conditions for life can be found everywhere in our galaxy and in the Universe at large. We note that we don't have a monopoly for these conditions here in our Solar System.

Overall relevant base concepts

What are we made of?

What chemical elements is the human body made of?

Major elements in the human body

Element	Percentage	Function
Oxygen	65.0	Part of all major nutrients of tissues; vital to energy production
Carbon	18.5	Essential life element of proteins, carbohydrates, and fats; building blocks of cells
Hydrogen	9.5	Part of major nutrients; building blocks of cells
Nitrogen	3.3	Essential part of proteins, DNA, RNA; essential to most body functions
Calcium	1.5	Form bone parts; it serves as a messenger between cells

Question: Are the chemical elements that make up the human body a privilege or monopoly of this part

of the Galaxy? Or are they found everywhere in the Universe?

Further justification for the search for life in outer space:
The detection of the adaptation of microbes to hostile environments here on Earth
Looking for extremophiles here on Earth to identify adaptation of microorganisms in hostile outer space places. And to estimate what ET microbial life may be like.

Method 1. Sending coded radio pulses with information about the Earth and our human civilization.

Professor Frank D. Drake in the early 1960's. Results. Early SETI: Project Ozma, Arecibo Message.

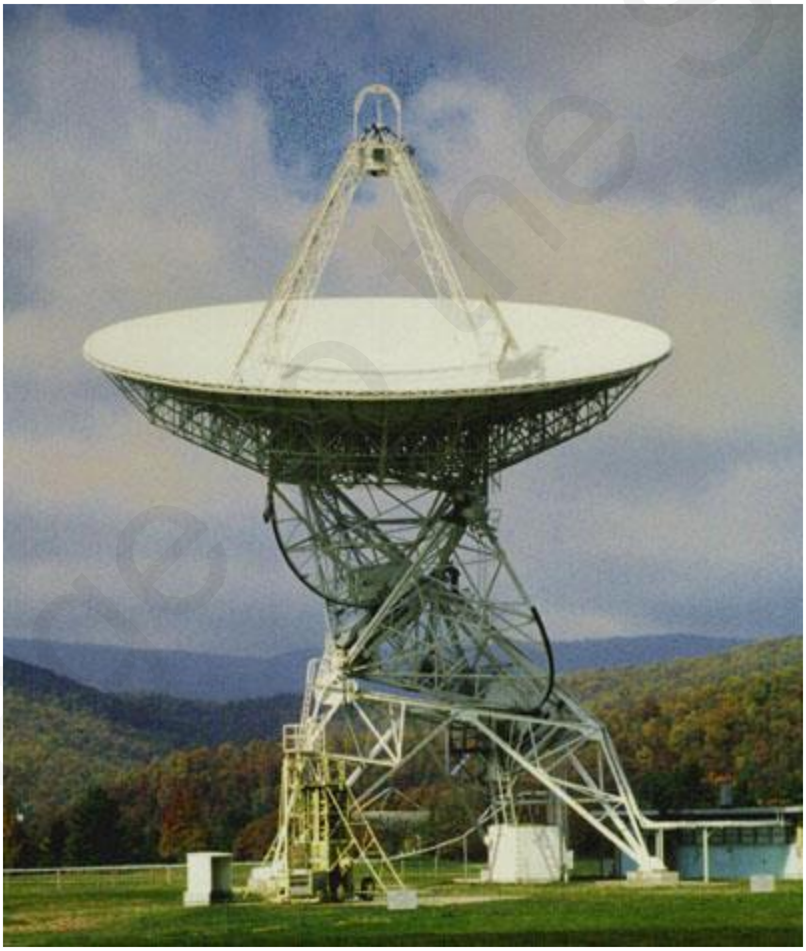


Image credit: The Planetary Society. The *Bruce Murray Space Image Library*
https://www.planetary.org/multimedia/space-images/

Early SETI (Search for Extraterrestrial Intelligence): Astronomer, Frank D. Drake, in 1960 started the first effort to detect ET civilizations. He did this by listening for a radio signal from at the National Radio Astronomy Observatory (NRAO) in Green Bank, West Virginia. The name of the project was Ozma, it was named after a character, a queen of L. Frank Baum's imaginary land of Oz -- a place far away, populated by strange beings. The stars targeted for this search were Tau Ceti in the Constellation Cetus (the Whale) and Epsilon Eridani in the Constellation Eridanus (the River), these stars are similar in size and age to the Sun and they are located at about 65 trillion miles away, at approximately 11 light years away. The 85-foot radio telescope was tuned to detect the 21-centimeter emission wavelength (or frequency of 1420 MHz) of cold hydrogen gas in interstellar space. At this frequency, the Universe is quiet and a technological civilization is expected to transmit signals on a band centered in this frequency. A channel of 100 Hz scanned 400,000 Hz of bandwidth. The astronomers checked for signals representing the prime numbers 1, 2, 3, 5, and 7. There was no signal detected. But, it represented a very important first effort that initiated the use of this method with radio telescopes.

The **Arecibo message** as described by wikipedia:
https://simple.wikipedia.org/wiki/Arecibo_message

was a short radio message sent into space to celebrate the remodeling of the Arecibo radio telescope in Puerto Rico in 1974. It was aimed at the globular star cluster M13, about 25,000 light years from Earth. M13 was chosen because it was the right size, and was in the sky at the right time and place for the ceremony.

Dr. Frank Drake, then at Cornell University and creator of the famous Drake equation, wrote the message, with help from Carl Sagan, among others.

The message was in seven parts which show:[3]

1. The numbers one (1) to ten (10)
2. The atomic numbers of the elements hydrogen, carbon, nitrogen, oxygen, and phosphorus, which make

   up deoxyribonucleic acid (DNA)

3. The formulas for the sugars and bases in the nucleotides of DNA
4. The number of nucleotides in DNA, and a graphic of the double helix structure of DNA
5. A figure of a human, the size of an average man, and the human population of Earth
6. The Solar System
7. The Arecibo Observatory and the diameter of the transmitting antenna dish

This is the coded Arecibo Message, 1974

Arecibo Radio Observatory funded by the National Science Foundation, NSF

The dish is 1,000 feet (305 meters) in diameter, 167 feet (51 m) deep, and covers an area of approximately 20 acres (81,000 square

The Observatory:

Address: PR-625, Arecibo, 00612, Puerto Rico
Area: 118 acres
Opened: 1963
The Arecibo message will take 25,000 years to reach the targeted stars and 25,000 years to get a reply.

Results: No response yet, as expected from the target stars. But, no response from all the intermediate objects on the way to the target stars.

Method 2. Using a disk with information about the location of the Earth and mankind in the Voyager spacecraft.

Results.

NASA image.

The Voyager 1 and Voyager 2 spacecraft flew by the outer planets and then left the solar system toward the stars. Each carries a disk showing the location of the Earth with respect to pulsars (neutron stars) which serve a function similar to the GPS, in the Milky Way Galaxy. It also carries many other messages and greetings.

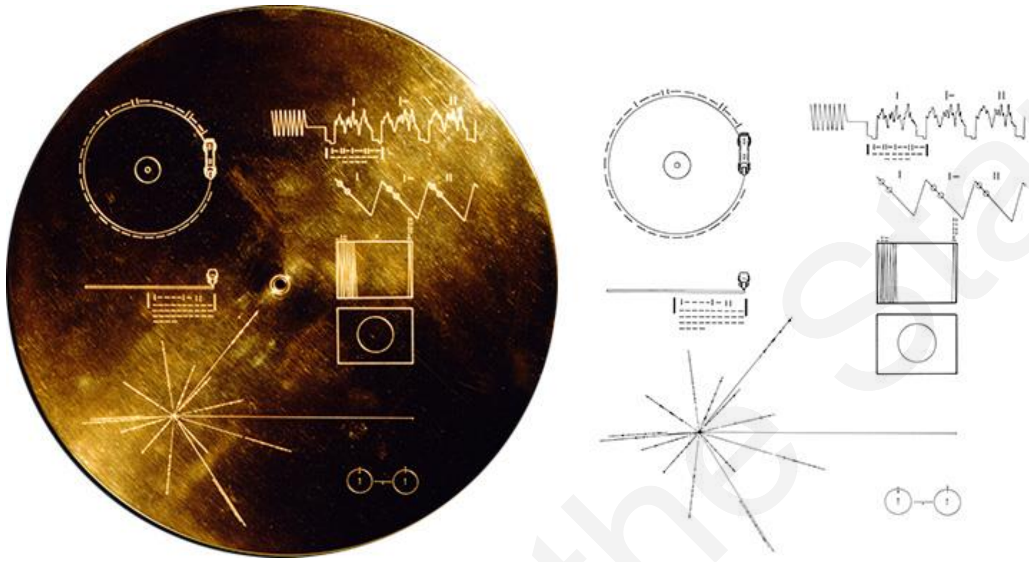


Image: NASA/JPL: The Voyager Golden Record

Sounds in the Voyager Golden Record

https://voyager.jpl.nasa.gov/golden-record/whats-on-the-record/sounds/

Concept: A sufficiently technologically advanced civilization will be able to intercept the Voyager spacecraft and take the Golden Record and decode and listen to the messages. Also, they will figure out where we are, our location in the Milky Way Galaxy. Results of this method: No response yet.

Reflection and Analysis:

What is the analysis of the ethics of broadcasting our location in the galaxy by radio or by the discs in the Voyager 1 and 2 spacecraft?

Two scenarios if the ETs find us

b. If they are non-hostile – Benevolent
c. If they are hostile

What are the possible consequences?

Method 3. Search in our solar system by sending robots to Mars, Europa, Titan, and Enceladus, comets and asteroids in search for water and microorganisms. Looking for signs of life. Results.

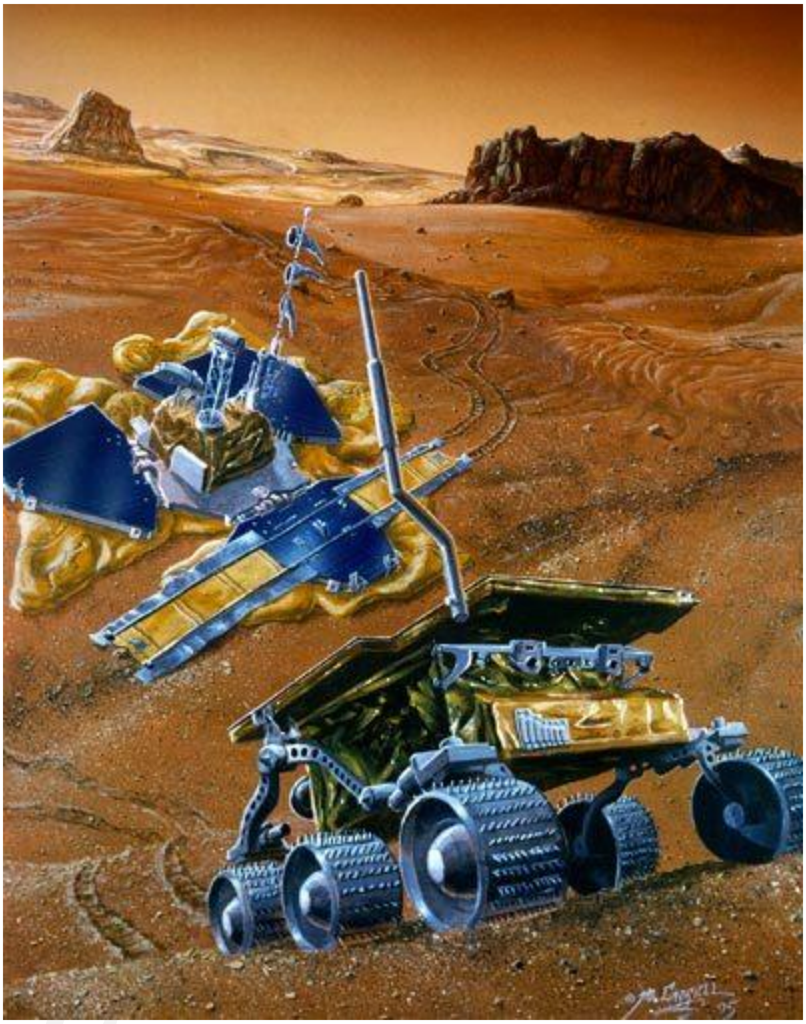
Prospects and probability: Dr. Moreno's Theory of Life on Mars and on the Moons of the outer planets.

The Viking 1 and 2 Spacecraft – The search for life on Mars

Viking 1 image of the surface of Mars

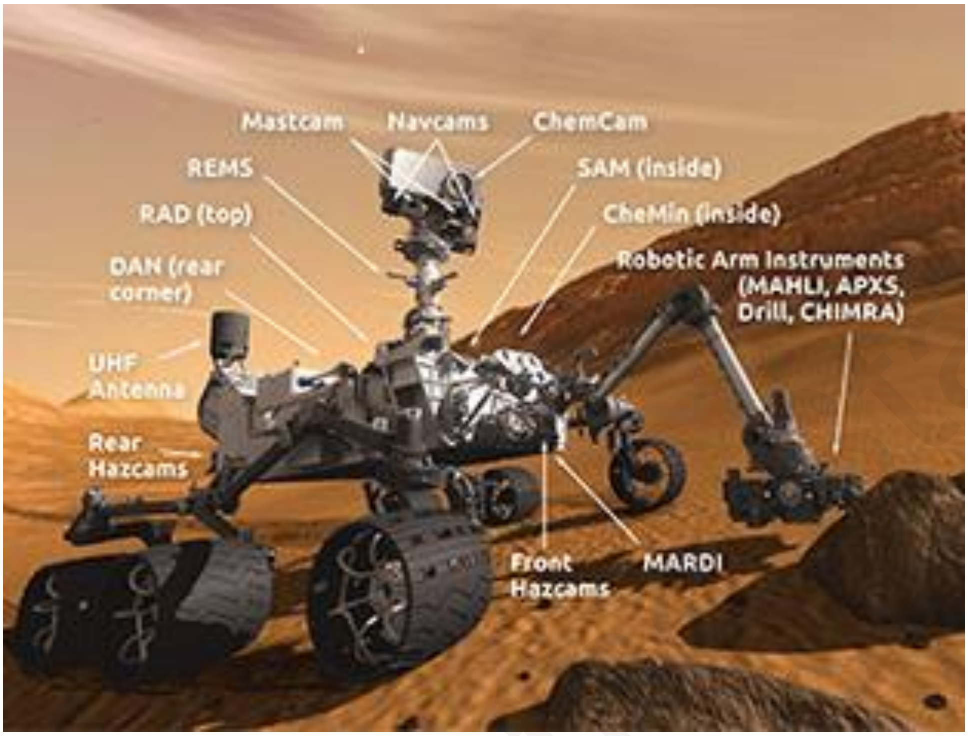
Results: The experiment and the results. It didn't find any microbial life on Mars.

Mars Pathfinder – 1997


Plans for the human explorations of Mars

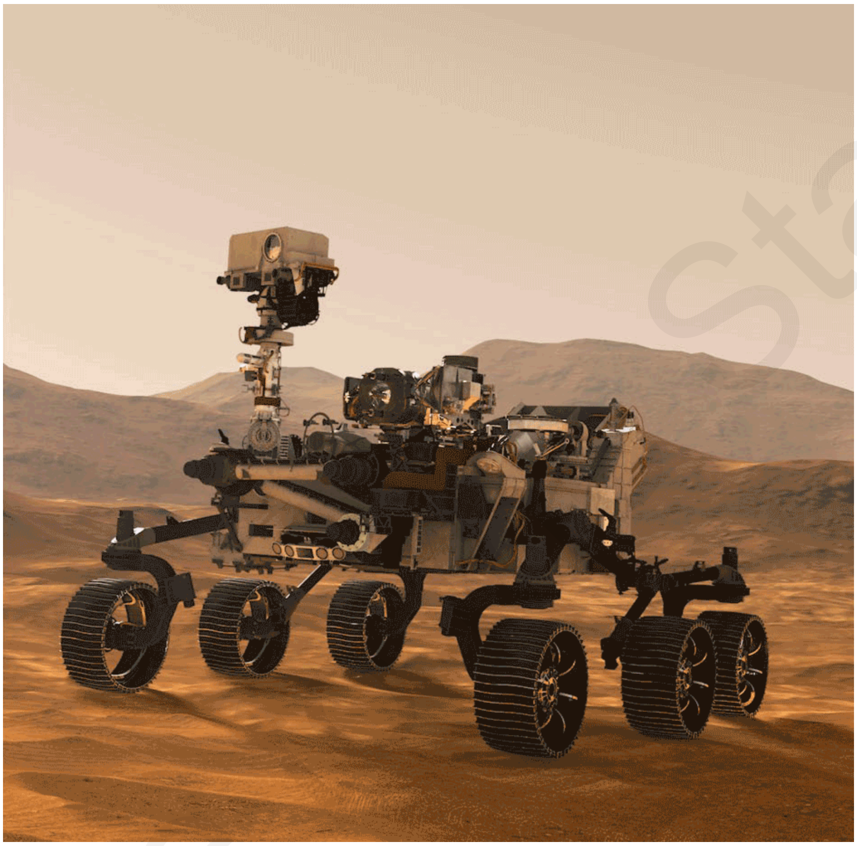
Spirit and Opportunity Rovers 2004.

Curiosity Rover



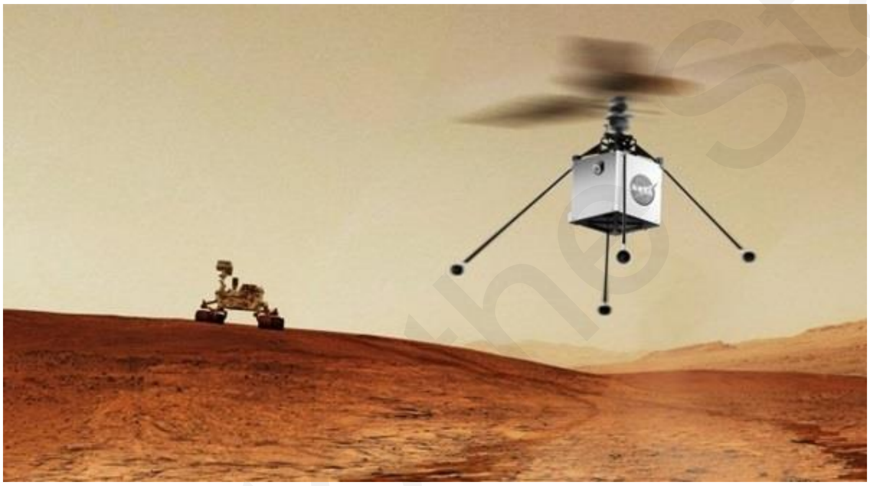
NASA/ JPL Images

Mars 2020



NASA/ JPL Image. Perseverance Rover.

Mars 2020 with the first helicopter on Mars



NASA/ JPL Image

Results: No life found yet, in progress

Space missions are planned by NASA to be sent to Europa, the moon of Jupiter, Titan the moon of Saturn and Enceladus also a moon of Saturn.

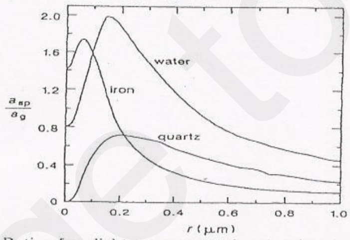
Prospects and probability: Dr. Moreno's Theory of Life on Mars and on the Moons of the outer planets. Please see the Nature publication below. Volume 336, November 1988.

NATURE VOL. 336 17 NOVEMBER 1988

Microorganism transport from Earth to Mars

SIR—In a recent letter, Melosh[1] presented the concept that large impacts on the Earth may eject rocks containing microorganisms that could fall on Mars or other planets. I have independently developed a similar model, and in November 1987 I submitted a very long article, which *Nature* was unable to publish. Here I would like to compare the two models. I will use the term dust/solar pressure/keplerian model (DSPK) to refer to my work and boulder/keplerian model (BK) when referring to Melosh's work; the meanings of these terms will become evident in what follows.

The DSPK model focuses on the transport of microorganisms from the Earth to Mars. This model starts with a meteorite impact on the Earth that can launch into space debris containing microorganisms from the surface of the planet. A fraction of this ejecta goes into orbit around the planet and some small fraction reaches escape velocity. The small particles (<0.5 µm) in the fraction that escapes the gravitational influence of the planet and is placed in Earth's orbit beyond $45R_{\oplus}$ (where $R_{\oplus}$ is the Earth radius) can reach Mars by means of solar light pressure as a propulsion mechanism[2]; larger particles may reach Mars by means of keplerian trajectories. The converse of the latter can be seen in the case of the SNC meteorites, which are thought to have come from Mars.



Ratio of sunlight-pressure acceleration (a_{sp}) to solar gravitational attraction (a_g) as a function of particle radius (r) for various materials [4].

The timescale for the transport of microscopic particles from Earth to Mars by the solar light pressure mechanism is about two months, whereas the boulder-sized rocks proposed by Melosh as the carriers of microorganisms take, on average, a few million years to reach Mars. Laboratory and other evidence do not support the idea that microorganisms could last in viable form for a million years in such a hostile environment. Furthermore we can expect that radiation from radioactive elements present in the rock itself would destroy the microorganisms over such long periods of time. The mechanism of propulsion by solar radiation pressure is much more efficient as a transport mechanism, but places the constraint that only particles with a diameter of 0.5 µm or less will be transported[4] (see figure). Since there are many microorganisms with diameters of ~ 0.01 µm, each dust particle could transport up to 50 such entities.

Another important feature considered in the DSPK model is that particles with diameters between 0.5 µm and 1 cm that have reached escape velocity are many orders of magnitude more abundant than boulder-sized rocks and are distributed over a dust cloud several thousand kilometres in diameter when leaving the Earth. The probability of impact of such a cloud on Mars is up to ~ 10^{10} times greater than for the boulders of ~ 1 m in diameter proposed by Melosh. Another important difference between the two models is that the DSPK model includes a consideration of the environment met by the transported microorganisms. The presence of liquid water on Mars in the past[5] suggests that at least at some time the transported microorganisms may have met with an environment favourable to their survival. Future Mars missions may thus find either fossils or live microorganisms and other forms of life in the north polar region, where there are still substantial amounts of water ice.

MIGUEL A. MORENO

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Argentina

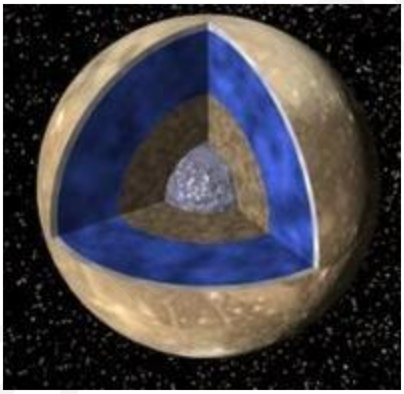
1. Melosh, H.J. *Nature* 332, 687–688 (1988).
2. Belton, M.J.S. *Science* 151, 35–44 (1966).
3. Mitchell, F.J. & Ellis, W.L. *Analysis of Surveyor 3 Material and Photographs Returned by Apollo 12* 239–248 (1972).
4. Shapiro, I.I., Lautman, D.A. & Colombo, G. *J. geophys. Res.* 71, 5695–5704 (1966).
5. Carr, M. *Icarus* 68, 187–216 (1986).

As concluded in the publication above it is possible that we may discover fossils of microorganisms on Mars

It is also possible that we may find live microorganisms underground, given that the presence of water and Methane has been detected on Mars.

Transport of Microorganisms from Earth to Mars, to Europa, and to the outer planets and Moons. Of special interest is Enceladus, a moon of Saturn. Dr. Moreno’s theory indicates that it is possible to transport micro-organisms from Earth to Enceladus.

The possibility of life on Europa, the moon of Jupiter, where we finf large and deep oceans under the ice.



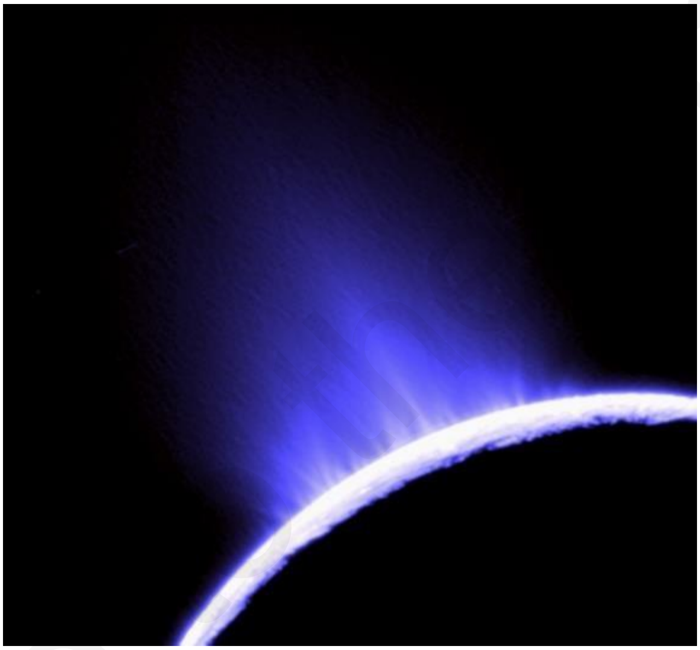
Structure, the environment and properties of Europa

The possibility of life on Ganymede, a

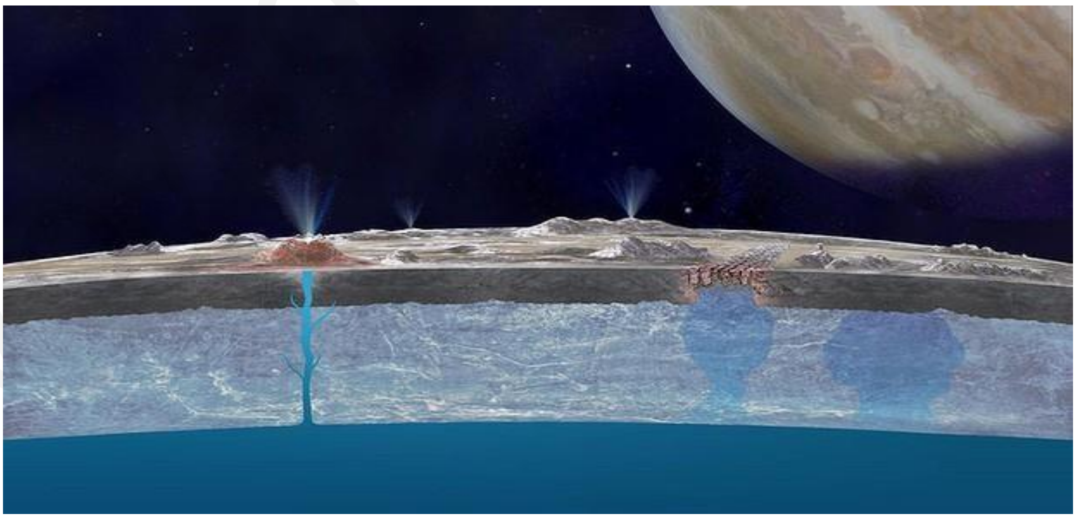
moon of Jupiter

The possibility of life on Titan

The possibility of life on Enceladus, a moon of Saturn, where NASA has found water geysers, which are indicative of an ocean below the ice. (Cassini Mission).



Water volcanoes, water geysers observed by the spacecraft Cassini on Enceladus, a moon of Saturn



Processes that cause water geysers on Enceladus

Artistic representation: View from the surface of Enceladus, Moon of Saturn

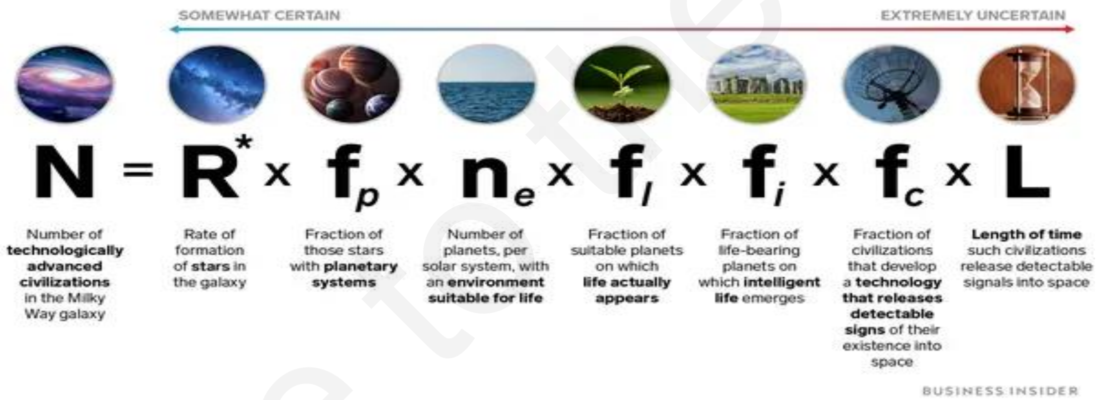
Dr. Moreno’s theory of the transport of microorganisms from Earth to the moons of the outer planets Points to a strong possibility that microbial and other forms of life may exist in the outer solar system.

Method 4. SETI. The search for extraterrestrial intelligence (SETI) by means of radio – telescopes. Results.

What is the probability of life in the Universe?

Consider the Drake Equation:

Credit: https://www.businessinsider.com/drake-equation-formula-alien-life-calculation-2018-7



Credit: https://www.businessinsider.com/drake-equation-formula-alien-life-calculation-20187

Professor Drake estimates that there may be up to 10,000 technological civilizations in the Milky Way Galaxy

Suggested:

Watch the following videos:

1. https://www.youtube.com/watch?v=EszGIvRdgTE

2. https://www.youtube.com/watch?v=mB2miQfI03k

3. https://www.youtube.com/watch?v=wM00s5q6wJQ

This is a view of the Allen Radio Telescope Array. SETI Institute.

Assumptions: “ The Cosmic Water Hole” . To be described in class.

Standards of Proof: Please note that detecting a radio signal from space is no proof of the existence of Aliens

A radio wave is not an alien, it may suggest the possibility of an Alien civilization, but it doesn’t constitute

a rigorous proof of the existence of aliens. As we develop this chapter we will discuss what constitutes proof

of the existence of aliens and an alien civilization.

Results: 45 years of search, no ET signal has been found.

Method 5. Light SETI: Optical SETI – The search for the detection of laser pulses in space originating from or sent by a technological civilization. Results.

The Laser Pulse Detection Program
UC Berkeley. Assumptions.

Time period: 15 years.

The assumption is that an ET civilization would deliberately send a signal aimed to the earth or to the Solar System.

It also involves the sending of a laser beam pulses to outer space to evoke a response from an ET civilization

Credit NASA images: Example lasser transmission: NASA laser data transmission to satellites

and back to Earth.

Results: After more than 15 years of search, No detection of an ET laser pulse yet.

Method 6. The Kepler Telescope Program. The search for exoplanets, i.e., planets similar to the Earth, in orbit in the habitable zone, around other stars. The study of exoplanets. Results.

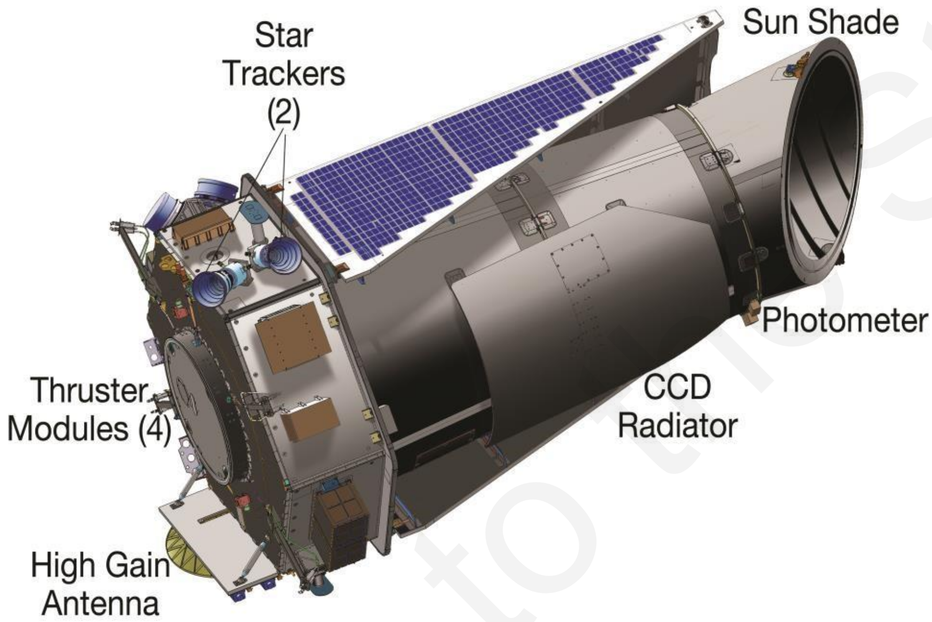
The Kepler Mission and the search for exo-planets

The effort to find another Earth

Exoplanets: How many Earths are out there? Where is ET?

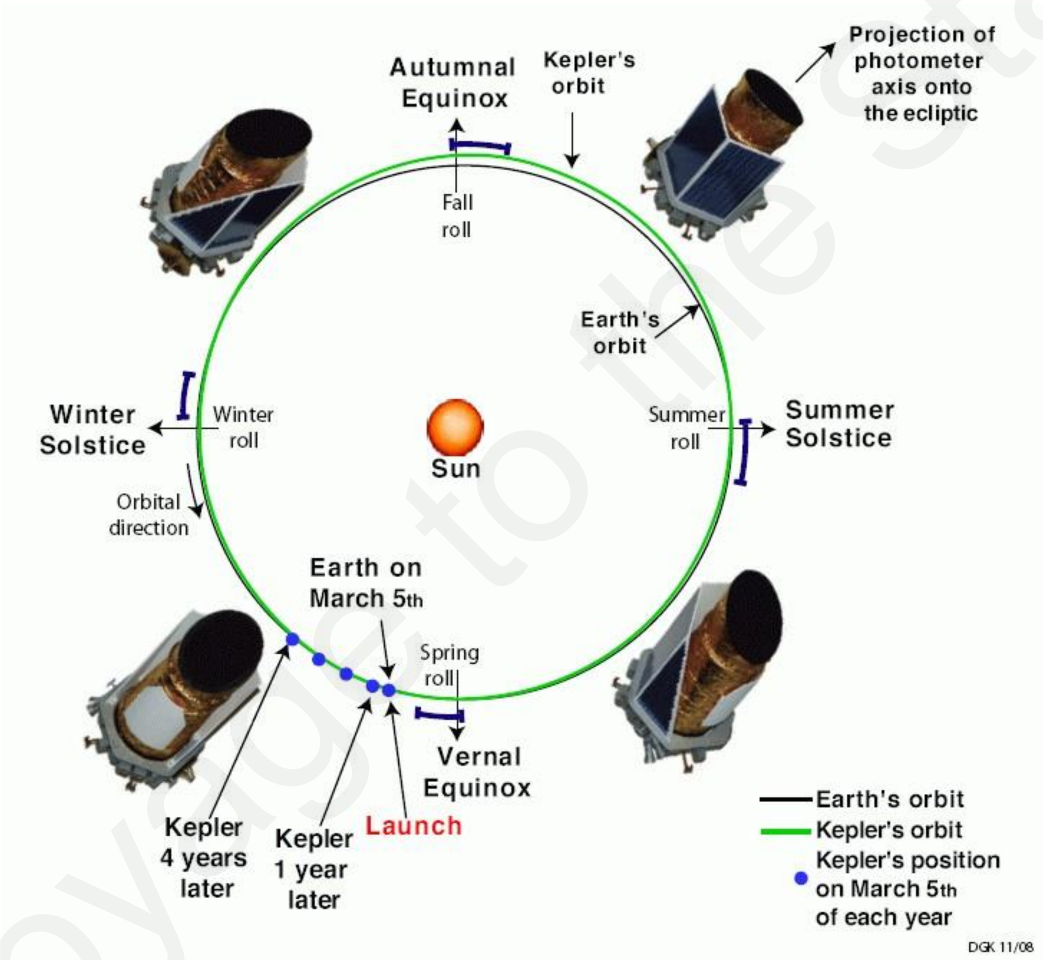
Another Method to look for ET: Find another earth

The Kepler Spacecraft and Mission



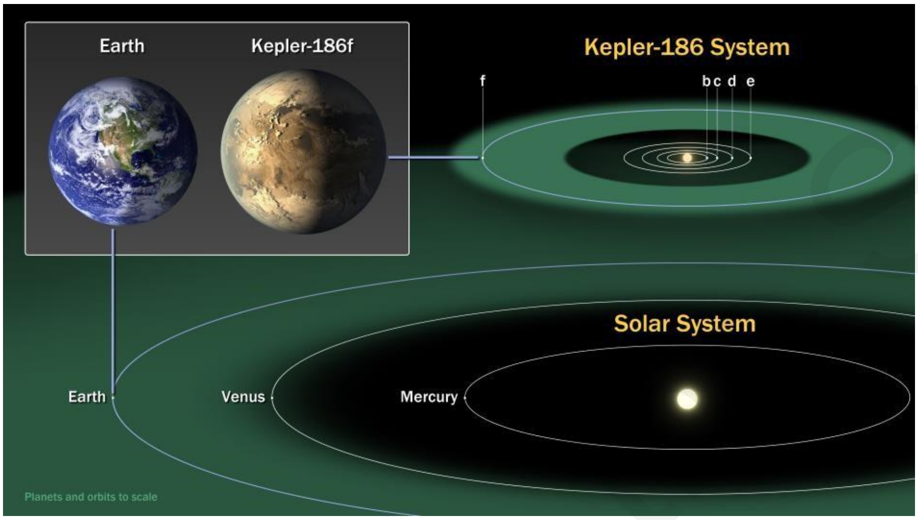
Objective: To find exoplanets

Kepler Telescope Orbit



Results:

The discovery of an Earth-like planet Kepler 186-f by the Kepler telescope above



This Earth-like planet is in the habitable zone

We estimate that there may be millions of earths around other stars in the Milky Way galaxy

Four earth-like planes out of 3,200 exo-planets

Kepler 186f

Earth 2.0 The case of Kepler 452b

The expectation, to find:

An earth-like planet with a technologically advanced civilization capable of radio communications and space travel.

Method 7. SETI on the Moon: Alternative search method SETI on the Moon

Dr. Moreno's Proposal. This is a proposed search for traces of an ET landing on the Moon. This proposed search covers a period of five million years. Any traces on the Moon would last for 5 million years, since they would only be erased by micrometeorite erosion. Results? Advantages of this search method as compared to other methods.

Time period analysis and comparison.

Also: Dr. Moreno's theory of possible traces of life on the Moon either ET

or transported from the Earth

SETI ON THE SURFACE OF THE MOON

A proposed search for physical evidence of traces of ET visits to the surface of the Moon in the last five million years

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Space Physicist
Director NASA-MSET Program
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(Updated September 2005)

Abstract. I propose a new and practical alternative method for the search for a signal from an extraterrestrial technological civilization. This method is an alternative to the search for radio waves and optical laser signals which have been the focus of the search for the last thirty years. The laws of Physics expressed in the Diffusion Equations indicate that if a technological civilization arises in the galaxy, then it would be able to visit every region in the galaxy in a time scale of ten million years. The surface soil of the Moon has kept a record of interaction with space objects for the past five million years due to the absence of wind or water erosion and where the only erosional agents are micrometeorites and solar wind particles. The search for physical evidence, traces on the surface of the moon would indicate a search in time of five million years. The proposal presented here involves an effort to find traces of a landing of an ET technology. I propose placing a small spacecraft in a low altitude lunar polar orbit, for example h ~ 6 km, carrying a high resolution reflecting telescope and camera system to map some sectors of the Moon's surface and later the entire surface of the Moon with a resolution of five to ten centimeters. The use of pattern recognition software and supercomputers will allow the detection of any traces of a landing on the Moon in areas not visited by humans. Even if no trace is detected, it will help place a constrain on the probability of the existence of a technological civilization in our galaxy, thus advancing the search process. This information together with the new results on extrasolar planets would at least help advance the process of improving the Drake equation. Additional benefits of this mission would include a survey of lunar surface resources such as the detection of water and mineral resources for future explorations as well as detailed information for numerous geological studies. The participation of the educational community in the study and analysis of images of specified sectors of the Moon, high schools and colleges, will help engage all high schools and colleges with this project and also bring the benefit of educating and motivating the next generation of scientists and engineers and acknowledge the work done by NASA. If a trace is discovered it would change our understanding of life in the universe and it would allow the focusing on the site by use of dating techniques to place limits on the time when the visit took place. I suggest that this project should be an integral part of the new effort to go back to the Moon. This project also represents an experimental test of the Fermi hypothesis.

Introduction

We know the importance of a discovery of a radio signal from a technological civilization in our galaxy and some of its implications. We know that the method using radio telescopes is cost effective. However, it has limitations in space and in time and in the last forty years of effort no signal has been detected in either the northern or southern hemisphere. Is it possible that an extraterrestrial technological civilization does not communicate using radio waves and that radio wave communication represents only a short time interval in the evolution of technology? Will it take hundreds of years of constant effort to find a signal? The effort to detect an ET signal from an optical pulsed laser is more than ten years old and it has not detected any signal either. The fraction of the galaxy and the time interval explored in these methods so far are very small compared to the time it takes a radio signal to travel across the galaxy and the corresponding spatial region. In what follows, I propose an alternative search that covers a much greater time period (five million years) than the radio signal detection has covered so far, and it would help place constrains on the presence of a technological civilization in our galaxy.

It is estimated that this footprint will remain detectable for a few million years

It is estimated that the footprint in the picture above will last for five million years. Micrometeorites and solar wind erosion will eventually erase it. What if a technological civilization spacecraft has visited the Earth and the Moon and left a small landing pod trace on the surface? By studying the surface of the Moon we would be answering the question, has ET visited the Earth region in the last five million years?

In this proposal I plan to review the relevant diffusion equations and place constraints on the probability of a visit and then use it as a guiding tool to conduct the search. I also propose to develop a visit probability map for each area of the moon.

I propose the development of a small spacecraft with high-resolution cameras, to place it in lunar orbit to map sectors of the Moon's surface. Subsequent studies using supercomputers for pattern detection would help identify any trace that does not originate in natural phenomena or human exploration visits. The high-resolution mapping would also bring side benefits such as a better understanding of the geology of the Moon and the inventory of surface resources for the more extensive NASA Moon program. It will also help with the subsequent validation of new technologies with applications in defense. It would in addition involve developing new pattern recognition software with applications in artificial intelligence. We can also assign different sectors of the surface of the Moon to high schools, colleges and universities, so students can do visual search projects as well as research projects with our software to help search for surface traces that may indicate a visit by a spacecraft from a technological civilization to the Moon in the past five million years.

The educational component of this research project will help to engage students, motivate them and encourage them to learn about Physics, Geology and Physical Science. It will also motivate the involvement of a wide sector of the learning population. It will help NASA promote interest in studying science, Physics, Geology, Chemistry and Technology.

Surface trace erasing model

This project involves the development of a surface trace-erasing model taking into account the measured flux of micrometeorites on the moon’s surface. It also involves the development of a model of the solar wind interaction based on measurements of the solar wind on the surface of the Moon and relative abundances of implanted H and He on the lunar soil. These and other related processes would be integrated into an erosion model of coupled differential equations that will help place time scale constraints on any physical evidence, trace, left on the lunar surface as well as deriving a better understanding of the actual surface of the Moon. A computer simulation model of the surface trace information erasing process, based on comprehensive micrometeorite and solar wind flux data, would be developed as part of the project. If a trace left by a visiting spacecraft on the lunar surface were discovered, this process and model would allow dating the visit, i.e., determining approximately when it took place during the last five million years.

Computer simulation model of galactic "colonization"

This project would involve the development of a computer simulation starting from a point source as the origin of a galactic technological civilization and how it would expand to the rest of the galaxy in a diffusion-like process. As the "colonization" or exploration takes place each new colony would behave as a point source, thus causing the extension to the entire galaxy to take place in short time scales ~10 million years, which is a small time interval compared to the life span of a sun-like star, ten billion years. Diffusion-like equations would be developed to simulate at least three cases. Case 1: The process of diffusion, or visit pattern, of a technological civilization within the boundaries of the ecological region or sector of the galaxy and Case 2: Colonization or visit patterns for the entire galaxy and Case 3: Colonization or visit pattern originating at a point from neighboring galaxies. This process would show how a visiting spacecraft would eventually reach this area of the galaxy and the Moon and leave a trace on its surface. Erosion processes on the Earth surface would erase any traces left, however a trace left on the Moon would last for millions of years. We assume that a visit to the Moon implies a visit to the Earth. Only the Moon's surface would keep a record of it for five million years.

Lunar surface exploration spacecraft

I propose here the development of a small spacecraft with a mission time scale of three years from the time of design to the time of orbit insertion. It would be deployed into a low altitude polar orbit, h~6 km. This spacecraft would be equipped with a high-resolution digital telescope. The objective is to search for any surface trace not attributed to natural processes, such as a footprint, or a spacecraft landing pod surface mark. The goal is to map entire sectors of the surface of the Moon with a resolution of 5 cm. The analysis of the data will involve the development of pattern recognition software vectorized for effective use in a supercomputer.

Geological and resource map identification benefits

This project will also help the understanding of the geology of the Moon as well as the evaluation of its mineral deposit resources and the identification of any water ice deposits all of which will represent a valuable resource for the future lunar exploration plans. It will benefit the establishment of future manned scientific posts and use of the Moon as a base for the exploration of Mars and the rest of the solar system and learning how to survive long times on a low gravity environment and the conditions of space. The data acquired in this project will also serve to help many graduate thesis projects on the study of the Moon and its implications for understanding the solar system.

New technological development, benefits

This project will help the development of new technological capabilities. It will advance image processing software development. It will require the use of advanced pattern recognition software, which is an integral part of new developments in artificial intelligence. It will require the installation of new high-speed computers on board the spacecraft and an opportunity to validate new propulsion and computer systems. It will also represent an opportunity to use the unused capacity of the latest supercomputers at JPL/NASA.

Benefits to science education in high schools and colleges

Engaging the larger community

One of the challenges for JPL and NASA is how to engage the larger educational community with participation and interest in the space program. How to engage the learning community to prepare the future citizens with understanding and support for the space program and for NASA? How to motivate the preparation of future scientists and engineers?

In this project, specific sectors of the Moon's surface images and related data can be assigned to high schools throughout the country for the direct visual search of surface traces and with the use of school's PC's and software downloaded from the web site developed for this project. Also, students would be involved in image processing and resource identification as science projects. This will help motivate science learning and engage the next generation of potential scientists and engineers in project activities with real data and specific research goals of important value to the scientific community. Most funding agencies require a presentation on the impact of research on the larger community and dissemination of information and results that is a goal that can be accomplished in this project. The development of partnerships is also viewed as a positive component that would lead to significant support.

Implications of results

If a trace, attributable to an outside technological civilization, is found the implications are well known, it will open the doors to a new chapter in human history and all the sciences. If no trace is found, these results can help place constraints on the possibility of the existence of a technological civilization in the galaxy, which in itself is a significant progress for the field of astrobiology. In addition, if no trace is found, there is a return in technological benefit. The associate survey of lunar mineral and other resources would be an important benefit to assist in the preparation for future lunar programs. Also, there is an important benefit that this project would bring to science education, specifically for motivating, engaging, inspiring and preparing, with updated tools and skills, the next generation of scientists and engineers.

Conclusion

The surface of the moon is a memory record of interactions with space objects. Physical traces on its surface soil last for up to five million years. Before embarking on a large scale Moon program, I think we should do a comprehensive survey of the lunar surface for physical evidence or traces of a visit, possibly by a robotic spacecraft from an extraterrestrial technological civilization. The project proposed here could be a stand alone self-contained mission or a component of another mission to survey surface resources for example. This project has research and educational benefits that would engage the learning communities from elementary schools to universities. The discovery of a concrete physical trace of a visit by a technological civilization on the Moon would mark the beginning of a new space age. The absence of a specific physical trace will help advance the process to place constraints on the possibility of life in the universe and it will bring benefits to research and education. The results will contribute to develop new constraints will be developed for the Drake equation which estimates the possible number of technological civilizations in the galaxy and a test for physical evidence can be developed for the Fermi Hypothesis.

Transport of Microorganisms from Earth to Mars
Review the article by Dr. Moreno in the world-wide scientific publication Nature, Volume 336, November 17, 1988.

Method 8. Panspermia. The concept that life came from outer space in a comet and then it developed here.

This search involves sending spacecraft to comets and the detection of aminoacids, the basic building blocks of life on a comet.

Example: Comet 67P/Churyumov – Gerasimenko
Radius: 1.2427 mi
Orbital period: 2,352 days
Orbits: Sun
Discoverers: Klim Churyumov, Svetlana Gerasimenko

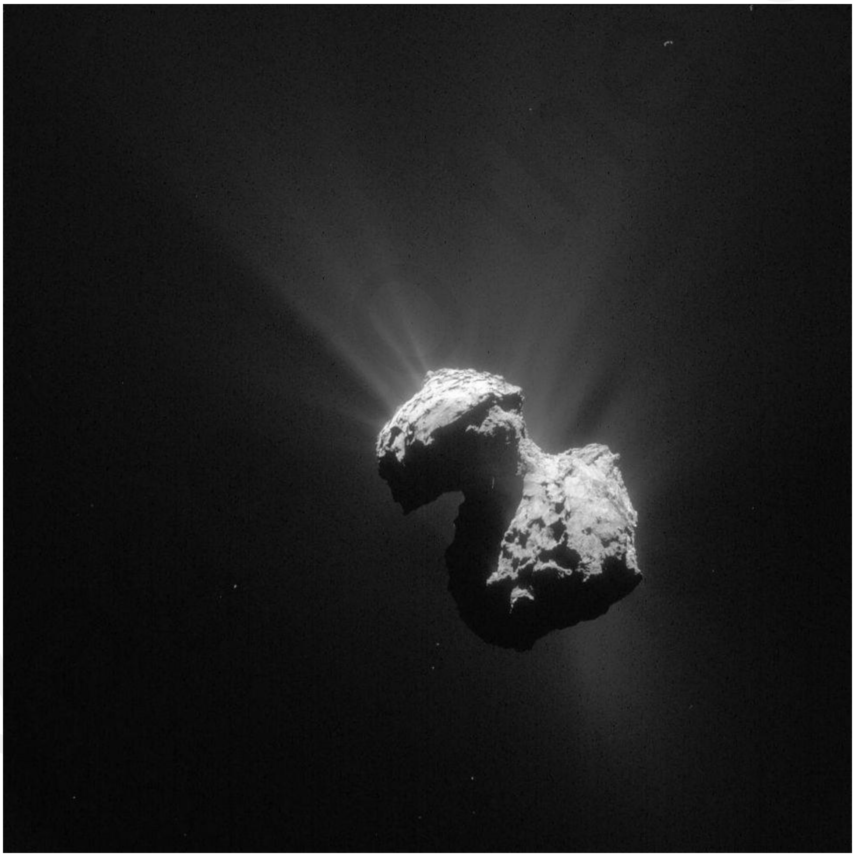
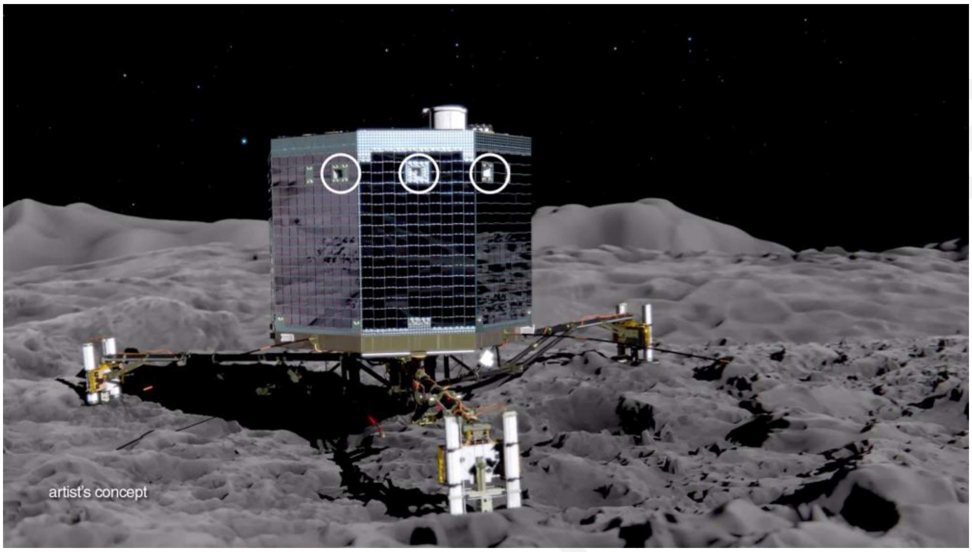


Image Credit: NASA/ ESA. Image taken by the Rosetta Orbiter from 154 kilometers away.

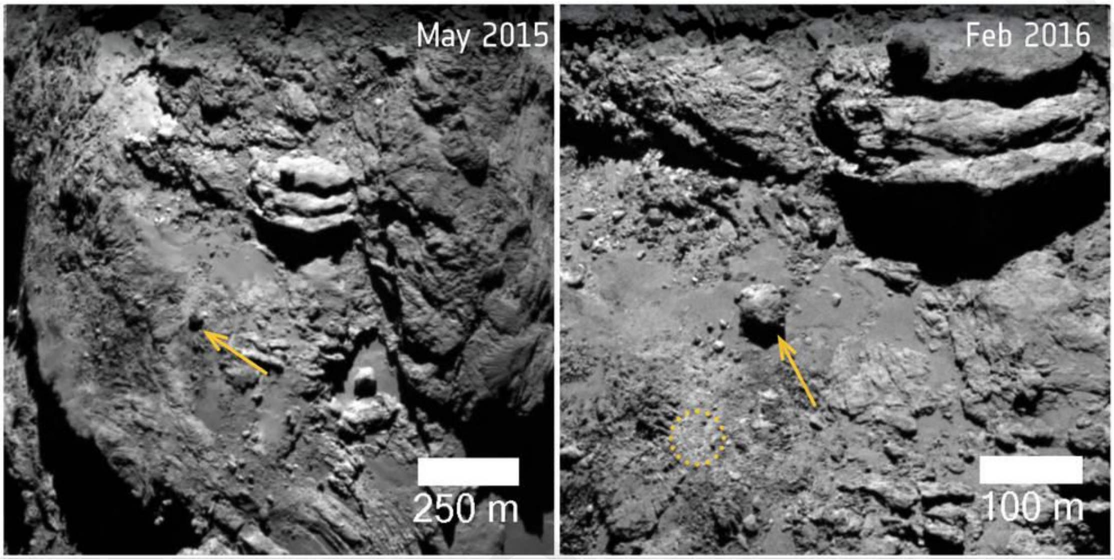


Example: Spacecraft Rosseta – Philae visit and landing on comet 67P/Churyumov – Gerasimenko

PHILAE'S INSTRUMENTS

Philae has 10 instruments:

APXS: Alpha Particle X-ray Spectrometer, for studying elemental composition
CIVA: Comet Nucleus Infrared and Visible Analyser, six black-and-white cameras for panoramic imaging
CONSERT: COmet Nucleus Sounding Experiment by Radiowave Transmission, for studying comet interior
COSAC: The COmetary SAmpling and Composition, an evolved gas analyzer for identifying organic molecules
Ptolemy: an evolved gas analyzer for measuring isotopes of light elements
MUPUS: MUlti-PUrpose Sensors for Surface and Sub-Surface Science, for studying comet physical properties
ROLIS: Rosetta Lander Imaging System, will provide context images of landing site
ROMAP: Rosetta Lander Magnetometer and Plasma Monitor, for studying the magnetic field and plasma environment of the comet
SD2: Sampling, drilling and distribution subsystem, can drill to 23 centimeters depth
SESAME: Surface Electric Sounding and Acoustic Monitoring Experiment, for studying comet physical properties



Credit: NASA/ESA. Movement by a distance of 140 meters, 460 feet, of a 30 meter diameter, 28 million pound boulder on the surface of the comet as it approached perihelion in August of 2015

Results: Philae's Instruments detected the ingredients for life, but no microorganisms.

The Rosetta mission detected phosphorus and organic compounds, such as glycine, this is the simplest amino acid there is. These compounds were detected in the haze around this Comet, 67P. Year 214 – 2015.

This discovery points to the possibility that comets could have helped to bring about life on Earth by the mechanism of seeding Earth with the necessary raw materials after impact.

However, no microorganisms or any other life forms were found

Method 9. Looking for objects that come to the solar system from other stars and to study them for any signs of

ET intelligence, such as non – natural orbits. Large strange shaped objects that some think may be large ET

Solar sail (Star sail) spaceships. Results.

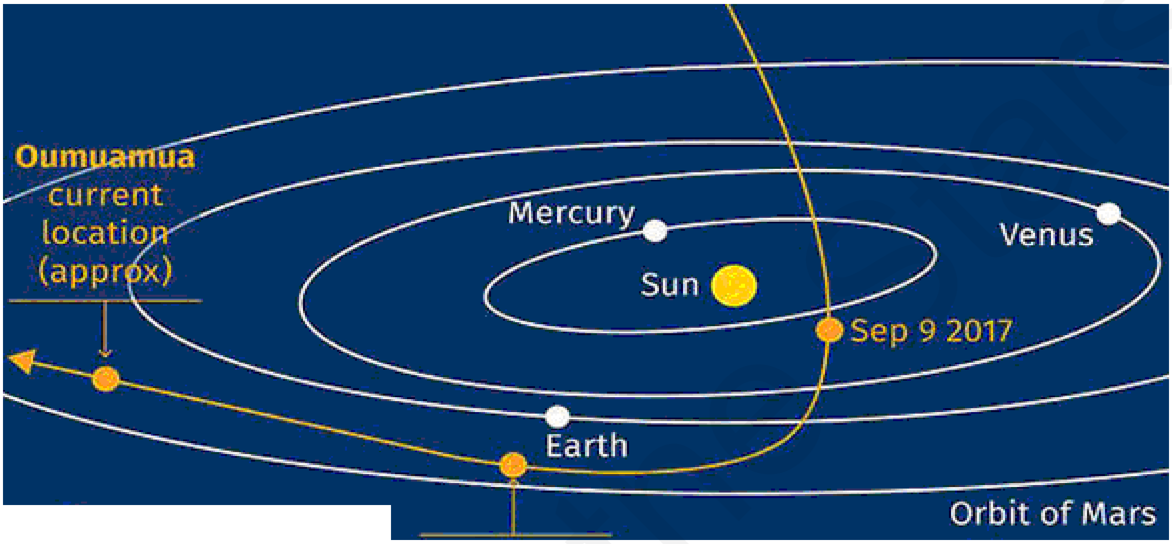
Shown in the image below is an artist conception of the interstellar asteroid object1I/2017 U1 ('Oumuamua), discovered in October 2017, as it passed through our solar system, by telescopes of the University of Hawaii funded by NASA. The ratio of length to diameter, aspect ratio, is 10:1. This is very different from all the other asteroids we know in our solar system.

Image Credit: NASA/European Southern Observatory / M. Kornmesser

This interstellar asteroid is given a Hawaiian name, Oumuamua, (Ou – mua – mua) which means messenger from afar who arrives first.

To quote from NASA: “The first known interstellar object to visit our solar system, 1I/2017 U1 ‘Oumuamua, was discovered Oct. 19, 2017 by the University of Hawaii’s Pan-STARRS1 telescope, funded by NASA’s Near-Earth Object Observations (NEOO) Program, which finds and tracks asteroids and comets in Earth’s neighborhood.”

It is the first interstellar object detected passing through the Solar System.



Velocity: 190,000 miles per hour or 84.94 kilometers per second.

For a simulation and further description, please see the link below.

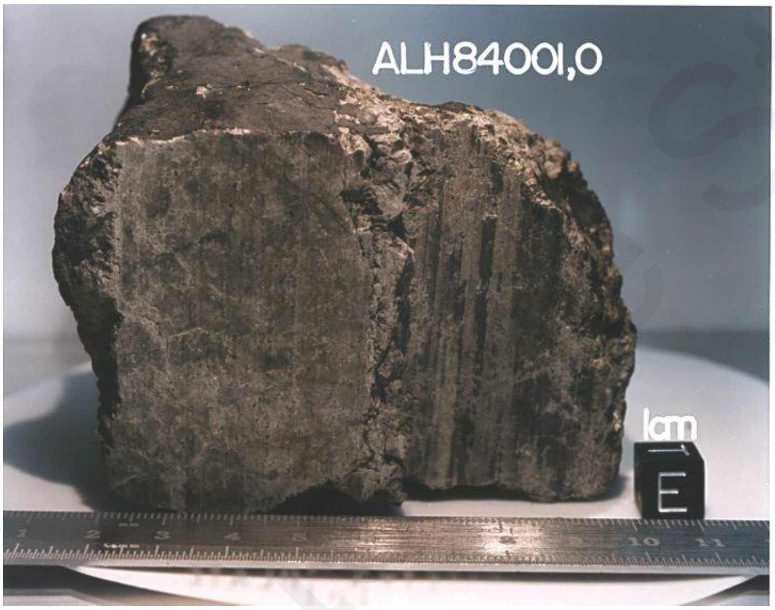
https://weather.com/science/space/video/could-oumuamua-interstellar-object-be-an-alien-spacecraft

Results: Harvard Astronomers speculated that due to its strange cylindrical cigar shaped, for an asteroid and that it came from interstellar space and that it had an unusual path around the Sun, that it may be an alien, ET star sail spaceship.

Results: It came into the solar system and then left the solar system for the stars and no signs of ET life were detected.

Method 10. Search for components of life forms and microbes or microbe fossils in a recovered meteorite that originated from Mars.

Life inside a Martian meteorite that fell on Earth?



Meteorite recovered from Antartica and determined that it came from Mars

The elongated structure in the center maybe a microfossil

Summary of the description from NASA

1. The original igneous rock solidified within Mars about 4.5 billion years ago, about 100 million years after the formation of the planet. (Based on isotope ages of the igneous component of the meteorite)
2. Between 3.6 and 4 billion years ago the rock was fractured, presumably by meteorite impacts. Water then permeated the cracks, depositing carbonate minerals and allowing primitive bacteria to live in the fractures.
3. About 3.6 billion years ago, the bacteria and their by-products became fossilized in the fractures. (Based on isotope ages of the minerals in the fractures)
4. 16 million years ago, a large meteorite struck Mars, dislodging a large chunk of this rock and ejecting it into space. (Based on the cosmic ray exposure age of the meteorite)
5. 13,000 years ago, the meteorite landed in Antarctica.
6. The meteorite, ALH84001, was discovered in 1984 in the Allan Hills region of

Antarctica. Credit: NASA

Results: The UCLA Origins of Life Institute determined that there were no fossils and no signs of life
In this meteorite.

Method 11. Future sample return missions to mars. Future Manned missions to Mars to explore and drill on the rocks and soil and bring samples to Earth to conduct studies and search for microbial life or other life forms.

Image credit: NASA: Artist concept: Launch of a rocket carrying soil and rock samples from Mars to the Earth

Quoting from NASA: " President Donald Trump's NASA budget request for the 2020 fiscal year includes funding for a Mars sample return mission that could launch as soon as 2026, the space agency's chief Jim Bridenstine said today (March 11, 2019). The mission would fetch rock samples packed up by the agency's Mars 2020 rover and bring them back to Earth for study in terrestrial labs.

Method 12. Dr. Moreno's Theory of Life on Mars, Europa and Enceladus, and other moons of the outer planets. Searching for microbial life in Mars and also the moons of the outer planets. Please refer to Dr. Moreno's Nature article above.

Method 13. The production of synthetic life in the Labs and the search for the possibility of synthetic life in the Universe. Also, the possibility of advanced robotic AI life forms.

Another possibility: ET Robots with artificial intelligence?

or Synthetic Life Forms. What if the first contact with ETS is with robots? For class discussion:

The example of ASIMO. The evolution of artificial intelligence and the future

What will a humanoid robot look like and think a million years from now, what will it converge to?

Will it be distinguishable from humans?

The first ET that humans encounter, will it be a robot?

Conversely, will the first "human" the ETs encounter will it

be a robot? Please see the following video regarding the

robot ASIMO

https://www.youtube.com/watch?v=JlRPICfnmhw

A thousand years from now, robots may be indistinguishable from humans

Highly intelligent human looking robots can be used for space exploration and to deal with the hostile environment of space, without risk to humans.

First, we will consider the possible scenarios of evolution of life forms in the universe

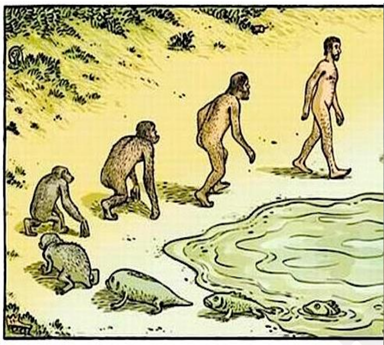
Evolution of life in the universe.

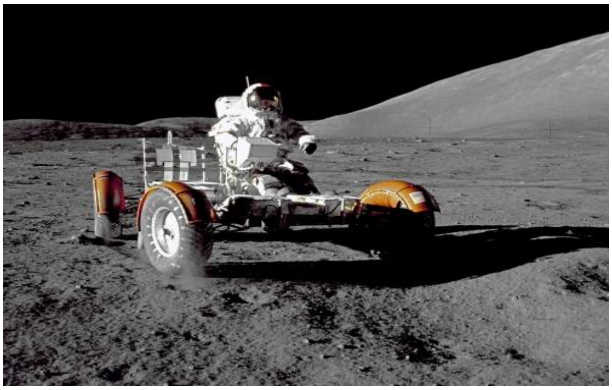
Possible scenarios.

(Discussion of a comparison of Dr. Moreno’s theory to other schools of thought)

1.
ammals – Where we started and where we converged to in evolution.

Mammals lead to primates and then evolve to humans- to technology



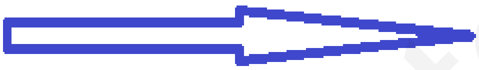



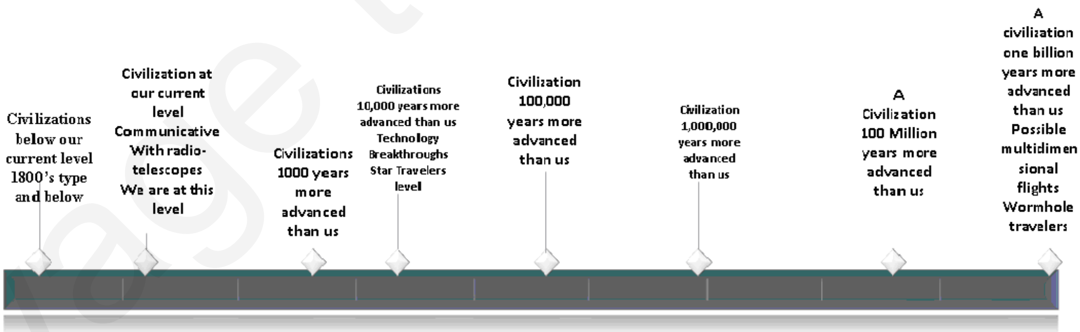
Leaving the Earth and exploring the Moon (Apollo Program).

From the fish in the ocean evolving to explore the Moon, the stars and the Universe.

Is it possible that this evolution can happen in many places in the Universe?

Dr. Moreno's Theory of levels of development of "Communicative" Advanced Technological Civilizations. Spectrum of ET technological civiliations in the Galaxy and the Universe. Spectral analysis of ET civilizations





Level of development – Evolutionary time difference – Information flow pattern. Information flows mostly from a lower civilization to a higher civilization. This is the core problem of proof by "Extraordinary claims require extraordinary evidence" We have a lot of cumulative highly credible circumstancial evidence, but no alien spacecraft, no alien body or no piece of alien technology. What constitutes proof? Lower technologies have a difficult time grasping higher technologies. Higher technologies are generally out of reach of lower technologies, to meet the "extraorninady evidence" absolute requirement.

Information flow –Asymetric information flow: Potential visitors to Earth those civilizations above 10,000 year more advanced, those with technologies capable of traveling to the stars. The information flow would be from a lower level to a higher level. Very small amounts of information would flow from a higher level to a lower level. The information flow would decrease, from a higher civilization to a lower civilization, exponentially as you go higher on the scale.

What will ET look like?

The possibilities

Dr. Moreno's Theory of Convergent Evolution, the evolution of life forms converging to the humanoid shape

Life in exo-planets, planets around other stars, similar to the Earth, throughout the Milky Way Galaxy and throughout the Universe would evolve and although they may have different origins, such as mammals, reptilians, insects, synthetic biological robots, all converge to the humanoid shape, as the form that develops technology to reach other planets and the stars and would have the capability to communicate with other species.

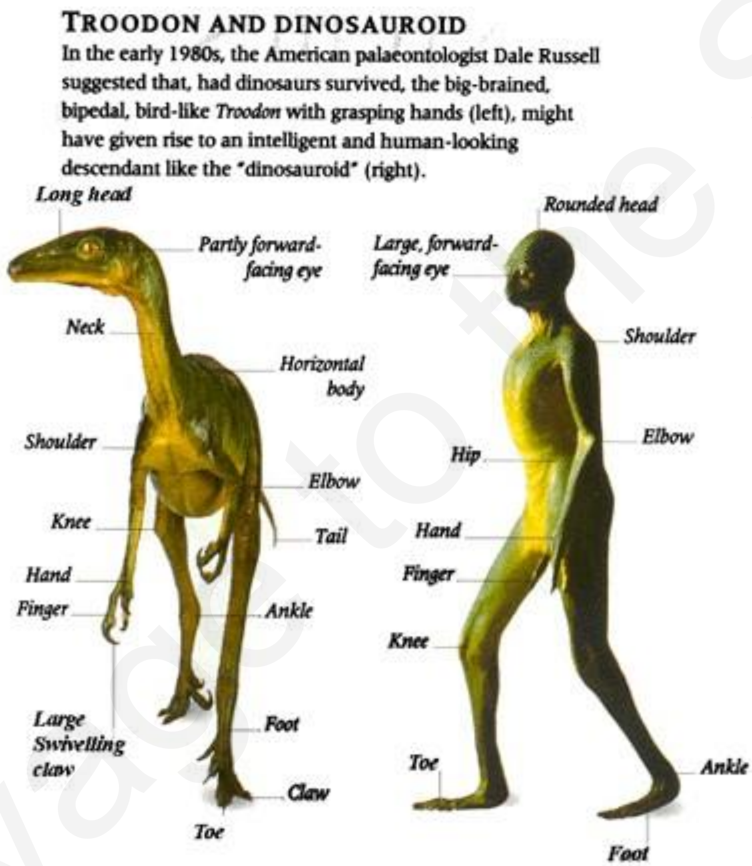
Question: What would an alien look like if it evolved from the reptiles? i.e., no asteroid impact, which means no extinction of the dinosaurs.

Reptilians – If the dinosaurs had not become extinct hat would they have evolved to?

Scientific speculation: In a "thought experiment" published in 1982 in the scientific journal Syllogeus by paleontologist Dr. Dale A. Russell, curator of vertebrate fossils at the National Museum of Canada in Ottawa, projected what the dinosaurs may have possibly evolved into, if they had survived the so called "extinction event" that took place 65 million years ago. He conjectured that bipedal predators (theropods) which existed at that time, such as Stenonychosaurus / Troodon, would have evolved into intelligent beings similar in body plan to humans. Troodontids had semi-manipulative fingers, able to grasp and hold objects to a certain degree, and binocular vision. Like most dinosaurs of the troodontid family, this imaginary creature, which Russell called the "Dinosauroid", would have had large eyes and three fingers on each hand, one of which would have been partially opposed.

Questions for discussion:

1. What would be your reaction of an alien looked like this?
2. What would be your first question if you met an alien that looked like this?
3. Would you sit down at a table and have a cup of coffee with someone like this?
4. If five people submitted an application for a job at your office four human and one Alien looking like this, would you hire him?



Humanoid reptilian evolving from the dinosaurs

Question: What would an alien look like if it evolved, over hundreds of millions of years, possibly a billion years, from insects?

Insects. Where they start and where they can converge to.

Simulation: Possible ET evolved from insects

For class discussion:

What would be your reaction if you met an alien that looked like this?

Would you sit down at a table with someone like this to have a cup of coffee?

If that were the case, what would be your first question?

Would you hire somebody like this to work in your office?

What would an alien look like if it evolved from insects, second scenario?

Speculation - Simulation: A humanoid intelligent alien evolved from insects over hundreds of millions of years.

For class discussion:

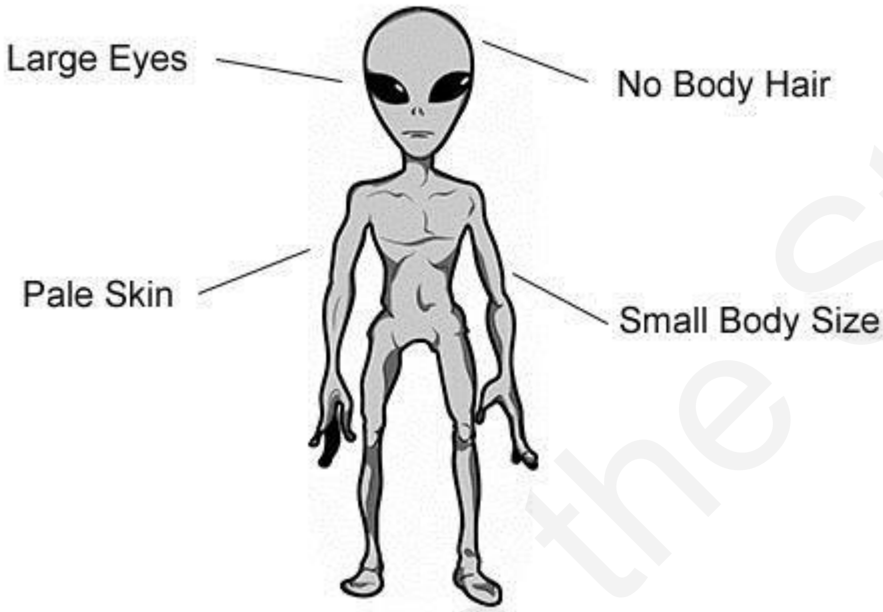
What would be your reaction if you met an alien that looked like this?

Would you sit down at a table with someone like this to have a cup of coffee?

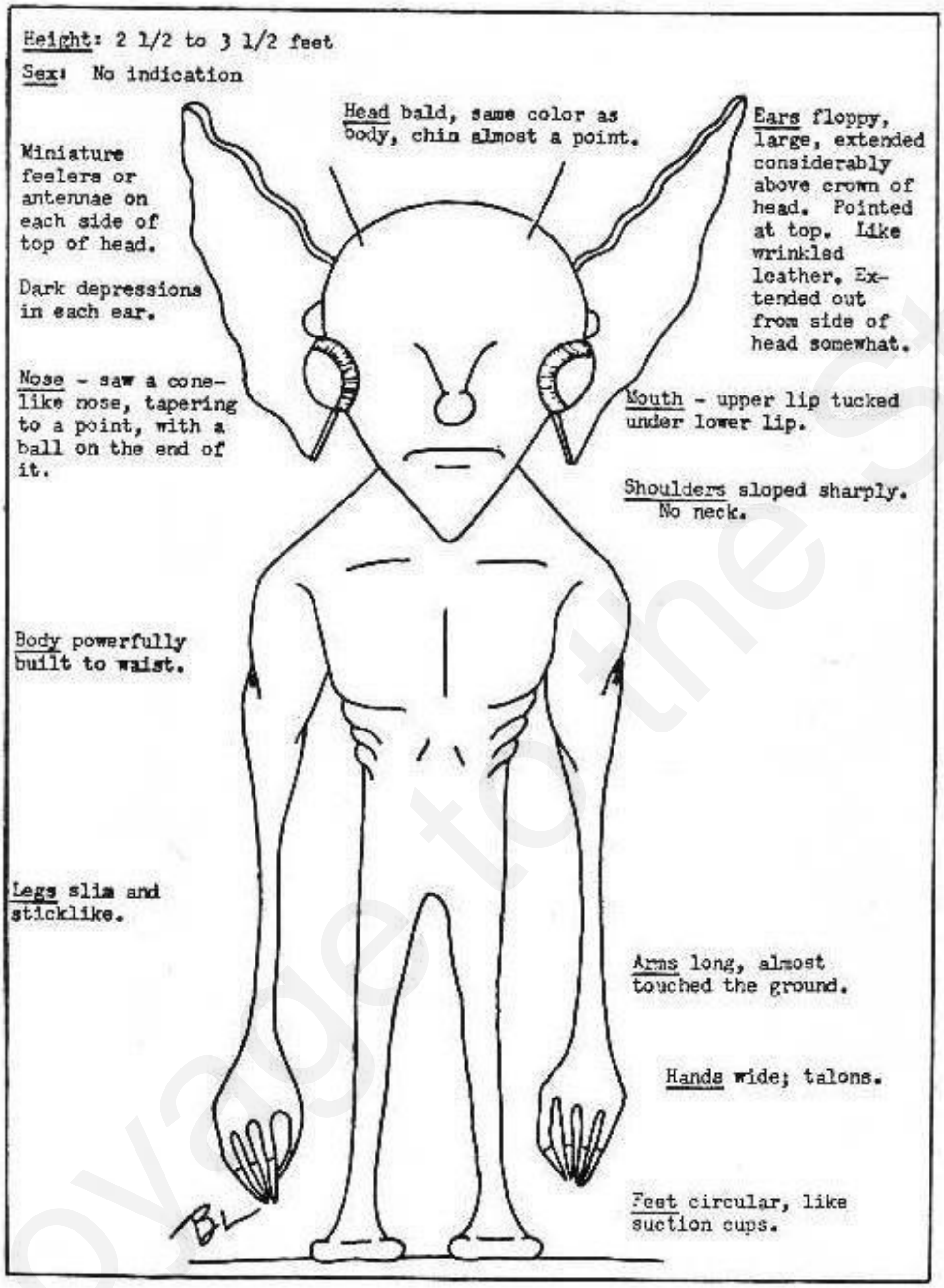
If that were the case, what would be your first question?

Would you hire somebody like this to work in your office?

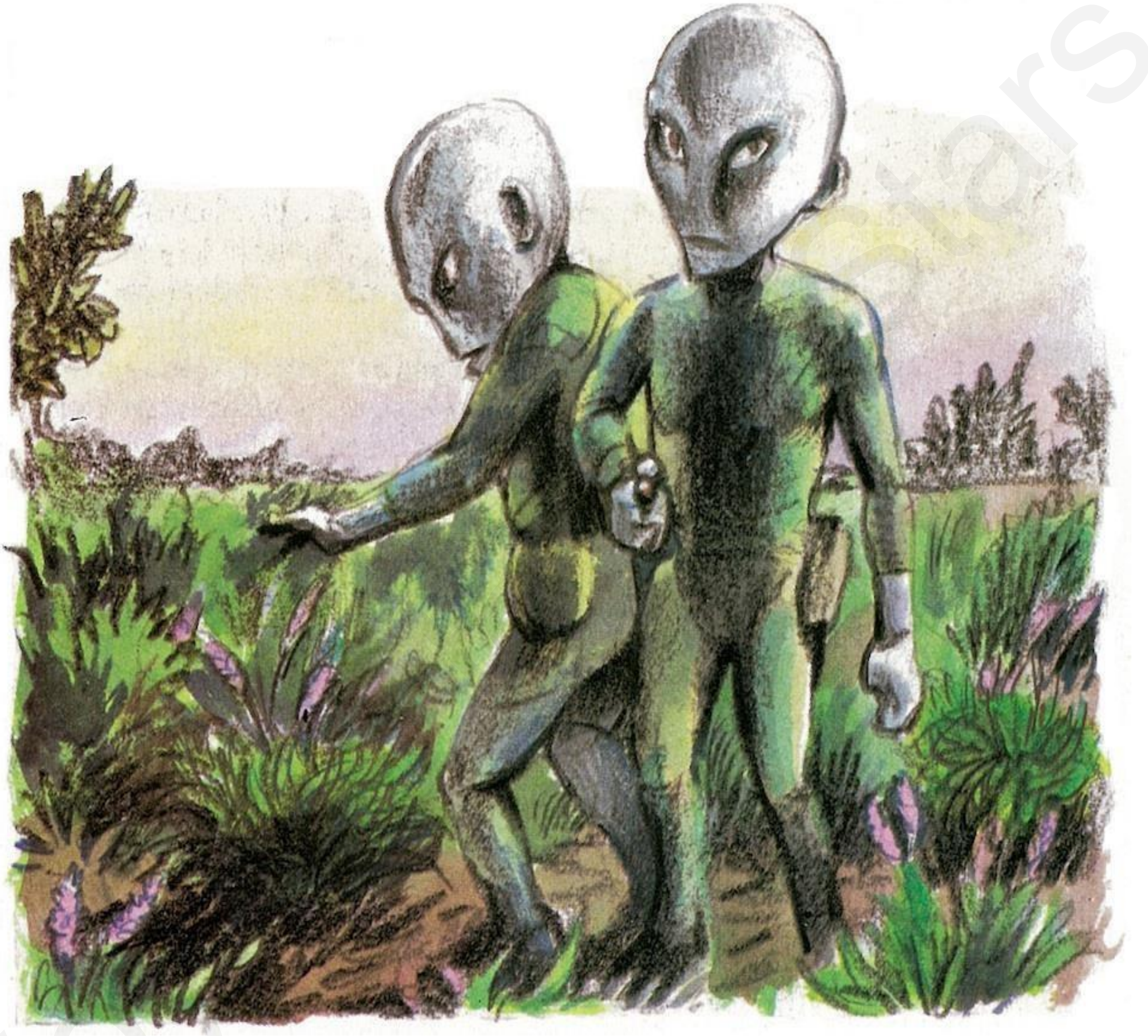
What would be your reaction if the alien looked like this?



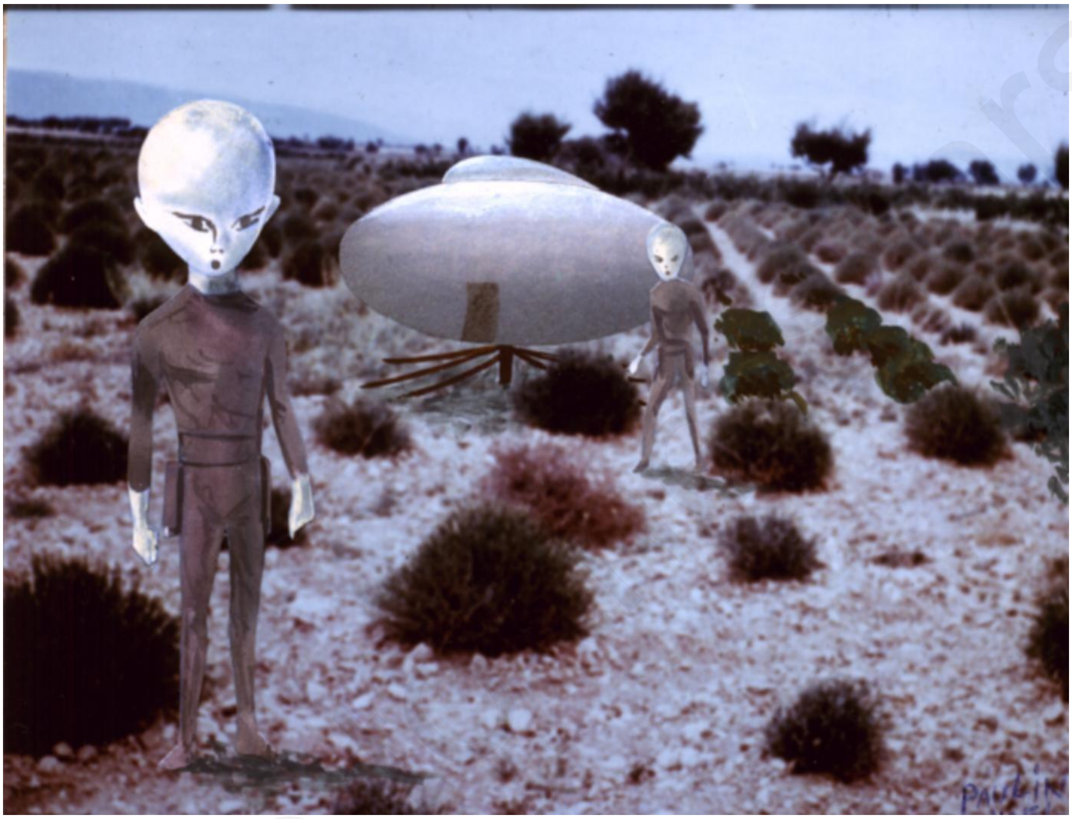
What some people claimed to have seen. Kentucky UFO case, August 21, 1955.



A sketch of one of the goblin-like entities which besieged a farmhouse at Kelly-Hopkinsville in Kentucky in August 1955. *(Mary Evans Picture Library)*



Maurice Masse UFO case, France 1965

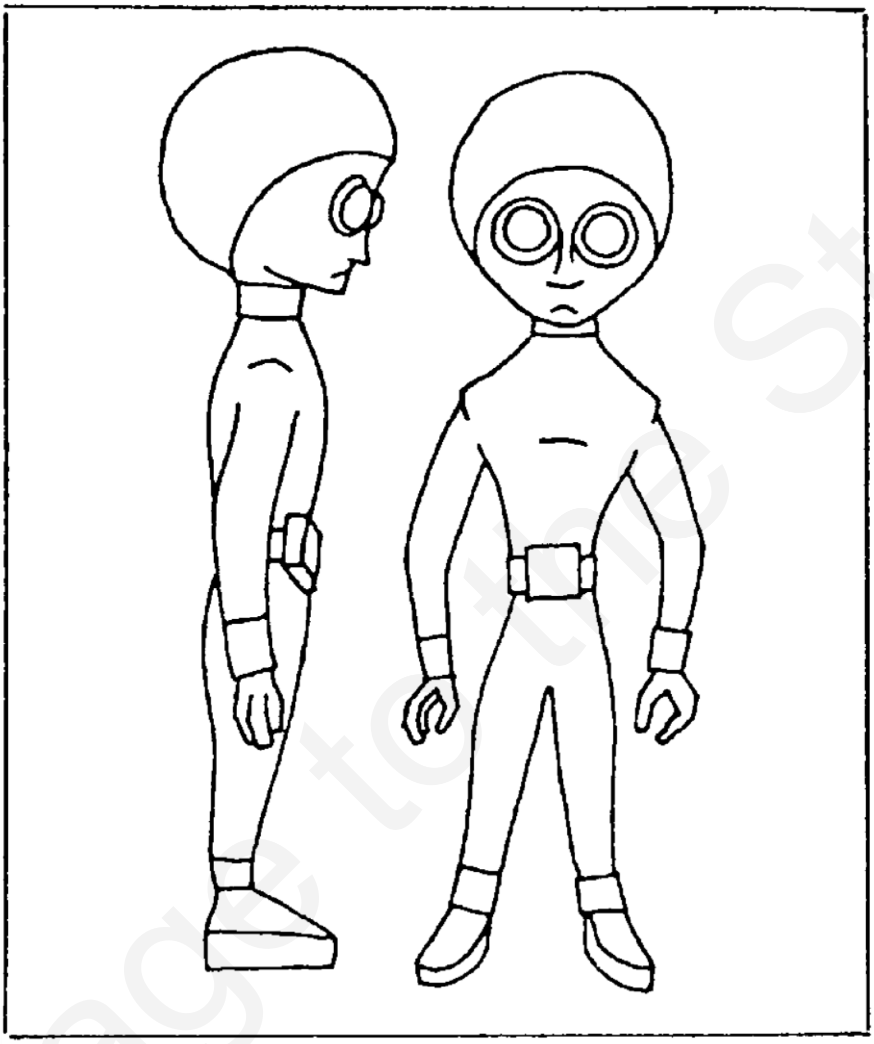


Maurice Masse case, France 1965

Hypothesis: Evolution from an octopus to an intelligent being?

Intelligent octopus-like ET?

Hypothetical consideration amd question: If the brain of an octopus were replaced by the brain of a human, do you think it would develop technology, rockets, spaceships and go to space to other planets and stars?



What some people say they have observed near a landed UFO: Small human like creatures, with a height of an 8-year old human, with big heads, two to three times bigger than a human head, big eyes and a uniform. Is carbon based life – similar to human life – a prevalent occurrence in the Universe? Does this support Dr. Moreno's hypothesis of evolutionary convergence? Credit: Reference: Sketch from the Humanoids, by Charles Bowen.

Subjects and questions for discussion in class:

1. Analysis of the ethical evolution of the human society.

   How people have treated the lower species, animals, since 1900 until now.

   Today we have new laws that protect animals. Expected ethical evolution and extrapolation to 1000 years from now. Implications for the ethics of a visiting alien civilization.

   Do we have a right to experiment with lower species?

   The selective principle of non-interference. Examples.

2. How have humans treated other more primitive human societies?

   The case of the European conquistadors and the Native Americans.

   Levels of technology and power. Impact on the lower civilization.

   The process of colonization of the West. The displacement of Native Americans.

   Interspecies effects

3. What would happen if a different species, an ET civilization were to interact with the human civilization and they represent a more developed technology? What can we expect?
4. Chimpanzees have an estimated 1.0% difference of DNA with humans.

   What if an advanced space ET species has a 1.0% improved DNA difference with respect to humans? How would they treat humans?

   Will they have a right to experiment with us in a manner similar to how we assign ourselves the right to experiment with lower species here on Earth?

   What do you think?

Interaction with ET: So far, we have two schools of thought:

1. That it is ok to send information to outer space, radio waves, discs with the Voyager spacecraft, etc.

   Indicating our location in the galaxy and information about us.

2. That it is not ok to send anything and have a low profile until we know the intentions of the ETs.

   Friend or foe?

   Which school of thought do you identify with?

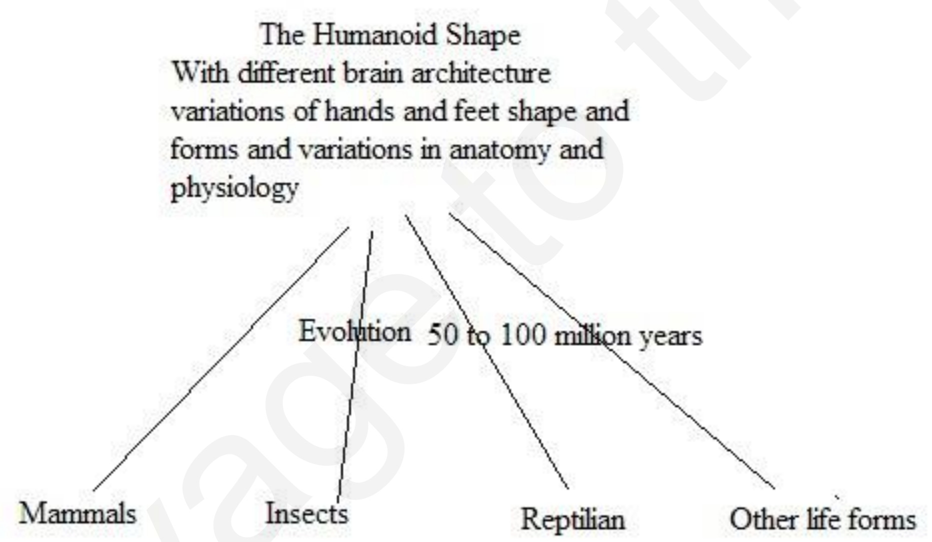
Concept:

Dr. Moreno's Hypothesis

Convergent Evolution

Or evolutionary Convergence

Universe's Convergence to the humanoid shape.



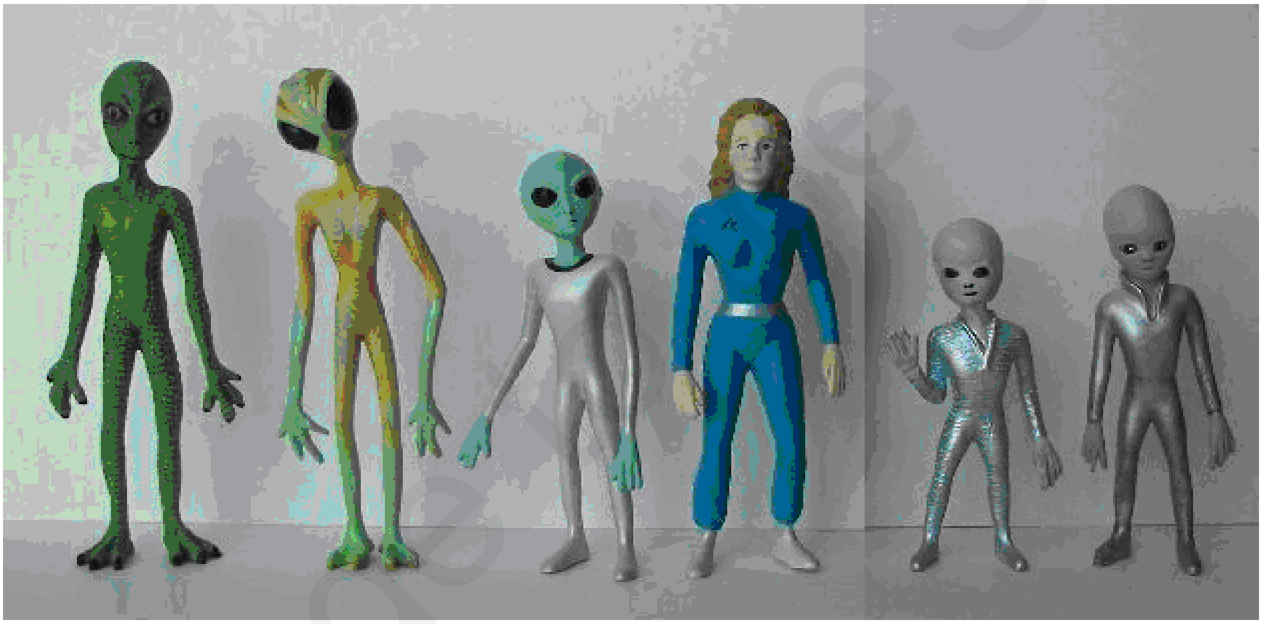
The laws of Physics and the human height and shape.

Energy balance. Heat production and heat loss:

The ratio of heat loss to heat production, inversely proportional to the average human body dimension, 1/D.

What would the ET's look like?

Speculation, analysis: Potential evolutionary candidates? Which one is more likely?



Analysis and reflections:

We have seen that the standard methods described in the previous sections SETI, Laser Method, robots on Mars, the Kepler Telescope mission, etc. have not produced any evidence of the existence of ET so far, whether it is microbial life or evolved intelligent life.

Now, I invite you to use a new and separate method of search for ET. To apply science and examine the evidence for UFOS. Keep in mind that there are people who have not looked at the evidence, yet they have an opinion about UFOs. We need to apply science and objectively study the evidence for each case.

The only evidence there is today of any suggested ET technology is provided by the observation of the technology of UFOs by reliable multiple witnesses, i.e., military commanders and officers, multiple police officers, engineers, and other professionals, people from all parts of the world. Please see examine the evidence below and develop your own opinion.

Method 14. The scientific study of UFOS. Results. This is the only effort that has produced results that suggest the presence of technologies from and advanced ET civilization.

Another Search for ET Method: Another way to look for possible evidence of a possible extraterrestrial technological civilization is **by considering the facts and doing a scientific study and analysis of the UFO Phenomenon.** The study of UFO cases with Physical evidence, and involving multiple, highly reliable witnesses. We will also examine this approach as part of the overview of the subject of possible life in the Universe.

I consider the following to be some of the best cases to analyze and I ask you to develop

your own opinion on the subject.

The basic question I present here, and that this section tries to address, is the following:

The key question to investigate is the following:

Are <u>some</u> UFOS a manifestation, evidence, of ET's advanced Technology?

I would like you to review the facts, the observations, the data, and reach your own conclusion:

Please remember the following considerations:

Scientifically, you are not entitled to broadcast an opinion, unless you have reviewed the data and all the facts.

Dr. Miguel A. Moreno

Ridicule is not part of the Scientific Method

Professor Josef Allen Heynek

The evidence relevant to the ET Hypothesis: In the following sections, I have selected the cases I consider reliable due to the high reliability, such as the US Navy multiple observers and instrument data, the Deputy Commander of **a** joint British/American airbases, Bentwaters and Woodbridge, in the Rendlesham Forest in England**,** where nuclear weapons are stored. These high level military officers have gone through extensive background checks and Top Secret Clearance and the military system has placed nuclear weapons in their trust.
Other cases involve police officers and people whose communities hold them in high regard.

The ET hypothesis: Some UFOs are technologies from an advanced ET civilization.

Arthur C. Clark: "Any sufficiently advanced technology is indistinguishable from magic". Meaning their technology would appear as if it were magic to the lower level civilization.

In this context, I ask: Isn't this what is happening with the technical flight performance pf some UFOs?

Please see the description of "The Five Observables" that support this hypothesis, the ET Hypothesis

Dr. Moreno's method: If we demonstrate, based on actual measurements, that the observed technologies and measured technological flight performance are not human – based, are not available on Earth, then we can infer that they originate outside of the Earth, outside of the human experience, thus it becomes one important piece of evidence that supports the ET hypothesis.

Consider the following summary, based on actual measurements, by multiple, reliable military personnel:

https://www.history.com/news/ufo-sightings-speed-appearance-movement

Now, in this context, let's review and study the evidence.

The Evidence

1. **US Navy Encounter and other reliable witness cases.** Multiple sophisticated instruments measure the presence and performance of UFOs. Multiple reliable military witnesses**.**

https://www.youtube.com/watch?v=PRgoisHRmUE&feature=youtu.be

https://www.youtube.com/watch?v=fHwmWnY4P1w&feature=youtu.be

https://www.youtube.com/watch?v=VgziDyPSUog

https://www.youtube.com/watch?v=NTLSQCF6ohQ

https://www.youtube.com/watch?v=X7c6LMgr_N0

https://www.youtube.com/watch?v=rs5HeZ-mfUE

Case 2. Bentwaters – Woodbridge December 26, 1980.

Please see the following video testimony:

https://www.youtube.com/watch?v=x8DHDsweaWE

Please see below the written report from Air Force Base Commander Lieutenant Colonel Charles Halt.

(6109

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 81ST COMBAT SUPPORT GROUP (USAFE)
APO NEW YORK 09755

REPLY TO ATTN OF: CD

13 Jan 81

SUBJECT: Unexplained Lights

TO: RAF/CC

1. Early in the morning of 27 Dec 80 (approximately 0300L), two USAF security police patrolmen saw unusual lights outside the back gate at RAF Woodbridge. Thinking an aircraft might have crashed or been forced down, they called for permission to go outside the gate to investigate. The on-duty flight chief responded and allowed three patrolmen to proceed on foot. The individuals reported seeing a strange glowing object in the forest. The object was described as being metalic in appearance and triangular in shape, approximately two to three meters across the base and approximately two meters high. It illuminated the entire forest with a white light. The object itself had a pulsing red light on top and a bank(s) of blue lights underneath. The object was hovering or on legs. As the patrolmen approached the object, it maneuvered through the trees and disappeared. At this time the animals on a nearby farm went into a frenzy. The object was briefly sighted approximately an hour later near the back gate.

2. The next day, three depressions 1 1/2" deep and 7" in diameter were found where the object had been sighted on the ground. The following night (29 Dec 80) the area was checked for radiation. Beta/gamma readings of 0.1 milliroentgens were recorded with peak readings in the three depressions and near the center of the triangle formed by the depressions. A nearby tree had moderate (.05-.07) readings on the side of the tree toward the depressions.

3. Later in the night a red sun-like light was seen through the trees. It moved about and pulsed. At one point it appeared to throw off glowing particles and then broke into five separate white objects and then disappeared. Immediately thereafter, three star-like objects were noticed in the sky, two objects to the north and one to the south, all of which were about 10^{o} off the horizon. The objects moved rapidly in sharp angular movements and displayed red, green and blue lights. The objects to the north appeared to be elliptical through an 8-12 power lens. They then turned to full circles. The objects to the north remained in the sky for an hour or more. The object to the south was visible for two or three hours and beamed down a stream of light from time to time. Numerous individuals, including the undersigned, witnessed the activities in paragraphs 2 and 3.

CHARLES I. HALT, Lt Col, USAF
Deputy Base Commander

The Bentwaters Military case December 1980.

A military, multiple witness (86), a highly reliable case.

Please see military Commander Charles Halt's direct testimony at the National Press Club

http://www.youtube.com/watch?v=x8DHDsweaWE

See the testimony of Security officer James Penniston who says he actually saw the object at close range, a few meters, and inspected the object with his team of soldiers for 45 minutes.

In total more than 80 highly trained military personnel witnessed the UFO at Bentwaters first hand and saw it take off silently and then move away at extremely high speed, a technology they had never seen.

http://www.youtube.com/watch?v=mHwhmc2m-tQ&feature=related

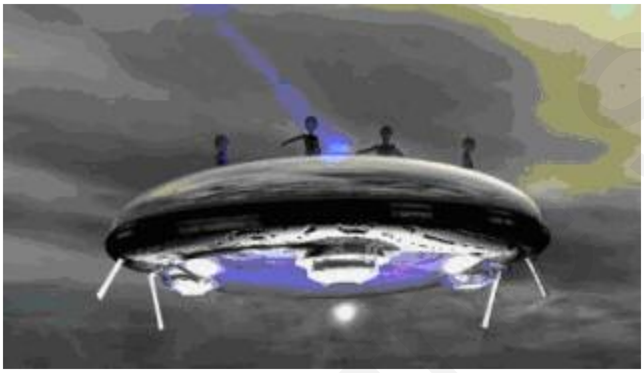
"The UFOs I saw were structured machines moving under intelligent control and operating beyond the realm of anything I have ever seen before or since," the Daily Star quoted Col Halt, now retired, as telling investigator Gary Heseltine.

Colonel Charles Halt, Base Commander.

Hear the tape recording of Colonel Halt in real time while making the observations at the site: http://www.youtube.com/watch?v=vaOz7xfAwBM

Case 3. The Fr. William Gill UFO Case, June 26, 1959

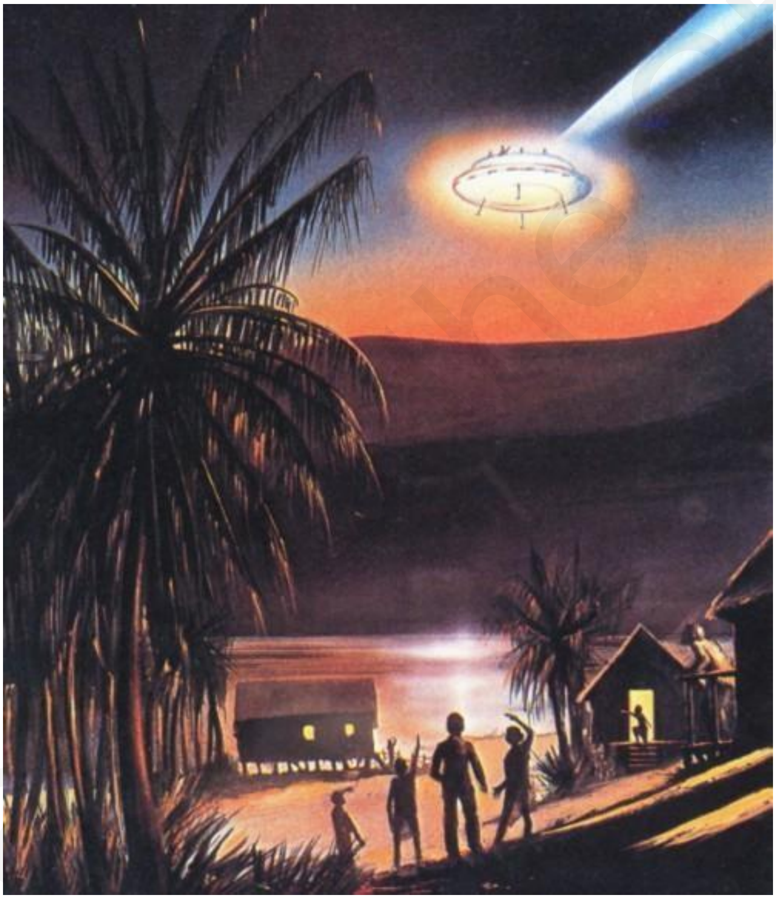
Please see: https://www.youtube.com/watch?v=ua8MmT4bIHU



The Boianai, Papua New Guinea, Visitors of the evening of June 26, 1959

Observations, by 38 witnesses

https://www.youtube.com/watch?v=ua8MmT4bIHU



The Boianai, Papua New Guinea, Visitors of the evening of June 26, 1959.
Artist's impression of the encounter by Australian missionary Father William Gill and 38 of his native parishioners. (Credit: Brooke Smith)

What constitutes proof?

Proof by technology analysis and comparison, with the most advanced Earthly technology at the time, and seven years later. My comparison is with the Apollo Lunar Lander spacecraft of 1967.

Neil Armstrong's accident: https://www.youtube.com/watch?v=OlJGQ92IgFk

It could only hover for six minutes – Compare that with more than 3 hours for three nights on a row of the case 2 UFO

Case 4. Trumbull County Police officers. Ohio.

https://www.youtube.com/watch?v=MZxnNRFRnWg

https://www.youtube.com/watch?v=o3wlS9yvnbI

Case 5. The Westfall case, 1966.

Description: http://en.wikipedia.org/wiki/Westall_UFO

https://www.youtube.com/watch?v=o1CBouzER5o

Case 6. Malmstrom AFB Case

Another important military case:

Please also see the separate case of direct testimony of

Captain Robert Salas, missile silo commander

http://bestevidence.blogspot.com/

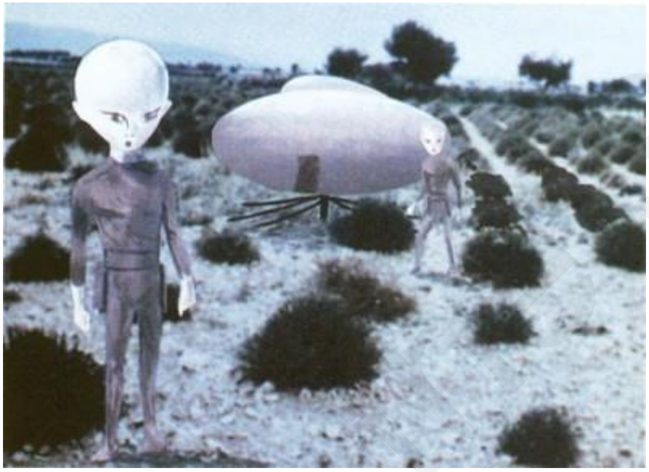
Case 7. Police Officer Lonie Zamora UFO case

http://www.youtube.com/watch?v=2m-g61zJ6I8

Case 8. The Maurice Masse case. France, July 1, 1965

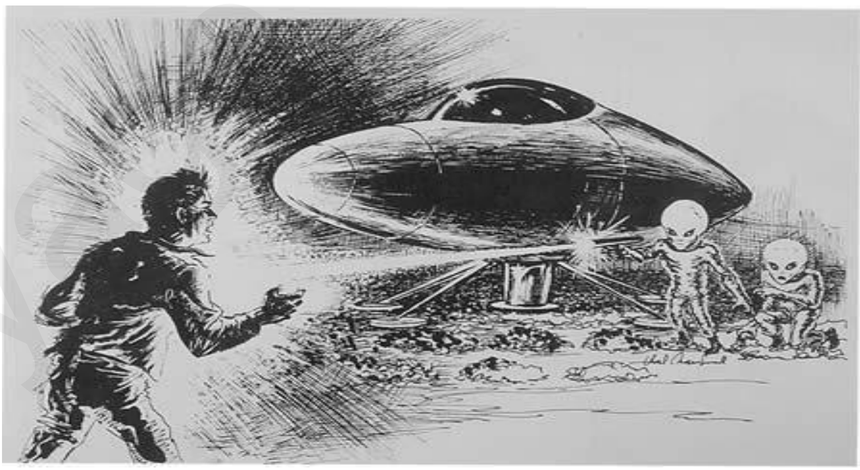
http://www.ufoevidence.org/cases/case140.htm

http://www.ufoevidence.org/Cases/CaseSubarticle.asp?ID=141



What Mr. Maurice masse Said he observed at close range, a distance of approximately 20 feet.

Two four feet tall aliens, with big heads, two to three times the size of a human head, slanted big eyes, a small mouth and wearing a uniform.



Mr. Masse said that one of the aliens took a small device from a side holster and aimed it at him and a light came from the device that paralyzed him at a distance of 20 feet. He was awake and saw how the aliens picked up samples from the ground and went into the spacecraft and then it flew away. He recovered his mobility in about 15 minutes afterwards.

Evidence that supports Dr. Moreno's Evolutionary Convergence hypothesis?

Case 9. The Colares Island case – Brazil 1977.

http://www.youtube.com/watch?v=GP8H1jauuBw

http://www.youtube.com/watch?v=YOjUO1N3qfk

Case 10. Japan Airlines flight 1628 over Alaska.

http://www.youtube.com/watch?v=1vpjP6Ygr2g

Case 11. Military. The Coyne UFO incident. Military case.

http://www.youtube.com/watch?v=4uxF9tRPIhM

https://www.ufoinsight.com/the-1973-mansfield-coyne-helicopter-ufo-incident/

Case 12. A series of cases. Title: Close encounters – The Science Channel. It presents some of the best cases at close range. In one case a Biochemist in France sees a UFO land on the backyard of his house and he approached it to within one yard.
Please go to the following web site and watch short videos describing each close encounter case. http://www.sciencechannel.com/tv-shows/close-encounters.

Case 13. Kelly Kentucky case, August 21, 1955.

http://www.youtube.com/watch?v=IeQPIs96Kak

http://www.youtube.com/watch?v=JlGrb74APy4

Six minutes the daughter of a direct witness Lucky Sutton,

describes it Kelly Kentucky UFO Incident August 1955

http://www.youtube.com/watch?v=JlGrb74APy4

http://www.youtube.com/watch?v=8dY5OlljKvw

Kelly Kentucky case August 21 1955

44 minutes

http://www.youtube.com/watch?v=quEcCvUPd7k

14. **The Kelly Johnson UFPO Case, December 16, 1953.**
Additional Evidence: See also, the Kelly Johnson UFO case. Kelly Johnson was the designed of the U- 2 and the SR-72 Spy planes.

https://www.youtube.com/watch?v=cX-IITRsqtU

15.The Stefan Michalak UFO case, near Falcon Lake Canada.

Falcon Lake UFO Lecture, November 7, 2019

The Falcon Lake UFO Files Talk by renowned Canadian Ufologist, Chris Rutkowski. Also featuring Stan Michalak, son of Stefan Michalak.

https://www.youtube.com/watch?v=dmc4nYKUBKM

References

Important please read the following reliable sources

1. **Unconventional flying objects. A Scientific study. A former NASA Scientist explains how UFOS really work**

2. **The COMETA report**

   http://www.ufoevidence.org/newsite/files/COMETA_part1.pdf

   http://www.ufoevidence.org/newsite/files/COMETA_part2.pdf

3. **UFOLOGY by James McCampbell**

   http://www.noufors.com/Documents/Books,%20Manuals%20and%20Published%20Papers/Books%2 0in%20PDF%20Format/UFOLOGY.pdf

   http://www.tarrdaniel.com/documents/Ufology/ufology2.html

4. **The Humanoids by Charles Bowen**

   http://www.slideshare.net/DirkTheDaring11/charles-bowen-ed-the- humanoids

Assignments

1. After considering each case above write a one - page report with your own opinion about the subject of UFOs.
2. Try to answer the question: Are we alone in the Universe?

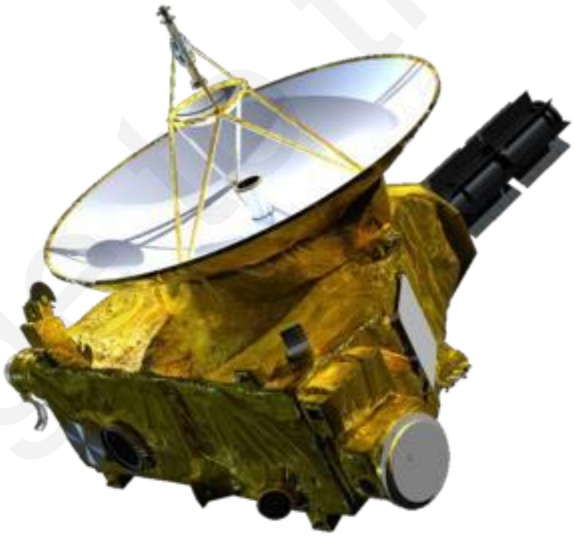
Update

Discoveries about Pluto and the Dwarf Planets

The New Horizons Spacecraft Mission

Planet Pluto

The New Horizons Spacecraft Mission



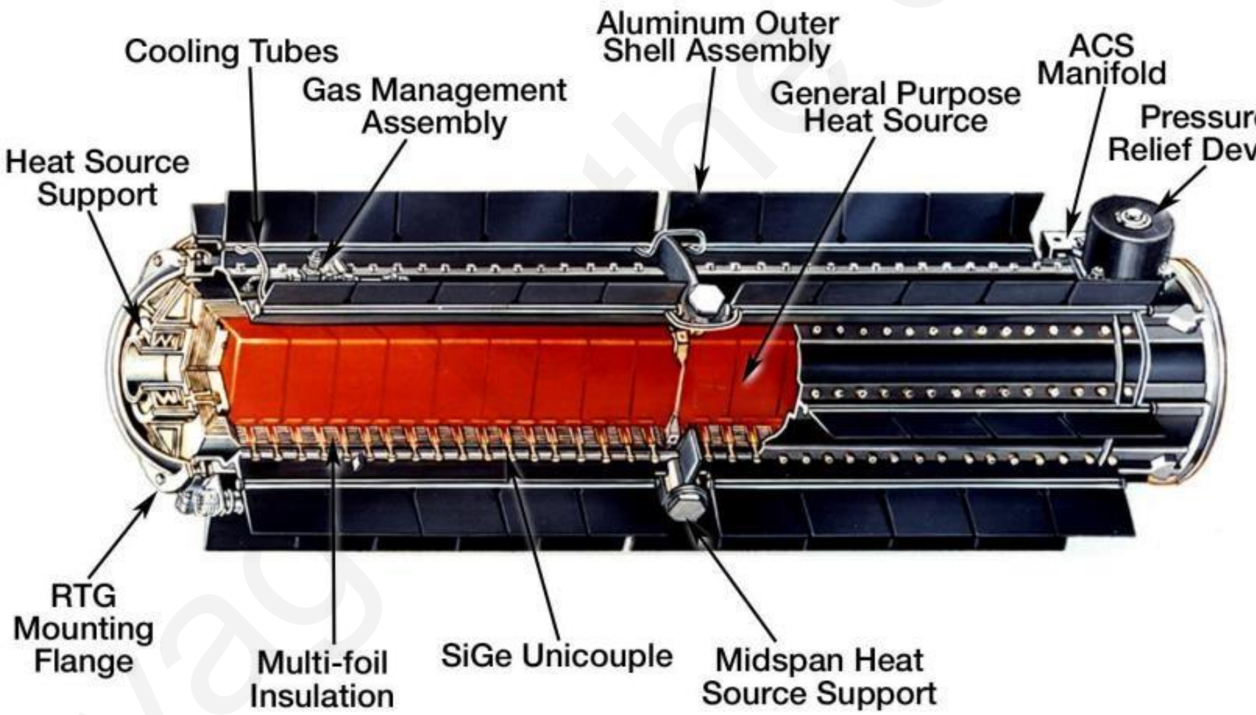
Launch of New Horizons Spacecraft

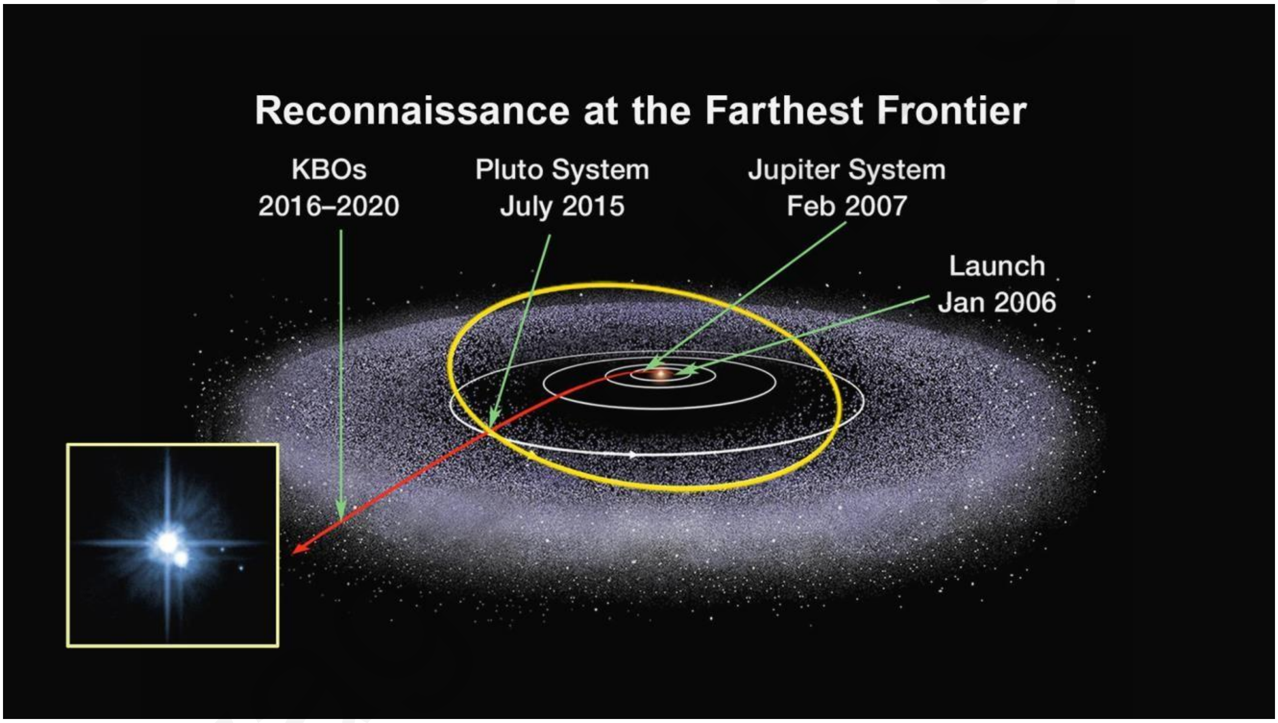
January 19, 2006. It took 10 years to reach the planet, Pluto.

Internal Power Generator RTG

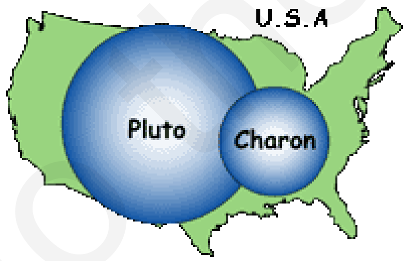
24 pounds of plutonium

A system of thermocouples
The Seebek Effect

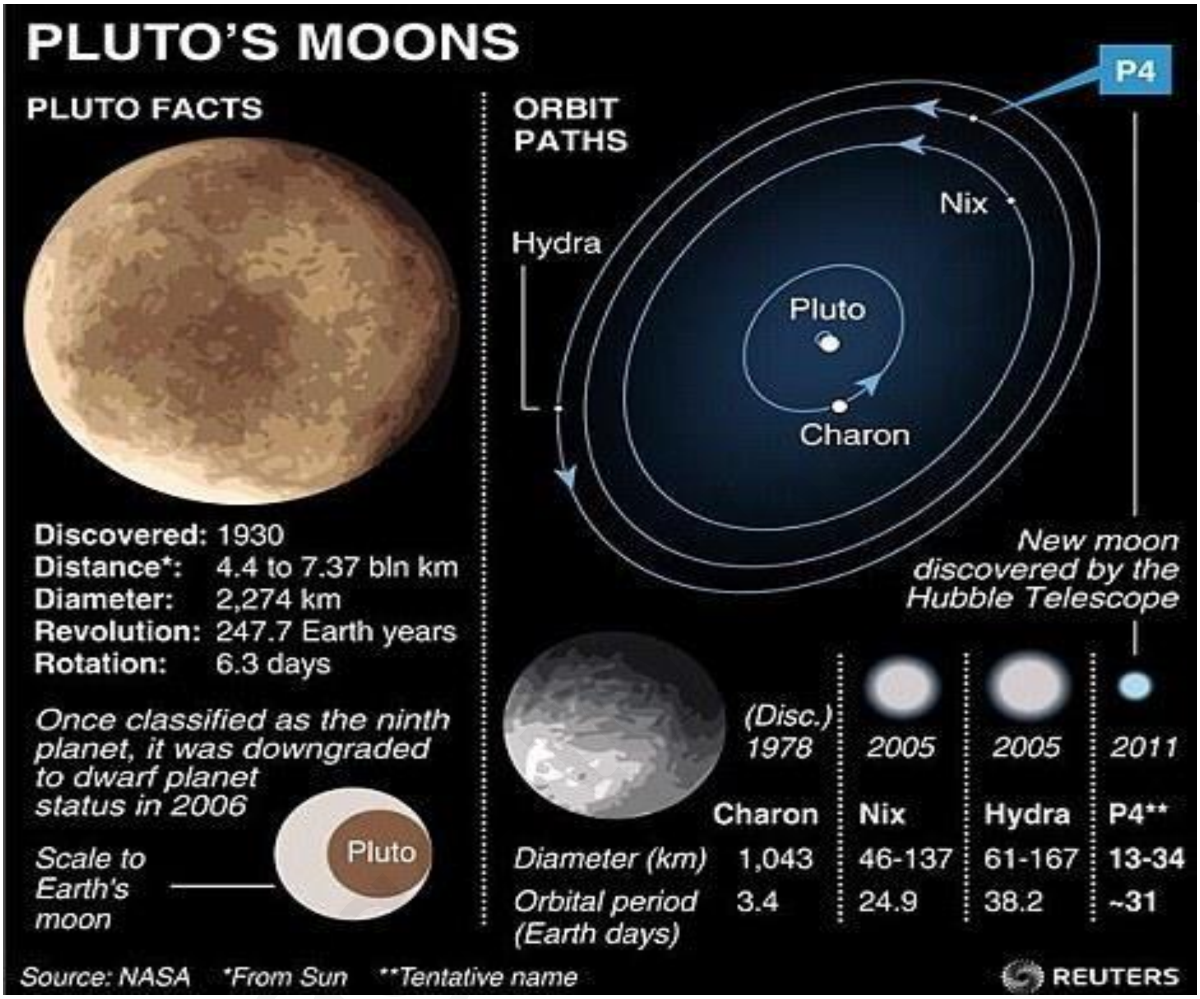




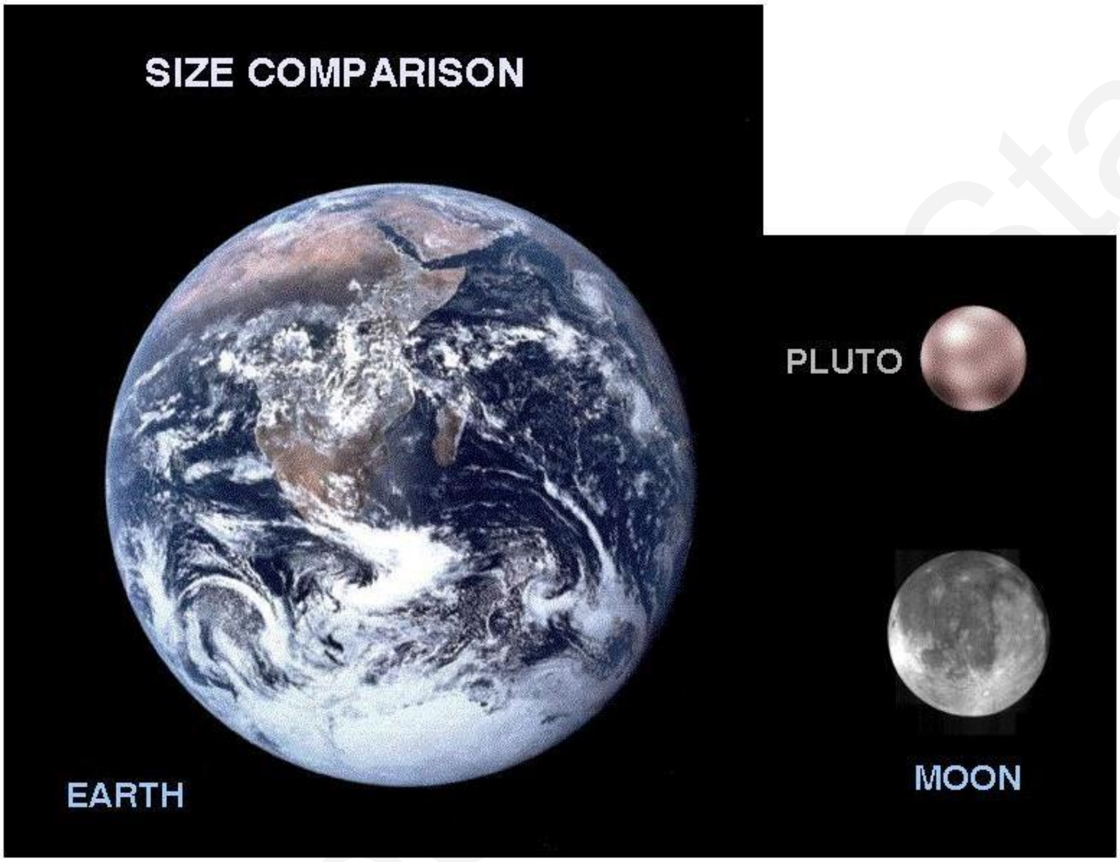
New Horizons Spacecraft Trajectory. Credit NASA.

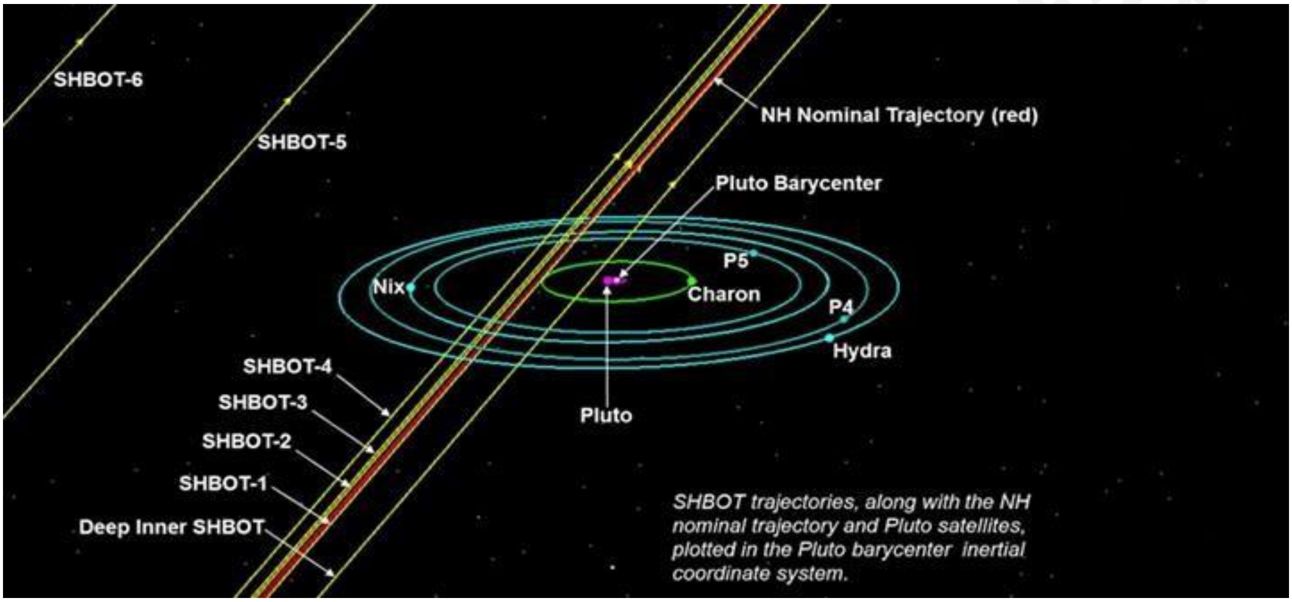


Pluto and its largest moon Charon compared to the size of the US



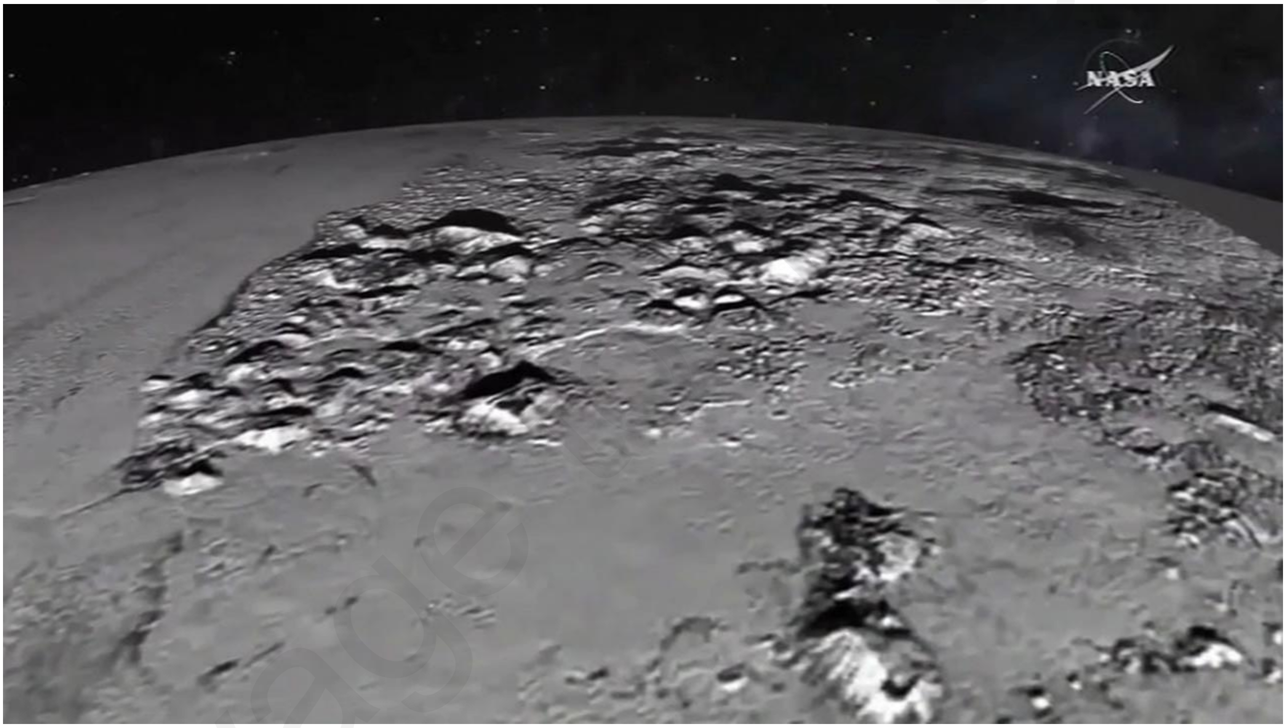
Pluto's system. The Planet and its five moons.


SIZE COMPARISON
PLUTO
EARTH
MOON

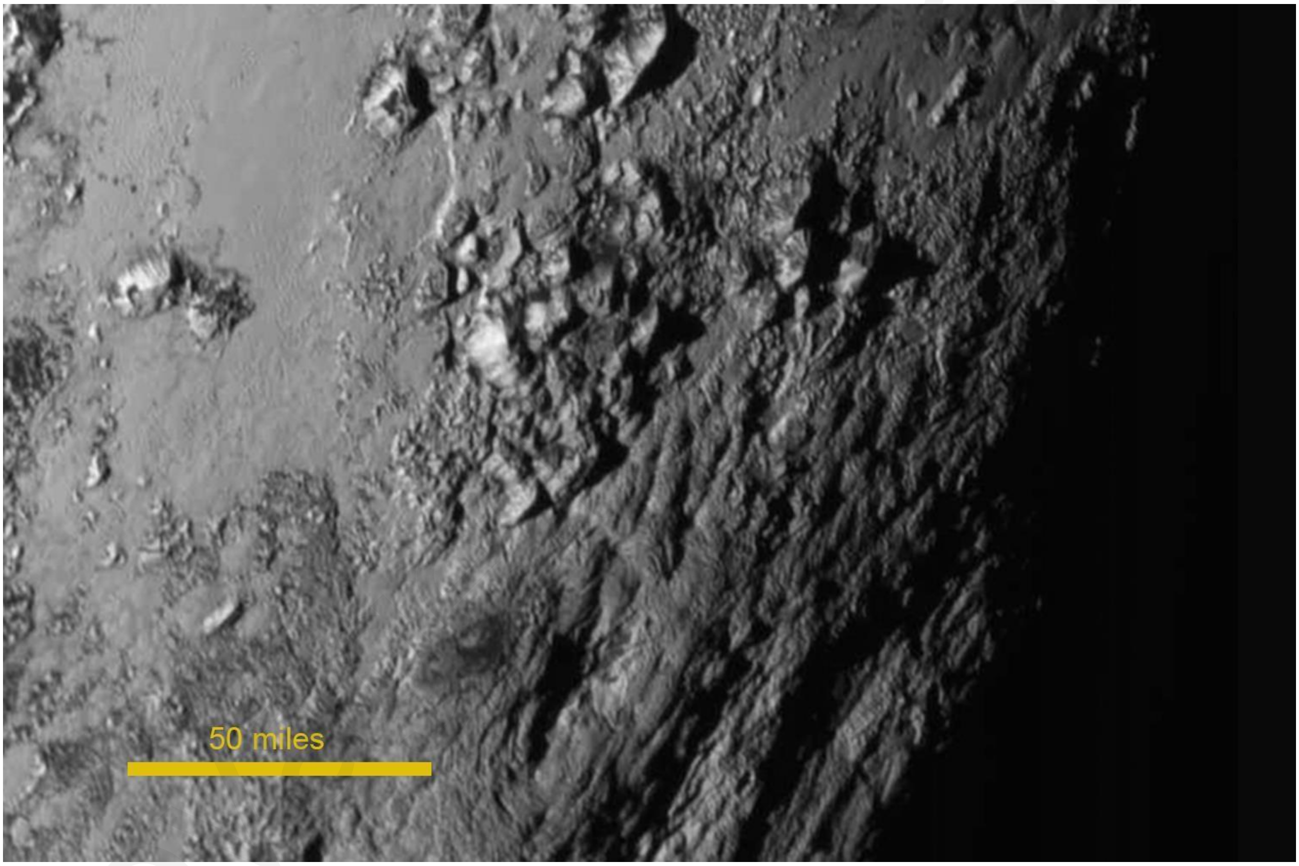


Credit: NASA

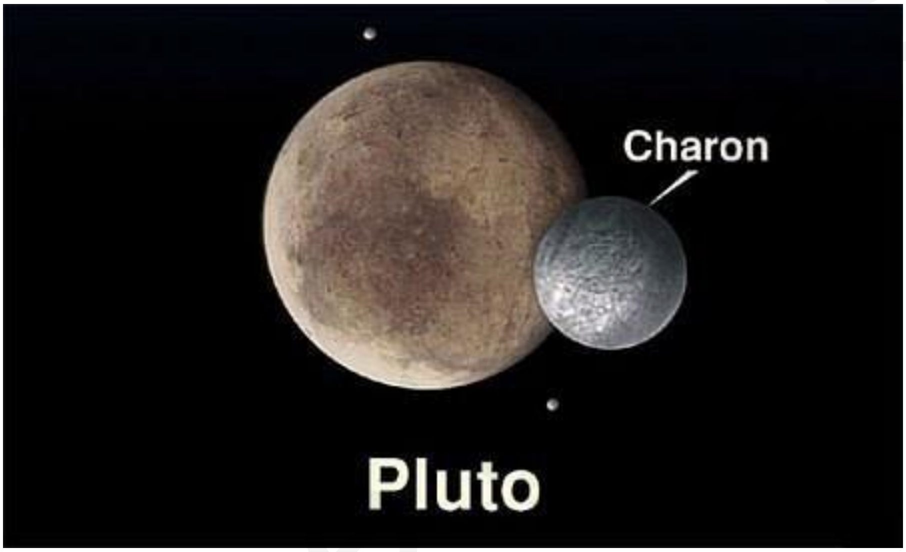
Spacecraft trajectory through Pluto's system. Planet and five moons.



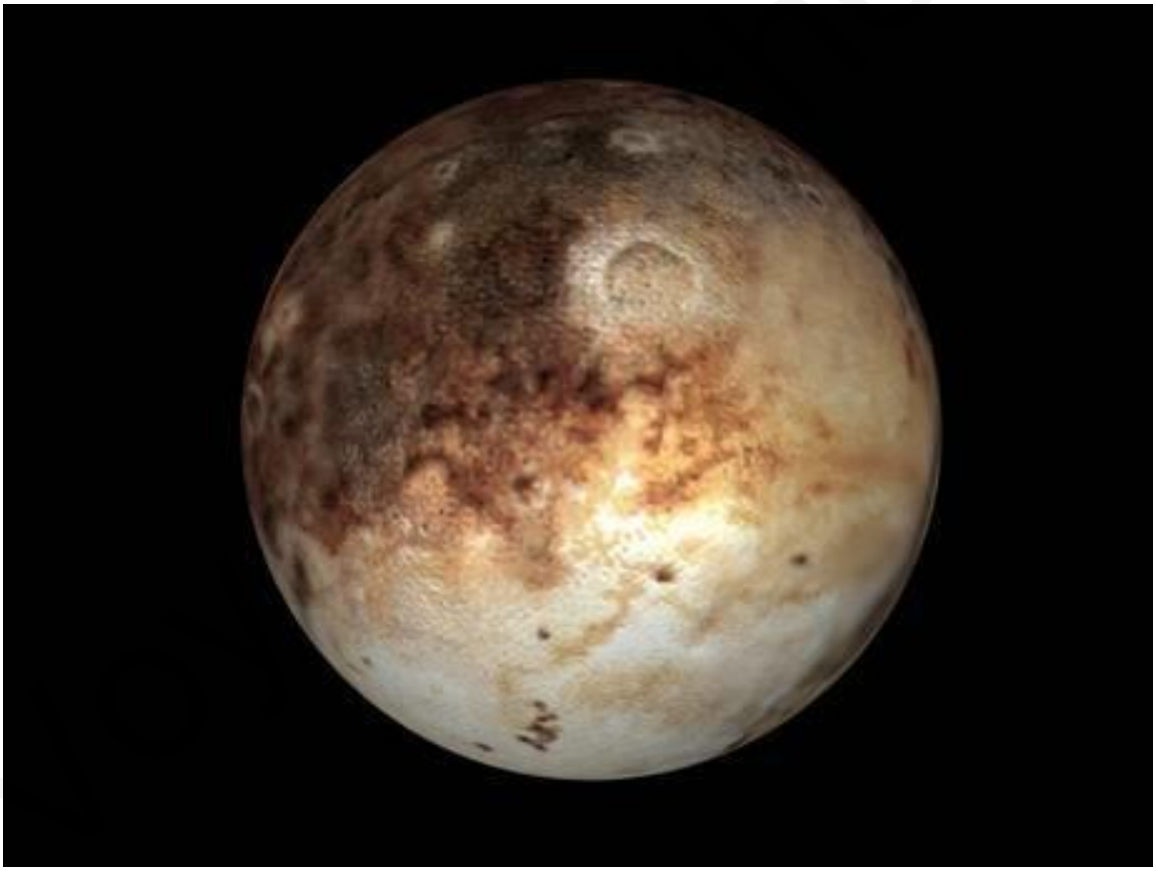
HD Image. Pluto's icy Mountains



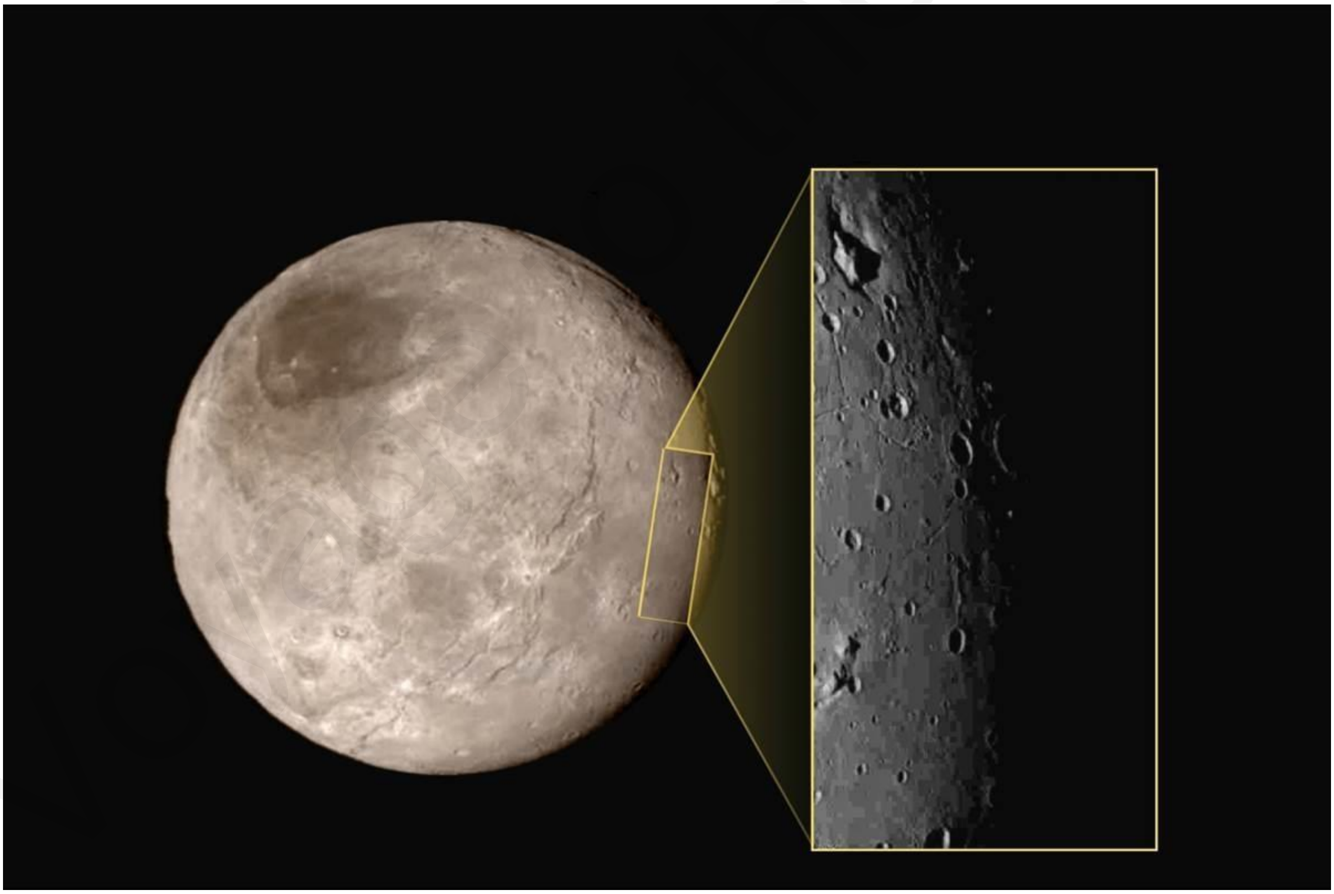
Mountain region with heights of up to 3,500 meters.(11,000 feet).



NASA images. Pluto and its moon Charon.



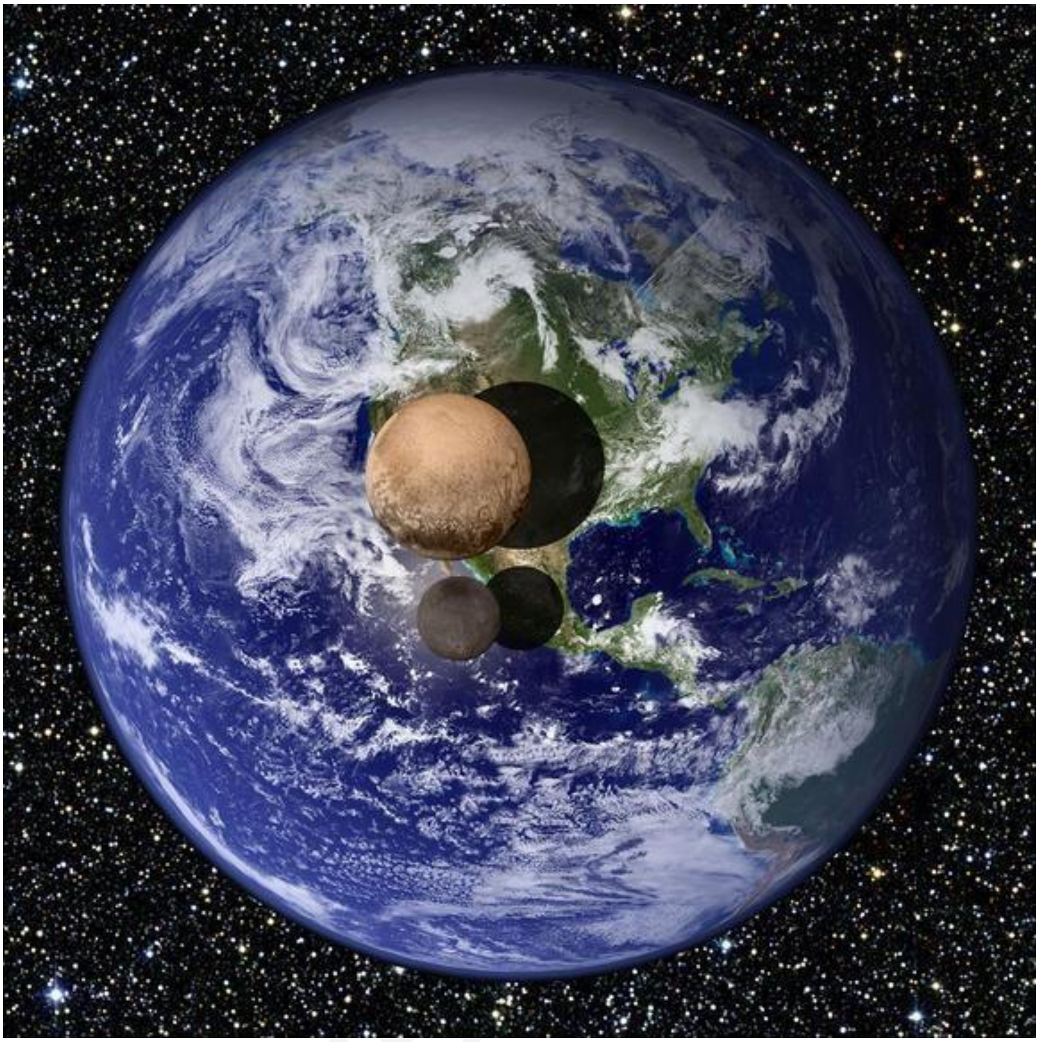
New Horizon’s image of Charon, the largest moon of Pluto



Enhanced image of Charon, a moon of Pluto


Concept of the view of Charon from the surface of Pluto. NASA.

Pluto and its largest moon, Charon. A comparison to the size of the Earth.



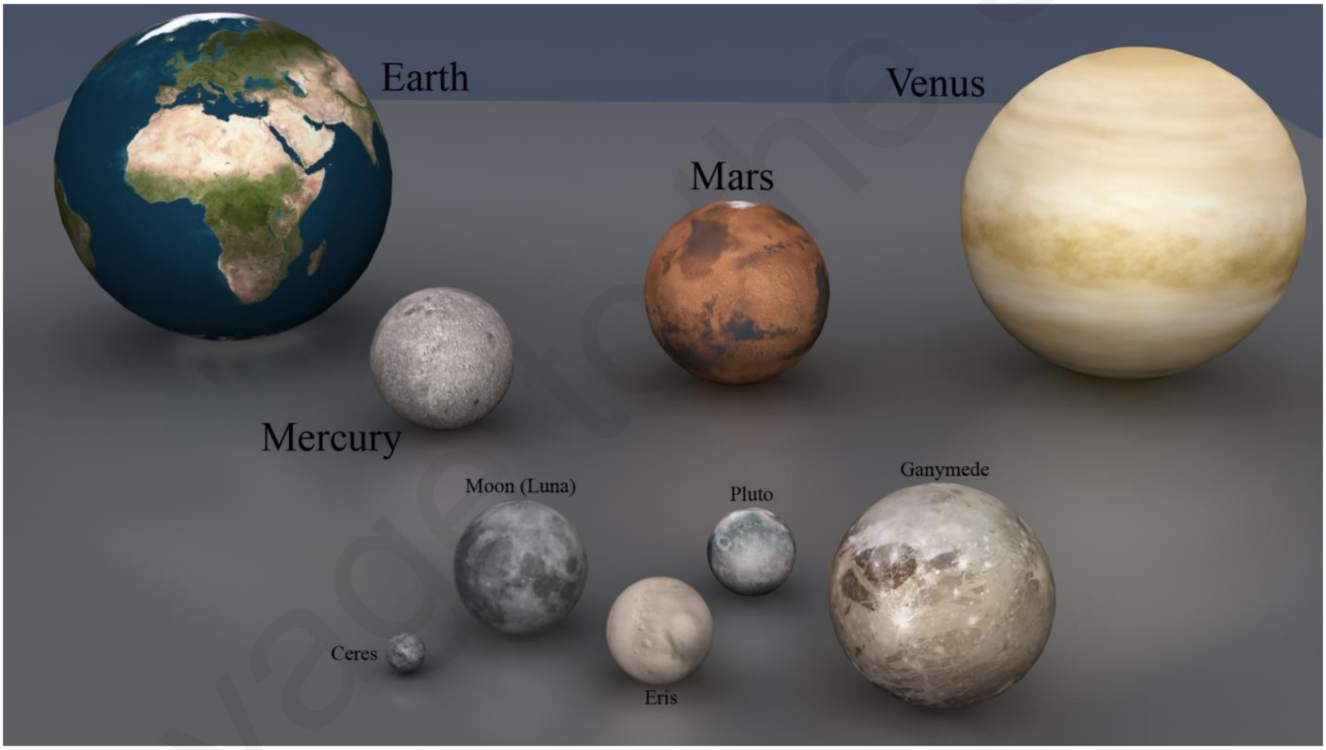
Relative size and Temperature

When Pluto is closest to the Sun in its orbit, the surface temperature is 369 Fahrenheit Below zero (-223 C). At its farthest point from the Sun, its temperature is minus 387 F (-233C). Its atmosphere made mostly of Methane freezes to its surface.

A Planetary Comparison

Dwarf Planets (5)

Ceres (Located in the Asteroid Belt, between Mars and Jupiter)
Located beyond the orbit of Neptune: Pluto, Quaoar, Sedna, Haumea, Makemake, and Eris. Ceres, Pluto, Eris, Makemake and Haumea.



A Comparison. Planets: Mercury, Venus, Earth andMars. Dwarf planets: Pluto,Ceres and Eris. Moons:

Earth’s Moon, Jupiter’s Moon Ganymede,

What is a Planet?

The **definition of *planet*** set in Prague in 2006 by the International Astronomical Union (IAU) states that, in the Solar System:

A planet is a celestial body which:

1. **is in orbit around the Sun,**
2. **has sufficient mass to assume hydrostatic equilibrium (a nearly round shape), and**
3. **has "cleared the neighbourhood" around its orbit.**

A non-satellite body fulfilling only the first two of these criteria is classified as a "dwarf planet". According to the IAU, "planets and dwarf planets are two distinct classes of objects". A non-satellite body fulfilling only the first criterion is termed a "small Solar System body" (SSSB). Initial drafts planned to include dwarf planets as a subcategory of planets, but because this could potentially have led to the addition of several dozens of planets into the Solar System, this draft was eventually dropped. The definition was a controversial one and has drawn both support and criticism from different astronomers, but has remained in use.

What is a Dwarf planet?

In 2006, a new and distinct class of celestial objects was named by the International Astronomical Union

(IAU). They were called “dwarf planets.” According to the IAU,

A Dwarf Planet is a celestial body that exhibits the following characteristics:

1. **It is in orbit around <u>the Sun</u>**
2. **It has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape**
3. **It has not cleared the neighborhood around its orbit; and 4. It is not a satellite (a moon)**

This definition of a dwarf planet differentiates it from a planet on two criteria: unlike the dwarf planet, a planet has cleared the neighborhood around its orbit, and the definition of a planet does not include the satellite distinction.

Planets - Data Table

Dwarf Planets are listed in a separate table below.

	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
diameter (Earth=1)	0.382	0.949	1	0.532	11.209	9.44	4.007	3.883
diameter (km)	4,878	12,104	12,756	6,787	142,800	120,000	51,118	49,528
mass (Earth=1)	0.055	0.815	1	0.107	318	95	15	17
mean distance from Sun(AU)	0.39	0.72	1	1.52	5.20	9.54	19.18	30.06
orbital period (Earth years)	0.24	0.62	1	1.88	11.86	29.46	84.01	164.8
orbital eccentricity	0.2056	0.0068	0.0167	0.0934	0.0483	0.0560	0.0461	0.0097
mean orbital velocity(km/sec)	47.89	35.03	29.79	24.13	13.06	9.64	6.81	5.43
rotation period (in Earth days)	58.65	-243*	1	1.03	0.41	0.44	-0.72*	0.72
inclination of axis (degrees)	0.0	177.4	23.45	23.98	3.08	26.73	97.92	28.8
mean temperature at surface (C)	-180 to 430	465	-89 to 58	-82 to 0	-150	-170	-200	-210
gravity at equator (Earth=1)	0.38	0.9	1	0.38	2.64	0.93	0.89	1.12
escape velocity (km/sec)	4.25	10.36	11.18	5.02	59.54	35.49	21.29	23.71
mean density (water=1)	5.43	5.25	5.52	3.93	1.33	0.71	1.24	1.67
atmospheric composition	none	CO_2	N_2 + O_2	CO_2	H_2+He	H_2+He	H_2+He	H_2+He
number of moons	0	0	1	2	63	62	27	13
rings?	no	no	no	no	yes	yes	yes	yes

Dwarf Planets (5)

	Ceres	Pluto	Haumea	Makemake	Eris
diameter (Earth=1)	0.076	0.180	0.110 (average)	0.102-0.149	0.188-0.235
diameter (km)	974.6	2,300	1,960 x 1,518 x 996 (ellipsoid)	1,300-1,900	2,400-3,000
mass (Earth=1)	0.00016	0.002	0.00070	0.00067	0.0028
mean distance from Sun (AU)	2.76596	39.44	43.335	45.791	67.6681
orbital period (Earth years)	4.599	247.7	285.4	309.88	557
orbital eccentricity	0.07976	0.2482	0.18874	0.159	0.44177
mean orbital velocity (km/sec)	17.882	4.74	4.484	4.419	3.436
rotation period (in Earth days)	0.378	-6.38*	0.163	?	> 8 hrs ?
inclination of axis (degrees)	3	122	?	?	?
mean temperature at surface (°C)	-106	-220	-223	-240	-230
gravity at equator (Earth=1)	0.028	0.06	0.045	0.051	0.082
escape velocity (km/sec)	0.51	1.27	0.84	0.8	1.31
mean density (water=1)	2.077	2.03	2.6-3.3	2	1.18-2.31
atmospheric composition	none	CH_4	none?	maybe CH_4	maybe CH_4
number of moons	0	5	2	0	1
rings?	no	no	no	no	no

* Negative values of rotation period indicate that the planet rotates in the direction opposite to that in which it orbits the Sun. called retrograde rotation.

The eccentricity (e) is a number which measures how elliptical orbits are. If e=0, the orbit is a circle. All the planets have eccentricities close to 0, so they must have orbits which are nearly circular. Except Mercury (plane) Pluto and Eris (Dwarf Planets).

APPENDIX

Planetaria in Los Angeles

UCLA Planetarium
UCLA, Physics/Astronomy Div.
405 Hilgard Ave.
Los Angeles, CA 90095
25 seats
Goto GX-10 star projector installed 1972
phone: 310-825-4434 E-mail: **liles@astro.ucla.edu**

Drescher Planetarium Santa Monica College
1900 Pico Blvd.
Santa Monica, CA 90405
28 foot dome - 56 seats
Evans & Sutherland Digistar II projector installed 1997
phone: 310-434-4223 E-mail: **jhodge@smc.edu**

<u>El Camino College Planetarium</u> 16007
Crenshaw Blvd.
Torrance, CA 90506
30 foot dome - 77 seats
Spitz A4 star projector installed 1969 phone: 310-660-3373
E-mail: **<u>jladerman@elcamino.edu</u>**

<u>Griffith Observatory Satellite Facility</u> - NOW OPEN
4800 Western Heritage Way (near Los Angeles Zoo & Gene Autry Western Museum)
Los Angeles, CA 90027
phone: 213-664-1181
taped information line: 323-664-1191

<u>Los Angeles Valley College Planetarium</u> 5800 Fulton Ave.
Van Nuys, CA 91401
24 foot dome - 45 seats
Spitz A3P star projector installed 1965 phone: 818-778-0335 ext. 335
Email: **<u>http://www.smc.edu/planetarium/falkdj@laccd.edu</u>**

Los Angeles Harbor College Planetarium
1111 S. Figueroa Place
Wilmington, CA 90744
33 foot dome - 40 seats
Spitz A4 star projector installed 1968 phone: 310-522-8231

Beattie
Planetarium
San
Bernadino
Valley
College 701
S. Mount
Vernon Ave.
San Bernardino, CA 92410
33 foot dome - 62 seats
Goto GX-10 star
projector installed 1979
phone: 909-888-6511
ext. 1458 E-mail:
bwilson@sbccd.cc.ca.us

Brackett Obs. &
Millikan Planetarium
Pomona College 610 N.
College Ave.
Claremont, CA 91711
20 foot dome - 45
seats Goto GEII
star projector
phone: 909-621-
8724 E-mail:
bpenprase@po
mona.edu

Donald Bianchi Planetarium
California State University
Northridge, CA 91330
40 foot dome - 105 seats
Spitz 512 star projector installed 1992
phone: 818-677-5601

Reuben H. Fleet Space Theater
Balboa Park
P.O. Box 33303
San Diego, CA 92163
75 foot dome - 336 seats
Spitz STS star projector installed 1973 phone: 619-238-1233, ext. 810
E-mail: **mammana@rhfleet.org**

Glendale College Science Center Planetarium
1500 N. Verdugo Road Glendale, CA 91208
30 foot dome - 48 seats
Sky-Skan SkyVision High Definition Full Dome Video projector installed 2003 phone: 818-240-1000 x 5387

Griffith Observatory
currently closed for rennovation
800 E. Observatory Rd.
Los Angeles, CA 90027
75 foot dome - 600 seats
Zeiss IX star projector to be installed

Mt. San Antonio College Planetarium
1100 North Grand Ave. Walnut, CA 91789
35 foot dome - 100 seats Spitz A3P star projector installed 1968
phone: 909-594-5611 ext. 4704

Orange Coast College Planetarium 2701 Fairview Rd. Costa Mesa, CA 92628 24 foot dome - 51 seats
Viewlex Apollo star projector installed 1973
phone: 714-432-5880

Pasadena City College Planetarium 1370 East Colorado Blvd.
Pasadena, CA 91106
30 foot dome - 50 seats
Spitz A3P star projector installed 1964 phone: 626-585-7322
E-mail: **maito:/jpsepikas@paccd.cc.ca.us**

Riverside Community College Planetarium 4800 Magnolia Ave.
Riverside, CA 92506
24 foot dome - 50 seats
Spitz A4 star projector installed 1976 phone: 909-222-8515 E-mail: **sblair@rccd.cc.ca.us**

S.A.G.E. Planetarium
38060 20th St. East
Palmdale, CA 93550
40 foot dome - 120 seats
Spitz 512A star
projector installed
1997 phone: 661-273-
7646 E-mail:
jsamarant@psd.k12.
ca.us Santa Barbara
Museum and
Gladwin Planetarium
2559 Puesta del Sol
Rd.
Santa Barbara, CA 93105
24 foot dome - 60 seats
Spitz A3PR star projector installed 1977
phone: 805-682-3224
fax: 805-569-3170

Tessma
nn
Planet
arium
Santa
Ana
College
1530
W.
17th St.
Santa Ana, CA 92706
35 foot dome - 120 seats
Goto Chronos star projector installed 2003
phone: 714-564-6356

Victor Valley College
Planetarium 18422 Bear
Valley Rd.
Victorville, CA 92392-5849
30 foot dome - 70 seats
Zeiss ZPK3 Skymaster star
projector installed 1996 phone:
619-245-4271, ext. 324 E-mail:
sbryan@victor.cc.ca.us

Beverly Hills High School Planetarium
241 South Voreno Drive
Beverly Hills, CA 90212
30 foot dome - 80 seats
Spitz A4 star projector
installed 1969 phone: 310-
246-1914

OBSERVATORIES

UCLA
UCLA, Physics/Astronomy Div.
405 Hilgard Ave.
Los Angeles, CA 90095
25 seats
Goto GX-10 star
projector installed 1972
phone: 310-825-4434
E-mail:
liles@astro.ucla.edu

Big Bear Solar Observatory
40386
North Shore
Lane Big
Bear City,
CA 92314
phone: 909-
866-5791

Frank P. Brackett Observatory
Dept. of Physics and Astronomy
Pomona College
610 N. College Ave.,
Claremont, CA 91711 USA
909-621-8724
E-mail: **bpenprase@pomona.edu**

Garvey Ranch Observatory
Los Angeles
Astronomical
Society Garvey
Ranch Park 751
S. Orange Ave.
Monterey Park, CA
213-673-7355
E-mail: **Timothy.J.Thompson@jpl.nasa.gov**

Gordon D. Crowell
Observatory Rio
Hondo Community
College 3600
Workman Mill Rd.
Whittier, CA 90608
562-908-3566

Mount Wilson Observatory
Mt. Wilson Institute
P. O.
Box
1909
Atlanta,
GA
30301-
1909
phone: 404-651-2932

Palomar
Observatory
Palomar
Mountain, CA
92060.
E-mail: **palomar@caltech.edu**

San Fernando Observatory
Department of Physics and Astronomy
CSU Northridge
Northridge, CA
91330 phone:
818-367-9333 E-
mail:
physics@galileo.
csun.edu

Table Mountain Observatory
P.O. Box 367
Wrightwood, CA 92397
619-249-3551

Dr. Miguel Angel Moreno

A short biographical note

Dr. Miguel A. Moreno at the Griffith Observatory

Dr. Miguel A. Moreno, Ph.D.
Former NASA Scientist-Hubble Space Telescope
Atomic and Space Physicist
Professor of Physics, Engineering and Astronomy
Chief Sustainability Officer, Support Services of America, Inc.
Advisor New Silicon Technology Corporation
Former President ADM Solar Corporation
Chairman Science and Engineering Department at LATTC

Science and Technology: The key to your future

Dr. Moreno is an experienced and accomplished International scientist And Professor of Physics, Engineering and Astronomy and Environmental Science. He came to the US from Argentina at the early age of 18. He had already earned a degree in Engineering. He then attended UC Berkeley where he received his Bachelor's Degree in Physics. He subsequently attended a graduate program in Quantum Mechanics at Cal State Hayward.
Subsequently he attended UCLA, where he received his Master's Degree in Atomic Physics and which included projects on Material Science and semiconductors. He subsequently moved to the Earth and Space Science Department at UCLA, and after many years of hard work, he received his Ph.D. Degree in two separate areas, Space Physics and in Geophysics. He subsequently worked for NASA in the Galileo Mission and in the Hubble Space Telescope Mission as a Senior Scientist. Today we see the images from the camera of the Hubble Space. Telescope in every science textbook and in every library in the world. Dr. Moreno has numerous publications on Space Science.

Dr. Moreno has participated in many world conferences on space exploration representing NASA/JPL. He has received many awards including the Distinguished International Scientist and Educator Presidential Award by the President of Argentina. He was recognized at a session of the California Legislature and received a nomination for the National Medal of Science in the US. He has been selected as Person of the Year in a magazine and in a major Television network for his work on space exploration. He was the co-producer of six television programs on space exploration. He has also developed innovative technology programs in Microchip Manufacturing, Robotics, and Nuclear Medicine. He has served as the Director of Department of Energy grants and NASA grants. Dr. Moreno has dedicated significant effort to developing partnerships with UCLA and USC and NASA to develop collaborations and new technology programs. All these programs have been very successful. He has served NASA as the Director of the NASA-MSET Program. He has taught Physics, Astronomy and Engineering for 30 years. He is a Tenured Professor of Physics, and Astronomy at the USC - LATTC program. He serves as advisor to the President of Support Services of America, a very important corporation in all 50 states. Dr. Moreno is also a managing partner for a Solar Energy Company.

Dr. Moreno also advised the President of LATTC 2002-2005 on matters of science and technology education. He was dedicated to bring grants to integrate innovative technologies and research results to the college educational process and prepare students for the jobs of the future. His students have successfully transferred to technology programs at UCLA, UC Berkeley, USC, Stanford University, Boston University, and Oxford University. He helped one of his students go to Harvard University.

Dr. Moreno has developed and taught courses in the field of Nanotechnology.
He is also an expert on solar energy and solar Photovoltaic panels and their applications and has served as a consultant in several large projects and was selected as President of Innovative Green technologies and Solutions, a company that sells and installs solar photovoltaic panels to produce electricity from sun light. He is now the producer of a documentary on Space Exploration, to be viewed on cable television.
As part of a program his name as well as other Space Scientists names was sent by NASA to the planet Mars in the Mars 2020 mission, and to Jupiter in the Galileo Mission.

Dr. Moreno is also LEED Certified, a professional certification for Leadership in Energy and Environmental Design. He has also recently earned certification from NASA to work with rocks from the Moon.
He recently earned professional certification from the Building Performance Institute, BPI, as an Energy Analyst and Auditor for buildings and building complexes.

Dr. Moreno is widely recognized in scientific and technological journals and by the media in the US with major articles in the LA Times and Telemundo Television Network and popular magazines. He is dedicated to his wife, their daughter and their granddaughter and to service to the Church and the community.

Dr. Moreno can be reached at
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