

The Planets

Rocks and Circles

<http://www.harkenobservatory.com>

Written by Scott Berg with generous commentary from Bob Scofield and Brian Bednarek.

First presented on Thursday June 29, 2006 to the teen group led by librarian Jenny Wegener.

Followed by outside viewing of Saturn, Jupiter and Moon.

Planets

- Rocks – The Planets
- Size of Planets and Stars
- Circles – Orbits & Solar System
- The Observatory

Planets

- There is no definition of "planet" agreed to by professional astronomers. A non-technical definition is:
 - **A big bunch of stuff circling around a star.**
- "Planet" is from the Greek word πλανήτης (planētēs) meaning "wanderer". Ancient sky watchers saw some points of light (planets) moving around compared to other points (stars).

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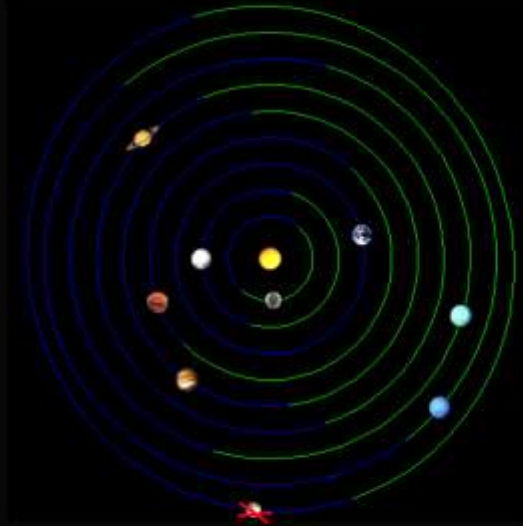
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"Stuff" will be discussed later. Earth, Mars, etc. are rock. Jupiter, Saturn, etc. are gas balls, like the sun but without the nuclear fusion. The formal term for this collection of matter is "accretion".

Solar System October 7, 2006

- Sun
- Mercury
- Venus
- Earth
- Mars
- Jupiter
- Saturn
- Uranus
- Neptune
- ~~Pluto~~

Positions correct
Not to scale



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<http://www.fourmilab.ch/solar/solar.html>

Sun – Mercury, Venus, Earth, Mars

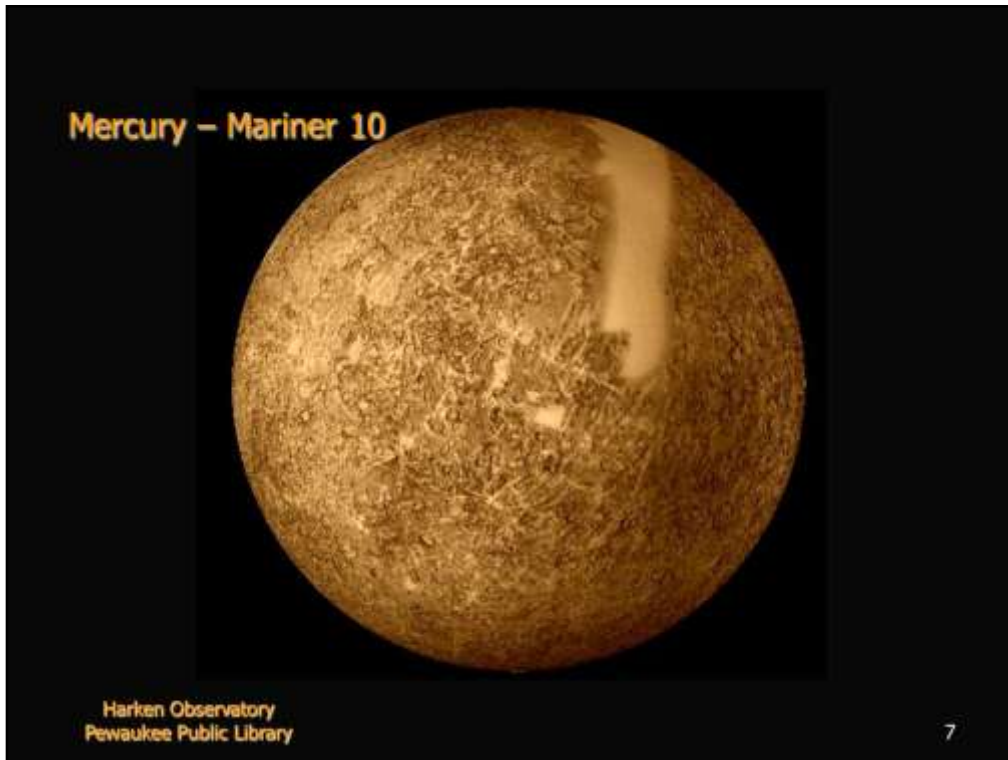


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Mercury ☿

Distance from Sun	36,000,000 miles (0.4 AU)
Diameter	3,030 miles (0.4x Earth)
# Moons	none
Day / Year	4,222 hours (176 days) / 88 days
Makeup	Rock with iron
Discovered	Ancient times
Description	800° F - Really hot!



<http://antwrp.gsfc.nasa.gov/apod/ap011124.html>

Explanation: [Mercury](#), the closest planet to the Sun, remains [the most mysterious](#) of the Solar System's inner planets. Hiding in the [Sun's glare](#) it is [a difficult target](#) for Earth bound observers. The only spacecraft to [explore Mercury](#) close-up was [Mariner 10](#) which executed three [flybys of](#) Mercury in 1974 and 1975, surveying approximately 45 percent of its surface. [Mariner 10](#) deftly maneuvered to photograph part of the sunlit hemisphere during each approach, passed behind the planet, and continued to image the sun-facing side as the spacecraft receded. Its highest resolution [photographs](#) recorded features approximately a mile across. A reprocessing [of the Mariner 10 data](#) has resulted in this dramatic mosaic. Like the Earth's Moon, [Mercury's surface](#) shows the scars [of impact](#) cratering - the smooth vertical band and patches visible above represent regions where no image information is available.

Venus ♀

Distance from Sun	67,300,000 miles (0.7 AU)
Diameter	7,521 miles (0.9x Earth)
# Moons	none
Day / Year	2,802 hrs (116 days) / 224 days
Makeup	Rock with CO ₂ atmosphere
Discovered	Ancient times
Description	900° F - Really hot!

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http://www.astrosurf.com/nunes/explor/mariner10/venus/mosaic_rgb2.jpg



<http://antwrp.gsfc.nasa.gov/apod/ap050903.html>

The surface of [Venus](#) is perpetually covered by a veil of thick [clouds](#) and remains hidden from even the powerful telescopic eyes of earth-bound astronomers. But in the early 1990s, using imaging radar, the Venus orbiting [Magellan spacecraft](#) was able to lift the veil from the [face](#) of Venus and produced spectacular high resolution images of the [planet's surface](#). Colors used in this [computer generated picture](#) of Magellan radar data are based on color images from the surface of Venus transmitted by the [Soviet Venera](#) 13 and 14 landers. The bright area running roughly across the middle represents the largest highland region [of Venus](#) known as [Aphrodite Terra](#).

Earth ☉ or ⊕

Distance from Sun	93,000,000 miles (1 AU)
Diameter	7,920 miles (1.0x Earth)
# Moons	1
Day / Year	24 hours / 365 days
Makeup	Rock with N & O ₂ atmosphere
Discovered	First!
Description	Home! Water, oxygen.



<http://solarviews.com/cap/earth/bluemarblewest.htm>

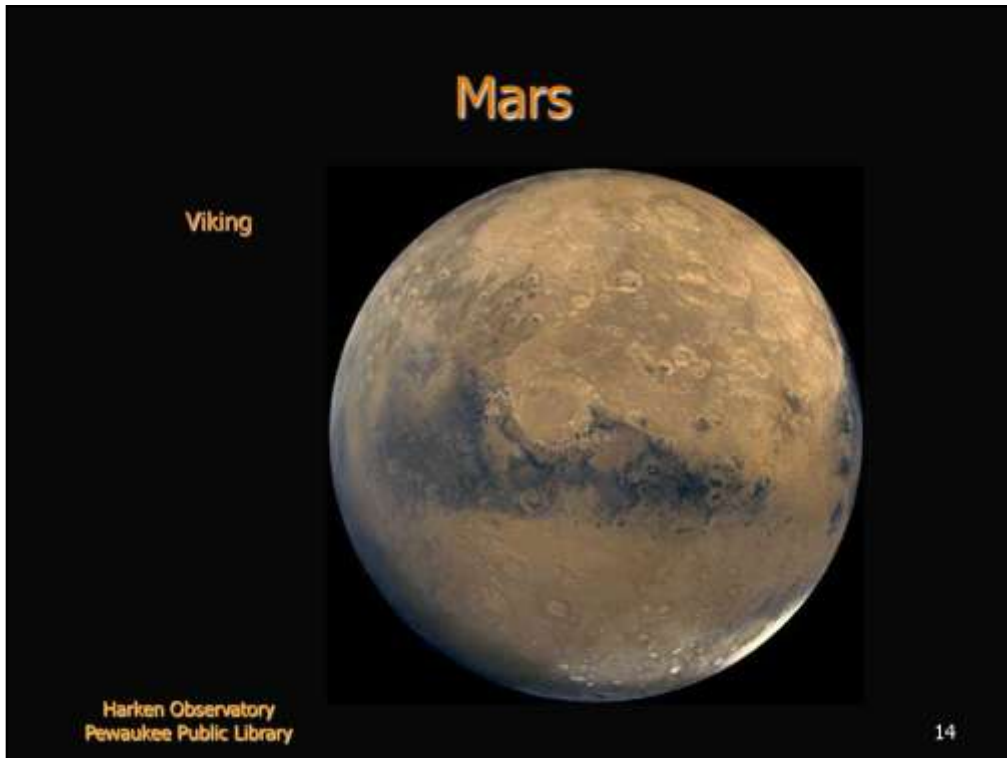
This spectacular "blue marble" image is the most detailed true-color image of the entire Earth to date. Using a collection of satellite-based observations, scientists and visualizers stitched together months of observations of the land surface, oceans, sea ice, and clouds into a seamless, true-color mosaic of every square kilometer (.386 square mile) of our planet.

Much of the information contained in this image came from a single remote-sensing device—NASA's Moderate Resolution Imaging Spectroradiometer, or MODIS. Flying over 700 km above the Earth onboard the Terra satellite, MODIS provides an integrated tool for observing a variety of terrestrial, oceanic, and atmospheric features of the Earth. The land and coastal ocean portions of these images are based on surface observations collected from June through September 2001 and combined, or composited, every eight days to compensate for clouds that might block the sensor's view of the surface on any single day. Two different types of ocean data were used in these images: shallow water true color data, and global ocean color (or chlorophyll) data. Topographic shading is based on the GTOPO 30 elevation dataset compiled by the U.S. Geological Survey's EROS Data Center. MODIS observations of polar sea ice were combined with observations of Antarctica made by the National Oceanic and Atmospheric Administration's AVHRR sensor the Advanced Very High Resolution Radiometer. The cloud image is a composite of two days of imagery collected in visible light wavelengths and a third day of thermal infra-red imagery over the poles.

Credit NASA Goddard Space Flight Center Image by Reto Stöckli (land surface, shallow water, clouds). Enhancements by Robert Simmon (ocean color, compositing, 3D globes, animation). Data and technical support: MODIS Land Group; MODIS Science Data Support Team; MODIS Atmosphere Group; MODIS Ocean Group Additional data: USGS EROS Data Center (topography); USGS Terrestrial Remote Sensing Flagstaff Field Center (Antarctica); Defense Meteorological Satellite Program (city lights).

Mars ♂

Distance from Sun	141,369,000 miles (1.5 AU)
Diameter	6,805 miles (0.5x Earth)
# Moons	2
Day / Year	24.6 hours / 687 days
Makeup	Rock with CO ₂ atmosphere
Discovered	Ancient times
Description	Red surface. UFOs?!



<http://pds.jpl.nasa.gov/planets/captions/mars/schiap.htm>

This mosaic of [Mars](#) is composed of about 100 Viking Orbiter images. The images were acquired in 1980 during mid-northern summer on Mars. [Crater Schiaparelli](#), left of center, is 461 km (277 mi) in diameter. The dark streaks with bright margins emanating from craters in the [Oxia](#) Palus region, in the upper left, are caused by erosion and deposition by the wind. Bright white areas to the south, including the [Hellas](#) impact [basin](#) at extreme lower right, are covered by carbon dioxide frost.

Typical Amateur Images of Mars



Courtesy: MAS
August 10, 2003



WebCam photo
www.starrynight.com

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www.starrynight.com
Milwaukee Astronomy Society



<http://solarviews.com/cap/earth/PIA04531.htm>

Earth/Moon: This is the first image of Earth ever taken from another planet that actually shows our home as a planetary disk. Because Earth and the Moon are closer to the Sun than Mars, they exhibit phases, just as the Moon, Venus, and Mercury do when viewed from Earth. As seen from Mars by MGS on 8 May 2003 at 13:00 GMT (6:00 AM PDT), Earth and the Moon appeared in the evening sky. The MOC Earth/Moon image has been specially processed to allow both Earth (with an apparent magnitude of -2.5) and the much darker Moon (with an apparent magnitude of +0.9) to be visible together. The bright area at the top of the image of Earth is cloud cover over central and eastern North America. Below that, a darker area includes Central America and the Gulf of Mexico. The bright feature near the center-right of the crescent Earth consists of clouds over northern South America. The image also shows the Earth-facing hemisphere of the Moon, since the Moon was on the far side of Earth as viewed from Mars. The slightly lighter tone of the lower portion of the image of the Moon results from the large and conspicuous ray system associated with the crater Tycho.

A note about the coloring process: The MGS MOC high resolution camera only takes grayscale (black-and-white) images. To "colorize" the image, a Mariner 10 Earth/Moon image taken in 1973 was used to color the MOC Earth and Moon picture. The procedure used was as follows: the Mariner 10 image was converted from 24-bit color to 8-bit color using a JPEG to GIF conversion program. The 8-bit color image was converted to 8-bit grayscale and an associated lookup table mapping each gray value of the image to a red-green-blue color triplet (RGB). Each color triplet was root-sum-squared (RSS), and sorted in increasing RSS value. These sorted lists were brightness-to-color maps for the images. Each brightness-to-color map was then used to convert the 8-bit grayscale MOC image to an 8-bit color image. This 8-bit color image was then converted to a 24-bit color image. The color image was edited to return the background to black.

HOAX e-mail on Mars

“ The Red Planet is about to be spectacular! This month and next, Earth is catching up with Mars in an encounter that will culminate in the closest approach between the two planets in recorded history. The next time Mars may come this close is in 2287. Due to the way Jupiter's gravity tugs on Mars and perturbs its orbit, astronomers can only be certain that Mars has not come this close to Earth in the Last 5,000 years, but it may be as long as 60,000 years before it happens again. ...”

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<http://www.snopes.com/science/mars.asp>

http://science.nasa.gov/headlines/y2005/07jul_marshoax.htm

Full text of hoax email:

“The Red Planet is about to be spectacular! This month and next, Earth is catching up with Mars in an encounter that will culminate in the closest approach between the two planets in recorded history. The next time Mars may come this close is in 2287. Due to the way Jupiter's gravity tugs on Mars and perturbs its orbit, astronomers can only be certain that Mars has not come this close to Earth in the Last 5,000 years, but it may be as long as 60,000 years before it happens again.

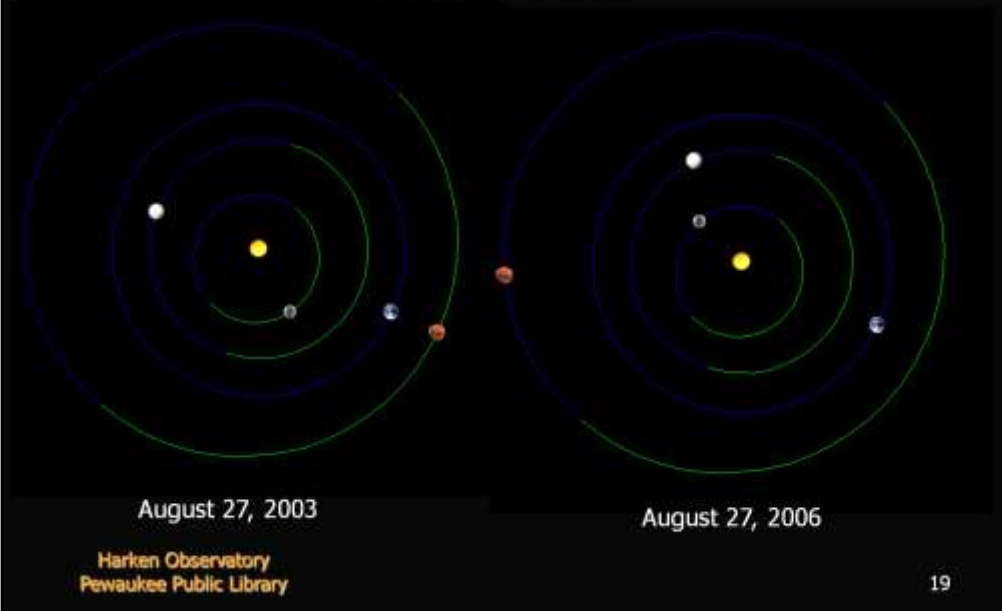
The encounter will culminate on August 27th when Mars comes to within 34,649,589 miles of Earth and will be (next to the moon) the brightest object in the night sky. It will attain a magnitude of -2.9 and will appear 25.11 arc seconds wide. At a modest 75-power magnification Mars will look as large as the full moon to the naked eye. Mars will be easy to spot. At the beginning of August it will rise in the east at 10p.m. and reach its azimuth at about 3 a.m.

By the end of August when the two planets are closest, Mars will rise at nightfall and reach its highest point in the sky at 12:30 a.m. That's pretty convenient to see something that no human being has seen in recorded history. So, mark your calendar at the beginning of August to see Mars grow progressively brighter and brighter throughout the month. Share this with your children and grandchildren. NO ONE ALIVE TODAY WILL EVER SEE THIS AGAIN “

Sort of True

- This claim was true for August 27, 2003
- Mars is now drifting away, as expected
- Mars will never appear “as big as the moon” or even “as bright as the moon”
- Urban legends never expire

Mars Orbit



Jupiter ♃

Distance from Sun	483,900,000 Miles (5.2 AU)
Diameter	88,846 Miles (11.2x Earth)
# Moons	63 (Io, Calisto, Ganymede, Europa, etc.)
Day / Year	10 hours (fastest) / 4,333 days
Makeup	Hydrogen, etc. "gas giant"
Discovered	Ancient times
Description	Huge! Stripes & Storm

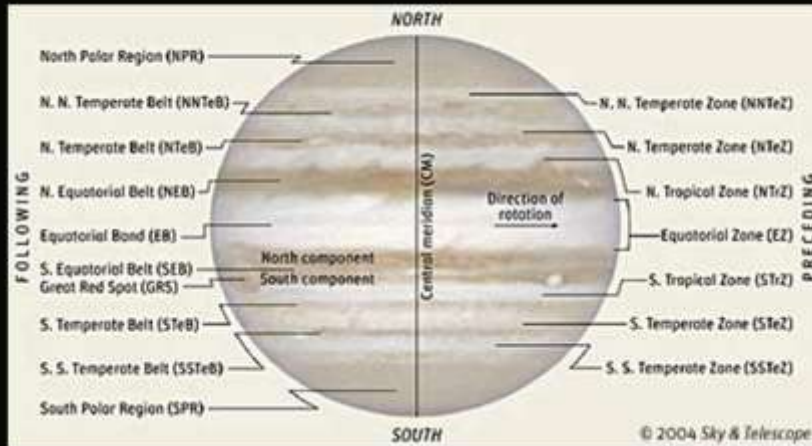
Jupiter

Hubble Image



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Jupiter has a number of belts and bands that are visible with the telescope. The details are subject to atmospheric turbulence ("the seeing" through earth's atmosphere) Jupiter rotates once completely around it's axis in less than 10 hours

Jupiter's most famous feature is its "Great Red Spot".
It is a large swirling storm cloud in Jupiter's atmosphere
(note Earth size comparison)



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Current news!

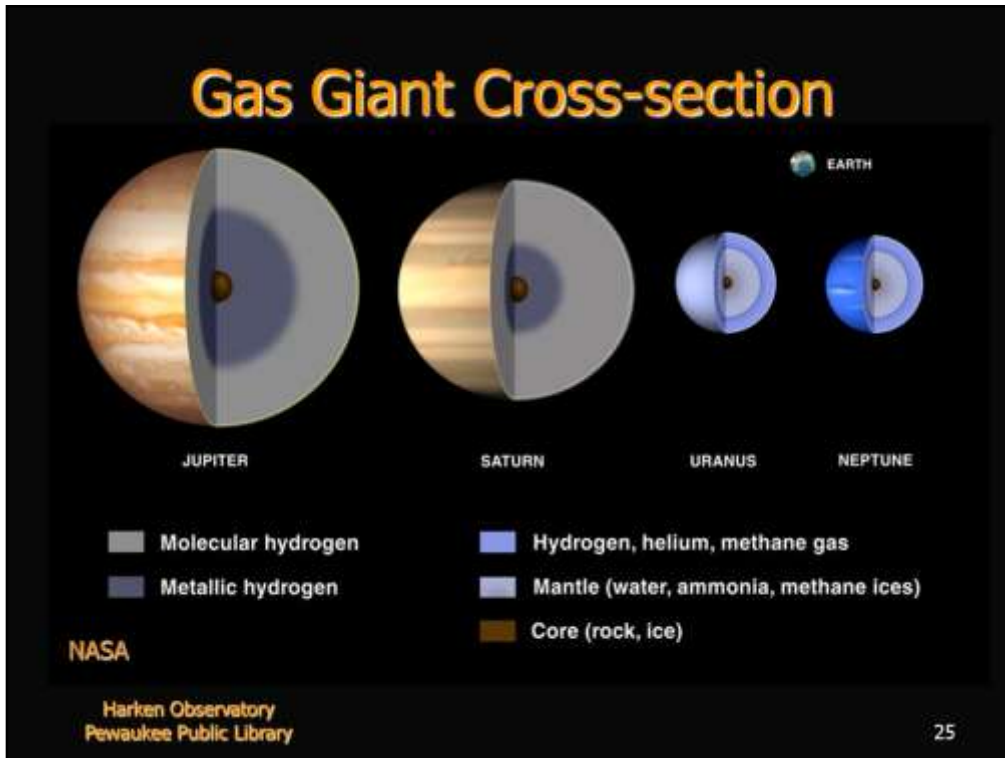
Jupiter seems to now have a second "Great Red Spot"



Christopher Go of the Philippines photographed it on February 27th using an 11-inch telescope and a CCD camera.

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http://sse.jpl.nasa.gov/multimedia/display.cfm?IM_ID=166

Gas Giant Interiors

Jupiter

Jupiter's composition is mainly hydrogen and helium. In contrast to planetary bodies covered with a hard surface crust (the Earth, for example), the jovian surface is gaseous-liquid, rendering the boundary between the atmosphere and the planet itself almost indistinguishable. Below the roughly 1000-kilometer-thick atmosphere, a layer of liquid hydrogen extends to a depth of 20,000 kilometers. Even deeper, it is believed that there is a layer of liquid metallic hydrogen at a pressure of 3 million bars. The planet core is believed to comprise iron-nickel alloy, rock, etc., at a temperature estimated to exceed 20,000C.

Saturn

As with Jupiter, Saturn is mainly composed of hydrogen and helium and is observed to be of extremely low density. In fact, Saturn's mean density is only about two-thirds that of water. The Saturn atmosphere comprises, in descending order of altitude, a layer of ammonia, a layer of ammonium hydrogen sulfide, and a layer of ice. Below this, the saturnian surface is a stratum of liquid hydrogen (as in the case of Jupiter) underlain with a layer of liquid metallic hydrogen. It is believed that the liquid hydrogen layer of Saturn is thicker than that of Jupiter, while the liquid metallic hydrogen layer may be thinner. The planet's core is estimated to be composed of rock and ice.

Uranus

Uranus is gaseous in composition, mainly comprising hydrogen and helium as in the case of Jupiter and Saturn. The planet atmosphere is mostly hydrogen but also includes helium and methane. The planet core is estimated to be rock and ice encompassed by an outer layer of ice comprised of water, ammonium, and methane.

Neptune

The atmosphere of Neptune consists of mainly hydrogen, methane and helium, similar to Uranus. Below it is a liquid hydrogen layer including helium and methane. The lower layer is made up of the liquid hydrogen compounds oxygen and nitrogen. It is believed that the planet core comprises rock and ice. Neptune's average density, as well as the greatest proportion of core per planet size, is the greatest among all the gaseous planets.

Image Credit: **Lunar and Planetary Institute**

Saturn ♄

Distance from Sun	887,100,000 Miles (9.5 AU)
Diameter	74,700 Miles (9.41x Earth)
# Moons	47
Day / Year	11 hours / 10,756 days (29.5 yrs)
Makeup	Hydrogen, etc. "gas giant"
Discovered	Ancient times
Description	Huge rings of small rocks

Saturn

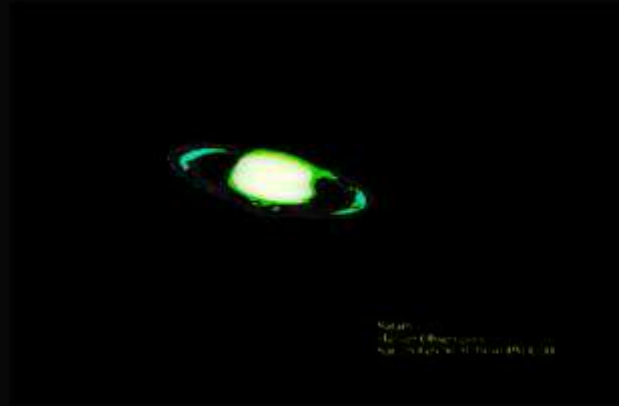
Hubble Image



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Harken Photo - 25 Feb 06

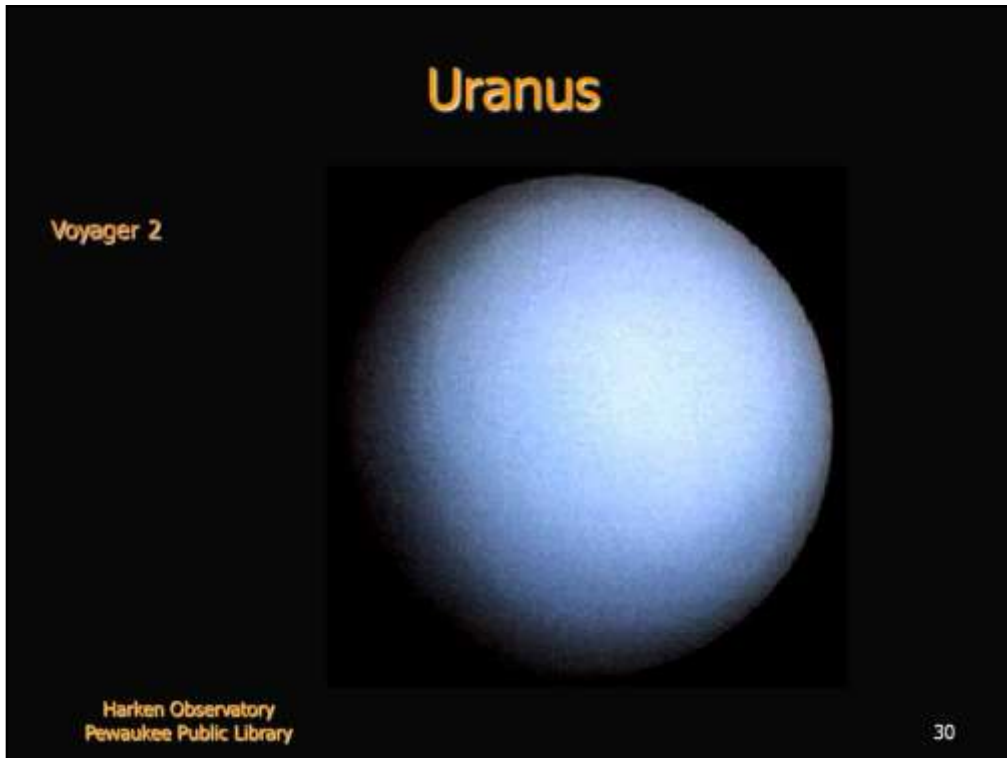


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Uranus ♅

Distance from Sun	1,748,800,000 Miles (19 AU)
Diameter	30,589 Miles (3.98x Earth)
# Moons	27
Day / Year	17 hours / 30,589 days
Makeup	Hydrogen, etc. "gas giant"
Discovered	1781, but observed in 1690
Description	Small rings.



<http://pds.jpl.nasa.gov/planets/captions/uranus/uranus.htm>

The greenish color of [Uranus'](#) atmosphere is due to methane and high-altitude photochemical smog. Voyager 2 acquired this view of the seventh planet while departing the Uranian system in late January 1986. This image looks at the planet approximately along its rotational pole.

Neptune ♆

Distance from Sun	2,795,700,000 Miles (30 AU)
Diameter	30,755 Miles (3.81x Earth)
# Moons	13
Day / Year	16 hours / 59,800 days (164 yrs)
Makeup	Hydrogen, etc. "gas giant"
Discovered	1846 by mathematical prediction
Description	1,200 mph winds, "ice giant"

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<http://pds.jpl.nasa.gov/planets/captions/neptune/fullnep.htm>

On its approach to [Neptune](#) in August 1989, Voyager 2 captured this image of the fourth and outermost of the giant gas planets. This image shows two of the four oval cloud features tracked by the cameras. The large dark oval near the left edge revolves around Neptune every 18 hours. The bright clouds immediately to the south and east of this oval substantially change their appearance in periods as short as 4 hours. The second dark spot, at lower right edge, revolves around Neptune every 16 hours.

Pluto ♇

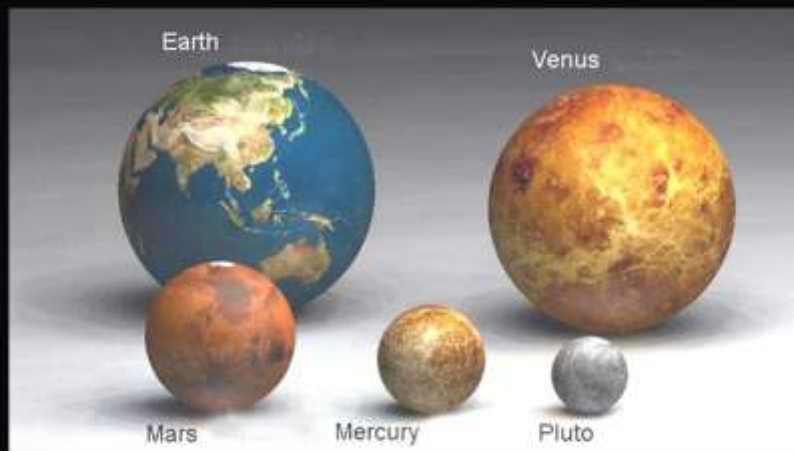
Distance from Sun	3,676,200,000 Miles (39 AU)
Diameter	1,485 Miles (0.18x Earth)
# Moons	3
Day / Year	153 hours / 90,588 days (248 yrs)
Makeup	Rock with N & CH ₄ atmosphere
Discovered	1930, but observed since 1915
Description	Demoted to "dwarf planet" on August 24, 2006

Planets

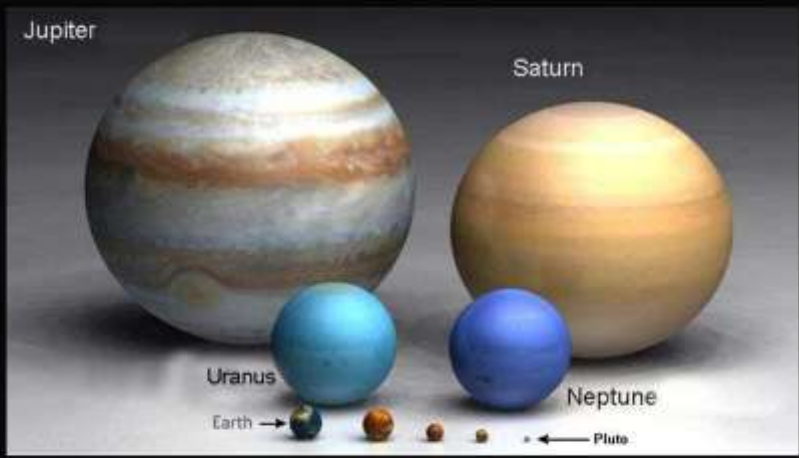
- Rocks – The Planets
- Size of Planets and Stars
- Circles – Orbits & Solar System
- The Observatory

Planet Sizes

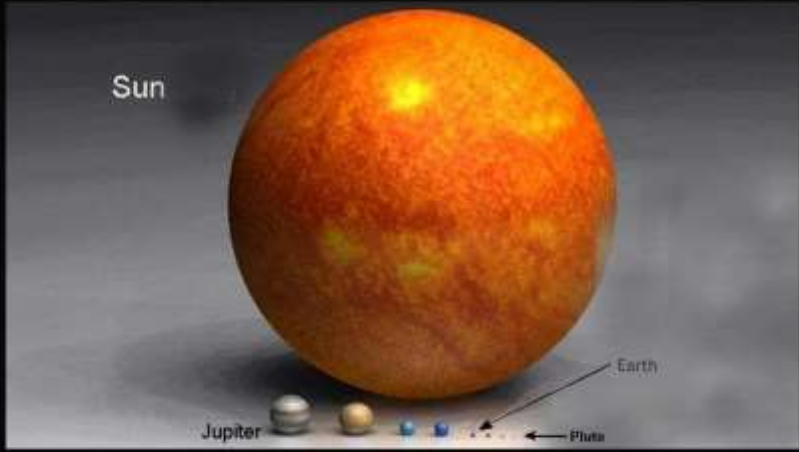
- Planets come in all sizes
- The following shows how they compare



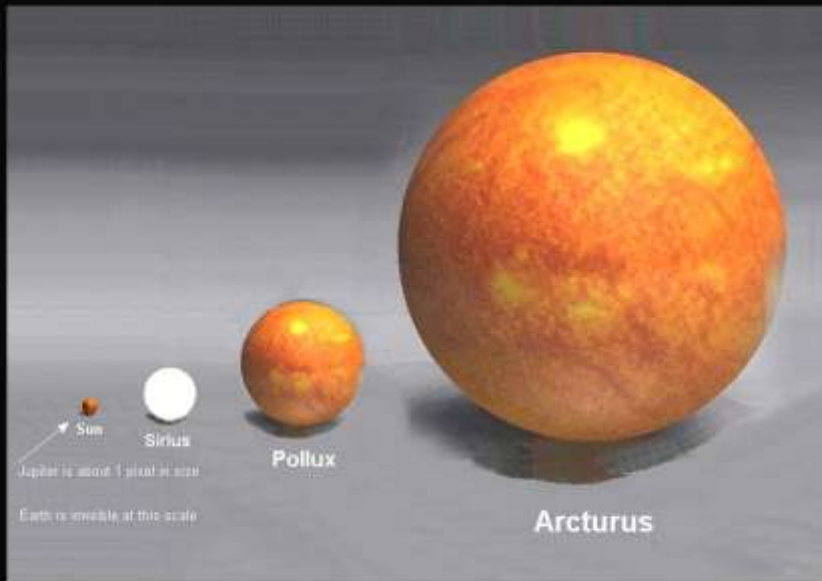
Earth's moon is midway between Pluto and Mercury.



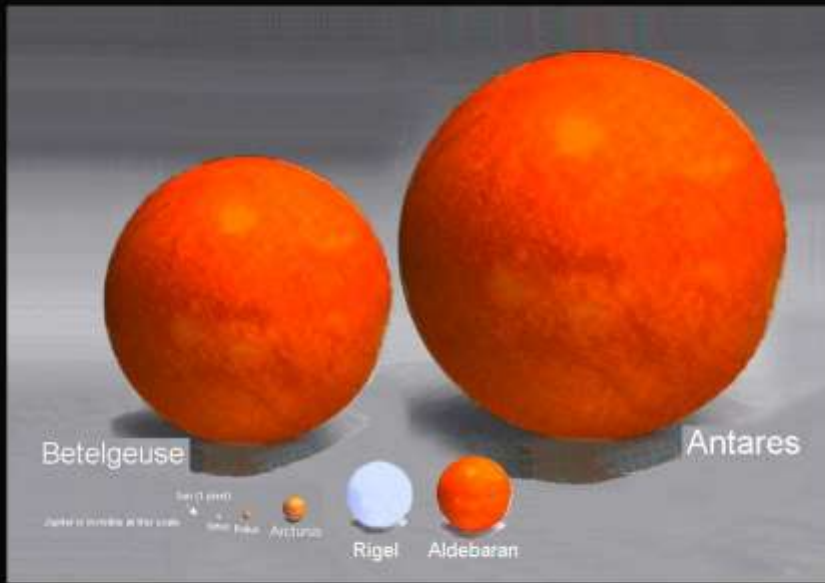
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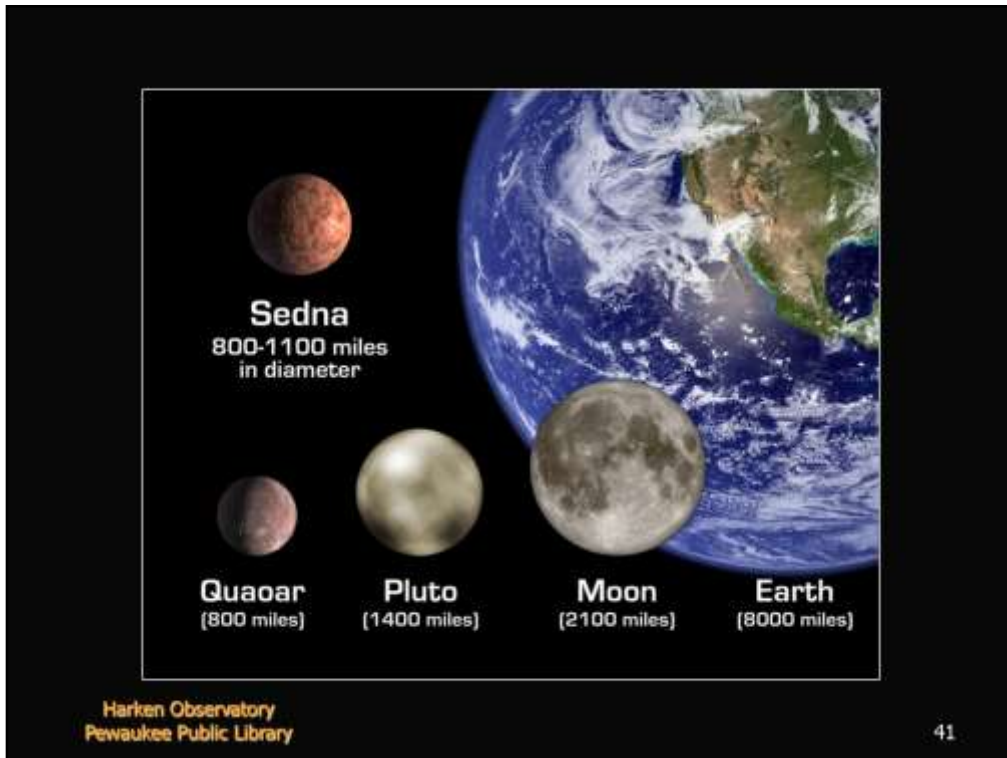
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Quaoar (kwah-o-wahr) is a planetoid discovered in June, 2002.

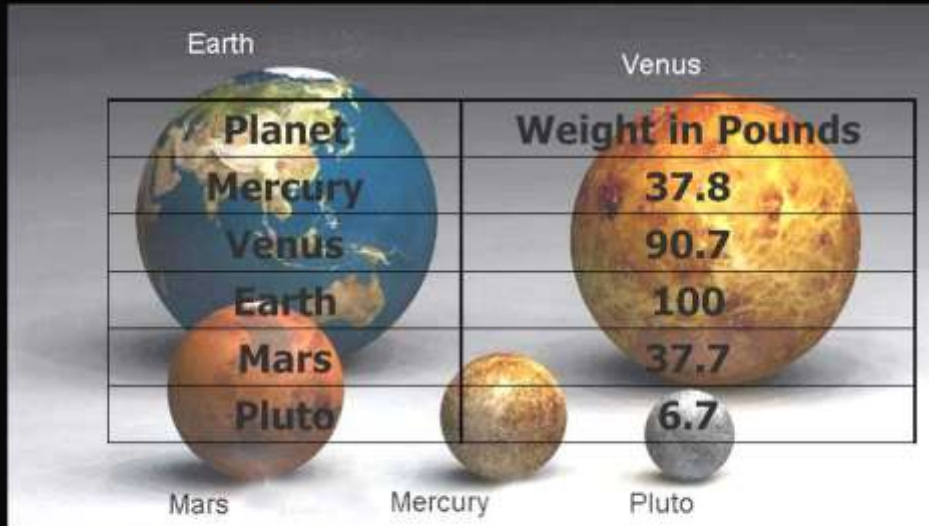
<http://www.gps.caltech.edu/~chad/quaoar/>

It's about 42AU from the Sun.

Weight on Other Planets

- Mass is the stuff something is made of. It is constant, even in outer space.
- Weight is gravity acting on mass.
- Gravity gets stronger as objects get more mass or get closer to each other.
- <http://www.exploratorium.edu/ronh/weight/index.html>

Weight on Rock Planets



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Weight on Other Planets

Planet	Weight in Pounds
Jupiter	253.3
Saturn	106.4
Uranus	88.9
Neptune	112.5

Weight Elsewhere

Planet	Weight in Pounds
Earth	100
Moon	16.6
Sun	2,707

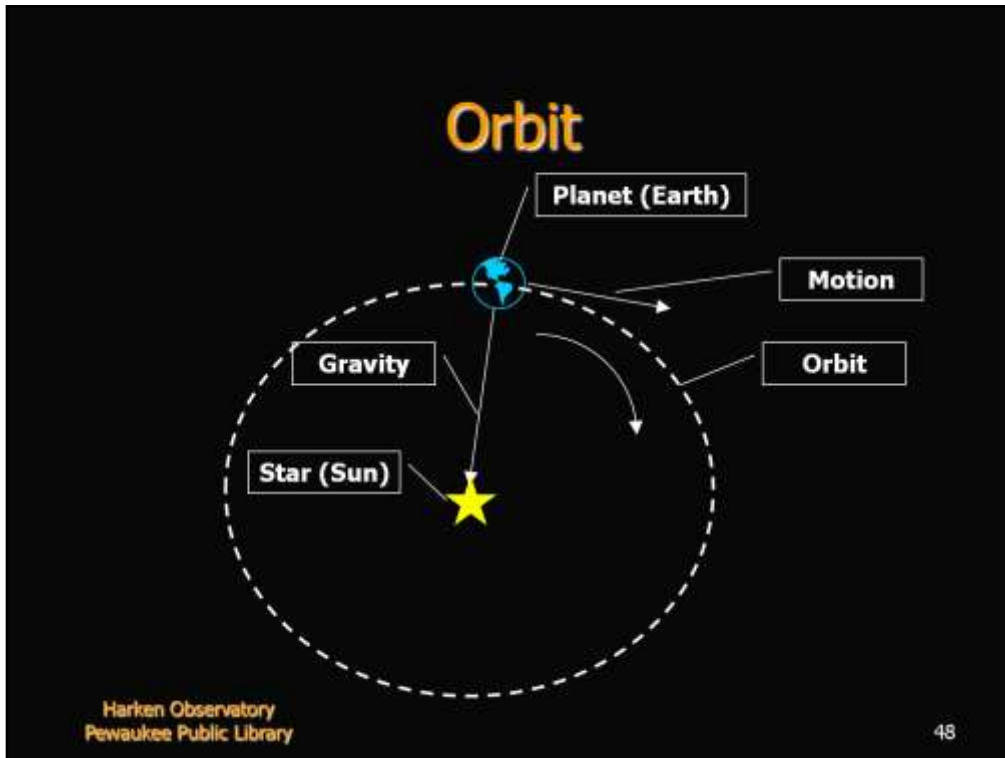
Planets

- Rocks – The Planets
- Size of Planets and Stars
- Circles – Orbits & Solar System
- More planets? More solar systems?
- The Observatory

Planets and Orbits

- There is no definition of "planet" agreed to by professional astronomers. A non-technical definition is:
A big bunch of stuff circling around a star.
- An orbit is the path that an object (planet) makes around another object (star) while being pulled by gravity.

"Stuff" will be discussed later. Earth, Mars, etc. are rock. Jupiter, Saturn, etc. are gas balls, like the sun but without the nuclear fusion.



Tie a string to a weight and spin around. The weight represents a planet and is orbiting around you. The string represents gravity and keeps the weight from flying away.

The actual path is an ellipse, not a circle. The bigger the path, the faster the planet's movement.

If the planet goes fast enough (escape velocity), it overcomes the pull of gravity and flies away from the sun. That's what happens to moon rockets, etc.

The sun and earth gravity pull on each other, but the sun's is far stronger due to its size.

The sun and earth both orbit around each other as determined by gravity and mass. As a practical matter, that point is the sun.

The earth is moving, trying to fly out of orbit, but the sun's gravity is too strong. In this case, gravity is a centripetal force.

A planetary year is one orbit around the star.

Which is what?

- The space station orbits around the earth. It's not a planet. **Why?**
- The moon orbits around the earth. It's not a planet. **Why?**
- The earth orbits around the sun. It is a planet. **Why?**

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The space station is too small to be a planet, and revolves around a planet (earth), not a star.

The moon is not a planet because the thing it revolves around, the earth, is not a star. However, the moon is bigger than the planet Pluto, so it is big enough.

The earth is a planet because the thing it revolves around, the sun, is a star.

Comets and asteroids orbit around the sun but are not big enough to be planets.

What is the Solar System?

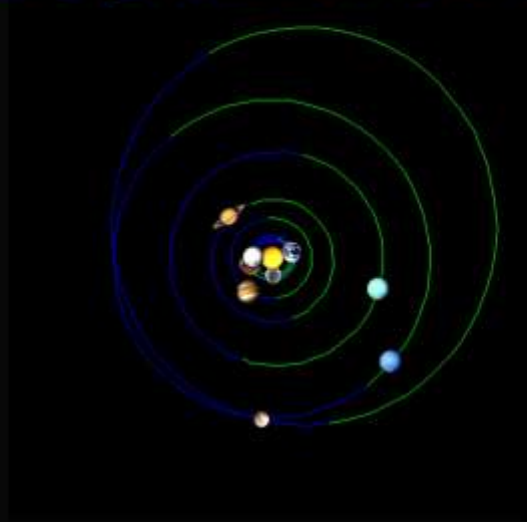
- The sun, planets, asteroids, comets, dust, etc.
- Compared to the rest of space this stuff is small and close together.
- Only one sun in our solar system.

Strictly speaking, a bunch of planets around some other star would be called a “planetary system”. “Solar” refers to the earth’s star specifically. The Latin word for the earth’s sun is Sol.

Planet Orbits

- Orbits are ellipses, not circles
- Since the inner planets are much closer together than the outer ones, it's hard to make a scale drawing.
- <http://www.fourmilab.ch/solar/solar.html>

Solar System Point of View



October 7, 2006

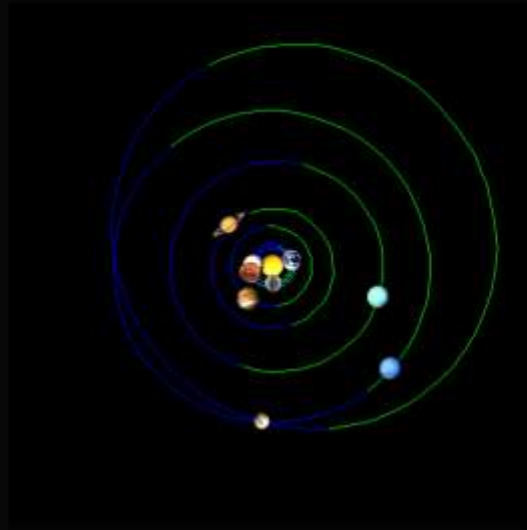
9:00pm CDT

Top Down

90°
Heliocentric

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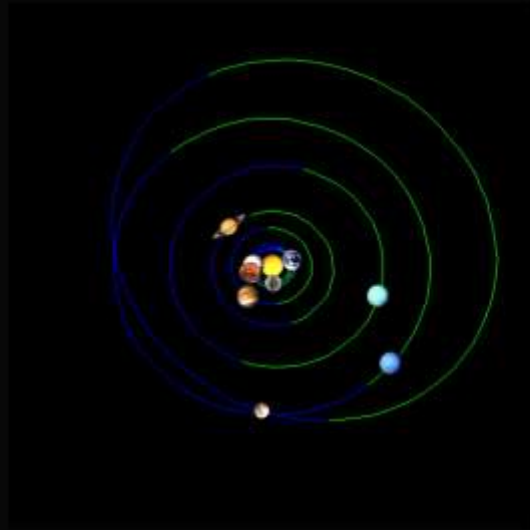
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80°
Heliocentric

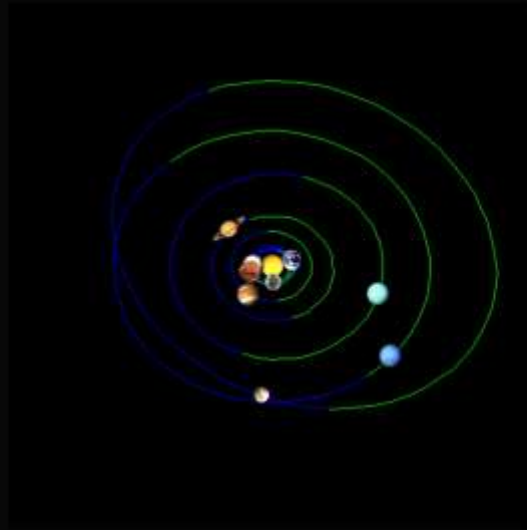
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70°
Heliocentric

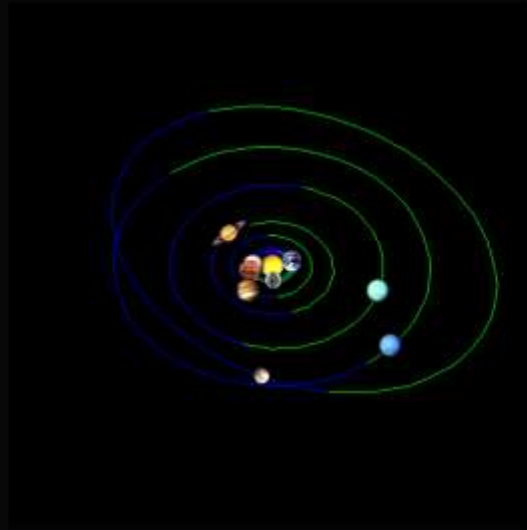
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60°
Heliocentric

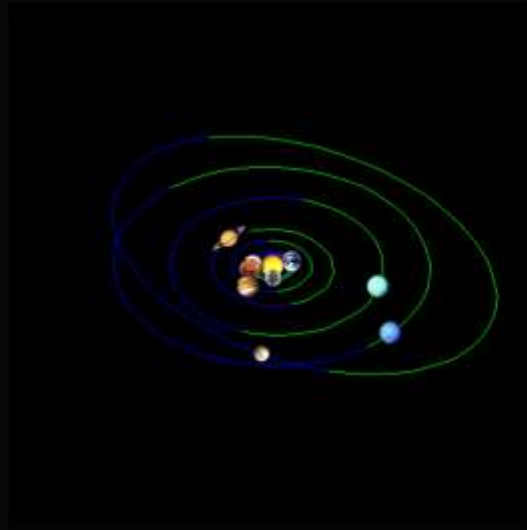
55



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50°
Heliocentric

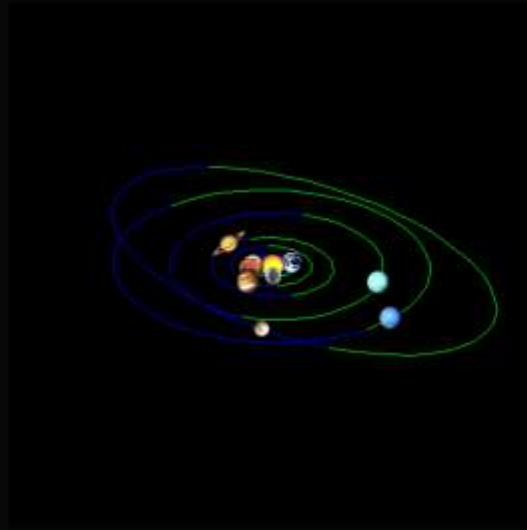
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40°
Heliocentric

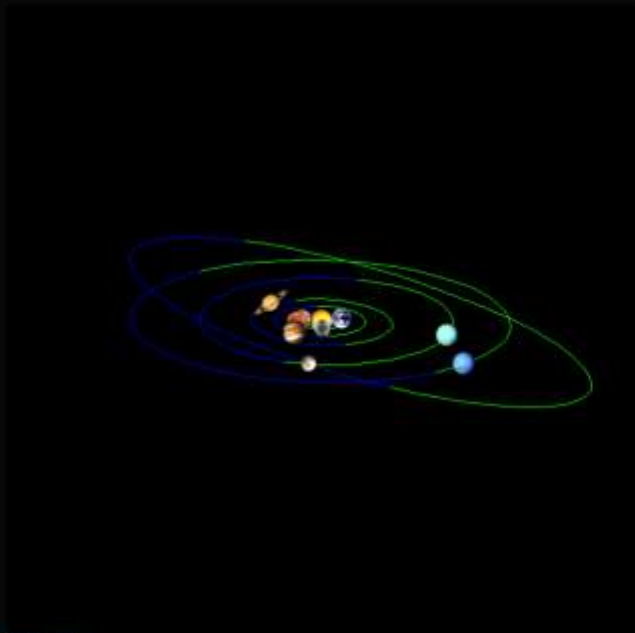
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30°
Heliocentric

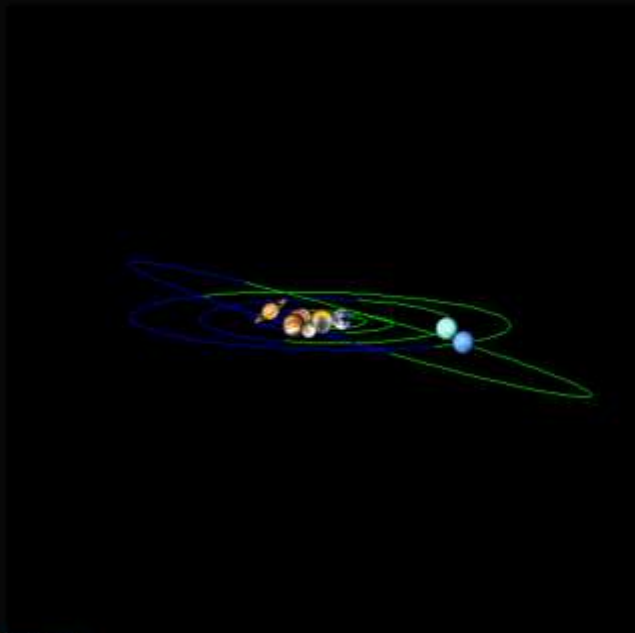
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20°
Heliocentric

59



Harken Observatory
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10°
Heliocentric

60

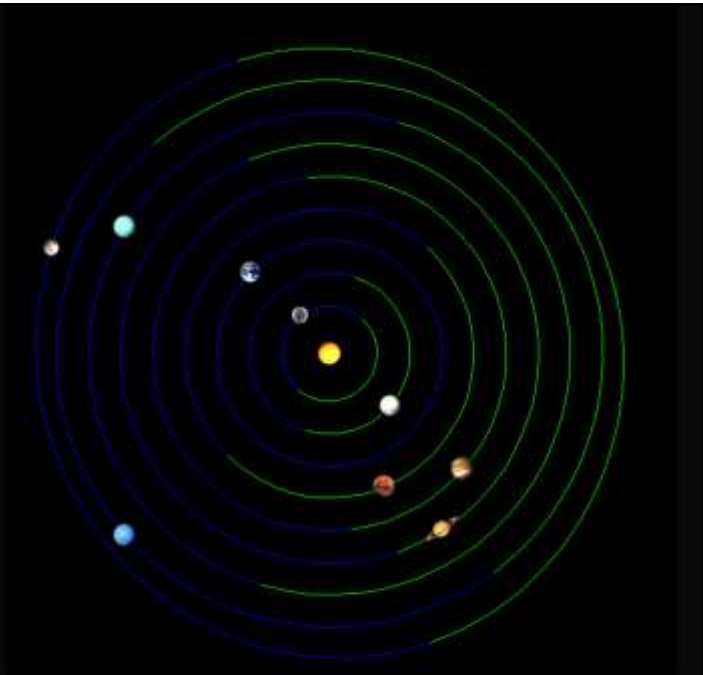


Pluto is at an incline to the ecliptic, suggesting that it is a rock from “out there” that got captured by the sun’s gravity.

Sygyzy

sız.ıd3i

Feb 4, 1962



Harken Observatory
Pewaukee Public Library

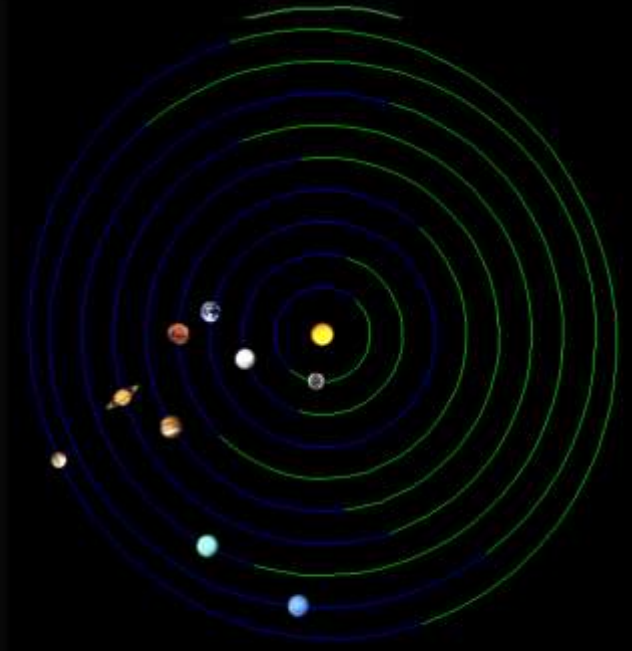
62

Sygyzy

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March 10,
1982

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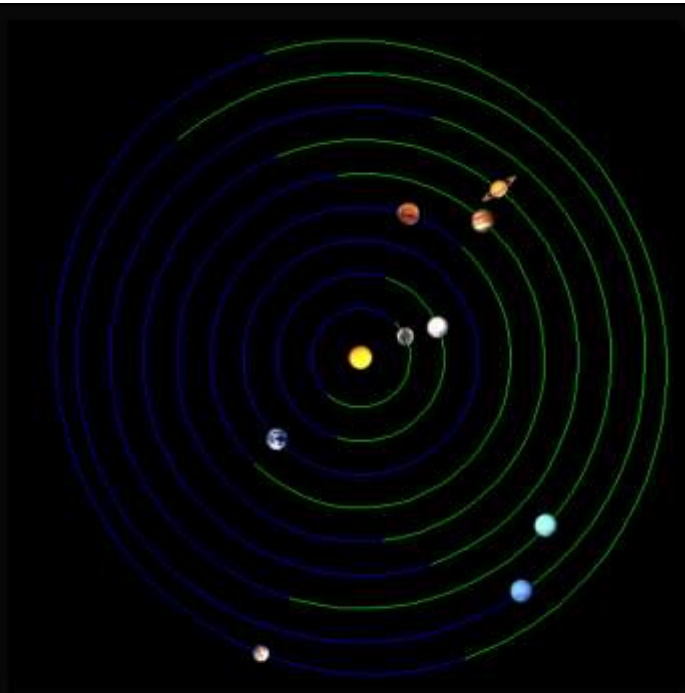
63

Sygyzy

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May 5, 2000

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Planets

- Rocks – The Planets
- Size of Planets and Stars
- Circles – Orbits & Solar System
- The Observatory

Planets

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Mission Statement

The Harken Astronomical Observatory provides education and brings the wonders of our incredible universe to families of our community in the friendly and casual environment of our new library.

It is a hands on experience with rare access to high tech and powerful equipment.

All funds, including original construction and equipment, are donated.

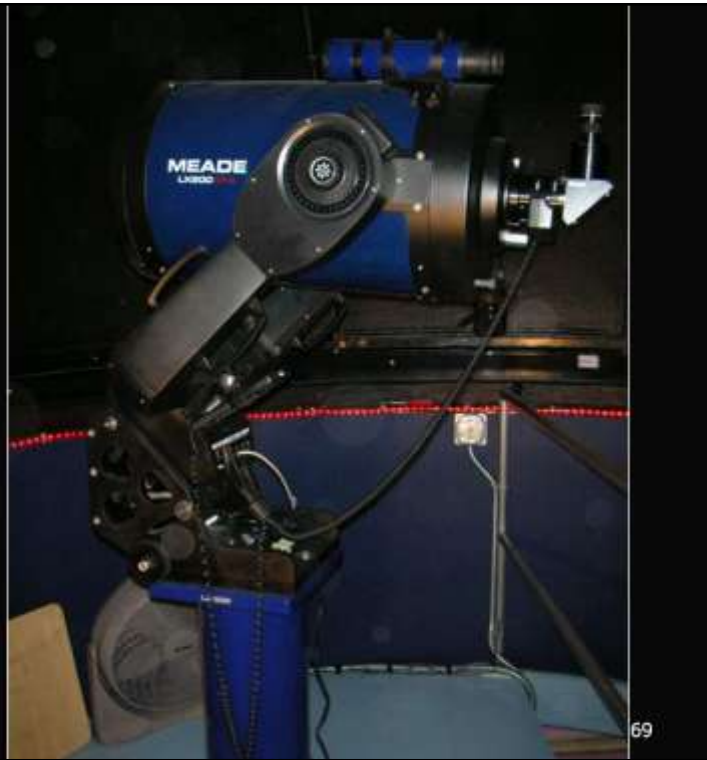
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Scope

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Equipment

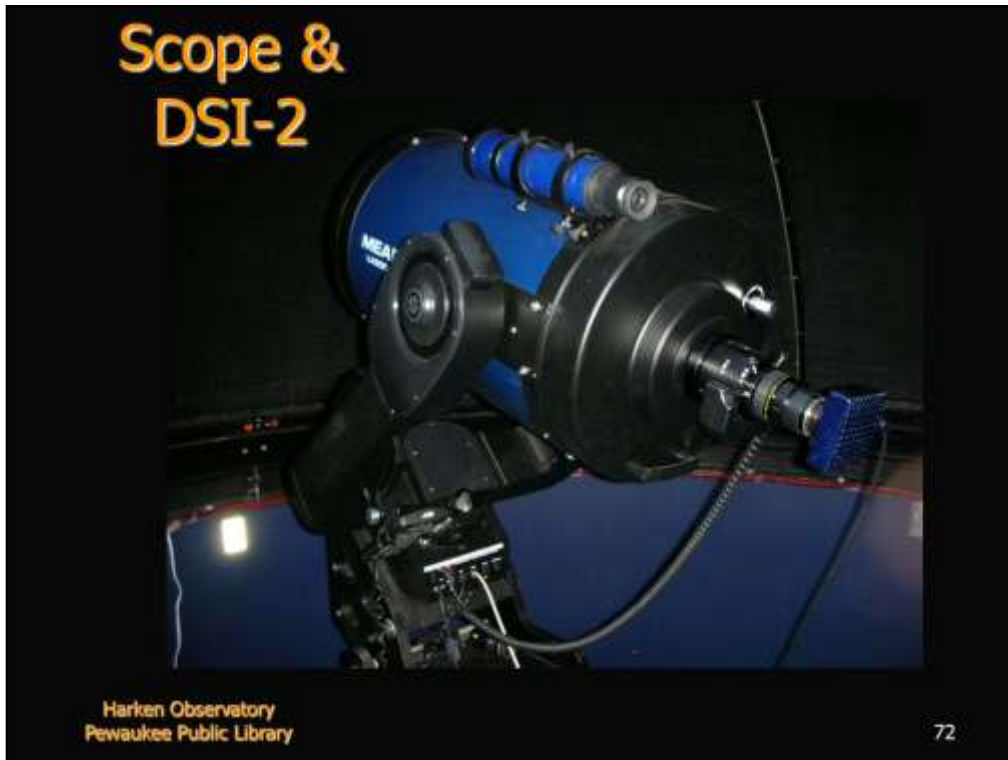
- Meade LX200-GPS Schmidt-Cassegrain Reflector Telescope
 - Aperture: 12 inches (305 mm)
 - Focal Length: 120 inches (3048 mm)
 - Focal Ratio: f/10
- Digital Cameras (StarLight Express SXV-H9C, Meade LPI, Meade DSI-2)
- Computerized Control Station w/ remote Station

Scope



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LPI imager is the box on top of the right angle eyepiece. Other cameras stick straight out the back.

Operate the scope

- in the dome
- on the platform
- downstairs



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Access to Dome

- Since we do not have access for the handicapped to go up into the dome, we are, by law, prohibited from letting the general public up there.
- Only instructors are allowed upstairs.
- Anyone can become an instructor (hint, hint!)

- "Turn left at Orion : a hundred night sky objects to see in a small telescope-- and how to find them" by Guy Consolmagno
- "The backyard astronomer's guide" by Terence Dickinson
- "The complete idiot's guide to astronomy" by Christopher De Pree
- National Geographic encyclopedia of space

On the television show Star Trek, Vulcans would greet each other with "Live long and prosper". Amateur astronomers say "Clear Skies!" (Actually, only the geeks without a real life say that.)

Clear Skies!

<http://www.harkenobservatory.com>

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