STELLAR SENTINEL
Grand Traverse Astronomical Society June 2014

How Mathemetics Discovered Neptune

By Richard Kuschell

Neptune was discovered before it was observed. This sounds backwards, but on June 1, 1846 a Frenchman, Urban LaVerrier, published a paper that mathematically predicted where the yet to be observed planet would be on New Year's Day, 1847. LaVerrier had been studying the orbit of Uranus (Yer' uh nus) and it wasn't following the predicted path. Something was influencing it. He and others thought an undiscovered planet beyond Uranus was influencing its orbit.

The Frenchman published first and gets the credit. At LaVerrier's urging, German astronomer Johann Galle captured the first view of Neptune as a planet on September 23, 1846. Others had seen it before, including Galileo, but believed it to be a fixed star.

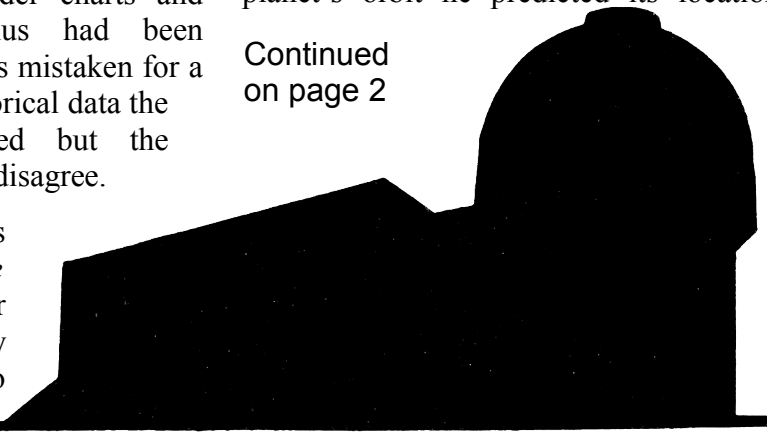
France's cross channel rival was embarrassed. Through bureaucratic mismanagement England's John Couch Adams doesn't get the credit although he solved the puzzle first. Adams was let down by George Airy the Royal Astronomer. Was Airy incompetent? He's credited with many accomplishments including measuring the density of the Earth, advances in solid body mechanics, and established Greenwich as the Prime Meridian. Paradoxically, he was an authority on planetary motion and should have recognized Adams' discovery.

William Herschel discovered Uranus in 1781. Astronomers plotted its orbit but found the planet's position didn't fit the calculations. Older charts and archives revealed Uranus had been observed by others but was mistaken for a fixed star. Using this historical data the calculations were refined but the observations continued to disagree.

Tom Standage, in his book *The Neptune File* (2000 by Walker Publishing), says ironically Adams was inspired to solve the puzzle after reading a book by Airy. Two years later in 1843, after graduating from Cambridge, he used his free summer to tackle it in earnest before returning in the fall to teach. He made some assumptions. First, Uranus was being influenced by an exterior planet. Second, the planet orbited the sun at twice the distance of Uranus in conformity with Bode's Law. The first assumption is true. The second is false but lucky. Lucky because Bode's Law is really just a coincidence. Bode said the planets' distances from the Sun conform to a mathematical sequence. Jupiter is twice the distance from the Sun as the Asteroid Belt and Saturn is twice the distance of Jupiter from the Sun. When Uranus was found to be twice Saturn's distance from the Sun the sequence was thought to be correct. It's not. Neptune is significantly closer than Bode's Law predicts. Both LaVerrier and Adams miscalculated the mass of Neptune; they thought it was more massive. Surprisingly, this mistake compensated for using Bodes formula.

Although not perfect these assumptions gave him a starting point. Adams placed the massive hypothetical planet at Bode's distance to see if the calculations predicted the eccentricities of Uranus's path. He received more observational data from Airy and worked on it again the next summer. In the fall of 1845 he successfully calculated the unseen planet's orbit and Uranus's path now made sense. Once he knew the unnamed planet's orbit he predicted its location.

Continued on page 2



How Mathemetics Discovered Neptune (Continued from page 1)

Although Adams hadn't observed it you could say he discovered it.

All the planets orbit roughly on the same plane around the Sun and are seen in the sky traveling along a narrow path through the constellations of the Zodiac. He calculated where it could be found on Oct. 1, 1845 and attempted to get Airy's successor at Cambridge, James Challis, to look for it. He declined; it was too novel a theory, and sent him to Airy. He hadn't made an appointment and Airy wasn't in. When he returned several hours later the astronomer was dining and couldn't be disturbed. Adams left the coordinates and an outline of his work. Weeks later Airy read the outline. Instead of looking for the planet he asked Adams to refine Uranus's orbit. Airy felt the perturbations were the result of incorrect observation and calculations.

In France, LaVerrier had begun working on the problem of Uranus's orbit late in the summer of 1845 and published his first paper on Nov. 10, 1845. By now Airy already had the new planets coordinates on his desk. LaVerrier's paper didn't unequivocally state there was a planet influencing Uranus but said the perturbations in Uranus's orbit could not be accounted for by Saturn's influence. His second paper published in June of 1846 concluded, as Adams had, that an unobserved planet was beyond Uranus and gave its predicted position for Jan. 1, 1847. Airy's response was to direct more technical questions to LaVerrier. They corresponded but Adams' name and work never came up. LaVerrier even asked Airy to look for the planet. He declined and asked more technical questions. Airy, belatedly, told Challis to look and gave him detailed instructions to chart a larger than necessary swath of the sky around the coordinates then wait, re-chart, and compare the two to see if a "star" had moved.

Challis started the search; plotted Neptune's position without realizing it and set the chart aside to compare later. Meanwhile, LaVerrier wrote to Johann Galle at the Berlin Observatory asking him to look for the planet. Galle obliged and found it on the first night.

Airy and the English scientific community tried to say Adams had pegged the new planets position well before LaVerrier. That's true but he who publishes first gets the credit. Adams remained above the controversy. Airy, on the other hand, knew he'd be the fall guy and for good reason. He came out fighting. Airy bobbed and weaved but ended up taking it on the chin and will forever be known for bungling the discovery of Neptune.

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Get the Stellar Sentinel in your email inbox

Postage rates have gone up and will rise again and again, so your editor has been digitizing the *Stellar Sentinel* to put it into Adobe Acrobat (PDF) format to read and print using the free Acrobat viewer on your computer. The PDF format also allows your editor to include bonus content we cannot include in the printed version of the Stellar Sentinel due to space constraints. This saves us money and forestalls dues increases.

Please send your email address along with your name from the label of your current *Stellar Sentinel* to info@gtastro.org. Emailed issues also have more content which cannot be mailed.

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GTAS Yard Sale – June 12-14. Drop your items off at Gary's house (The green house) 1473 Birmley Road, Traverse City, MI 49686. We need helpers too.

Grand Traverse Astronomical Society - Est. June 1982 – 32 years of service

-----Officers-----		*Directors*	*S.S Staff*	*----------Patrons----------*
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Society Events

Check http://www.gtastro.org for late breaking events.

June

6 Friday **Board of Directors Meeting** – 7 p.m. - NMC Rogers Observatory

General Meeting – 8 p.m. - NMC Rogers Observatory

Program: **Dr. David Penney** will present ***The Rare Earth***

Star Party: 9 p.m. - 11 p.m. - NMC Rogers Observatory.

7 Saturday **Star Party:** 4-6 p.m. & 9-11 p.m. - Sleeping Bear Dunes – Visitors Ctr & Dune Climb

12, 13, 14 Thursday thru Saturday **Annual GTAS Yard Sale** - 9:30 a.m. to 4:30 p..m. - 1473 Birmley Rd. (Drop off items in the 11th. We need helpers)

17 Tuesday **GTAS night at La Senorita's on Garfield.** Pickup coupon at earlier June GTAS events. GTAS gets 20% of your meal price.

21 Saturday **Star Party:** 9 p.m. - 11 p.m. - NMC Rogers Observatory.

24 Wednesday **Munson Day Camp** (private) 9:30 to 11 a.m. Need helpers w/telescopes for daytime observation.

July

11 Friday Note: This is the second Friday due to Independence Day holiday.

Board of Directors – 7 p.m. - NMC Rogers Observatory

General Meeting – 8 p.m. - NMC Rogers Observatory.

Star Party: 9 p.m. - 11 p.m. - NMC Rogers Observatory.

19 Saturday **Kingsley Heritage Days** – 10 a.m to 4 p.m., Civic Center South

19 Saturday **Star Party –** 9 p.m. - 11 p.m. - NMC Rogers Observatory.

20 Sunday **Kingsley Heritage Days** – 10 a.m to 3 p.m., Civic Center South

23 Wednesday **Kalkaska County Library** – 11 a.m. - 12:30 p.m. Summer Readers Group.

26 Saturday **Star Party:** 4-6 p.m. & 9-11 p.m. - Sleeping Bear Dunes, Visitor's Center, & Pierce Stocking Drive Stop #3.

---------- Star Parties ----------

Rogers Observatory star parties for the rest of 2014: 6/6, 6/21, 7/11, 7/19, 8/1, 8/16, 9/5, 9/20, 10/4, 10/18, 11/7, 11/15, 12/5. Eclipses: 10/8 lunar a.m., 10/23 solar p.m.

Sleeping Bear Dunes star parties for the rest of 2014: 6/7, 7/26, 8/9, 9/13, 10/21. Eclipses: 10/8 lunar a.m., 10/23 solar p.m.

---------- Some of the best objects for public viewing in June ----------

Planetary Object(s): Jupiter (early), Mars, Saturn

Deep Sky Object, description, constellation, distance	Rt. Asc. hr. min.	Declin. ° '
M 81: Sb Galaxy, M 82 nearby, UMa, about 12m l.y.	09 55.6	+69 04
M 82: Ip Starburst galaxy, companion of M 81, UMa, about 12m l.y.	09 55.8	+69 41
Al Geiba (γ Leonis): double star, Leo, sep 125 a.u., 90 l.y.	10 19.4	+19 54
M 97: Owl Nebula (planetary), UMa, about 3k l.y.	11 14.8	+55 01
M 66: Sb galaxy in a group of galaxies, Leo, 29-38m l.y.	11 20.2	+12 59
M 87: E1 galaxy-richest part of Virgo Cluster, Vir, about 42m l.y.	12 30.8	+12 24
Note: The rest of the objects for viewing are located in the emailed edition of the Stellar Sentinel.		

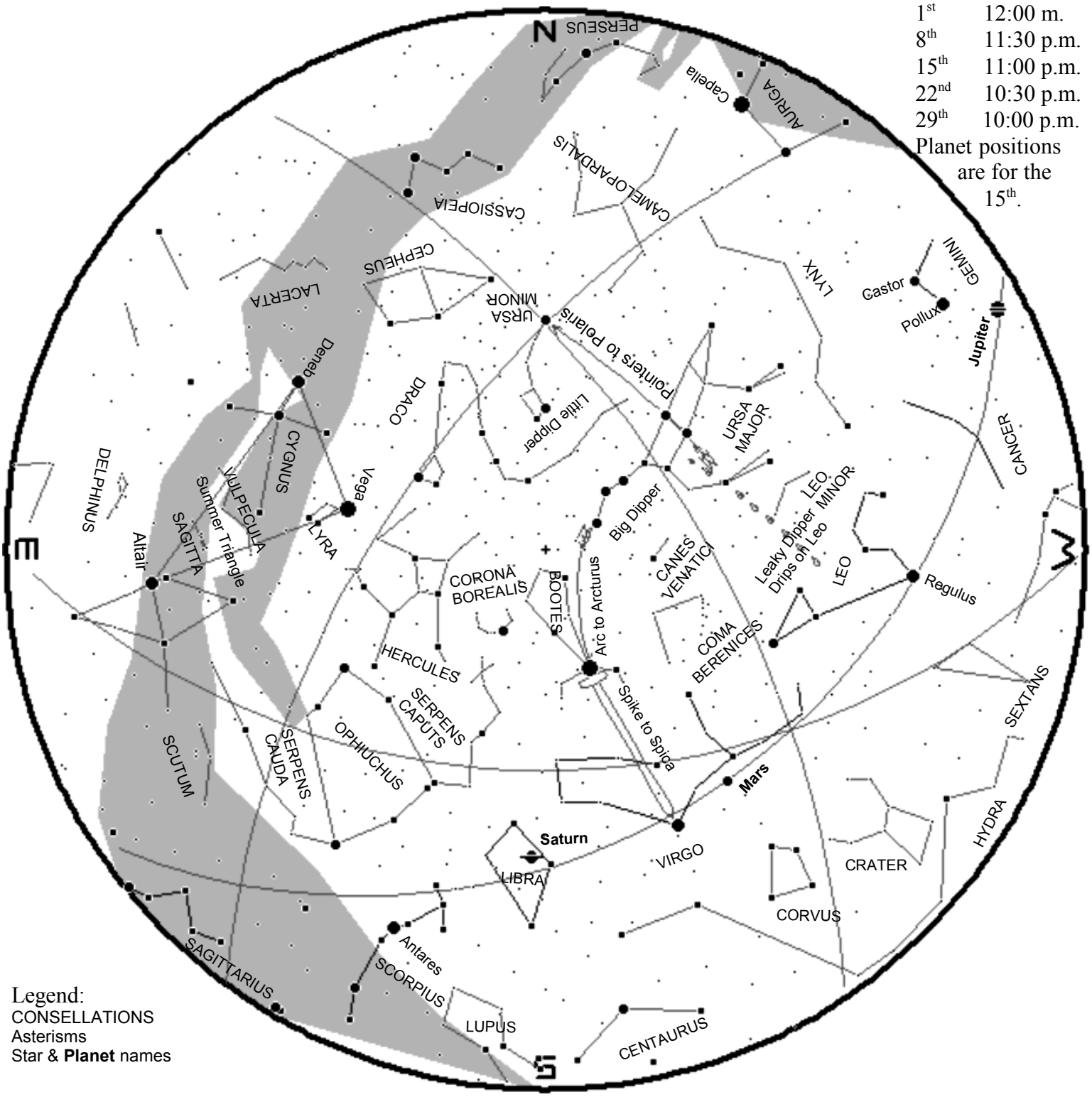
The Stars and Planets for June 2014

By Bob Moler

Planets are plotted for mid month. The star positions are correct for:

1st	12:00 m.
8th	11:30 p.m.
15th	11:00 p.m.
22nd	10:30 p.m.
29th	10:00 p.m.

Planet positions are for the 15th.



Legend:
CONSELLATIONS
Asterisms
Star & **Planet** names

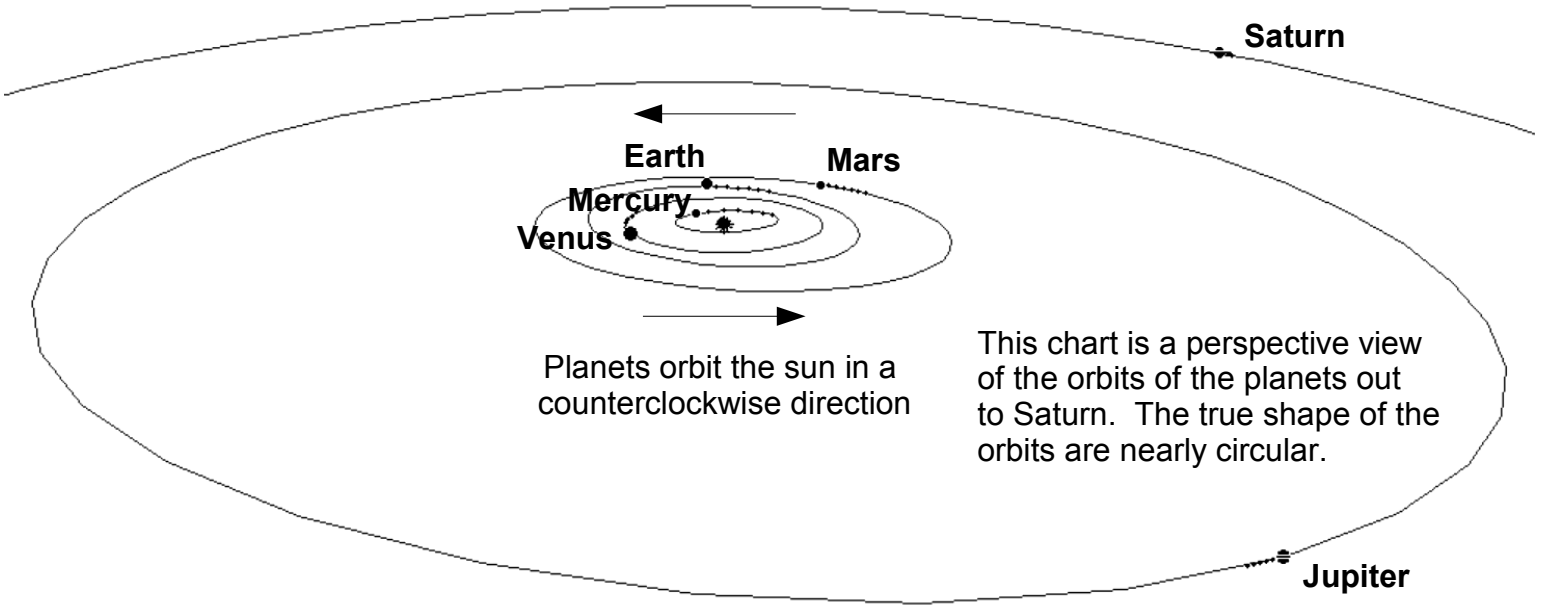
The 11 p.m. chart time is a compromise because astronomical twilight will not have ended. Yet most of the sky will be dark enough for constellations as long as the bright moon isn't out. Saturn is well placed for viewing while Jupiter is about to set on the 15th. Mars has moved to the southwest, and is getting too far away to detect much on its surface. The Summer Triangle is now completely up at chart time. The red giant star Antares is now in the south southeast, the heart of Scorpius as the promise of summer nears. Summer will begin on June 21st at 6:52 a.m.

PlanetFest
Computed by Bob Moler

For more information on planets and stars each month:
http://ephemeris.bjmoler.org

The Naked Eye Planets

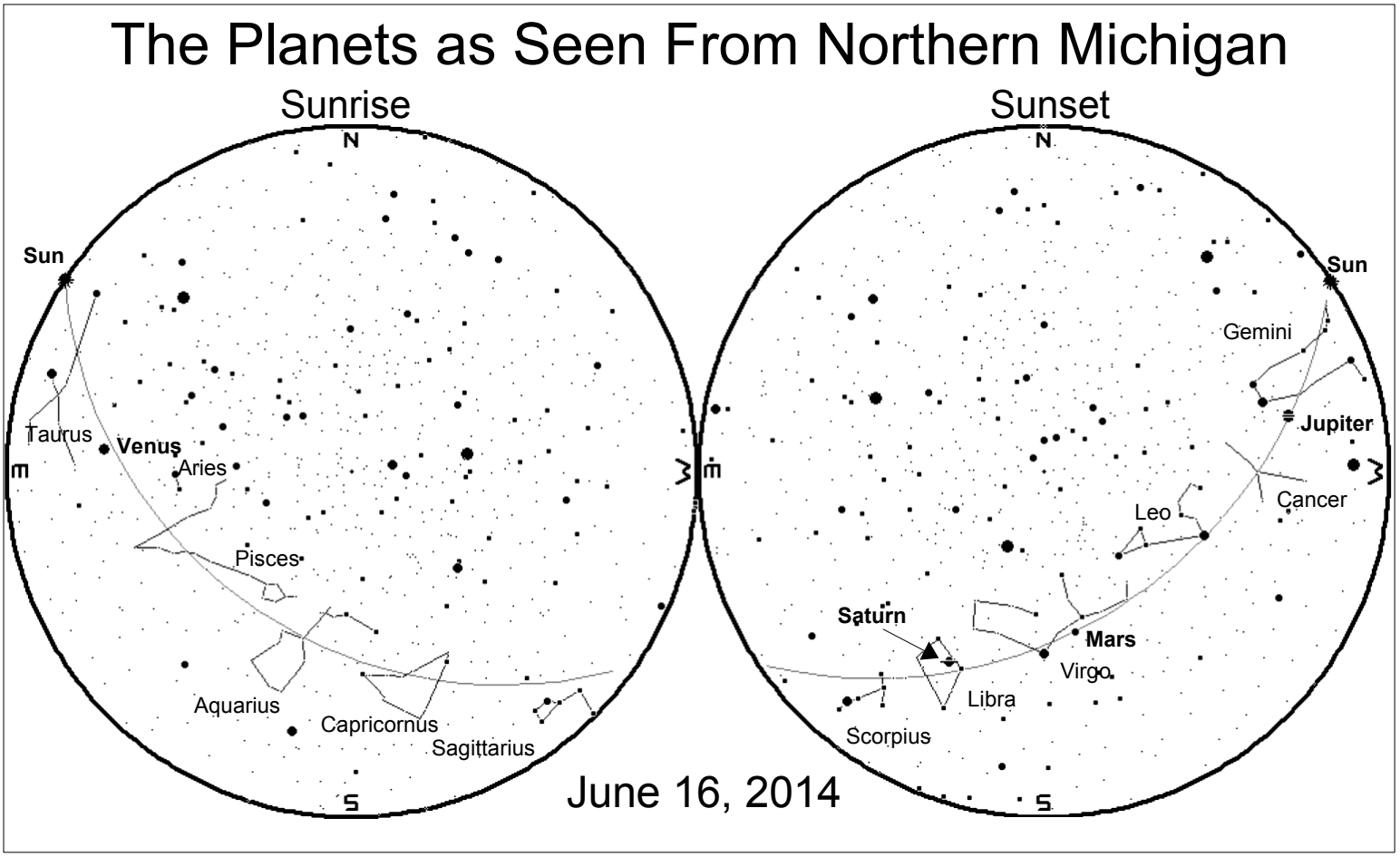
June 1st, 6th, 11th, 16th, 21st, 26th, July 1st



Planets orbit the sun in a counterclockwise direction

This chart is a perspective view of the orbits of the planets out to Saturn. The true shape of the orbits are nearly circular.

The Planets as Seen From Northern Michigan

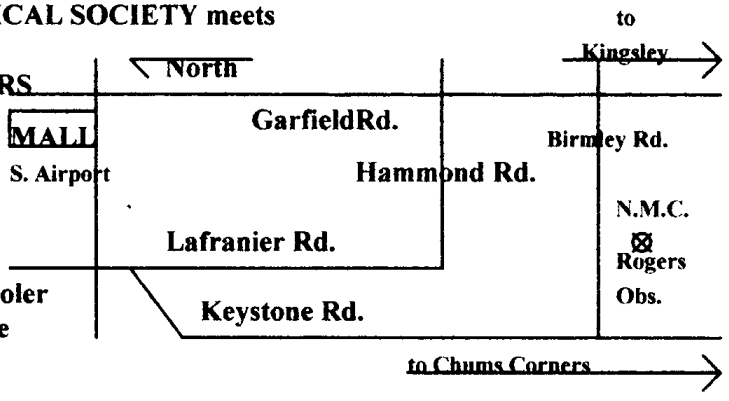


CELESTIAL CALENDAR

Jun 01 4:07 a.m. Jupiter 5.5°N of Moon
03 12:25 a.m. Moon at Apogee: 404956 km
04 1:35 p.m. Regulus 5.0°N of Moon
05 4:39 p.m. FIRST QUARTER MOON
06 7:00 p.m. GTAS Board of Directors Annual Meeting – NMC Obs.
06 8:00 p.m. GTAS Reguler Meeting – NMC Obs.
06 9:00 p.m. Star Party – NMC Obs. 07 20:44 Mars 1.6°N of Moon
07 4:00 p.m. Sun Party - Sleeping Bear Dunes Visitor's Center
07 8:44 p.m. Mars 1.6°N of Moon
07 9:00 p.m. Star Party - Sleeping Bear Dunes Dune Climb parking lot
08 6:05 p.m. Spica 1.8°S of Moon
09 1:36 a.m. Moon at Ascending Node
10 3:11 p.m. Saturn 0.6°N of Moon: Occn.
13 12:11 a.m. FULL MOON
14 11:34 p.m. Moon at Perigee: 362062 km
15 7:57 a.m. Jupiter 6.3°S of Pollux
17 5 p.m.? GTAS Night at La Senorita Garfield St. Location.
19 2:39 p.m. LAST QUARTER MOON
19 7 p.m. Mercury at Inferior Conjunction
21 6:52 a.m. Summer Solstice
21 4:30 p.m. Moon at Descending Node
21 9:00 p.m. Star Party – NMC Obs.
23 9:00 a.m. Venus 5.6°S of Pleiades
24 8:54 a.m. Venus 1.3°N of Moon
25 2:22 a.m. Aldebaran 2.0°S of Moon
27 4:09 a.m. NEW MOON
30 3:09 p.m. Moon at Apogee: 405932 km

Calendar of Astronomical Events Courtesy of Fred Espenak, www.AstroPixels.com

The GRAND TRAVERSE ASTRONOMICAL SOCIETY meets on the first Friday of each month at the NORTHWESTERN MICHIGAN ROGERS OBSERVATORY at 8 p.m. The public is invited to attend all Society functions as our guests. We are a non-profit group dedicated to the study of astronomy and the sky above us. If you would like more information on GTAS, please call Bob Moler at 946-8649, or write to the address on the last page of this publication.



Ephemeris of Sky Events for NMC Observatory

June, 2014 - Local time zone: EDT

Date		Sun			Twilight*		Moon			Illum
		Rise	Set	Hours	End	Start	Phase	R/S**	Time	Fractn
Sun	1	06:00a	09:20p	15:20	11:42p	03:39a		Set	12:09a	17%
Mon	2	05:59a	09:21p	15:21	11:43p	03:38a		Set	12:41a	24%
Tue	3	05:59a	09:22p	15:22	11:45p	03:36a		Set	01:11a	33%
Wed	4	05:59a	09:22p	15:23	11:46p	03:35a		Set	01:39a	42%
Thu	5	05:58a	09:23p	15:25	11:48p	03:34a	F Qtr	Set	02:05a	51%
Fri	6	05:58a	09:24p	15:26	11:49p	03:33a		Set	02:33a	61%
Sat	7	05:57a	09:25p	15:27	11:50p	03:32a		Set	03:01a	71%
Sun	8	05:57a	09:25p	15:28	11:52p	03:31a		Set	03:33a	79%
Mon	9	05:57a	09:26p	15:28	11:53p	03:30a		Set	04:09a	87%
Tue	10	05:57a	09:26p	15:29	11:54p	03:30a		Set	04:51a	94%
Wed	11	05:57a	09:27p	15:30	11:55p	03:29a		Set	05:40a	98%
Thu	12	05:56a	09:28p	15:31	11:56p	03:28a		Set	06:38a	100%
Fri	13	05:56a	09:28p	15:31	11:57p	03:28a	Full	Rise	09:54p	99%
Sat	14	05:56a	09:28p	15:32	11:58p	03:27a		Rise	10:46p	95%
Sun	15	05:56a	09:29p	15:32	11:58p	03:27a		Rise	11:31p	89%
Mon	16	05:56a	09:29p	15:33	11:59p	03:27a		Rise	12:11a	80%
Tue	17	05:56a	09:30p	15:33	11:59p	03:27a		Rise	12:46a	70%
Wed	18	05:56a	09:30p	15:33	12:00a	03:27a		Rise	01:18a	59%
Thu	19	05:56a	09:30p	15:33	12:00a	03:27a	L Qtr	Rise	01:50a	48%
Fri	20	05:57a	09:31p	15:33	12:01a	03:27a		Rise	02:21a	37%
Sat	21	05:57a	09:31p	15:33	12:01a	03:27a		Rise	02:54a	27%
Sun	22	05:57a	09:31p	15:33	12:01a	03:27a		Rise	03:30a	18%
Mon	23	05:57a	09:31p	15:33	12:01a	03:27a		Rise	04:09a	11%
Tue	24	05:58a	09:31p	15:33	12:01a	03:28a		Rise	04:53a	5%
Wed	25	05:58a	09:31p	15:33	12:01a	03:28a		Rise	05:41a	2%
Thu	26	05:58a	09:31p	15:32	12:00a	03:29a		Rise	06:32a	0%
Fri	27	05:59a	09:31p	15:32	12:00a	03:30a	New	Set	09:31p	1%
Sat	28	05:59a	09:31p	15:32	12:00a	03:30a		Set	10:09p	3%
Sun	29	06:00a	09:31p	15:31	11:59p	03:31a		Set	10:43p	7%
Mon	30	06:00a	09:31p	15:30	11:59p	03:32a		Set	11:14p	12%

* Astronomical Twilight

** Moonrise or moonset, whichever occurs between sunset and sunrise

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Grand Traverse Astronomical Society – Membership Application 2014

___ I am interested, please send me more information about the next GTAS meeting.

___ I'll join, payment enclosed Email Address:_____

___ Membership renewal **Newsletter Delivery: ___ Email ___ Mail**

Interests: _____

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Dues: ___ Single Membership $25.00/yr

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Traverse City, MI 49686

WANTED: Astronomers interested in working with Project ASTRO POLARIS.
Willingness to work with K-12 students and teachers. Visiting classrooms and conducting experiments, discussing astronomy interests and events. Sharing your love of astronomy with others. Will provide; training, materials, instuctionals and support.
Please contact: Jerry Dobek Site Coordinator Project ASTRO POLARIS NMC Science & Math 1701 East Front Street Traverse City, MI 49686 email jdobek@nmc.edu phone 946-1787 obsv. 223-4545 home

The Stellar Sentinel
Bob Moler, Editor
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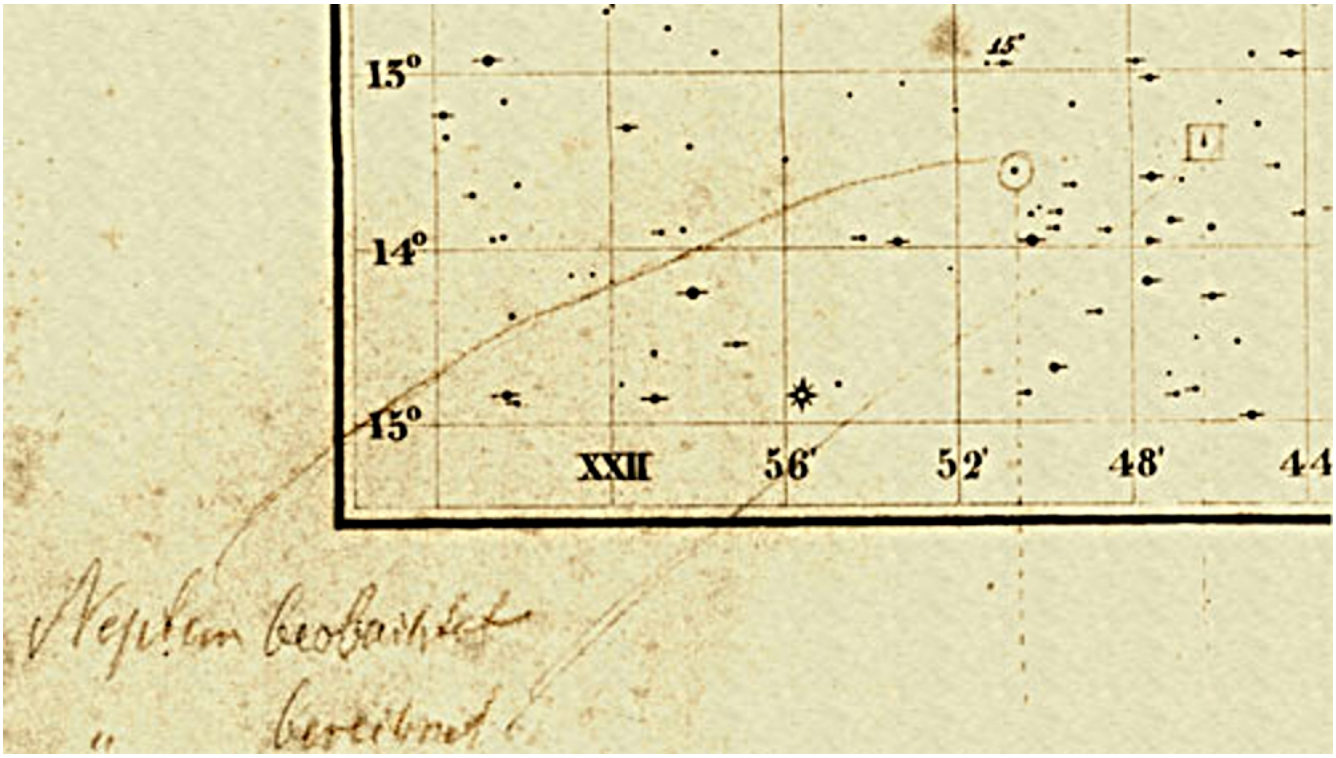
Traverse City, MI 49685

GRAND TRAVERSE ASTRONOMICAL SOCIETY
GTAS

Extras for June 2014

Image for *How Mathematics Discovered Neptune*



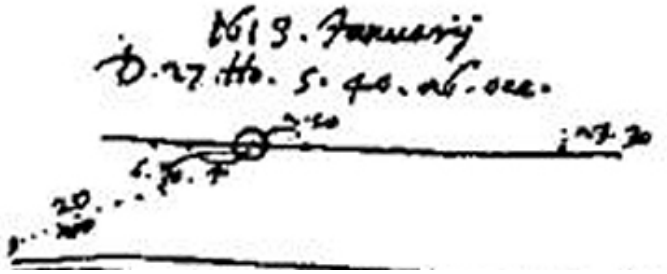
Neptune discovery plotted on a chart after it was discovered and named. The square shows LaVerrier's calculated position. The circle shows the actual position of Neptune when discovered by Galle.

Did Galileo really discover Neptune?

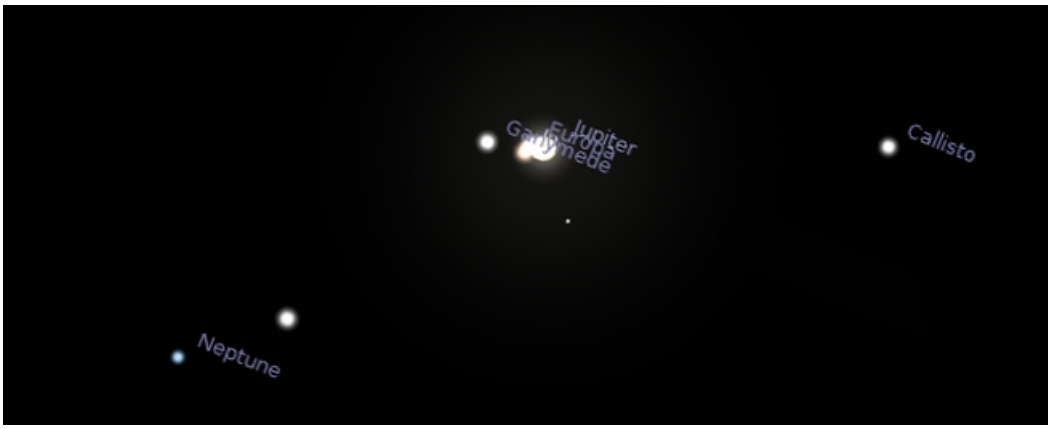
By Bob Moler

Galileo was observing Jupiter in 1612 and 1613 when he noticed a star near Jupiter. He tracked it for some time, but apparently it moved out of his field of view without additional comment. That star was the planet Neptune.

While searching for the image below I found a site that promotes the dea that Galileo actually did discover Neptune first. They were going to search Galileo's writings for an anagram that would decode into a discovery statement. That was a way to establish a discovery without tipping your hand while gathering more evidence an waiting for the discovery to be published.



Galileo's observation of Jupiter including the star at "20" and the "star" at the end of the dotted line. The "star' has been identified as Neptune.



Stellarium view of Jupiter, moons and background stars for January 27, 1613, which matches Galileo's drawing. Created using Stellarium.

Space Place Article

The Hottest Planet in the Solar System

By Dr. Ethan Siegel

When you think about the four rocky planets in our Solar System—Mercury, Venus, Earth and Mars—you probably think about them in that exact order: sorted by their distance from the Sun. It wouldn't surprise you all that much to learn that the surface of Mercury reaches daytime temperatures of up to 800 °F (430 °C), while the surface of Mars never gets hotter than 70 °F (20 °C) during summer at the equator. On both of these worlds, however, temperatures plummet rapidly during the night; Mercury reaches lows of -280 °F (-173 °C) while Mars, despite having a day comparable to Earth's in length, will have a summer's night at the equator freeze to temperatures of -100 °F (-73 °C).

Those temperature extremes from day-to-night don't happen so severely here on Earth, thanks to our atmosphere that's some 140 times thicker than that of Mars. Our average surface temperature is 57 °F (14 °C), and day-to-night temperature swings are only tens of degrees. But if our world were completely airless, like Mercury, we'd have day-to-night temperature swings that were *hundreds* of degrees. Additionally, our average surface temperature would be significantly colder, at around 0 °F (-18 °C), as our atmosphere functions like a blanket: trapping a portion of the heat radiated by our planet and making the entire atmosphere more uniform in temperature.

But it's the *second* planet from the Sun -- Venus -- that puts the rest of the rocky planets' atmospheres to shame. With an atmosphere **93 times as thick as Earth's**, made up almost entirely of carbon dioxide, Venus is the ultimate planetary greenhouse, letting sunlight in but hanging onto that heat with incredible effectiveness. Despite being nearly twice as far away from the Sun as Mercury, and hence only receiving 29% the sunlight-per-unit-area, the surface of Venus is a toasty 864 °F (462 °C), with *no difference* between day-and-night temperatures! Even though Venus takes hundreds of Earth days to rotate, its winds circumnavigate the entire planet every four days (with speeds of 220 mph / 360 kph), making day-and-night temperature differences irrelevant.

Catch the hottest planet in our Solar System all spring-and-summer long in the pre-dawn skies, as it waxes towards its full phase, moving away from the Earth and towards the opposite side of the Sun, which it will finally slip behind in November. A little atmospheric greenhouse effect seems to be exactly what we need here on Earth, but as much as Venus? No thanks!

Check out these "10 Need-to-Know Things About Venus":
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Venus.

Kids can learn more about the crazy weather on Venus and other places in the Solar System at NASA's Space Place: http://spaceplace.nasa.gov/planet-weather.

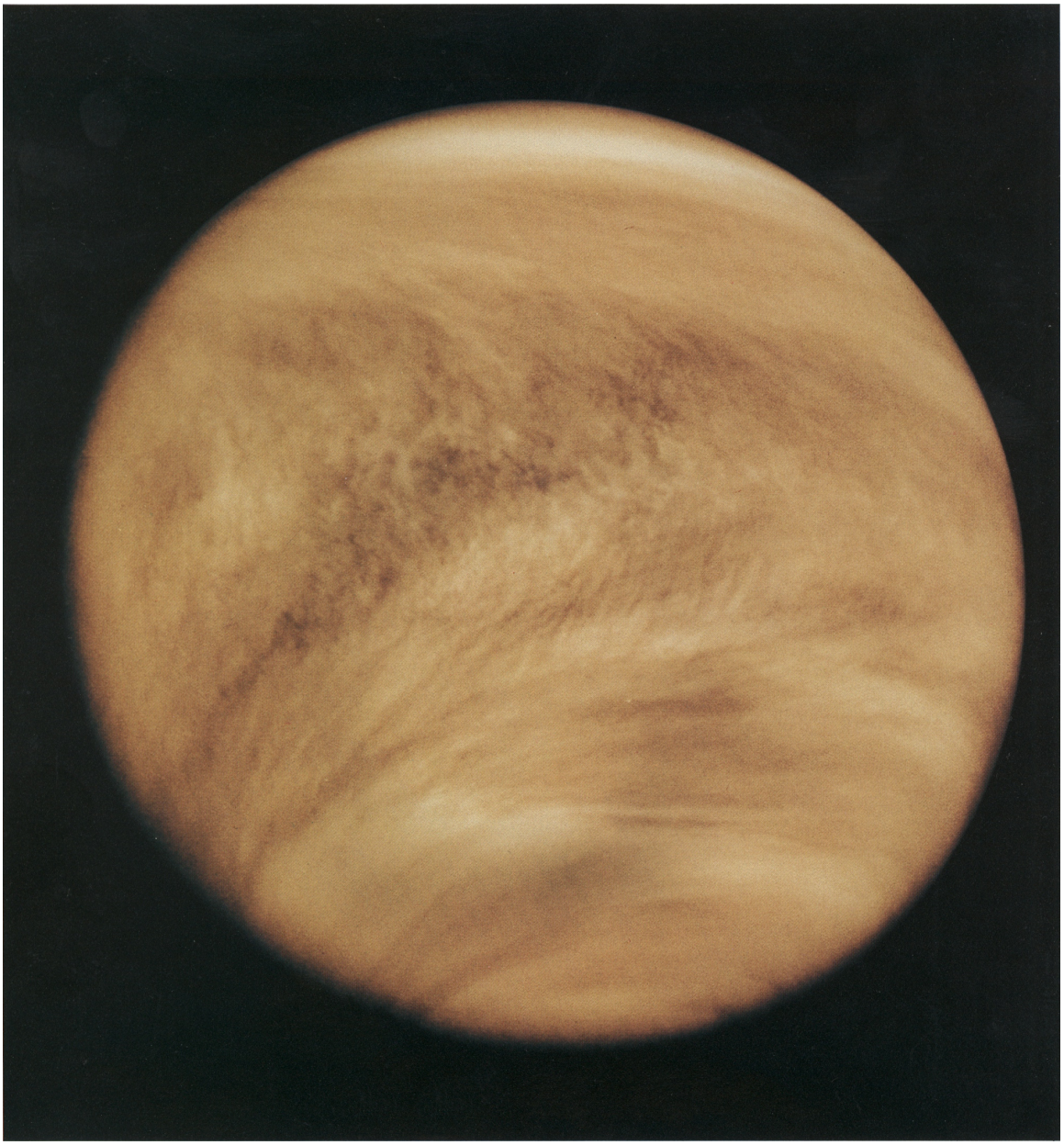


Image credit: NASA's Pioneer Venus Orbiter image of Venus's upper-atmosphere clouds as seen in the ultraviolet, 1979.

Some of the best objects for public viewing in June Continued from page 3

Deep Sky Object, description, constellation, distance	Rt. Asc.	Declin.
	hr. min.	o '
NGC 4565: Edge-on Sb galaxy, Com, about 20m l.y.	12 36.3	+25 59
M 104: Sombrero Galaxy (edge-on Sa), Vir, about 40m l.y.	12 40.0	-11 37
M 3: Globular cluster, CVn, 35-40k l.y.	13 42.2	+28 23
M 51: Whirlpool Galaxy (Face-on Sc), CVn, 35m l.y.	13 29.9	+47 12
M 5: Globular cluster, Ser, 26-27k l.y.	15 18.6	+02 05
M 13: Great Hercules globular cluster, Her, 25k l.y.	16 41.7	+36 28
M 57: Ring Nebula (planetary), Lyr, 1500 l.y.	18 53.6	+33 02
Alberio (β Cygni): Gold and blue double star, Cyg, 160 l.y., actual separation = 400b miles	19 30.3	+27 43