STELLAR SENTINEL
Grand Traverse Astronomical Society
April 2014

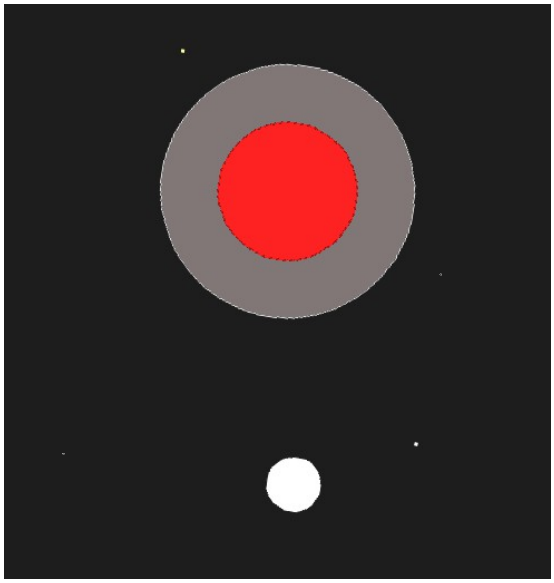
Correction:
Page 2 U2 time has been corrected.

Tax Day Eclipse

By Bob Moler

If you stay up April 14th or get up early on April 15th to watch the total lunar eclipse that morning, make sure your taxes are done, because you might not be good for much of anything during the day on the 15th.

That being said, let's take a look at the what and where of the eclipse. Lunar eclipses only occur at full moon. The Sun, Earth and Moon have to line up so the the Earth casts its shadow on the Moon. This occurs in about one in six full moons. Below is the Moon and the earth's shadow at the March full moon.



On March 16, 2014 the full Moon missed the Earth's shadow, so no eclipse was seen.

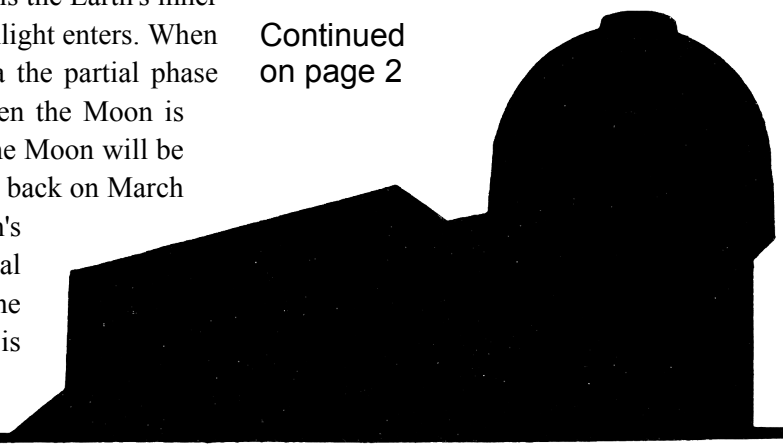
In the illustration above the "bulls-eye" is the Earth's shadow as it would appear at the Moon's distance. The outer gray circle represents the Earth's penumbra, where the sun's light is increasingly blocked by the earth. The umbra (in red for emailed PDF versions of this newsletter) is the Earth's inner shadow where no direct sunlight enters. When the Moon enters the umbra the partial phase of the eclipse begins. When the Moon is entirely within the umbra the Moon will be totally eclipsed. The Moon back on March 16th missed the earth's shadow by passing several degrees south of it. When the moon is in the umbra it is still dimly lit indirectly to some degree by the combined rays of the sun that are refracted through Earth's from all the accumulated sunrises and sunsets occurring around the Earth at that time. Back in 1967 the robotic lunar soft lander Surveyor 3 was able to take some images of the earth during a lunar eclipse. For Surveyor this was a solar eclipse and illustrated the light being refracted around the earth.

Solar eclipse by the Earth as viewed by Surveyer 3, April 24, 1967. Credit: NASA

The current Chinese Chang'e 3, should it survive one more lunar night, has a chance to take a better quality photograph of the eclipsed Sun this April 15th if its camera can tilt far up enough.

The light that illuminates the Moon in the Earth's umbra is generally red in color, though the edge of the umbra generally has a gray cast to it. The light level is so low in the

Continued on page 2

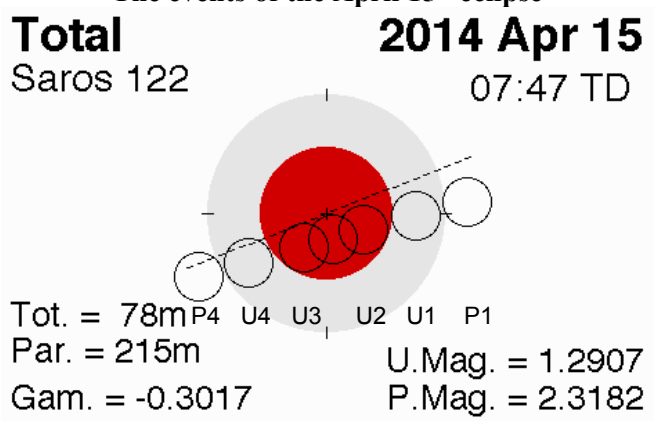


Tax Day Eclipse (Continued from page 1)

umbra, that, to the naked eye, it appears that the Moon is indeed being eaten by something invisible as the ingress partial phase progresses. About three quarters the way in the color of the umbra can be perceived even to the naked eye.

There are exceptions. Two notable lunar eclipse of this person's memory occurred in 1982. On July 6, 1982 the early morning eclipse when the Moon passed centrally through the umbra the Moon was unevenly lit. The top or northern half was much darker than the southern half. In late March and early April that year the El Chichón volcano erupted in southern Mexico sending 20 million metric tons of ash high into the stratosphere. Apparently it masked the light from the northern hemisphere making it into the earth's shadow. That year's December 30th lunar eclipse was exceptionally dark. In fact during totality one had to hunt to find the Moon at all with the naked eye.

The events of the April 15th eclipse



The Moon travels through the Earth's shadow from right to left. What are seen are points of contact with the shadow and mid-eclipse. From Five Millennium Canon of Lunar Eclipses (Espenak & Meeus) NASA.

Contact times are labeled P1, U1, U2, U3, U4, and P4. P2 and P3 are omitted because they are synonymous with U2 and U3 respectively:

- P1 – 12:53:37 a.m. Enter the penumbra (unseen). By about 1:30 the duskiness on the left edge of the Moon will start to be pronounced.
- U1 – 1:58:19 a.m. Enter the umbra (partial eclipse begins).
- U2 – 3:06:47 a.m. Totality begins.
- Mid eclipse 3:49:40 a.m.
- U3 – 4:24:35 a.m. Totality ends, egress partial phase begins.
- U4 – 5:33:04 a.m. Partial phase ends. The Moon's upper right edge should appear dusky for the next half hour or so.
- P4 – 6:37:37 a.m. Penumbral phase ends (unseen).

Note: The duskiness of the penumbral phase of the eclipse can be enhanced by viewing through sunglasses.

Weather permitting there will be two GTAS venues to view this eclipse. The first will be the NMC Rogers Observatory. The second will be at the Sleeping Bear Dunes National Lakeshore in the Dune Climb parking lot on M109. Both start at 1:30 a.m. if it's clear.

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. This saves us money and forestalls dues increases.

To achieve these savings we need your email address. 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.

Society Events

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

April

3 Thursday	**Night at the Nature Center** – our part is from 9:30-10-:30 p.m. - Boardman River Nature Ctr
4 Friday	**Board of Directors Meeting** – 7 p.m. - NMC Rogers Observatory
	General Meeting – 8 p.m. - NMC Rogers Observatory
	Program: **Don Flegel** will explore ***The Far Reaches of the Solar System***
	Star Party: 9 p.m. - 11 p.m. - NMC Rogers Observatory.
15 Tuesday	**Total Lunar Eclipse** – 1:30-5:30 a.m. NMC Rogers Obs. & SBDNL Dune Climb
25 Friday	**Star Party:** 9 p.m. - 11 p.m. - Sleeping Bear Dunes – Dune Climb Parking Lot.
26 Saturday	**Star Party:** 9 p.m. - 11 p.m. - NMC Rogers Observatory.

May

2 Friday	**Board of Directors Meeting** – 7 p.m. - NMC Rogers Observatory
	General Meeting – 8 p.m. - NMC Rogers Observatory
	Program: **Dave Kane** will show how he **built his observatory**
	Star Party: 9 p.m. - 11 p.m. - NMC Rogers Observatory.
9 Friday	**Star Party:** 9 p.m. - 11 p.m. - Sleeping Bear Dunes, Platte River Point.
10 Saturday	**Star Party:** 9 p.m. - 11 p.m. - NMC Rogers Observatory.
16 Friday	**Star Party:** 8:30 p.m. - 11 p.m. - Betsie Valley District Library, Thompsonville.
17 Saturday	**Star Party:** 9 p.m. - 11 p.m. - Interlochen Arts Academy.
18 Sunday	**NMC Barbecue:** 11 a.m. - 5 p.m. - NMC Campus

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

Rogers Observatory star parties for the rest of 2014: 4/4, 4/26, 5/2, 5/10, 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: 4/15 lunar a.m., 10/8 lunar a.m., 10/23 solar p.m.

Sleeping Bear Dunes star parties for the rest of 2014: 4/25, 5/9, 6/7, 7/26, 8/9, 9/13, 10/21. Eclipses: 4/15 lunar a.m., 10/8 lunar a.m., 10/23 solar p.m.

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

Planetary Object(s): Jupiter, Mars late

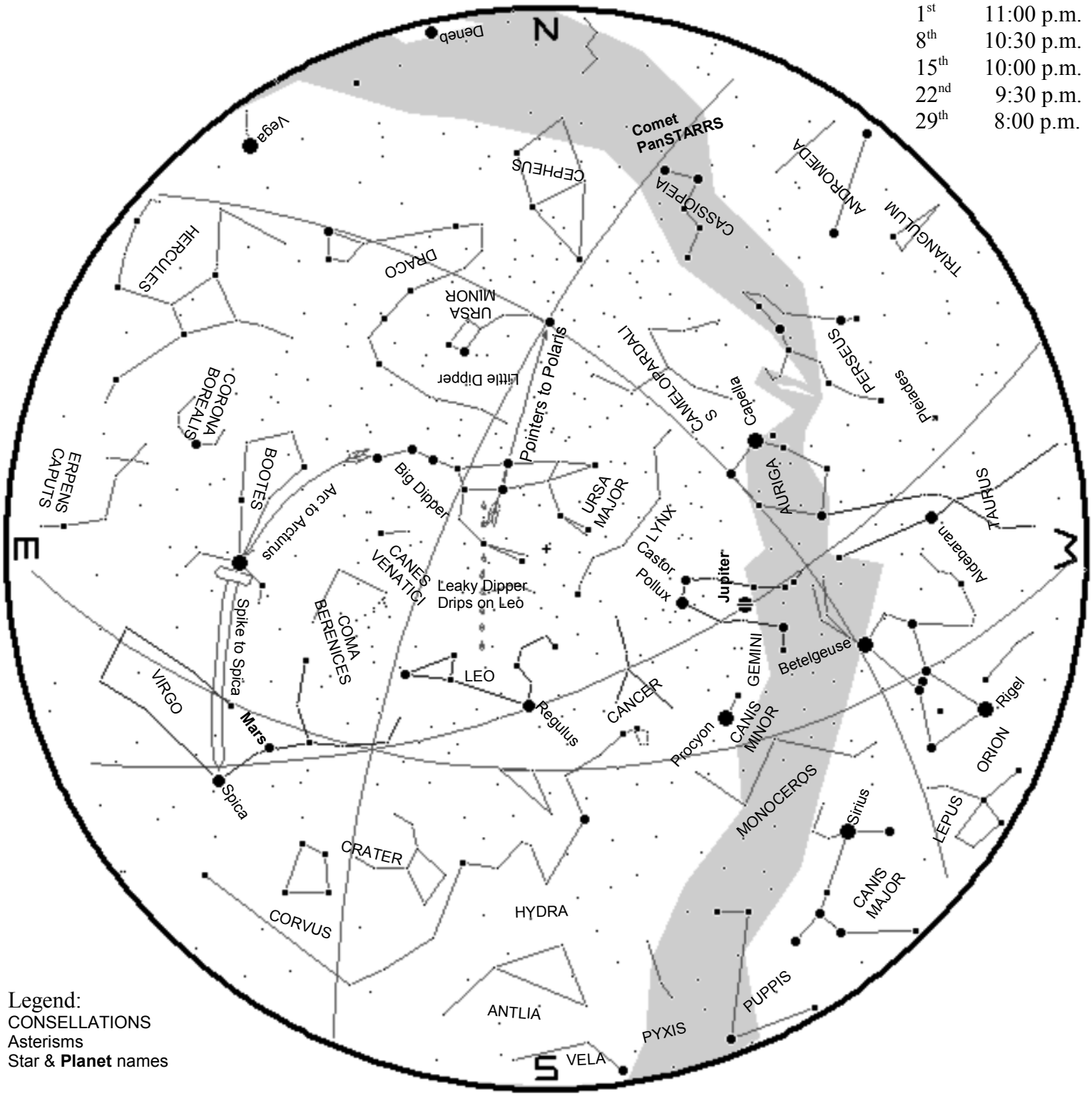
Deep Sky Object, description, constellation, distance	**Rt. Asc.**	**Declin.**
	hr. min.	° '
M 45: Pleiades open cluster - use finder or binoculars, Tau, 410 l.y.	03 47.0	+24 07
M 1: Crab Nebula (supernova remnant), Tau, 6.3k l.y., July 5, 1054 AD	05 34.5	+22 01
M 42: Great Orion Nebula, Ori, 1.5k l.y.	05 35.4	- 05 27
M 35: Open cluster, Gem, 2.8k l.y.	06 08.9	+24 20
β Monocerotis: Triple star, Mon, 150-200 l.y., angular separation = 7.4" & 2.8"	06 28.8	- 07 01
M 41: Open Cluster, CMa, 2.3k l.y.	06 46.0	-20 44
M 44: Beehive or Praesepe open cluster, best seen in finder, Cnc, 525 l.y.	08 40.1	+19 59
M 67: Open cluster, very old, Cnc, 2.7k l.y.	08 50.4	+11 49
M 81: Sb Galaxy, M 82 nearby, UMa, about 12m l.y.	09 55.6	+69 04

The Stars and Planets for April 2014

By Bob Moler

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

1st	11:00 p.m.
8th	10:30 p.m.
15th	10:00 p.m.
22nd	9:30 p.m.
29th	8:00 p.m.



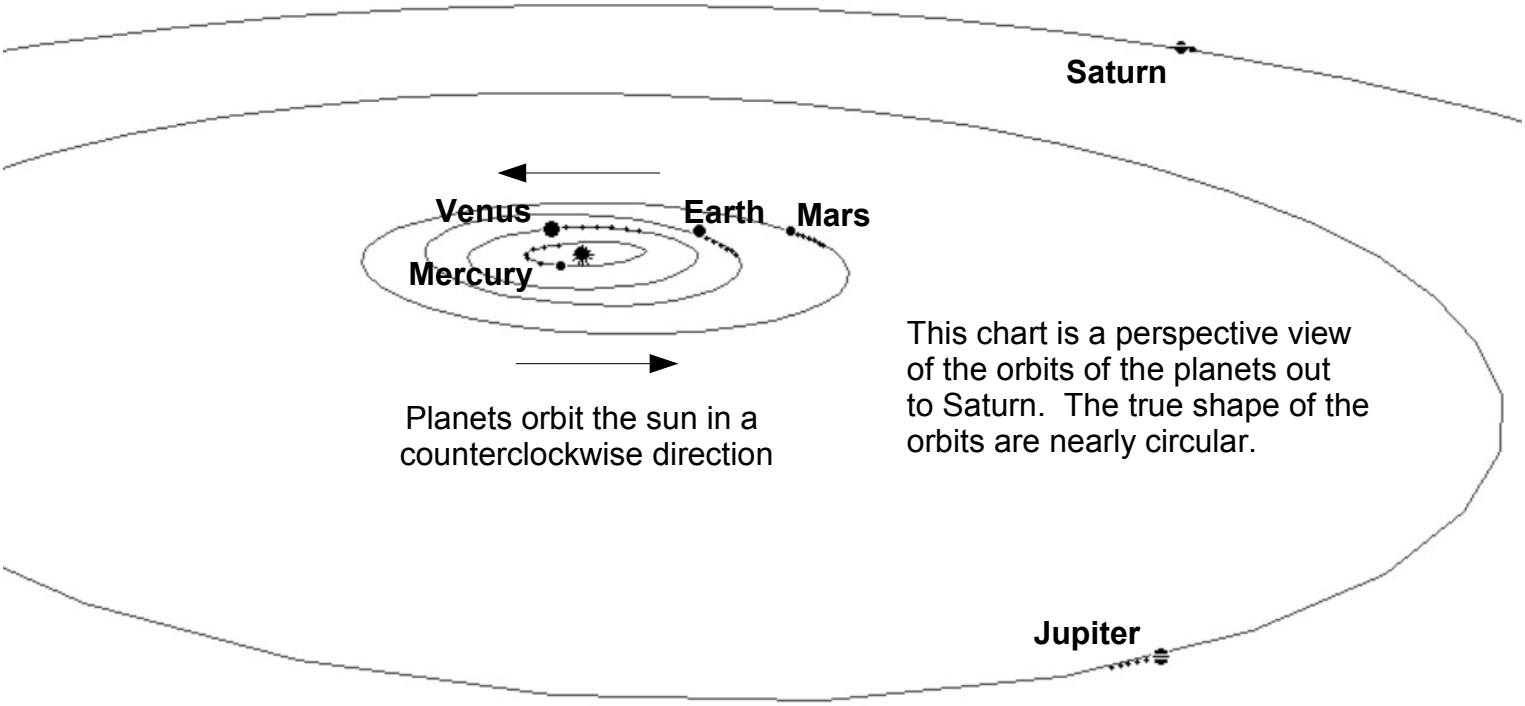
Legend:
CONSELLATIONS
Asterisms
Star & **Planet** names

The constellation of Leo is center stage in the south at chart time. Orion will be actually lost in the twilight by the end of the month as the stars of spring take over the southern sky. Jupiter is in the west in Gemini at chart time, with Mars brighter than it shows here near Spica in Virgo. The Big Dipper serves as a pointer to some of the interesting stars and constellations of spring. Its stars point to the star Polaris the pole star, the constellation Leo, the star Arcturus a bright yellow orange star and by extension blue Spica.

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

The Naked Eye Planets

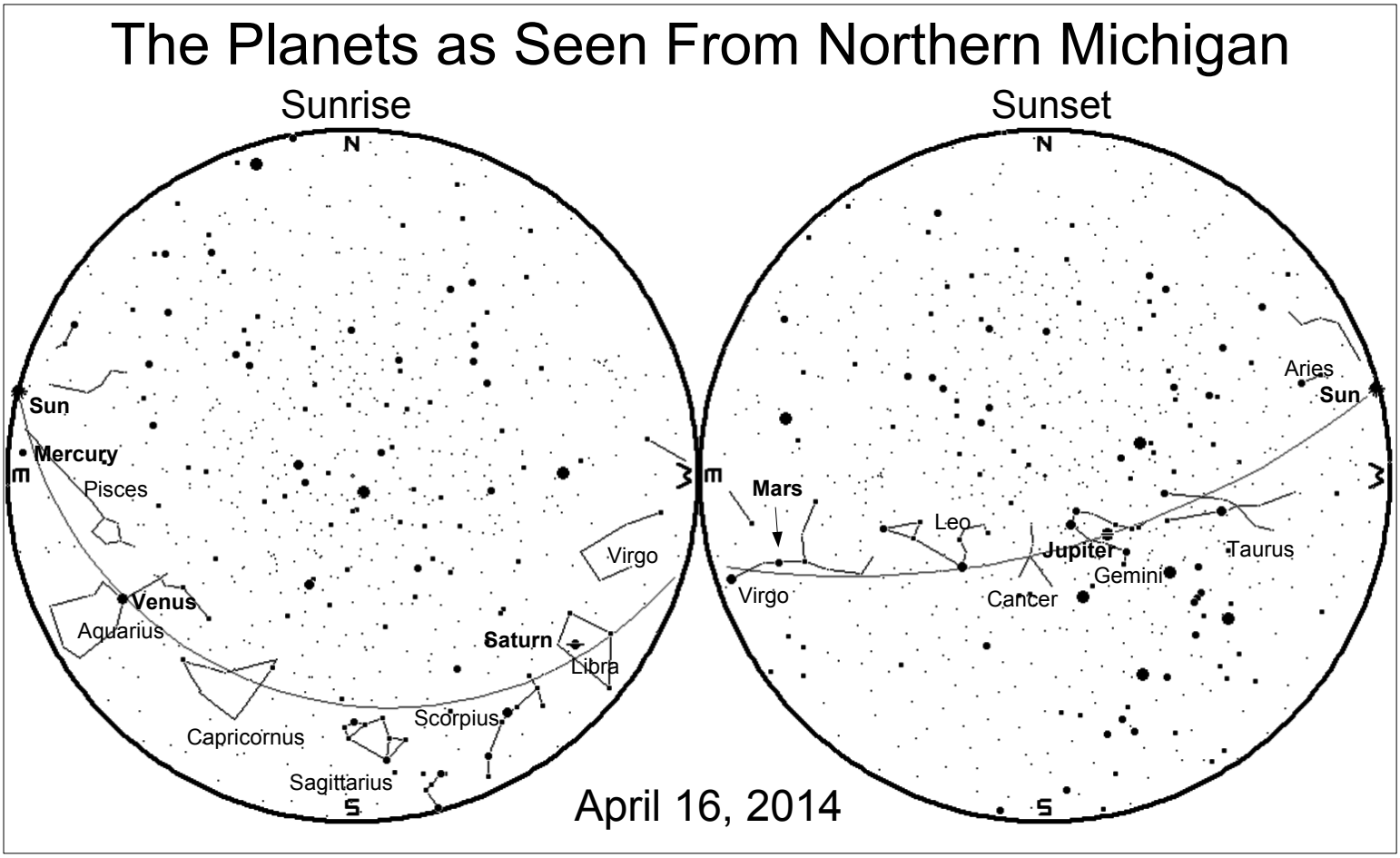
April 1st, 6th, 11th, 16th, 21st, 26th, May 1st



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



April 16, 2014

CELESTIAL CALENDAR

April 2014 – EDT

02	3 a.m.	Uranus in Conjunction with Sun
03	**10:30 p.m.**	**Night at the Nature Center (Private)**
04	2:52 a.m.	Aldebaran 2.0°S of Moon
04	**8:00 p.m.**	**GTAS Monthly Meeting – NMC Observatory**
04	**9:00 p.m.**	**Star Party – NMC Observatory**
06	6:25 p.m.	Jupiter 5.4°N of Moon
07	4:31 a.m.	FIRST QUARTER MOON
08	10:52 a.m.	Moon at Apogee: 404503 km
08	4 p.m.	Mars at Opposition
10	9:26 p.m.	Regulus 5.2°N of Moon
14	2:24 p.m.	Mars 3.5°N of Moon
14	11:57 p.m.	Spica 1.7°S of Moon
15	3:42 a.m.	FULL MOON
15	**3:47 a.m.**	**Total Lunar Eclipse (midpoint); mag=1.296 ***
15	9:22 a.m.	Moon at Ascending Node
17	3:42 a.m.	Saturn 0.4°N of Moon: Occn.
22	3:52 a.m.	LAST QUARTER MOON
22	1 p.m.	Lyrid Meteor Shower
22	8:27 p.m.	Moon at Perigee: 369765 km
25	7:16 p.m.	Venus 4.4°S of Moon
25	11 p.m.	Mercury at Superior Conjunction
25	**9:00 p.m.**	**Star Party – Sleeping Bear Dunes, Dune Climb**
26	**9:00 p.m.**	**Star Party – NMC Observatory**
28	7:36 a.m.	Moon at Descending Node
29	2:04 a.m.	Non-Central Annular Solar Eclipse; mag=0.982 **
29	2:14 a.m.	NEW MOON

*** See page 2 for times & page 3 for viewing locations**

**** Visible only in Antarctica, S. Chile and Argentina**

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

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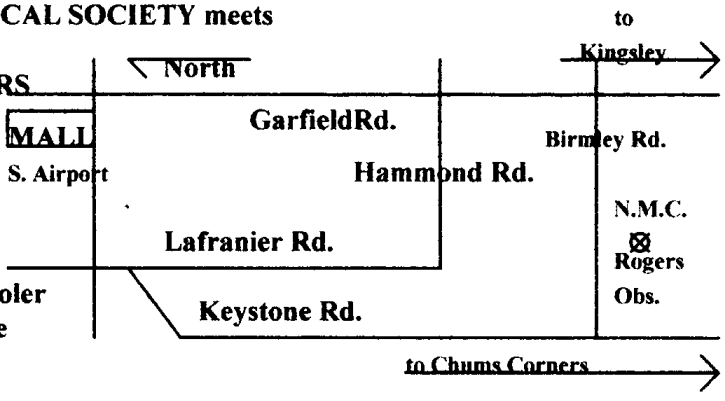
The GRAND TRAVERSE ASTRONOMICAL SOCIETY meets on the first Friday of each month at the NORTHWESTERN MICHIGAN ROGERS OBSERVATORY at 8 p.m. The public is invited to attend all Society functions as our guests. We are a non-profit group dedicated to the study of astronomy and the sky above us. If you would 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										
April, 2014 - Local time zone: EDT										
Date		**Sun**			**Twilight***		**Moon**			**Illum**
		Rise	**Set**	**Hours**	**End**	**Start**	**Phase**	**R/S****	**Time**	**Fractn**
Tue	1	07:23a	08:09p	12:46	09:51p	05:42a		Set	10:37p	6%
Wed	2	07:21a	08:11p	12:49	09:52p	05:40a		Set	11:41p	12%
Thu	3	07:19a	08:12p	12:52	09:54p	05:38a		Set	12:39a	19%
Fri	4	07:17a	08:13p	12:55	09:56p	05:36a		Set	01:32a	28%
Sat	5	07:16a	08:14p	12:58	09:57p	05:33a		Set	02:19a	37%
Sun	6	07:14a	08:16p	13:01	09:59p	05:31a		Set	03:01a	47%
Mon	7	07:12a	08:17p	13:04	10:00p	05:29a	F Qtr	Set	03:37a	56%
Tue	8	07:10a	08:18p	13:07	10:02p	05:27a		Set	04:10a	65%
Wed	9	07:08a	08:19p	13:11	10:04p	05:25a		Set	04:40a	74%
Thu	10	07:07a	08:21p	13:14	10:05p	05:23a		Set	05:09a	82%
Fri	11	07:05a	08:22p	13:17	10:07p	05:20a		Set	05:36a	89%
Sat	12	07:03a	08:23p	13:20	10:09p	05:18a		Set	06:04a	94%
Sun	13	07:01a	08:24p	13:23	10:10p	05:16a		Set	06:33a	98%
Mon	14	07:00a	08:26p	13:26	10:12p	05:14a		Set	07:05a	100%
Tue	15	06:58a	08:27p	13:29	10:14p	05:11a	Full	Rise	09:08p	99%
Wed	16	06:56a	08:28p	13:31	10:16p	05:09a		Rise	10:14p	97%
Thu	17	06:54a	08:29p	13:34	10:17p	05:07a		Rise	11:19p	92%
Fri	18	06:53a	08:31p	13:37	10:19p	05:05a		Rise	12:21a	84%
Sat	19	06:51a	08:32p	13:40	10:21p	05:03a		Rise	01:17a	75%
Sun	20	06:49a	08:33p	13:43	10:23p	05:00a		Rise	02:08a	65%
Mon	21	06:48a	08:34p	13:46	10:25p	04:58a		Rise	02:52a	54%
Tue	22	06:46a	08:36p	13:49	10:26p	04:56a	L Qtr	Rise	03:31a	42%
Wed	23	06:45a	08:37p	13:52	10:28p	04:54a		Rise	04:06a	31%
Thu	24	06:43a	08:38p	13:55	10:30p	04:52a		Rise	04:39a	21%
Fri	25	06:41a	08:39p	13:57	10:32p	04:49a		Rise	05:11a	13%
Sat	26	06:40a	08:41p	14:00	10:34p	04:47a		Rise	05:43a	6%
Sun	27	06:38a	08:42p	14:03	10:36p	04:45a		Rise	06:17a	2%
Mon	28	06:37a	08:43p	14:06	10:38p	04:43a		Rise	06:53a	0%
Tue	29	06:35a	08:44p	14:09	10:39p	04:41a	New	Set	09:24p	1%
Wed	30	06:34a	08:45p	14:11	10:41p	04:39a		Set	10:25p	3%
* Astronomical Twilight										
** Moonrise or moonset, whichever occurs between sunset and sunrise										

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: _____

Name: _____ Telephone: _____

Address: _____

Street City State ZIP

Dues: ___ Single Membership $25.00/yr

___ Family.....$30.00/yr

___ Student (up to 18 years age)....$15.00/yr

Addl: ___ Sky & Telescope Magazine.....$32.95/yr

Mail check to: G.T.A.S.

Gary Carlisle, Treasurer

1473 Birmley Road

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

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GRAND TRAVERSE ASTRONOMICAL SOCIETY
GTAS

April 2014 Stellar Sentinel Extras

Contents

2014 A Year of Eclipses

By Bob Moler

(Reprinted from the January 2014 issue of the Stellar Sentinel)

After a drought in visible eclipses seen from our part of the planet last year and a single partial solar eclipse the year before, we have a chance, weather permitting, to view two total lunar eclipses and the first half of a partial solar eclipse this year. OK, we did have a penumbral lunar eclipse last year, but I usually don't count penumbral eclipses, since the casual observer may look at the moon and not know they are occurring. They're what I call a 5 o'clock shadow eclipse, where parts of the moon are illuminated by a partially blocked sun. There is no obvious dragon or Cookie Monster nibbling at the moon.

Eclipse Seasons

In 2014 the two eclipse seasons are in April and again in October. These are about six months apart centered around the moon's ascending and descending nodes, where the plane of the Moon's orbit crosses the Earth's orbital plane when the new moon's shadow can fall upon the earth and the earth's shadow can fall on the full moon.

The line of nodes regresses westward or clockwise slowly in an 18.6 year period. That means that the eclipse seasons slowly move backward through the calendar. Every time the sun passes a node there are either two or rarely, three eclipses. Either one each of lunar and solar separated by two weeks from the other. Or, rarely, a central eclipse with 2 weeks before and two weeks later a very partial eclipse near the poles in the case of solar eclipses or penumbral eclipses in the case of lunar eclipses. 2014 is a year of two total lunar eclipses and two partial solar eclipses near the poles.

Saros

A means of predicting eclipses was developed by the Chaldeans in what is now Iraq some centuries before the common era (BC or BCE). The Greeks learned of it. Hipparchus and Ptolemy knew of it. Solar and lunar eclipses repeat every 18 years 11 1/3 days. This cycle was called the Saros by Sir Edmund Halley of Halley's Comet fame, then Astronomer Royal in England.

The saros is the near coincidence of 3 lunar “months”: the Synodic Month, or lunation the period between new moons; the Draconic Month, the period between the moon's passage of the ascending node of its orbit as explained above; and the Anomalistic Month, the period between passages of the moon through perigee, the closest point in its orbit to the earth.

The synodic month is on average 29.530589 days, and the basis for the Jewish and Islamic lunar calendars.

The draconic month is 27.212220 days long on average. The ascending node regresses westward, so meets the moon, traveling eastward than the synodic month, where it has to catch up with the eastward moving sun. Remember the dragon eating the sun image from above. The ancients thought a dragon lived at the nodes to devour the Sun or Moon in eclipses. The symbol for the ascending node "☊" is called the Dragon's Head. For the descending node the symbol is inverted and called the Dragon's Tail. These symbols may be seen on orbital diagrams.

The anomalistic month is 27.554551 days. In celestial mechanics an anomaly doesn't means anything is wrong, it's the angle between, in the case of the moon, the perigee of its orbit and the position of the moon as seen from the earth. It has to do with the perigee and that's why it's used.

It turns out that:

223 Synodic Months = 6585.322 days
242 Draconic Months = 6585.8 days
239 Anomalistic months = 6585.5 days

Thus the Saros cycle is 6585.322 days long, or 18 years 11 1/3 days, meaning that the next eclipse of that Saros occurs a third of the earth in longitude west of the previous eclipse. It takes three saros cycles for an eclipse to repeat near the same longitude. For instance, my first total solar eclipse was viewed from Quebec on July 20, 1963. The third Saros of that eclipse will occur on August 21, 2017. I expect to be around to see that, my 5th total solar eclipse. The path will shift southward and be seen across the continental United States.

There are something like 40 Saros cycles active at one time. Eclipses at the descending node head southward each eclipse, while those at the ascending node move northward.

The Eclipses of 2014

Here are the dates of the eclipses:

- Total Lunar Eclipse April 15, 2014
- Total Lunar Eclipse October 8, 2014
- Partial Solar Eclipse October 23, 2014

Interestingly, all these eclipses will occur in the western part of the sky for us in northern Michigan. Both October eclipses will end with the eclipsed body setting before the official end of the eclipse. This means that both lunar eclipses are early morning eclipses and the solar eclipse will be a late afternoon eclipse.

Lunar eclipses start and end with the moon traveling through the earth's penumbral shadow. It's been my experience that this shadow only becomes visible in the half hour before and after the partial phases of the eclipse. The partial phase of the Tuesday April 15th lunar eclipse will start at 1:58 a.m., totality starts at 3:06 and ends at 4:24; with the partial phase ending at 5:33 as twilight begins to brighten.

The Wednesday October 8th lunar eclipse will start later in the morning. The partial phase will start at 5:14 a.m. Totality will run from 6:25 to 7:24 a.m. all in the growing morning twilight. Sunrise and moonset will interrupt the eclipse by 7:57.

The partial solar eclipse is on Thursday October 23. The eclipse will begin around 5:33 p.m. for Traverse City with sunset at 6:44. Times and whether the eclipse is visible at all depend on the location of the observer.

FIGURE 1

Total Lunar Eclipse of 2014 Apr 15

Ecliptic Conjunction = 07:43:24.8 TD (= 07:42:17.6 UT)
Greatest Eclipse = 07:46:47.0 TD (= 07:45:39.8 UT)

Penumbral Magnitude = 2.3183 P. Radius = 1.2267° Gamma = -0.3017
Umbral Magnitude = 1.2907 U. Radius = 0.6952° Axis = 0.2863°

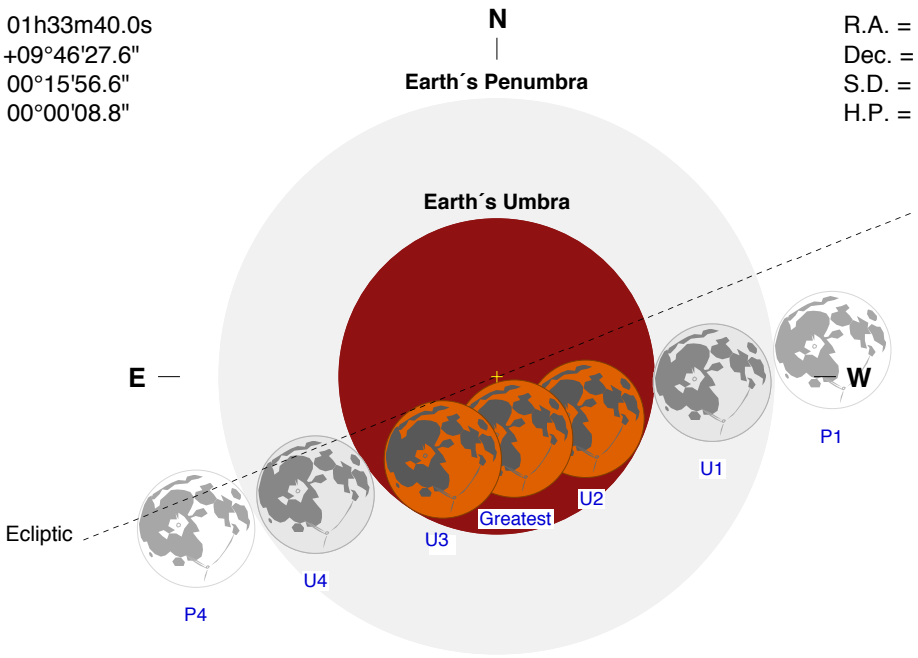
Saros Series = 122 Member = 56 of 75

Sun at Greatest Eclipse
(Geocentric Coordinates)

R.A. = 01h33m40.0s
Dec. = +09°46'27.6"
S.D. = 00°15'56.6"
H.P. = 00°00'08.8"

Moon at Greatest Eclipse
(Geocentric Coordinates)

R.A. = 13h33m21.1s
Dec. = -10°02'59.8"
S.D. = 00°15'30.9"
H.P. = 00°56'56.4"



Eclipse Durations

Penumbral = 05h44m00s
Umbral = 03h34m44s
Total = 01h17m48s

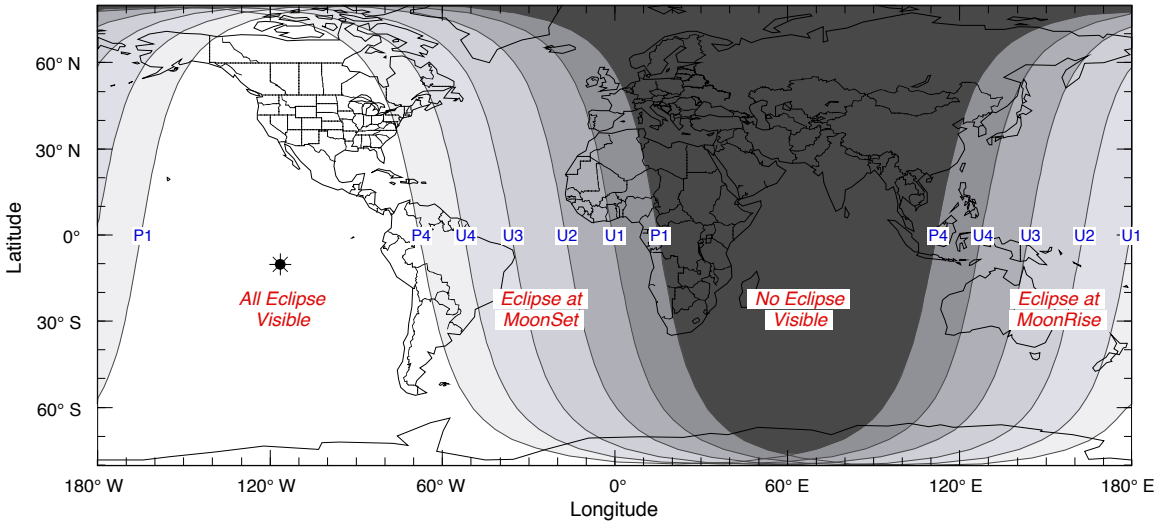
ΔT = 67 s
Rule = CdT (Danjon)
Eph. = VSOP87/ELP2000-85

0 15 30 45 60
Arc-Minutes

F. Espenak, NASA's GSFC
eclipse.gsfc.nasa.gov/eclipse.html

Eclipse Contacts

P1 = 04:53:37 UT
U1 = 05:58:19 UT
U2 = 07:06:47 UT
U3 = 08:24:35 UT
U4 = 09:33:04 UT
P4 = 10:37:37 UT



"Eclipses During 2014", F. Espenak, **Observer's Handbook - 2014**, Royal Astronomical Society of Canada

Old Tool, New Use: GPS and the Terrestrial Reference Frame

By Alex H. Kasprak

Flying over 1300 kilometers above Earth, the Jason 2 satellite knows its distance from the ocean down to a matter of centimeters, allowing for the creation of detailed maps of the ocean's surface. This information is invaluable to oceanographers and climate scientists. By understanding the ocean's complex topography—its barely perceptible hills and troughs—these scientists can monitor the pace of sea level rise, unravel the intricacies of ocean currents, and project the effects of future climate change.

But these measurements would be useless if there were not some frame of reference to put them in context. A terrestrial reference frame, ratified by an international group of scientists, serves that purpose. "It's a lot like air," says JPL scientist Jan Weiss. "It's all around us and is vitally important, but people don't really think about it." Creating such a frame of reference is more of a challenge than you might think, though. No point on the surface of Earth is truly fixed.

To create a terrestrial reference frame, you need to know the distance between as many points as possible. Two methods help achieve that goal. Very-long baseline interferometry uses multiple radio antennas to monitor the signal from something very far away in space, like a quasar. The distance between the antennas can be calculated based on tiny changes in the time it takes the signal to reach them. Satellite laser ranging, the second method, bounces lasers off of satellites and measures the two-way travel time to calculate distance between ground stations.

Weiss and his colleagues would like to add a third method into the mix—GPS. At the moment, GPS measurements are used only to tie together the points created by very long baseline interferometry and satellite laser ranging together, not to directly calculate a terrestrial reference frame.

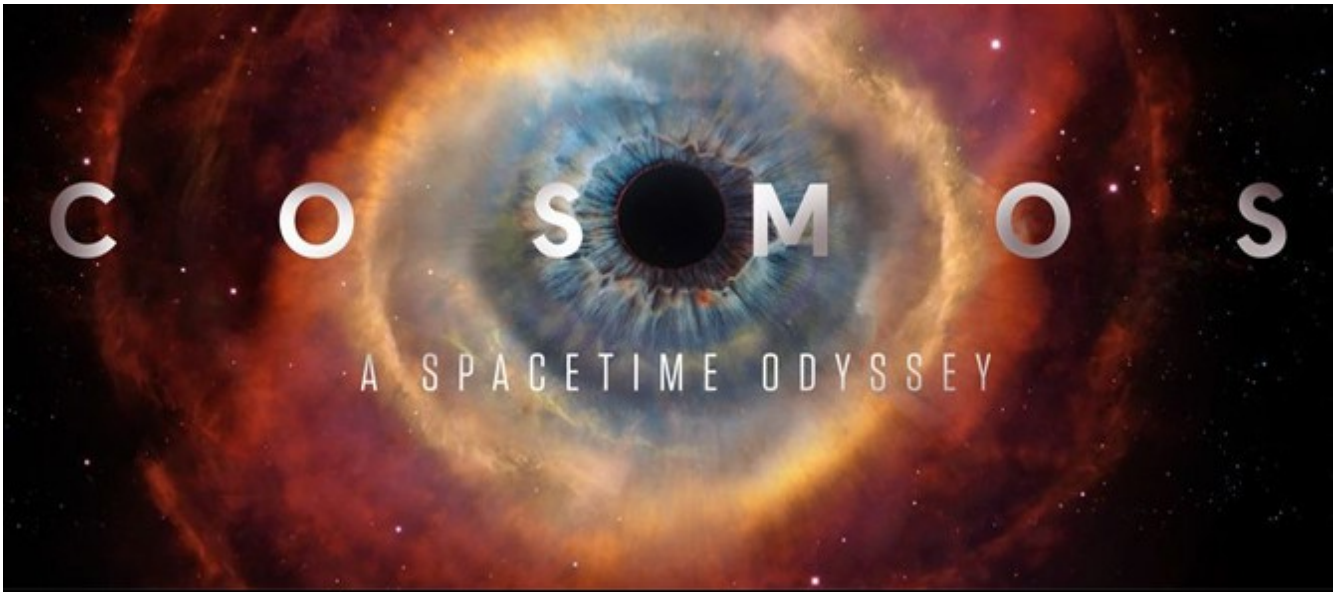
"There hasn't been a whole lot of serious effort to include GPS directly," says Weiss. His goal is to show that GPS can be used to create a terrestrial reference frame on its own. "The thing about GPS that's different from very-long baseline interferometry and satellite laser ranging is that you don't need complex and expensive infrastructure and can deploy many stations all around the world."

Feeding GPS data directly into the calculation of a terrestrial reference frame could lead to an even more accurate and cost effective way to reference points geospatially. This could be good news for missions like Jason 2. Slight errors in the terrestrial reference frame can create significant errors where precise measurements are required. GPS stations could prove to be a vital and untapped resource in the quest to create the most accurate terrestrial reference frame possible. "The thing about GPS," says Weiss, "is that you are just so data rich when compared to these other techniques."

You can learn more about NASA's efforts to create an accurate terrestrial reference frame here: http://space-geodesy.nasa.gov/.

Kids can learn all about GPS by visiting http://spaceplace.nasa.gov/gps and watching a fun animation about finding pizza here: http://spaceplace.nasa.gov/gps-pizza.

Artist's interpretation of the Jason 2 satellite. To do its job properly, satellites like Jason 2 require as accurate a terrestrial reference frame as possible. Image courtesy: NASA/JPL-Caltech.



From the Bob Moler's Ephemeris Blog: http://bobmoler.wordpress.com

Unless you've been living under a rock for the past few months, you are aware of the new Cosmos series that's been broadcast on Fox and National Geographic Channels. The title is Cosmos, a Spacetime Odyssey, and it's hosted by New York's Hayden Planetarium director Neil deGrasse Tyson. If the TV is not your thing there are free apps for the iPhone, iPad and Android devices to view the programs. Also there's a web site cosmosontv.com, where the episodes can be replayed. However it looks like each episode will be only be available for something like 8 weeks from the air date. It's on Fox TV at 9 p.m. on Sundays, National Geographic Channel at 10 p.m. on Mondays. Cosmos: A Spacetime Odyssey is a really great series, a worthy successor to Carl Sagan's original Cosmos series 34 years ago.

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From someone in Traverse City: I have a Meade 8" telescope with heave duty field tripod with equatorial wedge and drive. It includes 8 eye pieces with a hard case. This is a nice telescope at a good price, but I don't get to use it much so I an selling it.

More Information etc: http://nmi.craigslist.org/for/4388891313.html