STELLAR SENTINEL
Grand Traverse Astronomical Society January 2014

2014: A Year of Eclipses

By Bob Moler

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

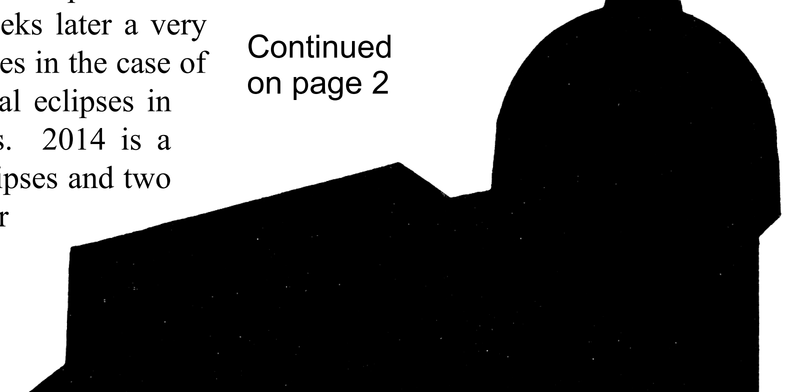
A means of predicting eclipses was developed by the Chaldeans in what is now Iraq some centuries before the common era (BC or BCE). The Greeks learned of it. Hipparchus and Ptolemy knew of it. Solar and lunar eclipses repeat every 18 years 11 1/3 days. This cycle was called the Saros by Sir Edmund Halley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

Continued on page 2



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.

Diagrams for all these eclipses will be included with the emailed copy of this edition of the Stellar Sentinel, and on the members section of the (gtastro.org/members) website.

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Postage rates are going to rise again soon, so your editor has been working to digitize the *Stellar Sentinel* and put it into Adobe Acrobat (PDF) format to read and print using the free Acrobat viewer on your computer to save money and forestall dues increases.

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Society Events

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

January

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

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

Program: Richard Kuschell – ***Aristotle's Mistake***

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

14 Tuesday **Greenspire School Family STEM Night**

February

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

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

Program: Tentative – ***Star Bowl NMCAC vs. GTAS***

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

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

Rogers Observatory star parties for 2014: 1/3, 2/7, 3/7, 3/22, 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: To be determined.

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

Planetary Object(s): Jupiter

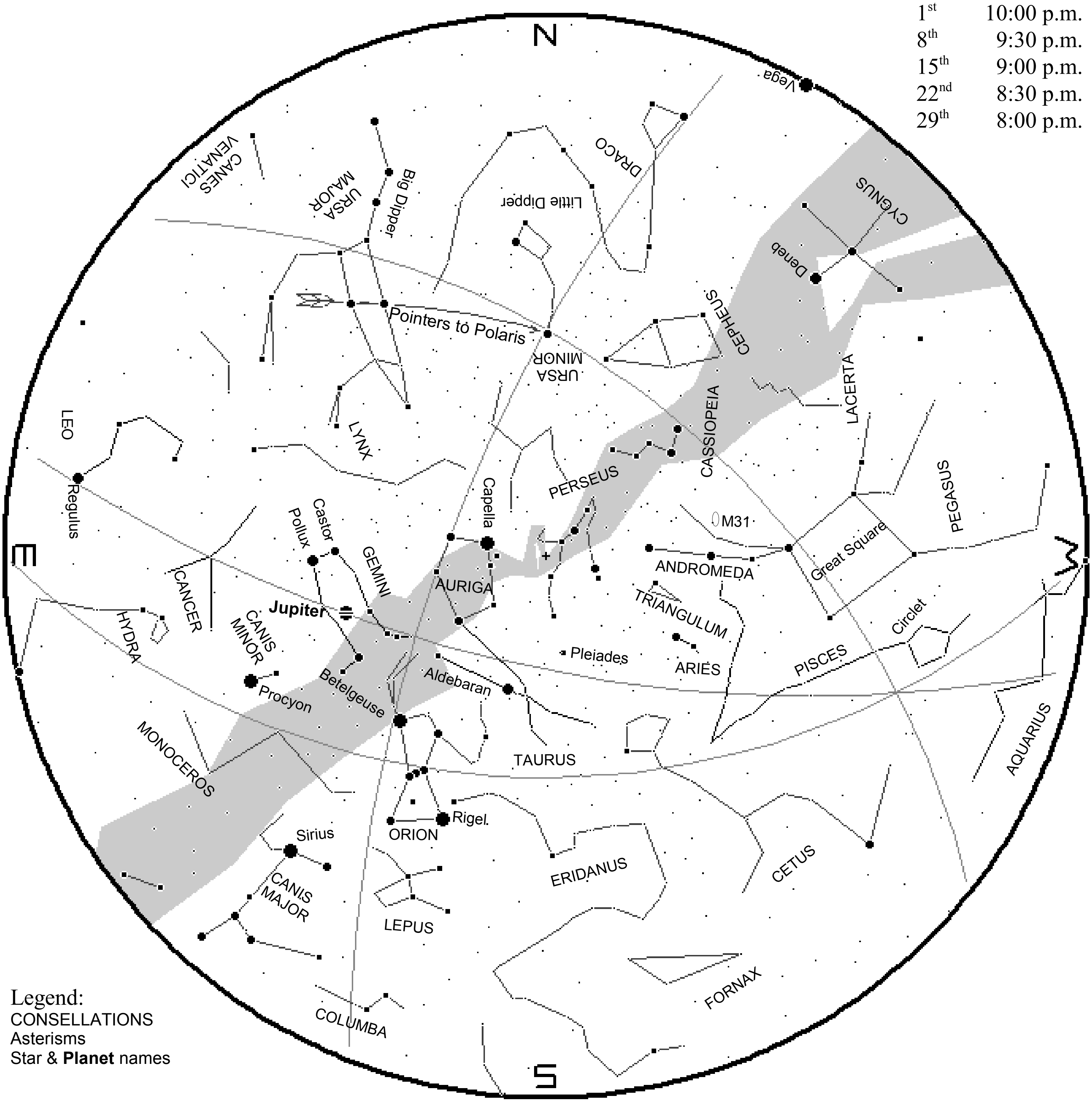
Deep Sky Object, description, constellation, distance	**Rt. Asc.**	**Declin.**
	hr. min.	° '
M 31: Great Andromeda Galaxy, And, 2.3m l.y.	00 42.7	+41 16
M52: Rich open cluster, Cas,5.5k l.y.	23 24.2	+61 35
Almach (γ Andromedae): Yellow and greenish-blue double star, And, 260 l.y.	02 03.2	+42 17
χ & h Persei: Double Cluster, Per, 7k l.y.; χ Per, 8.1k l.y.	02 20.0	+57 08
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
M 82: Ip Exploding galaxy, companion of M 81, UMa, about 12m l.y.	09 55.8	+69 41

The Stars and Planets for January 2014

By Bob Moler

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

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



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

The central constellation of winter, Orion the hunter, is moving to take its place in the south of our evening sky now. It has two of the seven first magnitude stars of winter in the brilliant Winter Circle. The planet Jupiter holds forth near the Hyades, the face of Taurus the bull and the beautiful Pleiades. At chart time the autumn stars are setting toward the west. Only the tail end of Cygnus of the summer stars survives in the northwest. The spring constellation of Leo, or at least the front part of him called the Sickle has cleared the horizon. Jupiter is the planet to observe at chart time. It is brighter than any of the winter stars.

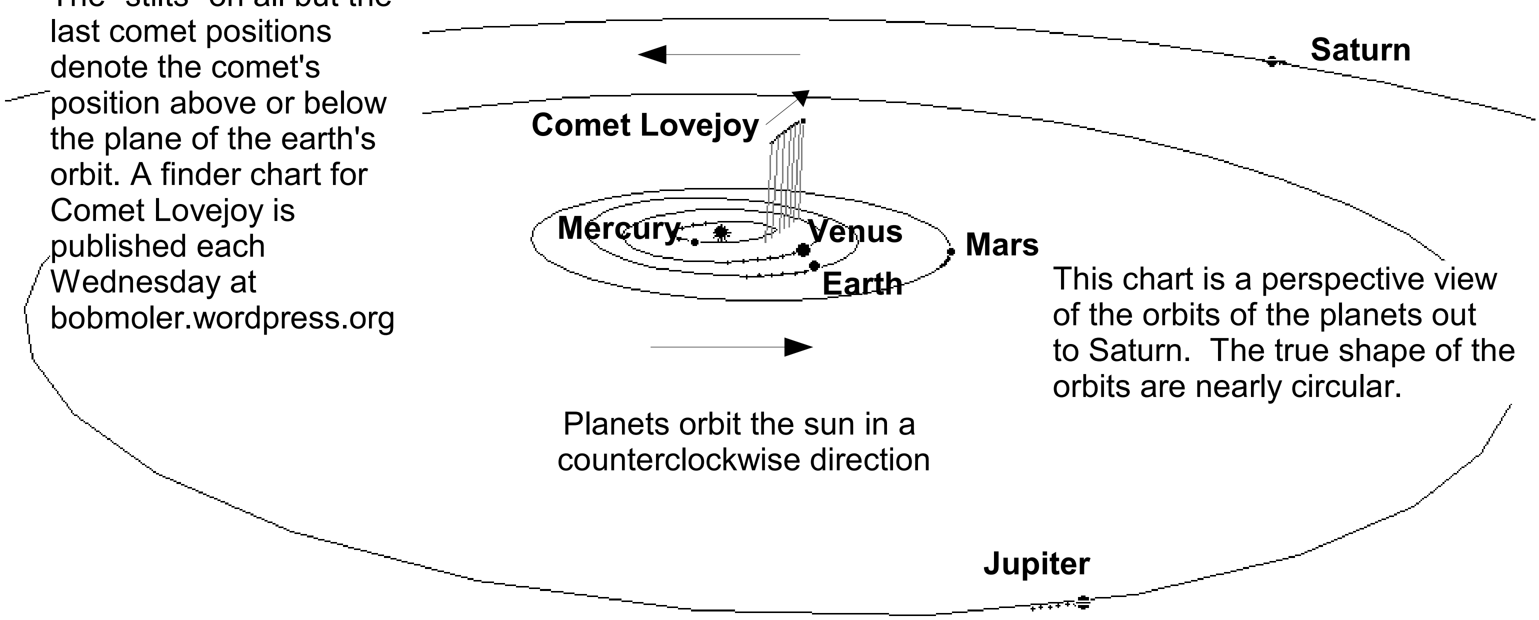
For more information on planets and stars each month:
http://ephemeris.bjmoler.org

Computed by Bob Moler

The Naked Eye Planets

January 1st, 6th, 11th, 16th, 21st, 26th, & 31st

The “stilts” on all but the last comet positions denote the comet's position above or below the plane of the earth's orbit. A finder chart for Comet Lovejoy is published each Wednesday at bobmoler.wordpress.org

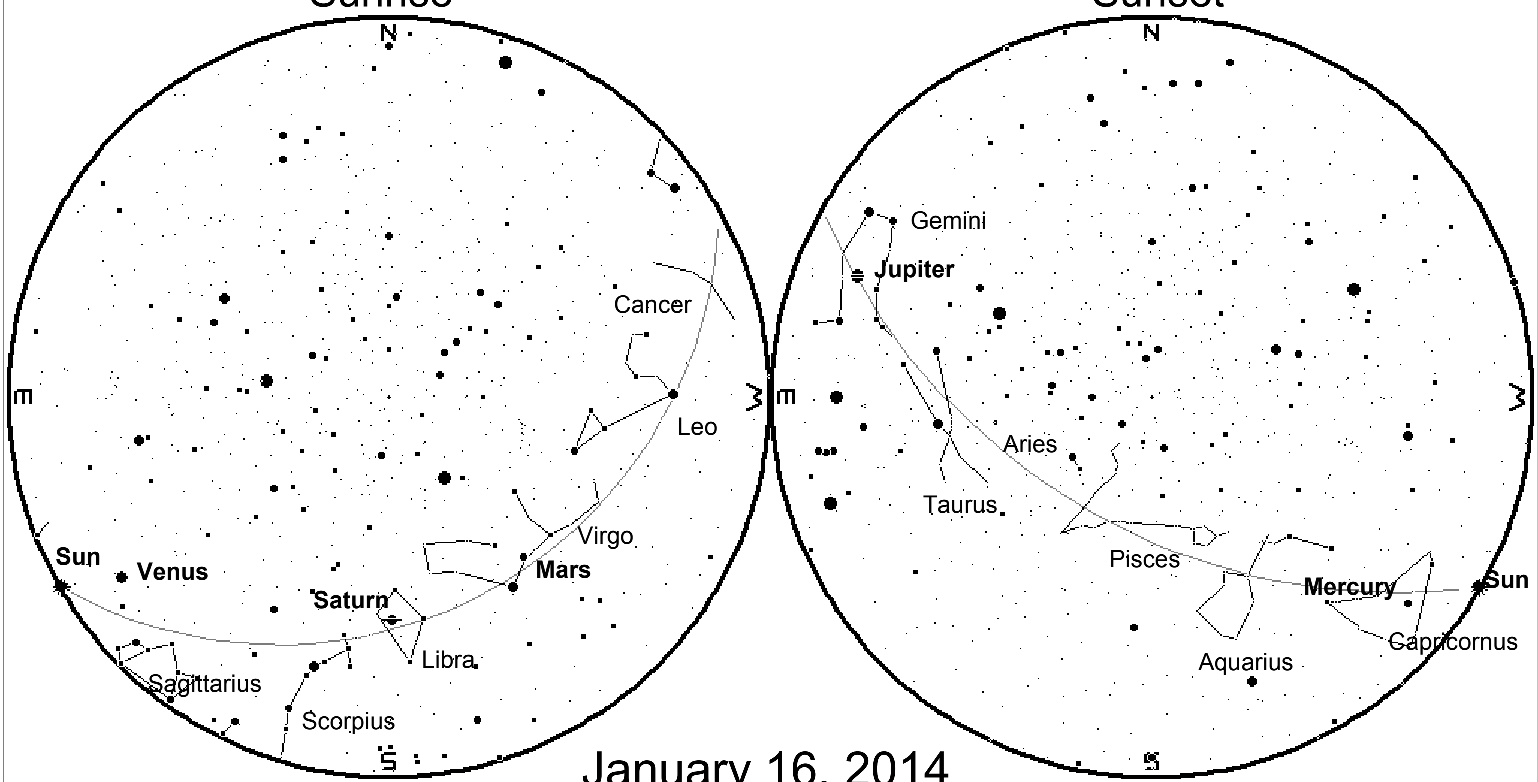


This chart is a perspective view of the orbits of the planets out to Saturn. The true shape of the orbits are nearly circular.

Planets orbit the sun in a counterclockwise direction

The Planets as Seen From Northern Michigan

Sunrise | Sunset



January 16, 2014

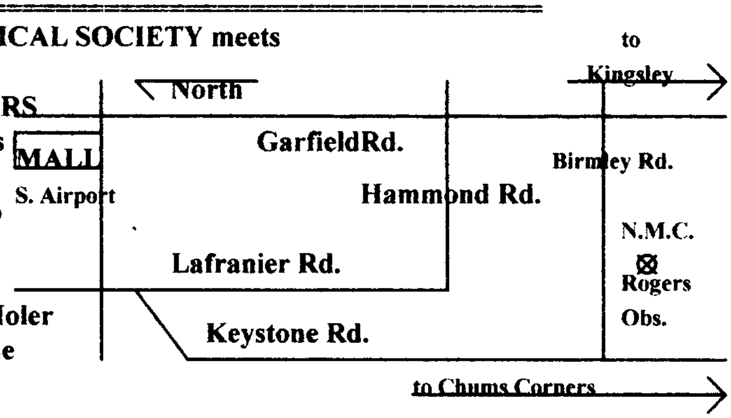
CELESTIAL CALENDAR

January 2014 EST

01	6:14 a.m.	NEW MOON
01	4:00 p.m.	Moon at Perigee: 356922 km
02	7 p.m.	Mars at Aphelion
03	3 p.m.	Quadrantid Meteor Shower
03	**7:00 p.m.**	**GTAS Board of Directors Meeting**
03	**8:00 p.m.**	**GTAS Monthly Meeting**
03	**9:00 p.m.**	**GTAS Star Party**
04	12:59 a.m.	Earth at Perihelion: 0.98333
05	3 p.m.	Jupiter at Opposition
07	10:39 p.m.	FIRST QUARTER MOON
09	6:26 a.m.	Moon at Descending Node
11	7 a.m.	Venus at Inferior Conjunction
12	3:36 a.m.	Aldebaran 2.6°S of Moon
14	**5 p.m.?**	**STEM Family Night at Greenspire School**
15	1:00 a.m.	Jupiter 4.9°N of Moon
15	8:53	Moon at Apogee: 406537 km
15	11:52 p.m.	FULL MOON
18	11:43 p.m.	Regulus 5.2°N of Moon
23	1:29 a.m.	Mars 3.7°N of Moon
23	4:22 a.m.	Spica 1.3°S of Moon
23	9:55 p.m.	Moon at Ascending Node
23	11 p.m.	Venus at Perihelion
24	12:19 a.m.	LAST QUARTER MOON
25	9:18 a.m.	Saturn 0.5°N of Moon: Occn.
28	9:36 a.m.	Venus 2.2°N of Moon
30	4:58 a.m.	Moon at Perigee: 357080 km
30	4:39 p.m.	NEW MOON
31	5 a.m.	Mercury at Greatest Elongation: 18.4°E

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										
January, 2014 - Local time zone: EST										
Date		**Sun**			**Twilight***		**Moon**			**Illum**
		Rise	**Set**	**Hours**	**End**	**Start**	**Phase**	**R/S****	**Time**	**Fractn**
Wed	1	08:19a	05:13p	08:53	06:58p	06:33a	New	Set	06:00p	1%
Thu	2	08:19a	05:14p	08:54	06:59p	06:33a		Set	07:16p	4%
Fri	3	08:19a	05:14p	08:55	07:00p	06:34a		Set	08:32p	10%
Sat	4	08:19a	05:15p	08:56	07:01p	06:34a		Set	09:46p	18%
Sun	5	08:19a	05:16p	08:57	07:02p	06:34a		Set	10:58p	27%
Mon	6	08:19a	05:18p	08:58	07:02p	06:34a		Set	12:07a	38%
Tue	7	08:18a	05:19p	09:00	07:03p	06:34a	F Qtr	Set	01:14a	48%
Wed	8	08:18a	05:20p	09:01	07:04p	06:34a		Set	02:18a	59%
Thu	9	08:18a	05:21p	09:02	07:05p	06:33a		Set	03:20a	68%
Fri	10	08:18a	05:22p	09:04	07:06p	06:33a		Set	04:19a	77%
Sat	11	08:17a	05:23p	09:05	07:07p	06:33a		Set	05:14a	85%
Sun	12	08:17a	05:24p	09:07	07:08p	06:33a		Set	06:04a	91%
Mon	13	08:16a	05:25p	09:09	07:09p	06:33a		Set	06:49a	96%
Tue	14	08:16a	05:27p	09:10	07:10p	06:32a		Set	07:29a	99%
Wed	15	08:15a	05:28p	09:12	07:11p	06:32a	Full	Rise	05:28p	100%
Thu	16	08:15a	05:29p	09:14	07:12p	06:32a		Rise	06:25p	99%
Fri	17	08:14a	05:30p	09:16	07:14p	06:31a		Rise	07:23p	97%
Sat	18	08:14a	05:32p	09:18	07:15p	06:31a		Rise	08:22p	93%
Sun	19	08:13a	05:33p	09:20	07:16p	06:30a		Rise	09:22p	87%
Mon	20	08:12a	05:34p	09:22	07:17p	06:30a		Rise	10:22p	80%
Tue	21	08:11a	05:36p	09:24	07:18p	06:29a		Rise	11:23p	72%
Wed	22	08:11a	05:37p	09:26	07:19p	06:29a		Rise	12:27a	63%
Thu	23	08:10a	05:38p	09:28	07:20p	06:28a		Rise	01:31a	52%
Fri	24	08:09a	05:40p	09:30	07:22p	06:27a	L Qtr	Rise	02:37a	42%
Sat	25	08:08a	05:41p	09:33	07:23p	06:27a		Rise	03:44a	31%
Sun	26	08:07a	05:43p	09:35	07:24p	06:26a		Rise	04:48a	21%
Mon	27	08:06a	05:44p	09:37	07:25p	06:25a		Rise	05:47a	12%
Tue	28	08:05a	05:45p	09:40	07:26p	06:24a		Rise	06:40a	6%
Wed	29	08:04a	05:47p	09:42	07:27p	06:23a		Rise	07:27a	1%
Thu	30	08:03a	05:48p	09:45	07:29p	06:23a	New	Set	06:01p	0%
Fri	31	08:02a	05:50p	09:47	07:30p	06:22a		Set	07:18p	2%
* Astronomical Twilight										
** Moonrise or moonset, whichever occurs between sunset and sunrise										

Grand Traverse Astronomical Society – Membership Application 2013

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Mail check to: G.T.A.S.
Gary Carlisle, Treasurer
1473 Birmley Road
Traverse City, MI 49686

The Stellar Sentinel
Bob Moler, Editor
6003 Secor Rd.
Traverse City, MI 49685

(This article is also on gtastro.org)
The Big Picture: GOES-R and the Advanced Baseline Imager

By Kieran Mulvaney

The ability to watch the development of storm systems – ideally in real time, or as close as possible – has been an invaluable benefit of the Geostationary Operational Environmental Satellites (GOES) system, now entering its fortieth year in service. But it has sometimes come with a trade-off: when the equipment on the satellite is focused on such storms, it isn't always able to monitor weather elsewhere.

"Right now, we have this kind of conflict," explains Tim Schmit of NOAA's National Environmental Satellite, Data, and Information Service (NESDIS). "Should we look at the broad scale, or look at the storm scale?" That should change with the upcoming launch of the first of the latest generation of GOES satellites, dubbed the GOES-R series, which will carry aloft a piece of equipment called the Advanced Baseline Imager (ABI).

According to Schmit, who has been working on its development since 1999, the ABI will provide images more frequently, at greater resolution and across more spectral bands (16, compared to five on existing GOES satellites). Perhaps most excitingly, it will also allow simultaneous scanning of both the broader view and not one but two concurrent storm systems or other small-scale patterns, such as wildfires, over areas of 1000km x 1000km.

Although the *spatial* resolution will not be any greater in the smaller areas than in the wider field of view, the significantly greater *temporal* resolution on the smaller scale (providing one image a minute) will allow meteorologists to see weather events unfold almost as if they were watching a movie.

So, for example, the ABI could be pointed at an area of Oklahoma where conditions seem primed for the formation of tornadoes. "And now you start getting one-minute data, so you can see small-scale clouds form, the convergence and growth," says Schmit.

In August, Schmit and colleagues enjoyed a brief taste of how that might look when they turned on the GOES-14 satellite, which serves as an orbiting backup for the existing generation of satellites.

"We were allowed to do some experimental imaging with this one-minute imagery," Schmit explains. "So we were able to simulate the temporal component of what we will get with ABI when it's launched."

The result was some imagery of cloud formation that, while not of the same resolution as the upcoming ABI images, unfolded on the same time scale. You can compare the difference between it and the existing GOES-13 imagery here: http://cimss.ssec.wisc.edu/goes/blog/wpcontent/uploads/2013/08/GOES1314_VIS_21AUG2013loop.gif

Learn more about the GOES-R series of satellites here: http://www.goes-r.gov.

Kids should be sure to check out a new online game that's all about ABI! It's as exciting as it is educational. Check it out at http://scijinks.gov/abi

The Advanced Baseline Imager. Credit: NOAA/NASA.

Download photo at: http://www.goes-r.gov/spacesegment/images/ABI-complete.jpg.

2014 Eclipse Maps Follow

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°

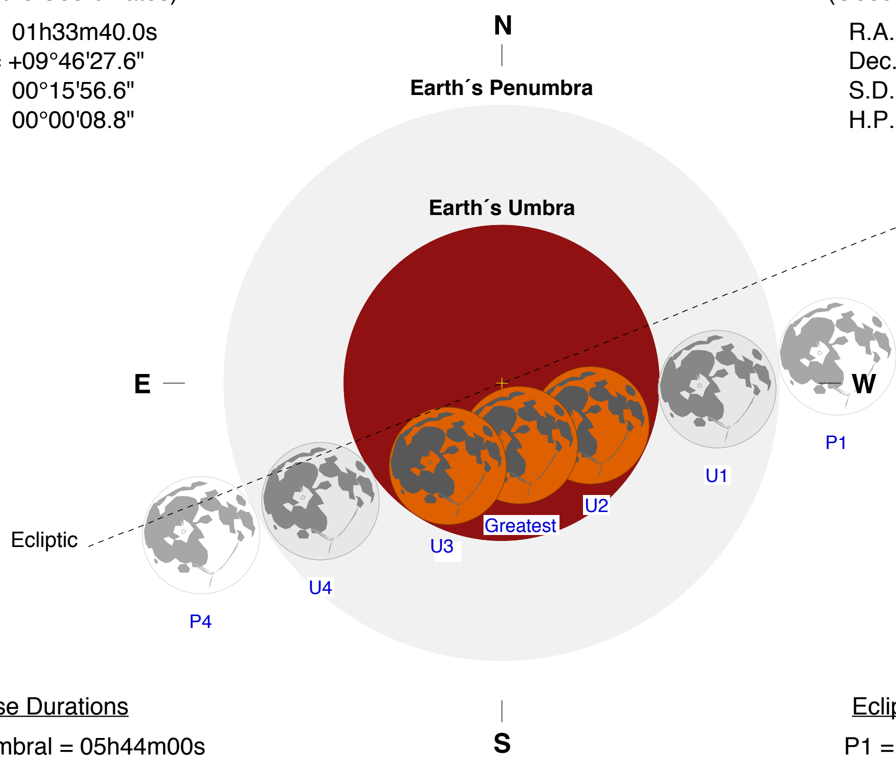
Saros Series = 122 Member = 56 of 75

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)

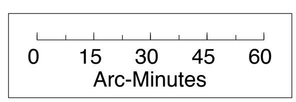
R.A. = 13h33m21.1s
Dec. = -10°02'59.8"
S.D. = 00°15'30.9"
H.P. = 00°56'56.4"



Eclipse Durations

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

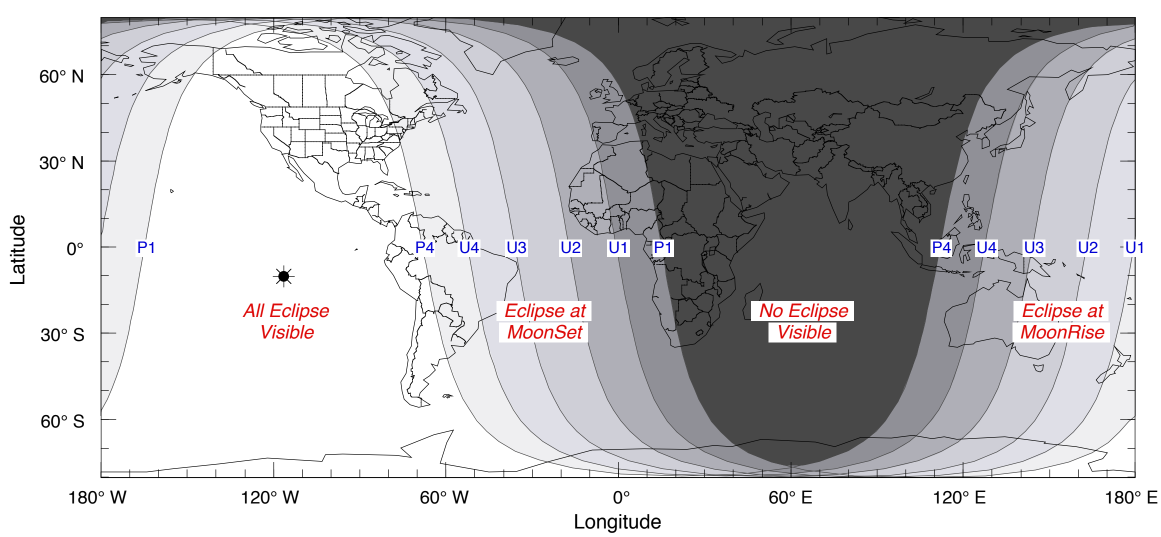
ΔT = 67 s
Rule = CdT (Danjon)
Eph. = VSOP87/ELP2000-85



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

FIGURE 3

Total Lunar Eclipse of 2014 Oct 08

Ecliptic Conjunction = 10:51:42.8 TD (= 10:50:35.5 UT)
Greatest Eclipse = 10:55:43.6 TD (= 10:54:36.2 UT)

Penumbral Magnitude = 2.1456 P. Radius = 1.2787° Gamma = 0.3827
Umbral Magnitude = 1.1659 U. Radius = 0.7451° Axis = 0.3824°

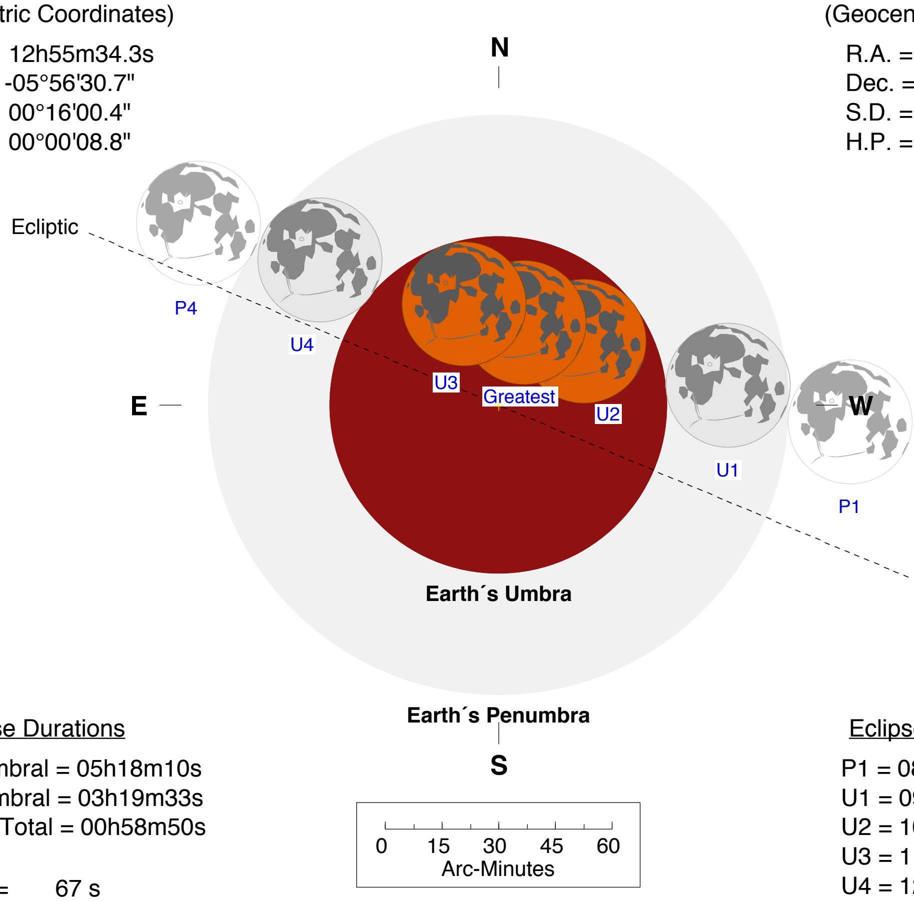
Saros Series = 127 Member = 42 of 72

Sun at Greatest Eclipse
(Geocentric Coordinates)

R.A. = 12h55m34.3s
Dec. = -05°56'30.7"
S.D. = 00°16'00.4"
H.P. = 00°00'08.8"

Moon at Greatest Eclipse
(Geocentric Coordinates)

R.A. = 00h55m07.2s
Dec. = +06°18'26.8"
S.D. = 00°16'20.3"
H.P. = 00°59'57.9"



Eclipse Durations

Penumbral = 05h18m10s
Umbral = 03h19m33s
Total = 00h58m50s

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

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

Eclipse Contacts

P1 = 08:15:33 UT
U1 = 09:14:48 UT
U2 = 10:25:10 UT
U3 = 11:24:00 UT
U4 = 12:34:21 UT
P4 = 13:33:43 UT

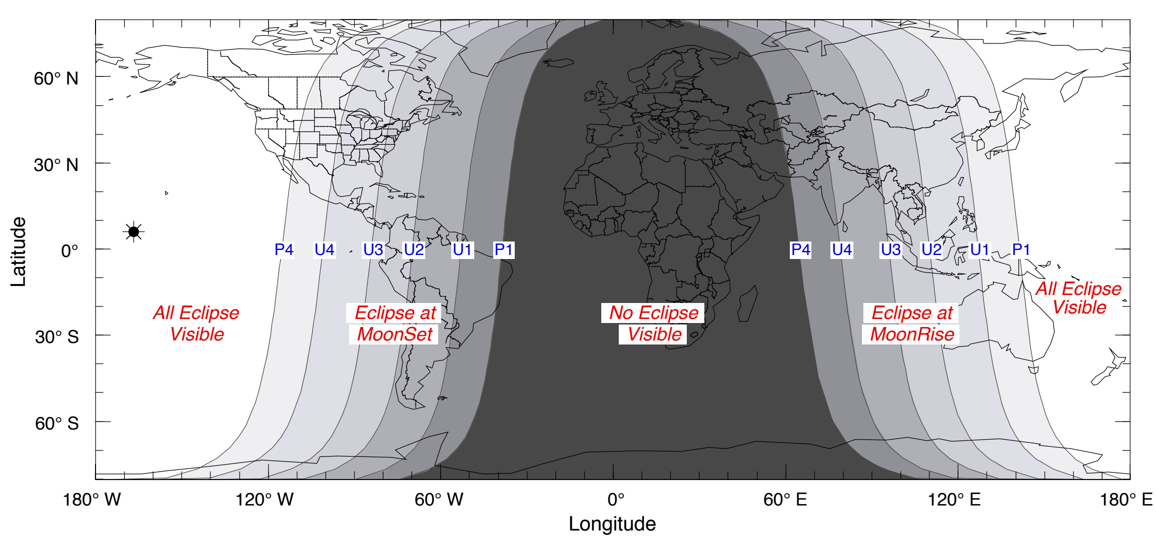


Figure 4

Partial Solar Eclipse of 2014 Oct 23

Ecliptic Conjunction = 21:57:46.8 TD (= 21:56:39.5 UT)
Greatest Eclipse = 21:45:38.7 TD (= 21:44:31.4 UT)

Eclipse Magnitude = 0.8114 Gamma = 1.0908

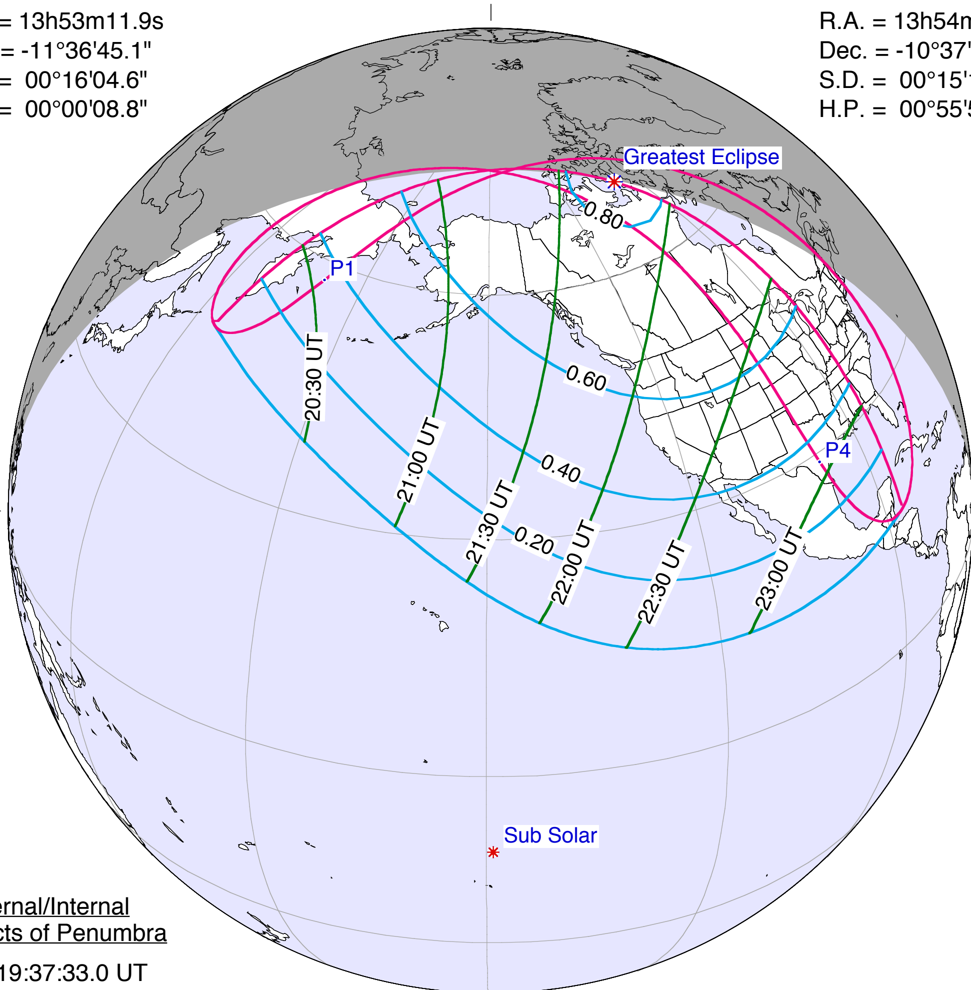
Saros Series = 153 Member = 9 of 70

Sun at Greatest Eclipse
(Geocentric Coordinates)

R.A. = 13h53m11.9s
Dec. = -11°36'45.1"
S.D. = 00°16'04.6"
H.P. = 00°00'08.8"

Moon at Greatest Eclipse
(Geocentric Coordinates)

R.A. = 13h54m15.8s
Dec. = -10°37'52.6"
S.D. = 00°15'15.5"
H.P. = 00°55'59.9"



External/Internal
Contacts of Penumbra

P1 = 19:37:33.0 UT
P4 = 23:51:39.8 UT

Constants & Ephemeris

ΔT = 67.4 s
k1 = 0.2724880
k2 = 0.2722810
Δb = 0.0" Δl = 0.0"
Eph. = VSOP87/ELP2000-85

0 1000 2000 3000 4000 5000
Kilometers

Geocentric Libration
(Optical + Physical)

l = -4.52°
b = -1.27°
c = 21.96°

Brown Lun. No. = 1136

F. Espenak, NASA's GSFC

eclipse.gsfc.nasa.gov/eclipse.html