Obsidians ExploraTalk - June 18, 2013

Hiking Astronomy

Using and Enjoying the Sun, Moon, Planets and Stars

John Hartman

softwareunderstanding.com/hiking-astronomy

Topics

1. Day – Hiking With the Sun

Time, Direction, Altitude

Sunset – when and where

Sun Position Science – time, position for day, year

2. Evening

Twilight Length

Moon – moonlight, phase, position, illusions

Planets and Bright Stars

3. Night

Finding Things In The Sky

Eyes, Binoculars and Small Telescopes

Fun Objects – satellites, moon, planets,
stars, clusters, galaxies, nebulae...

Supplemental Slides Follow *Conclusion* Slide:

Combined Alt Az Plots for Each Season

Analemma Details

Sun Shadow Tracing

Survival Direction Finding

Hiking With the Sun

Solar Time('s) Hiking System

1. Time – organize day
2. Direction – stay oriented
3. Sun Altitude – how intense?

What Time Is It?

Time

Best Time System For Hiking?

Time

Best Time System For Hiking?

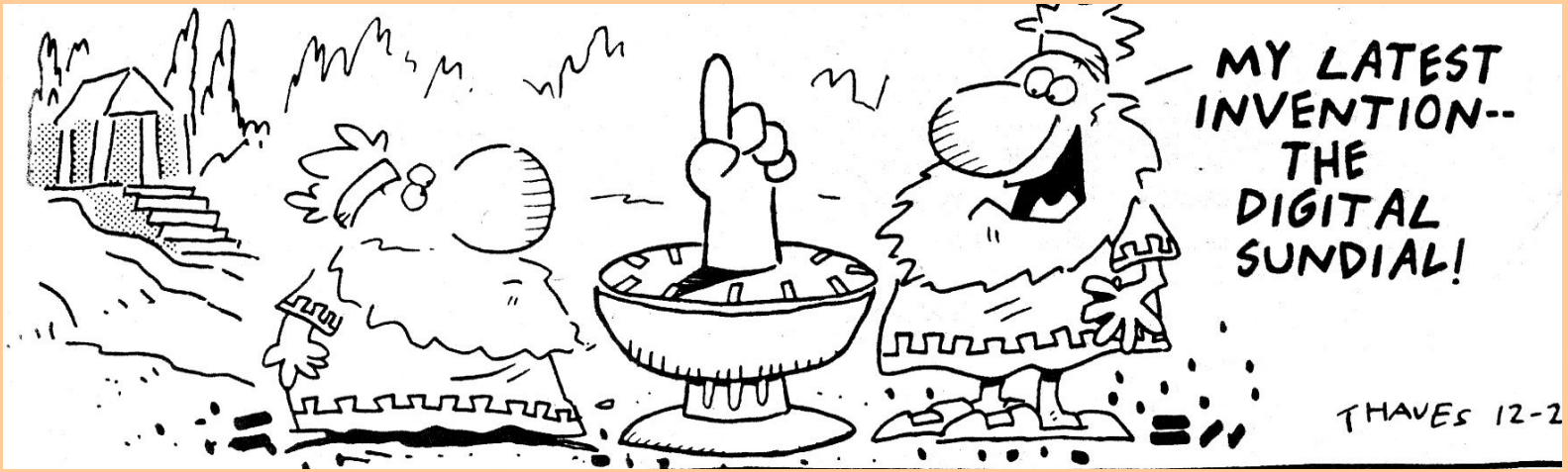
Solar Time

Time = Sun

Time Is Local

Time

Best Time System For Hiking?



Time

Best Time System For Hiking?

Clock Time

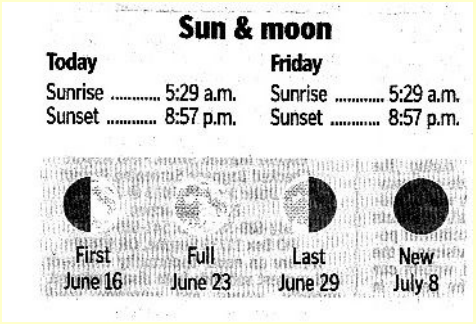
Time ≠ Sun

Time Not Local

3 Artificial Additives

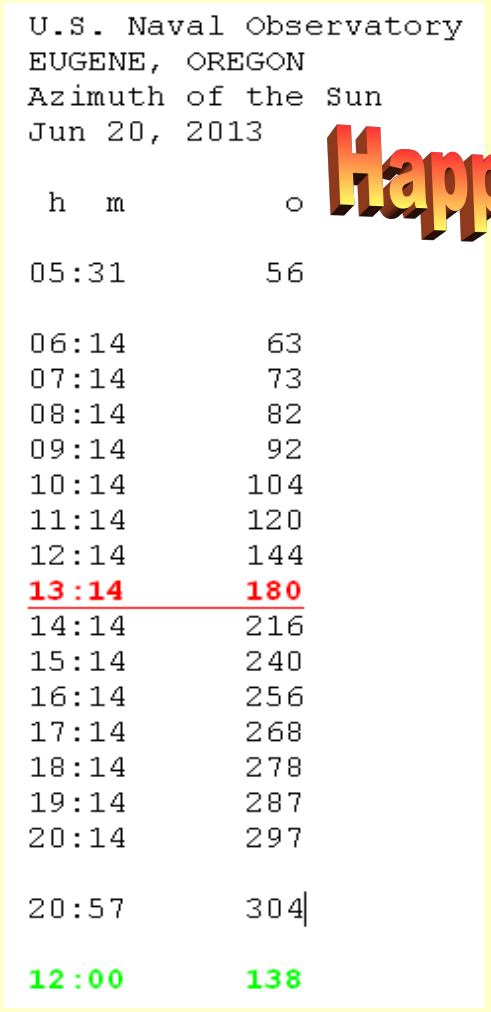
Organize Hiking Day

Middle of Day?



1:14 PM

Hours of Daylight?



Hours in morning, afternoon?

15 hr 26 min

Difficult With Clock Time

Organize Day With Solar Time

Reset watch to solar time for multi-day hikes

Solar Noon

Middle of day
Sun is due south
Highest

12 PM Solar Time

Clock Time	-01:14	Solar Time	Sun Azimuth
5:31 AM		*04:17 AM*	
6:14 AM		5 AM	
7:14 AM		6 AM	
8:14 AM		Adjust table column M	
9:14 AM		**8 AM**	
10:14 AM		9 AM	
11:14 AM		10 AM	
12:14 PM		11 AM	
1:14 PM		**12:00 PM**	**180**
2:14 PM		1 PM	
3:14 PM		2 PM	
4:14 PM		3 PM	
5:14 PM		**4 PM**	
6:14 PM		5 PM	
7:14 PM		6 PM	
8:14 PM		7 PM	
8:57 PM		*07:43 PM*	

Sunrise, sunset symmetrical, easy to remember

7 hr 43 min before noon

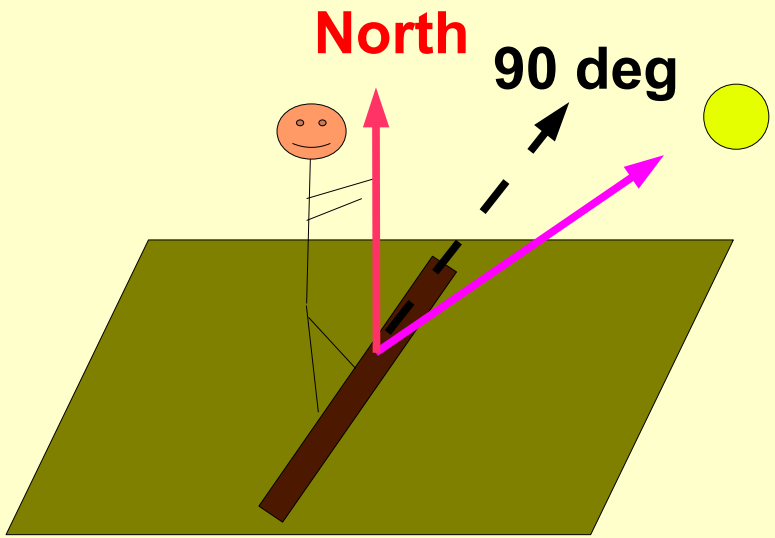
Lunch break at true mid-day

7 hr 43 min after noon

Direction

Constant Situational Awareness

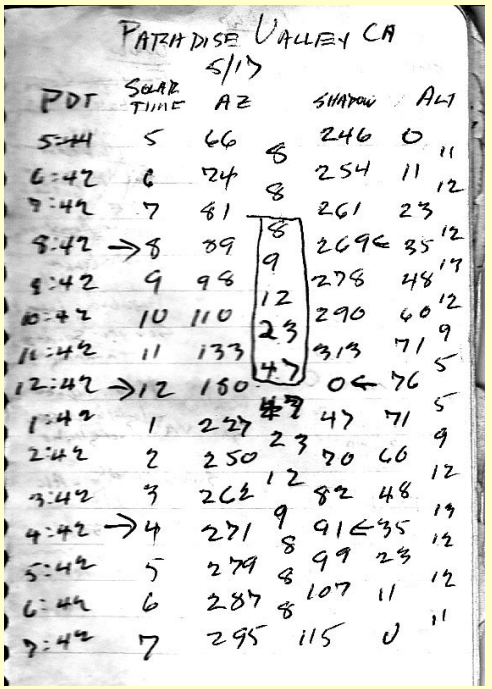
Compass In The Sky



Direction With Solar Time

Clock Time	-01:14	Solar Time	Sun Azimuth	Azimuth Change
5:31 AM		*04:17 AM*		
				7
6:14 AM		5 AM		
				10
7:14 AM		6 AM		
				10
8:14 AM		7 AM		
				10
9:14 AM		**8 AM**		
				12
10:14 AM		9 AM		
				16
11:14 AM		10 AM		
				24
12:14 PM		11 AM		
				36
1:14 PM		**12:00 PM**	**180**	
2:14 PM		1 PM		
3:14 PM		2 PM		
4:14 PM		3 PM		
5:14 PM		**4 PM**		
6:14 PM		5 PM		
7:14 PM		6 PM		
8:14 PM		7 PM		
8:57 PM		*07:43 PM*		

Remember Five Magic Numbers



Direction With Solar Time

Clock Time	-01:14	Solar Time	Sun Azimuth	Azimuth Change
5:31 AM		*04:17 AM*	*56*	
				7
6:14 AM		5 AM	**63**	
				10
7:14 AM		6 AM	**73**	
				10
8:14 AM		7 AM	**82**	
				10
9:14 AM		**8 AM**	**92**	
				12
10:14 AM		9 AM	**104**	
				16
11:14 AM		10 AM	**120**	
				24
12:14 PM		11 AM	**144**	
				36
1:14 PM		**12:00 PM**	**180**	
				36
2:14 PM		1 PM	**216**	
				24
3:14 PM		2 PM	**240**	
				16
4:14 PM		3 PM	**256**	
				12
5:14 PM		**4 PM**	**268**	
				10
6:14 PM		5 PM	**278**	
				10
7:14 PM		6 PM	**287**	
				10
8:14 PM		7 PM	297	
				7
8:57 PM		*07:43 PM*	*304*	

Subtract and Add Changes To Get Azimuths

Azimuth Changes Fastest, In Few Hours Before/After Noon

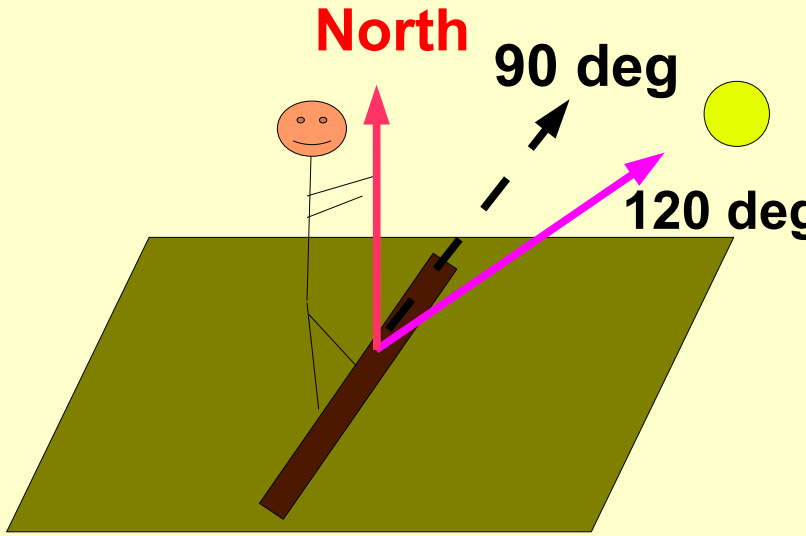
Direction With Solar Time

Clock Time	-01:14	Solar Time	Sun Azimuth	Azimuth Change
5:31 AM		*04:17 AM*	*56*	
				7
6:14 AM		5 AM	63	
				10
7:14 AM		6 AM	73	
				10
8:14 AM		7 AM	82	
				10
9:14 AM		8 AM	92	
				12
10:14 AM		9 AM	104	
				16
11:14 AM		10 AM	120	
				24
12:14 PM		11 AM	144	
				36
1:14 PM		12:00 PM	180	
				36
2:14 PM		1 PM	216	
				24
3:14 PM		2 PM	240	
				16
4:14 PM		3 PM	256	
				12
5:14 PM		4 PM	268	
				10
6:14 PM		5 PM	278	
				10
7:14 PM		6 PM	287	
				10
8:14 PM		7 PM	297	
				7
8:57 PM		*07:43 PM*	*304*	

Sun Gives
Compass In The Sky

Sun Is East

Sun Is West

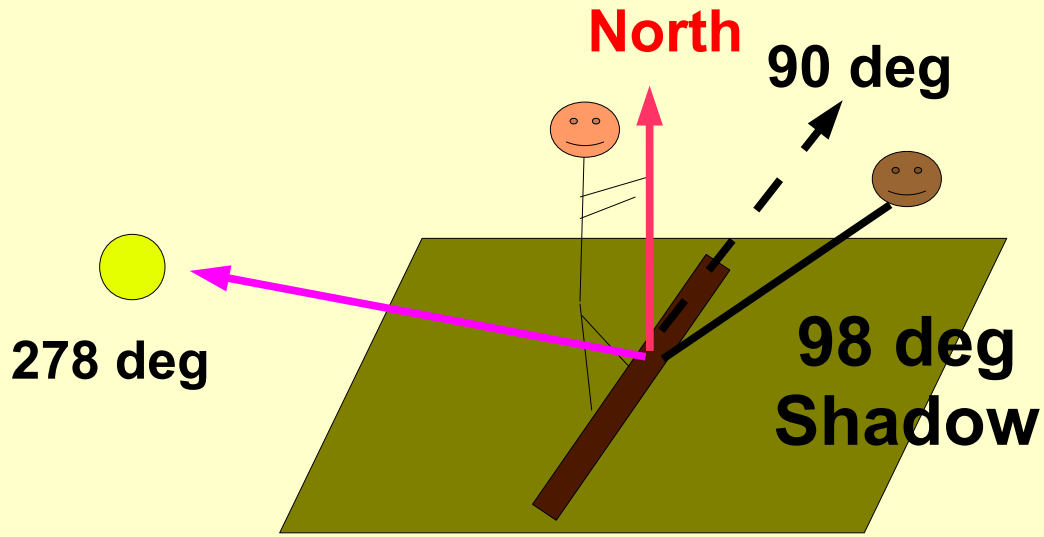


10 AM Solar Time

Direction With Solar Time

Clock Time	-01:14	Solar Time	Sun Azimuth	Azimuth Change	Shadow Azimuth
5:31 AM		*04:17 AM*	*56*		
				7	
6:14 AM		5 AM	63		243
				10	
7:14 AM		6 AM	73		253
				10	
8:14 AM		7 AM	82		262
				10	
9:14 AM		8 AM	92		272
				12	
10:14 AM		9 AM	104		284
				16	
11:14 AM		10 AM	120		300
				24	
12:14 PM		11 AM	144		324
				36	
1:14 PM		12:00 PM	180		360
				36	
2:14 PM		1 PM	216		36
				24	
3:14 PM		2 PM	240		60
				16	
4:14 PM		3 PM	256		76
				12	
5:14 PM		4 PM	268		88
				10	
6:14 PM		5 PM	278		98
				10	
7:14 PM		6 PM	287		108
				10	
8:14 PM		7 PM	297		117
				7	
8:57 PM		*07:43 PM*	*304*		

Shadow Gives Compass On The Ground



5 PM Solar Time

Seasonal Differences - Azimuth

	Summer Solstice		Equinoxes		Winter Solstice	
Solar Time	Sun Azimuth	Azimuth Change	Sun Azimuth	Azimuth Change	Sun Azimuth	Azimuth Change
5 AM	63					
		10				
6 AM	73		90			
		10		11		
7 AM	82		101			
		10		11		
8 AM	92		112		127	
		12		13		12
9 AM	104		125		139	
		16		15		12
10 AM	120		140		151	
		24		19		14
11 AM	144		159		165	
		36		21		15
12:00 PM	180		180		180	
		36		21		15
1 PM	216		201		195	
		24		19		14
2 PM	240		220		209	
		16		15		12
3 PM	256		235		221	
		12		13		12
4 PM	268		248		233	
		10		11		
5 PM	278		259			
		10		11		
6 PM	287		270			
		10				
7 PM	297					

Different At Different Latitudes!

Sun **Altitude** With Solar Time

Clock Time	-01:14	Solar Time	Sun Altitude	Altitude Change
5:31 AM		*04:17 AM*	*0*	
				6
6:14 AM		5 AM	6	
				10
7:14 AM		6 AM	16	
				10
8:14 AM		7 AM	27	
				10
9:14 AM		**8 AM**	37	
				10
10:14 AM		9 AM	48	
				10
11:14 AM		10 AM	58	
				6
12:14 PM		11 AM	66	
				3
1:14 PM		**12:00 PM**	**69**	
				3
2:14 PM		1 PM	66	
				6
3:14 PM		2 PM	58	
				10
4:14 PM		3 PM	48	
				10
5:14 PM		**4 PM**	37	
				10
6:14 PM		5 PM	27	
				10
7:14 PM		6 PM	16	
				10
8:14 PM		7 PM	6	
				6
8:57 PM		*07:43 PM*	*0*	

Most Intense,
Changes Slowest,
In Few Hours
Before/After Noon

Remember
Changes,
Peak/Noon Altitude

Changes
~ 10 deg/hour
In Morning/Evening

Seasonal Differences - Altitude

	Summer Solstice		Equinoxes		Winter Solstice	
Solar Time	**Sun Altitude**	**Altitude Change**	**Sun Altitude**	**Altitude Change**	**Sun Altitude**	**Altitude Change**
5 AM	6					
		10				
6 AM	16		0			
		10		10		
7 AM	27		11			
		10		10		
8 AM	37		21		3	
		10		10		8
9 AM	48		31		11	
		10		8		6
10 AM	58		39		17	
		6		5		4
11 AM	66		44		21	
		3		2		2
12:00 PM	69		46		23	
		3		2		2
1 PM	66		44		21	
		6		5		4
2 PM	58		39		17	
		10		8		6
3 PM	48		31		11	
		10		10		8
4 PM	37		21		3	
		10		10		
5 PM	27		11			
		10		10		
6 PM	16		0			
		10				
7 PM	6					

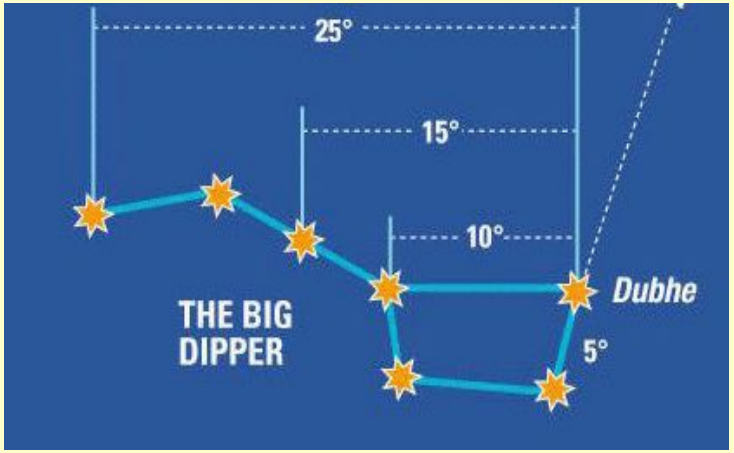
Different At Different Latitudes!

Measuring Angles

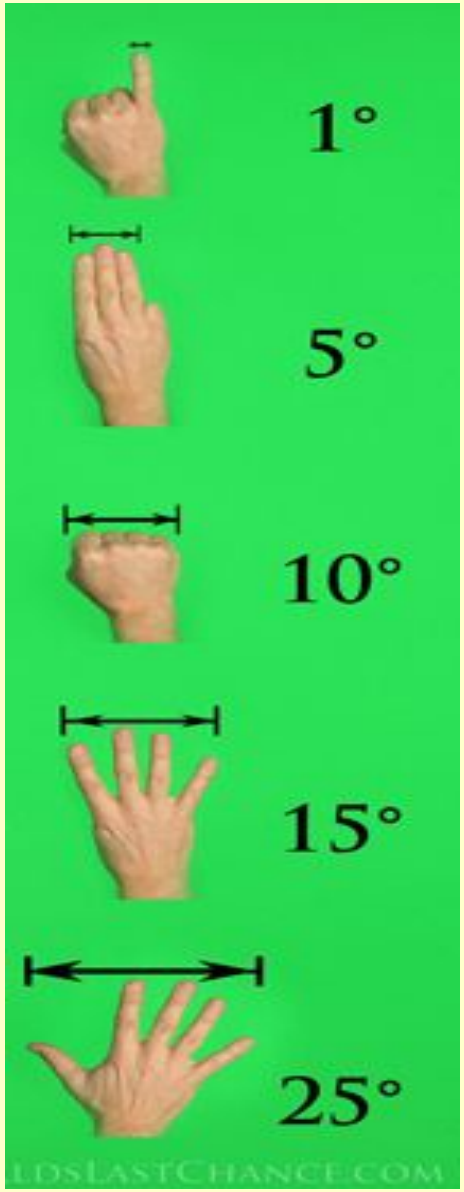
In Sky

Sun and Moon
.5 deg diameter

Binocular field
is ~ 6 deg



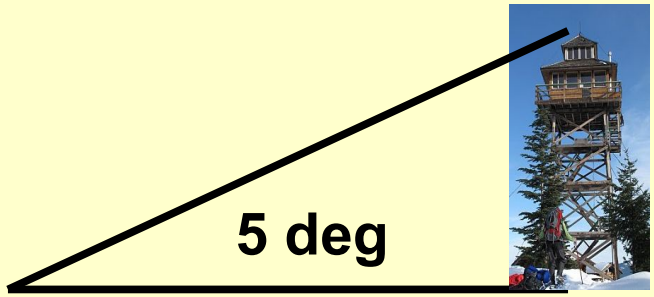
Arm Outstretched



~ 1/60 radian

~ 1/12 radian

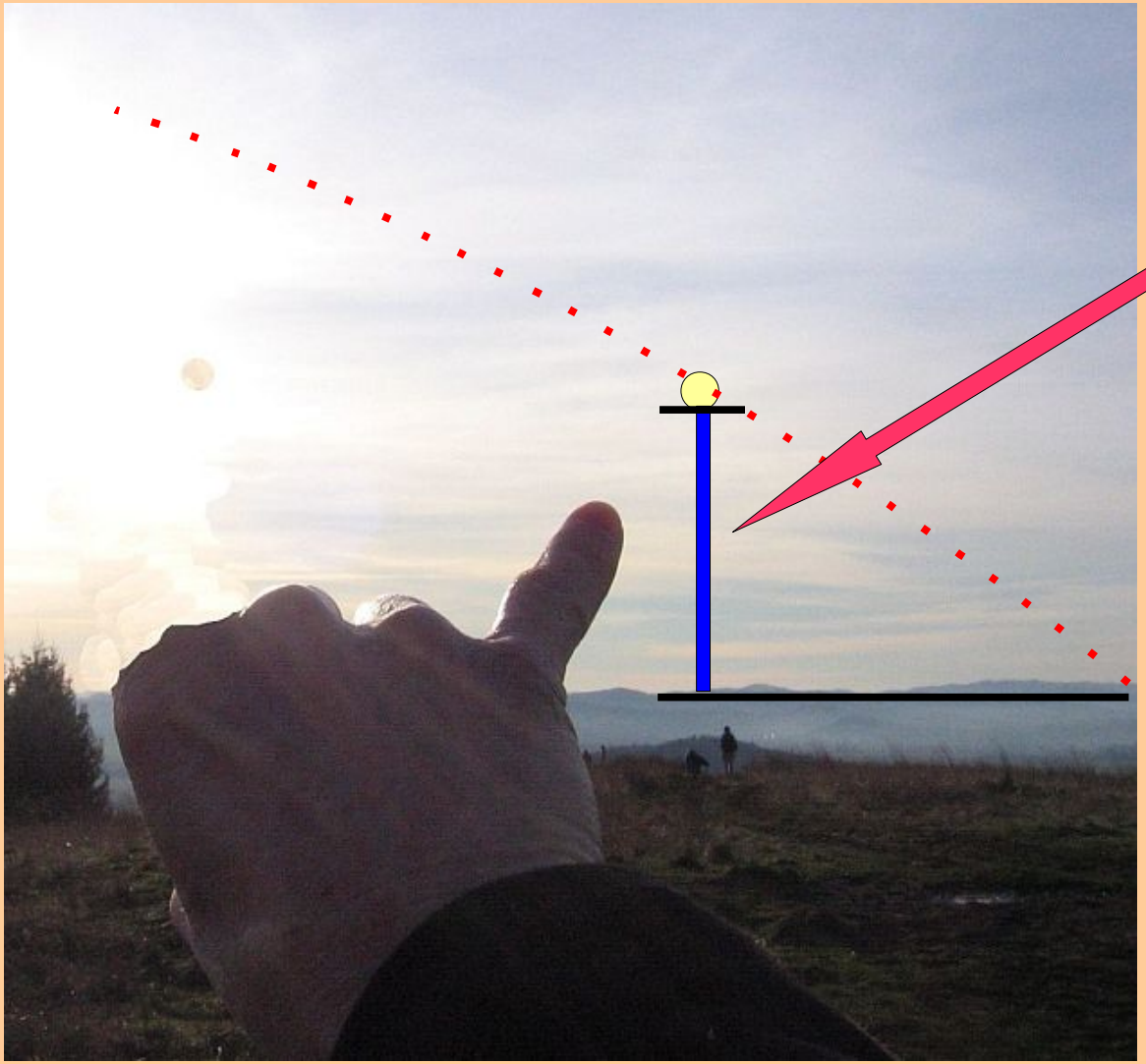
Distances, Heights



Height is 1/12 Distance

Distance is 12 x Height

Time To Sunset Using Sun's Altitude



Altitude is 4 deg
4 little finger widths,
8 sun diameters

If Altitude Change Is
10 deg/hour,
6 minutes/deg

Sun Will Set
In 24 Minutes

Time To Sunset Using Sun's Path

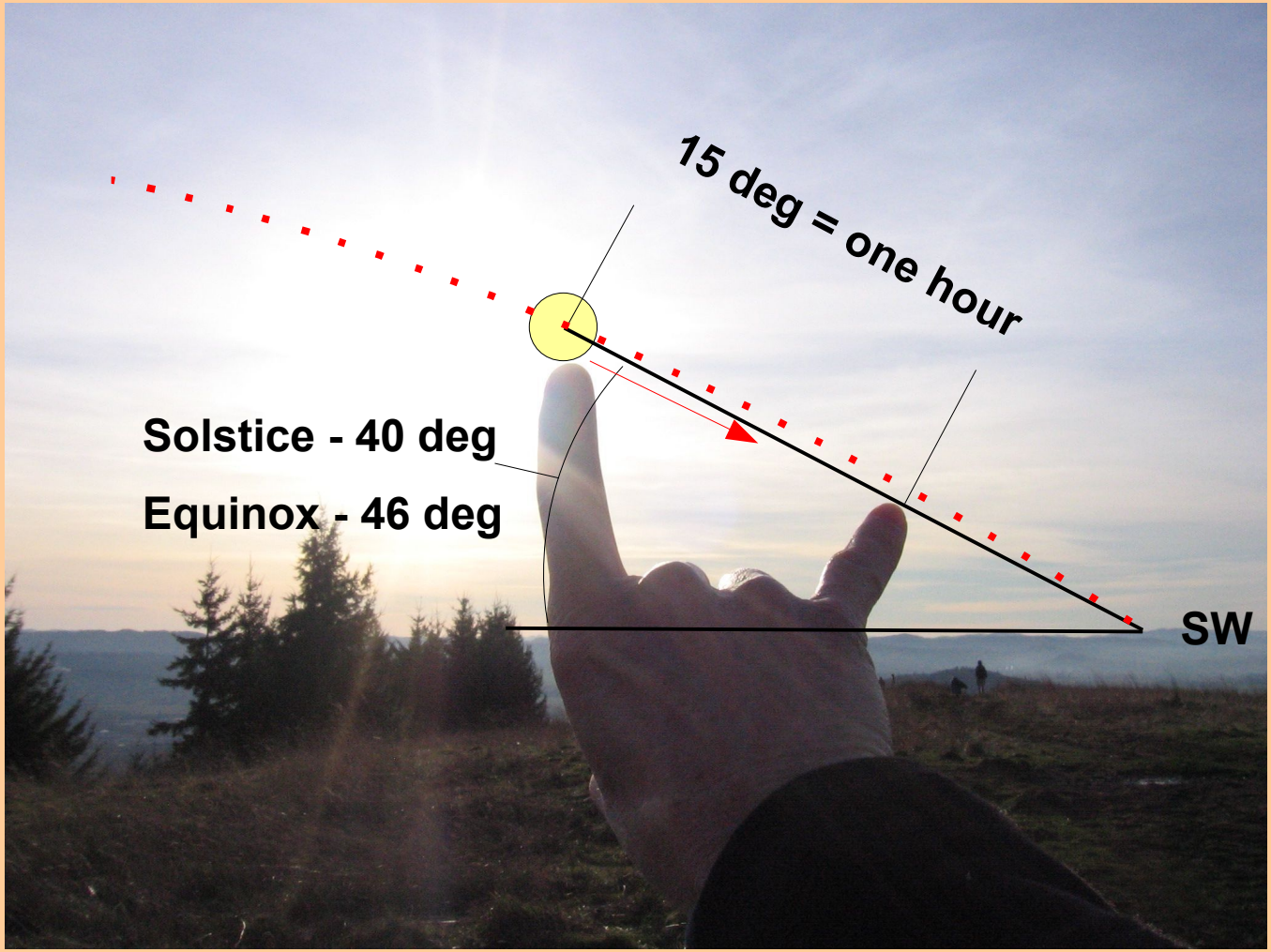
Noon Altitude

70 deg Summer Solstice

46 deg Equinoxes

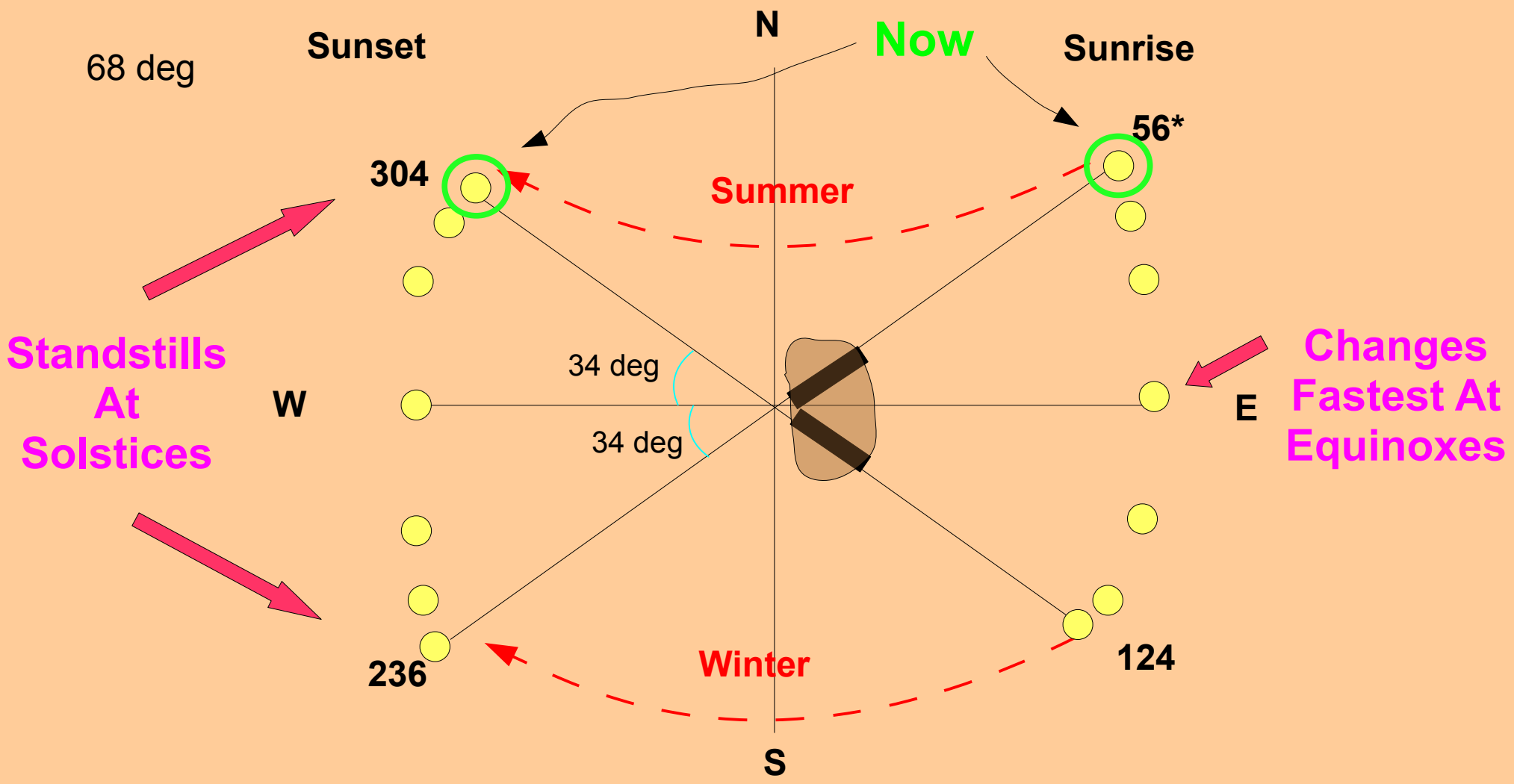
23 deg Winter Solstice

S



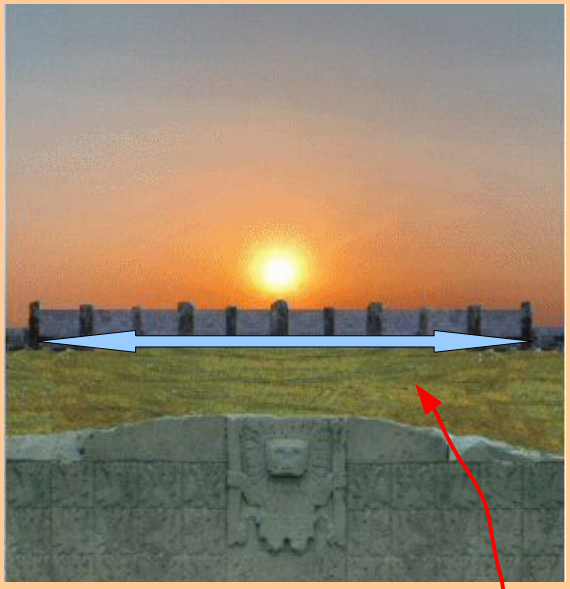
Solstice Sunrise and Sunset Azimuth

Solstice Sunrise and Sunset Azimuth



General Sunrise and Sunset Azimuth

Day Marks



Solstices
Slows To Standstill

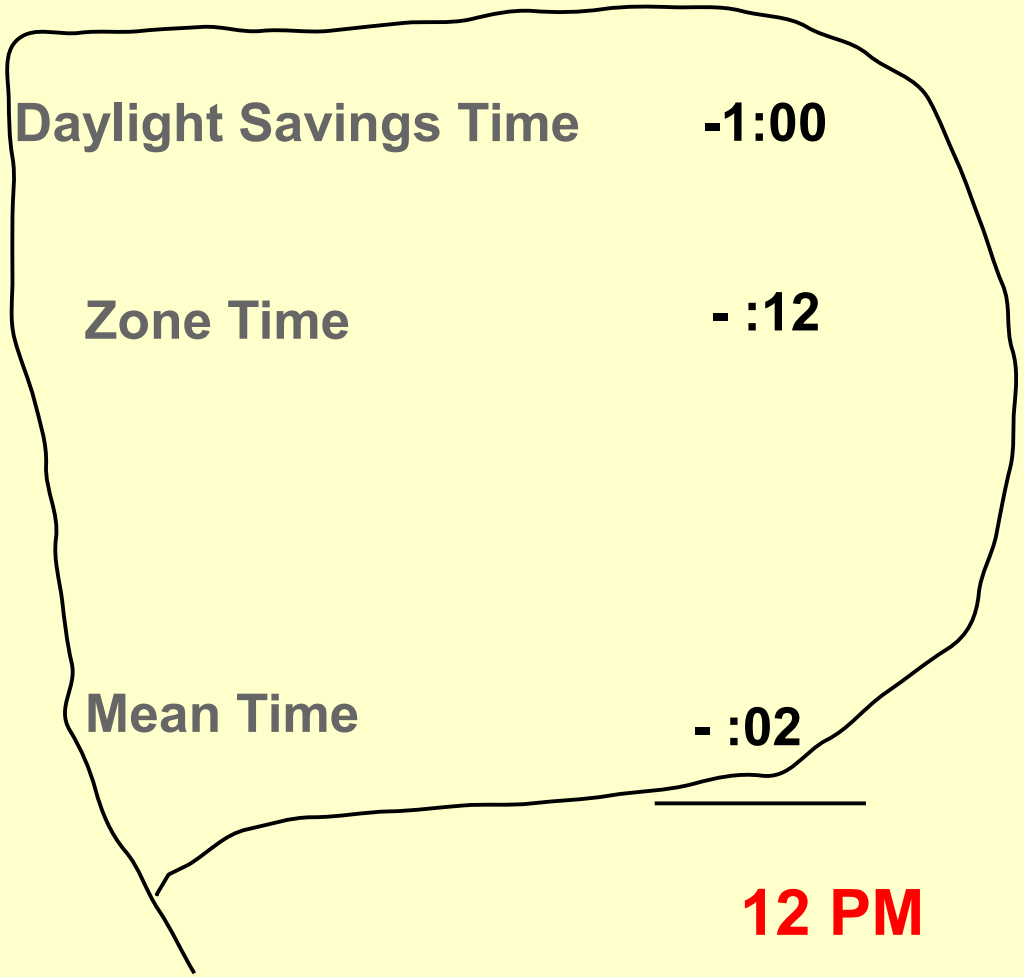
Equinoxes
Rises/Sets Due East
Changes Fastest

Use Sun Azimuth Between Solstices and Equinoxes

<u>Amplitude</u>
68 deg at Eugene
Increases With Latitude

Solar Time For Different Days, Longitudes

Clock Time 1:14 PM



Remove Artificial Additives

Solar Time 12PM

Standard Time

Local Time

Longitude
4 minutes/deg W of zone meridian
4 x (123-120)

True Sun Daily Variation

Ahead/Behind Mean Sun As Much As 15 min
Equation Of Time
Orbit Non-Circular and Tilted

Sun Demonstration

I ran Sun Motions Simulator

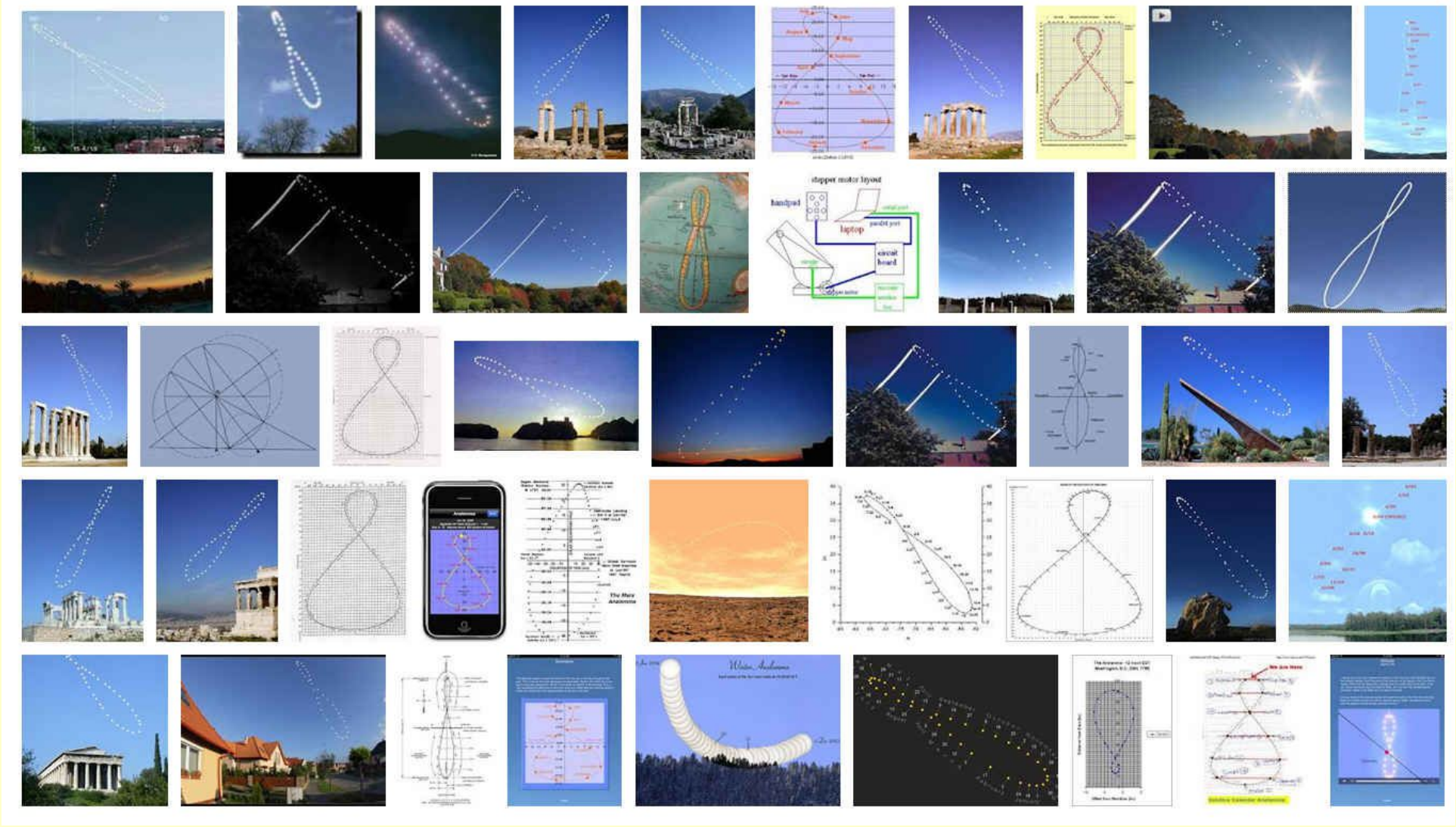
astro.unl.edu/classaction/animations/coordsmotion/sunmotions.html

For Eugene, latitude 44 deg N:

Showed sun's path in sky for different seasons
(*loop day* animation, date slider)

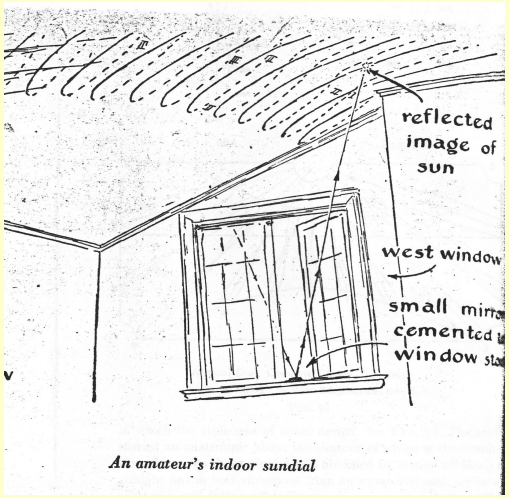
Showed true sun early and late at local mean noon for different seasons, then analemma (*step by day* animation)

Analemma Examples



Analemma

Sun at given clock time for a year



An amateur's indoor sundial

Points, analemmas

at time intervals

tell time

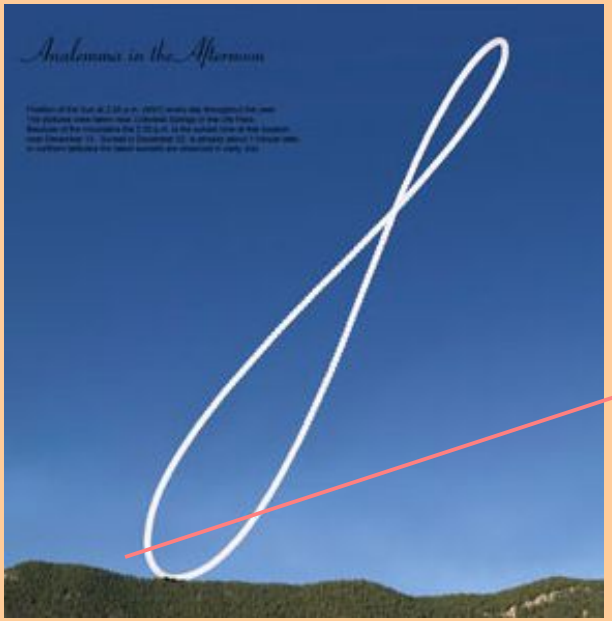
(knowing season)

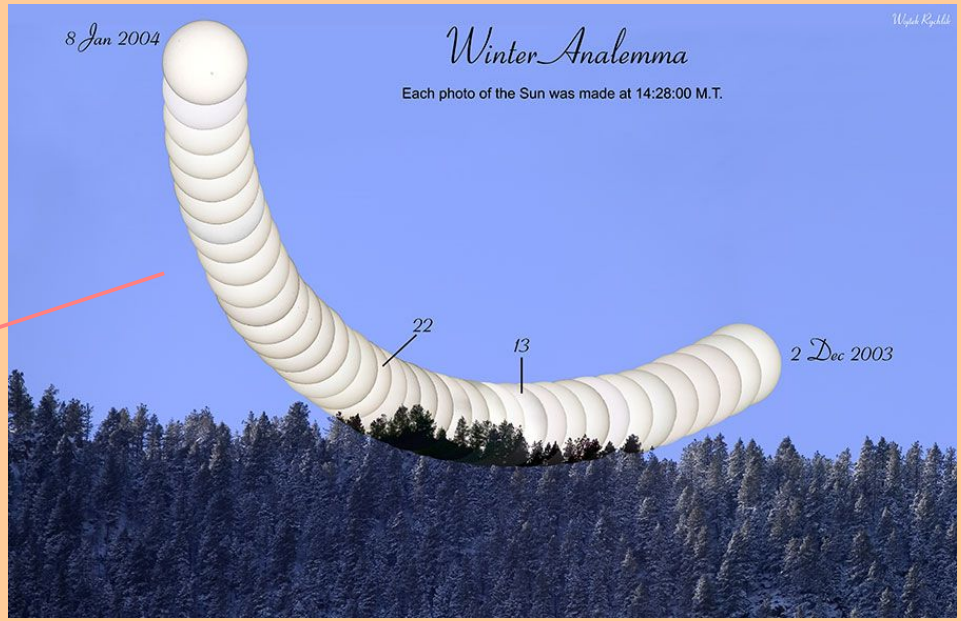
Declination on a Meridian x Eqn of Time

Earliest Sunset

~ Dec. 7, not solstice

pikespeakphoto.com/analemma.html

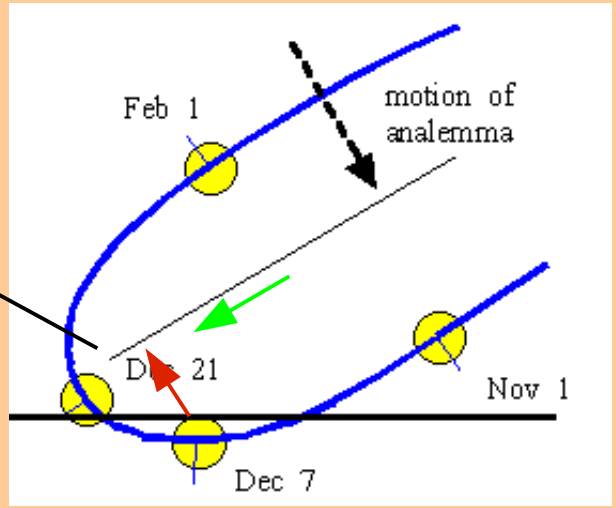




Equation of Time causes

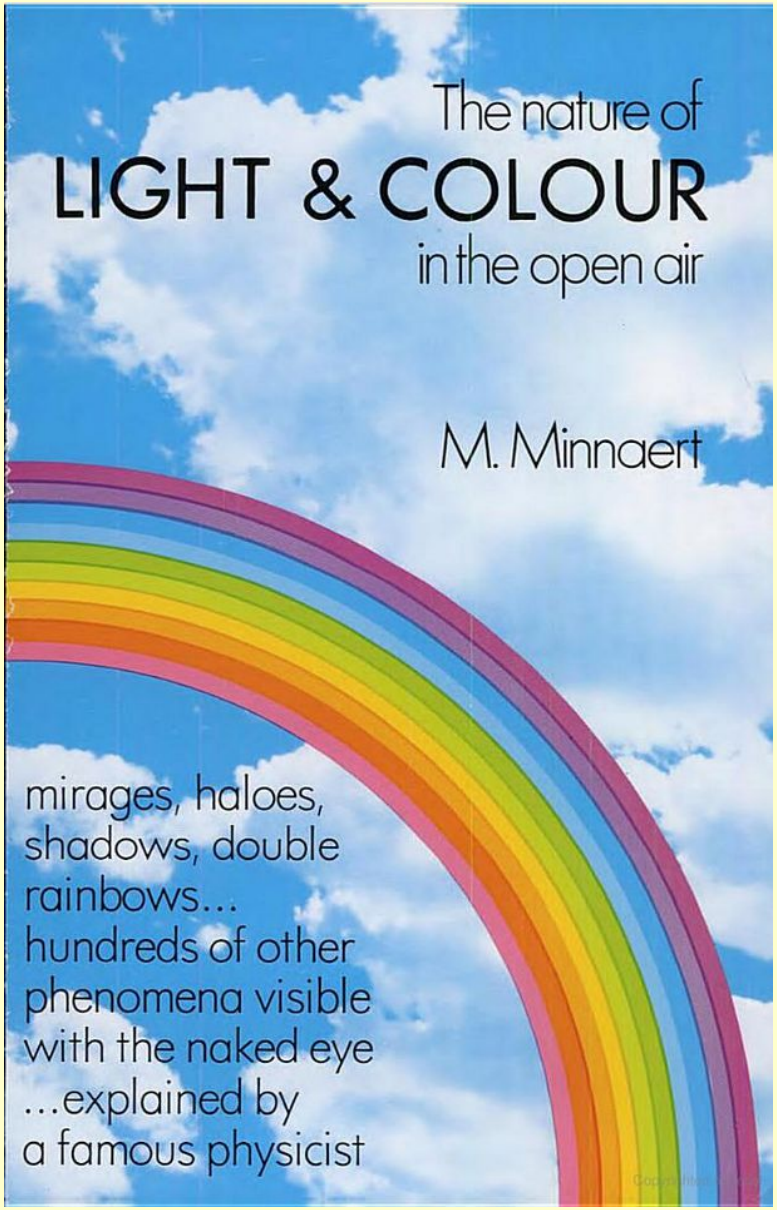
sun to move later

overcoming declination change



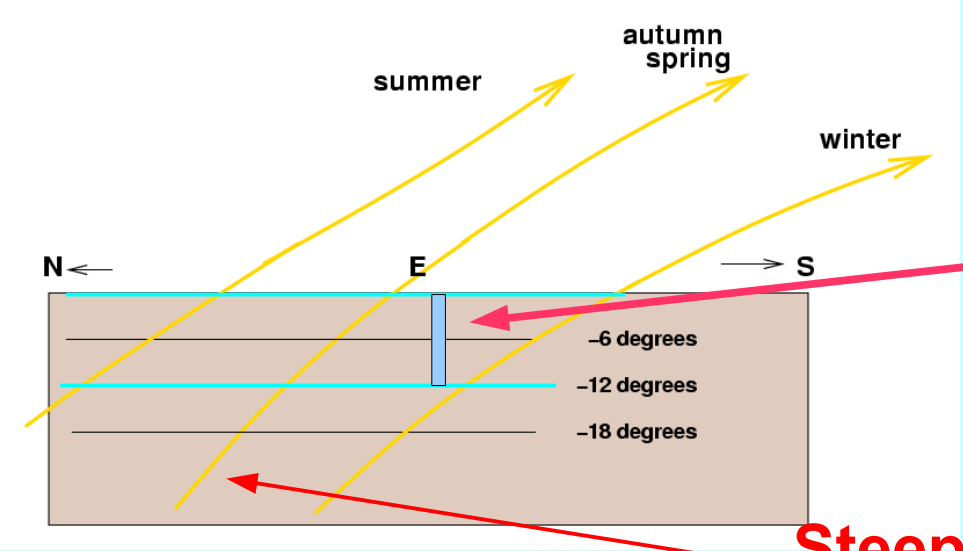
Earliest Sunrise - June 15
Latest Sunset - June 26

Other Daylight Observations



Green Flash, Rainbows, Mirages, Judging Angles...

Twilight Length



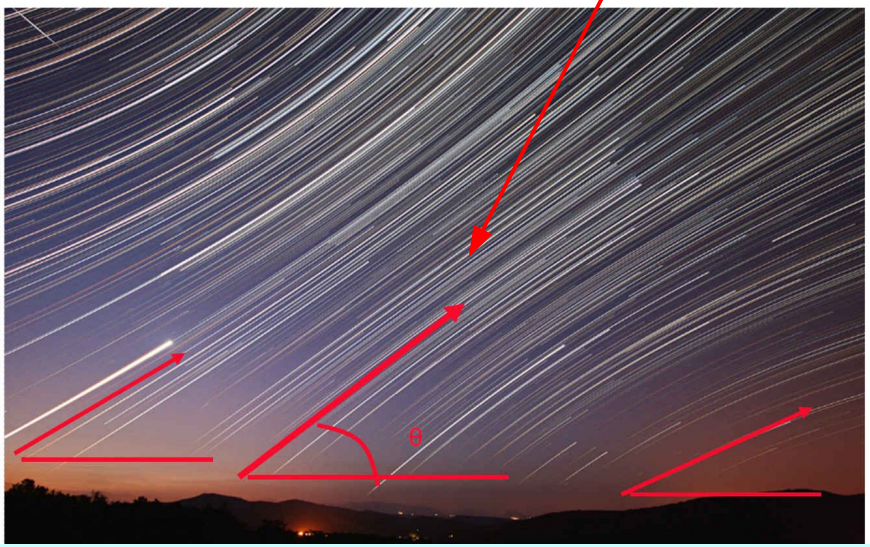
~ Length of Nautical Twilight

Eugene 44 deg N

Spring Equinox	64 min
Summer Solstice	86 min
Fall Equinox	63 min
Winter Solstice	70 min

Steeper Path

Rising/setting angle is (90° – Latitude) due east/west – along celestial equator
Angles are smaller the further N/S one goes

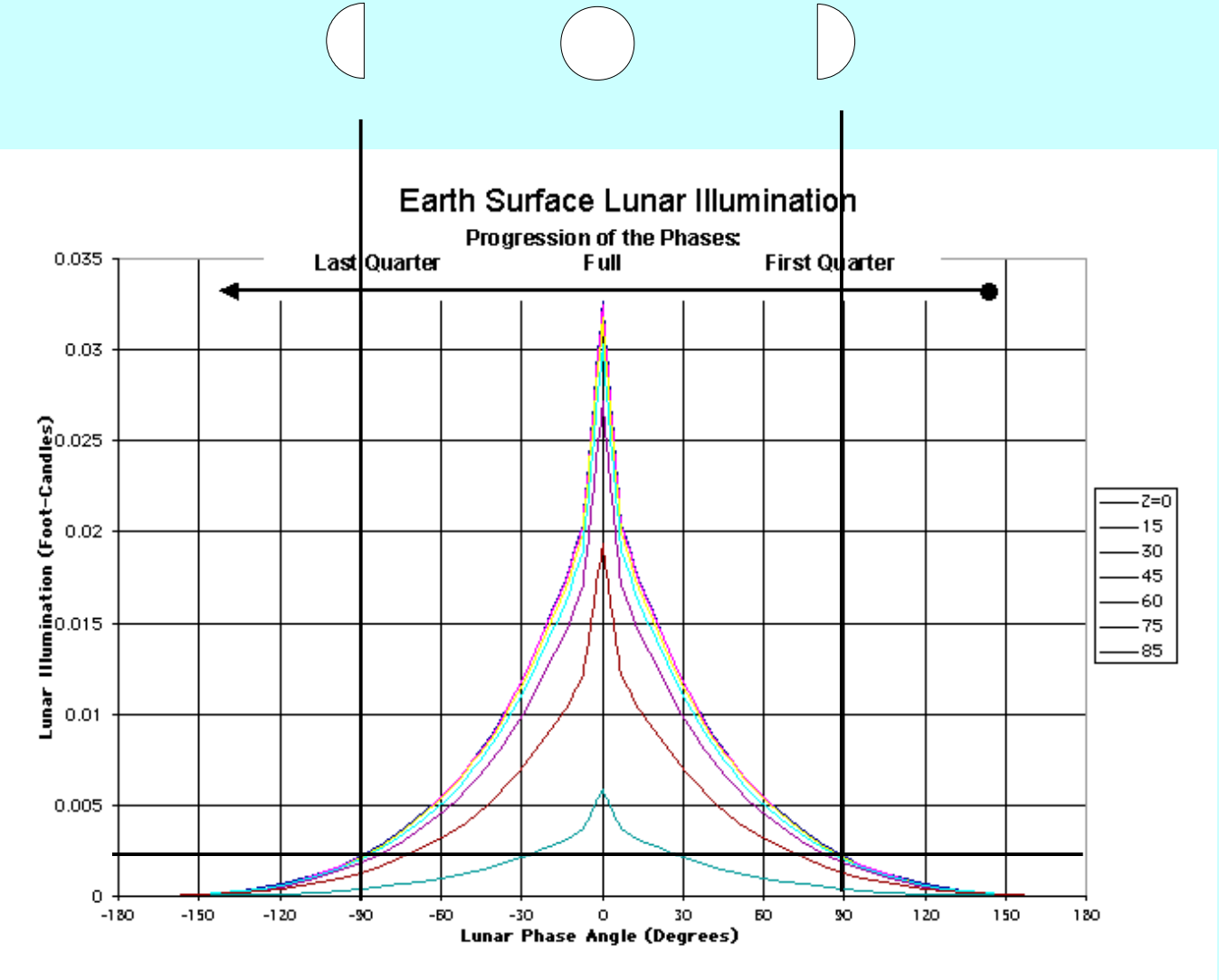


Twilight Length Increases With Latitude

Moonlight

Illumination – Phase and Altitude

Brightest In Few Days Around Full Moon



Moonlight, Moon Rise/Set

Illumination/Altitude Depends On Phase and Season

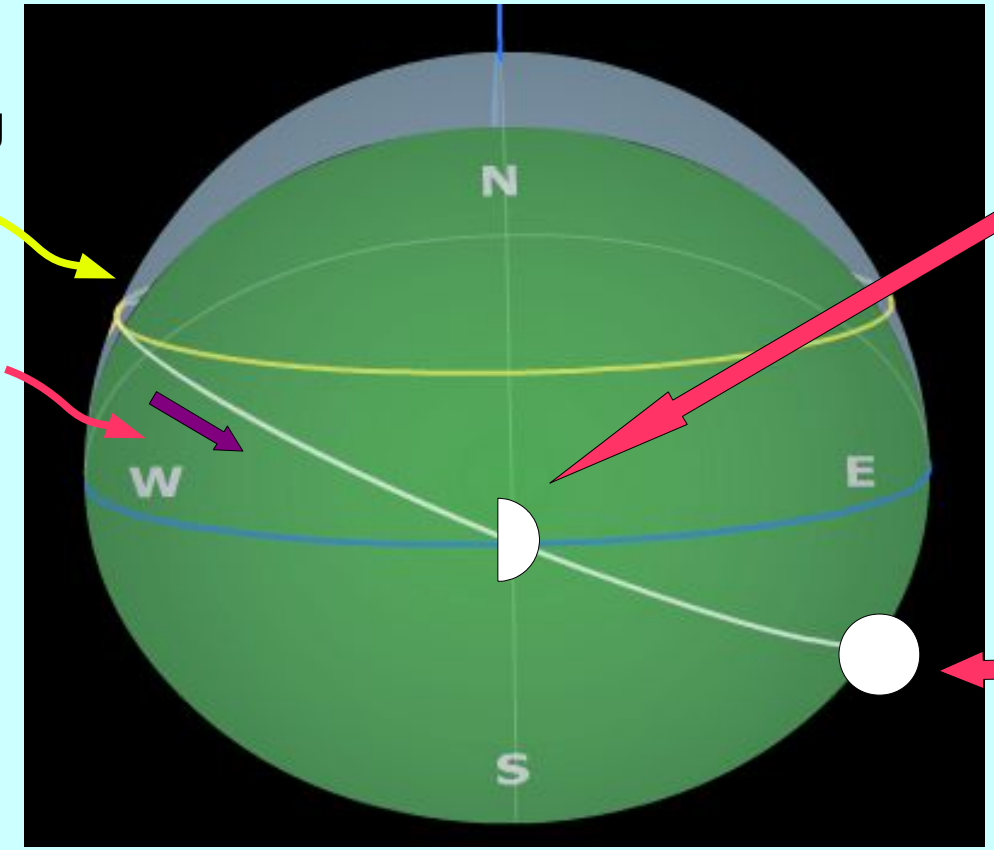
Summer Solstice

Sun Setting In North

Each Day:

Moon Moves 13 Deg E

Sets ~ 55 Minutes Later On Average

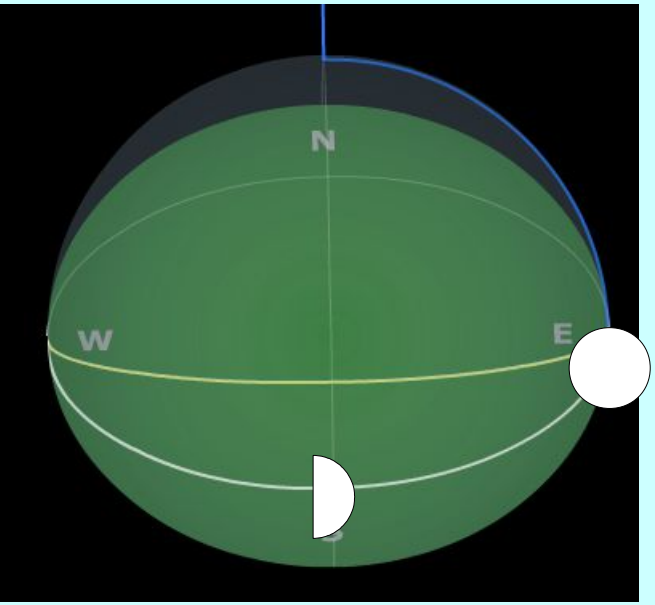


First Quarter Moon Will Be Where Sun Will Be In ~ 3 Months:
On Celestial Equator
Setting ~ Midnight

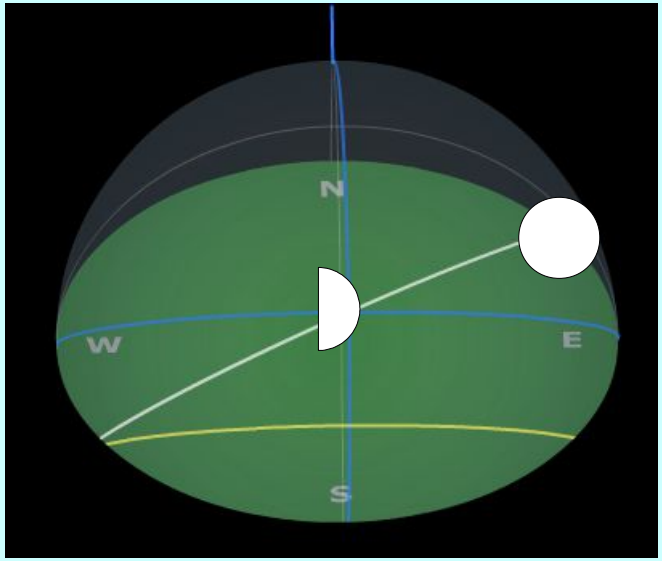
Full Moon Will Be Where Sun Will Be In ~ 6 Months,
Opposite Sun:
In South
Rising ~ Sunset

Moonlight, Moon Rise/Set

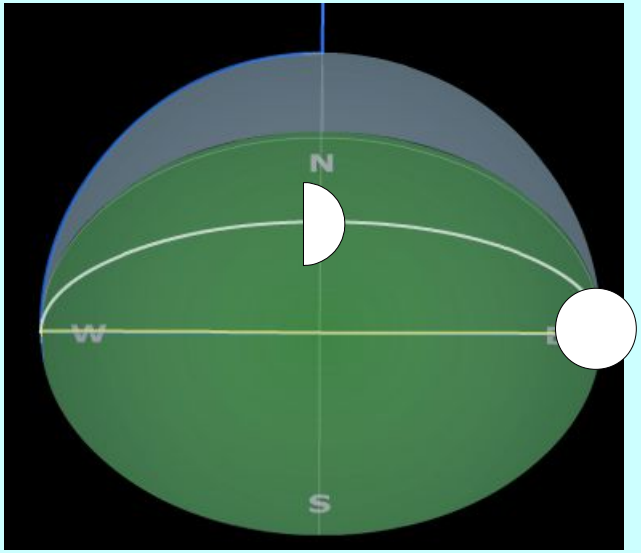
Fall Equinox



Winter Solstice

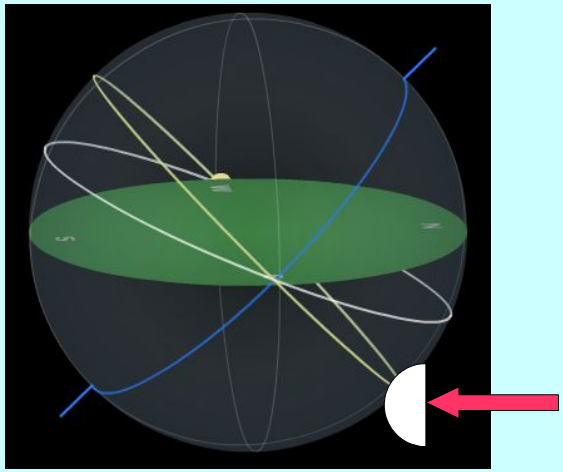


Spring Equinox



First Quarter Moon Will Be Where Sun Will Be In ~ 3 Months

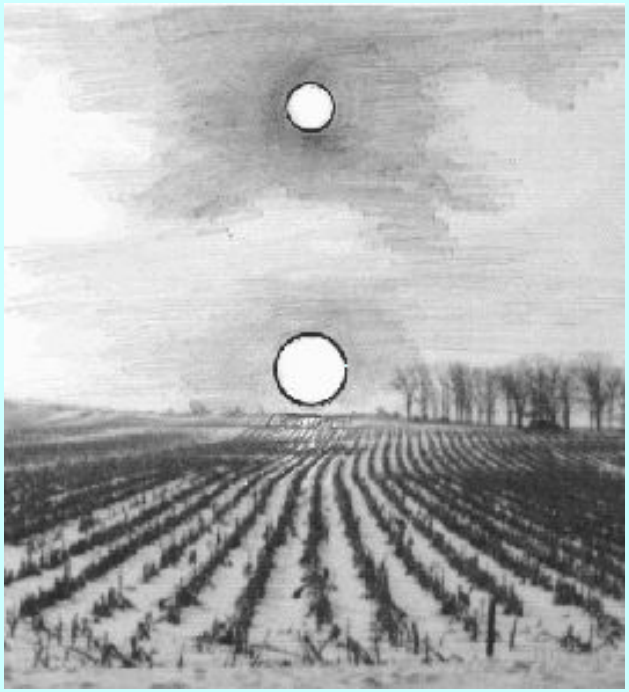
Full Moon Will Be Where Sun Will Be In ~ 6 Months, Opposite Sun



Third Quarter Moon Will Be Where Sun Will Be In ~ 9 Months

Moon Illusion

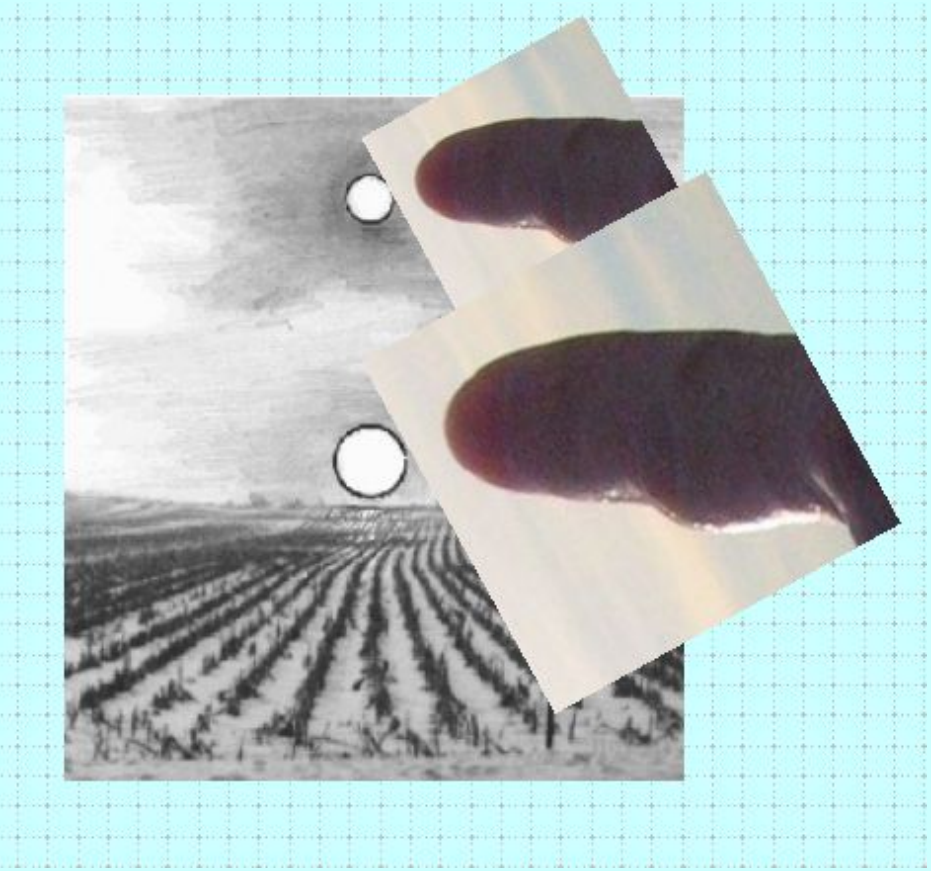
Moon Appears Huge When Close To Horizon



However, It Is Always ½ deg

Moon Illusion

Moon Appears Huge
When Close To Horizon

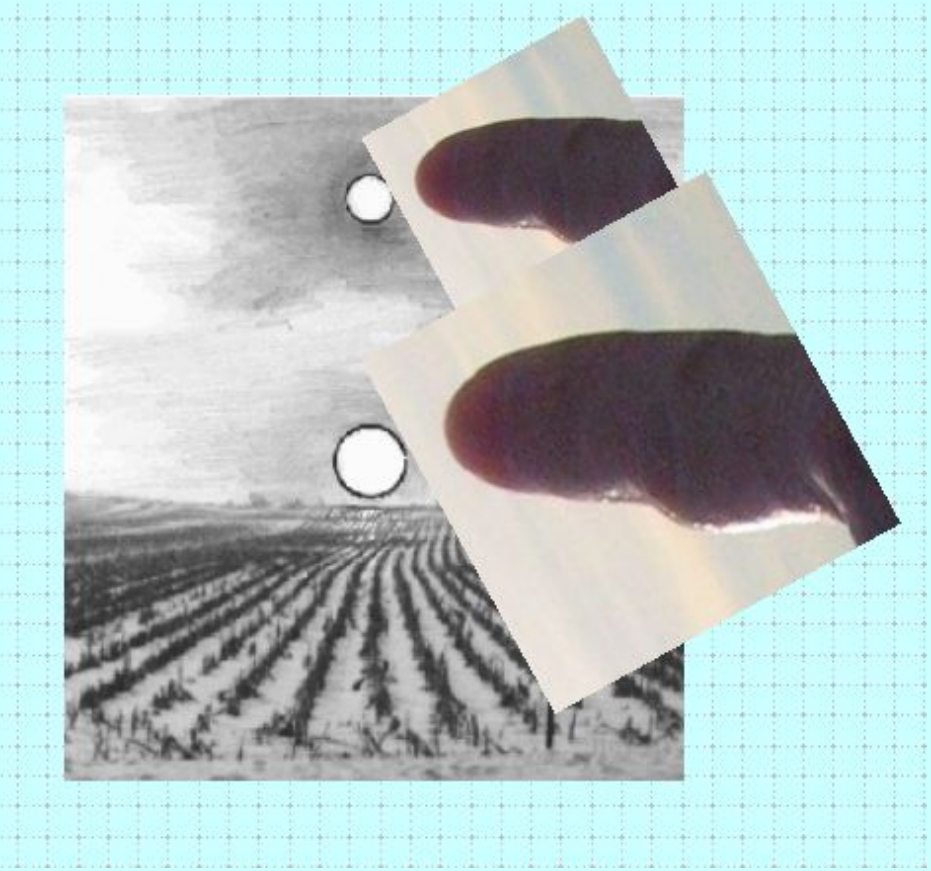


However,
It Is Always ½ deg

Can Confirm
With Finger Measurement

Moon Illusion

Moon Appears Huge When Close To Horizon

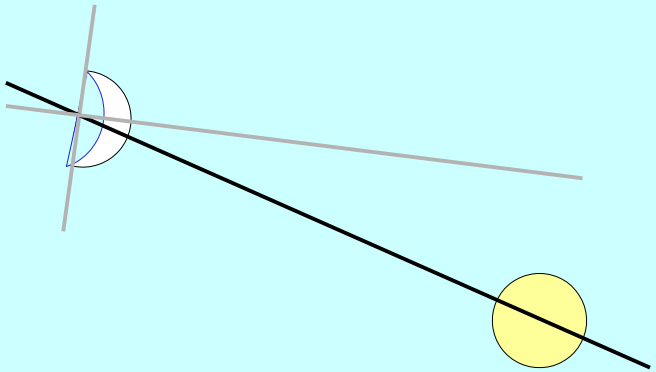


However, It Is Always ½ deg

Can Confirm With Finger Measurement

Same With Sun, Constellations, And Other Objects

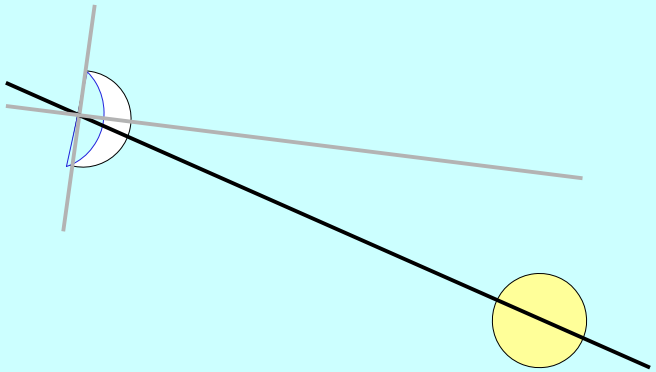
Moon Tilt Illusion



Appearance

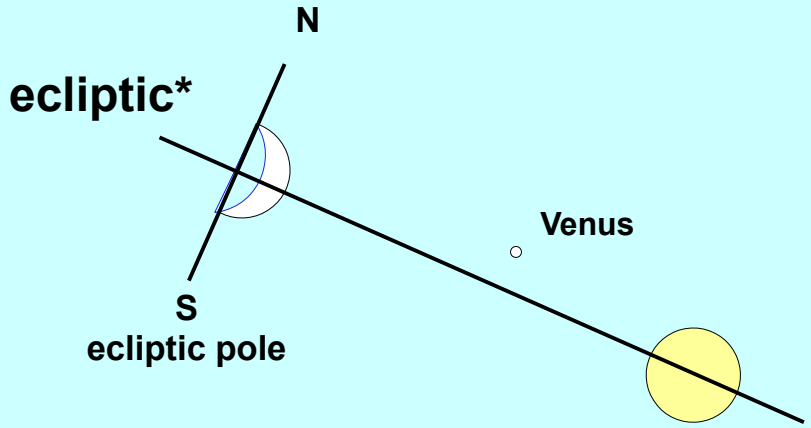
Doesn't Match Physics

Moon Tilt Illusion



Appearance

Doesn't Match Physics



Stretch String

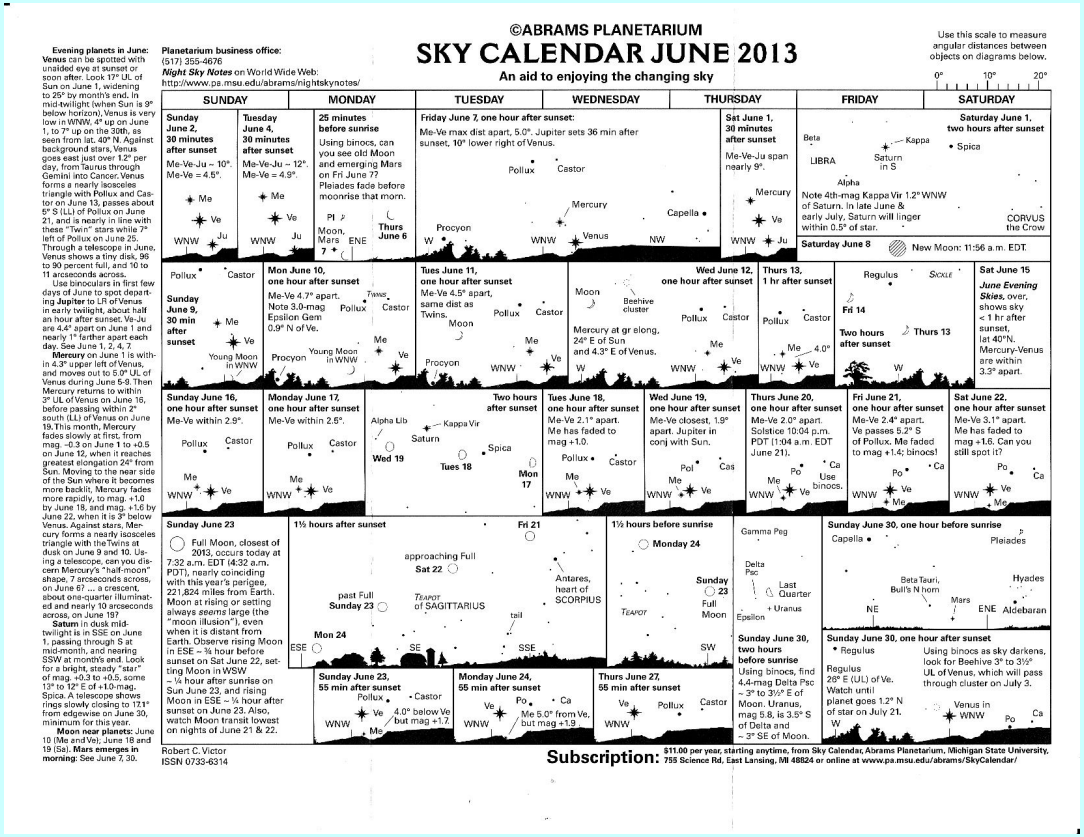
To See Actual Alignment

Locates Ecliptic

Planets and Bright Stars

Abrams Sky Calendar (or Software)

Start With Brightest Objects



©ABRAMS PLANETARIUM

SKY CALENDAR JUNE 2013

An aid to enjoying the changing sky

Use this scale to measure angular distances between objects on diagrams below.

Evening planets in June: **Venus** can be spotted with unaided eye at sunset or soon after. Look 17° UL of Sun on June 1, widening to 25° by month's end. In mid-twilight (when Sun is 9° below horizon), Venus is very low in WNW. 4° up on June 1, to 7° up on the 30th, as seen from lat. 40° N. Against background stars, Venus goes east just over 1.2° per day, from Taurus through Gemini into Cancer. Venus forms a nearly isosceles triangle with Pollux and Castor on June 13, passes about 5° S (LL) of Pollux on June 21, and is nearly in line with these "Twin" stars while 7° left of Pollux on June 25. Through a telescope in June, Venus shows a tiny disk, 96 to 90 percent full, and 10 to 11 arcseconds across.

Use binoculars in first few days of June to spot departing **Jupiter** to LR of Venus in early twilight, about half an hour after sunset. Ve-Ju are 4.4° apart on June 1 and nearly 1° farther apart each day. See June 1, 2, 4, 7.

Mercury on June 1 is within 4.3° upper left of Venus, and moves out to 5.9° UL of Venus during June 5-9. Then Mercury returns to within 3° UL of Venus on June 16, before passing within 2° south (LL) of Venus on June 19. This month, Mercury fades slowly at first, from mag. –0.3 on June 1 to +0.5 on June 12, when it reaches greatest elongation 24° from Sun. Moving to the near side of the Sun where it becomes more backlit, Mercury fades more rapidly, to mag. +1.0 by June 18, and mag. +1.6 by June 22, when it is 3° below Venus. Against stars, Mercury forms a nearly isosceles triangle with the Twins at dusk on June 9 and 10. Using a telescope, can you discern Mercury's "half-moon" shape, 7 arcseconds across, on June 6? ... a crescent, about one-quarter illuminated and nearly 10 arcseconds across, on June 19?

Saturn in dusk mid-twilight is in SSE on June 1, passing through S at mid-month, and nearing SSW at month's end. Look for a bright, steady "star" of mag. +0.3 to +0.5, some 13° to 12° E of +1.0-mag. Spica. A telescope shows rings slowly closing to 17.1° from edgewise on June 30, minimum for this year.

Moon near planets: June 10 (Me and Ve); June 18 and 19 (Sa). **Mars emerges in morning:** See June 7, 30.

Planetarium business office:
(517) 355-4676
Night Sky Notes on World Wide Web:
http://www.pa.msu.edu/abrams/nightskynotes/

SUNDAY

Sunday June 2, 30 minutes after sunset — Me-Ve-Ju – 10°. Me-Ve = 4.5°.

Sunday June 9, 30 min after sunset — Me-Ve 4.7° apart. Note 3.0-mag Epsilon Gem 0.9° N of Ve.

Sunday June 16, one hour after sunset — Me-Ve within 2.9°.

Sunday June 23 — Full Moon, closest of 2013, occurs today at 7:32 a.m. EDT (4:32 a.m. PDT), nearly coinciding with this year's perigee, 221,824 miles from Earth. Moon at rising or setting always *seems* large (the "moon illusion"), even when it is distant from Earth. Observe rising Moon in ESE ~ ½ hour before sunset on Sat June 22, setting Moon in WSW ~ ¼ hour after sunrise on Sun June 23, and rising Moon in ESE ~ ¼ hour after sunset on June 23. Also, watch Moon transit lowest on nights of June 21 & 22.

MONDAY

Tuesday June 4, 30 minutes after sunset — Me-Ve-Ju – 12°. Me-Ve = 4.9°.

Mon June 10, one hour after sunset — Me-Ve 4.7° apart. Note 3.0-mag Epsilon Gem 0.9° N of Ve.

Monday June 17, one hour after sunset — Me-Ve within 2.5°.

25 minutes before sunrise — Using binocs, can you see old Moon and emerging Mars on Fri June 7? Pleiades fade before moonrise that morn.

1½ hours after sunset — Sun Jun 23: approaching Full Sat 22; past Full Sun 23; Mon 24; Fri 21; Antares, heart of SCORPIUS; tail; TEAPOT of SAGITTARIUS.

Sunday June 23, 55 min after sunset — Pollux, Castor, Ve, 4.0° below Ve but mag +1.7.

TUESDAY

Friday June 7, one hour after sunset: Me-Ve max dist apart, 5.0°. Jupiter sets 36 min after sunset, 10° lower right of Venus.

Tues June 11, one hour after sunset — Me-Ve 4.5° apart, same dist as Twins.

Two hours after sunset — Alpha Lib, Kappa Vir, Saturn, Spica, Wed 19, Tues 18, Mon 17.

Monday June 24, 55 min after sunset — Ve, Po, Ca, Me 5.0° from Ve, but mag +1.9.

WEDNESDAY

Tues June 18, one hour after sunset — Me-Ve 2.1° apart. Me has faded to mag +1.0.

Wed June 19, one hour after sunset — Me-Ve closest, 1.9° apart. Jupiter in conj with Sun.

Wed June 12, one hour after sunset — Moon, Beehive cluster, Mercury at gr elong, 24° E of Sun and 4.3° E of Venus.

1½ hours before sunrise — Monday 24; Sunday 23 Full Moon; TEAPOT; Gamma Peg; Delta Psc; Last Quarter; + Uranus; Epsilon.

Thurs June 27, 55 min after sunset — Ve, Pollux, Castor.

THURSDAY

Sat June 1, 30 minutes after sunset — Me-Ve-Ju span nearly 9°.

Thurs June 13, 1 hr after sunset — Pollux, Castor, Me, 4.0°, Ve.

Thurs June 20, one hour after sunset — Me-Ve 2.0° apart. Solstice 10:04 p.m. PDT (1:04 a.m. EDT June 21). Po, Ca, Use binocs.

Sunday June 30, two hours before sunrise — Using binocs, find 4.4-mag Delta Psc ~ 3° to 3½° E of Moon. Uranus, mag 5.8, is 3.5° S of Delta and ~ 3° SE of Moon.

FRIDAY

Saturday June 1, two hours after sunset — Beta, Kappa, Spica, LIBRA, Saturn in S, Alpha. Note 4th-mag Kappa Vir 1.2° WNW of Saturn. In late June & early July, Saturn will linger within 0.5° of star. CORVUS the Crow.

Saturday June 8 — New Moon: 11:56 a.m. EDT.

Fri June 14 — Regulus, Sickle, Two hours after sunset, Thurs 13.

Sunday June 30, one hour before sunrise — Capella, Pleiades, Beta Tauri, Bull's N horn, Hyades, Mars, NE, ENE, Aldebaran.

Sunday June 30, one hour after sunset — Regulus. Regulus 28° E (UL) of Ve. Watch until planet goes 1.2° N of star on July 21. Using binocs as sky darkens, look for Beehive 3° to 3½° UL of Venus, which will pass through cluster on July 3. Venus in WNW, Po, Ca.

SATURDAY

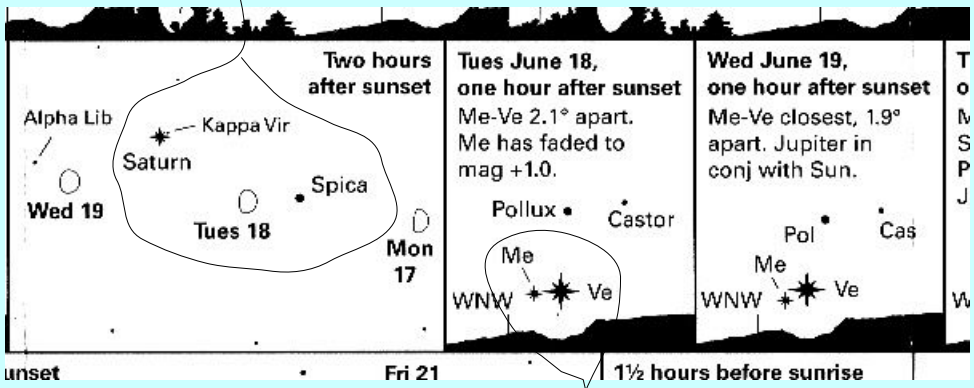
Sat June 15 — *June Evening Skies*, over, shows sky < 1 hr after sunset, lat 40°N. Mercury-Venus are within 3.3° apart.

Sat June 22, one hour after sunset — Me-Ve 3.1° apart. Me has faded to mag +1.6. Can you still spot it?

Robert C. Victor
ISSN 0733-6314

Subscription: $11.00 per year, starting anytime, from Sky Calendar, Abrams Planetarium, Michigan State University, 755 Science Rd, East Lansing, MI 48824 or online at www.pa.msu.edu/abrams/SkyCalendar/

Locate Saturn and Spica Using Moon



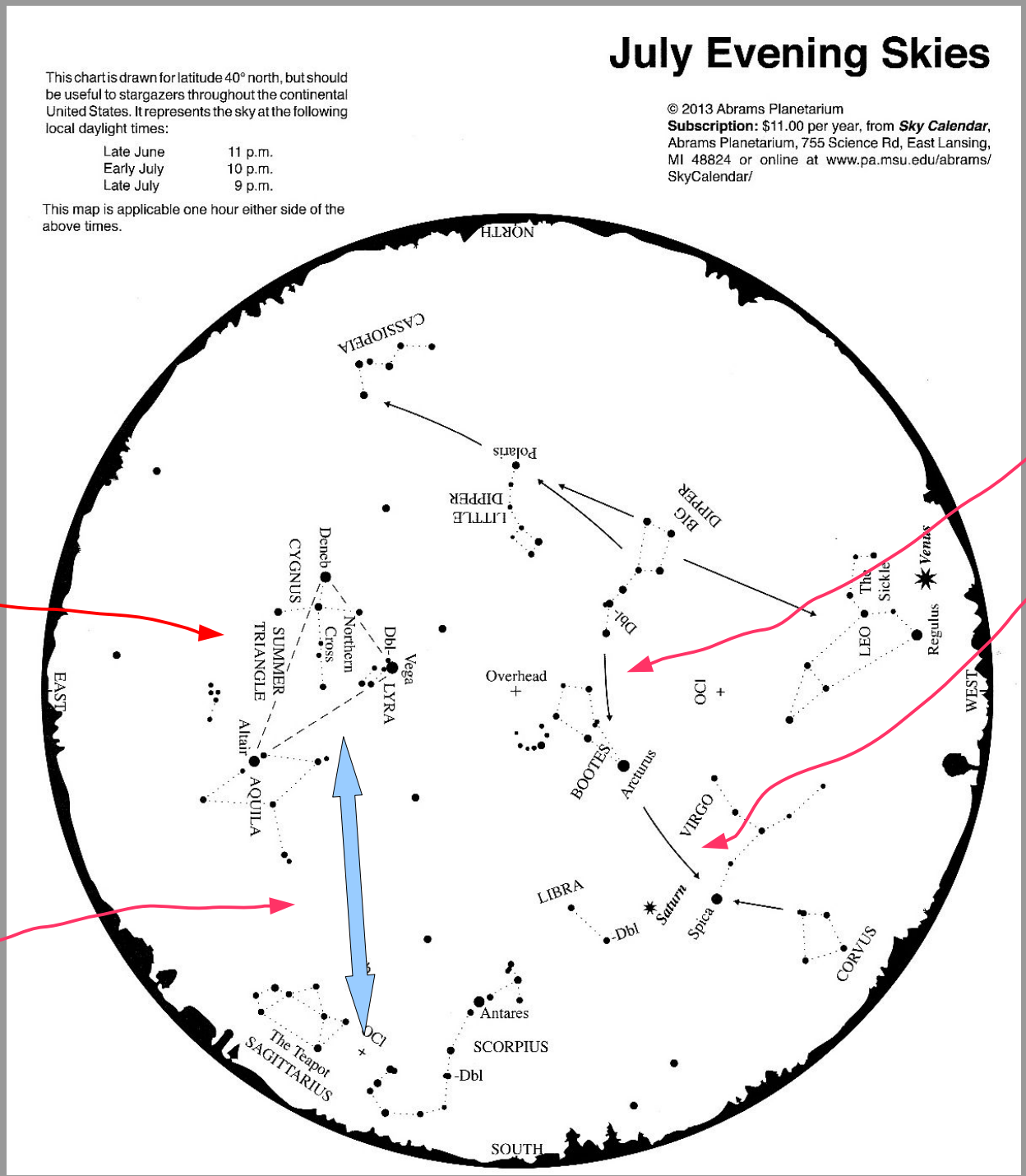
Locate Mercury Using Venus

www.pa.msu.edu/abrams/SkyCalendar/
$11/year

Night

Four Minutes Earlier Every Night

Planisphere



Summer Triangle Asterism

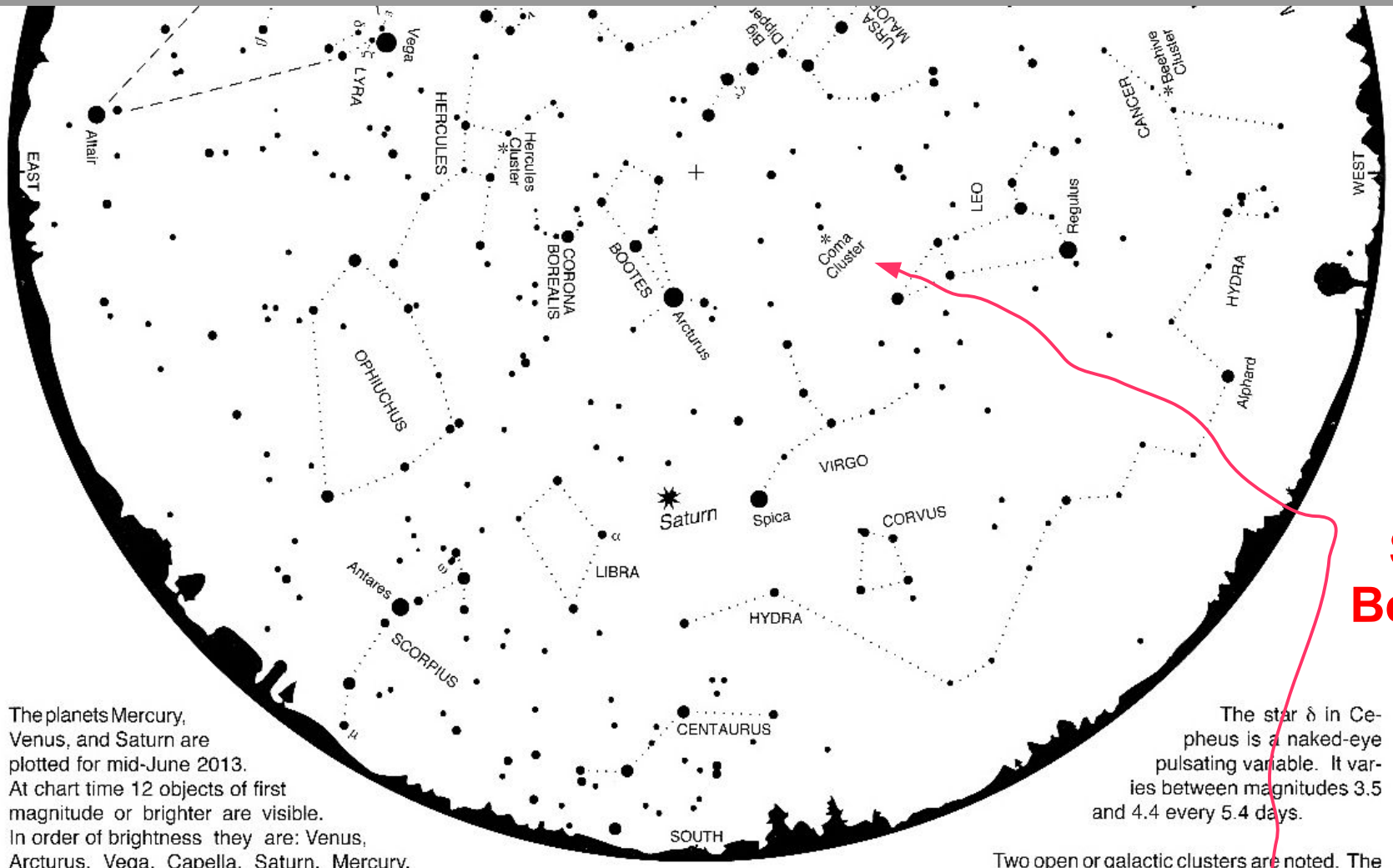
Milky Way

Arc To Arcturus

Spike To Spica

Saturn Now Left Of Spica

Night



The planets Mercury, Venus, and Saturn are plotted for mid-June 2013. At chart time 12 objects of first magnitude or brighter are visible. In order of brightness they are: Venus, Arcturus, Vega, Capella, Saturn, Mercury, Altair, Antares, Spica, Pollux, Deneb, and Regulus.

Our usual monthly maps are designed for stargazers just beginning to find their way around the sky. This month's map is useful for serious stargazing from dark locations. It contains many more stars, inclusive to magnitude 4.5 and some fainter stars as needed to complete patterns or assist in locating special objects.

A selection of double stars (labeled with Greek letters) and "deep sky objects" is also plotted. All are visible with modest equipment; most are within the range of the unaided eye or binoculars.

The double stars, in order of decreasing angular separation, are ω Sco, ζ UMa, δ Lyr, μ Sco, ο Cyg, α Lib, ε Lyr, ν Dra, ζ Lyr, β Cyg.

The star δ in Cepheus is a naked-eye pulsating variable. It varies between magnitudes 3.5 and 4.4 every 5.4 days.

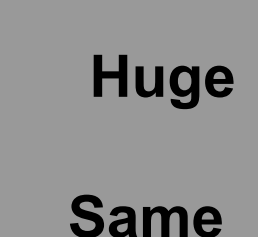
Two open or galactic clusters are noted. The Coma Cluster is a loose group of naked-eye stars below the handle of the Big Dipper. The Beehive or Praesepe in Cancer is much more compact, resembling a hazy patch of light.

The Hercules Cluster appears still more compact. It is a fine example of a globular cluster, a dense concentration of about a million stars.

Coma Star Cluster Berenice's Hair

Double Stars

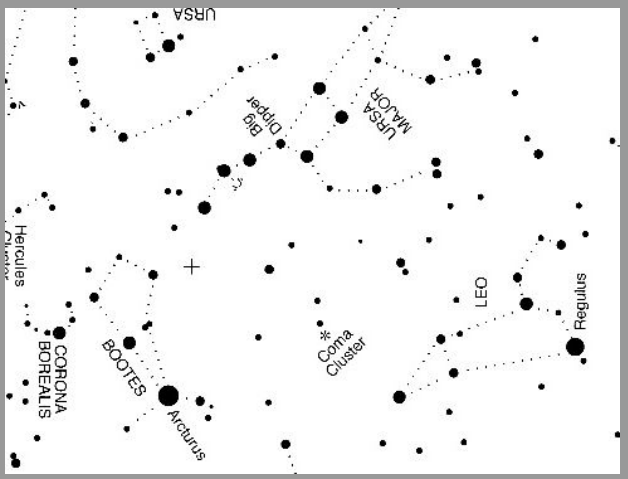
	Eyes	Binoculars	Small Telescopes
Power	1x	8x	20-60x
Apparent Field	Huge	~ 50 deg	~ 50 deg
True Field	Same	~ 6 deg	2.5 - < 1 deg
Aperture	4mm x 2	40 mm x 2	70 mm
Light	1	100	150

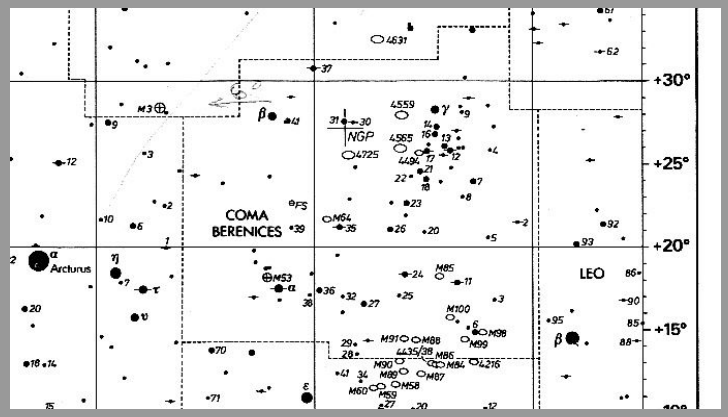


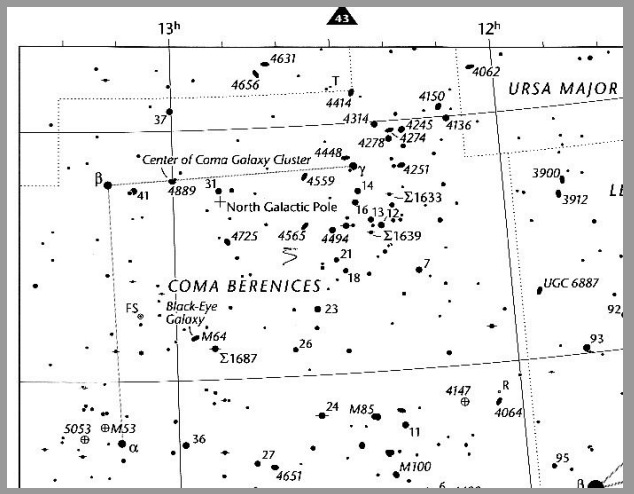
Abrams/ Planisphere

Tirion Bright Star Atlas

Pocket Sky Atlas

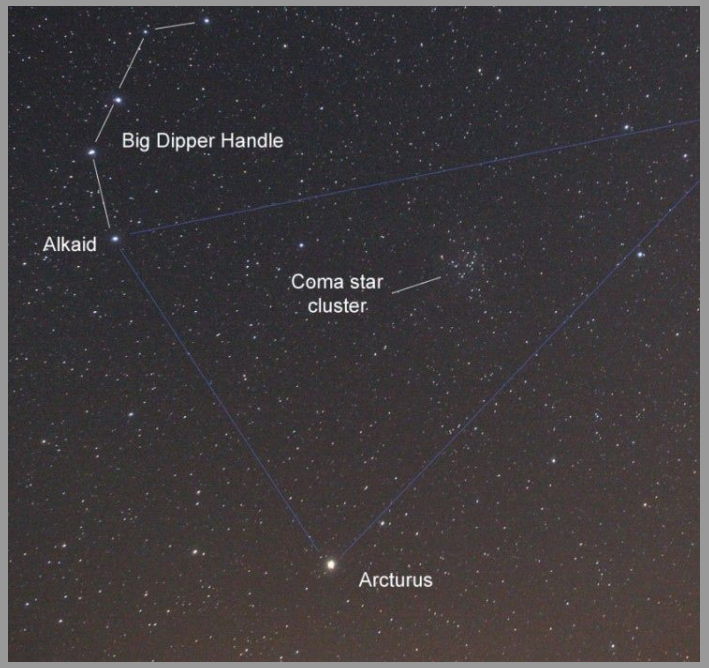




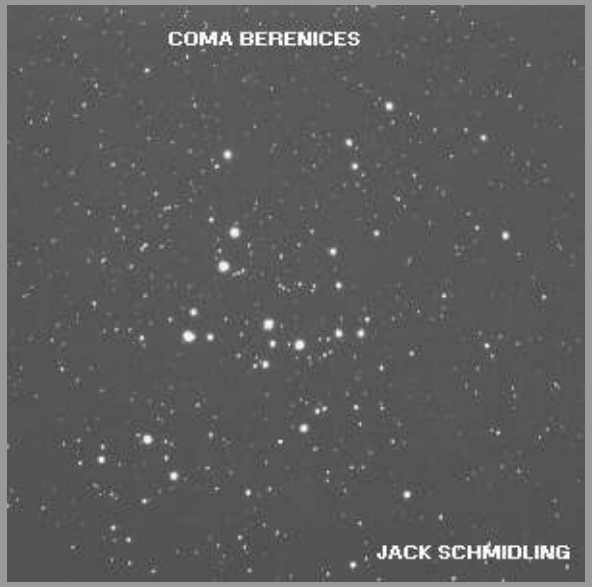


Coma Berenices Star Cluster

Eyes



Binoculars



Small Telescopes

Fun Objects

Satellites
After sunset. ID with software. Flares

Moon
Phases, position, libration, Earthshine.
Craters and mountains on terminator

Planets
Movement. Jupiter's moons.
Venus, Mercury phases. Saturn rings. Asteroids

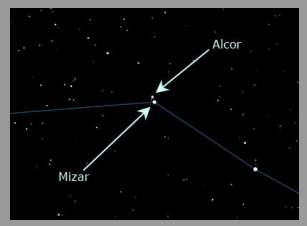
Meteors
Sporadic and showers. Best after midnight

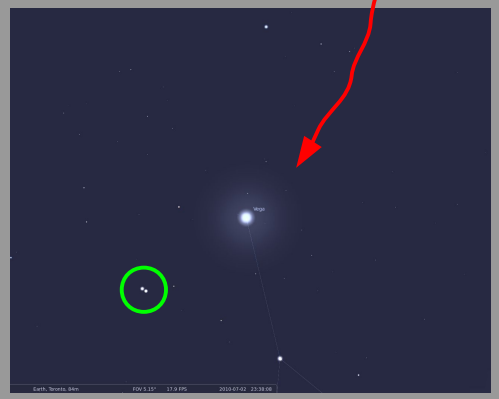
Comets
Catch when you can!

Fun Objects

Stars

Color. Asterisms.
Multiple stars, Mizar/Alcor, e Lyrae – double double, Albireo...
Variables. Supernovae...





Open Clusters - Coma, Plieades, Beehive, M6, M7, double cluster...

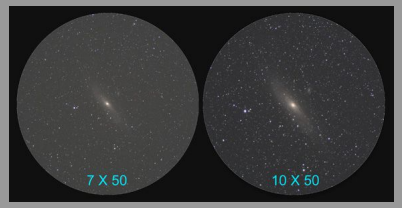
Fun Objects

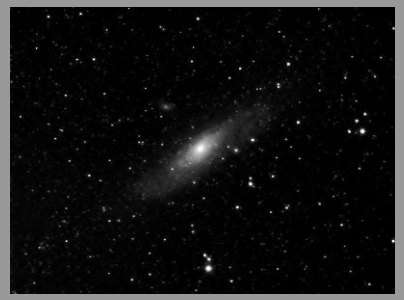
Globular Clusters

M13...

Galaxies

Milky Way. M31 – Andromeda Galaxy...





Nebulae

Orion Nebula – M42, Ring Nebula – M57...

Summary

- Solar Time
- Direction From Sun; Sun Altitude
- Sunset
- Sun Movement and Analemma
- Twilight
- Moonlight and Moon Illusions
- Bright Stars and Planets
- Astronomy With Eyes, Binoculars, Small Telescopes

Supplemental Slides Follow *Conclusion* Slide:

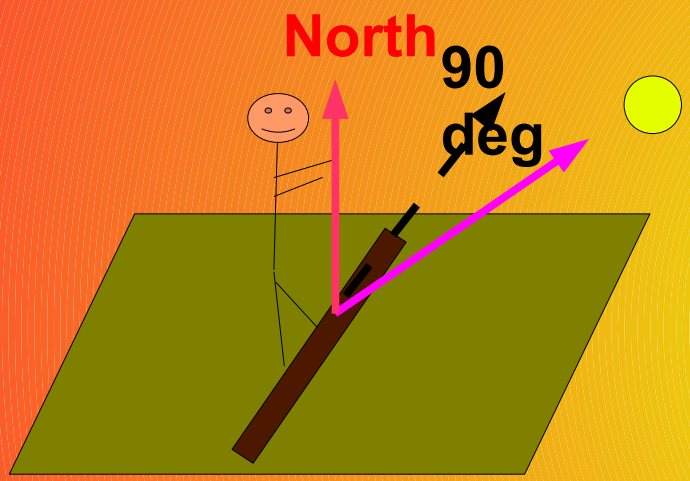
Combined Alt Az Plots for Each Season

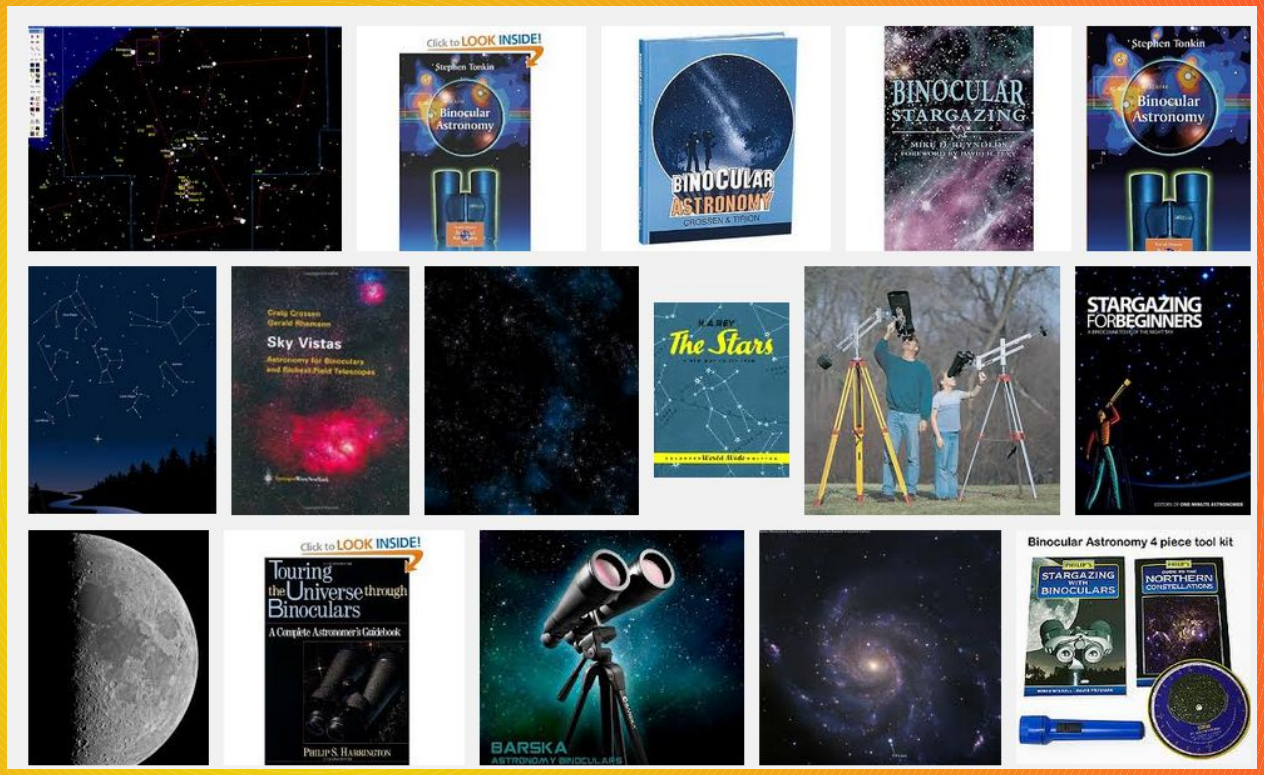
Analemma Details

Sun Shadow Tracing

Survival Direction Finding

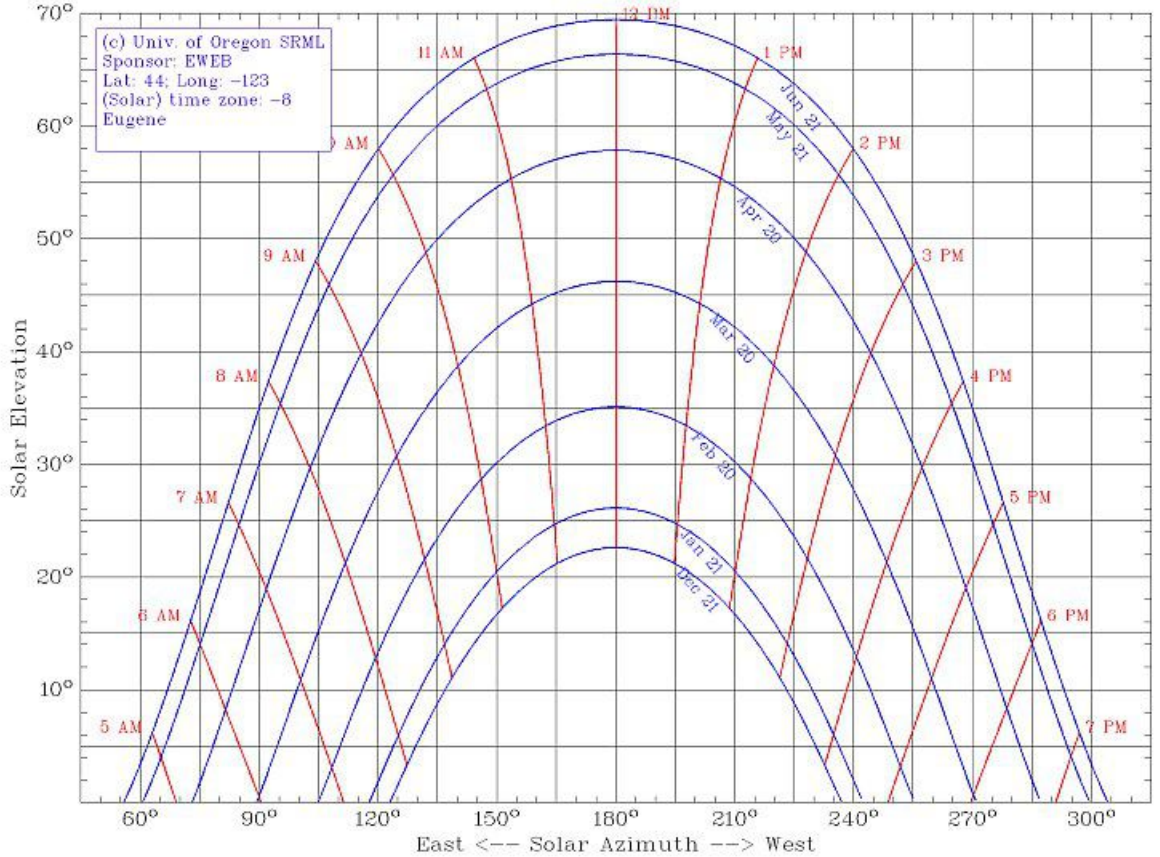
Conclusion





softwareunderstanding.com/hiking-astronomy

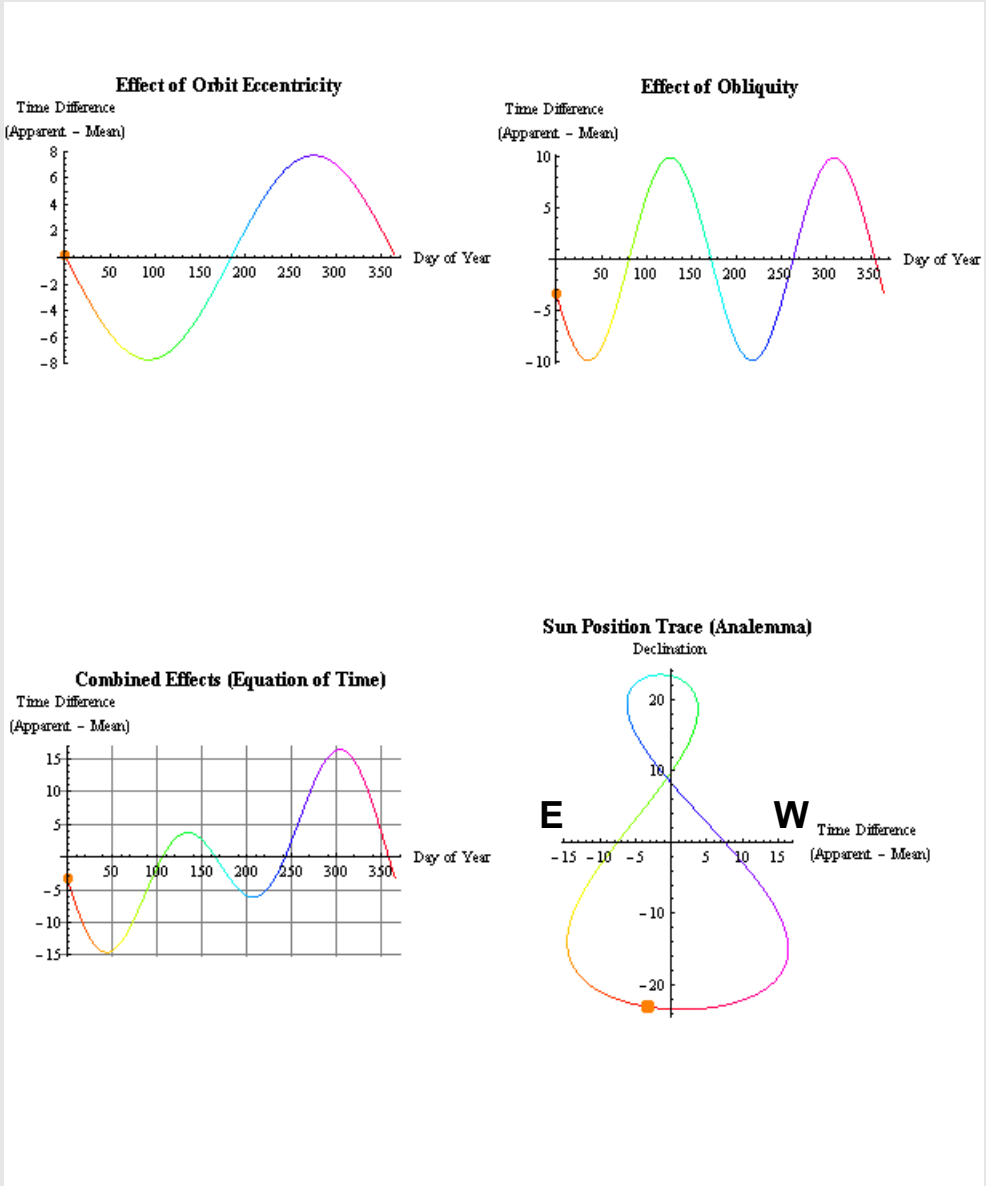
Daily Movement



6/20	**6**	*10*	**16**	*11*	**27**	*11*	**37**	*11*	**48**	*10*	**58**	*8*	**66**	*3*	**69**
3/20 Alt			**0**	*11*	**11**	*11*	**22**	*11*	**33**	*8*	**41**	*6*	**47**	*2*	**49**
12/21							**3**	*8*	**11**	*6*	**17**	*4*	**21**	*2*	**23**
6/20	**63**	*10*	**73**	*10*	**82**	*10*	**92**	*12*	**104**	*16*	**120**	*24*	**144**	*36*	**180**
3/20 Az			**90**	*10*	**100**	*11*	**111**	*12*	**123**	*16*	**139**	*19*	**158**	*22*	**180**
12/21							**127**	*11*	**139**	*13*	**151**	*14*	**165**	*15*	**180**
Solar time	**5**		**6**		**7**		**8**		**9**		**10**		**11**		**12**

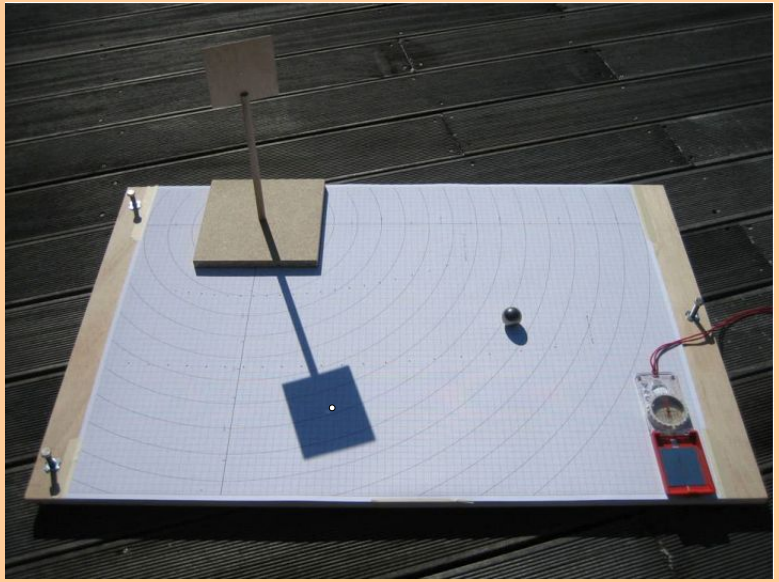
The Analemma

Sun at given clock time for a year



www.analemma.com

Shadow Stick Astronomy



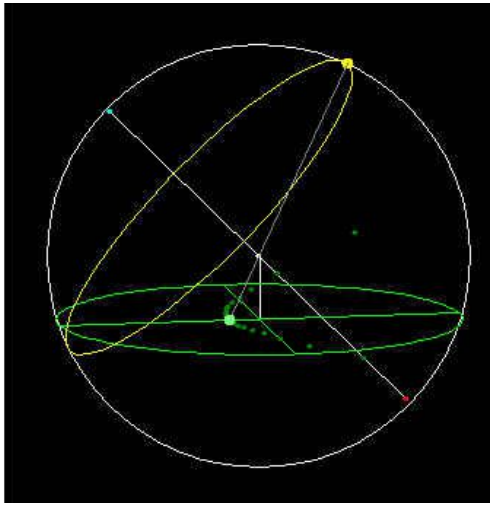
Mark time

Trace path

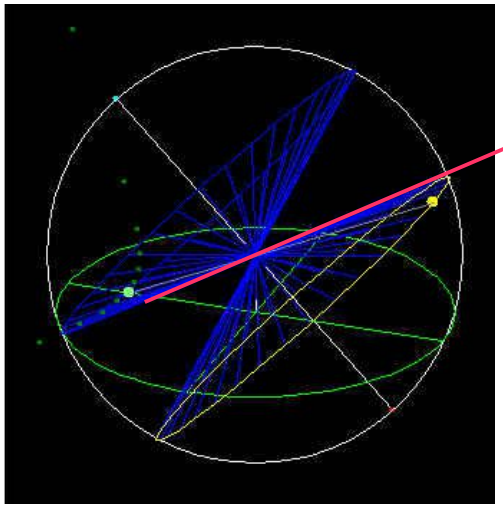
Measure altitude and azimuth

Find Location

Sun Traces Declination Lines

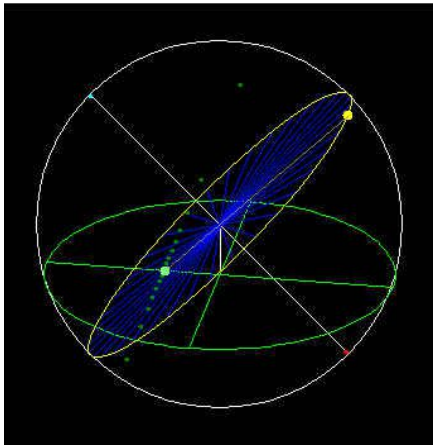


Summer



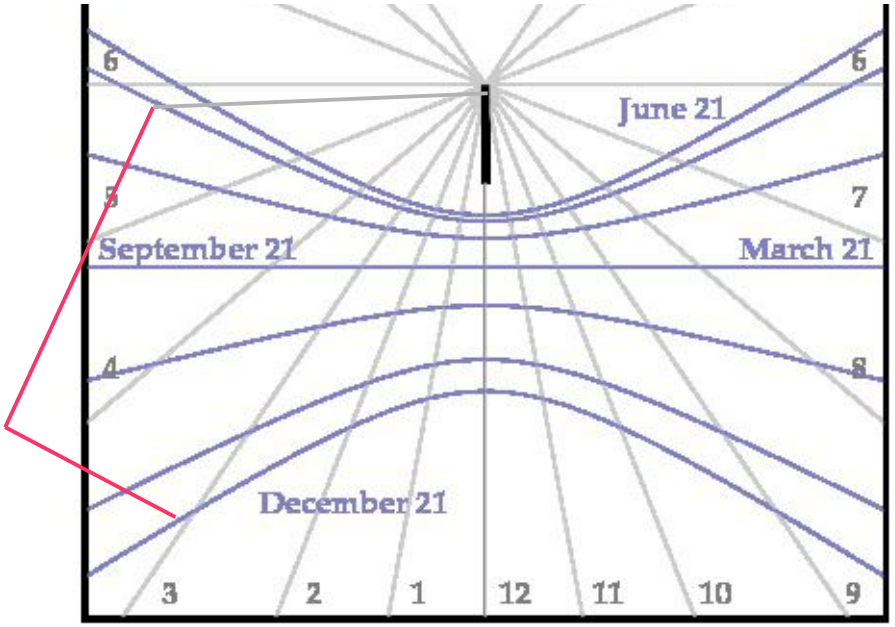
Winter

Cone cut by plane



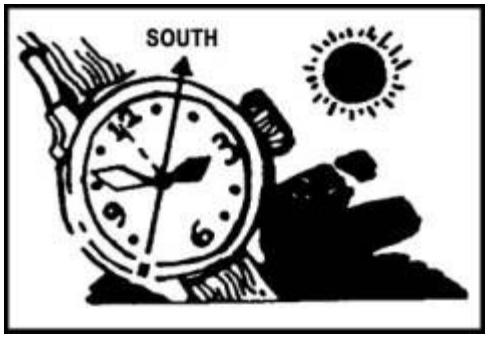
Equinoxes

Shadow of point traces hyperbola* for each day/declination



Primitive Direction Finding

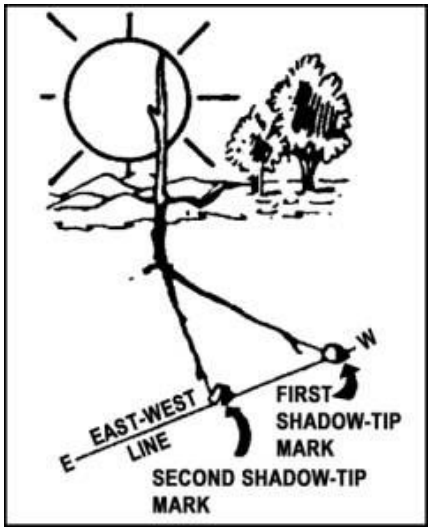
Watch Method



Assumes

- watch gives solar time
- azimuth of 15 deg/hour

Two Point Method



When do pairs of points show E-W?