The Day Through the Seasons

Rising and Setting of the Sun: Seasons and Latitude

The azimuths where an object at a ***declination*** δ will rise and set, and the length of time that object will be above the horizon as seen by an observer at a ***latitude*** λ are given by:

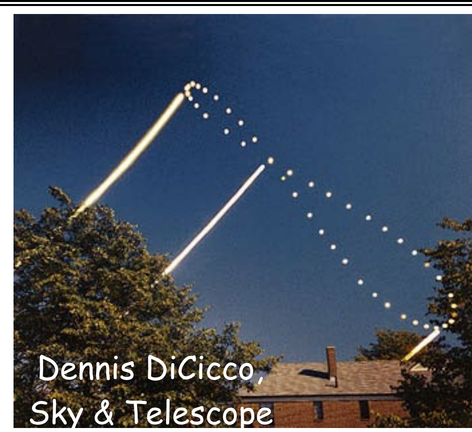
$$A_{rise} = \cos^{-1}\left(\frac{\sin\delta}{\cos\lambda}\right) \text{ degrees} \qquad A_{set} = 360 - A_{rise} \text{ degrees} \qquad \Delta t = \frac{2}{15}\cos^{-1}(-\tan\lambda\tan\delta) \text{ hours}$$

Using these, find the rising and setting azimuths and the length of the day for the following locations and dates, using the declination of the sun given by the analemma: [30]

Date	$\delta_\odot$	Canton, New York (λ = 44° 36′ N)			Quito, Equador (λ = 0° N)			Igloolik, Nunavut, Canada (λ = 69° 24′ N)		
		A_{rise}	A_{set}	Δt_{day}	A_{rise}	A_{set}	Δt_{day}	A_{rise}	A_{set}	Δt_{day}
Feb. 12										
Dec. 25										
Jun. 25										

Variation of the Solar Day: The Analemma

If you mark the position of the tip of a sundial's shadow at noon each day of the year, it will scribe the shape known as the ANALEMMA. This shape describes the difference between *mean solar noon* (or clock noon) and *solar noon*. The analemma's shape is due to both the tilt of the Earth's axis, and the elliptical shape of the Earth's orbit. Check out www.analemma.com for details.



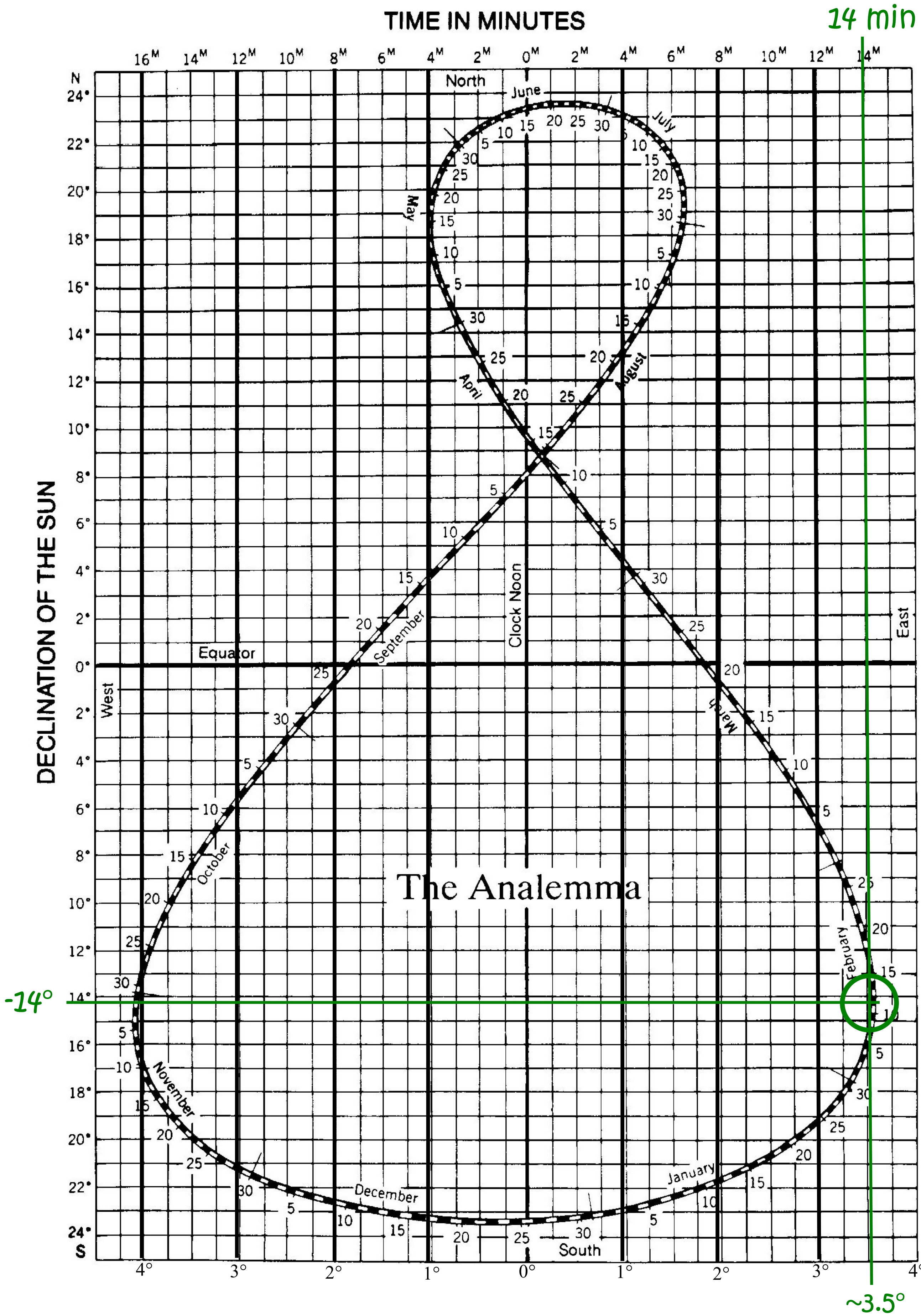
This is used to find the declination of the Sun and the time by which the Sun is early or late for clock noon (mean solar noon … not accounting for the observer's position within the time zone). [20]

LATE: Sol is to the ***east*** of the meridian at clock noon (Sun has not yet arrived at noon)

EARLY: Sol is to the ***west*** of the meridian at clock noon (Sun has already passed noon).

TAKE POSITION TO THE CLOSEST ½ DEGREE, TIME TO THE CLOSEST ½ MINUTE.

Date	Declination of Sun	Sol's position in degrees **East or West** of clock noon	Minutes by which Sol will be **early or late** for clock noon	**Clock time of solar noon**
February 12				
June 25				
September 14				
December 25				
Your Birthday *Date:_______*				


TIME IN MINUTES
DECLINATION OF THE SUN
The Analemma
North
South
East
West
Equator
Clock Noon
January
February
March
April
May
June
July
August
September
October
November
December
14 min
-14°
~3.5°