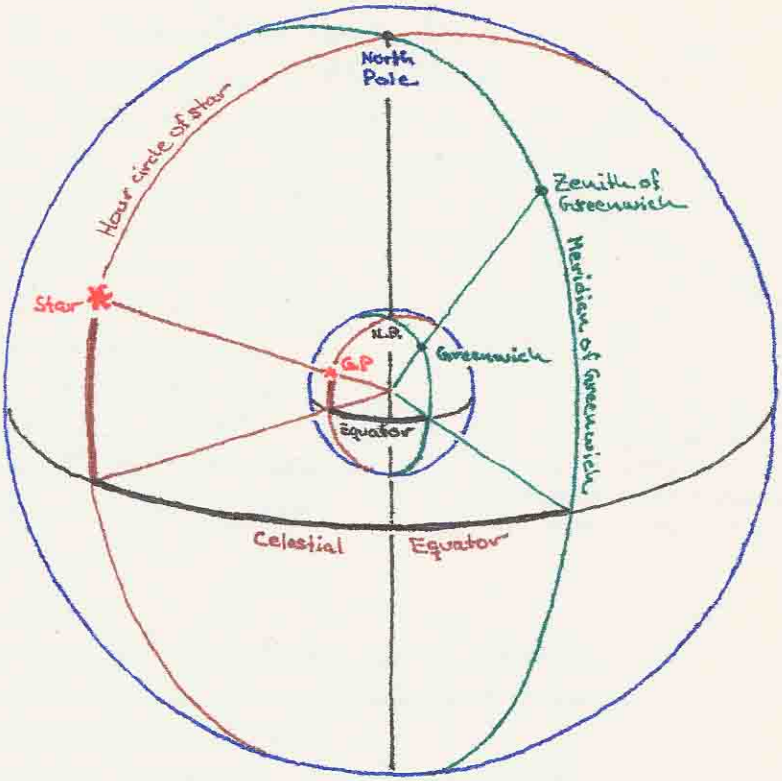
CELESTIAL NAVIGATION

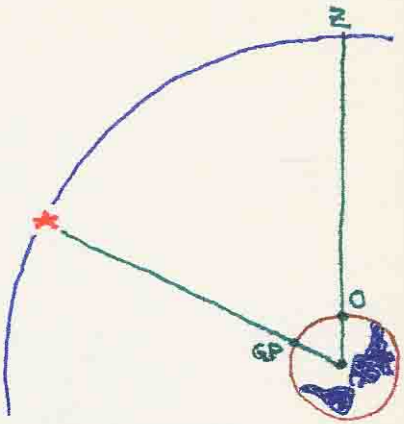


At any particular instant
each heavenly body is at the zenith
of a particular point on the Earth
called the geographic position (G.P) of the body
or the substellar (subsolar, submoon, etc.) point

The latitude and longitude of the G.P
are the declination and the Greenwich hour angle
of the body

An observation
with the sextant or octant
gives the altitude of the star
at the place of observation.

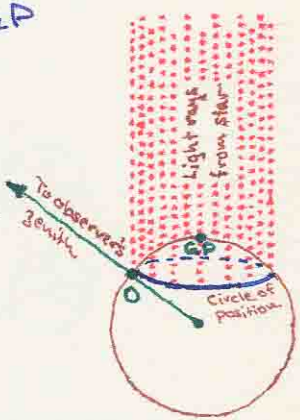
Subtracting this from 90°
gives the zenith distance
of the star
and the value of this
in minutes of arc
equals the distance
in nautical miles
on the Earth's surface
between the observer
and the GP



The zenith distance (degrees)
of a star
equals the observers distance
from its GP

Therefore
the observer must be somewhere
on a circle on the Earth's surface
each point of which
is at this distance from the GP

This circle
is called a circle of position.



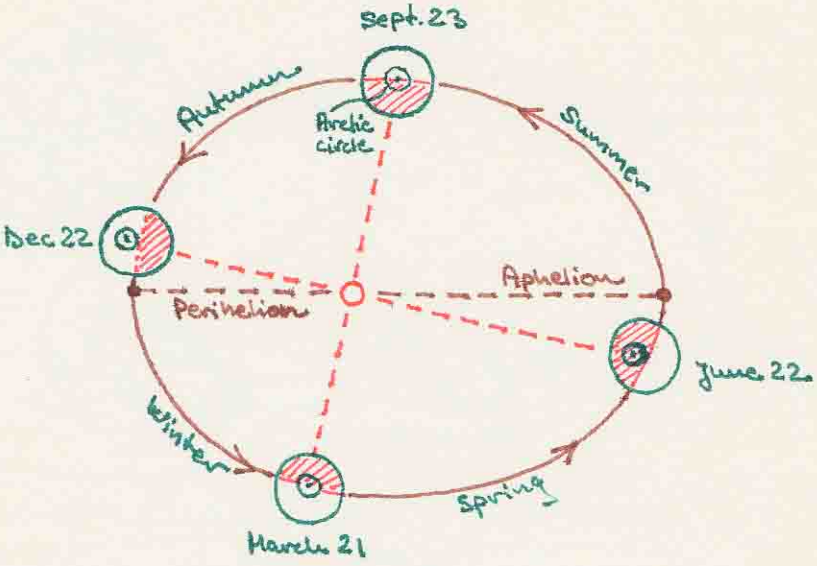
Observation of another star
determines a second circle of position
intersecting the first at two points

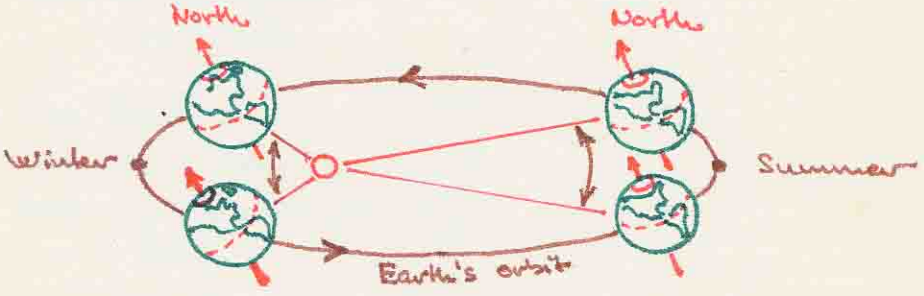
The observer must be
at one of these points
and as they are usually
hundreds of miles apart
he is not likely to be in doubt
as to which one.

This point is called a fix.

The most satisfactory fix is obtained
by observing in rapid succession
three stars at moderate altitudes
and in azimuths about 120° apart

The Seasons in the Northern Hemisphere





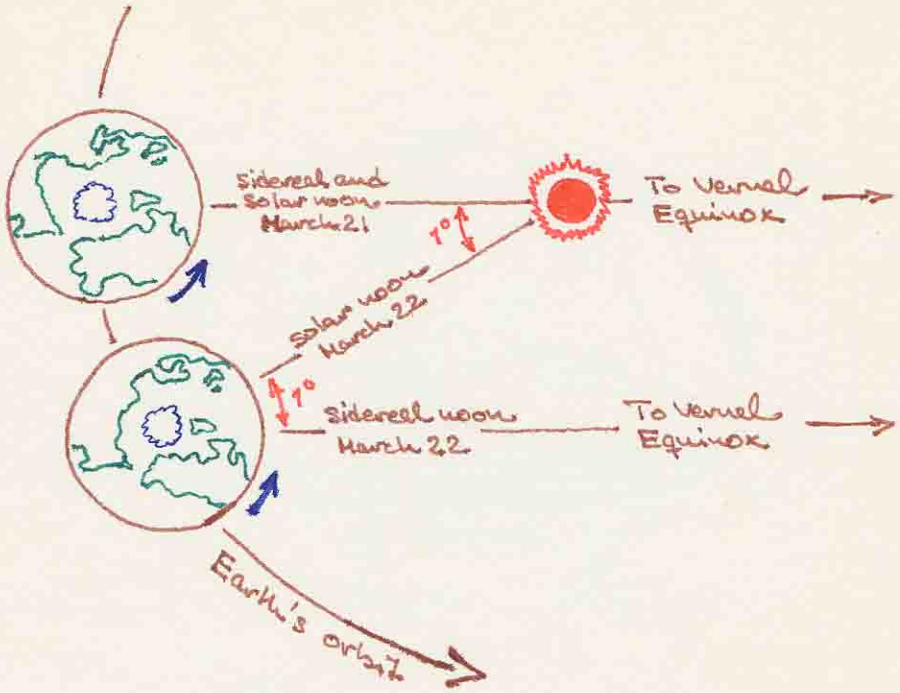
The Earth's revolution
around the Sun
is not at a uniform rate

The Earth revolves
in its elliptical orbit
in accordance with
the law of equal areas:

The line
joining the Earth to the Sun
sweeps over equal areas
in equal times

The shorter line
joining the Earth and Sun
in winter
must go around farther
than the longer line
in summer
to sweep over the same area.

Accordingly
the Earth revolves farther
in a day in winter

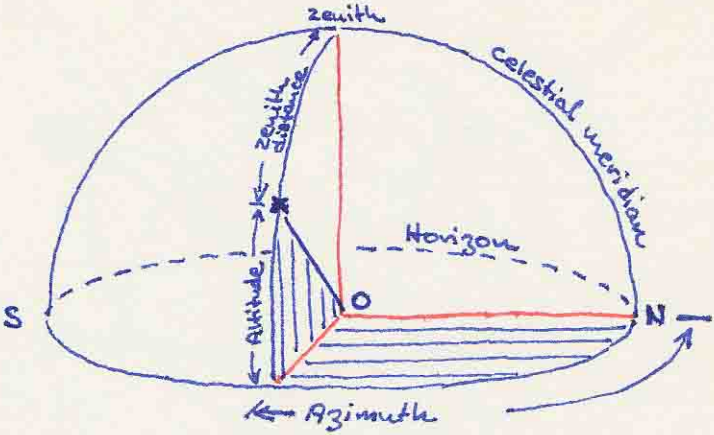


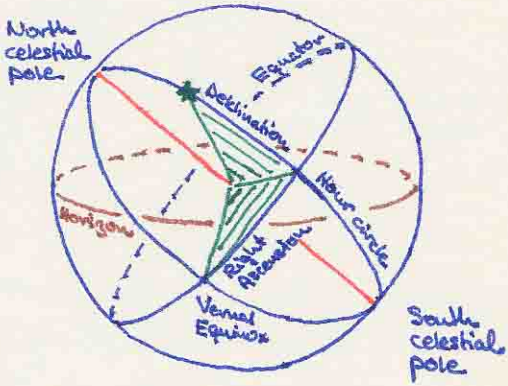
The Earth
rotates 1 degree
around its axis
in 4 minutes

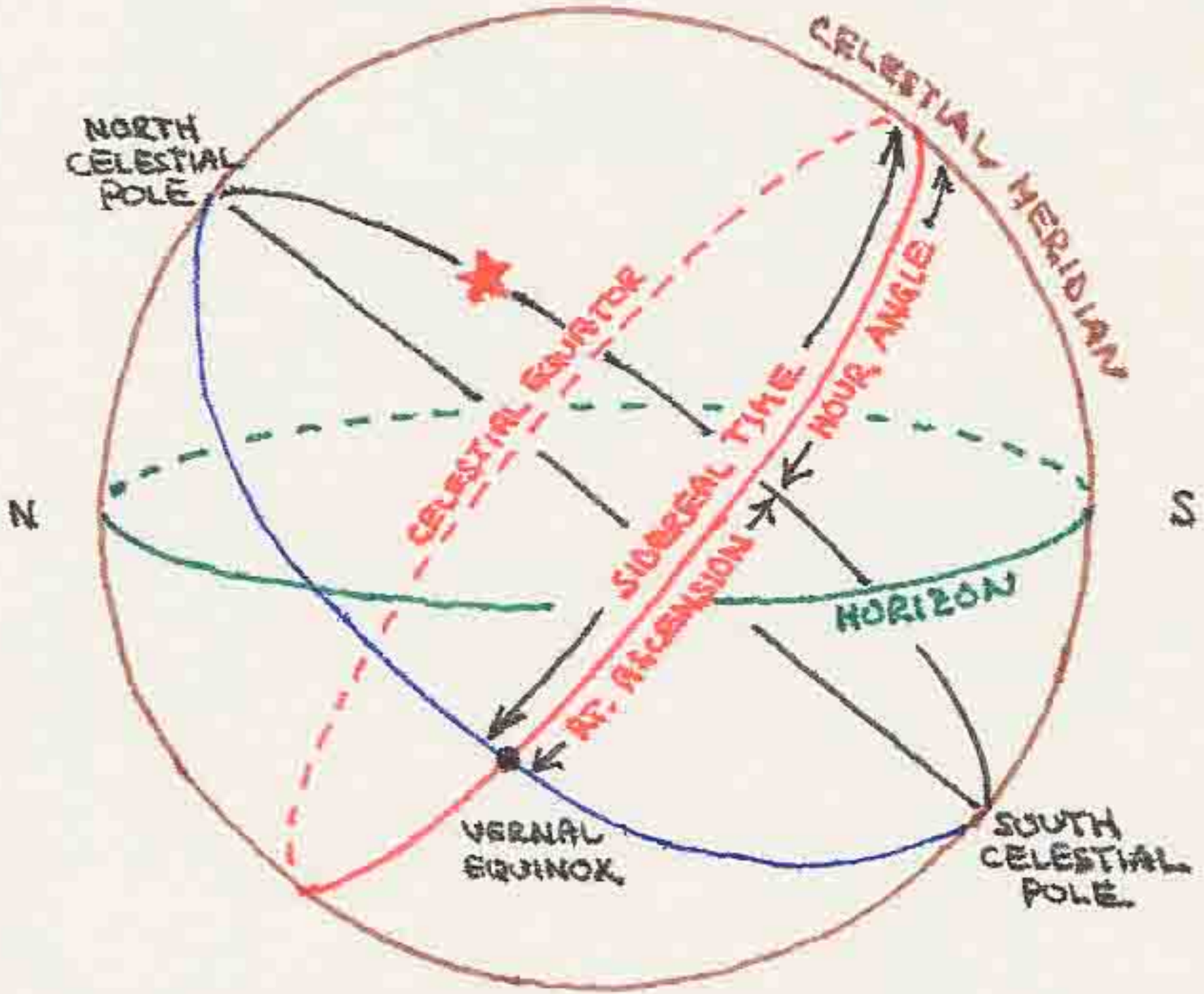
The Earth
revolves 1 degree
around the Sun
in 1 day

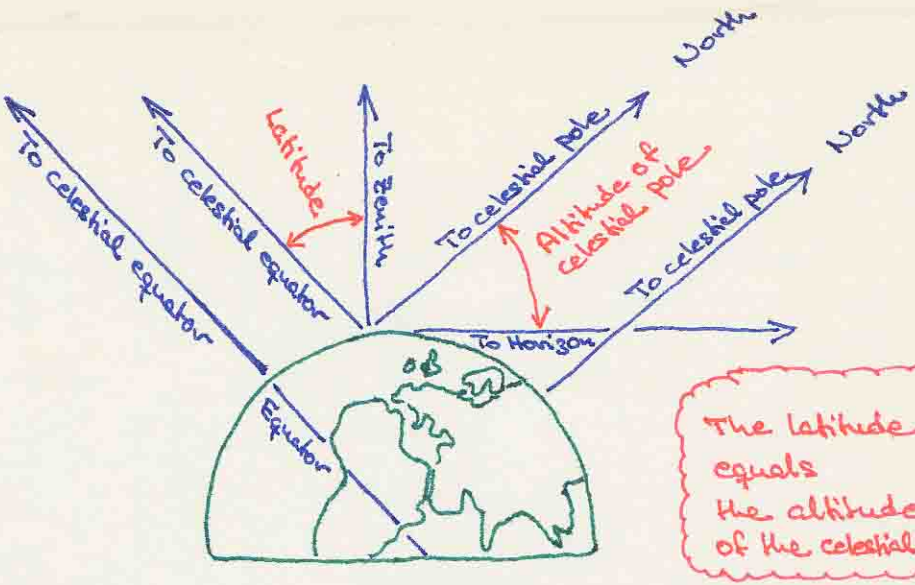
Therefore
the Solar Day
is 4 minutes longer
than the Sidereal Day
which means that
the Stars rise 4 minutes earlier
every day

v.s

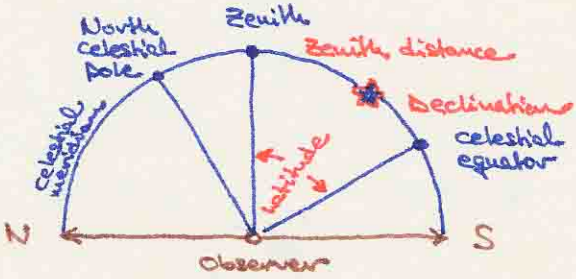

zenith
celestial meridian
zenith distance
Horizon
Altitude
S
O
N
Azimuth


North celestial pole
Equator
Declination
Hour circle
Horizon
Right Ascension
Vernal Equinox
South celestial pole


CELESTIAL MERIDIAN
NORTH CELESTIAL POLE
CELESTIAL EQUATOR
SIDEREAL TIME
RT. ASCENSION
HOUR ANGLE
N
S
HORIZON
VERNAL EQUINOX
SOUTH CELESTIAL POLE

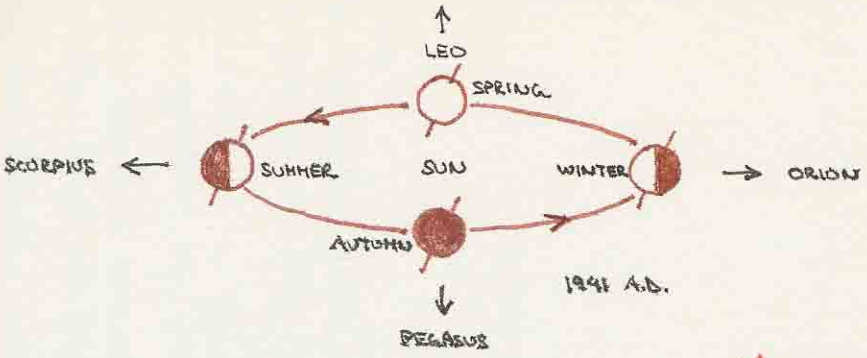


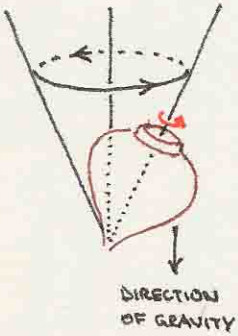
The latitude equals the altitude of the celestial pole

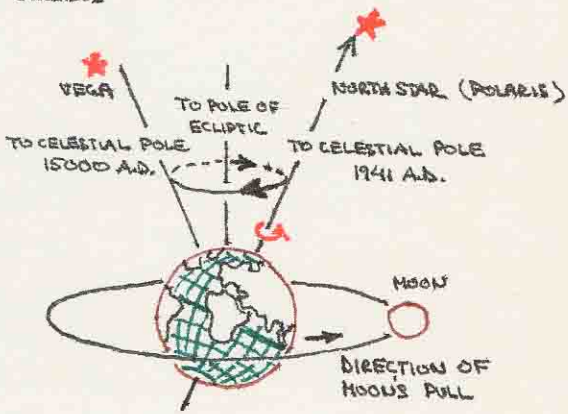


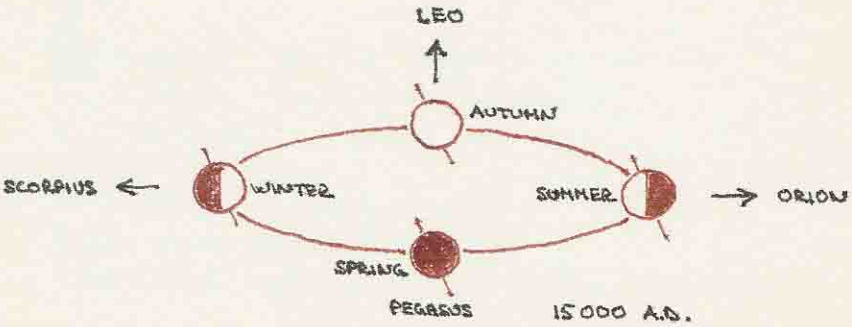
The latitude of a place equals the Zenith distance of a celestial body at its upper transit of the Meridian of the place plus its Declination at that time

The Precession of the Equinoxes



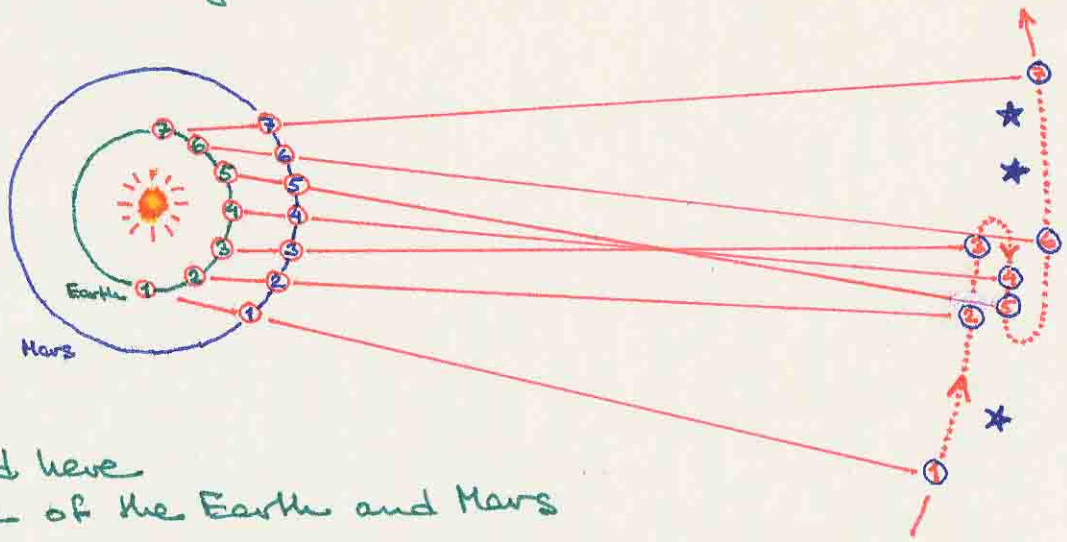






The Copernican System

can explain the retrograde (= backwards) motion
of the planets
much more simply
than the Ptolemaic System



This
is illustrated here
in the case of the Earth and Mars

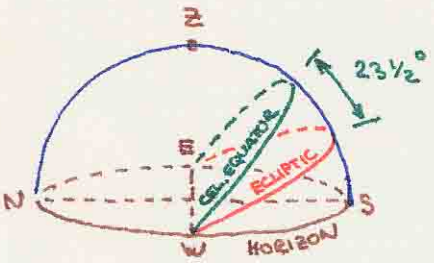
The closer a planet is to the Sun
the greater is its velocity

The Earth's speed is 18½ miles/second
while that of Mars is only 15 miles/second

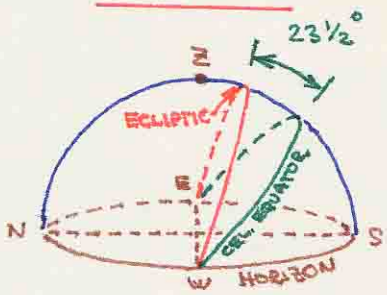
As the Earth overtakes Mars
the latter seems to move backwards

The Ecliptic in relation to the Horizon

Minimum



Maximum



The Celestial Equator
keeps the same position in the sky
throughout the year

Because the Ecliptic is inclined 23½°
to the Celestial Equator
its inclination to the Horizon
can differ as much as 23½° either way
from that of the Equator

At sunset at the beginning of autumn
in middle northern latitudes
the Ecliptic is least inclined to the Horizon

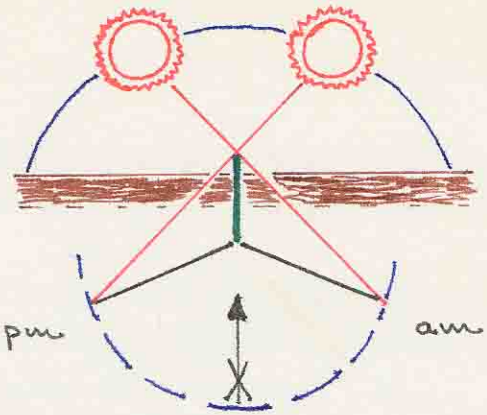
The moon and bright planets
that may be visible at the time
are seen rather low in the south

At sunset at the beginning of spring
the Ecliptic is most inclined to the Horizon

The moon and the planets
are then crossing more nearly overhead

The varying inclination of the Ecliptic
is responsible for :

the harvest moon
the direction of the horns of the crescent moon
the best time to see Mercury as an evening or morning star
the favourable seasons for viewing the Zodiacal light



This
is a south finding trick
that has come
down to us
from the ancients

All you need is
a plumb-true stick
in the ground
a long piece
of stretchless cord
and the sun

v.s

Loop one end
of the cord
over the stick

About 2 or 3 hours
before high noon
— when you have
a good, long shadow —
measure
that shadow's length
with the cord

Use that length
as a radius
and draw an arc

Mark the point
on the arc
where the shadow's tip
touches

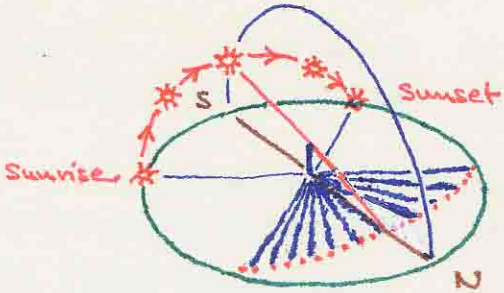
In the afternoon
when the shadow's tip
just touches the arc
again
mark that point

Now
simply bisect this arc
using the two points
as centers

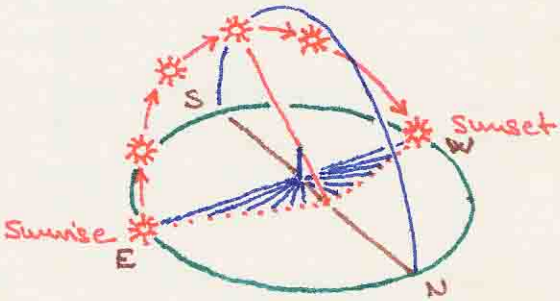
Draw a line
from the stick
to the point of bisection

That line
will be a bit of
true meridian

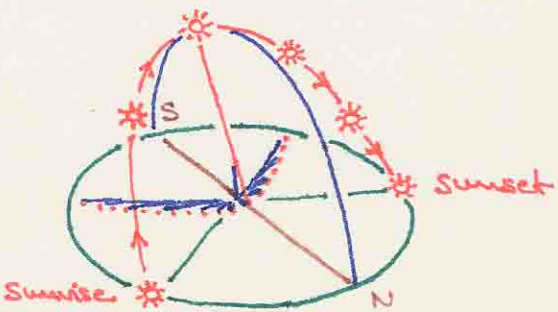
It will be
true north and south



December 21



March 21 and September 23



June 21