CELESTIAL

NAVIGATION

Captain Stephen Miller – Chapman School of Seamanship

A Brief Marine Navigation Primer

- Marine Navigation deals with going from one place to another by water.

- The Navigator first determines where his departure point and destination points are located.

- The next step is to determine the direction that must be traveled from departure point to destination point.

MARINER'S CHART

**Our Estimated Position
on 11 March 2011
For Our NOON Sight**

C-290° T
S-20 kts

A Brief Marine Navigation Primer

- The direction can be converted to a Course to be followed and drawn on a Mariner's chart (ocean map)

- By using Time and Speed calculations the Navigator can indicate on his chart where he expects to be at any given time during the trip.

- This is the Deduced Reckoning Plan (DR)

MARINER'S CHART

Our Estimated Position
on 11 March 2011
For Our NOON Sight

C-290° T
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A Brief Marine Navigation Primer

- Once underway, the Navigator uses various methods for determining his location and compares that position with his plan.

- These methods include:

  – Two or three bearings to land based objects
  – RADAR bearings and distances – again to land based objects

  – GPS (Global Positioning System – Satellite based)
  – Depth soundings and bearings to land based objects

A Brief Marine Navigation Primer

- It should be obvious that once well out of sight of land that some of these methods are no longer an option.

- As one proceeds out to sea the depth of the water becomes too deep to measure

- It is at this point that the only options are GPS and Celestial Navigation methods.

- The only drawback of GPS is that you are only sure it is working properly is when you arrive at your destination and relies on electricity.

- The only way to be sure of where you are far out to sea involves using Celestial Navigation

YOUR
initial questions
about
Celestial Navigation
probably start out with

WHAT
is
Celestial Navigation?

WHAT

do we **USE**
to do
Celestial Navigation?

When

do we **DO** Celestial?

HOW

do we **obtain**

a Position from Celestial Bodies?

Here

are

some brief answers

to

those questions

What is Celestial?

Celestial Navigation

is the

Art and Science of Navigating

out of the sight of land using only the Celestial Bodies for position determination

WHAT

do we **USE**
to do
Celestial Navigation?

The **Celestial Bodies** we use are:

SUN

MOON

Four PLANETS

VENUS, MARS, JUPITER, SATURN

and

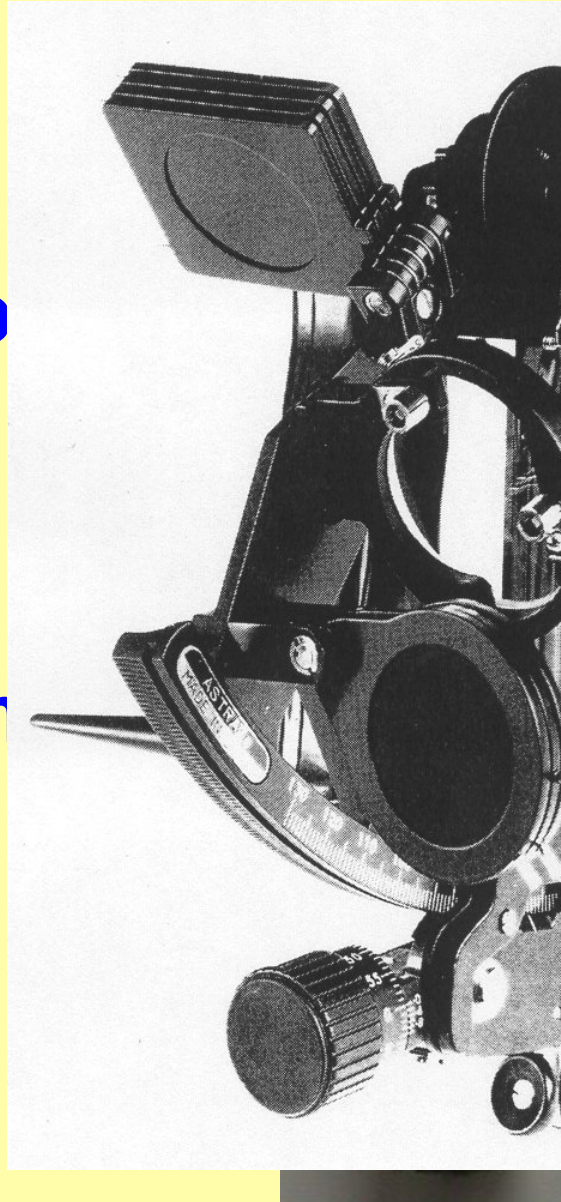57 STARS plus POLARIS

WE WILL USE THE SUN FOR OUR OBSERVATIONS

IN THIS SERIES OF LECTURES AND IF THERE IS TIME WE WILL LOOK AT USING THE NORTH STAR - POLARIS

Tools of the 'Trade'

Sextant

Timekeep[ing]
Watch

Nautical
Almanac

Workform[s]

Starpath Form 107 for Local Apparent Noon Sights

Step 1 Correct Hs to get Ho

				°	'
1-1	Record Maximum Sextant Height (Hs = peak height of the sun at noon), and mark limb	Lower Upper	Hs		
1-2	Record Index Correction (mark sign + if off, - if on)	IC	Off On	+ -	
1-3	Record eye height (HE) and Look up Dip Correction on the right-hand side of Table A2, front of the Almanac (T-8 in notes)	HE (ft)	Dip	-	
1-4	Sum the above three numbers to get Apparent Height		Ha	°	'
1-5	Look up altitude correction on lefthand side of Table A2, front of the Almanac (T-8 in notes) (correction depends on Ha, Limb, and month) (mark sign + for lower limb, - for upper limb)		Alt corr.	+ -	'
1-6	Sum the above two numbers to get Observed Height		Ho	°	'

Step 2 Determine the Zenith Distance **89° 60.0'**

					°	'
2-1	Record Ho from Step 1, above, and then subtract it from 90° to get the zenith distance.		Ho	-	°	'
2-2	Zenith distance		z		°	'

Step 3 Use the Almanac to Find Sun's Declination   GMT date =

					°	'
3-1	Record the date and GMT of the sight (the time the sun reached its peak height)	GMT (hr) =	GMT (min) =			
3-2	Turn to the daily page of the Almanac for the date of the sight, and find the sun's declination (dec) for the hour of the sight (line 3-1) and record it here.	Dec (hr)	N S		°	'
3-3	Record the d-value from the bottom of the dec column in the Almanac. Mark the signs of the d-value and d-corr + if the dec for the next hour is larger, or - if it is smaller.	d-value = + -	d-corr =	+ -		'
3-4	Turn to the Increments and Corrections pages at the back of the Almanac (T-9 to 12, in the notes) and find the minutes table for the GMT minutes (line 3-1). On the right-hand side of the double line in the table, find the d-corr corresponding to the d-value of line 3-3	Declination =	N S		°	'
3-5	Apply the d-corr to the dec(hr) and record it above.					

Step 4 Find Latitude from Zenith Distance and Declination

Record DR Latitude to use as a guide, and then take the sum or difference of zenith distance and declination to find your true Latitude at LAN.

	°	'
Declination or Zenith distance	°	'
Zenith distance or Declination	°	'
Latitude =	°	'

When IS CELESTIAL DONE?

- Stars, Planets, and/or Moon are observed **before Sunrise** – results in a **FIX**

- The SUN is observed **mid-morning** – results in a **LOP only**

- NOON Sight is done at **'NOON'** – results in **a LOP** (our Latitude) and a **Running FIX**

- The SUN is observed **mid-afternoon** – results in a **LOP only**

- Stars, Planets, and/or Moon are observed **after Sunset** - results in a **FIX**

HOW

do we **obtain**

a Celestial Position?

Our position from a Body can be measured in distance and a direction

NOW Wait a Minute

we are approximately

93 million miles

away from the Sun and the SUN is up in the SKY so how could we possibly plot from that information?

WE are NOT getting

THAT

Distance !

WHEN using **CELESTIAL**

The object we are sighting

Is   **MOVING**

Relative to us

BUT...

For our purposes
the instant

we observe the **BODY**

We will

FREEZE TIME

So the **BODY** is

essentially

STATIONARY

From **THAT** instant of time
we can determine from the
NAUTICAL ALMANAC
where on EARTH
the BODY is Located

YES

I DID SAY ON

EARTH !

The location on EARTH is the point on the EARTH's surface where a **line** from the Center of the Body (SUN) to the Center of the EARTH passes, it is called the

Geographic Position, or **GP**
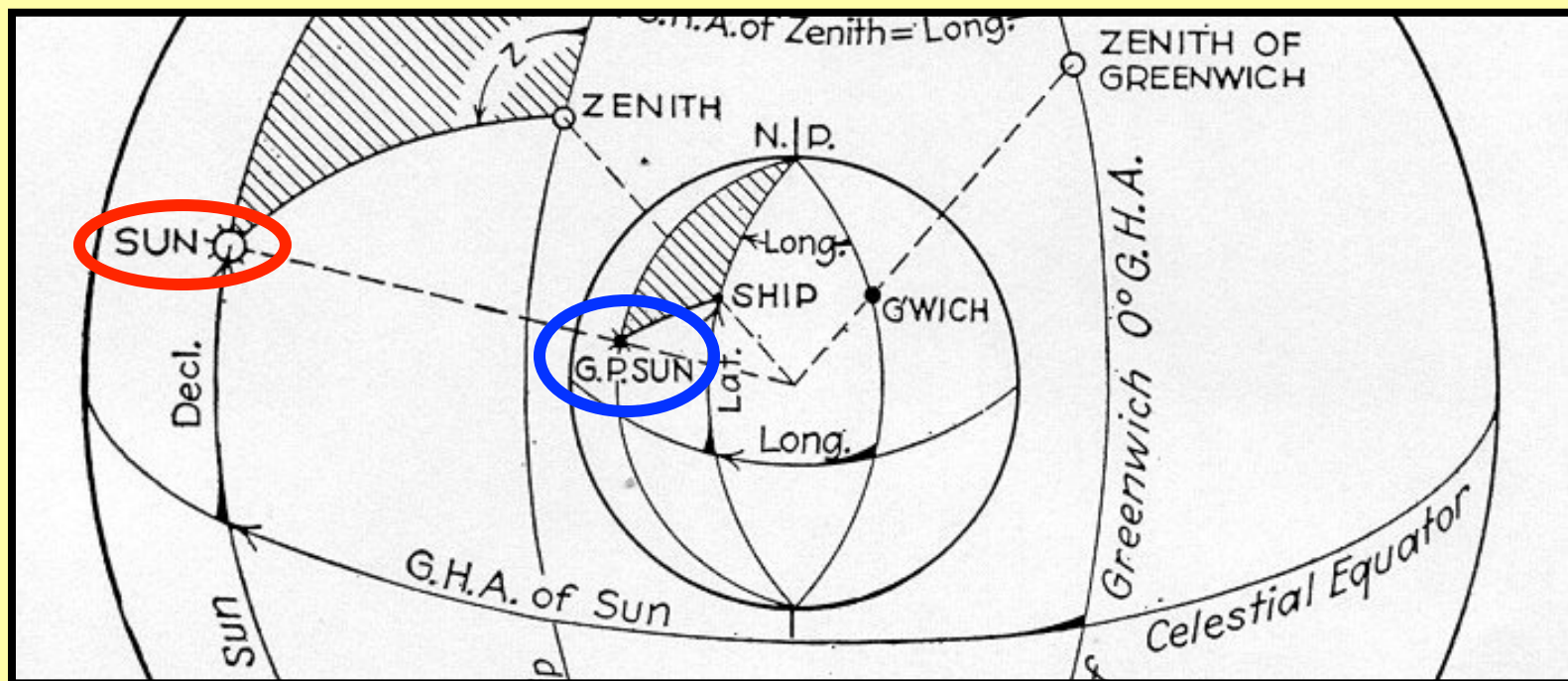
When we OBSERVE A BODY with our Sextant we measure the ANGLE of the body above the Horizon.
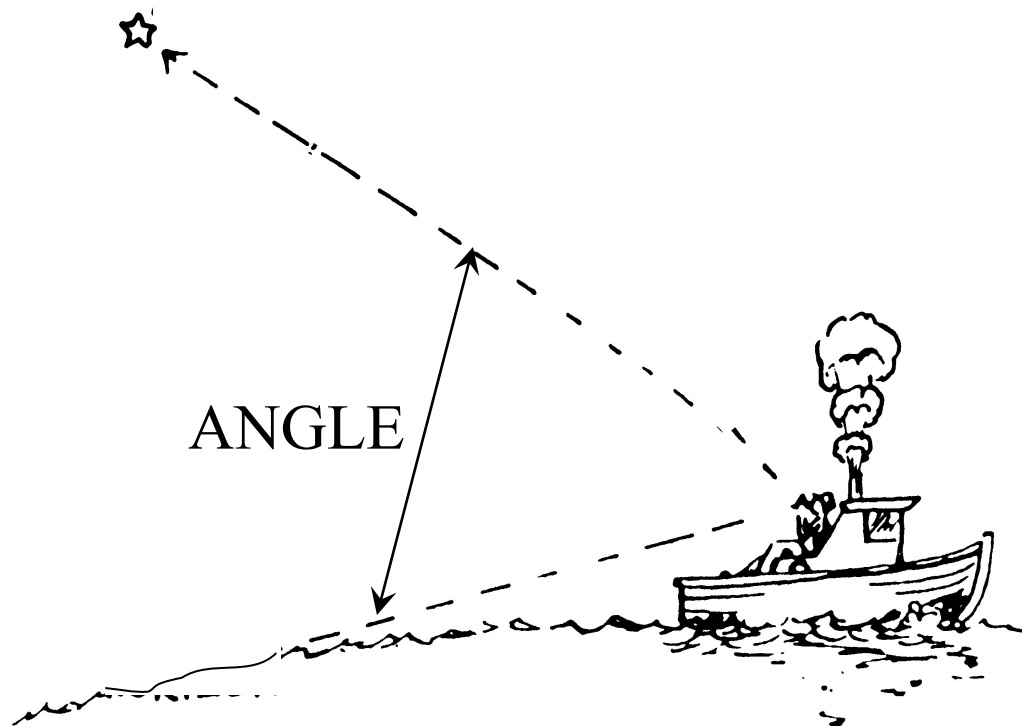
The mathematical
complement of this **Angle**
is the
ANGULAR DISTANCE
we are from the **GP** of the
BODY.

The Complement
called
Zenith Distance
is
90° - Our **Angle**
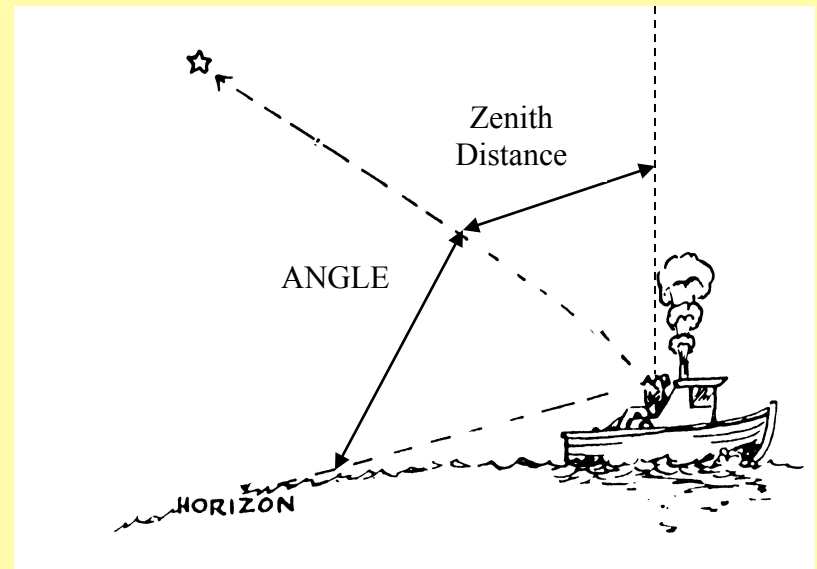
An IMPORTANT
ANGLE - DISTANCE
relationship
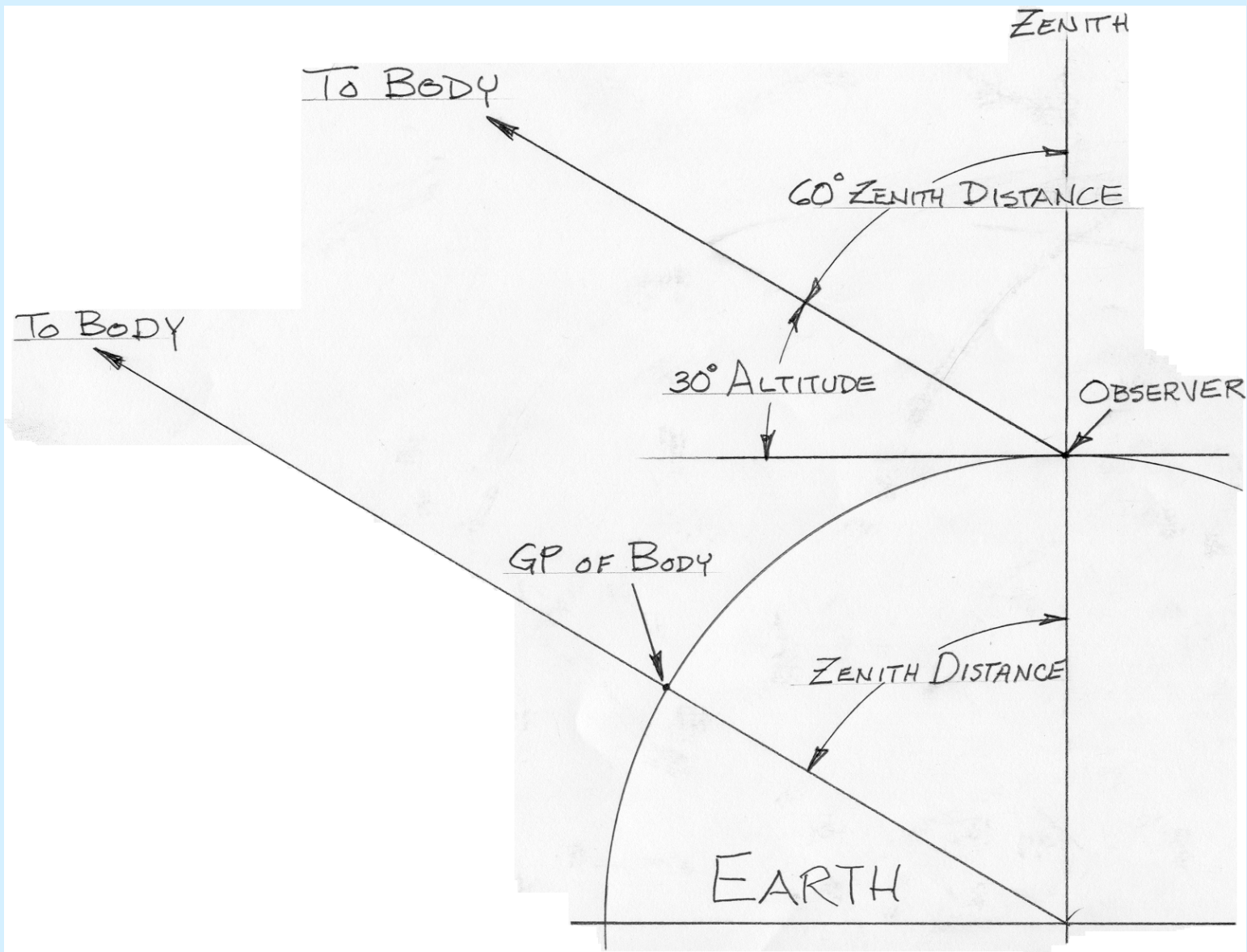from
Chart Navigation
IS

1° equals 60 nautical miles

Converting the
Zenith Distance

from an **ANGLE**

to a **DISTANCE**

is accomplished by
applying THAT
relationship.

ZENITH DISTANCE

ZENITH DISTANCE

In the example Zenith Distance is 60° of Arc
(the complement of our 30° Angle)
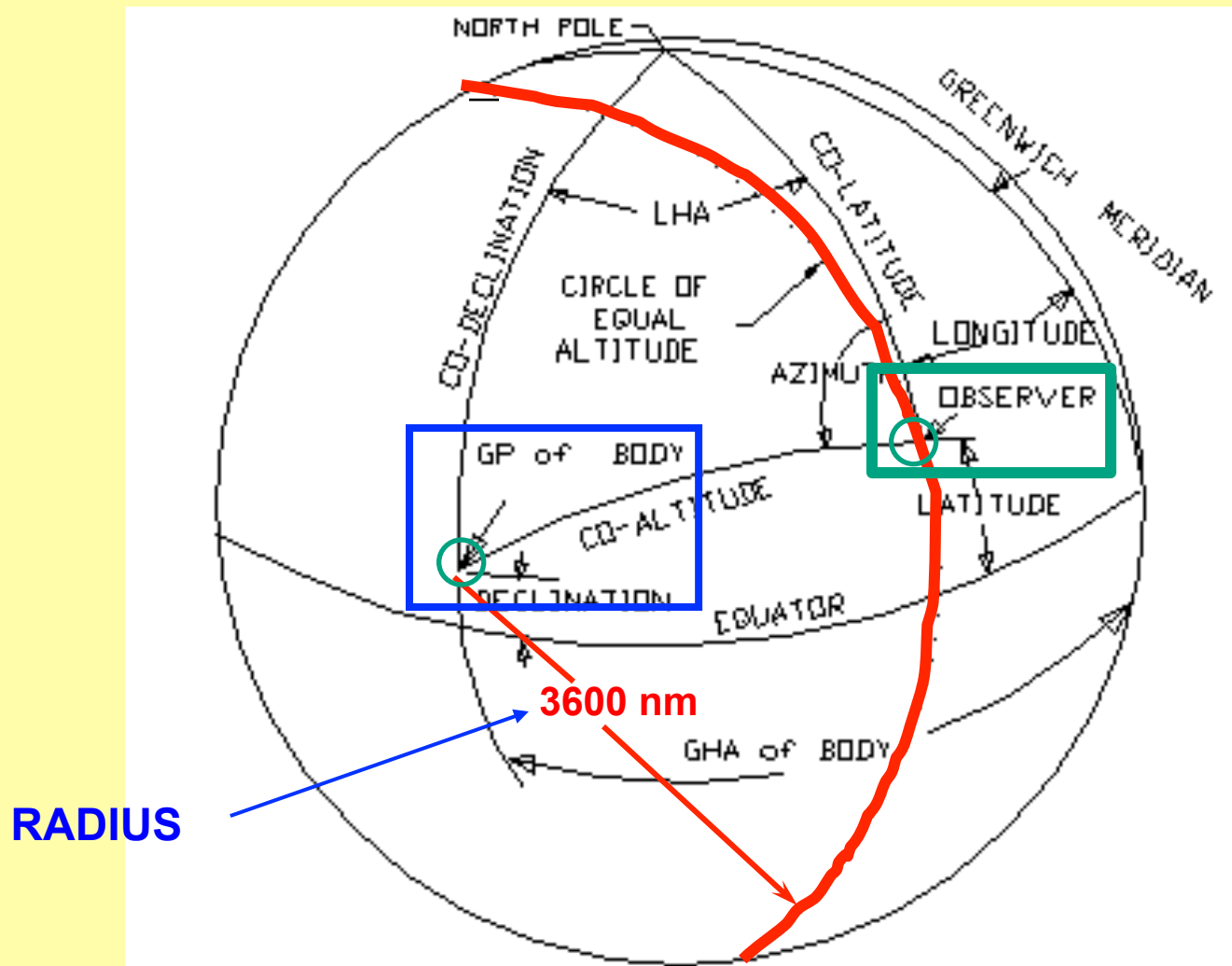
One ° of Arc on a Great Circle is Sixty nm

Therefore:
Zenith Distance = 60° x 60 nm/° or 3600 nm

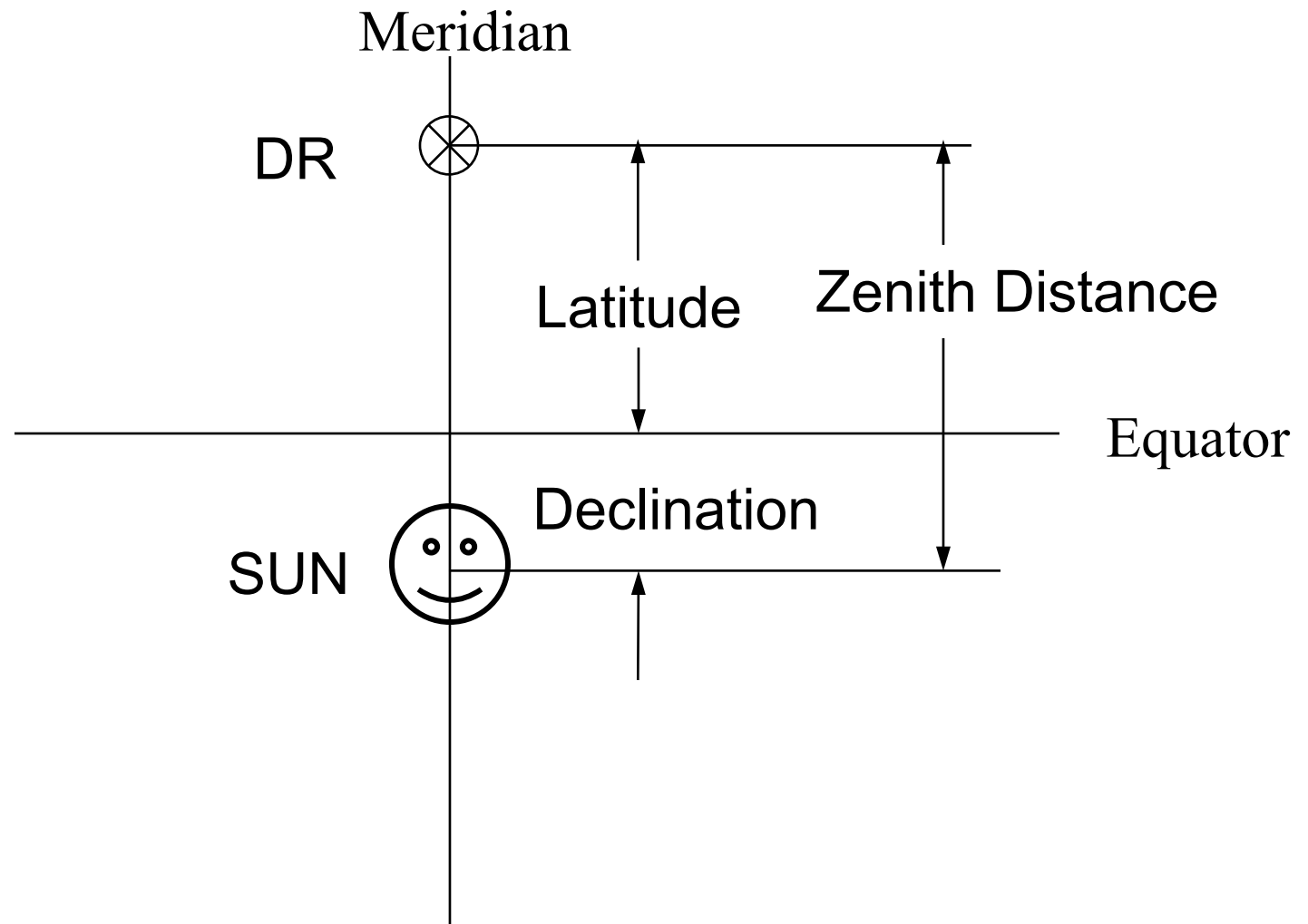THIS is the **RADIUS** of a Circle of Position –
with it's center at the GP of SUN

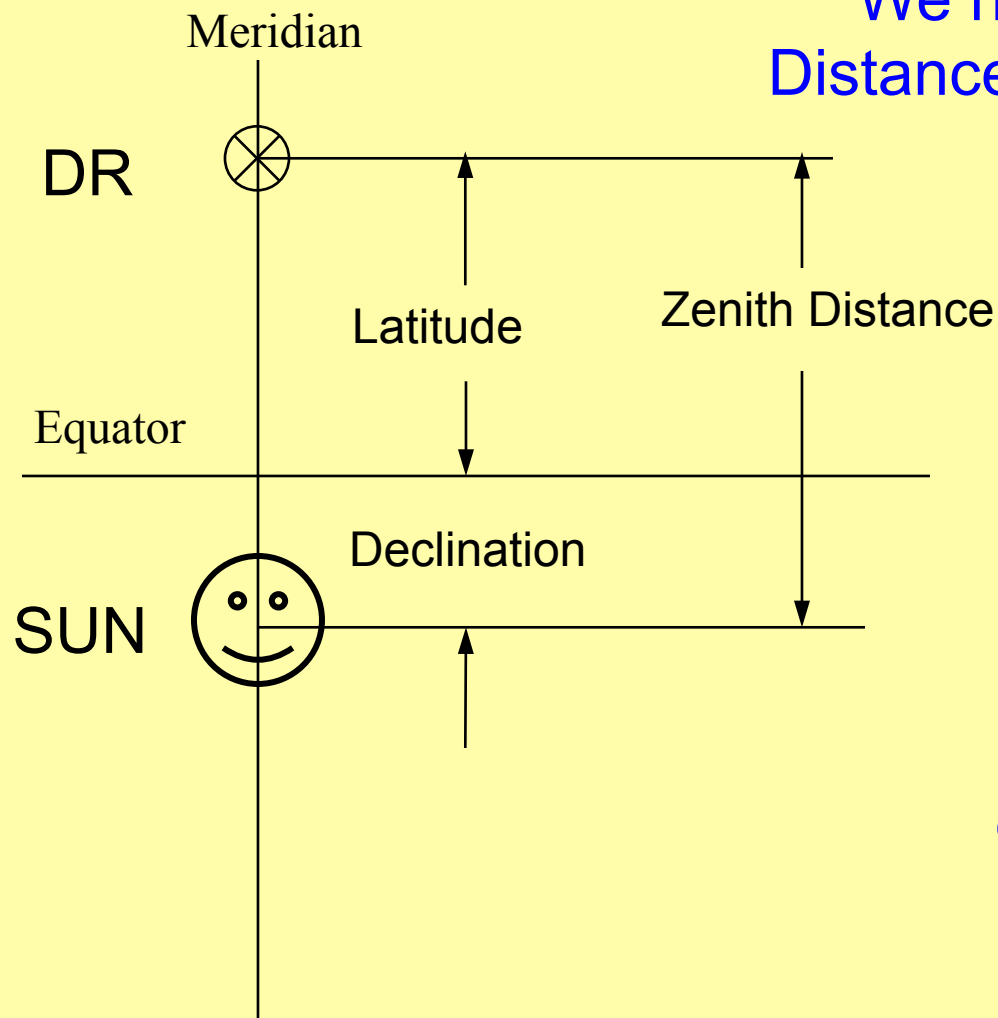# CIRCLE OF POSITION

Diagram indicates an Afternoon Situation

The Noon Diagram

Latitude by Noon Sight

Meridian

DR

Equator

Latitude

Zenith Distance

Declination

SUN

We have determined our Zenith Distance from our Observation (Sight)

From the Time of our Sight we can find the Declination of the Sun at that time from the Nautical Almanac

With the Zenith Distance known and the Declination known We can find the difference between them and the **RESULT IS OUR LATITUDE**

For Determining Latitude by a Noon Sight

THAT is

HOW

CELESTIAL

NAVIGATION

WORKS

There is Certainly
MORE
to
CELESTIAL NAVIGATION
than what you have just
seen.

By studying Celestial Navigation
YOU will be able to
FIND OUT

WHERE
in the
WORLD
YOU ARE !