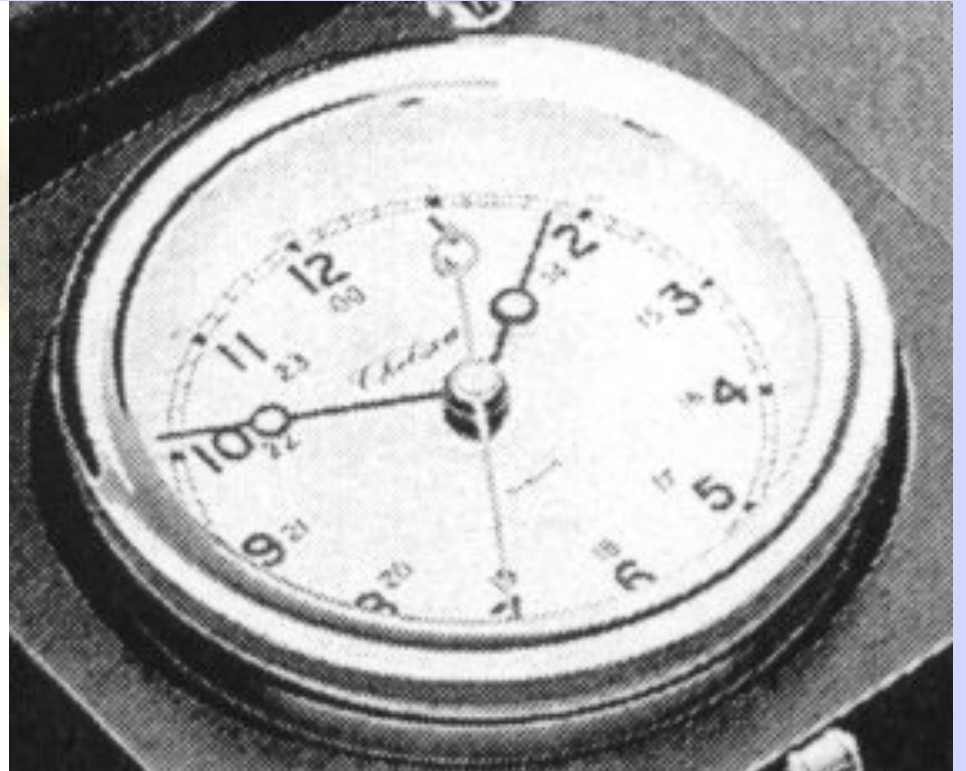
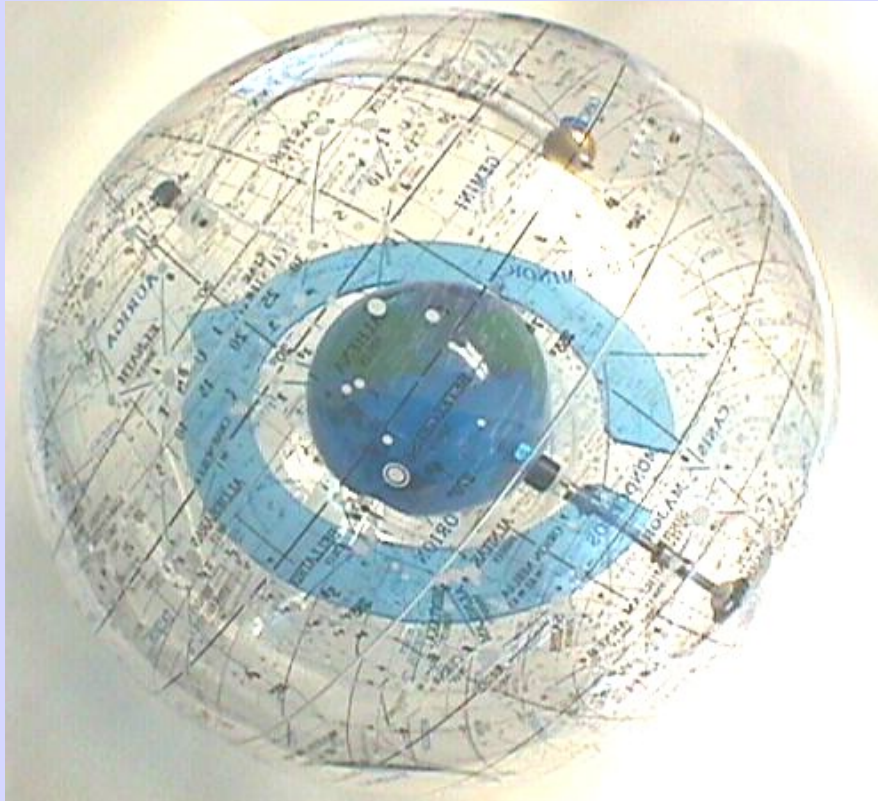


# Celestial Coordinate System and TIME



# Introduction

- The SKY or Celestial Sphere has a Coordinate System whereon all of the Heavenly Bodies can be positioned.
- This session will explore that Coordinate System and the Importance of Time and how the two are related

# Agenda

- Latitude on the Celestial Sphere
- Longitude on the Celestial Sphere
- Terrestrial and Celestial relationships

# Overview

- The Coordinate System on the Celestial Sphere is similar to the Coordinate System used on the EARTH

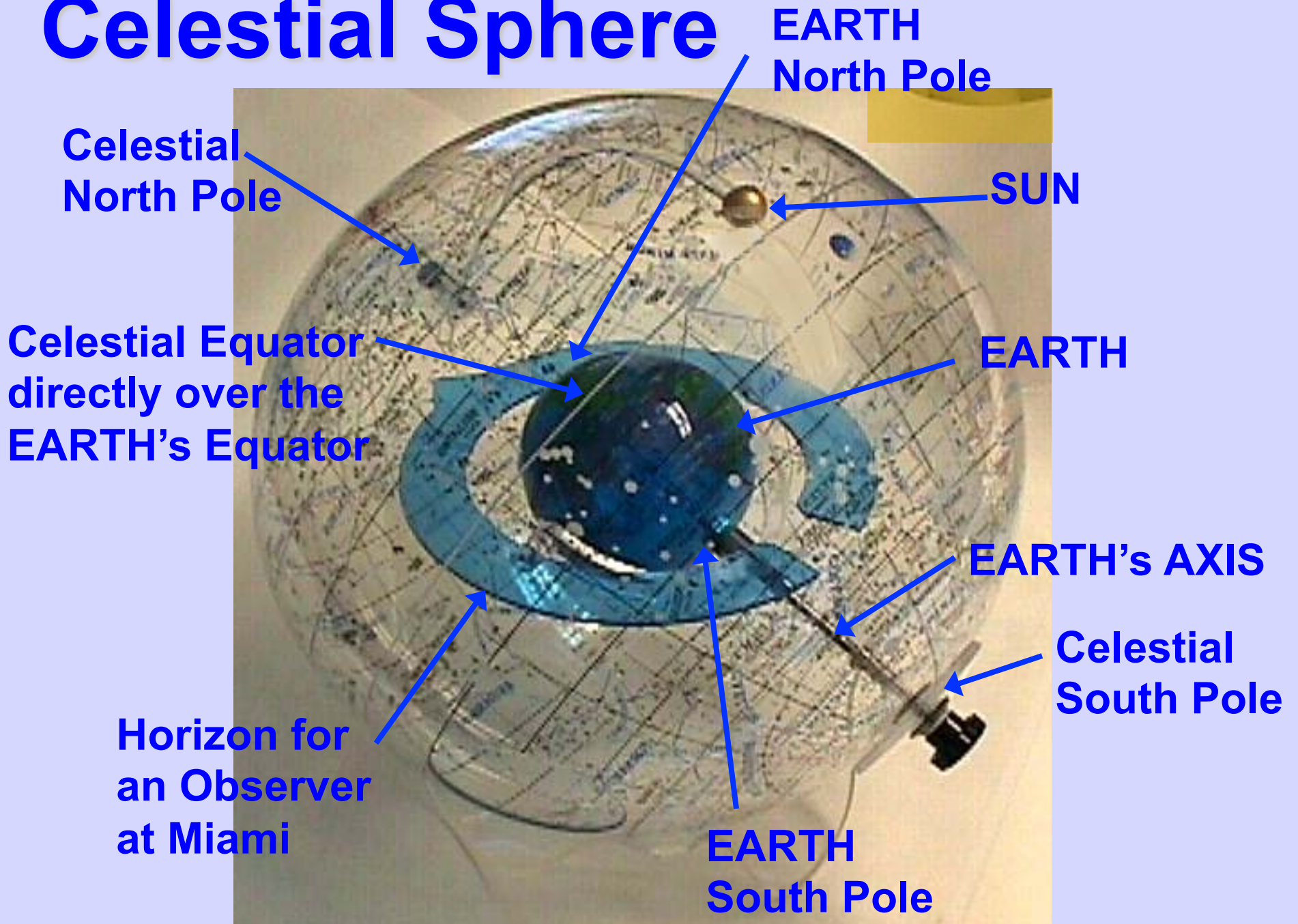
# New Terms

- Celestial Sphere
- Greenwich Hour Angle - GHA
- Local Hour Angle – LHA
- Declination
- Geographic Position - GP

# Celestial Sphere

- Celestial Sphere can be considered as a 'Clear' Sphere with the Earth at its center and ALL the Heavenly Bodies on its surface.
- The North and South Poles on the Celestial Sphere are directly over their counterparts on Earth
- The Celestial Equator is a projection of the Earth's Equator
- The Greenwich Meridian on Earth is projected to the Celestial Sphere as well

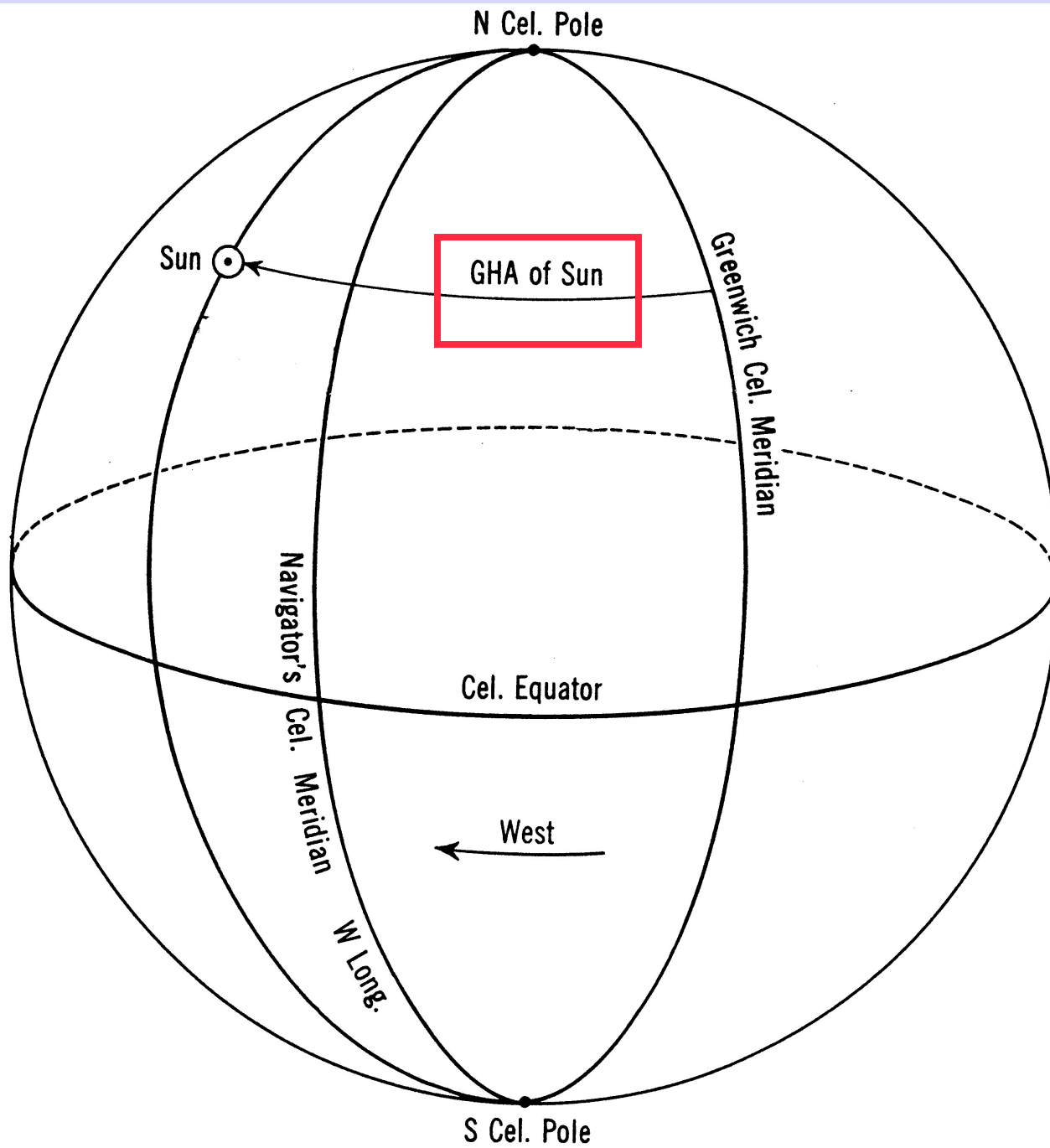
# Celestial Sphere

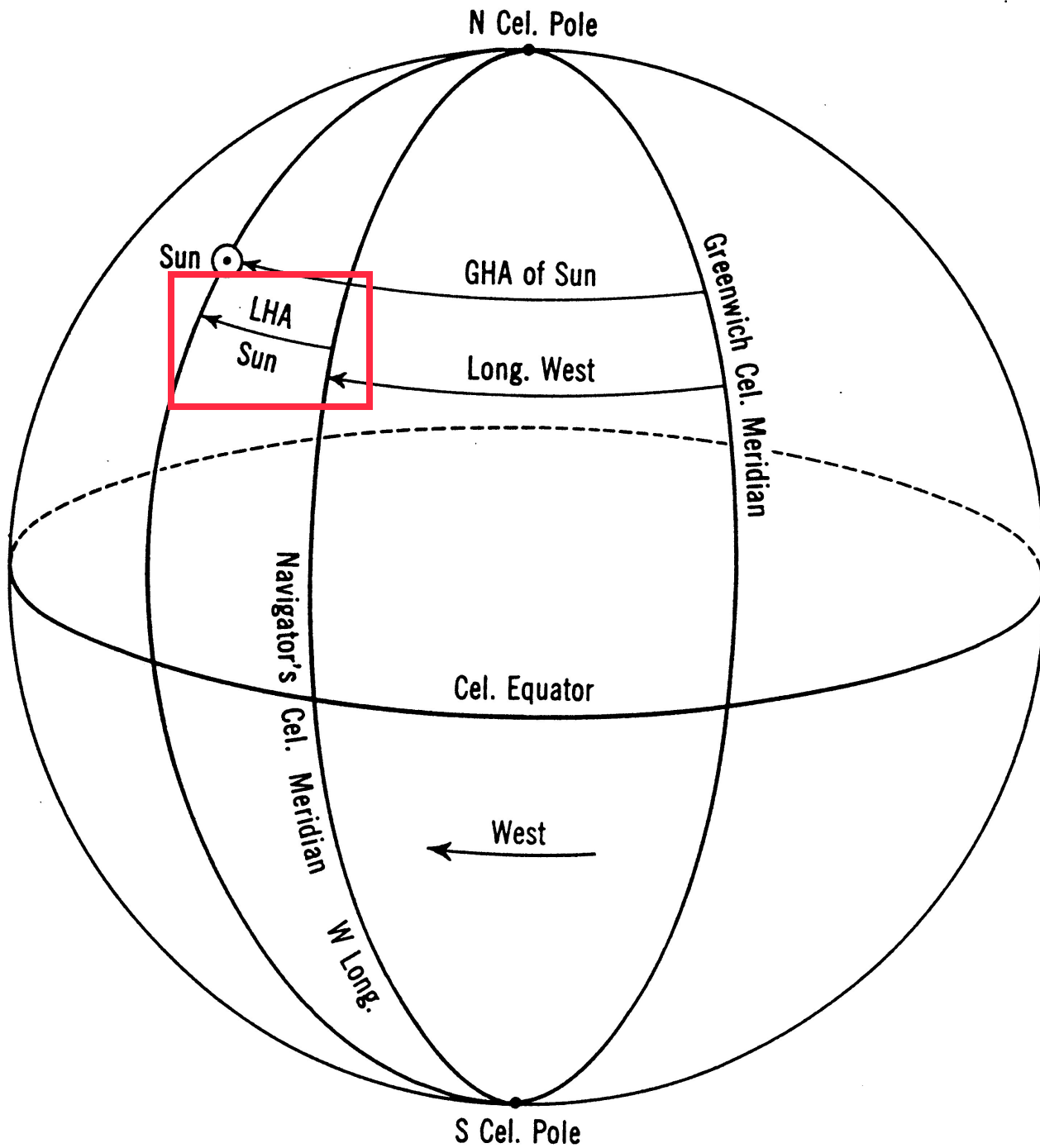


# Greenwich Hour Angle - GHA

- The Celestial Sphere's LONGITUDE
- Measured ONLY in a WESTWARD direction
- Can be measured in ARC or TIME
- $15^\circ$  is equivalent to 1 hour
- $1^\circ$  is equal to 4 minutes
- 15' of Arc is equal to 1 minute of Time
- 1' of Arc is equal to 4 seconds of Time
- Navigators DO NOT use Right Ascension as a general Rule. There is only one special situation that RA is used.





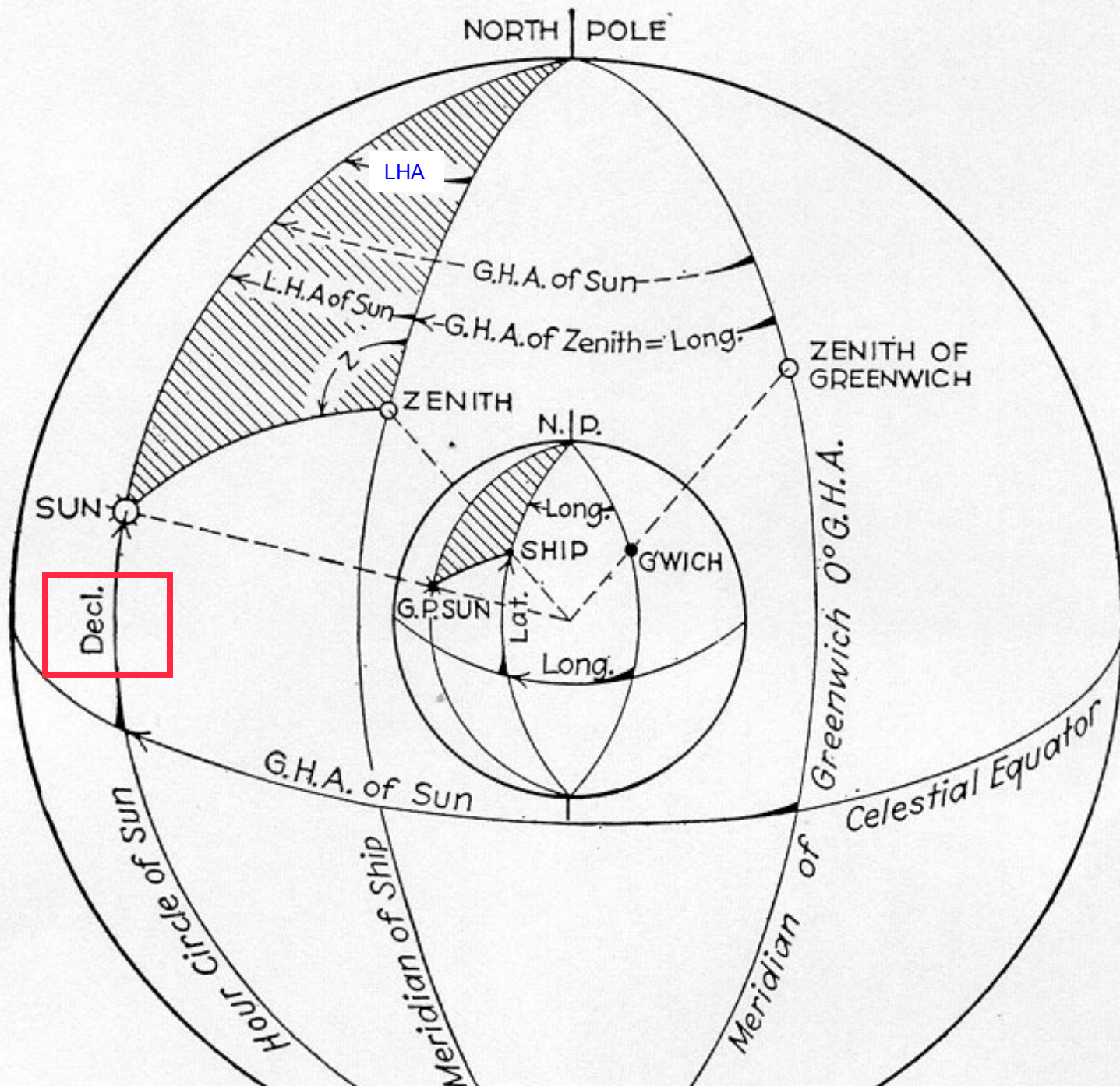


# Local Hour Angle - LHA

- The angular difference between the Navigator's Longitude and the GHA of the Body
- Measured **ONLY** Westerly
- One of the Angles in the Navigation Triangle

# Declination

- The Celestial Sphere's **LATITUDE**
- Measured the same way as done on the Earth – both North and South of the Equator



# TIME

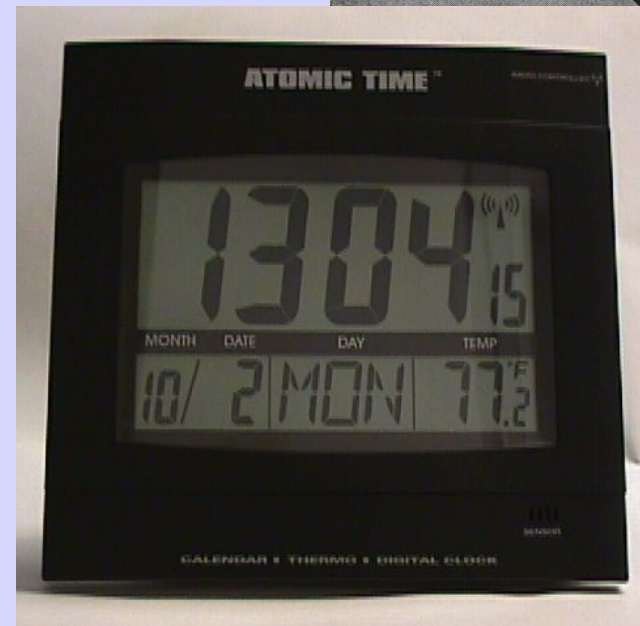
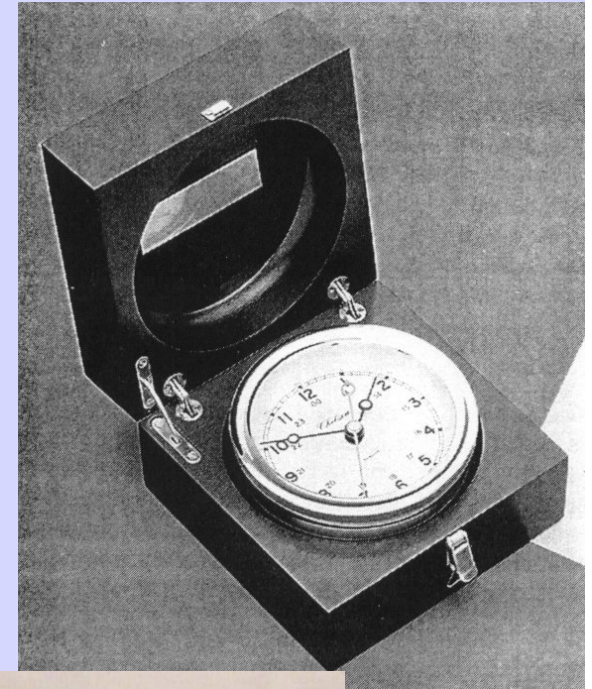
- We need to know the Time in order to find the GP of the Body at the Instant it was Observed
- We will use Greenwich Time, Local Time and Watch Time
- We will use Mean Time as opposed to Solar Time

# How Do we Keep track of Time?

- We keep track of Time by using Chronometers, Watches, Radios, etc.
- When we use Chronometers or Watches, we must know their Error Rate
- We can also use the movement of the Sun and Moon

# Mean Time

- The time that is kept by Mechanical Devices
- The 'Tick' interval is 'Consistent'
- 'Consistent' with an Error Rate





# Solar Time

- Time as reckoned by the apparent movement of the Sun (Sun Dials)
- Can differ from Mean Time by as much as 16 minutes (Equation of Time)
- Not used these in these days of mechanical and quartz clocks/watches

# Greenwich Time

- Since the Meridian passing through Greenwich, England was chosen as the Prime Meridian, Time also is measured from Greenwich
- Greenwich Mean Time (GMT) is used by the Celestial Navigator.
- Nautical Almanac uses GMT (UT)

# Watch Time

- This is the Time that is noted by the Watch or Chronometer the Navigator uses
- There is usually an Error Rate established for the given Timepiece
- Should be checked Daily (by Time Ticks) and the Errors noted



# Local Time

- This is the Time at the Navigator's Meridian (Longitude)
- Usually determined by Watch Time with the Watch Error Rate applied

# Time Zones

- The difference between Greenwich Time and Local Time is based on our Longitude
- Earlier it was stated that  $15^\circ$  is equal to 1 hour of Time
- The Earth can be divided into 24 Time Zones, each  $15^\circ$  wide
- Center of Time Zone is at even  $15^\circ$  intervals
  - Time Zone extends  $7\frac{1}{2}^\circ$  each side of the center of the Time Zone

# STANDARD TIME ZONE CHART OF THE WORLD

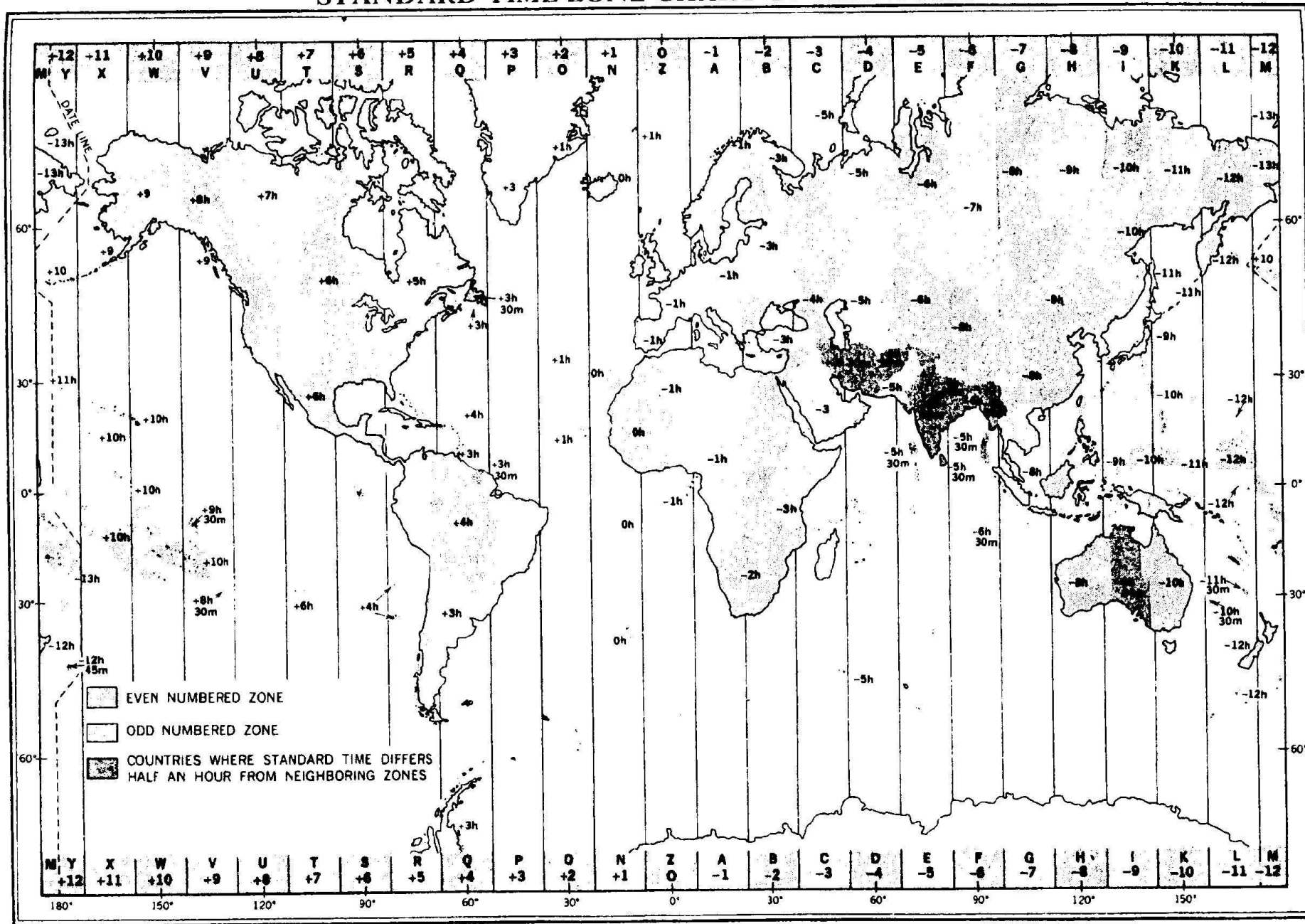


FIGURE 1814.—Time zone chart of the world.

# Summary

- You have now learned that the Celestial Coordinate System is very similar to the Geographic (Terrestrial) Coordinate System.
- Declination is equivalent to Latitude
- Greenwich Hour Angle is equivalent to Longitude
- TIME is important to the Navigator
- GMT is the Time the Navigator uses in his practice of Celestial Navigation