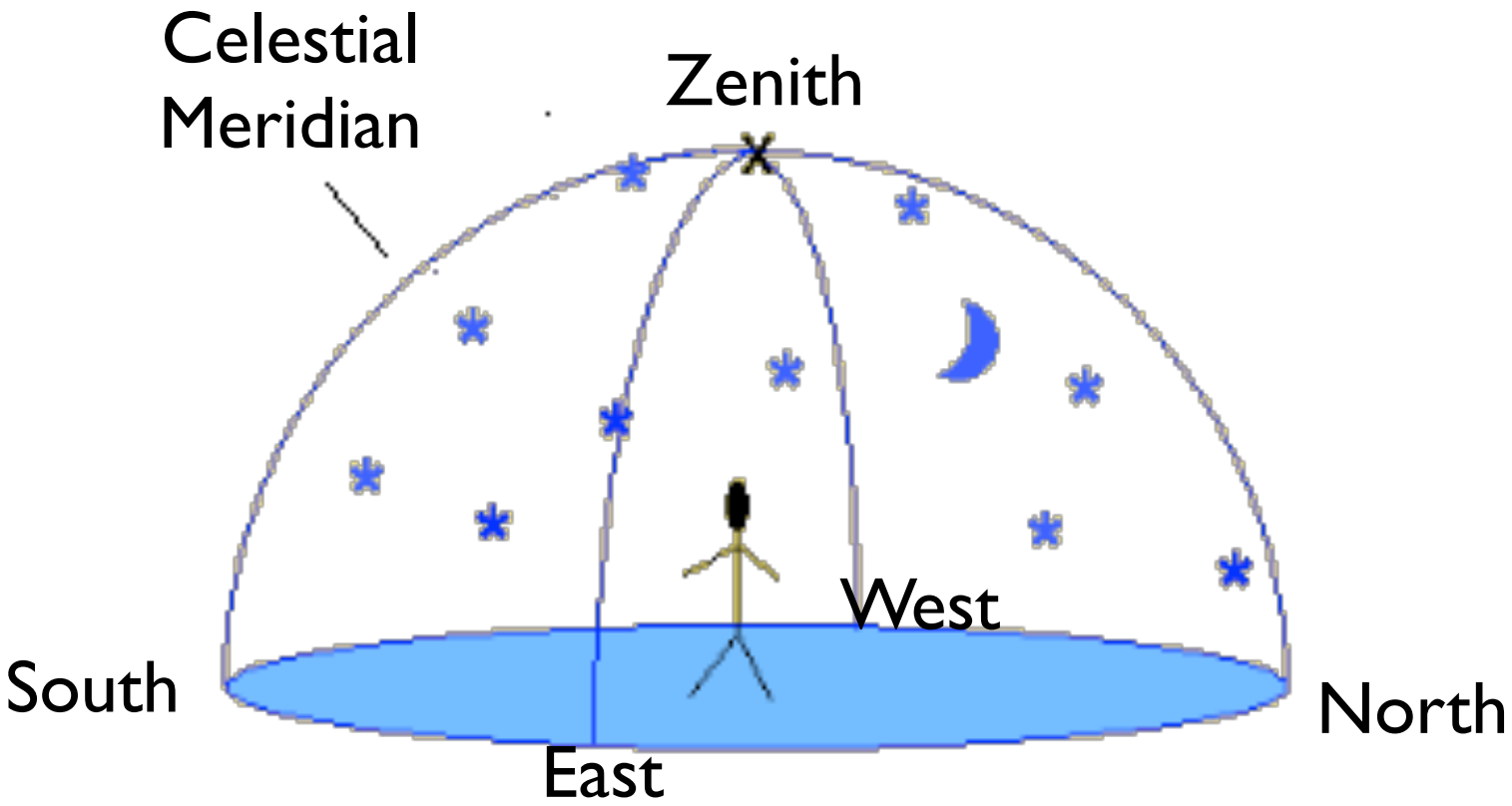
The Celestial Sphere and Coordinate Systems

Ast 401/Phy 580
Fall 2013

The Celestial Sphere



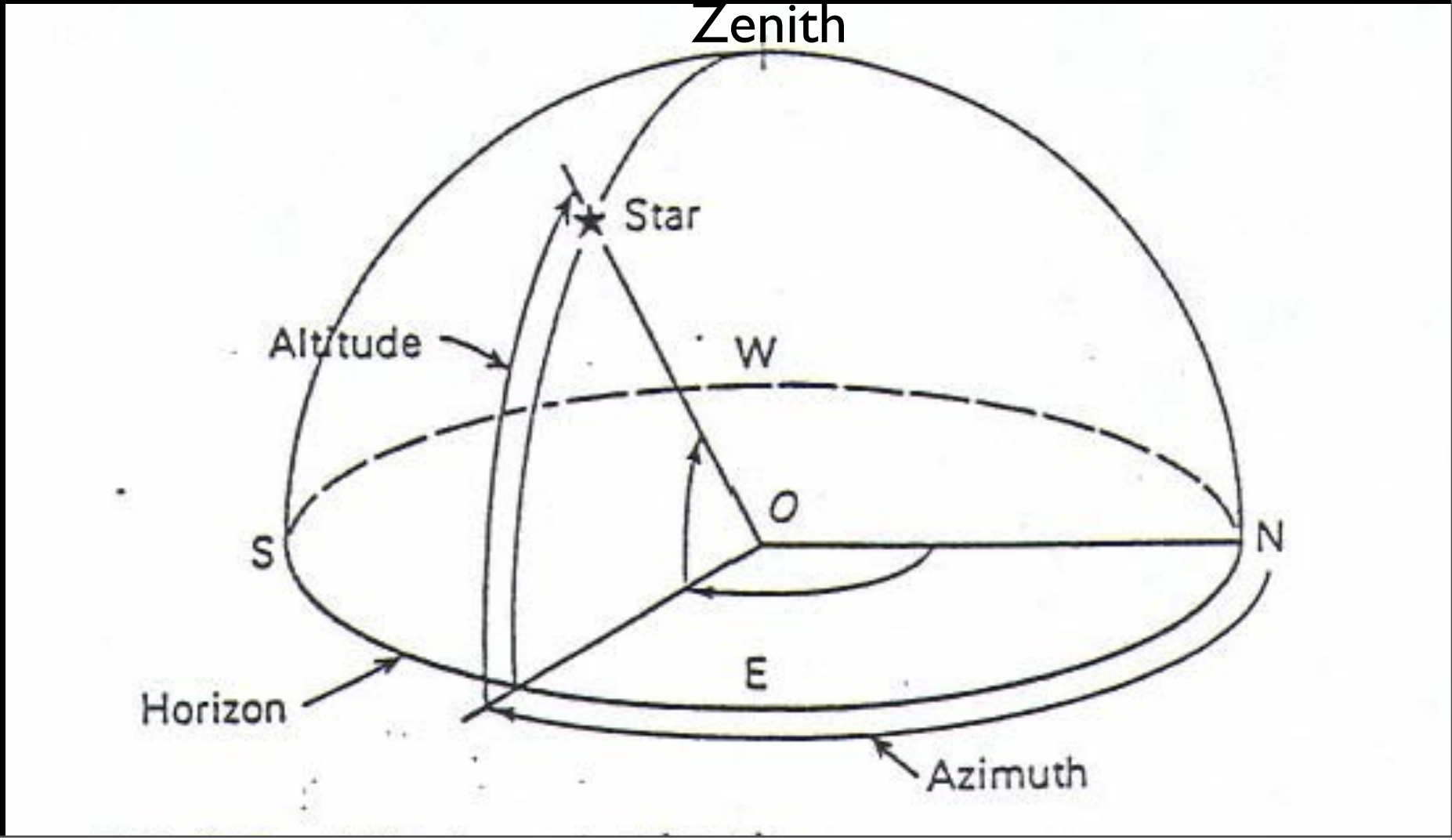
Coordinate Systems

- Altitude and Azimuth
- Equatorial (right ascension and declination)
- Ecliptic coordinates (not used much)
- Galactic coordinates

Altitude and Azimuth

- Most intuitive coordinate system.
- Zenith is the "pole" and horizon is the "equator"
- Altitude: Measured in degress (°), arcminutes (′), and arcseconds (″), from 0°-90°
- Azimuth: Same, but from 0-360° from north through east.
- Great for locating where your telescope is pointing physically, but star alt and az are continuously changing as the earth moves.

Altitude and Azimuth



Altitude and Azimuth

What is the altitude of the NCP from Flagstaff?

A. 90°

B. 35.2°

C. 54.8°

D. 0°

Altitude and Azimuth

What is the azimuth of the NCP?

A. 0°

B. 90°

C. 180°

D 270°

Altitude and Azimuth

What is the azimuth of a star that is due east?

A. 0°

B. 90°

C. 180°

D 270°

Altitude and Azimuth

Altitude is especially important to know at the time of an observation: it tells you how much air you're looking through. But, not the primary coordinate system!

Equatorial (right ascension and declination)

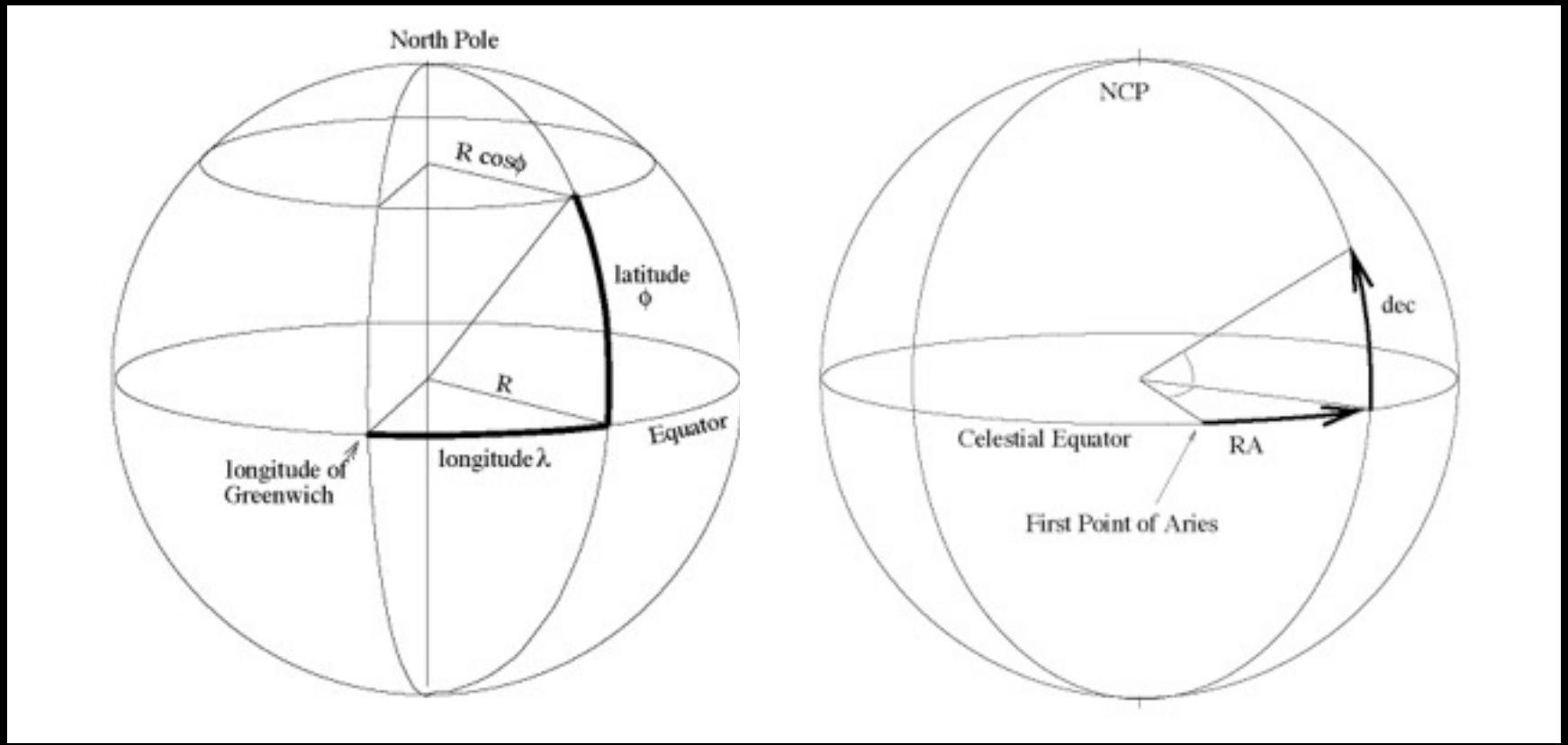
Primary coordinate system used in astronomy. You can look up the equatorial coordinates of an any astronomical object. These, together with the equinox, are unchanging for a galaxy, changing over years for nearby stars (proper motion), and change only slightly night-to-night for a planet.

In other words, they are tied to the stars!

Equatorial (right ascension and declination)

Think of a transparent globe with a light-bulb in the middle projecting latitude and longitude lines onto the sky.

Longitude and Latitude vs right ascension and declination



Longitude and Latitude vs right ascension and declination

Right ascension is given in hours (hh), minutes (mm), and seconds (ss.ss) from 0^h to 24^h .The zero point is at the Vernal Equinox (i.e., where the sun is on March 22nd).

Declination is given in degrees (°), arcminutes (′), and arcseconds (″), from -90° to 0° to +90°

Equatorial (right ascension and declination)

If you were standing at the north pole:

- NCP would be right overhead at the zenith
- Celestial equator would be on the horizon.

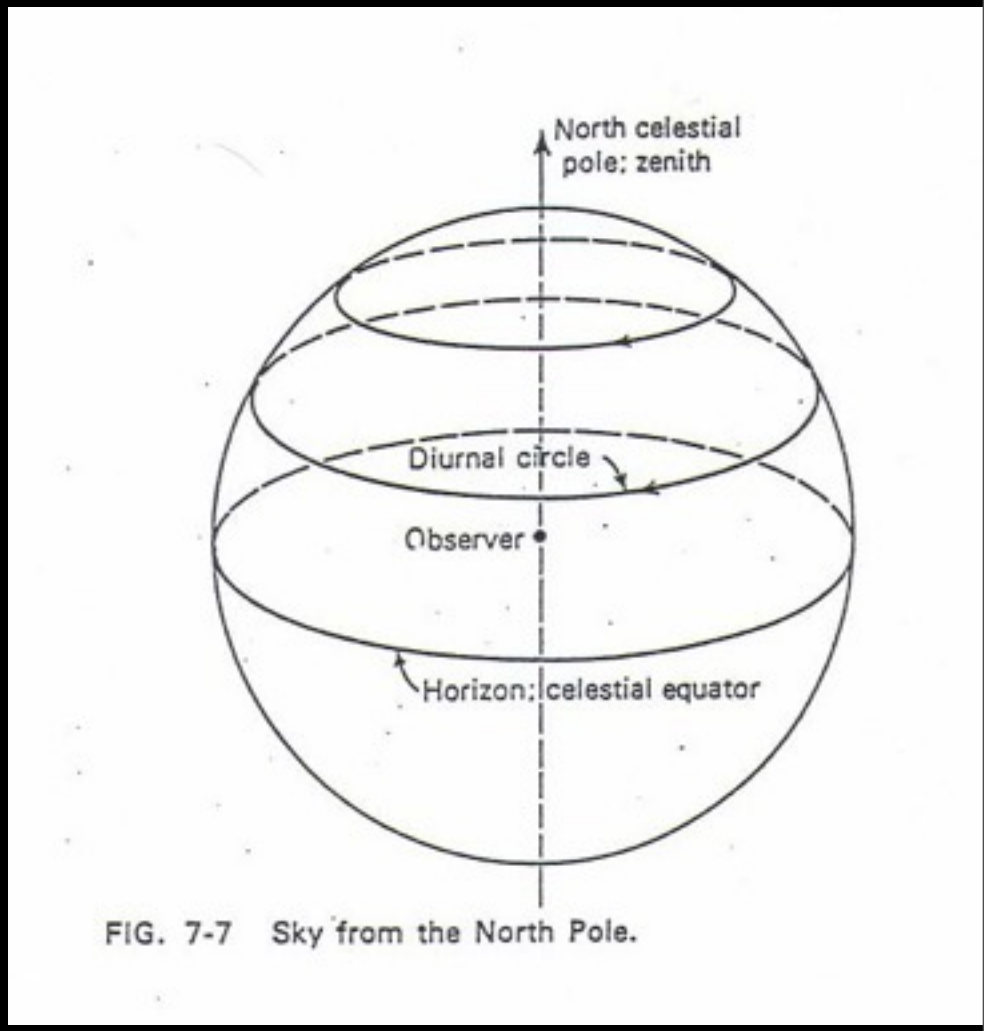


FIG. 7-7 Sky from the North Pole.

Equatorial (right ascension and declination)

If you were standing at the equator:

- NCP would be on the horizon (due north)
- Celestial equator would go from east, through the zenith, to west.

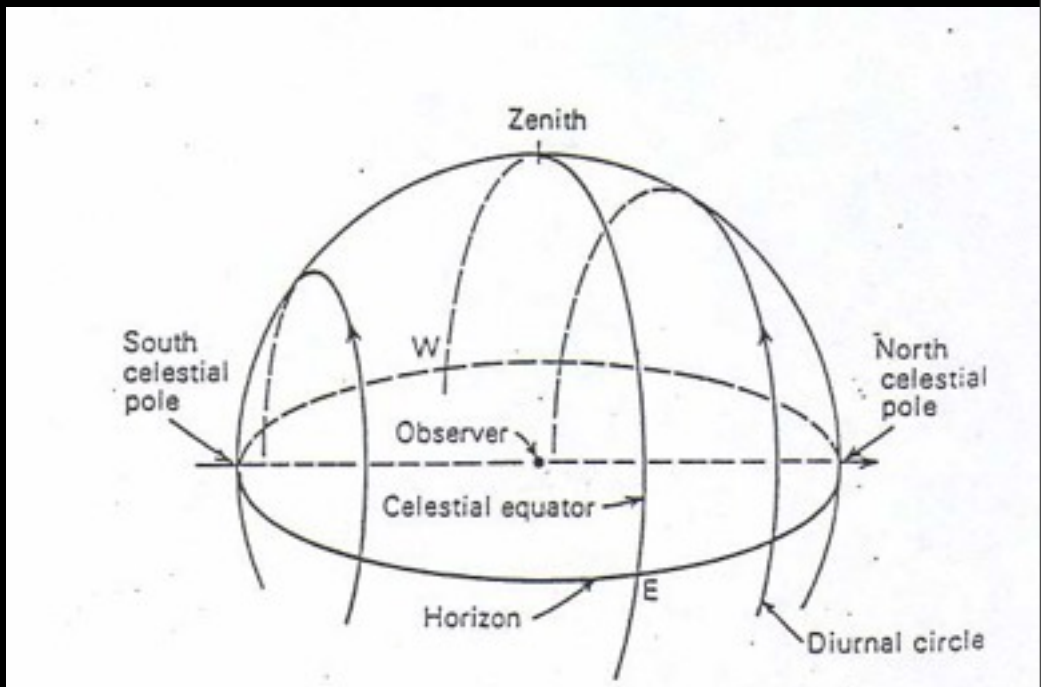
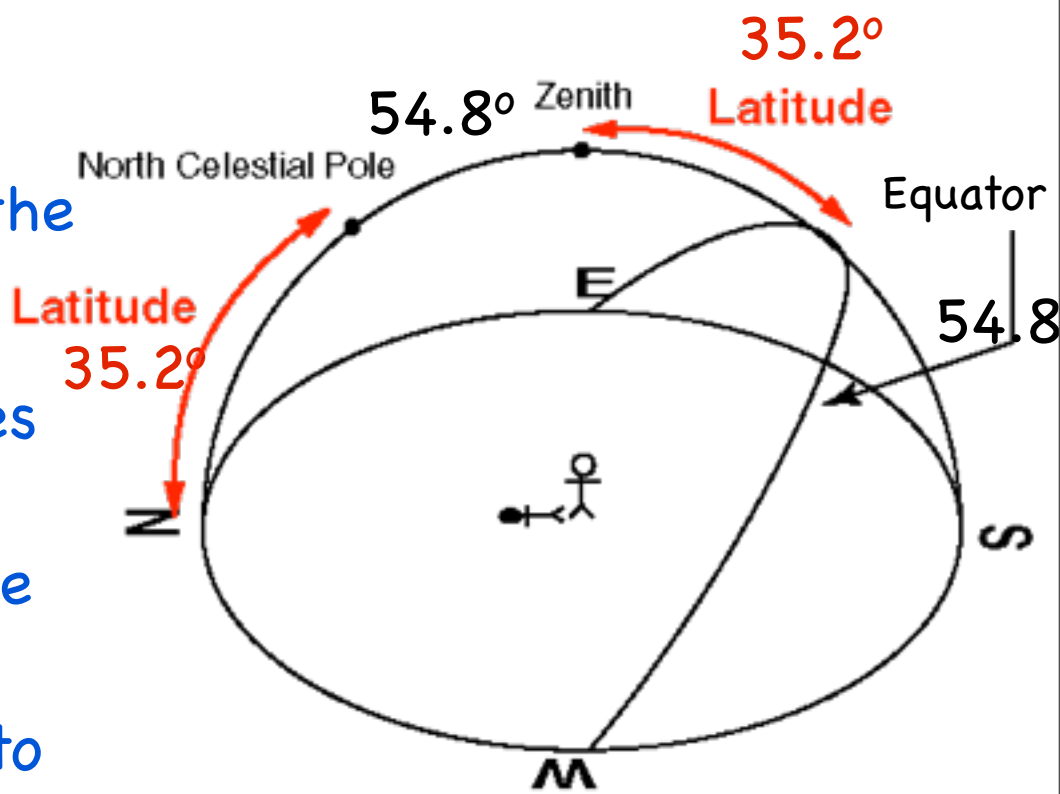


FIG. 7-8 Sky from the equator.

Equatorial (right ascension and declination)

If you're in Flagstaff, then:

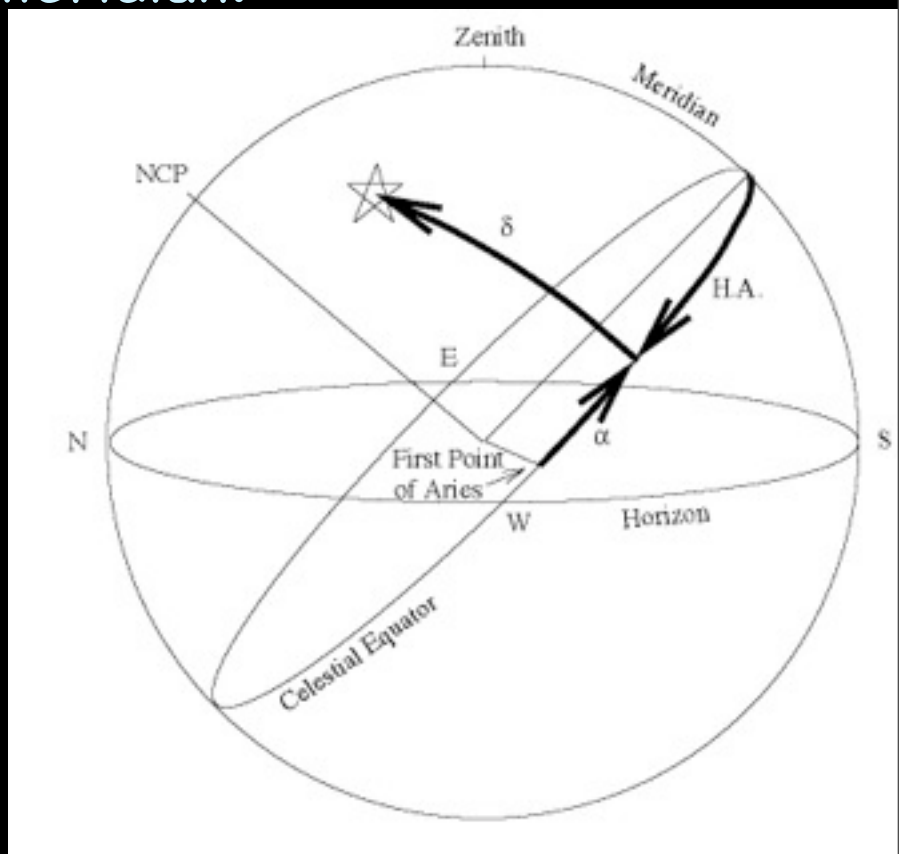
- The NCP is 35.2° above the northern horizon.
- The celestial equator goes from E, crosses the southern sky (54.8° above the southern horizon on the meridian), and goes to the W.



Hour Angle

Hour Angle (HA) is a measure of how far an object is east or west of the meridian.

- Measured along the celestial equator
- HA < 0 is east (e.g., $-1^h25^m16^s$)
- HA > 0 is west (e.g., $+1^h25^m16^s$)
- Tells how long until or how long ago an object crossed the meridian.
- The meridian (HA=0) is the best place to observe an object. Highest in sky, and hence least amount of Earth's atmosphere.



Hour Angle

A star that's rising due east has an hour angle of :

A. -6^{hr}

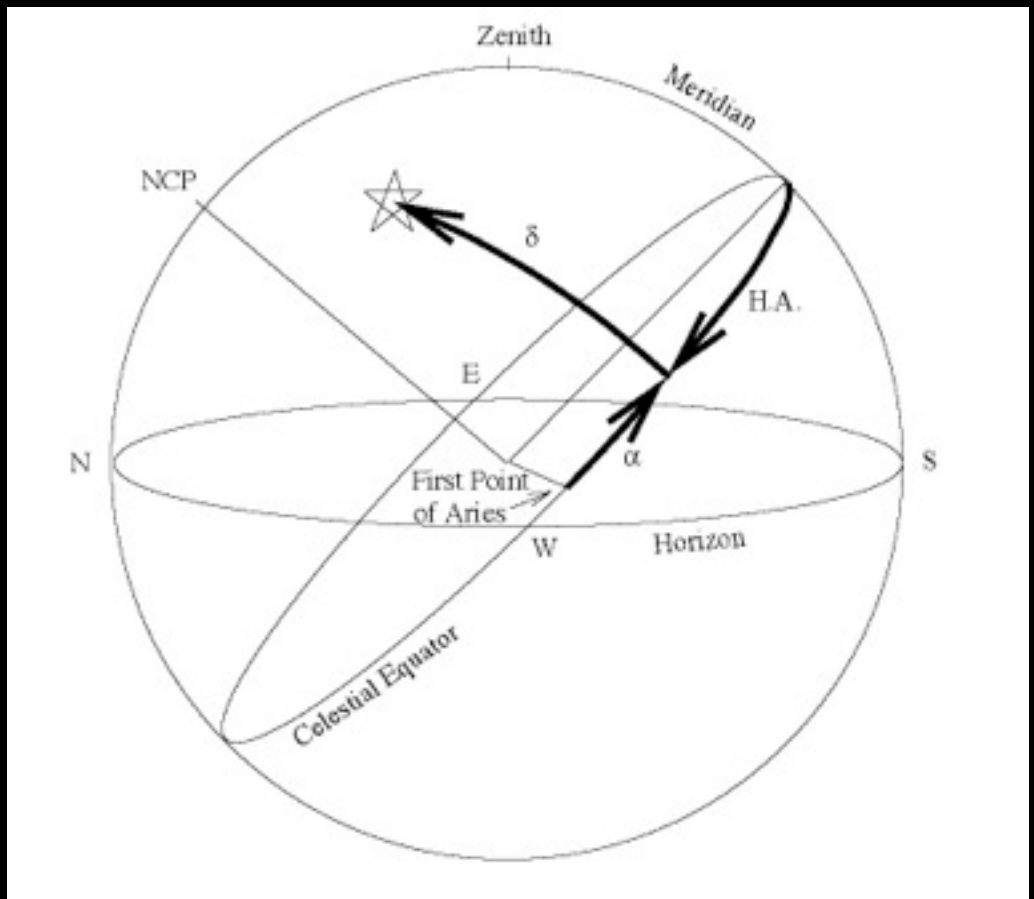
B. -3^{hr}

C. 0^{hr}

D. $+6^{hr}$

Summary: Some Things to Know

- Horizon
- Zenith
- Meridian
- Altitude
- Azimuth
- North Celestial Pole (NCP)
- Celestial Equator
- Right ascension
- Declination
- Hour angle



Review questions

1. Flagstaff is at a latitude of 35° 11' 53". What is that in decimal degrees?

2. You see a star due south that is just barely above the horizon. What is its declination?

3. You see a star due north that is just barely above the horizon. What is its declination?

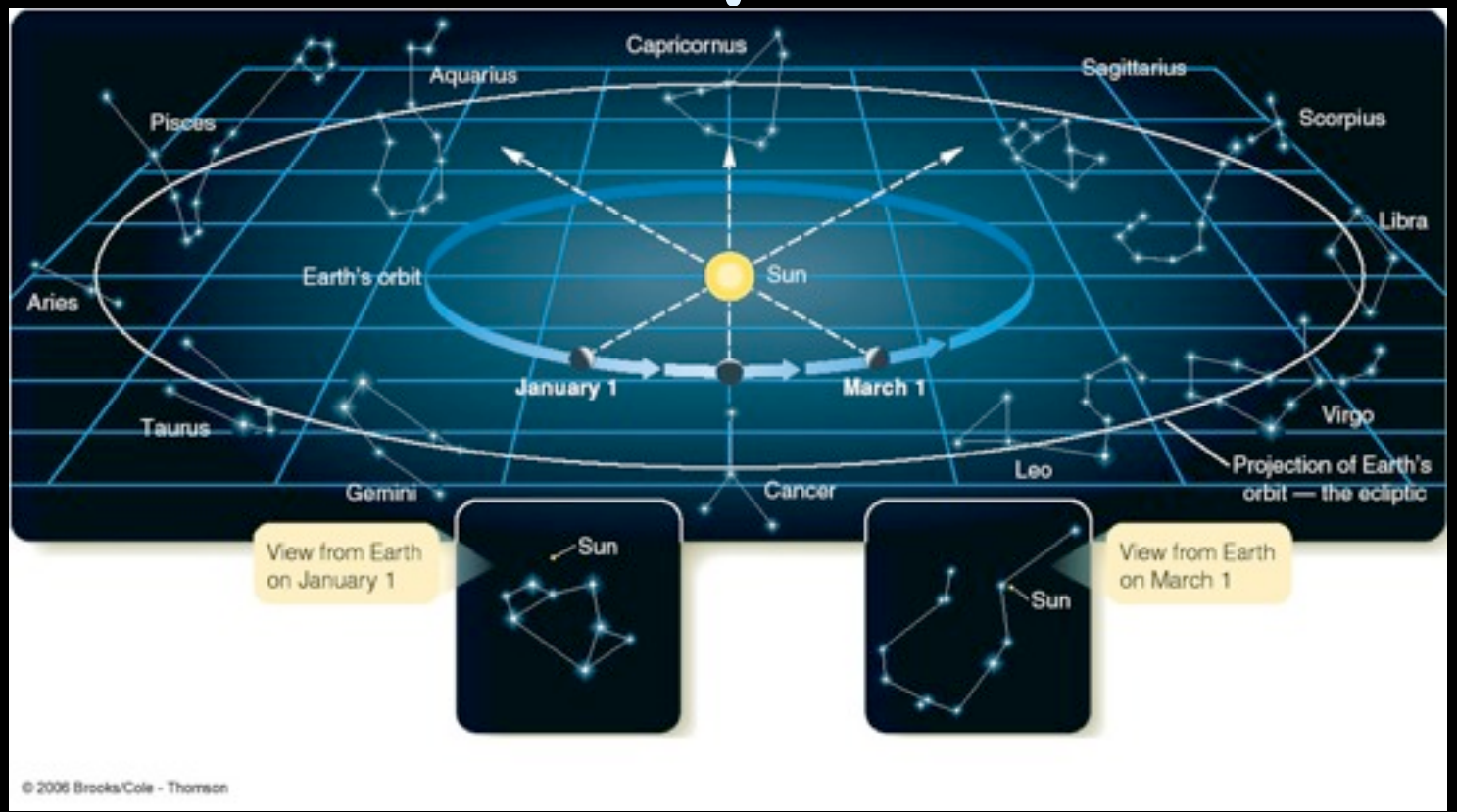
4. You see a star on the zenith. What is its declination?

Quiz time!

1) You would like to observe the Andromeda Galaxy (RA=00^h40^m DEC=41^o). If you observe it when it is on the meridian how many degrees will it be from the zenith? And in which direction? (What is this in azimuth and altitude?)

2) You're on the equator. What is the declination of a star at an azimuth of 90^o and an elevation of 41.25^o?

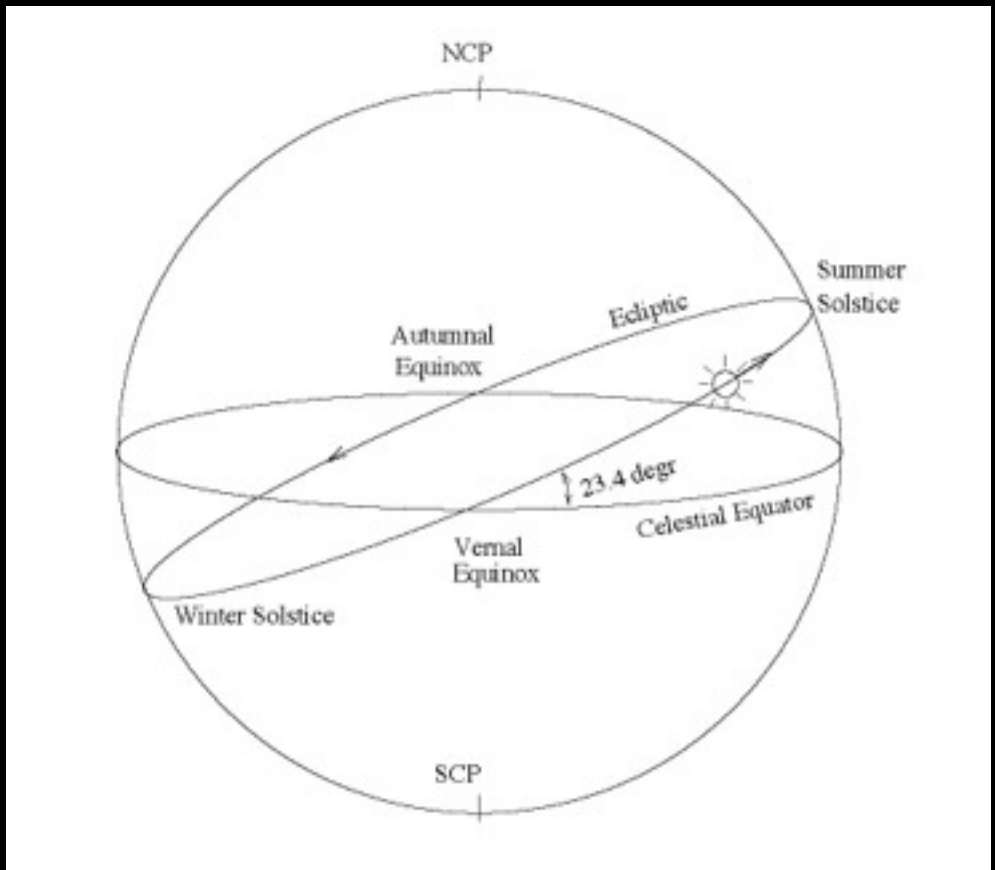
Ecliptic



Ecliptic: Plane that Contains the Orbit of the Earth
From the Earth, the Sun Appears to Move Through Constellations of Zodiac

Ecliptic On Celestial Sphere

- Sun's apparent annual path around the sky
- Circle passes through 12 constellations of the zodiac
- Dates on sphere give location of sun on that date



Ecliptic On Celestial Sphere

What is the declination of the sun on the equinox (i.e., Sept 22 or March 22)?

A. +23.5 degrees

B. 0 degrees

C. -23.5 degrees

Ecliptic On Celestial Sphere

Most of the planets stay very close to the ecliptic:

Mercuy: 7.0°

Venus 3.4°

Mars 1.9°

Jupiter 1.3°

Saturn 2.5°

Uranus 0.8°

Neptune 1.8°

Ecliptic On Celestial Sphere

If Jupiter happens to be in opposition (opposite the sun) on June 22, what is its approximate declination?

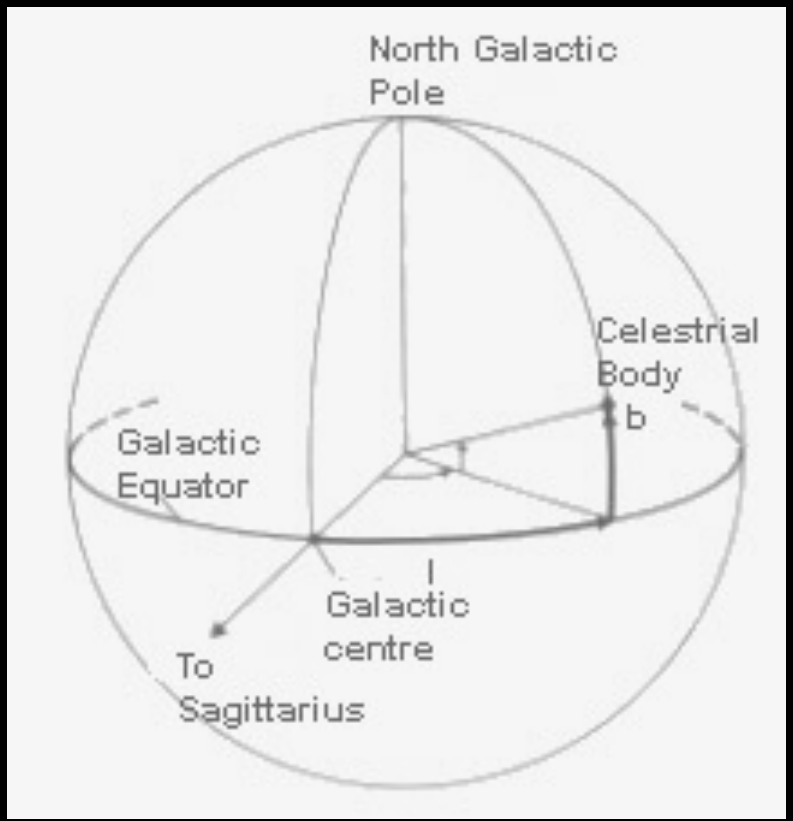
A. +23.5°

B. 0°

C -23.5°

Galactic coordinates

Basically the great circle that goes through the plane of the Milky Way is 0 degrees in "galactic latitude" (b) The direction of the center of the Milky Way is then 0 degrees in "galactic longitude" (l).



Useful to know for galaxies---how much Milky Way junk are you looking through?

Where are the planets?

You go out and see Venus in early evening. If you drew a map of the solar system looking down on the ecliptic from the north ecliptic pole, where would Venus be located w.r.t. the Earth? There are two possible answers; how would you tell the difference?