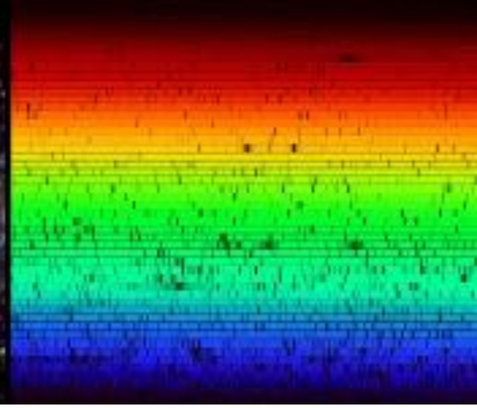
ASTR/PHYS 2500: Foundations Astronomy



Week 1: Night Sky & Coords

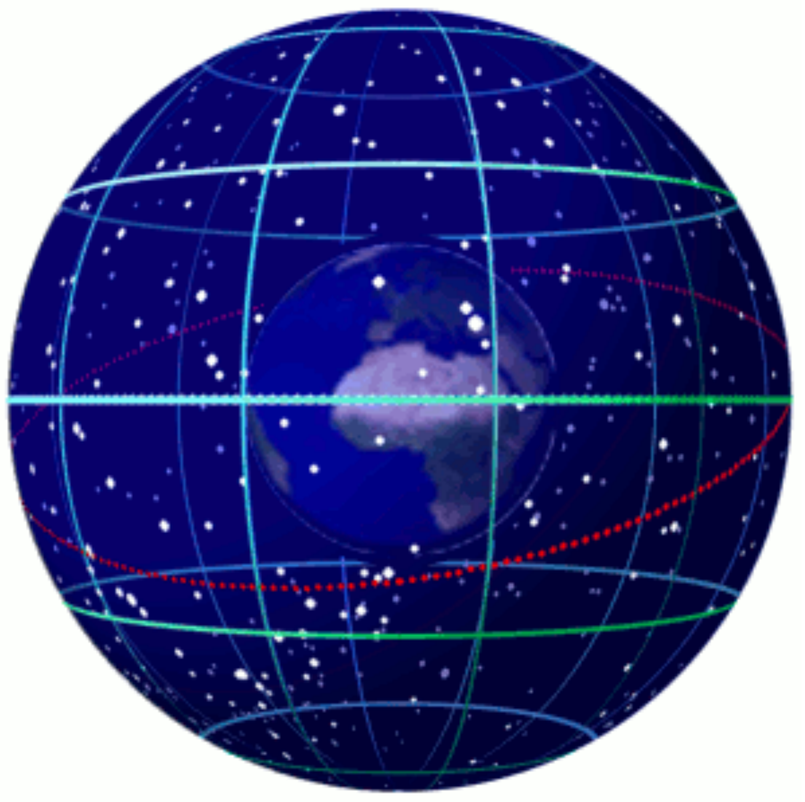
Please complete the Student Info and Pre-course Asssessment, if you haven't yet

Name our Llama!

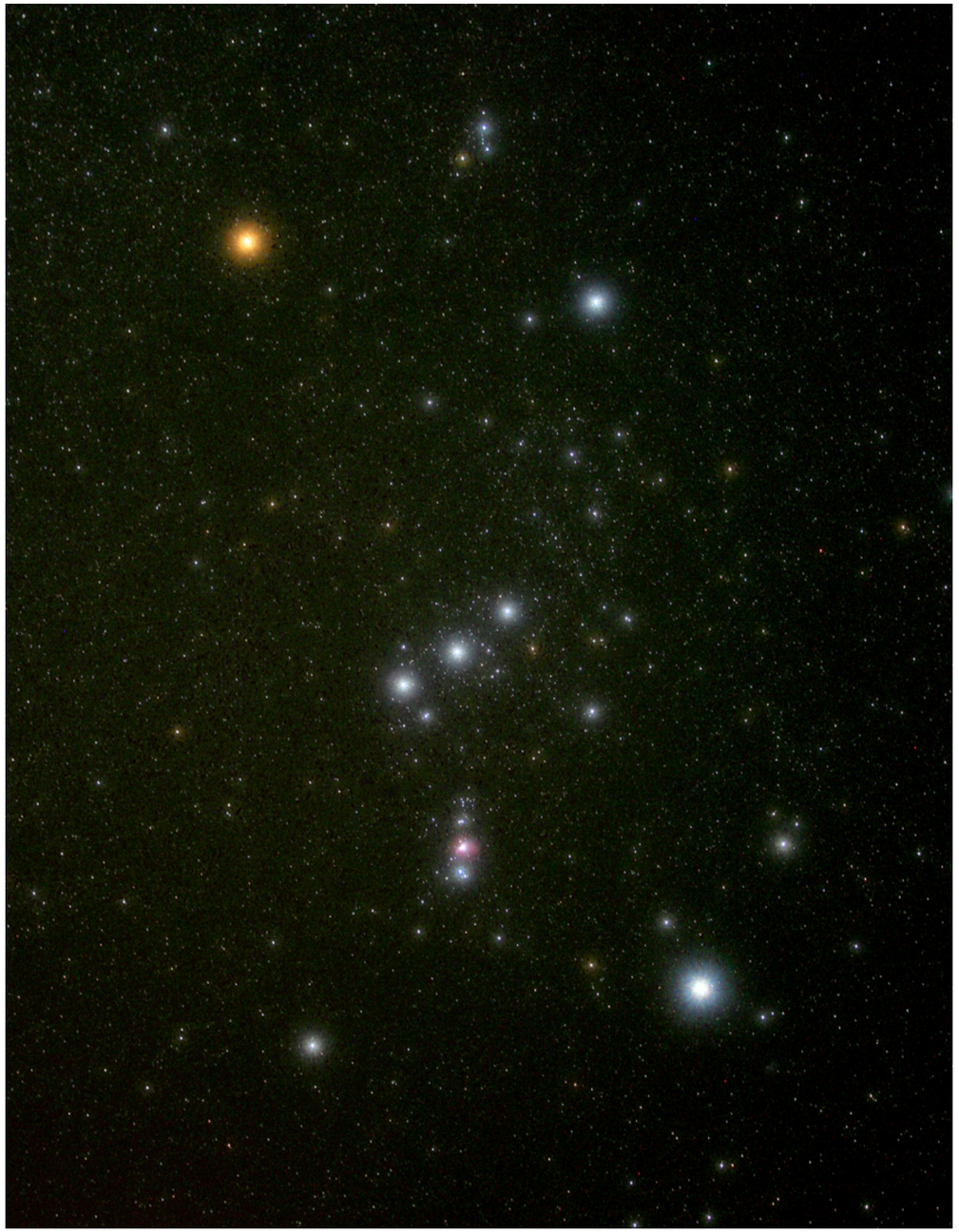
HW1 due in 1 week

Read indicated sections of Ch. 2 & 3 by Tuesday

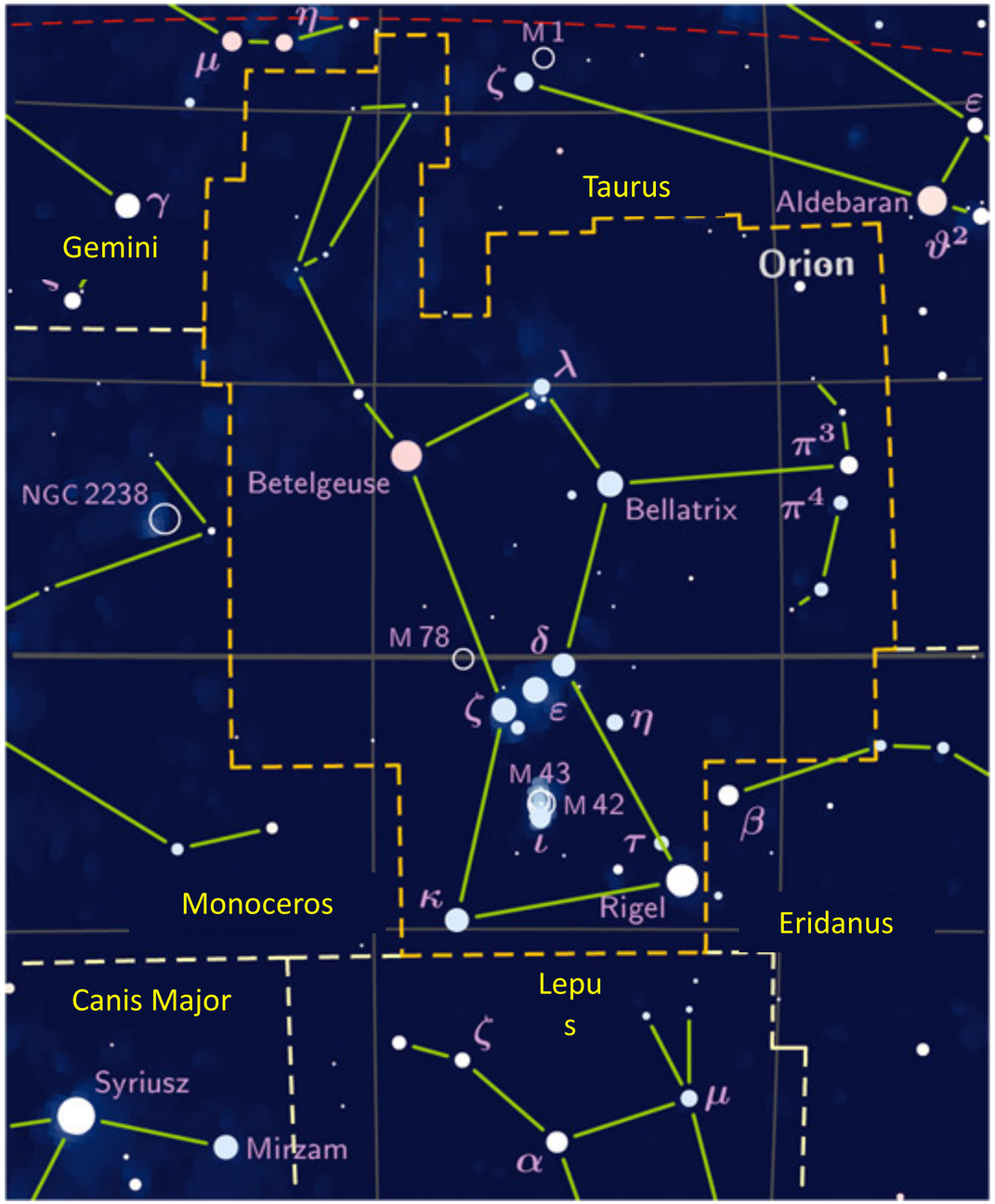
The Night Sky & Astronomical Coordinates



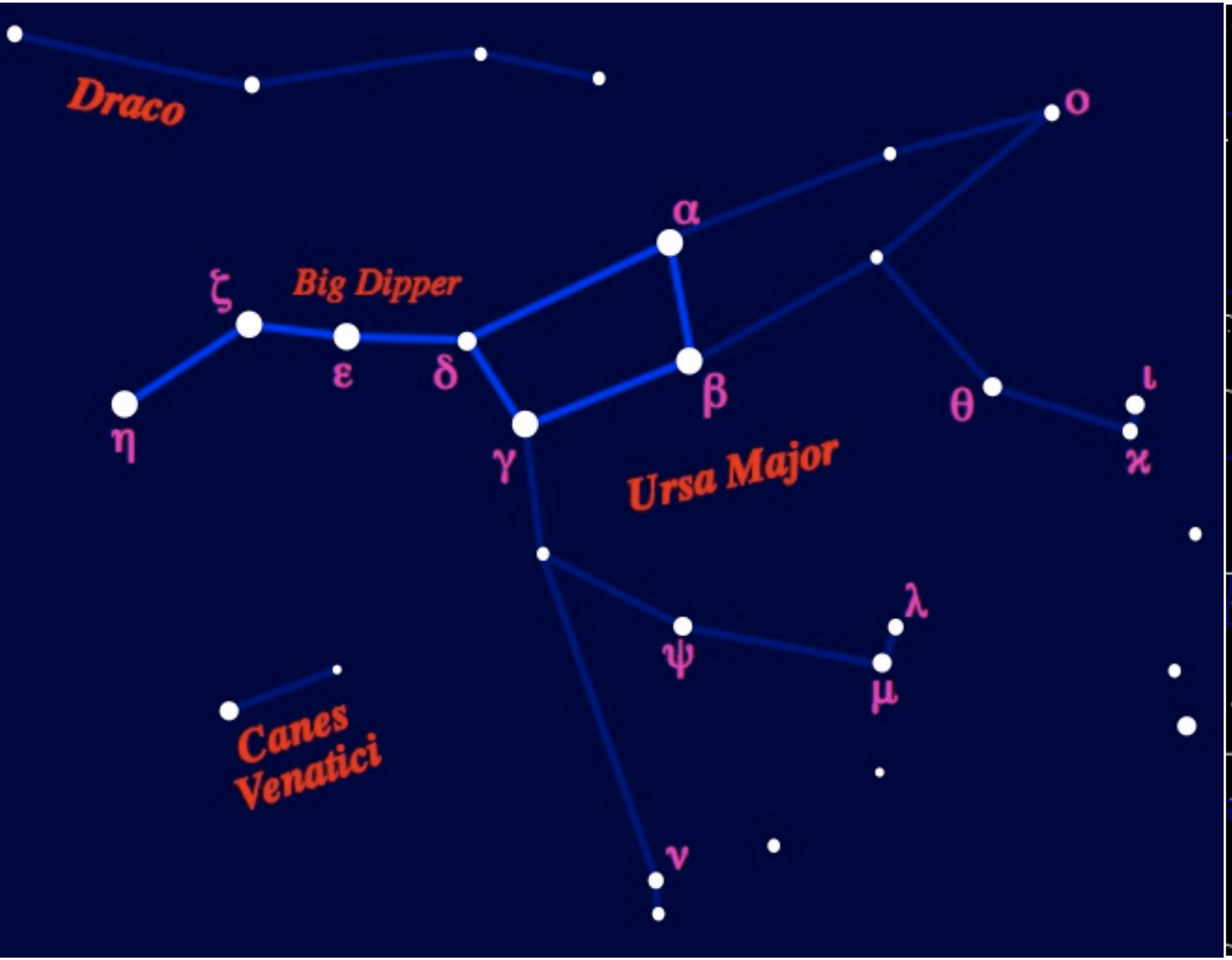
Star trails over the Gemini South telescope

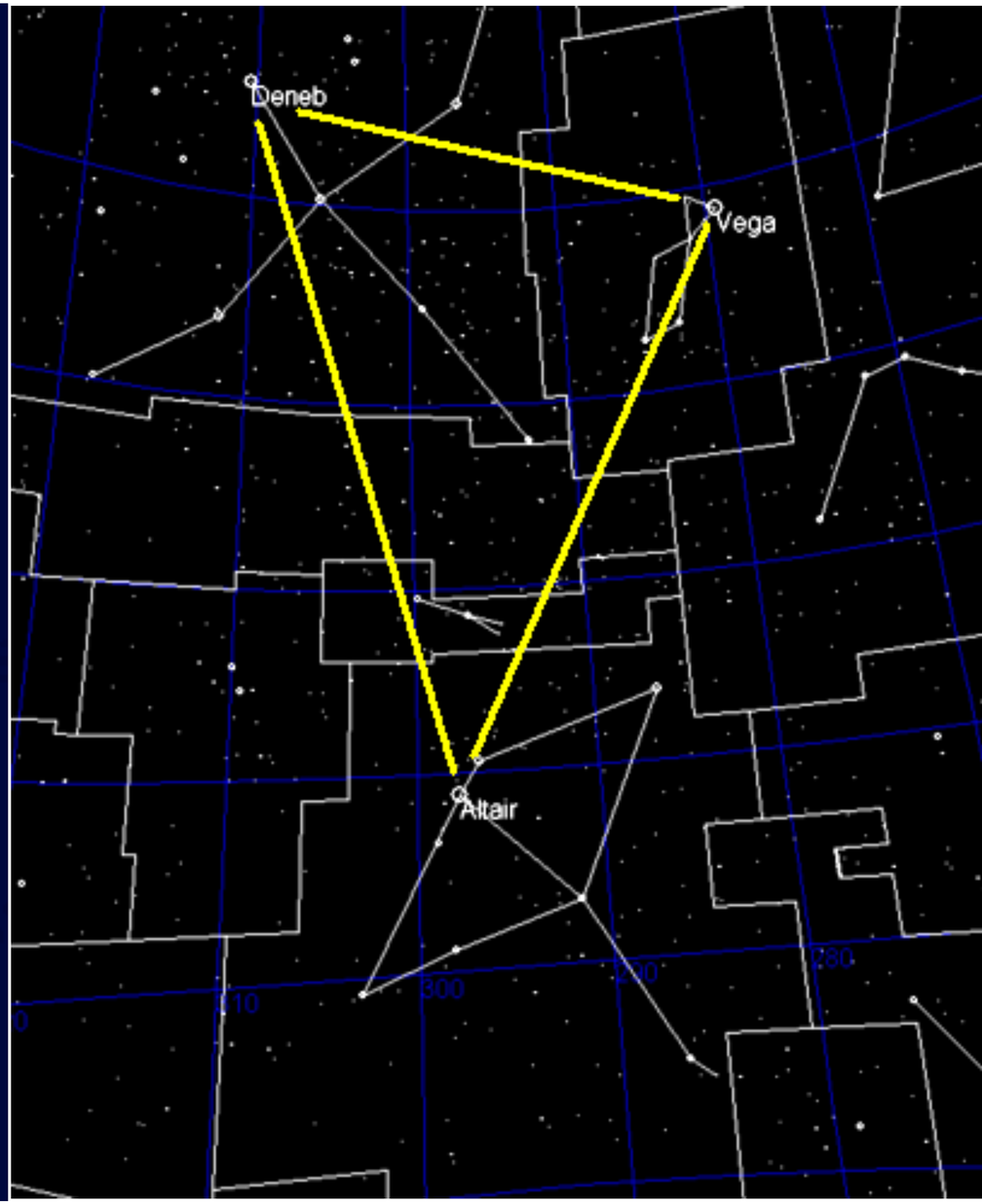


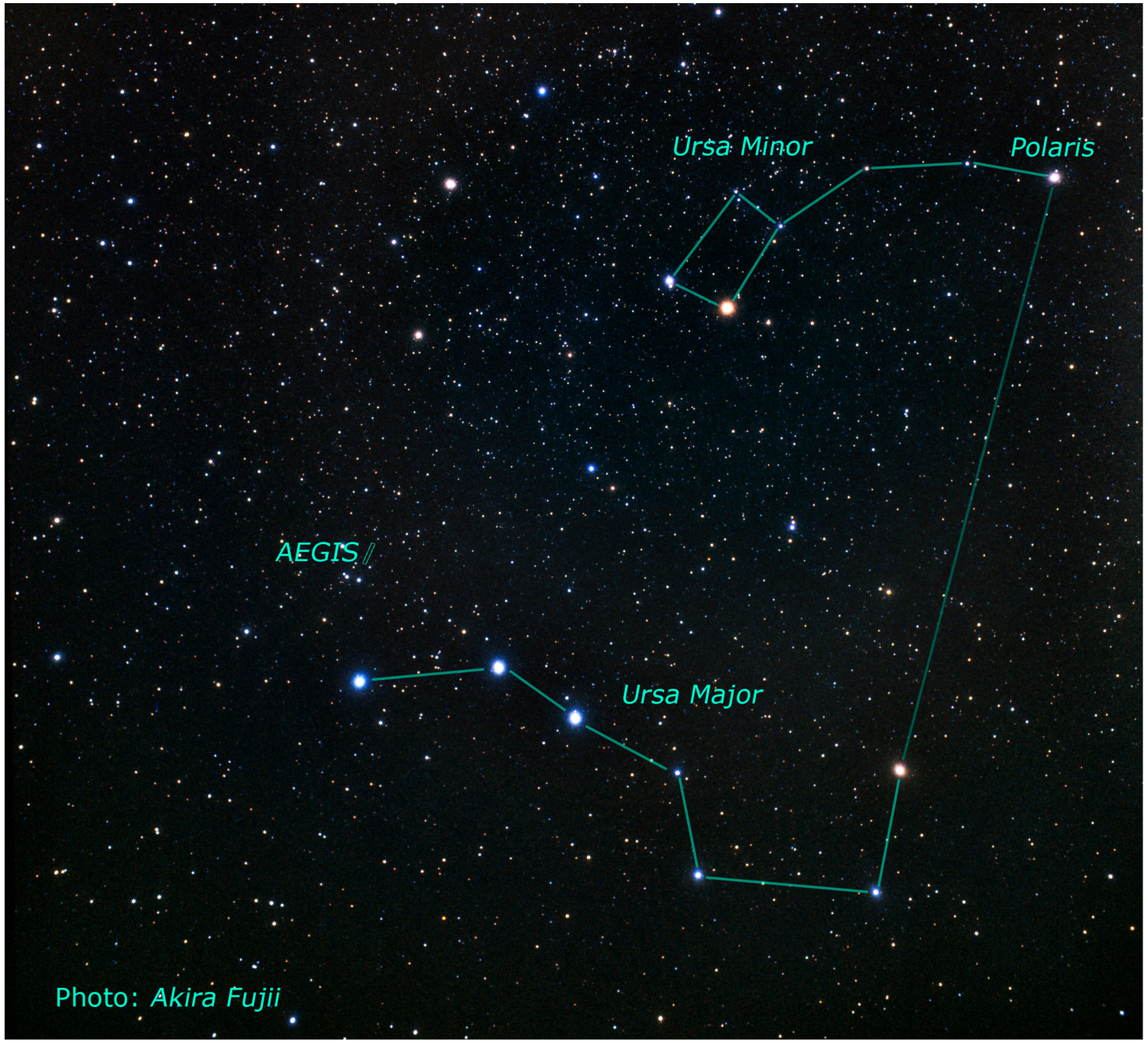
Orion


M 1
Taurus
Aldebaran
Gemini
Orion
Betelgeuse
NGC 2238
Bellatrix
M 78
M 43
M 42
Monoceros
Rigel
Eridanus
Canis Major
Lepus
Syriusz
Mirzam

Constellation versus Asterism





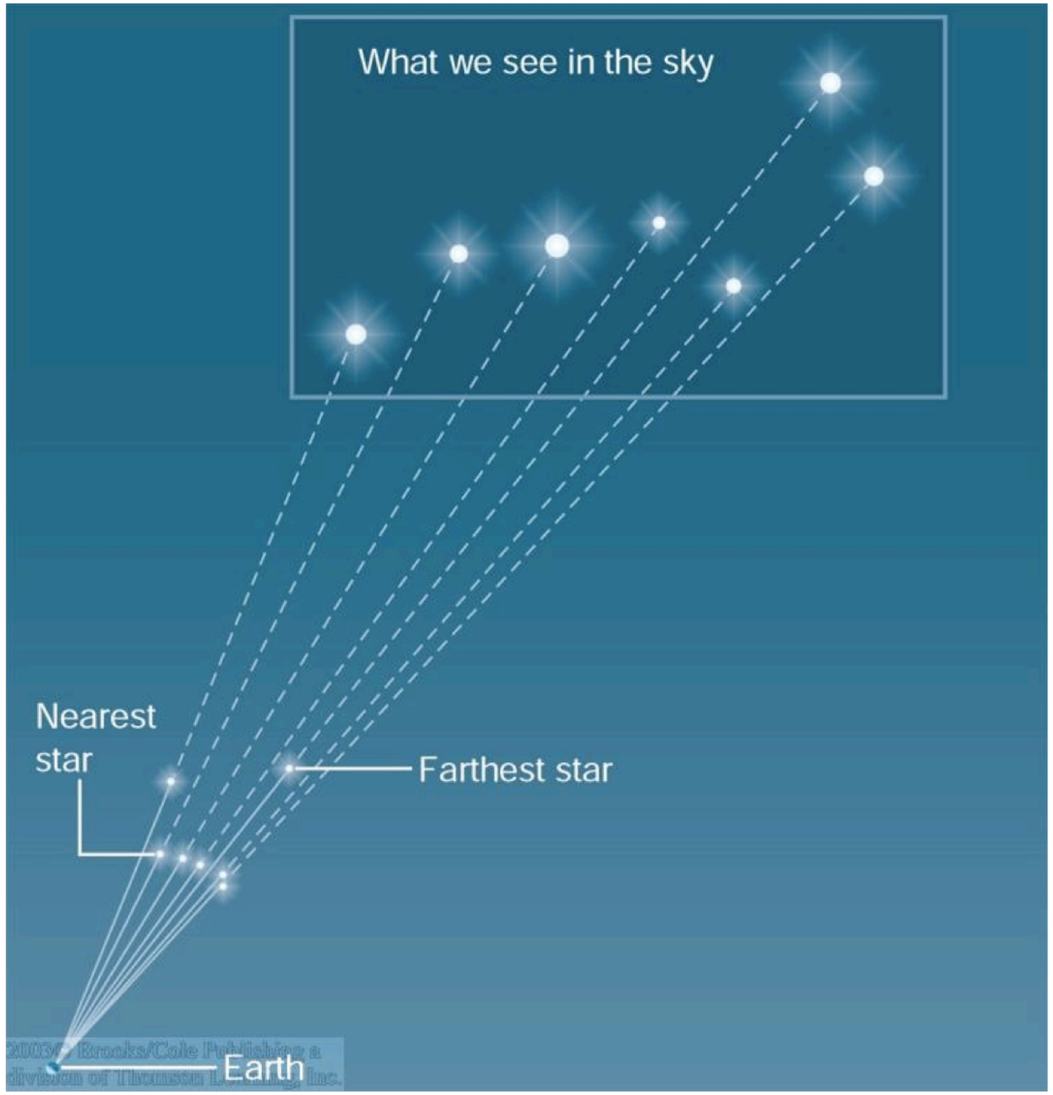


Ursa Major & Minor (Big and Little Bears)

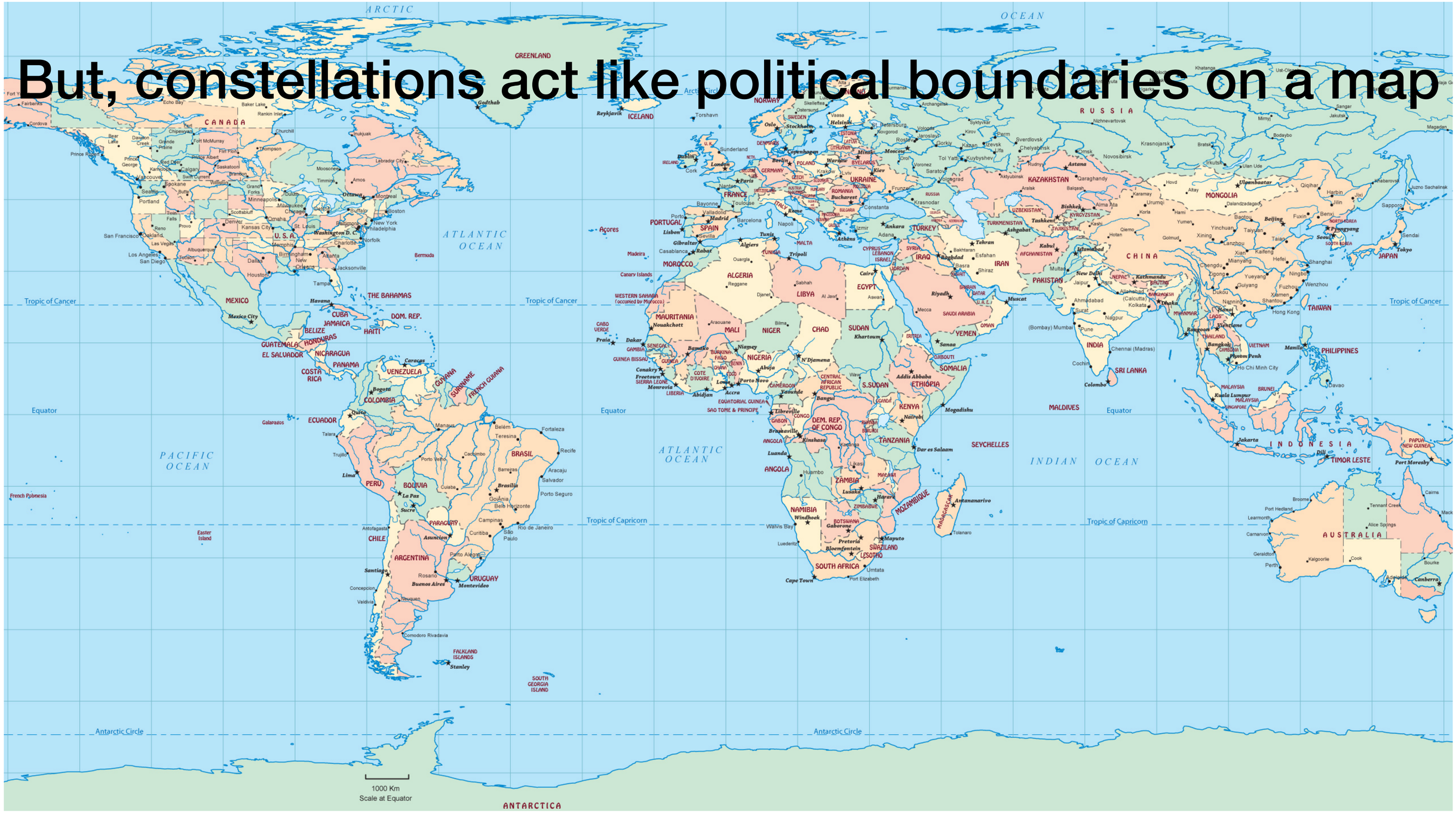
Big & Little Dippers

Polaris (North Star)

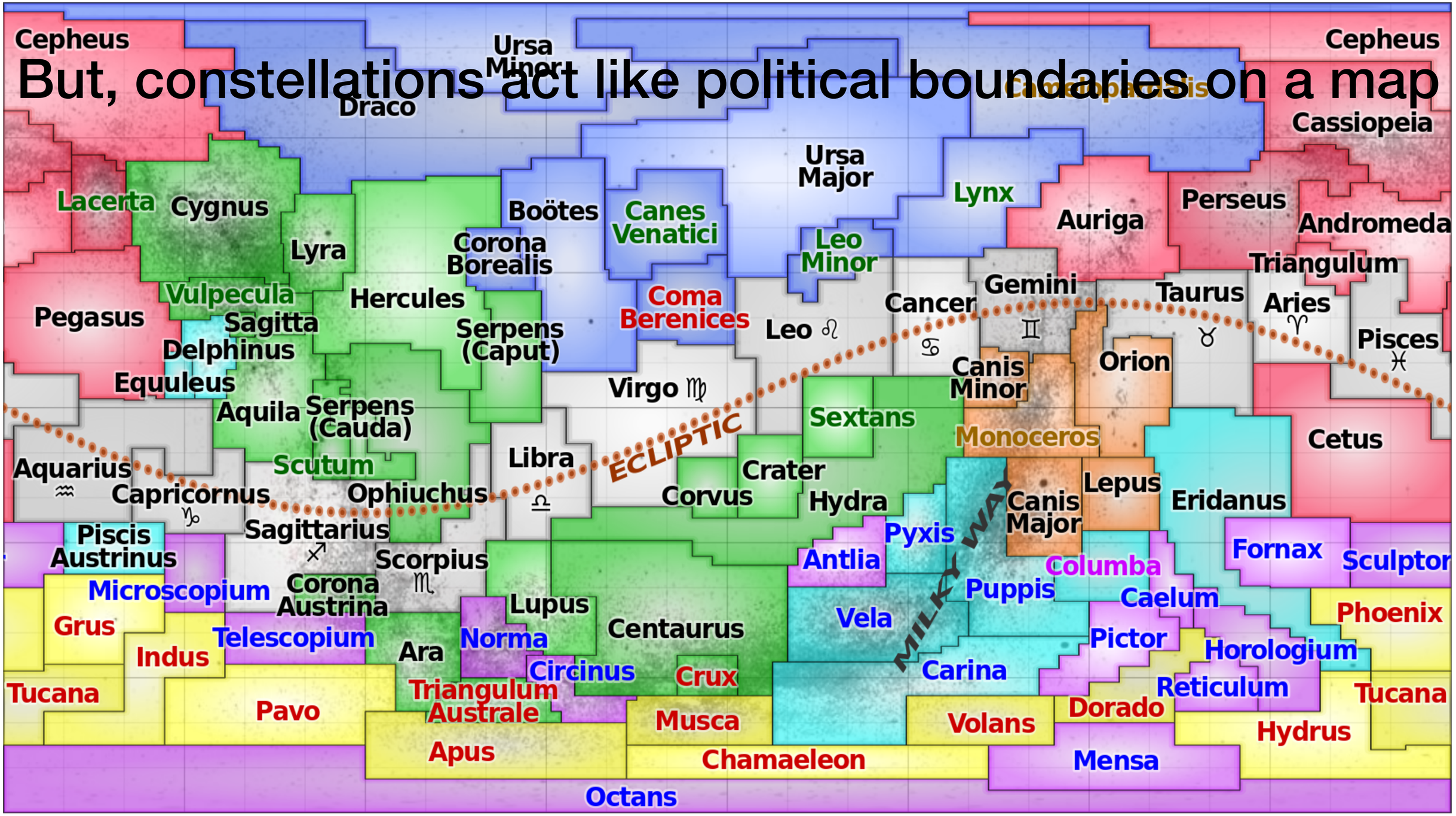
These star patterns are of little use to modern astronomers



But, constellations act like political boundaries on a map



But, constellations act like political boundaries on a map



But, constellations act like political boundaries on a map

Useful for naming objects:

Brightest stars in a constellation are ordered from brightest to faintest with Greek letters (e.g., brightest star in Centaurus is called alpha Centauri)

Similar convention in radio and X-ray, e.g., the radio supernova remnant Casseopia (Cas) A, the black hole systems Cygnus X-1 and X-3, the supermassive black hole at the center of the Milky Way, Sagittarius (Sgr) A*

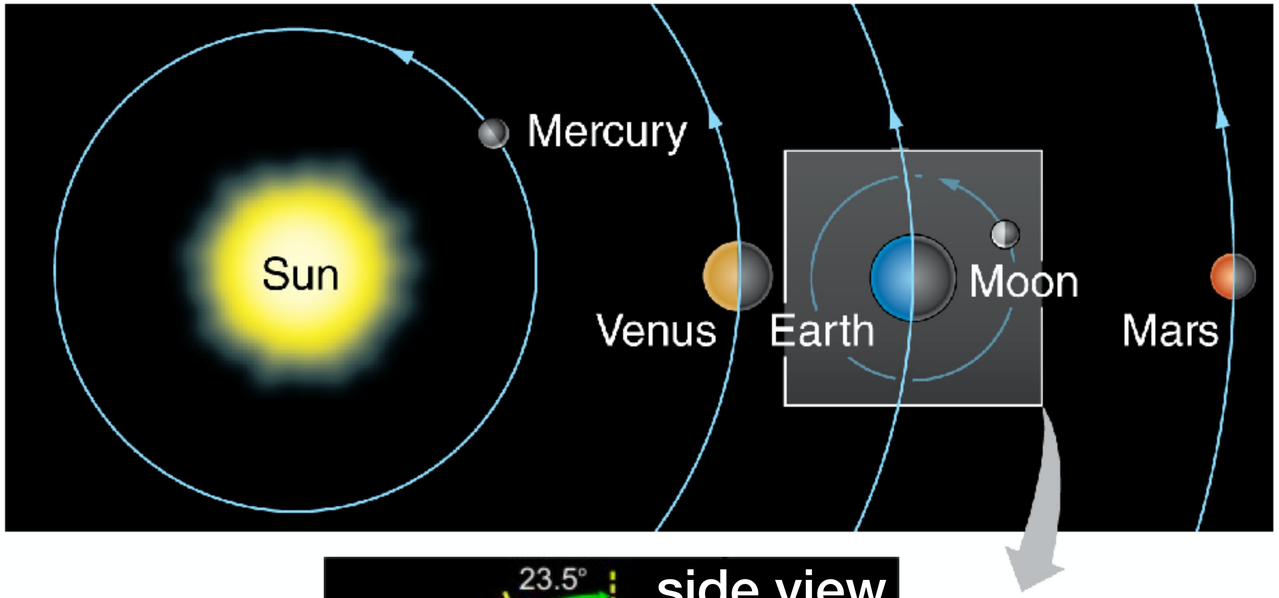
Nearby galaxies and galaxy groups and clusters also take constellation names (Andromeda Galaxy, Coma Cluster, Virgo Cluster)

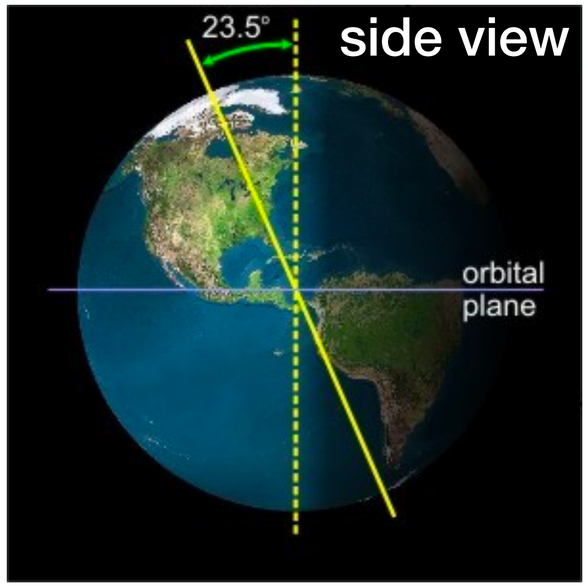
Constellations aren’t that useful in practice though, because the sky is constantly “moving”

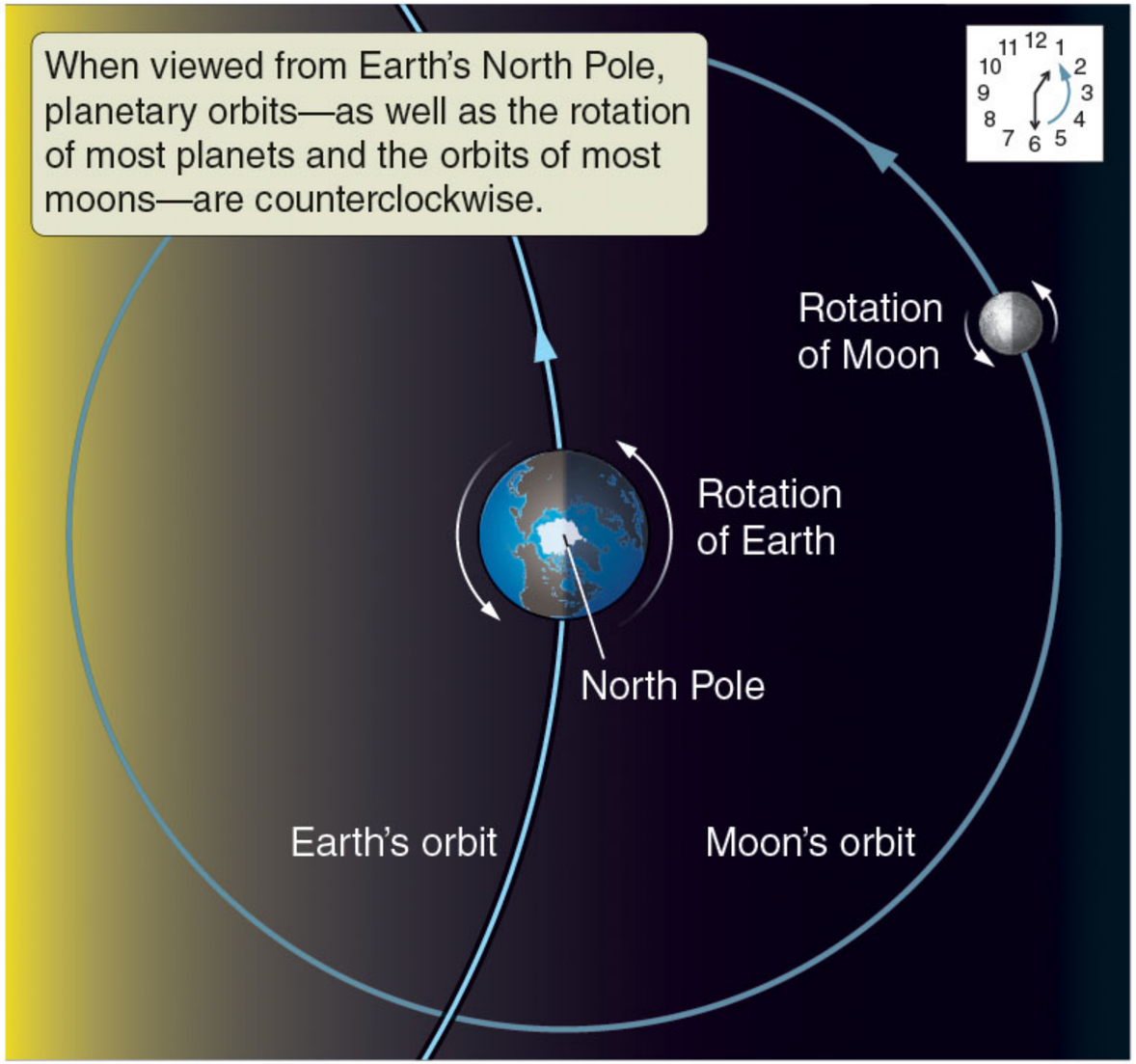
VSauce: How the Earth Moves

https://www.youtube.com/watch?v=IJhgZBn-LHg

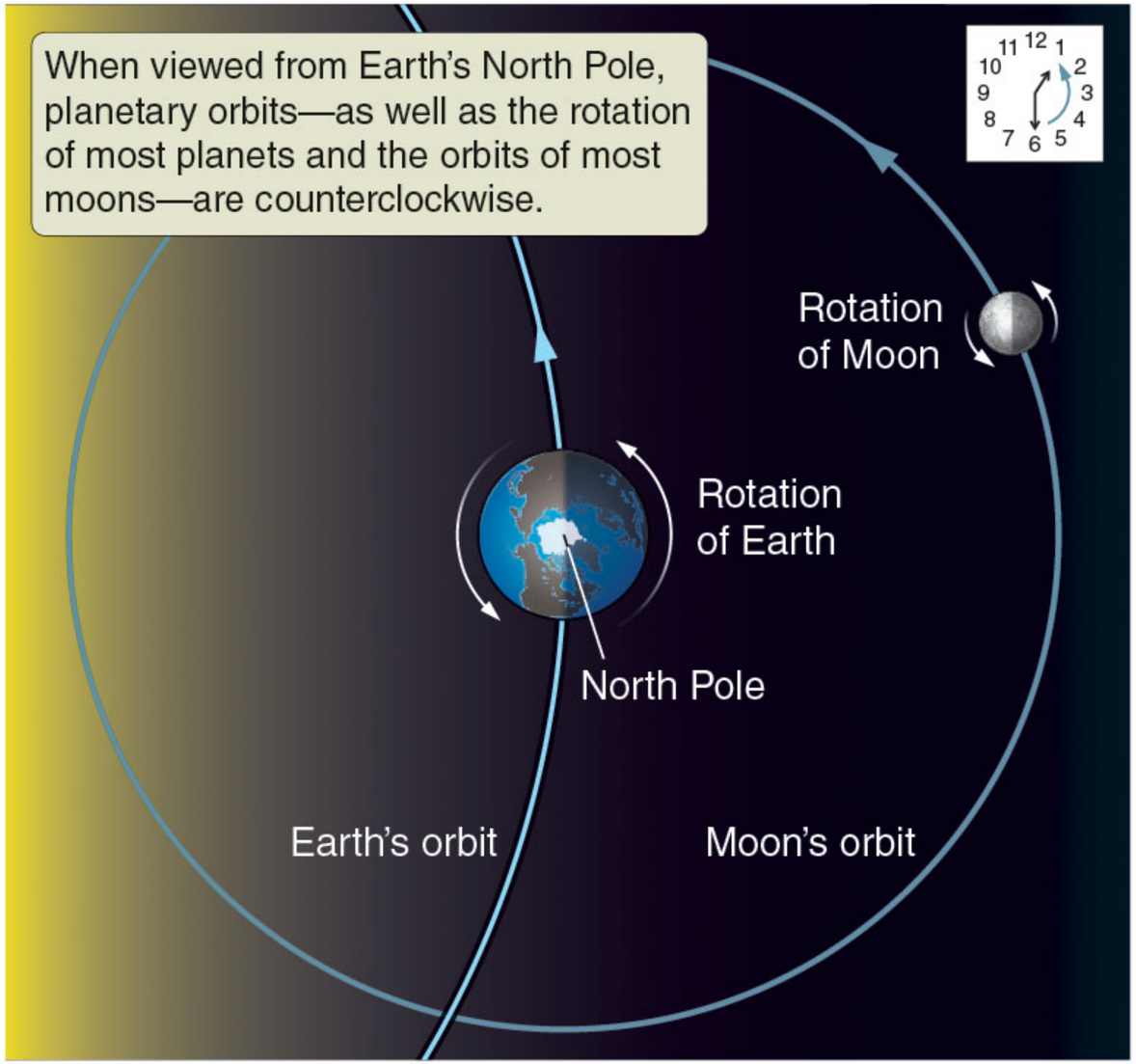
Everything moves and is a tad cockeyed





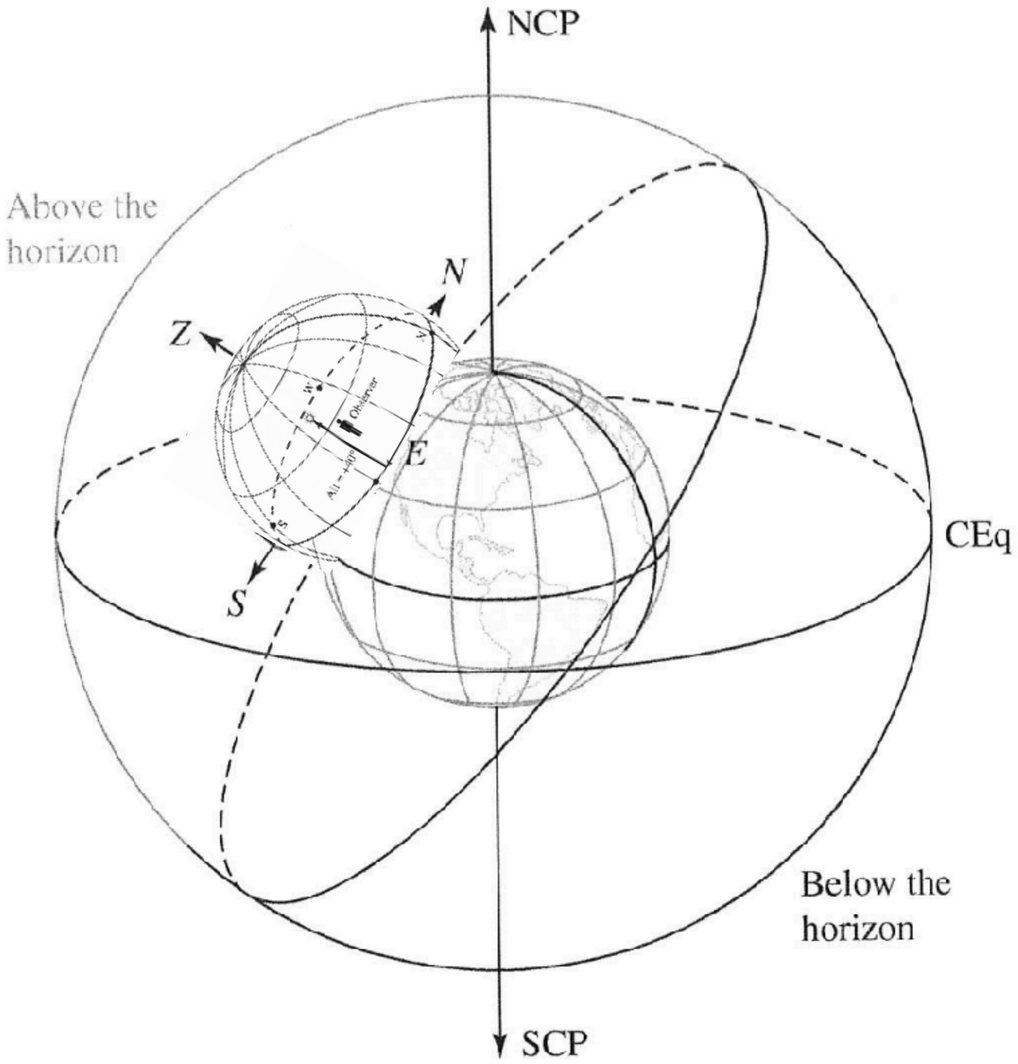


MOON PHASES!!!!

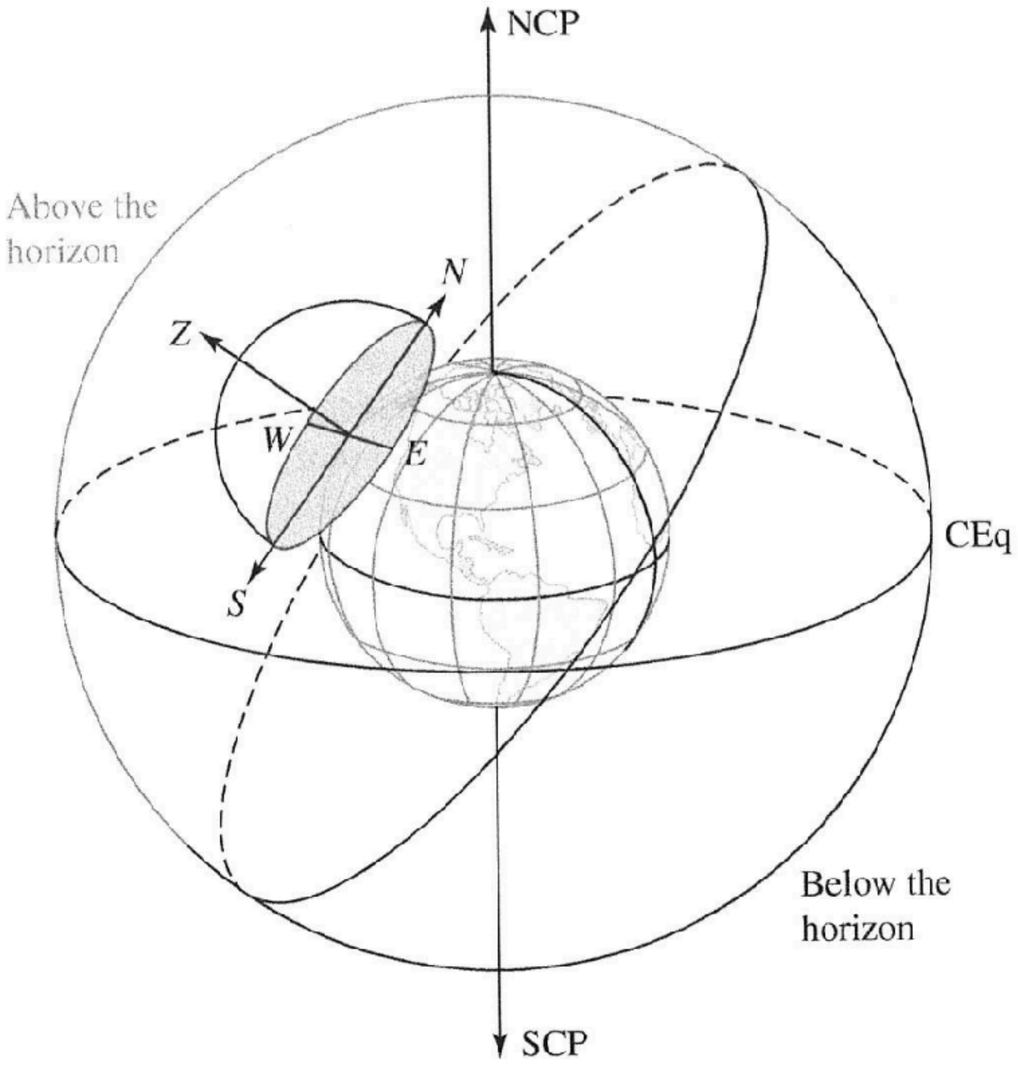


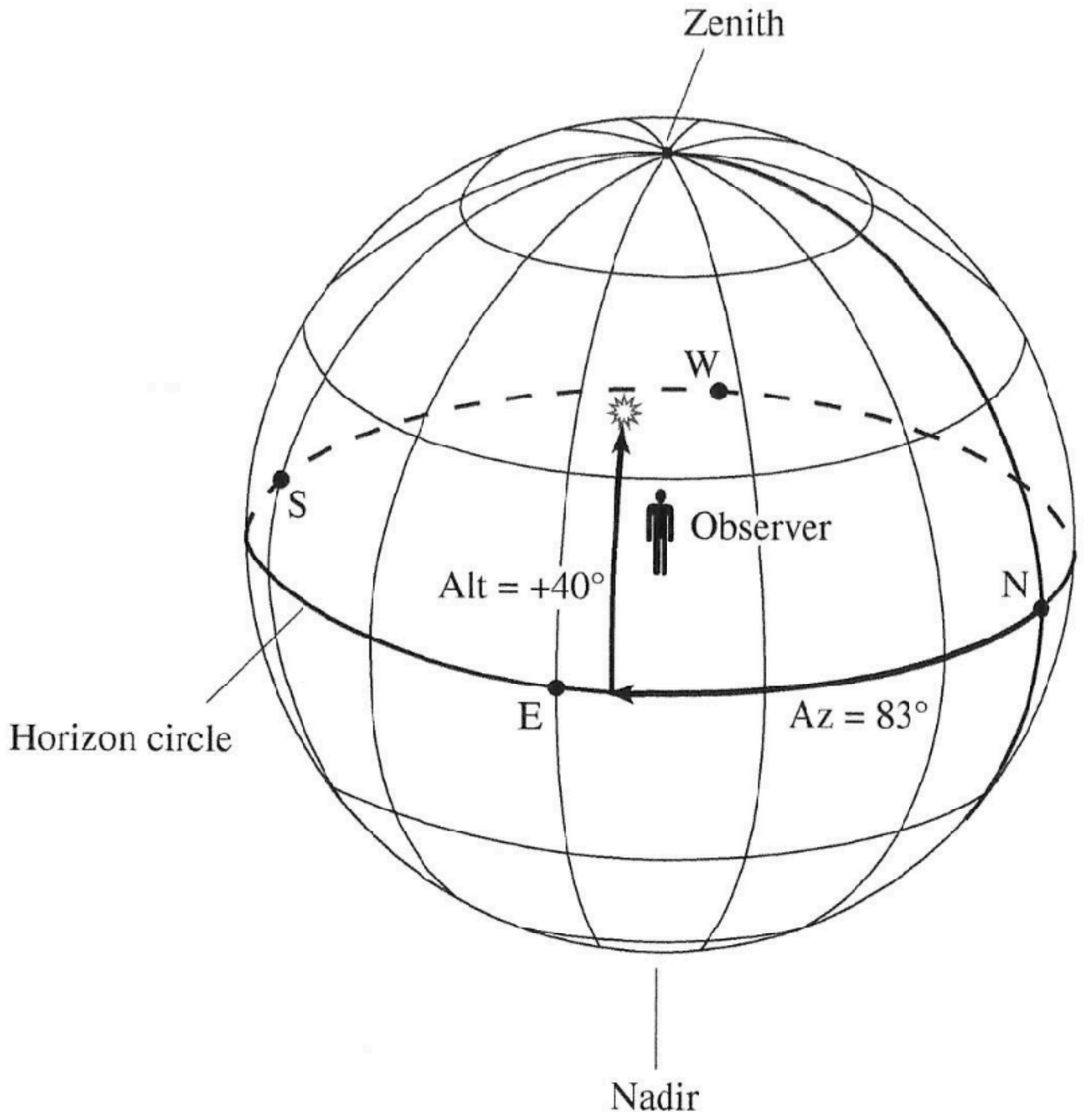
You wake up outside, no idea how long you were unconscious for.
You look to the horizon and see this Moon.
Is it waxing or waning? What time is it (roughly)? What direction are you looking? What time will the Moon rise a week from now?

Coordinates on the Sky

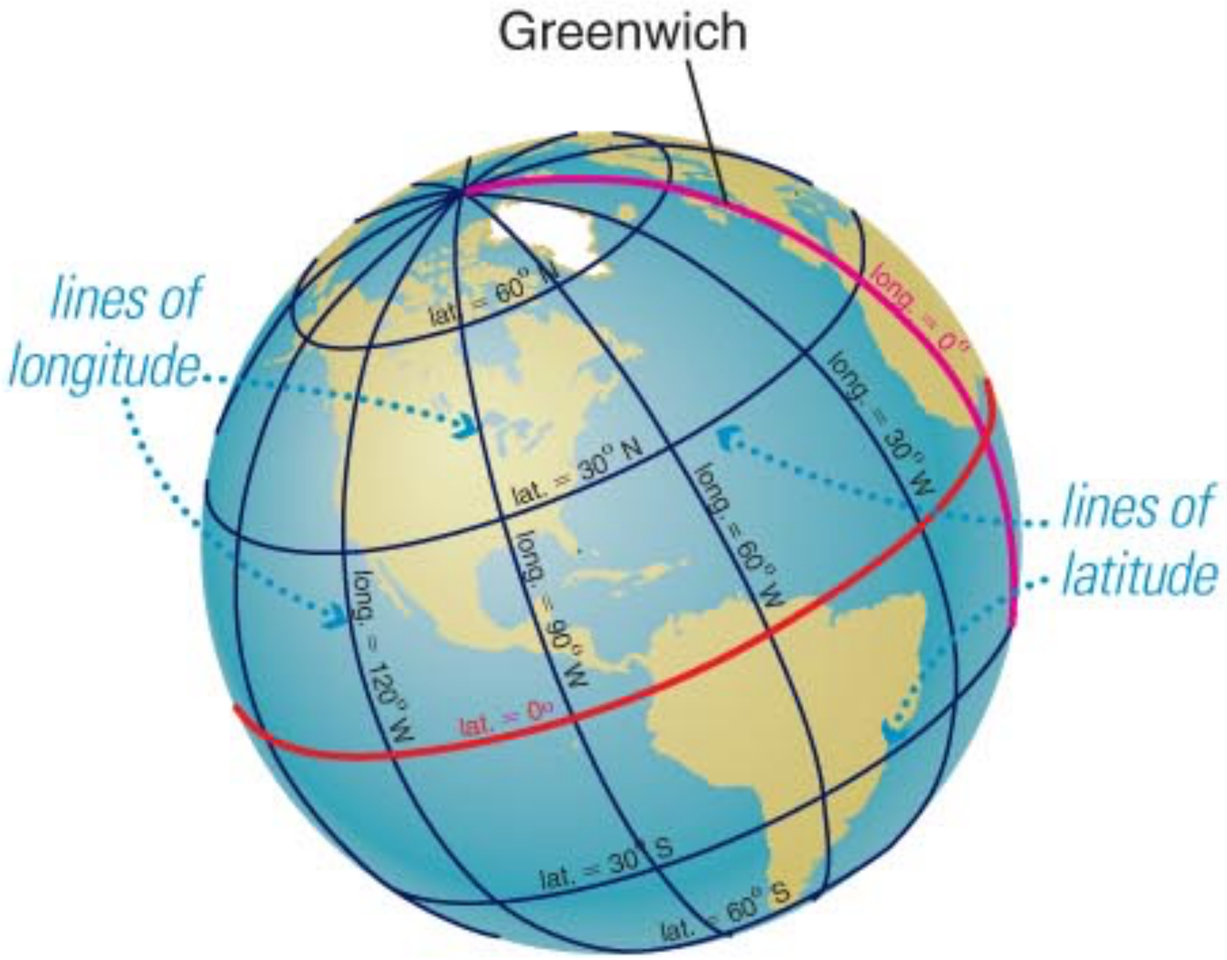


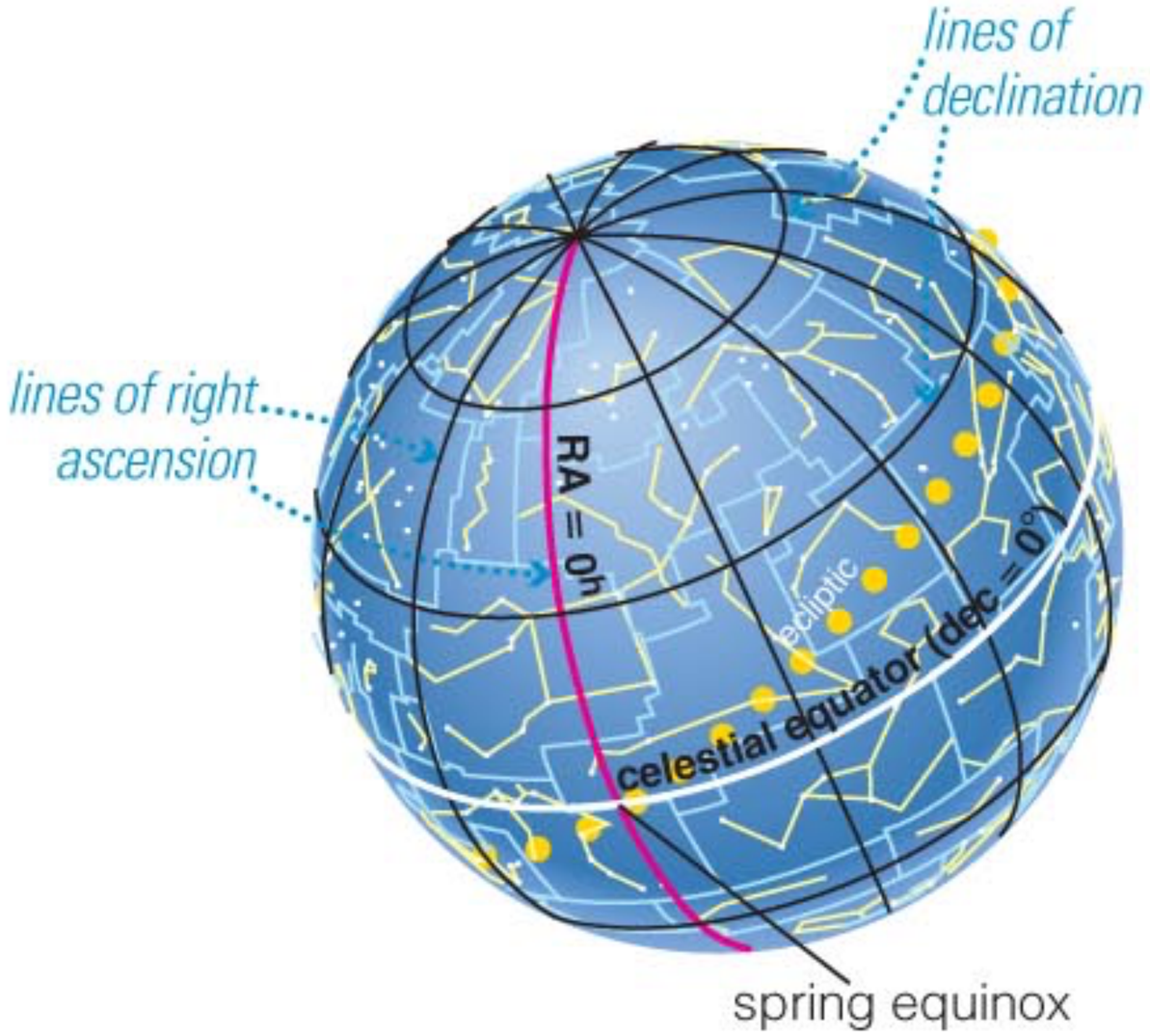
Coordinates on the Sky





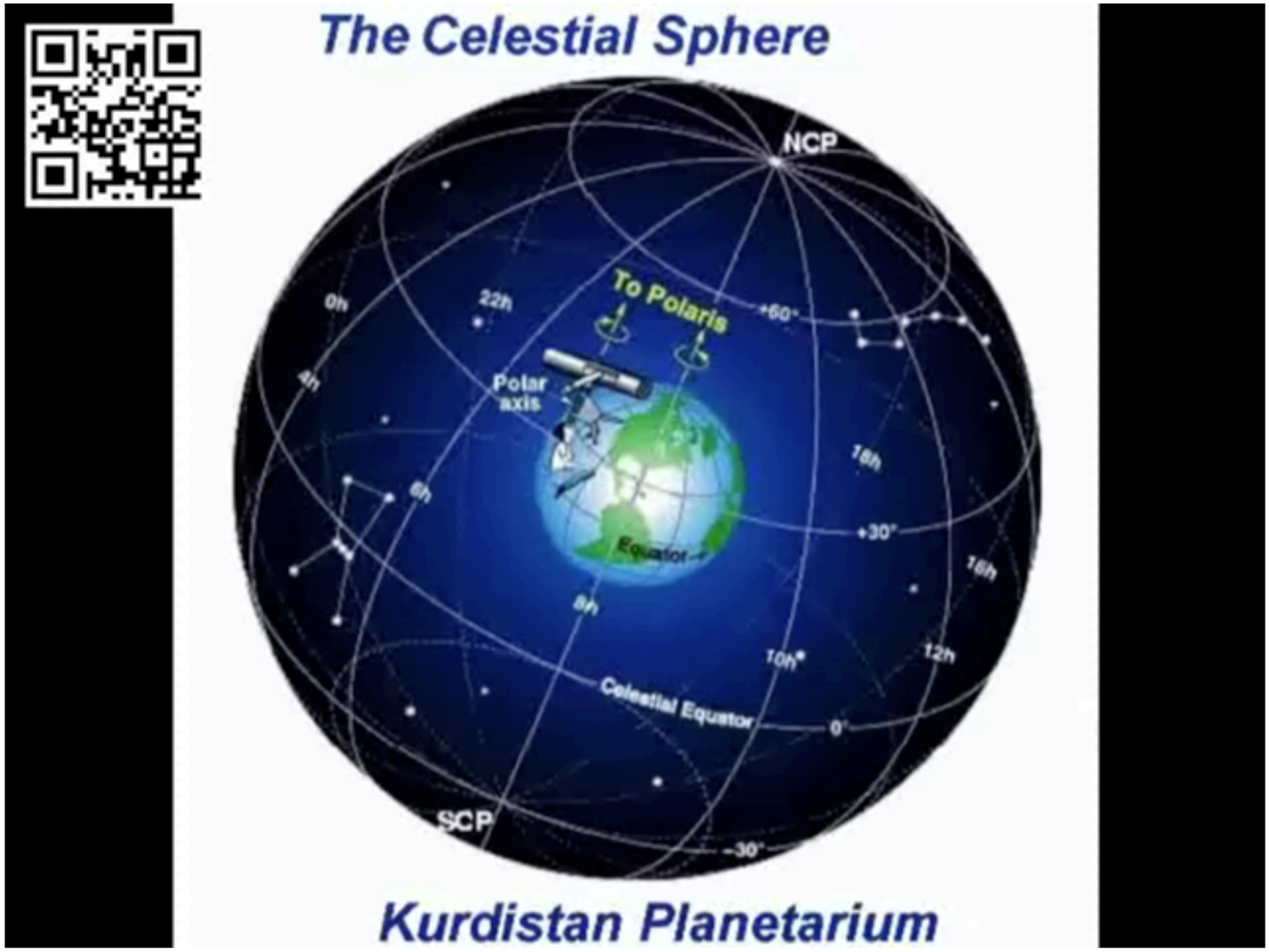
Coordinates on the Sky



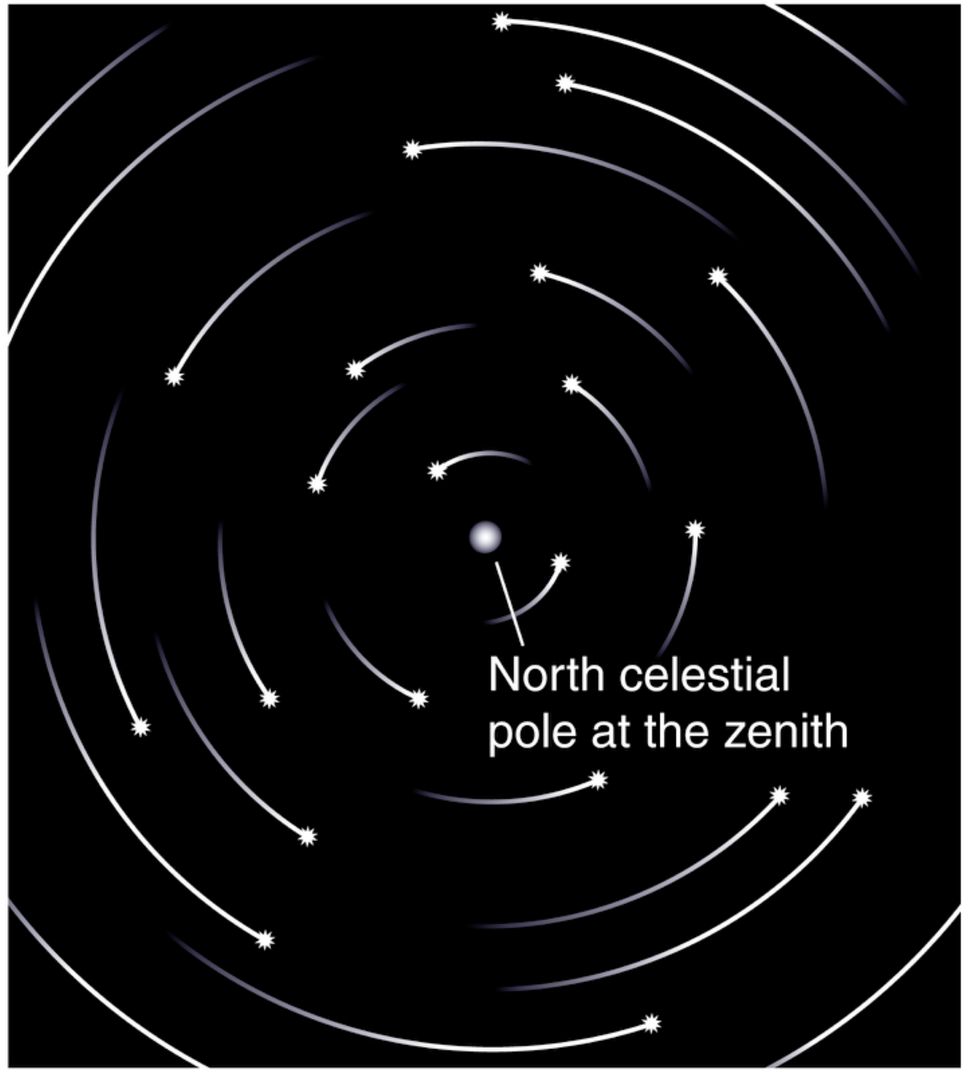


https://www.youtube.com/watch?v=1Toya19H12w

The Celestial Sphere

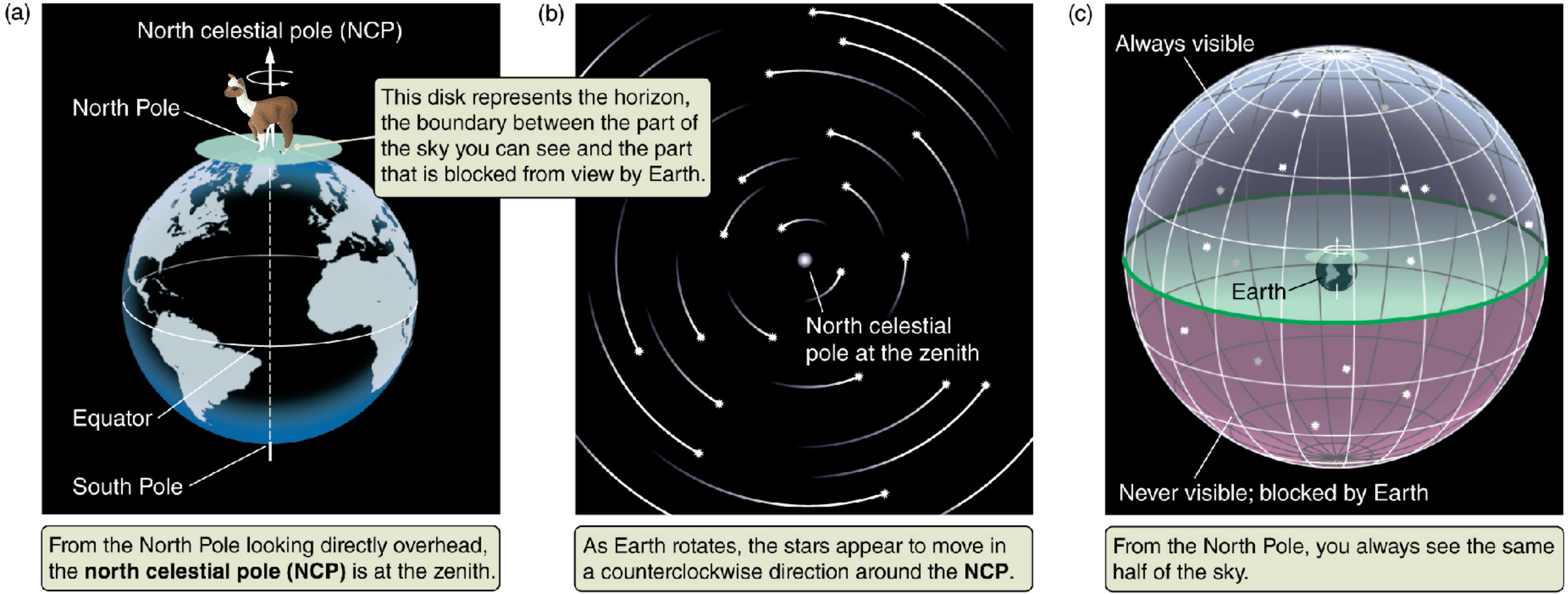


If the north star is directly above our illustrious llama (i.e., at their zenith), where are they on the Earth?



As Earth rotates, the stars appear to move in a counterclockwise direction around the **NCP**.

North Pole!

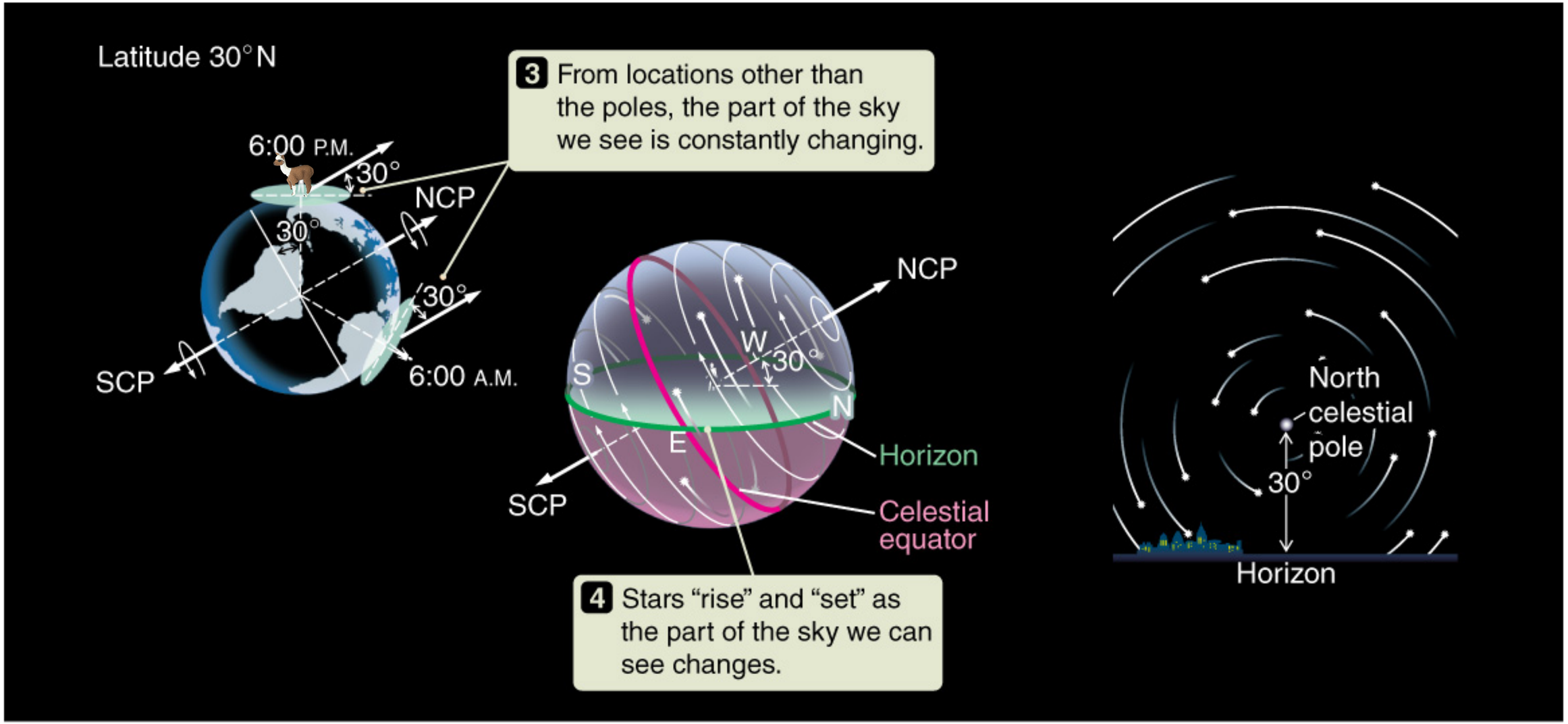


From the North Pole looking directly overhead, the **north celestial pole (NCP)** is at the zenith.

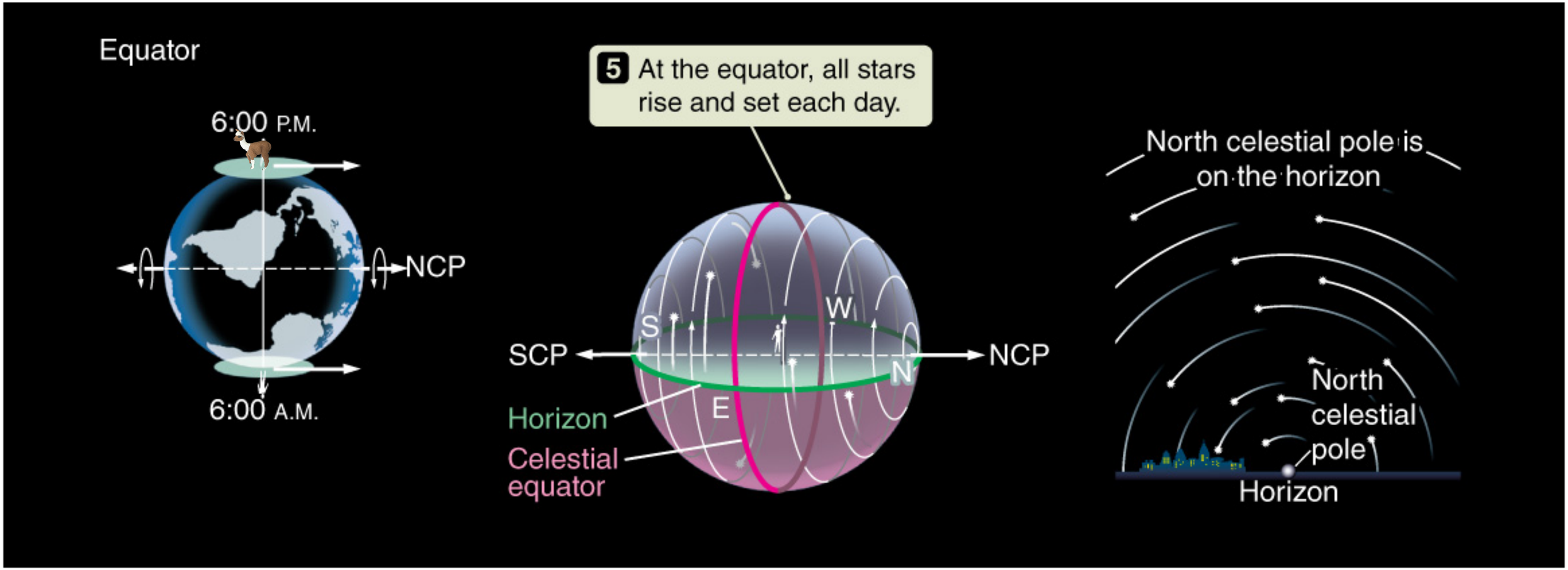
As Earth rotates, the stars appear to move in a counterclockwise direction around the **NCP**.

From the North Pole, you always see the same half of the sky.

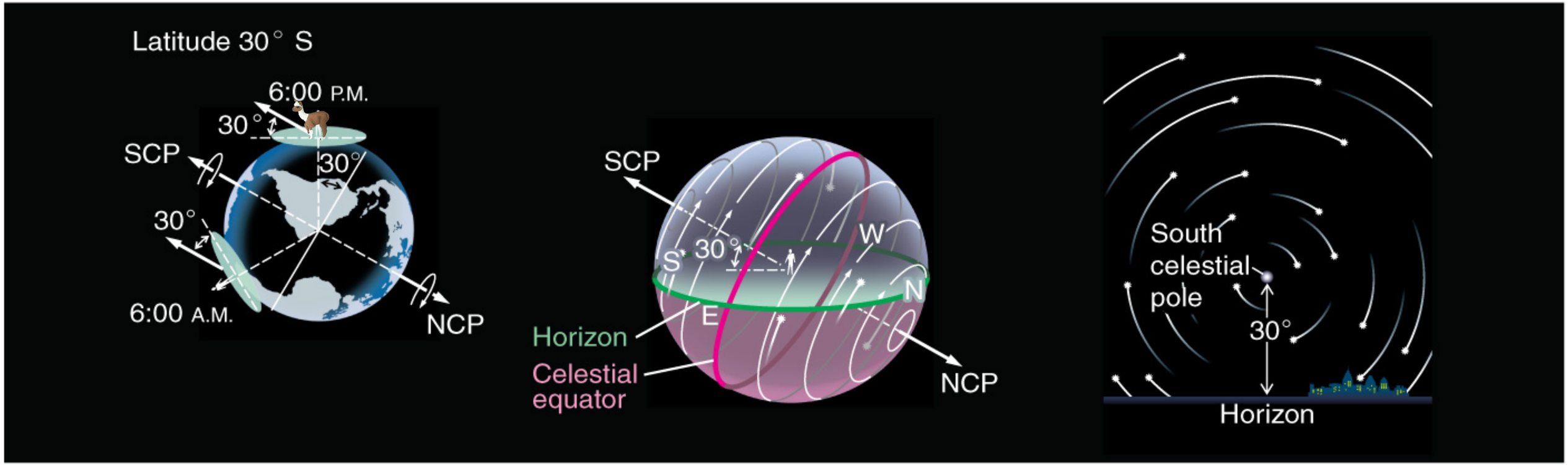
If you're 30 degrees north of the equator:



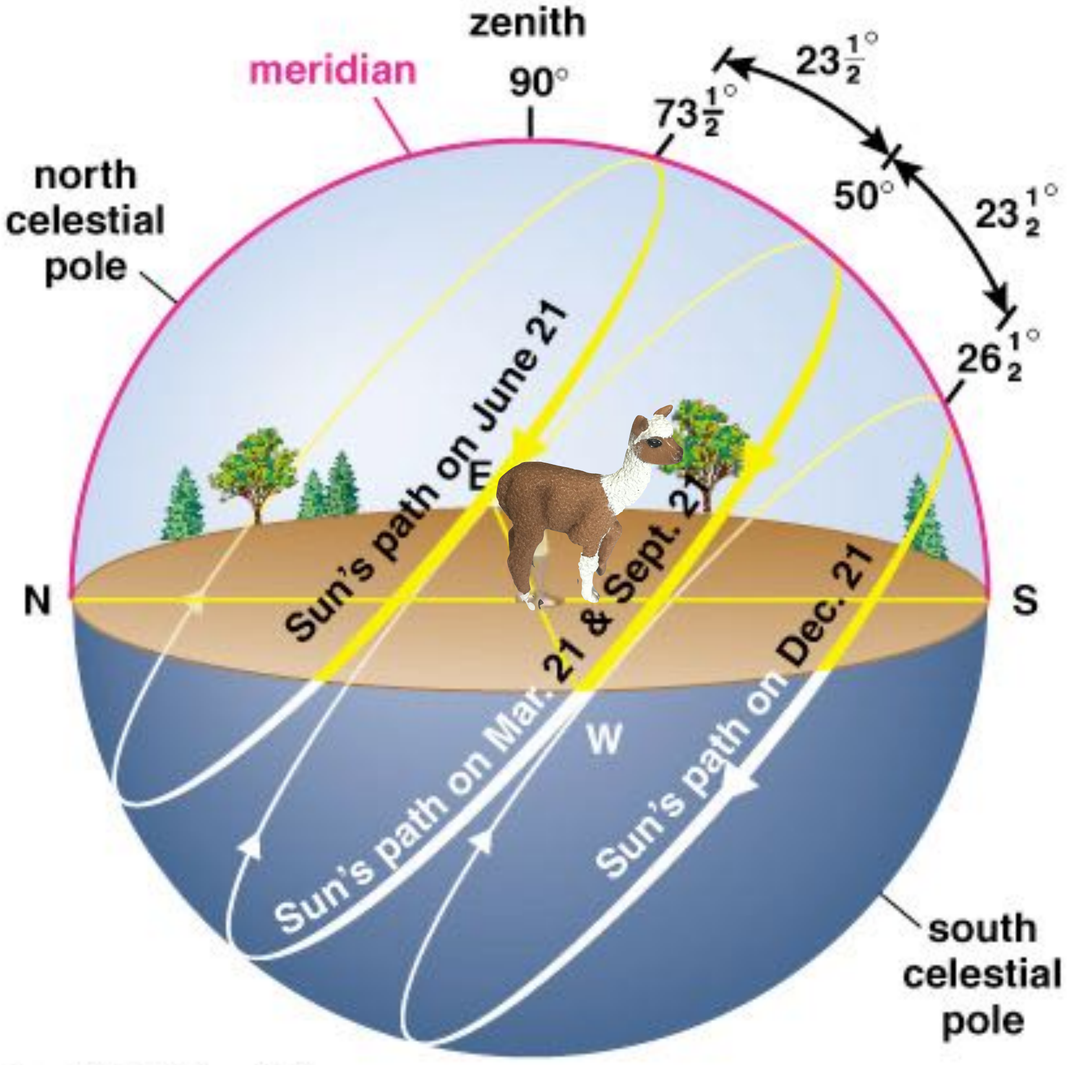
At the Equator, where you can see the entire sky:

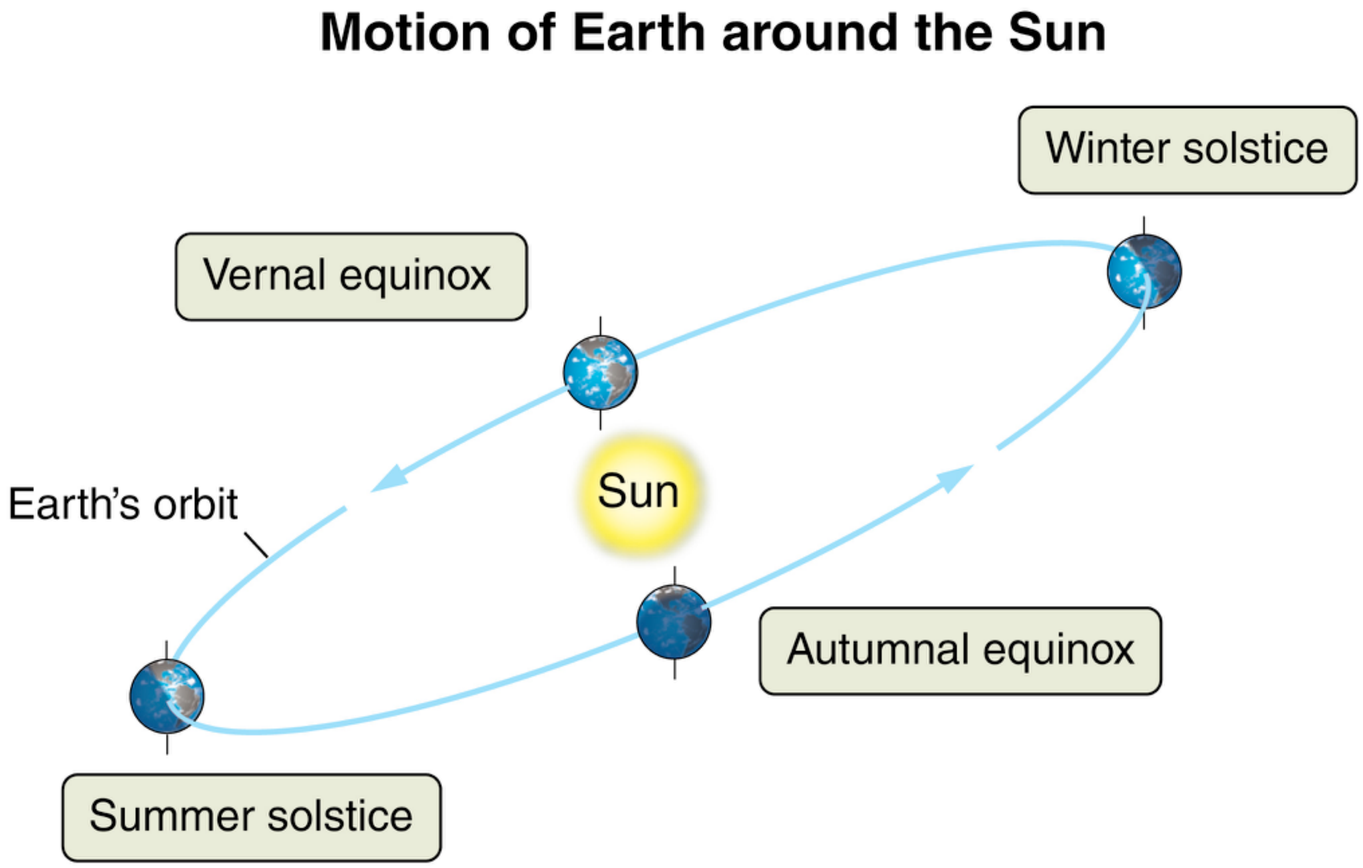


Southern Hemisphere, same as in the north but relative to the South Celestial Pole



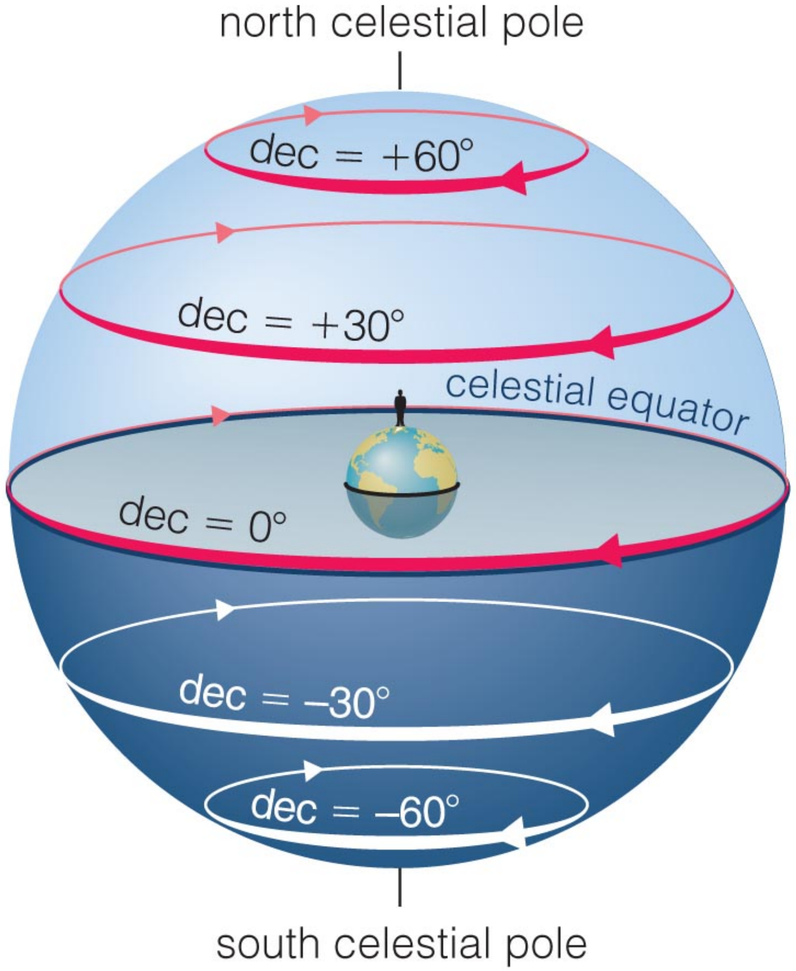
Max altitude of the Sun determined by where we are on Earth and where the Earth is in its orbit

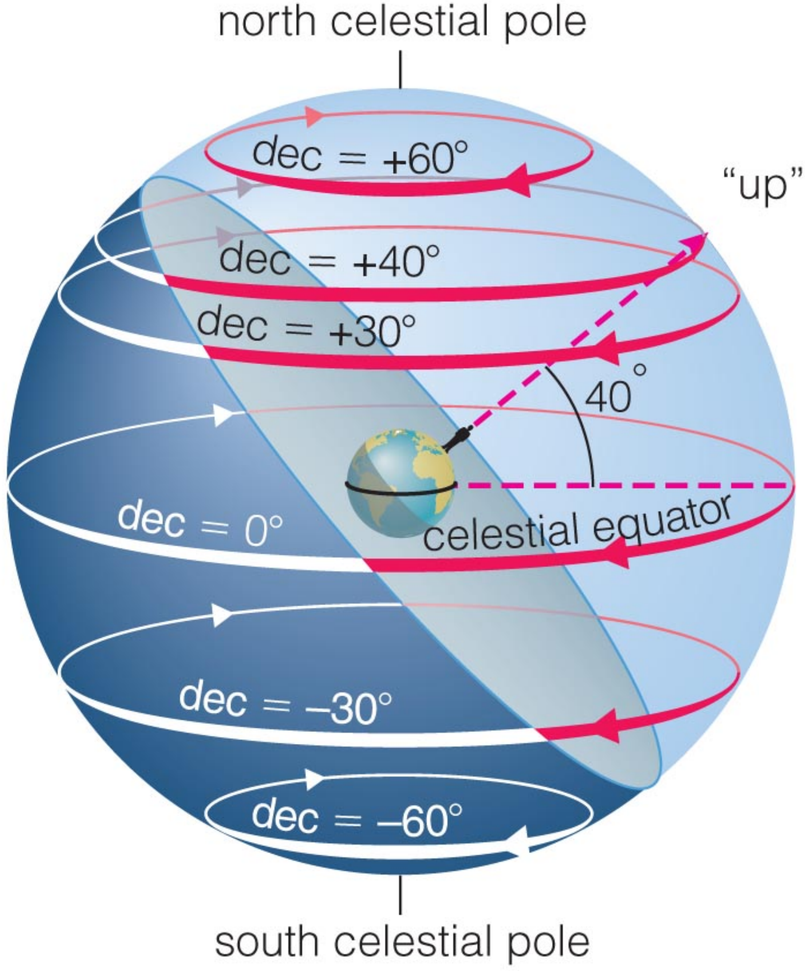




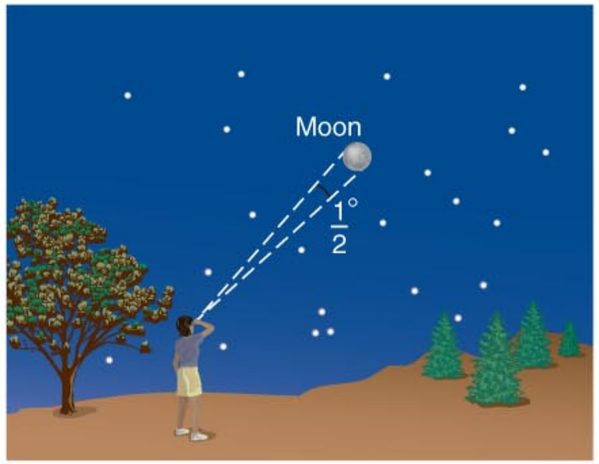
http://www.youtube.com/watch?v=Xm_Cn8-DCNc

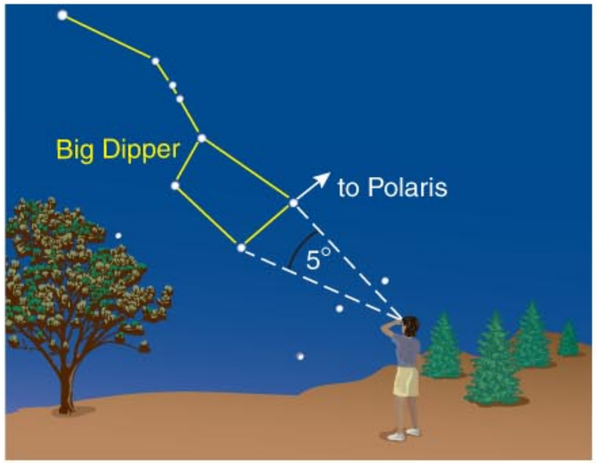
Right Ascension & Declination

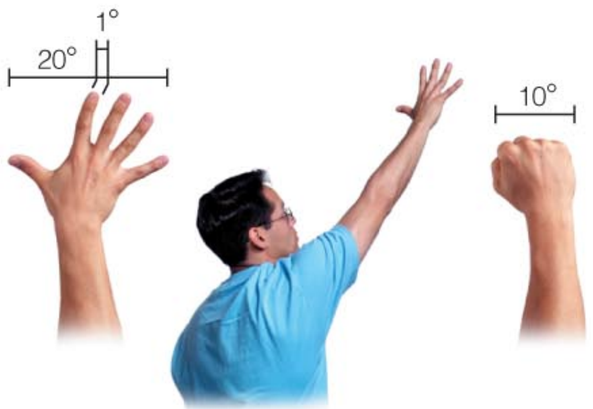




Angular Sizes / Distances on the Celestial Sphere



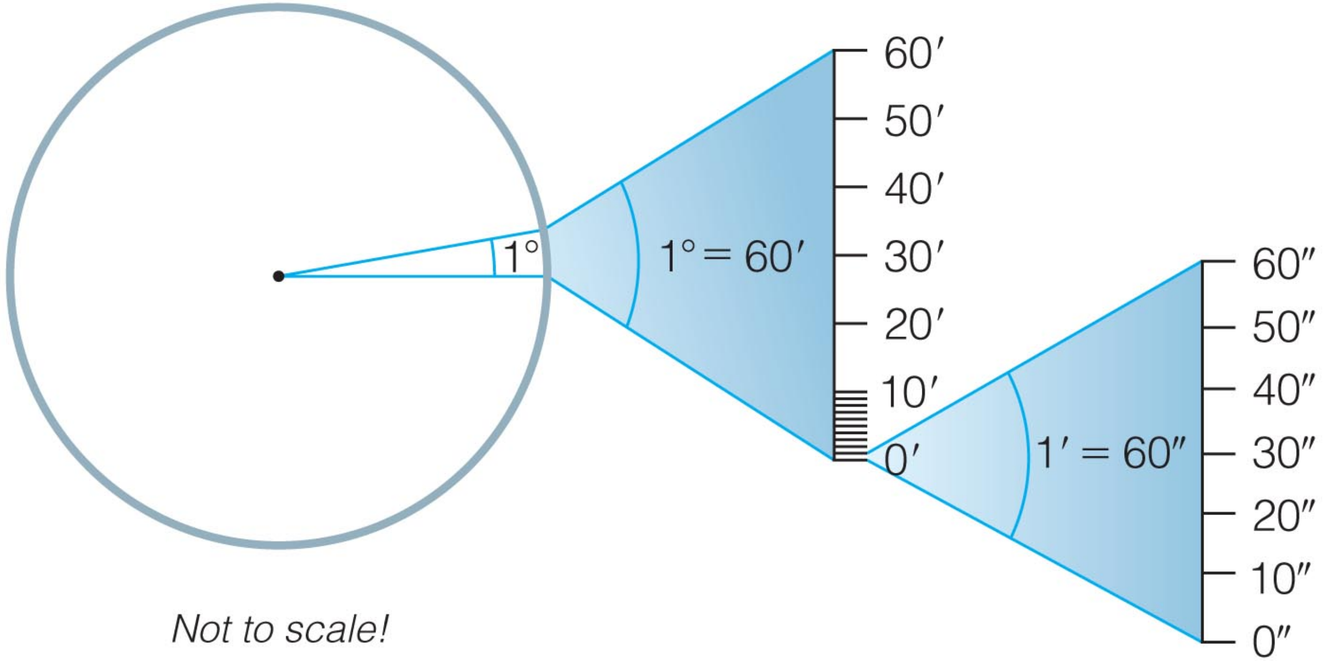




Stretch out your arm as shown here.

<u>Right Ascension</u>

- tells time, marking when stars cross an Hour Angle of 0^h
- can be quoted either in degrees or hours/minutes/seconds where $24^h = 360^o$
- differences of RA DO NOT correspond to angular differences except when Dec = 0^o

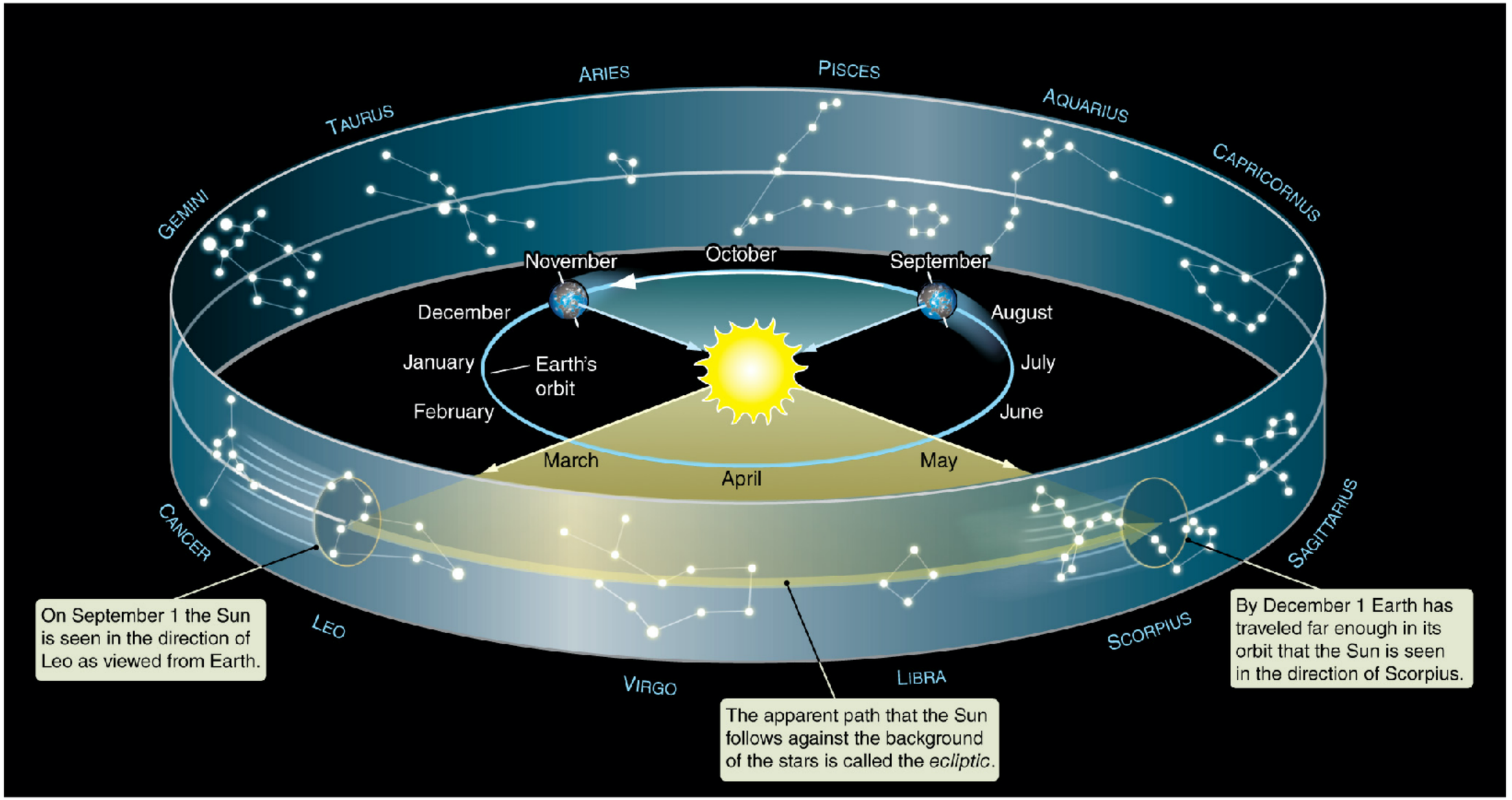


Not to scale!

If the Sun has an Hour Angle of $+3^h$, what time of year will the Sun set in 3 hours no matter your latitude on the Earth?

If the Sun has a declination of $+15^o$, where on the Earth is the Sun on the horizon no matter its Hour Angle?

The Ecliptic: Sun's path on the Celestial Sphere



The Ecliptic

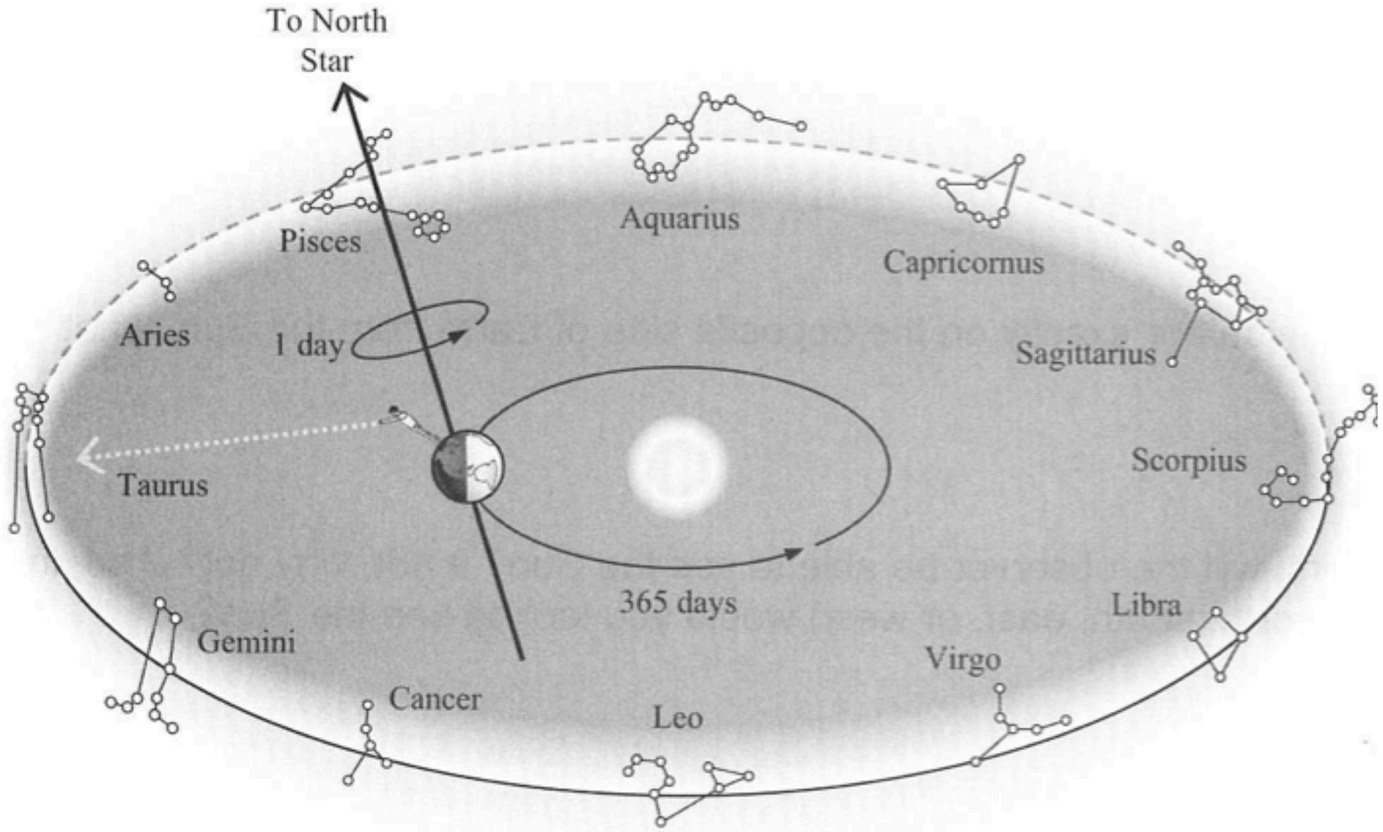


Figure 1

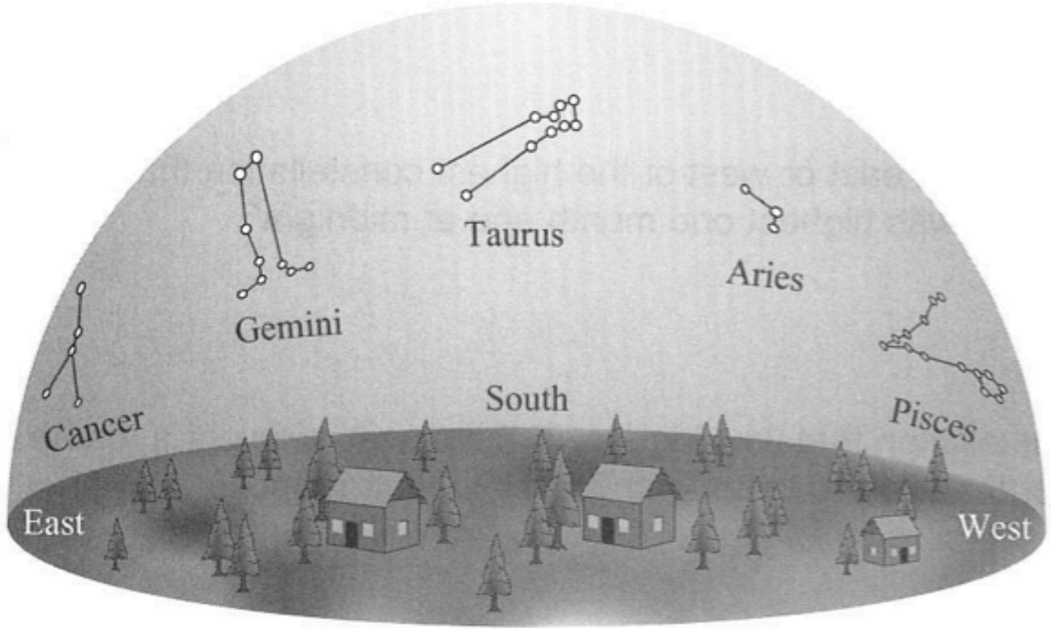
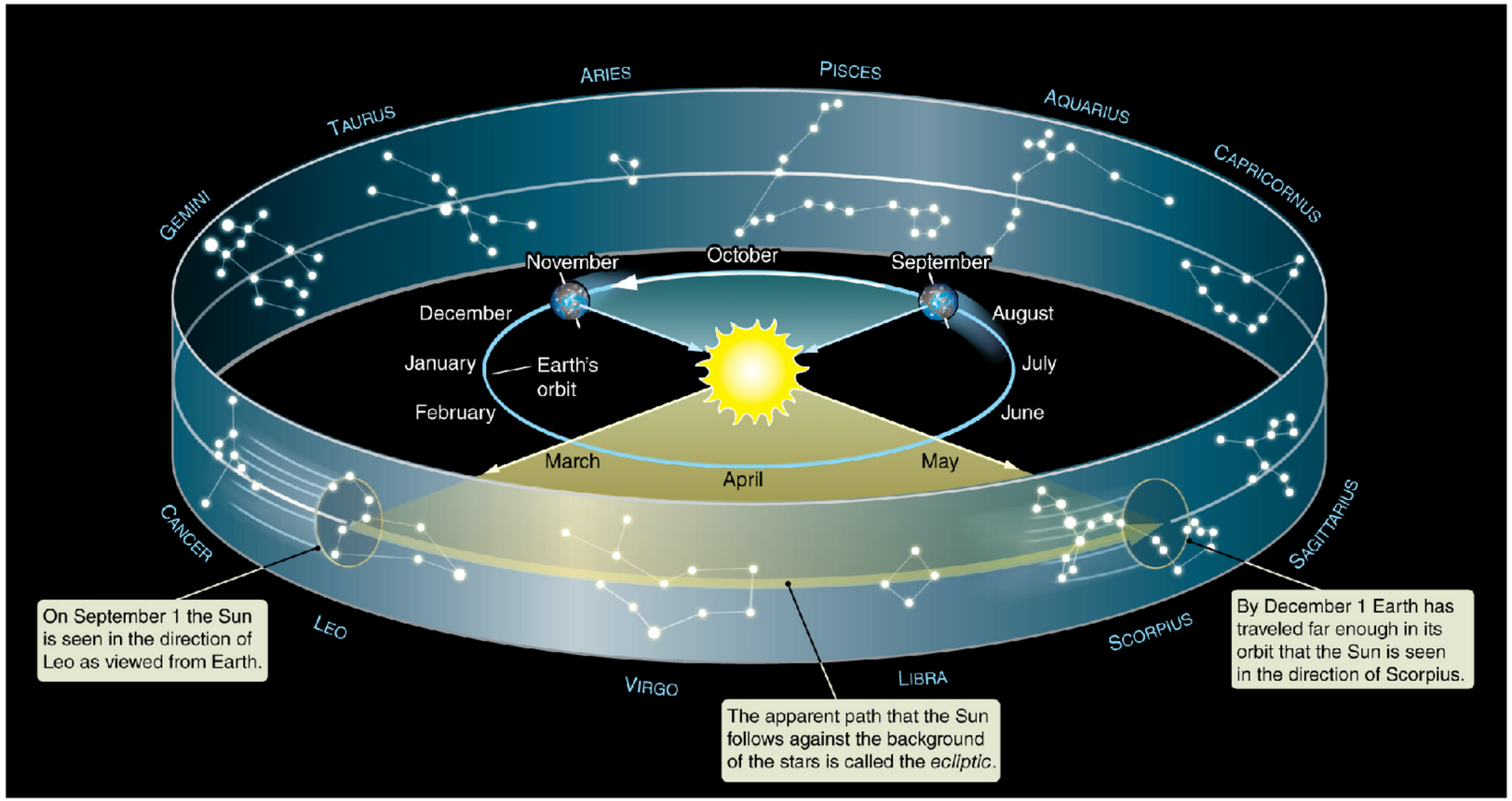


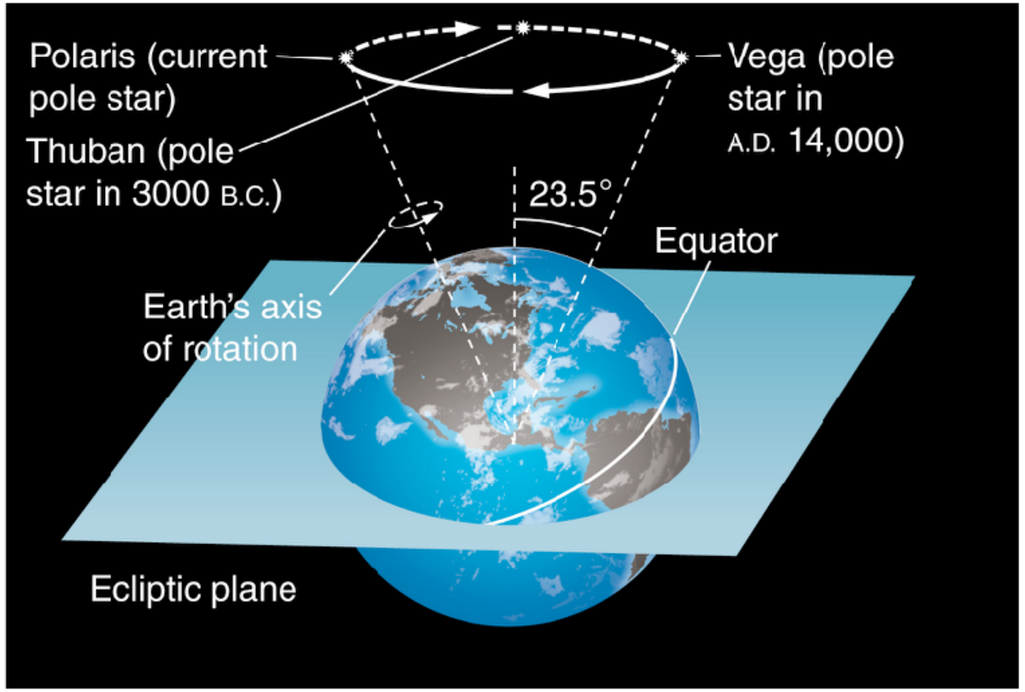
Figure 2

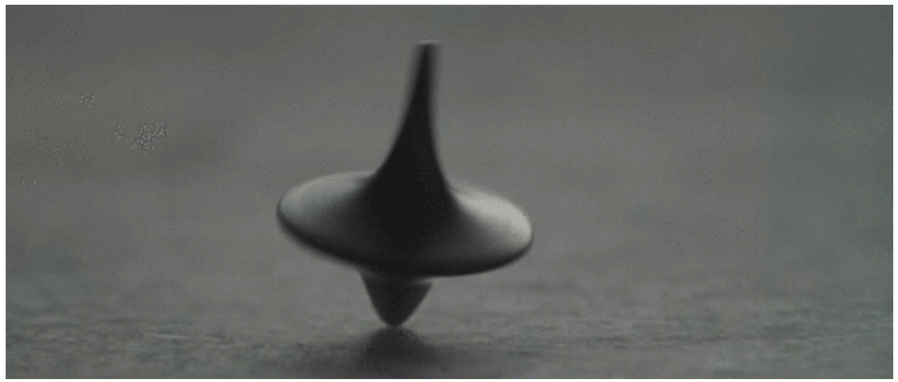
Hey you, what's your sign?

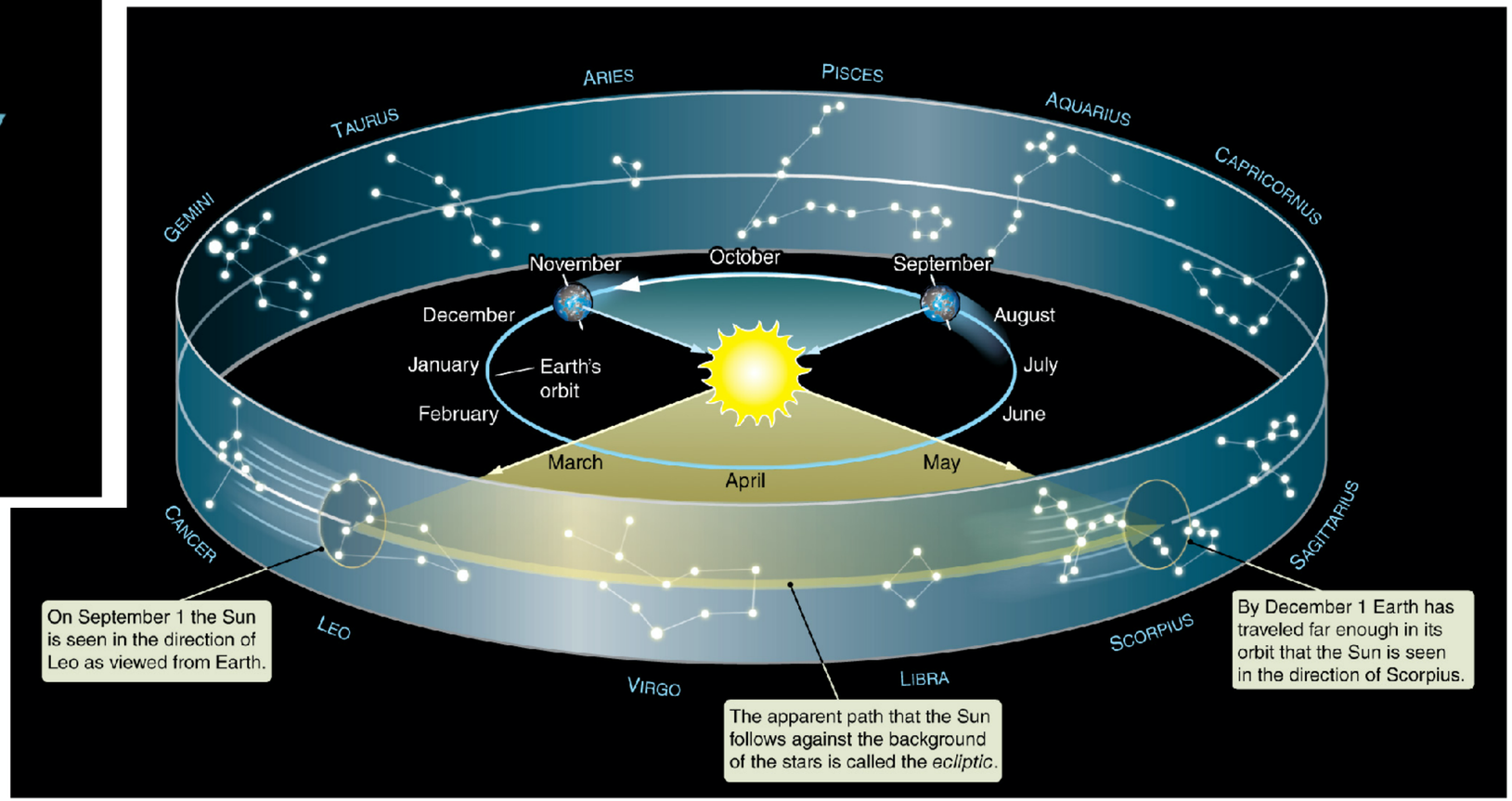
Astrology is bunk!



Earth's axis wobbles like a top: called Precession







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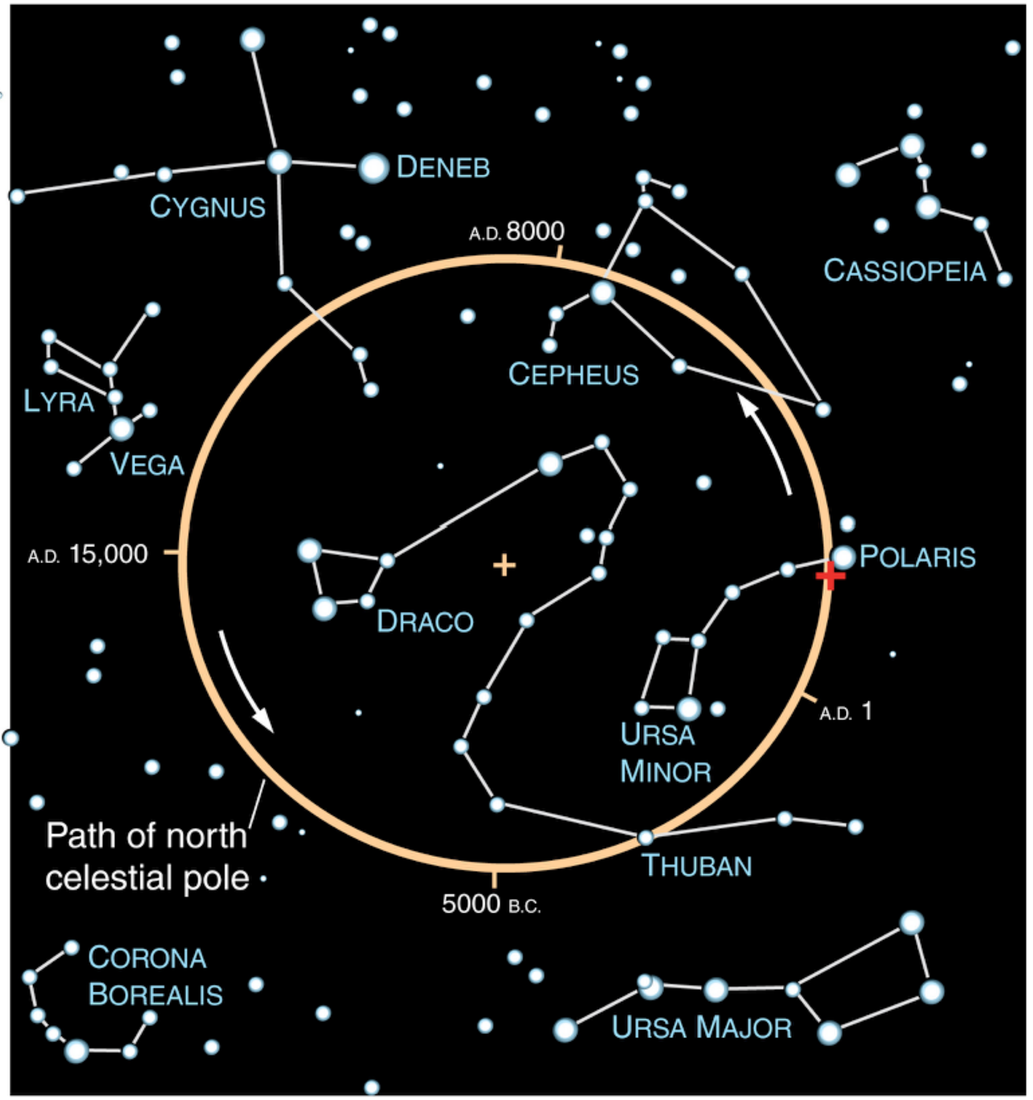
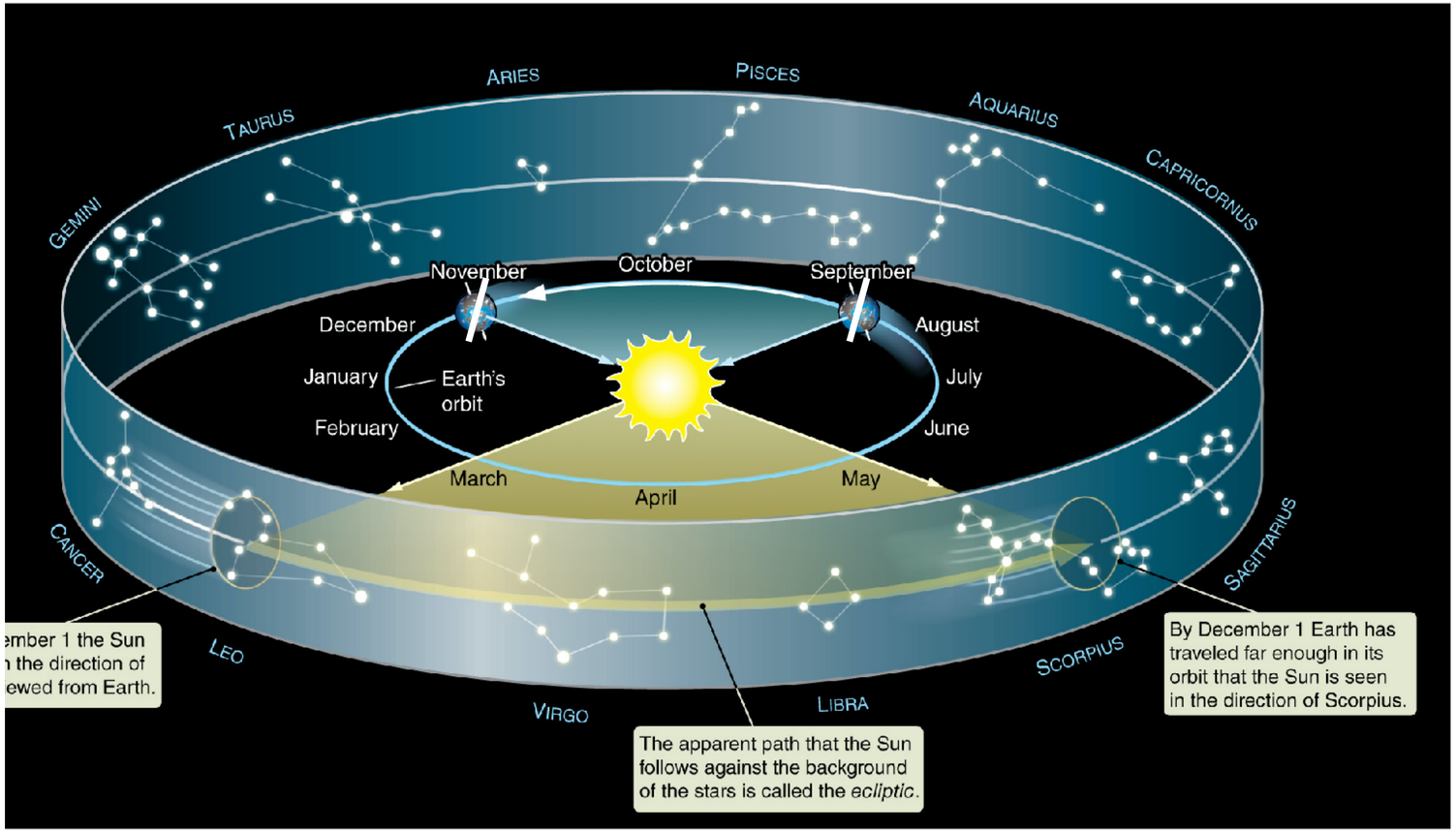




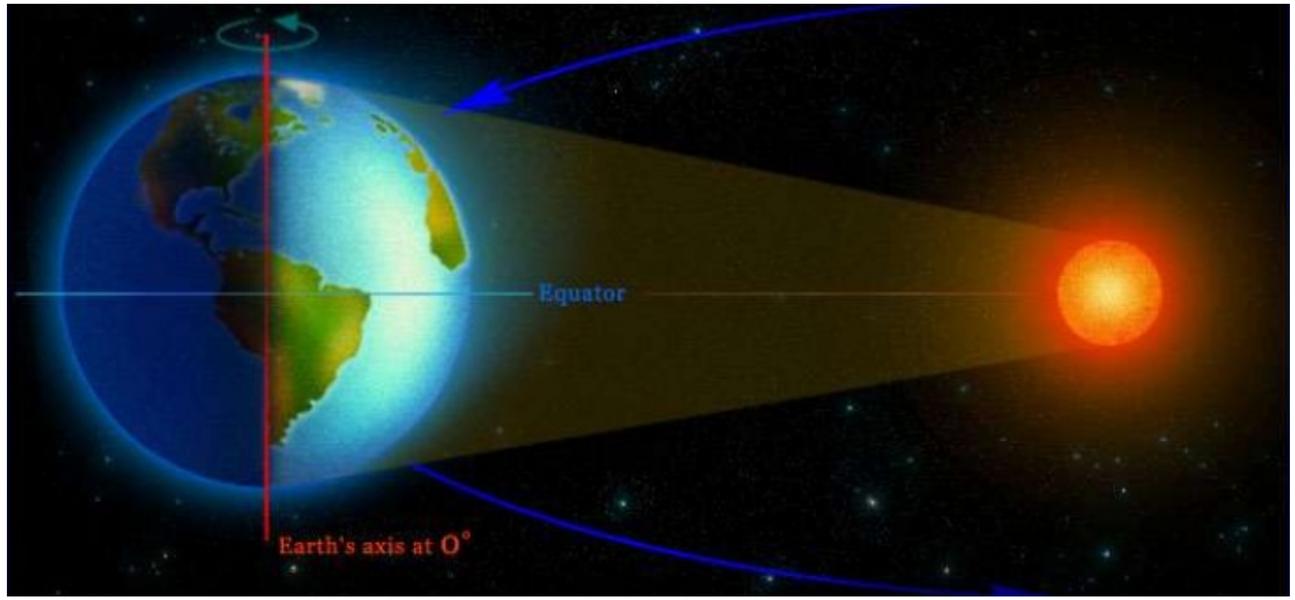
Because of precession, the RA & Dec of a star are always changing!

To keep sane, astronomers use coordinates from a particular time, referred to as the Epoch; at present, we use Epoch J2000, the RA/Dec objects had at midnight on January 1st, 2000.

To actually locate a star or object when observing, the coordinates must be “precessed”.

This “precession of the equinoxes” has a rate of ~50” per year (modest optical telescopes tend to have angular resolutions of ~1” and fields of view of a few arcminutes across, so this rate is quite significant!

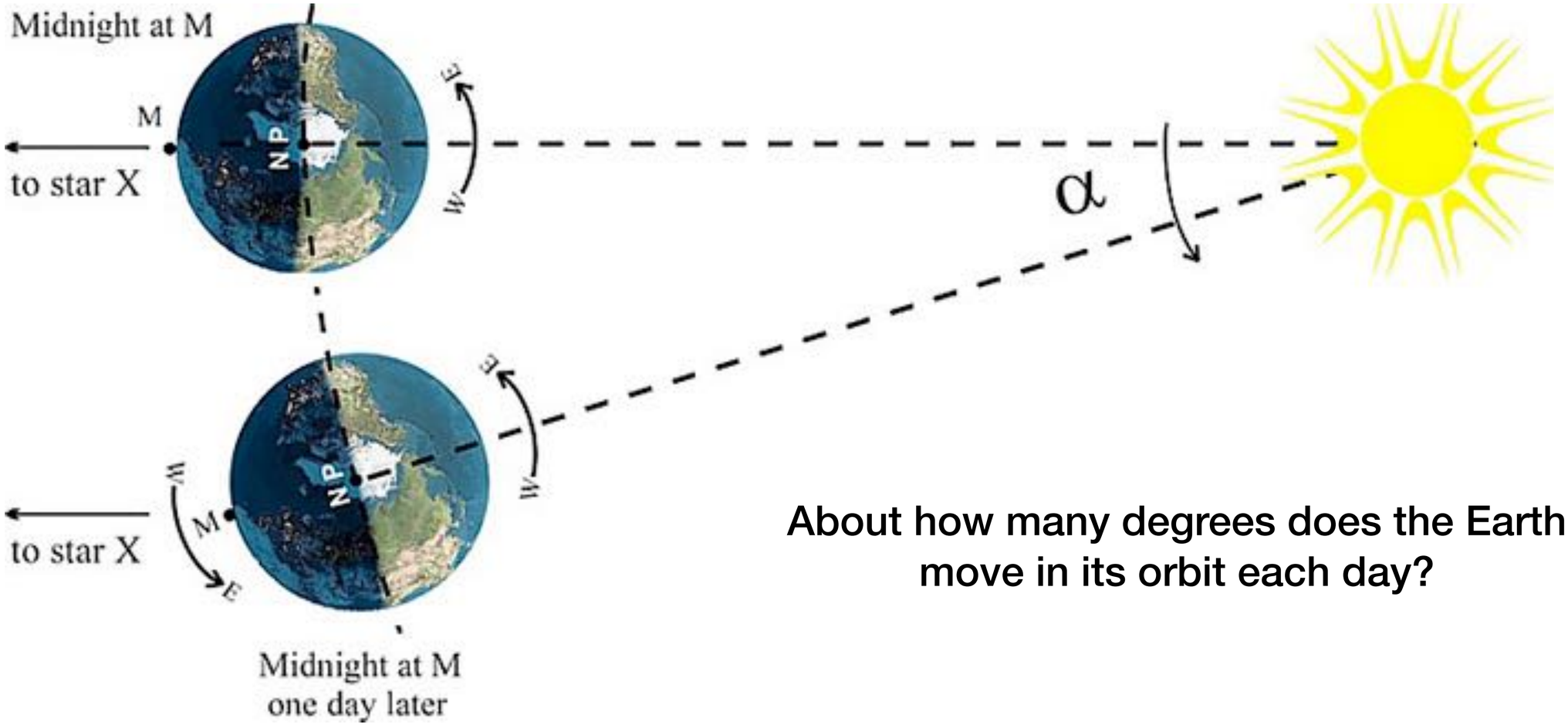
Imagine that a team of highly advanced -- but extremely mischievous aliens -- has changed the tilt of Earth's rotation axis, relative to its orbital plane, from 23.5° to 0°.



Which of the following features of the celestial sphere would be altered? How?

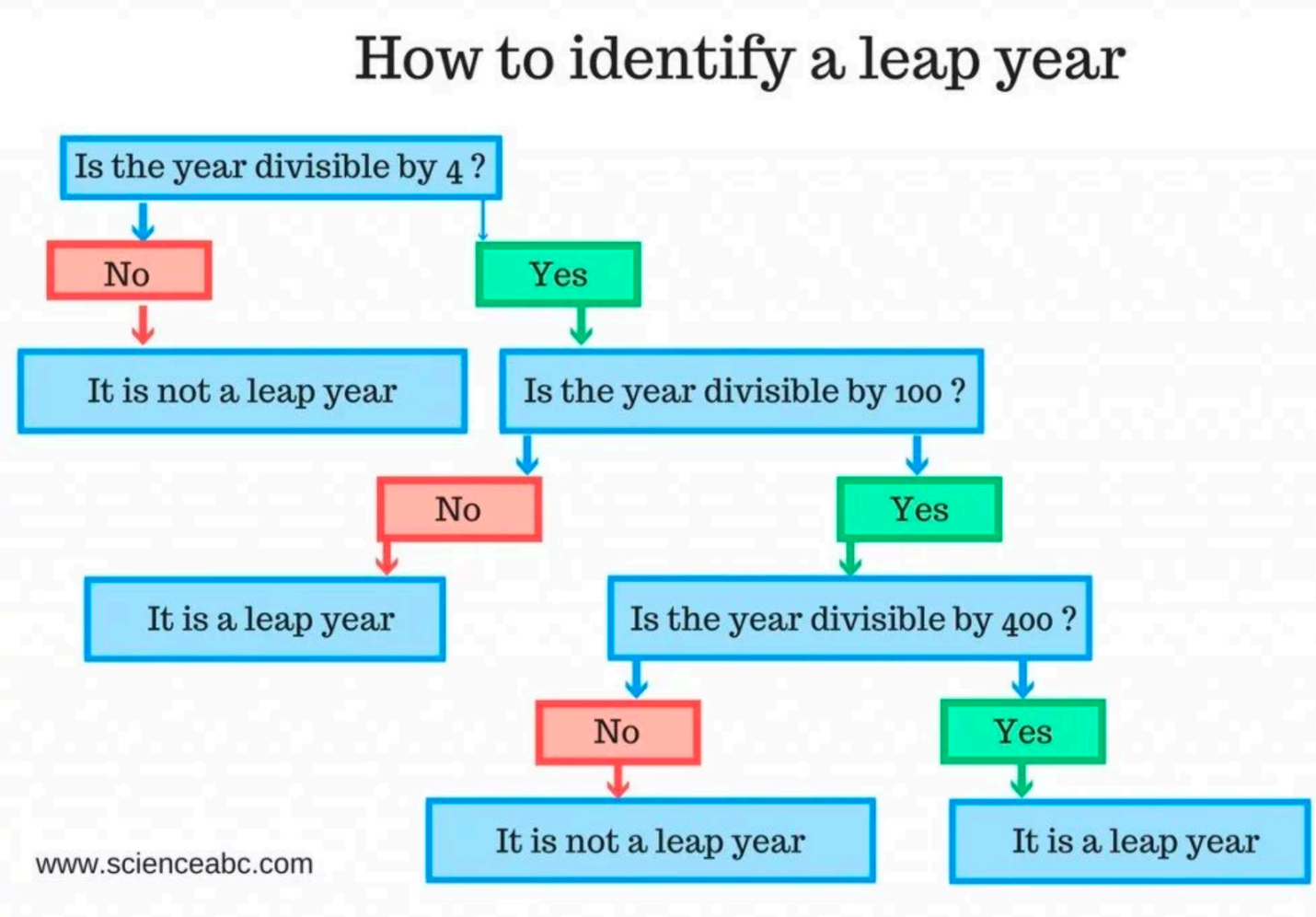
A. local altitude of the North Celestial Pole
B. the constellations along the ecliptic
C. length of the year
D. altitude of the Sun at noon on June 21st

Why star rise/set times change



About how many degrees does the Earth move in its orbit each day?

Calendars aren't trivial, because an orbit around the Sun takes 365.2422 days



Julian calendar was used for over 1000 years (leap day every 4 years). Every 400 years, the calendar is offset from the seasons by 3 more days.

Gregorian Calendar (what we use today)

Constellations aren’t that useful in practice though, because the sky is constantly “moving”

VSauce: How the Earth Moves

https://www.youtube.com/watch?v=IJhgZBn-LHg

Why isn’t there a solar eclipse every month?

Why do the Sun and Moon appear to be the same size on the sky?

What causes precession (i.e., how is Earth's angular momentum able to change)?

What causes seasons?
What effects result from this cause that leads to colder/hotter temperatures?