



# **Astronomy 100**

**Section 2– MWF 1200-1300**  
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**Office Hours:**

**MTF 10:30-11:30 a.m. or by  
appointment**

# Class Web Page



Remember that you can access the syllabus, observing sheets, and homework through the class website.

<http://eeyore.astro.uiuc.edu/~lwl/classes/astro100/fall03/>



# Outline

- Celestial sphere
  - To help visualize both diurnal and yearly motions
- The Sun's motion on the Celestial Sphere
- Why do we have seasons?
- Why do we see phases of the moon?

# Motions in the Sky



Photograph from Mt.  
Kilimanjaro in Tanzania,  
Africa, which is at 3 Degrees  
South Latitude.

<http://www.danheller.com/images/Africa/Tanzania/Kilimanjaro/Mountain/Slideshow/img15.html>

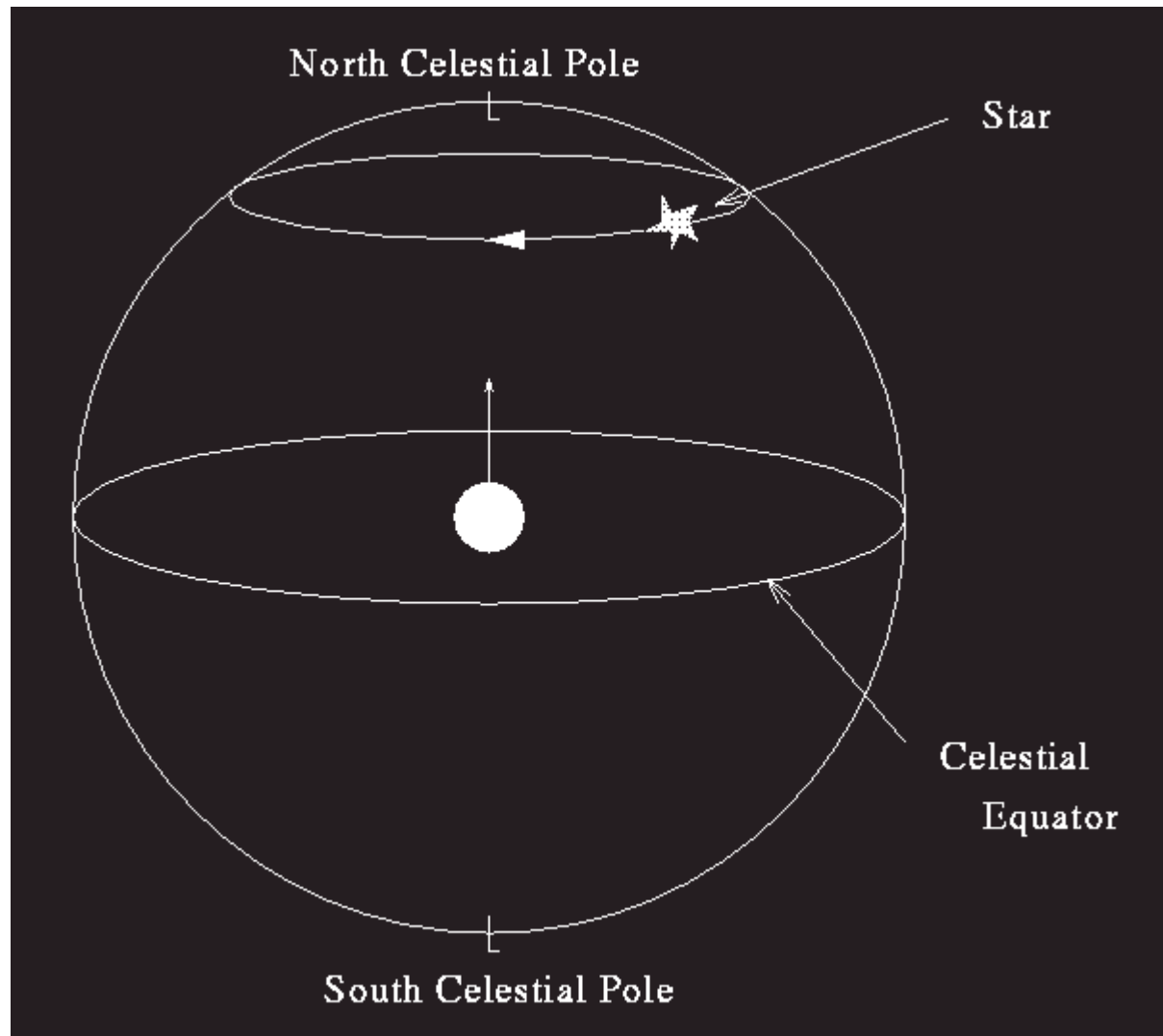
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# The Celestial Sphere



We set the diurnal data we have into a simple picture?

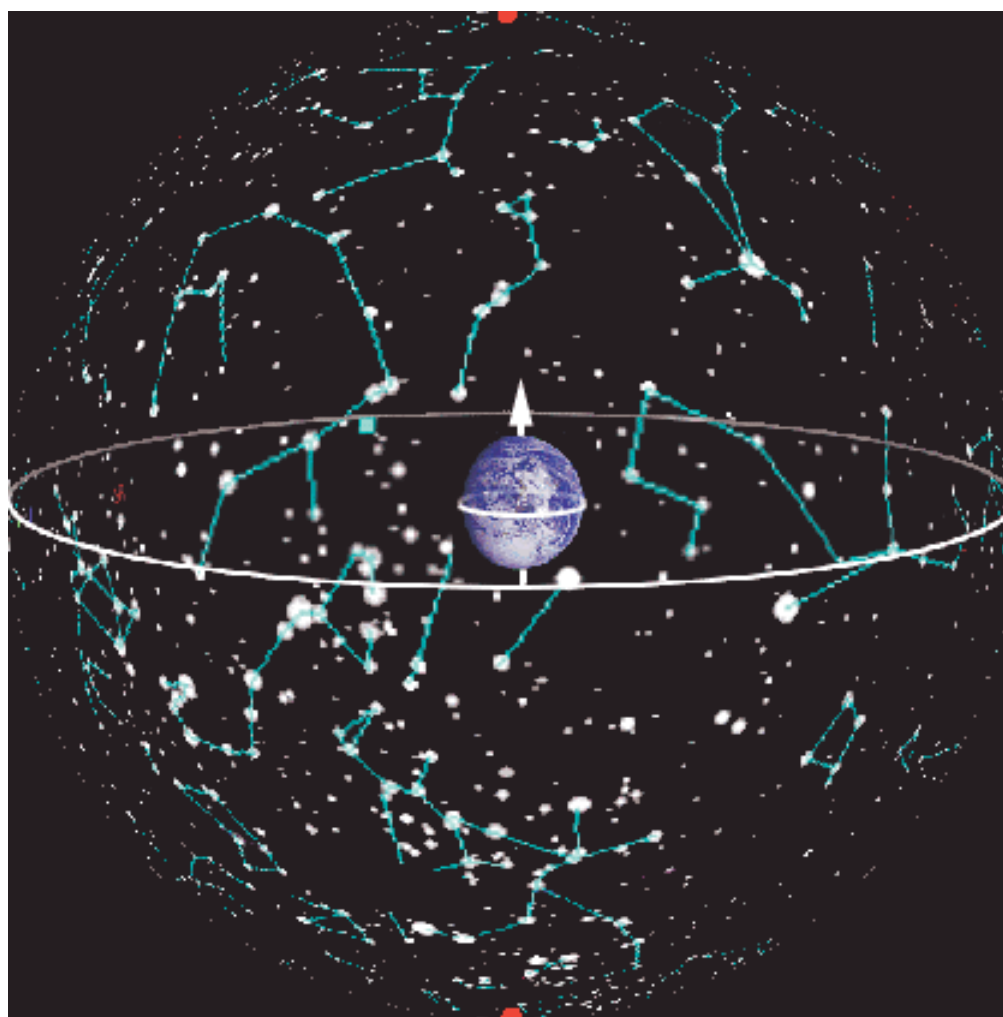


# The Celestial Sphere



Put all of the stars  
on a transparent  
globe.

- The Earth's North Pole is under the North Celestial Pole.
- The Earth's South Pole is under the South Celestial Pole.
- The Earth's equator is under the Celestial equator.



<http://www.astro.uiuc.edu/classes/archive/astr210/s02/Images/spheroid1.gif>

# Earth's Orbit around the Sun



- The picture changes a little when we add the Earth's annual trip around the Sun.
- Takes slightly more than 365 days to orbit the Sun, this sets the length of a year.
  - Really it's approximately 365.2425 days
  - Leap Year! Ensures that first day of Spring, etc. happens on same day each year.
  - Modern system is called Gregorian Calendar for leap year determination

# Obvious Differences



Look at the sky every night at the same time and you will eventually realize that the constellations are slightly different each night and the Sun is in a different place each day when observed at the same time.





# Question:

If we take a picture of the Sun everyday at 9:00 AM, what will the photograph look like?

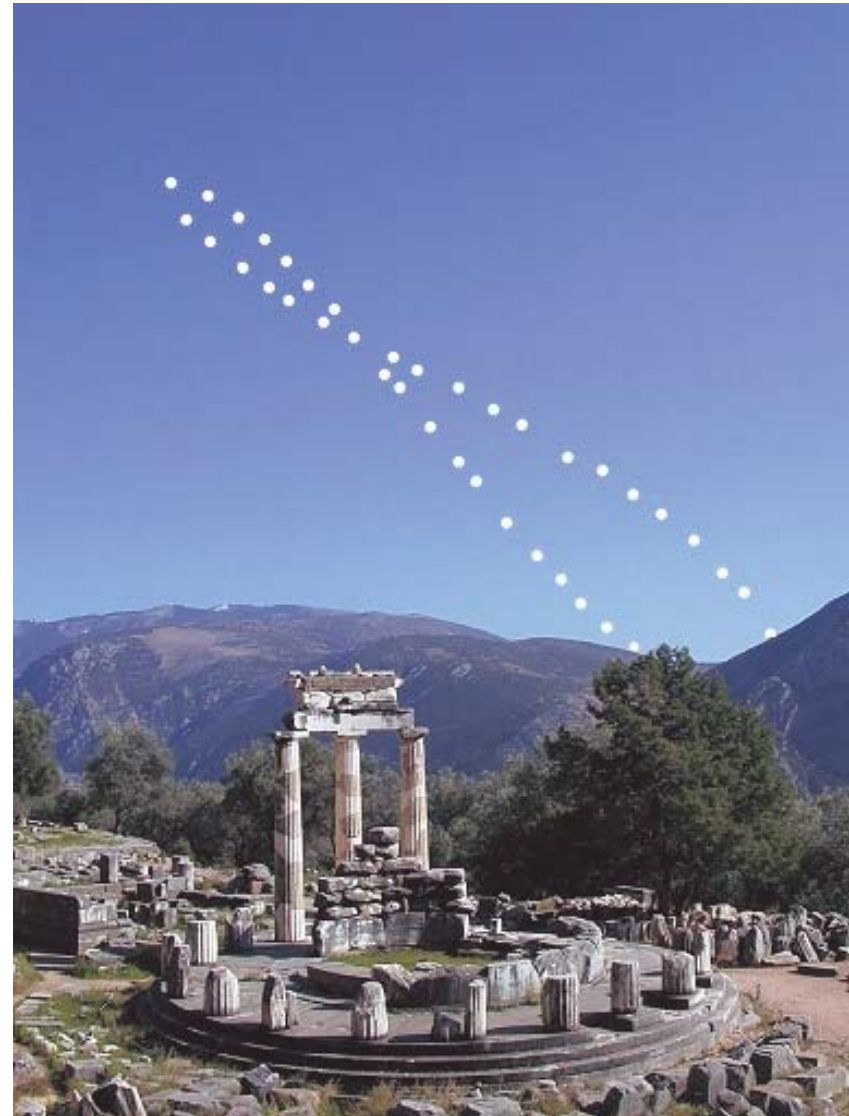
1. As long as the Daylight savings time is taken into account, the Sun will be in the same position.
2. As the Earth has a tilt, the Sun will make a funky looped pattern.
3. As the Sun's height varies with time of year, the Sun will make a vertical line.



# Lazy Year: Watching the Sun “Move”

If you take photographs of the Sun at the same time, you’ll see the analemma shape.

Now that we have this physical data, let’s try to understand why this happens.



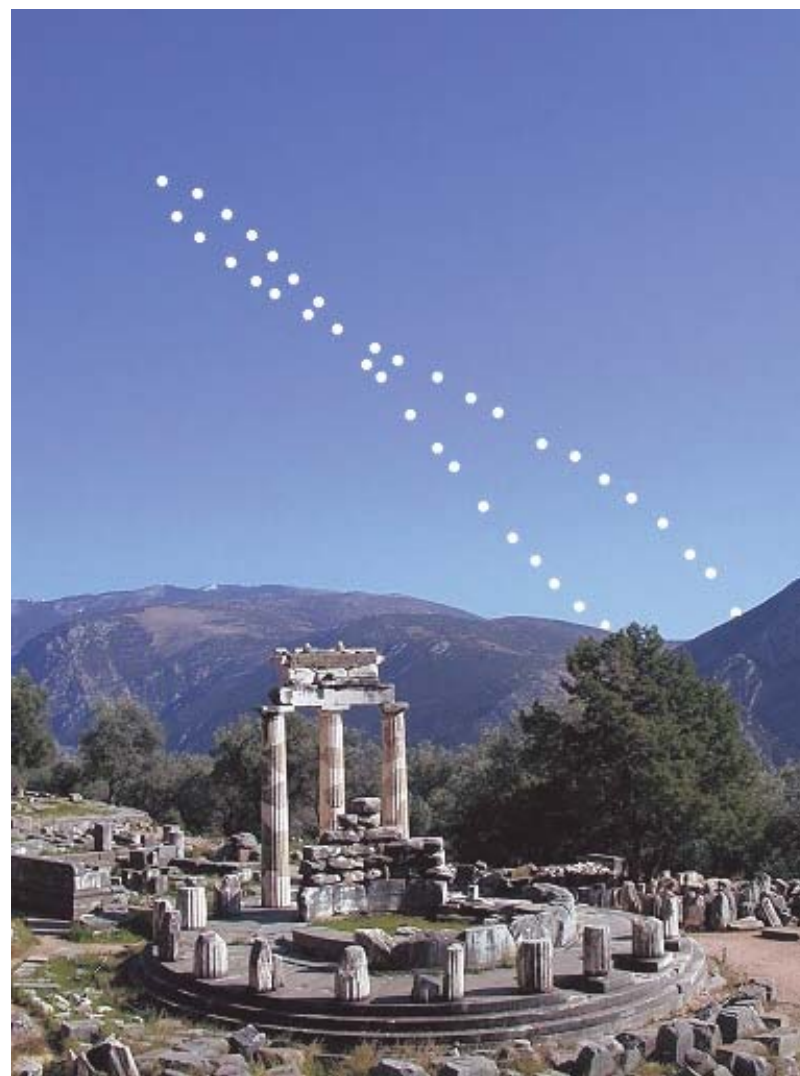
# Watching the Sun Move



If the Earth's orbit was circular and not tilted, the Sun would be in the same spot every day.

The picture shows that at the highest point the sun is above the celestial equator by 23.5 degrees (late June) and at the lowest point below by 23.5 degrees (late December).

So, the fact that the Sun's location is not fixed indicates that the Earth's Orbit is tilted— in fact we know it is tilted by 23.5 degrees with respect to its orbit around the Sun.

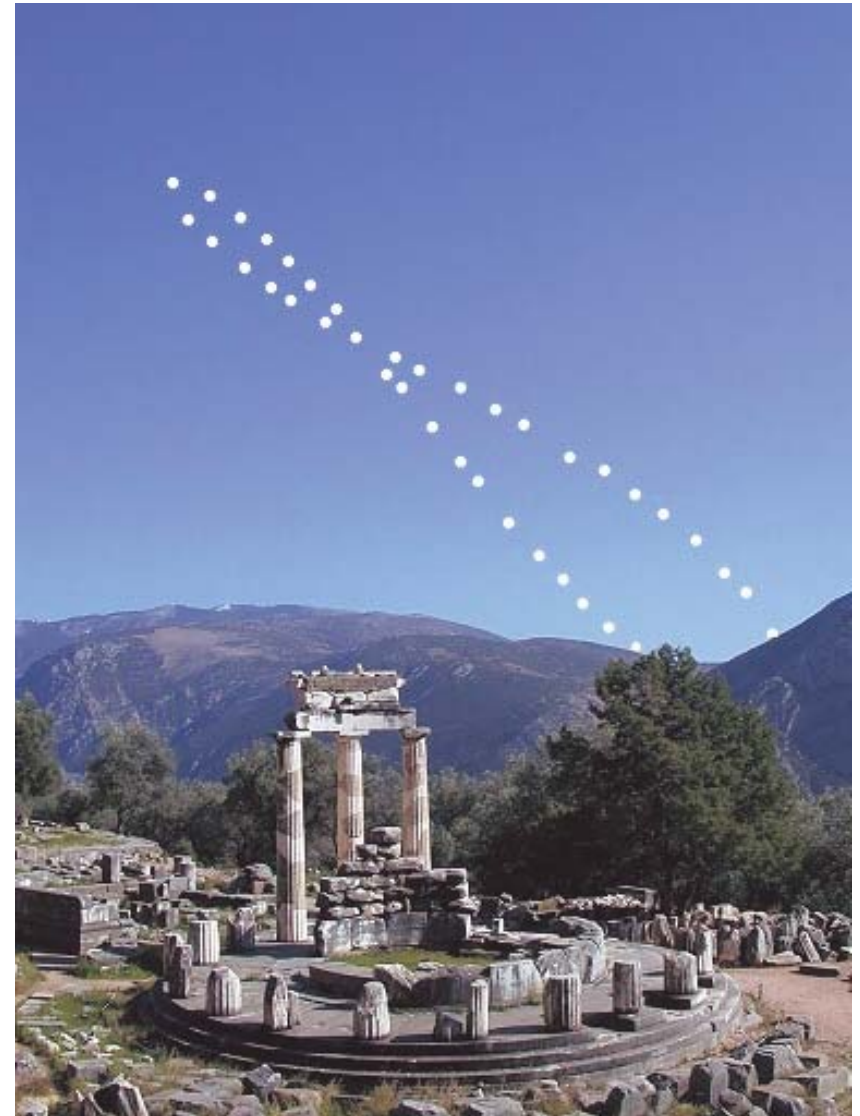


# Watching the Sun Move

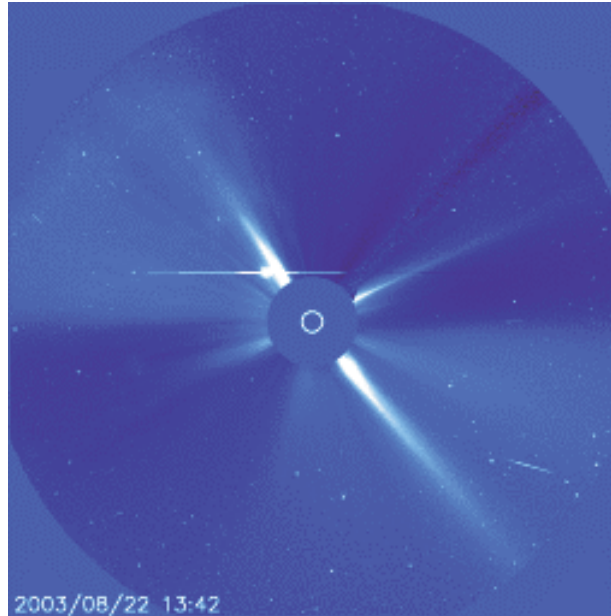


BUT, where does the funky figure 8 shape come from?

As the orbit is tilted, the Sun is usually a little ahead or a little behind clock time, so that causes a small “time” shift in the the shape. And if the Earth’s orbit was circular the loops would be equal lengths.



# And the Sun “Moves”



Last week's data of the Solar Corona from SOHO. Even over a few hours, one can see that the Sun is moving with respect to the stars.



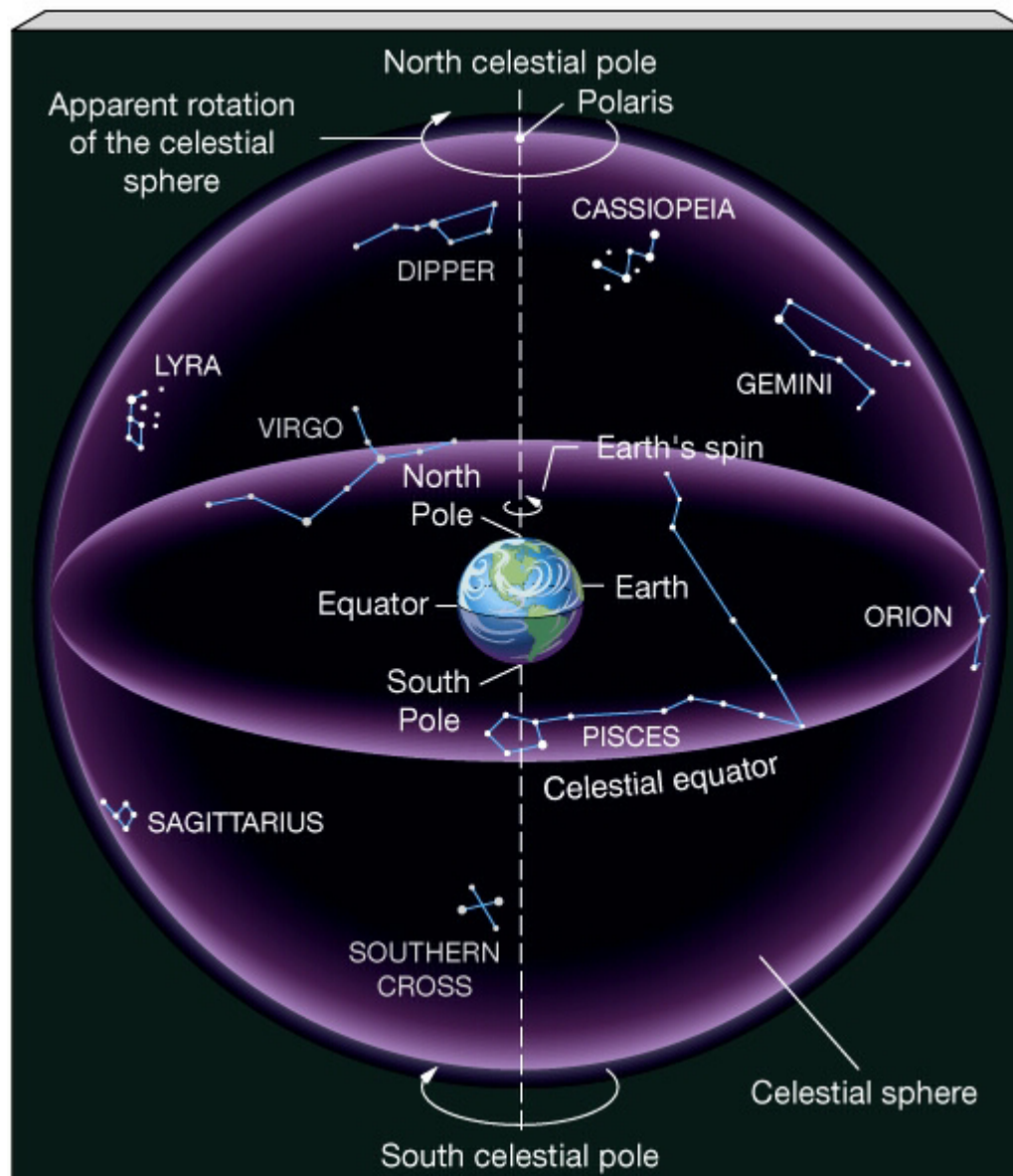
# The Ecliptic

If you could see the stars in the daytime, and you could plot the Sun's location on the celestial sphere, what would it look like?

[http://planck.phys.uwosh.edu/mike/exercises/anim/ecliptic\\_movie  
.mov](http://planck.phys.uwosh.edu/mike/exercises/anim/ecliptic_movie.mov)

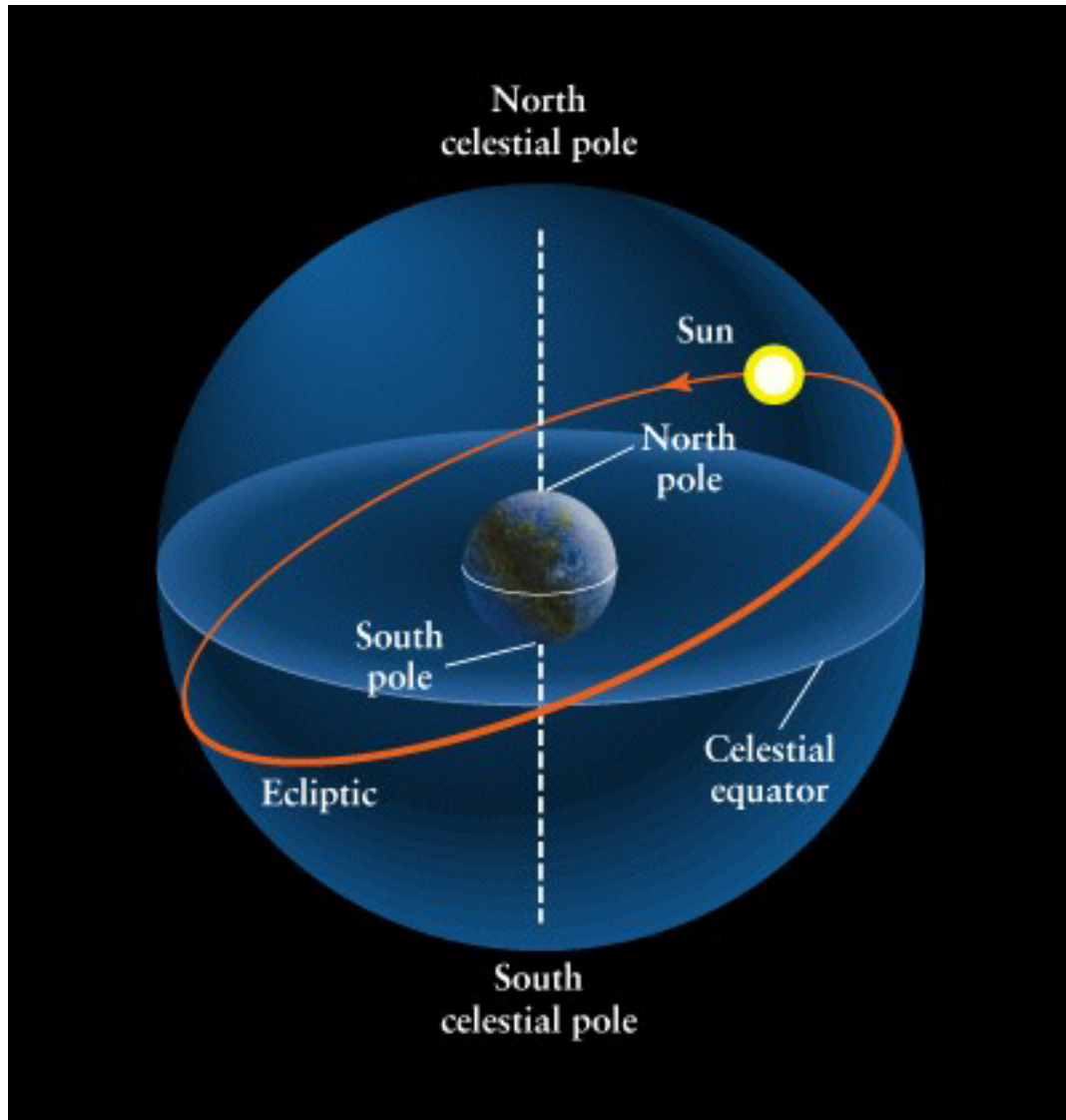


We know  
the celestial  
sphere.



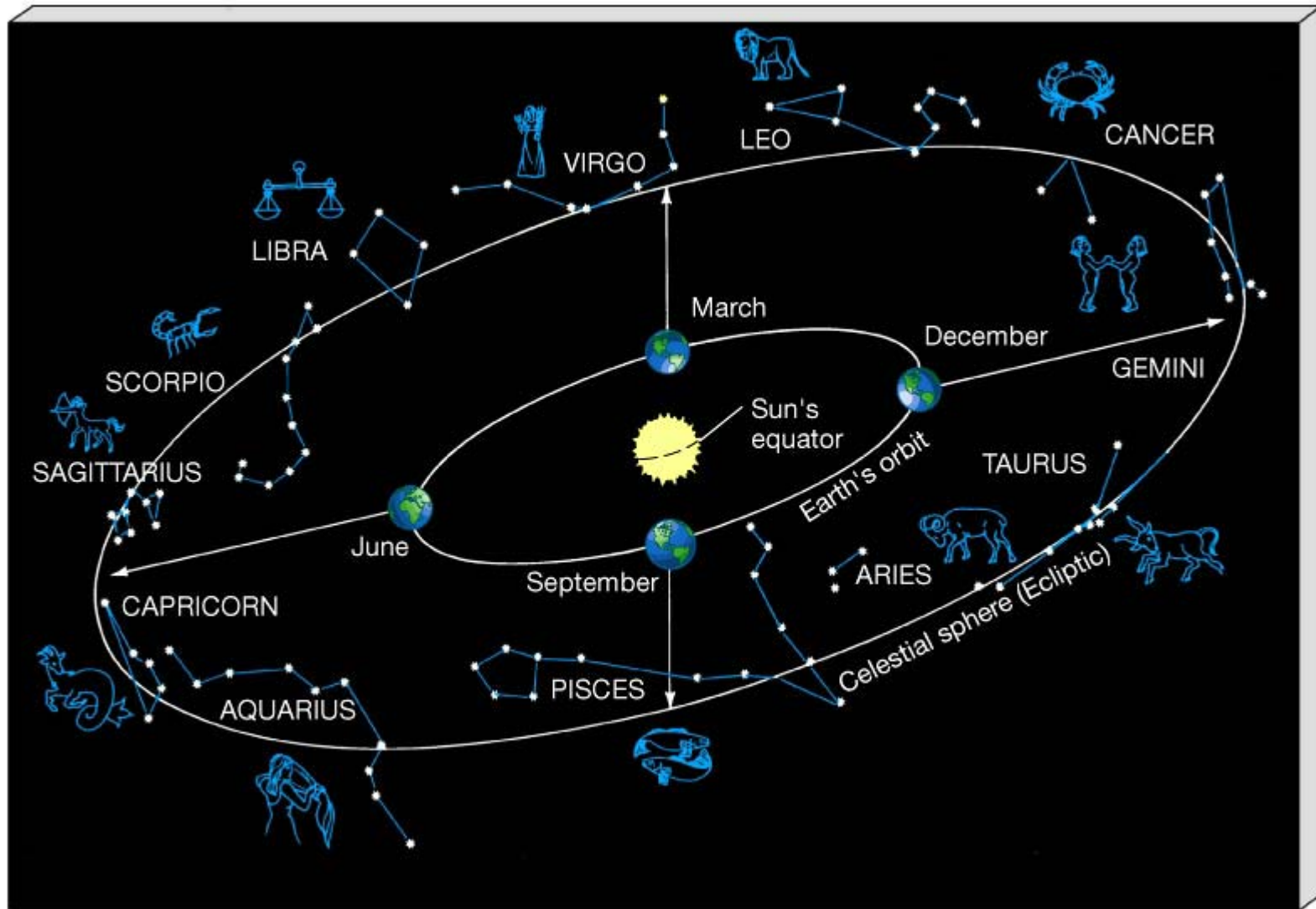


Now, we can add the ecliptic-- where the Sun “moves” throughout the year.





# Ecliptic Defines the Zodiac





# The Real Zodiac

**Table 1-1**  
The 13 Constellations of the Zodiac

Constellation	Dates of Sun's Passage Through
Pisces	March 13–April 20
Aries	April 20–May 13
Taurus	May 13–June 21
Gemini	June 21–July 20
Cancer	July 20–August 11
Leo	August 11–September 18
Virgo	September 18–November 1
Libra	November 1–November 22
Scorpius	November 22–December 1
Ophiuchus	December 1–December 19
Sagittarius	December 19–January 19
Capricorn	January 19–February 18
Aquarius	February 18–March 13

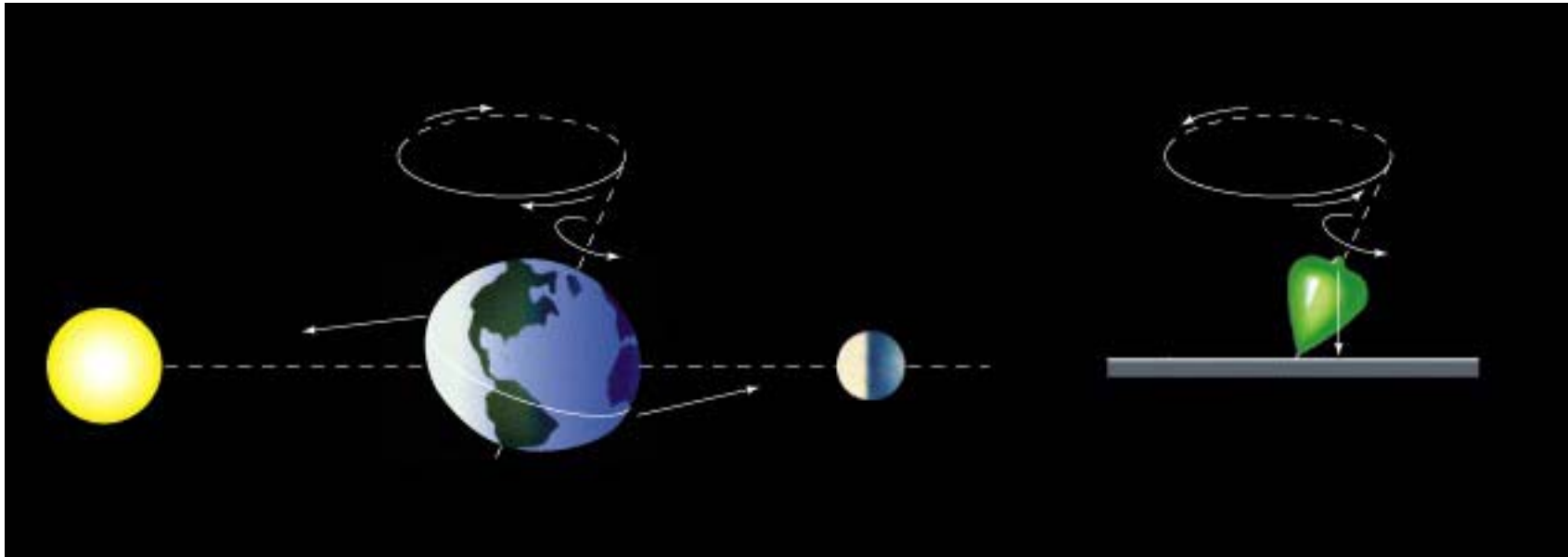
# Polaris is not always the North Star



As the Earth spins it also slightly wobbles slowly. This wobble takes 26,000 years. This wobble is called precession.



# Why?



It's like a spinning top.



# Question:

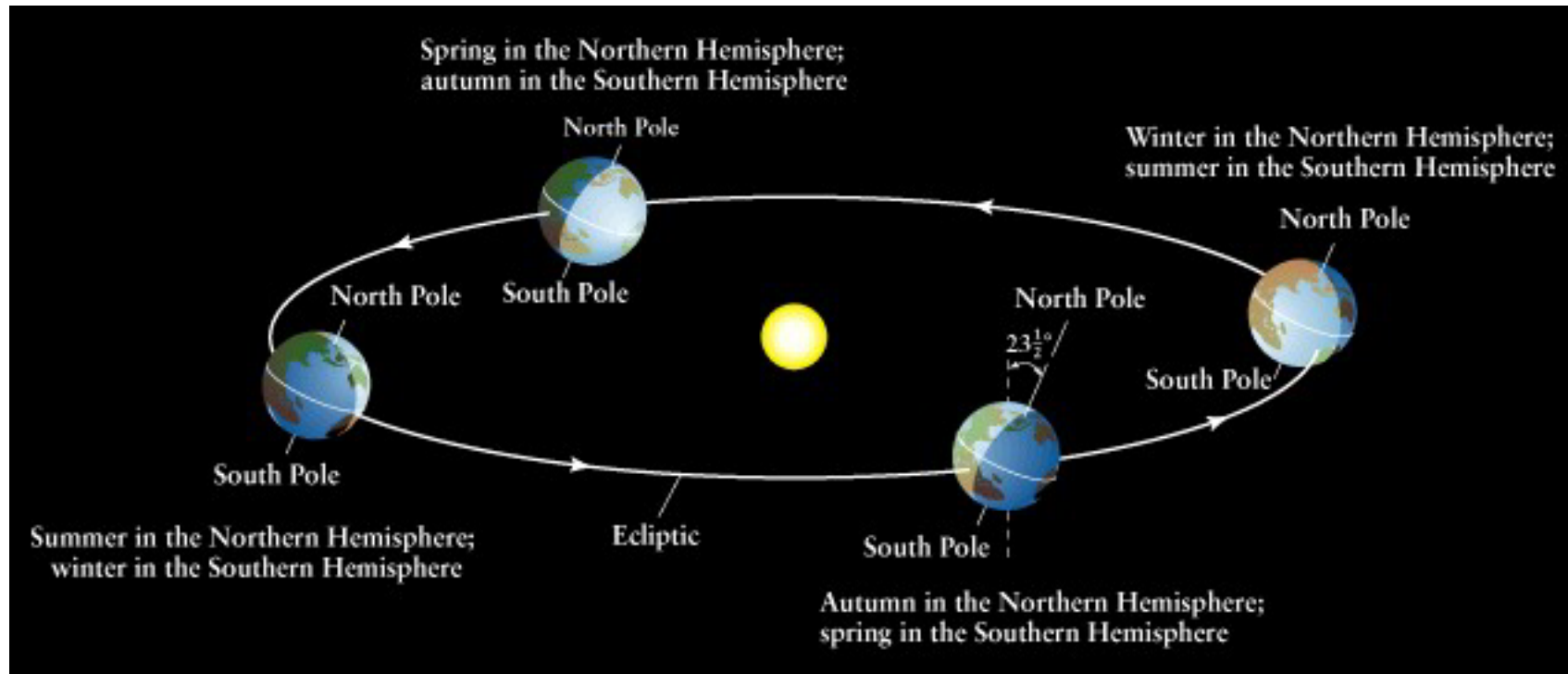
## Why do we have seasons?

1. As the Earth's orbit is elliptical, the Earth is farther away from the Sun in Winter.
2. Main reason is because the Earth's axis is tilted by 23.5 degrees.
3. The Moon blocks some of the Sun's energy– solar eclipses.
4. Global warming is worse in the Summer months.

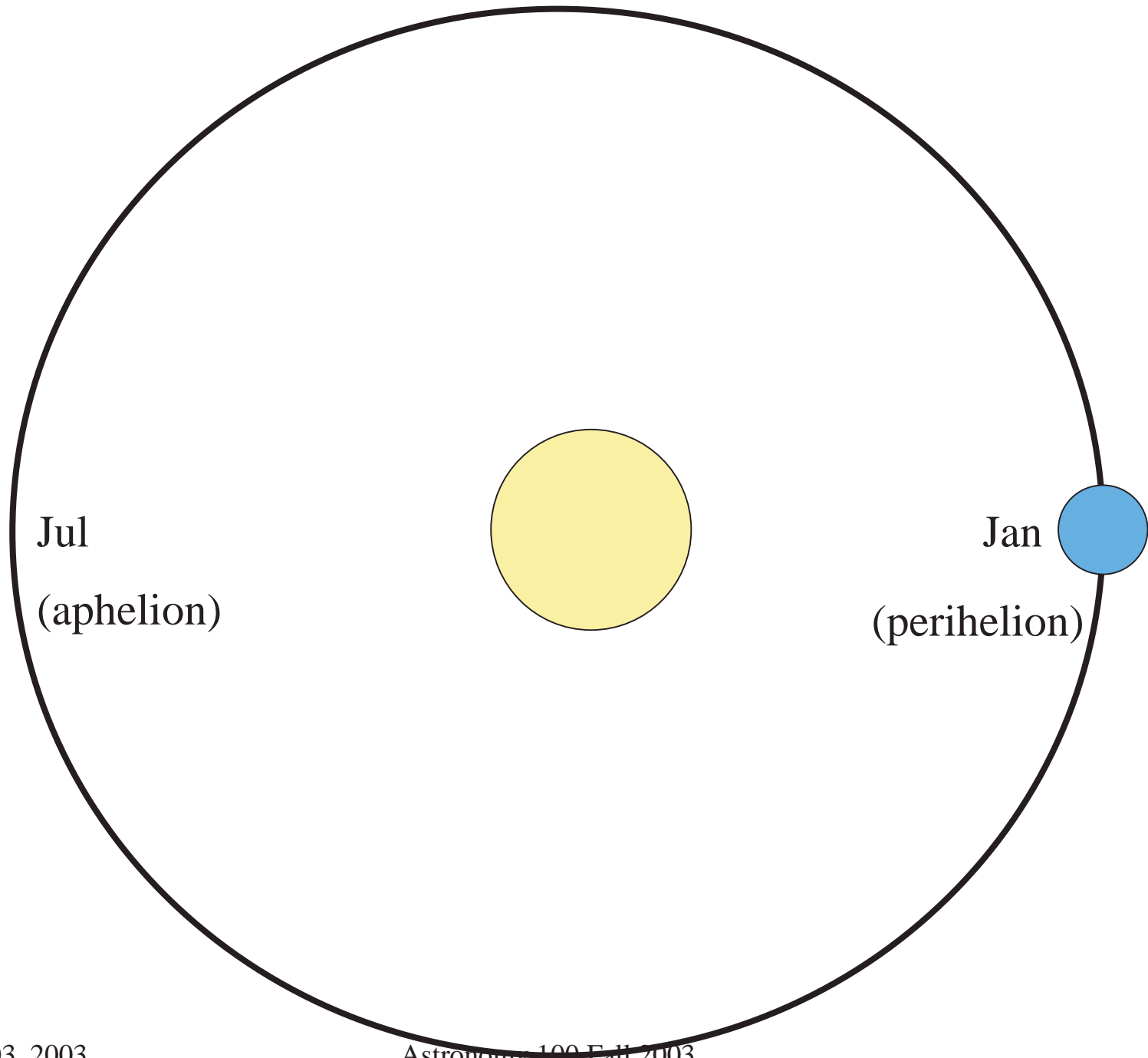
# Seasons



Main Reason for the Seasons is the Tilt of the Earth's Axis.

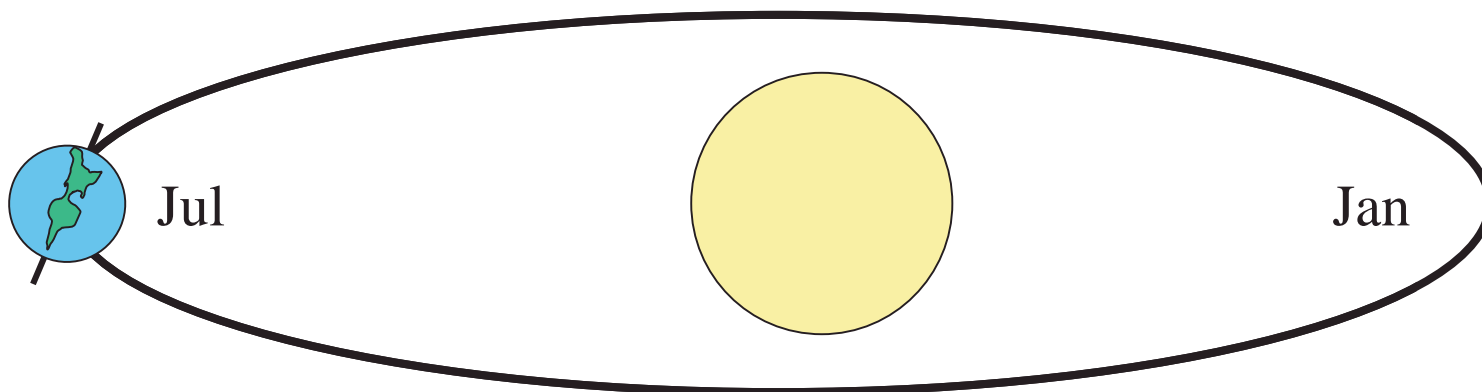


Ever visited South of the Equator?



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Southern Winter  
Northern Summer

Northern Winter  
Southern Summer



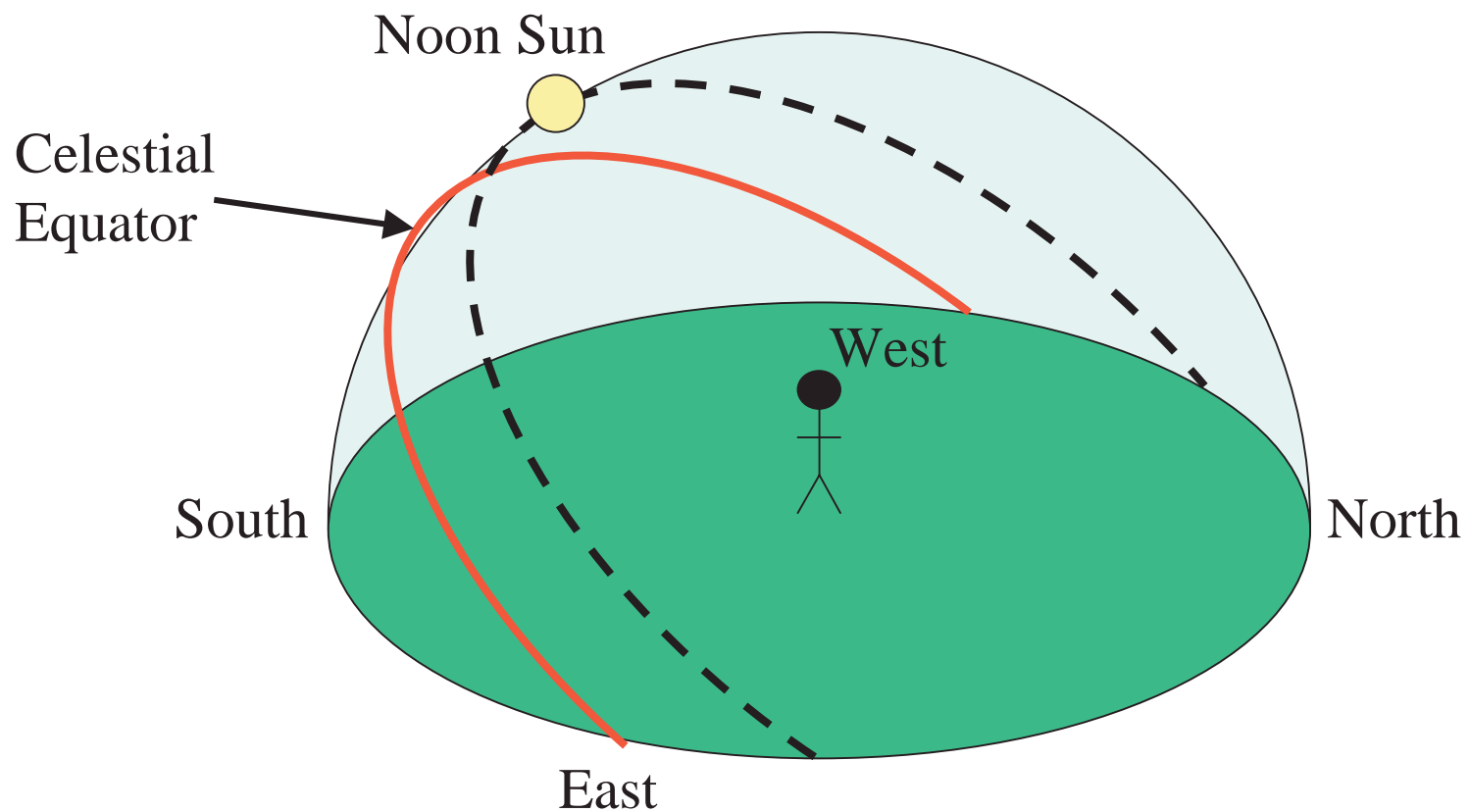
# Seasons



- Two consequences of the Earth's Tilt:
  - Longer days during Summer, shorter during Winter.
  - Direct vs. Indirect Rays.

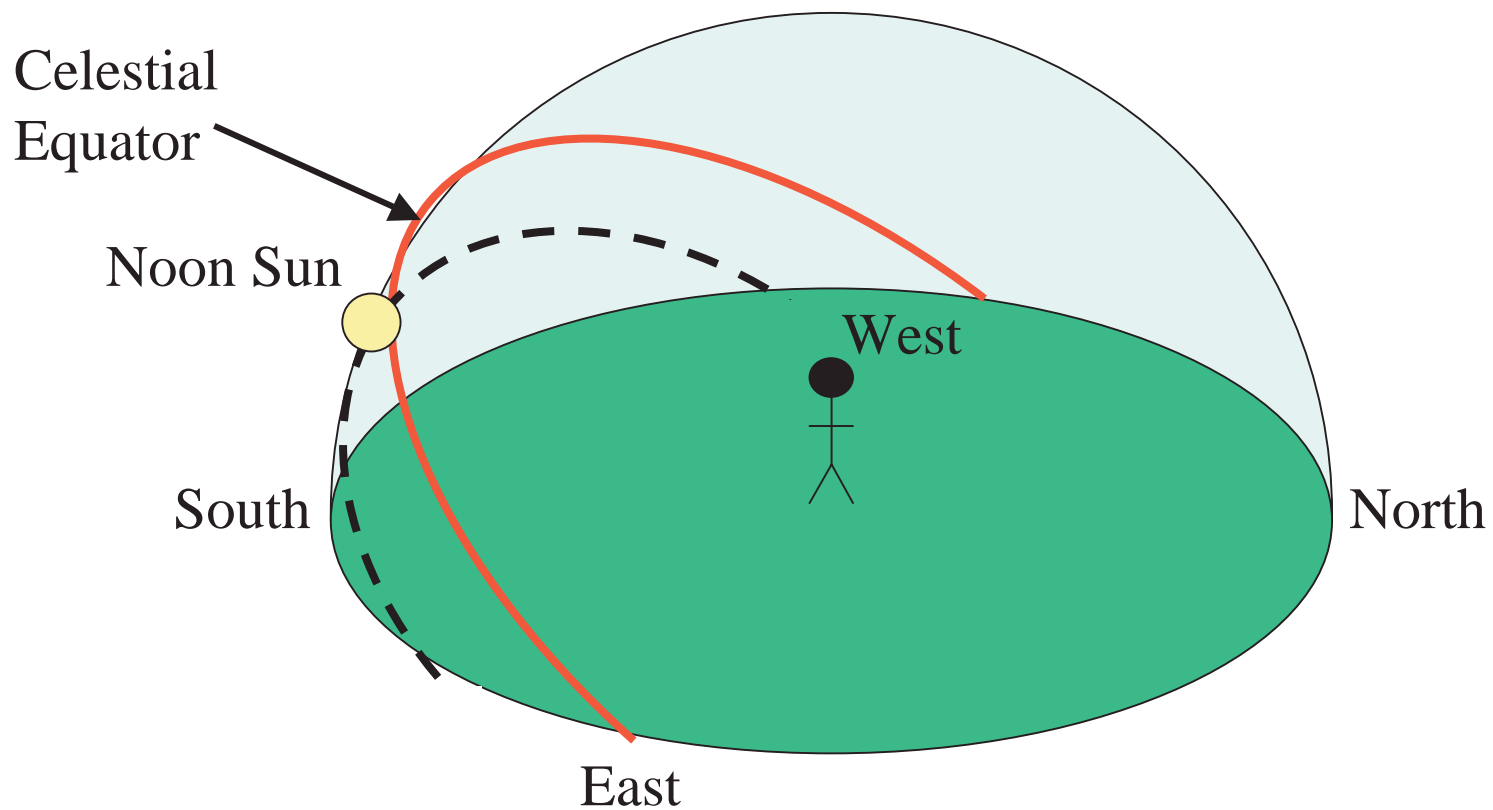


# Summer Solstice

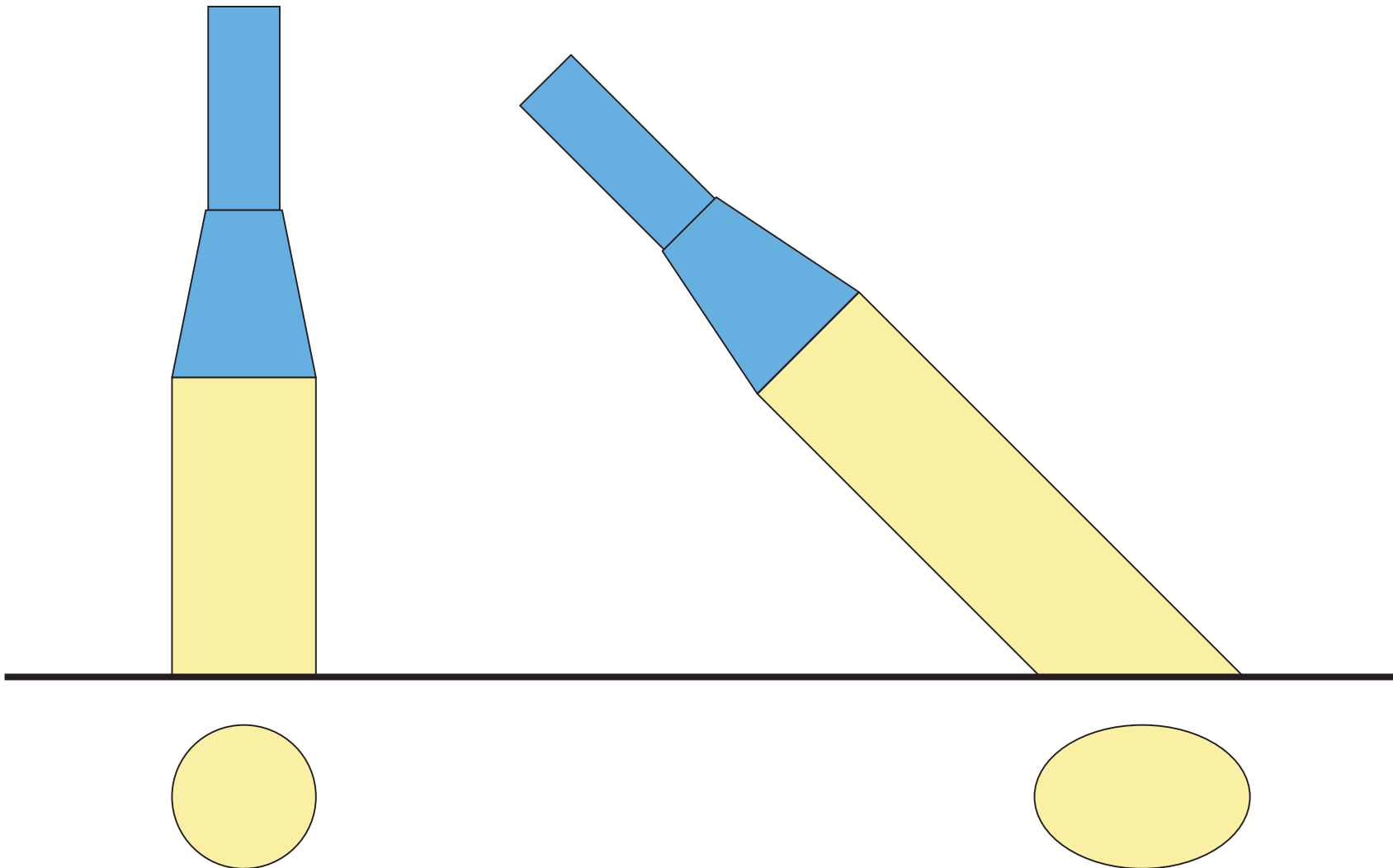




# Winter Solstice



# Direct vs. Indirect Rays



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# Important Dates



Summer Solstice—

June 21

Winter Solstice—

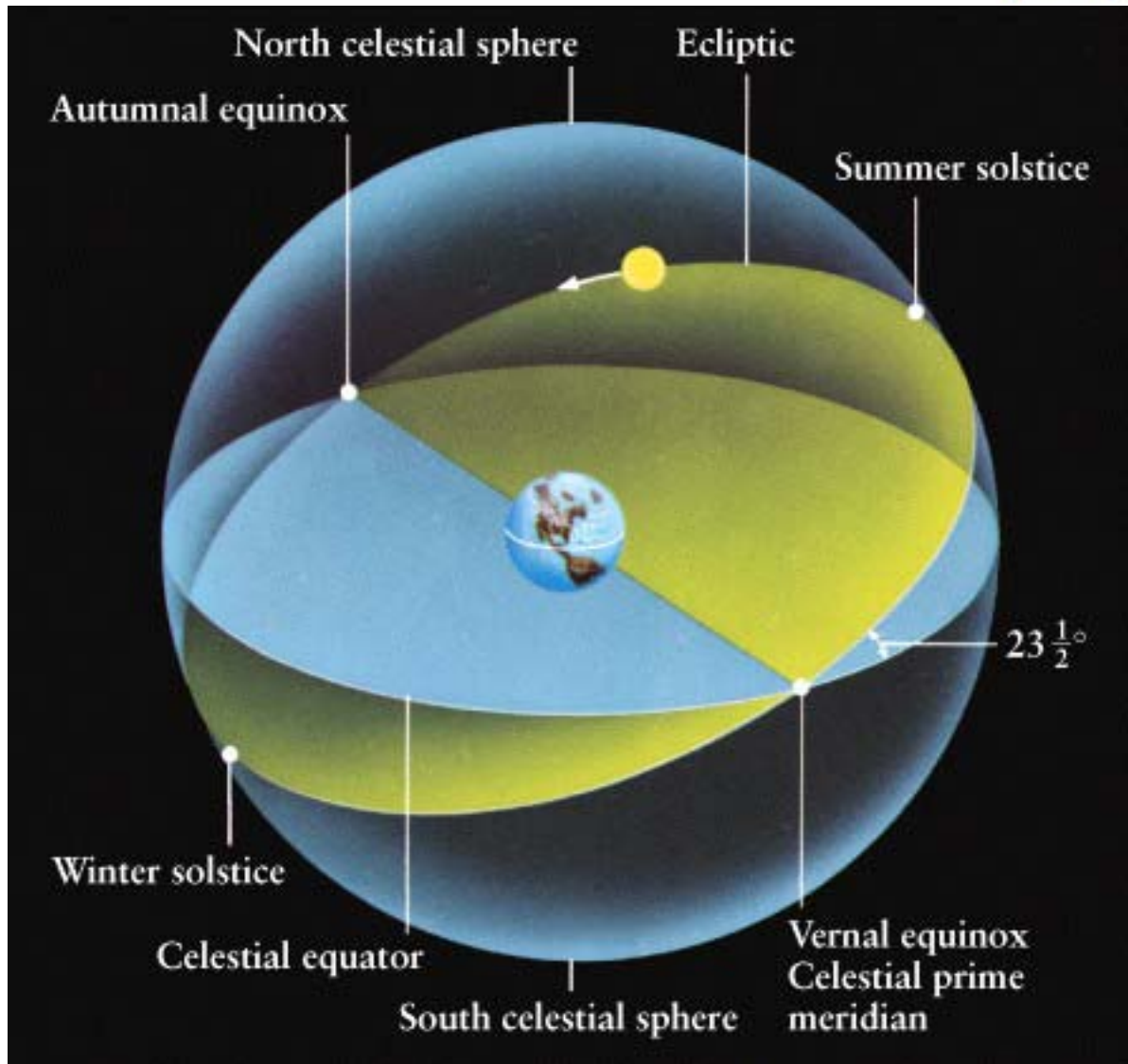
Dec 21

Vernal Equinox—

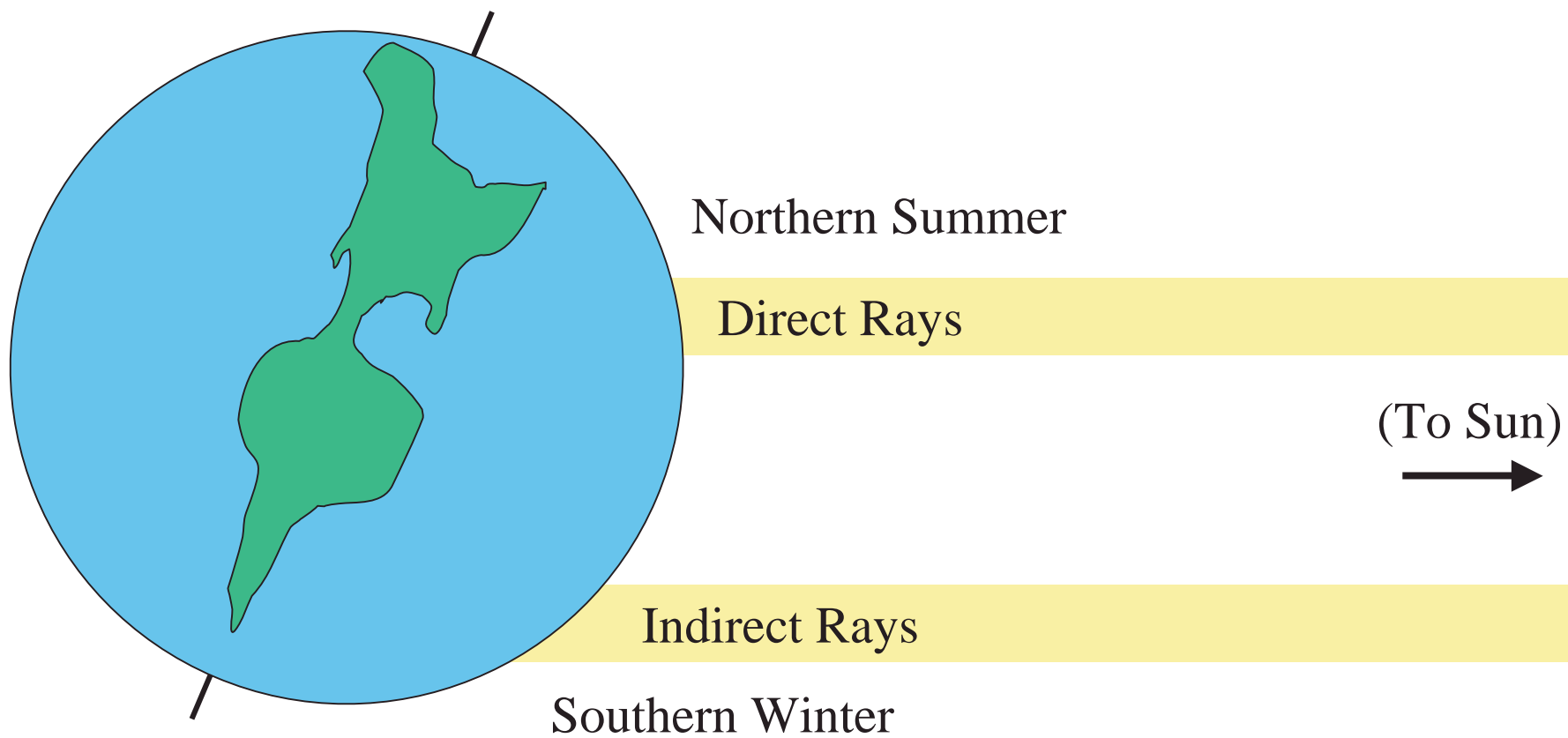
March 21

Autumnal Equinox—

Sept 22



# Summer Solstice



# Winter Solstice



Northern Winter

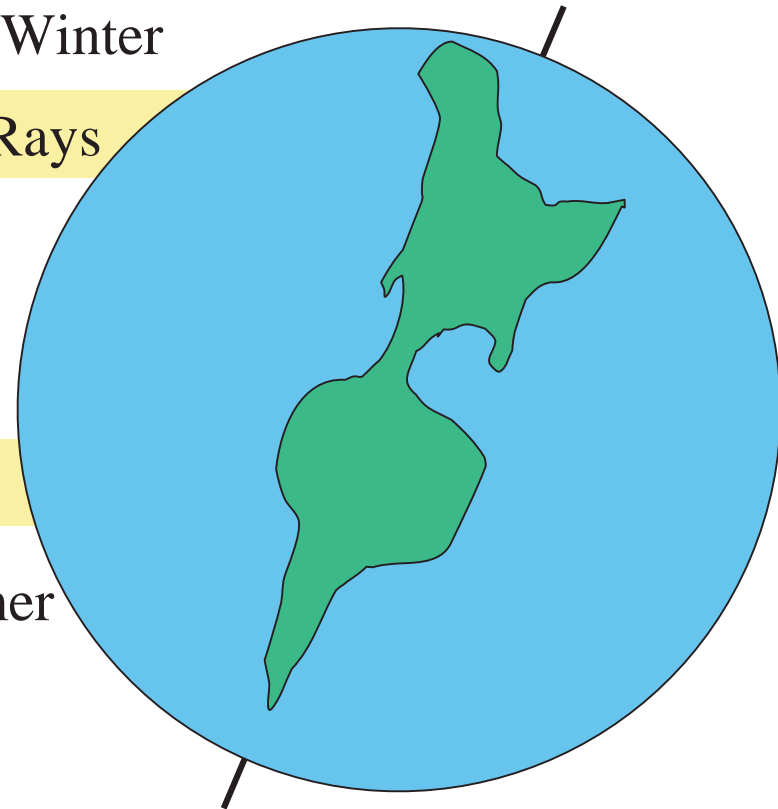
Indirect Rays

(To Sun)



Direct Rays

Southern Summer

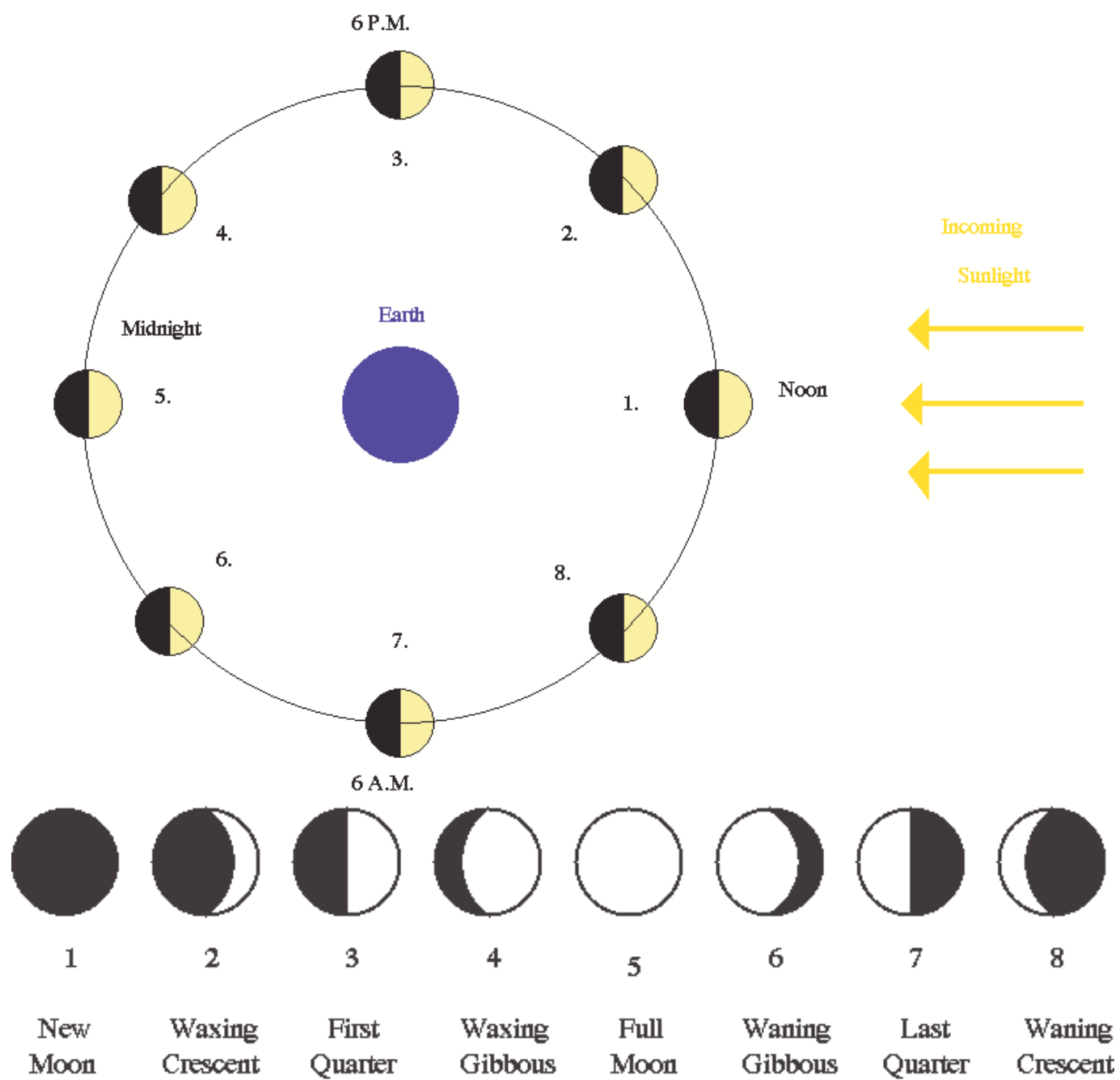


# Phases of the Moon



- Phases of the Moon are caused by the relative positions of the Earth, Moon, and Sun.
- The Moon does not give off any light of its own. The light we see is reflected sunlight.







# Lunar Periods

- **Sidereal Period** – the amount of time it takes the Moon to circle the sky once and return to the same position among the stars (27.3 days).
- **Synodic Period** – the amount of time it takes the Moon to go through one complete cycle of phases (29.5 days).

# Summer Triangle

