Astronomy 100

Section 2– MWF 1200-1300
100 Greg Hall

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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?

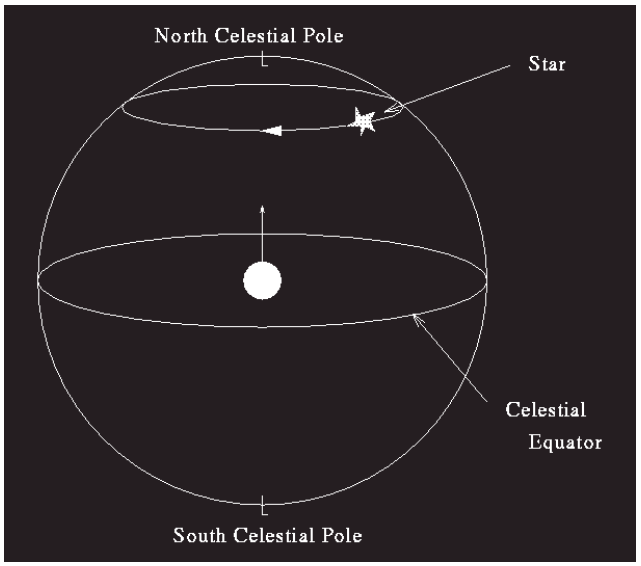
Motions in the Sky

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

The Celestial Sphere

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



http://zebu.uoregon.edu/~imamura/121/images/diurnal.gif

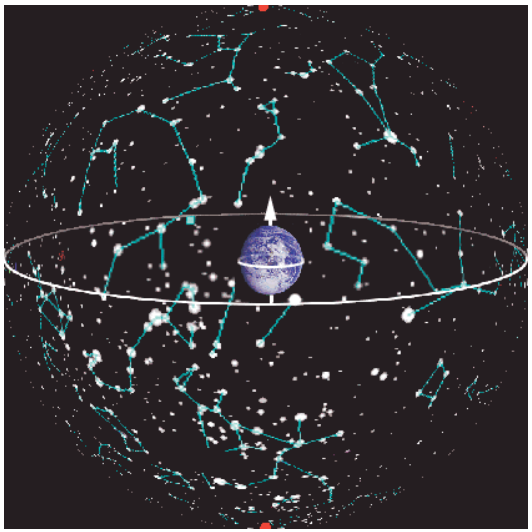
The Celestial Sphere

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:

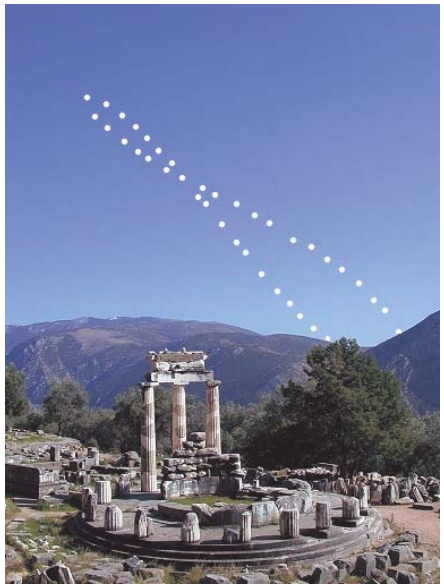
If we take a picture of the Sun everyday at 9:00 AM, what will the photograph look like?

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.



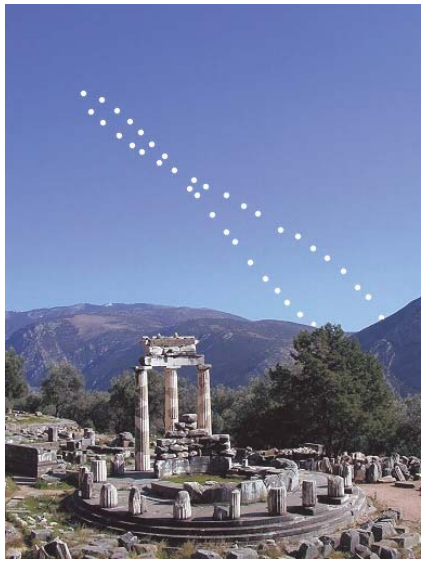
http://www.brera.mi.astro.it/apod/ap030320.html

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).

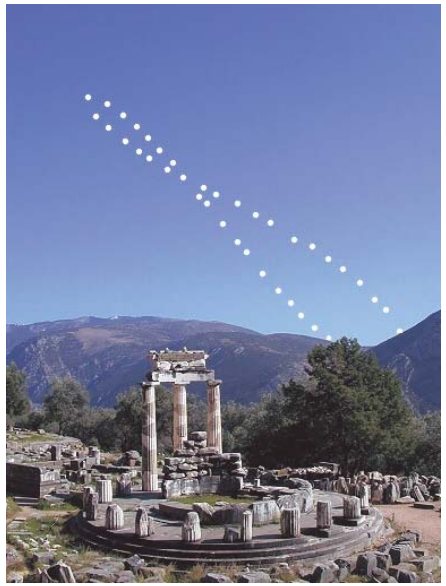
So, the fact that the Sun's location is not fixed indicates that the Earth's Orbit is tilted– in fact we know it is tilted by 23.5 degrees with respect to its orbit around the Sun.



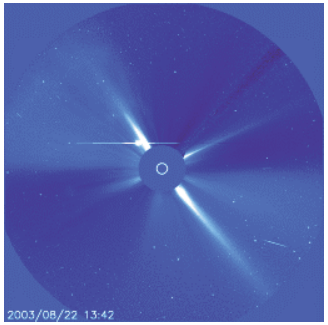
Watching the Sun Move

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.

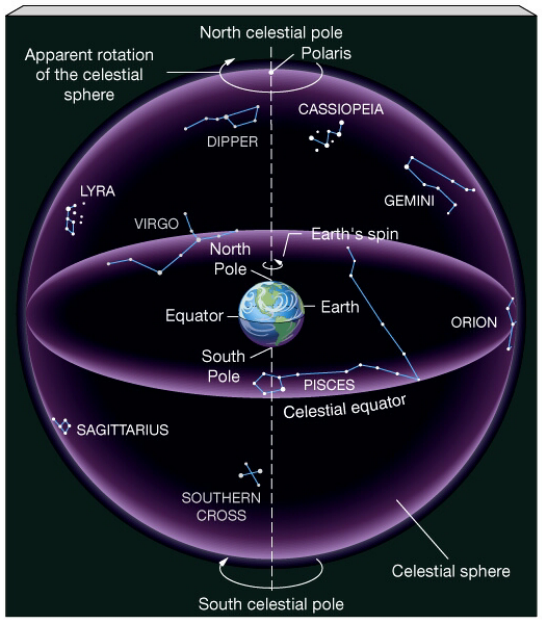
http://sohowww.nascom.nasa.gov/

The Ecliptic

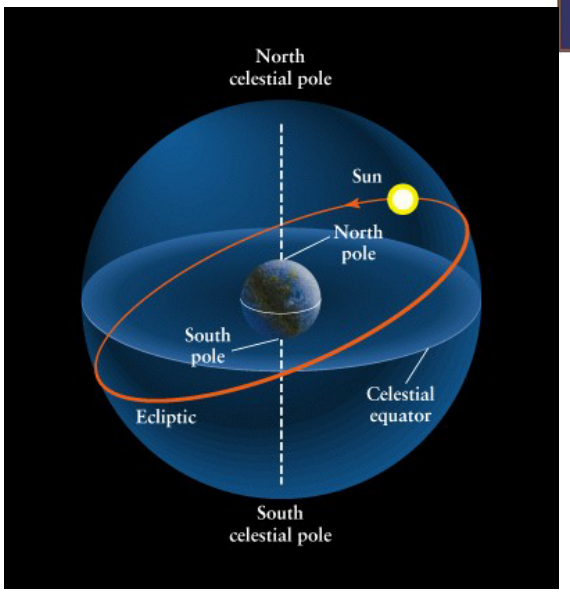
If you could see the stars in the daytime, and you could plot the Sun's location on the celestial sphere, what would it look like?

http://planck.phys.uwosh.edu/mike/exercises/anim/ecliptic_movie.mov

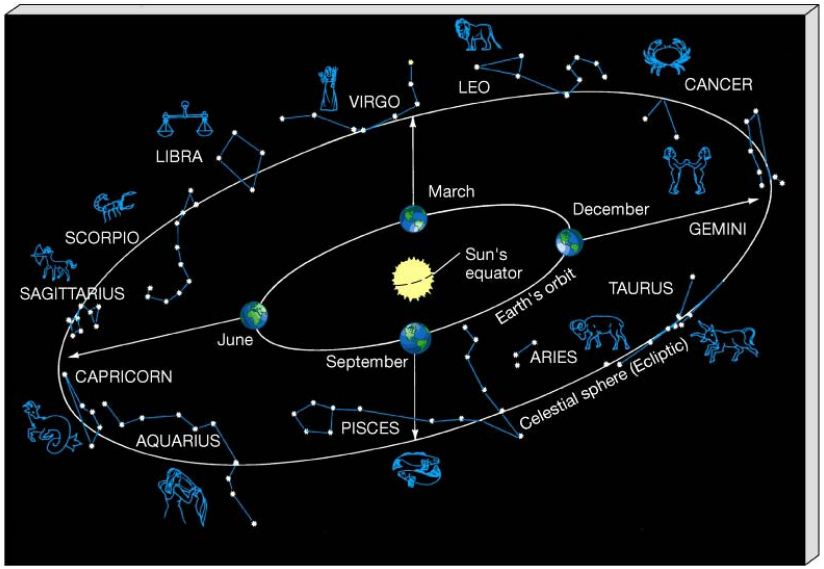
We know the celestial sphere.



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



Ecliptic Defines the Zodiac



The Real Zodiac

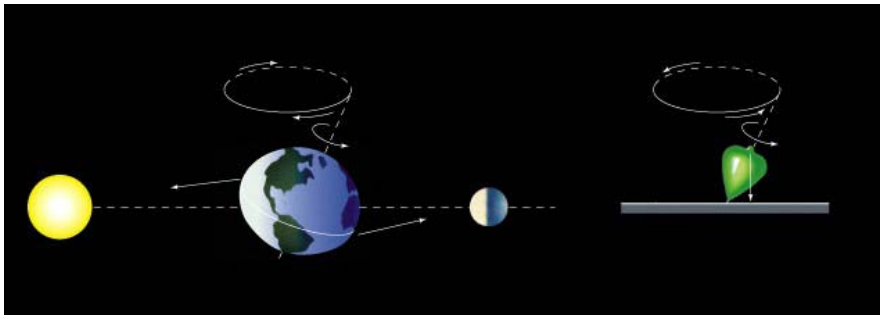
Table 1-1
The 13 Constellations of the Zodiac

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?



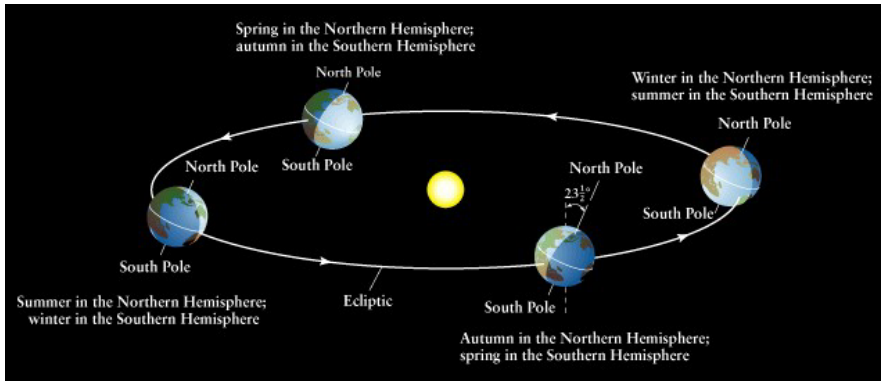
It's like a spinning top.

Question:
Why do we have seasons?

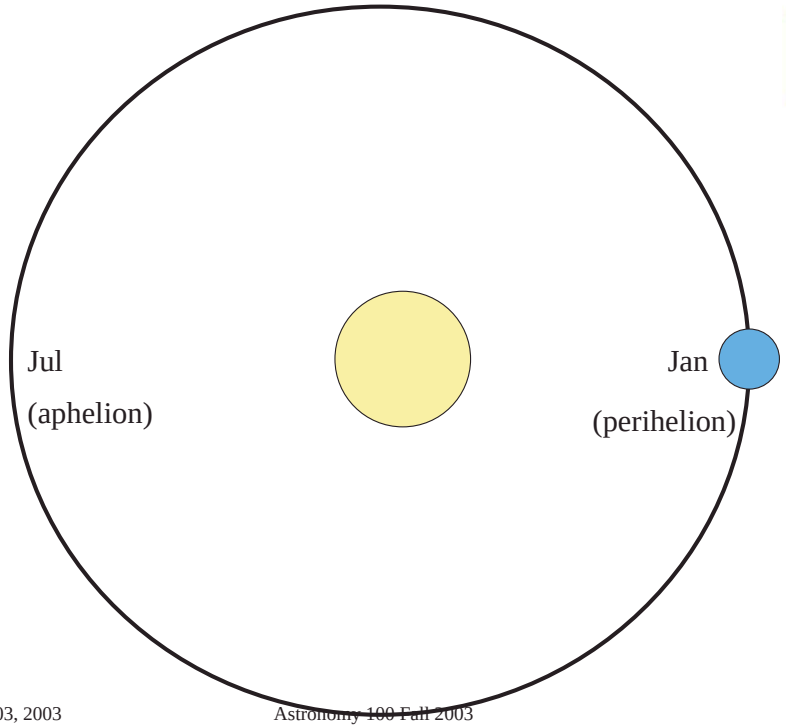
1. As the Earth's orbit is elliptical, the Earth is farther away from the Sun in Winter.
2. Main reason is because the Earth's axis is tilted by 23.5 degrees.
3. The Moon blocks some of the Sun's energy– solar eclipses.
4. Global warming is worse in the Summer months.

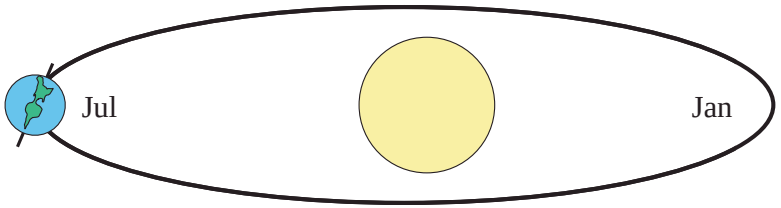
Seasons

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



Ever visited South of the Equator?





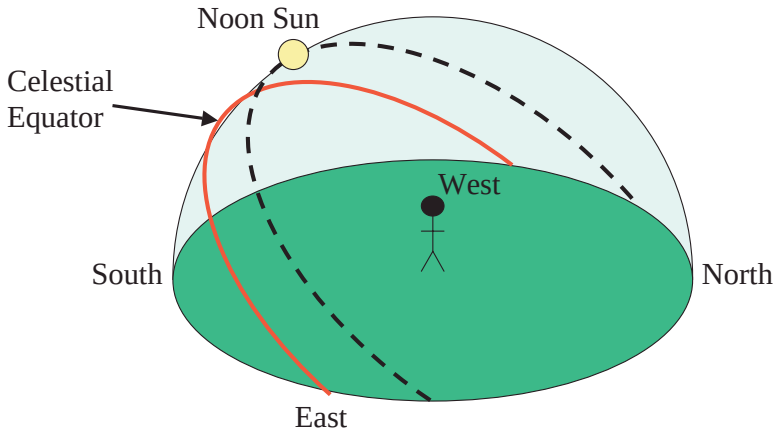
Southern Winter
Northern Summer

Northern Winter
Southern Summer

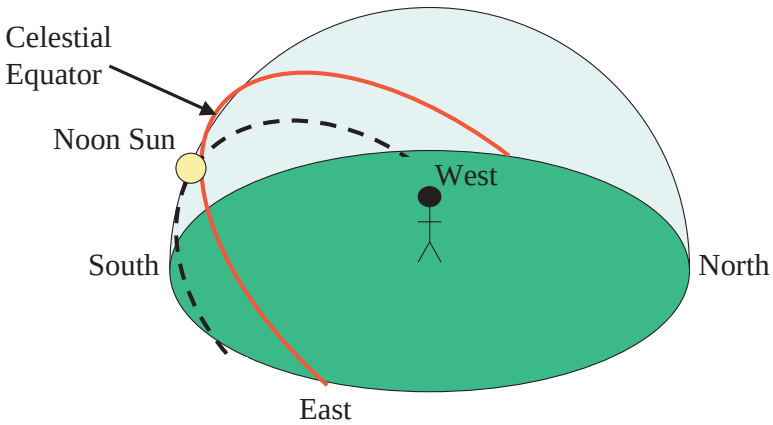
Seasons

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

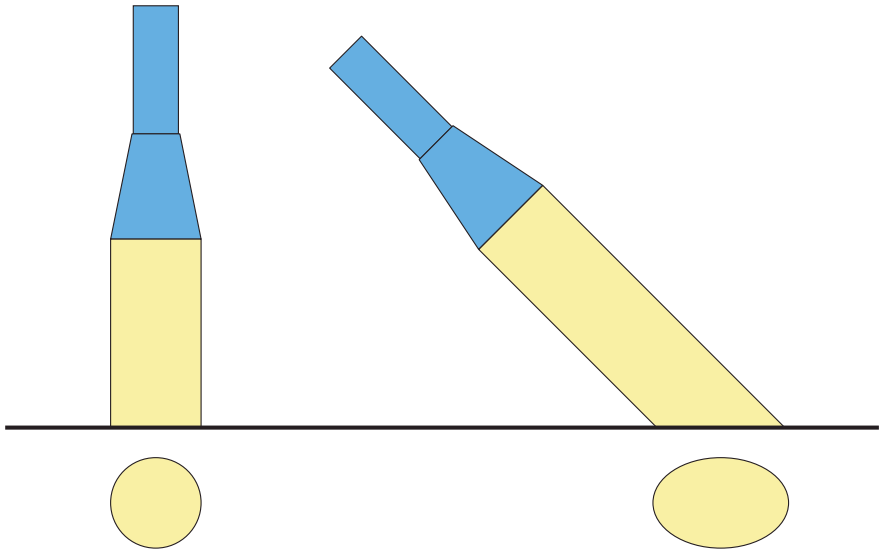
Summer Solstice



Winter Solstice

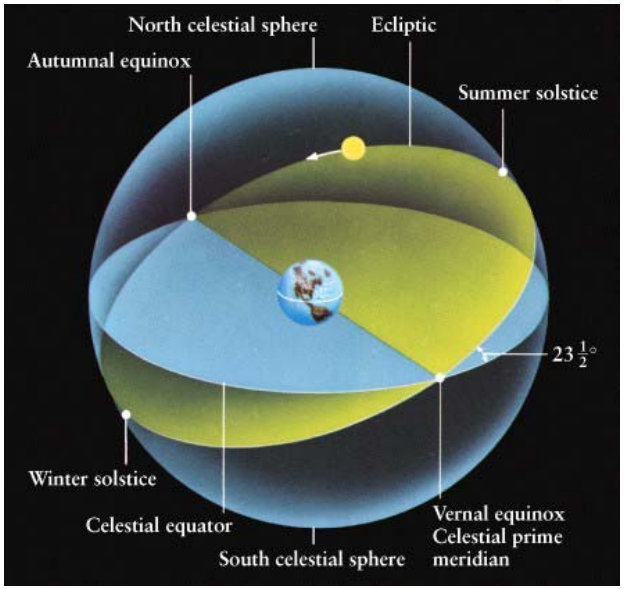


Direct vs. Indirect Rays

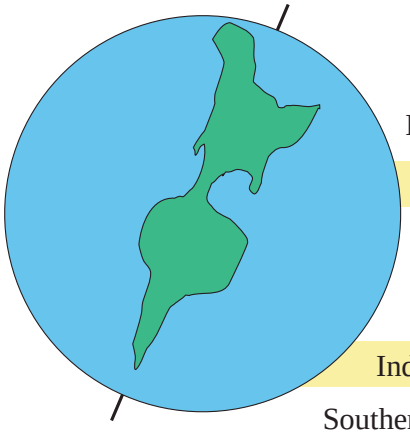


Important Dates

Summer Solstice–
June 21
Winter Solstice–
Dec 21
Vernal Equinox–
March 21
Autumnal Equinox–
Sept 22



Summer Solstice



Northern Summer

Direct Rays

(To Sun)

Indirect Rays

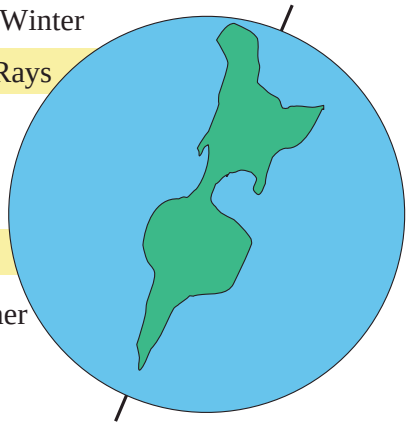
Southern Winter

Winter Solstice

Northern Winter

Indirect Rays

(To Sun)

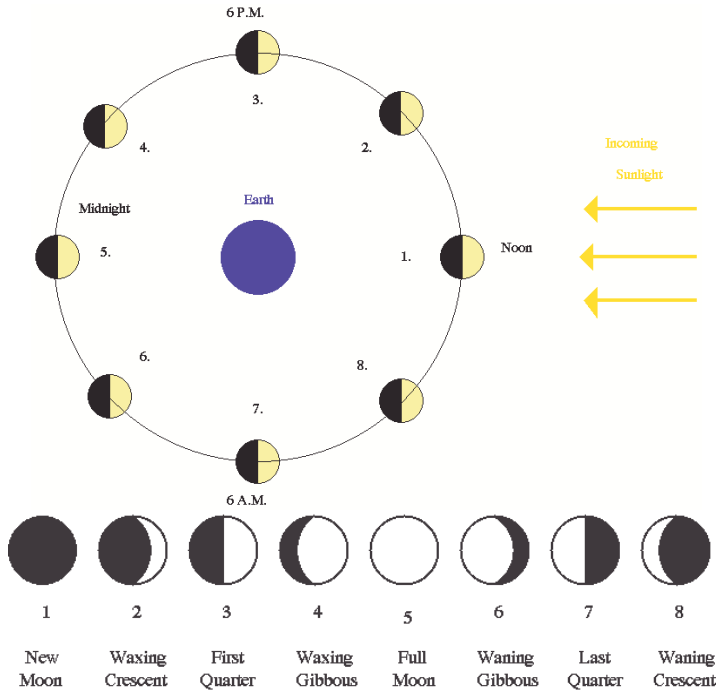


Direct Rays

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