The Earth and the Sky

In this class, we want to understand why the objects in the sky – **as seen from the Earth -** appear as they do.

Even though we haven't yet discussed the details, I am assuming that there are some simple facts that we all know . . . *from elementary school, maybe:*

- **The Earth is a sphere that spins on its axis once a day causing objects in the sky to rise and set.**

- **The Earth orbits the Sun in a roughly circular path once/year.**

- **Compared to the Sun, the Moon, and the planets, the stars are very far away.**

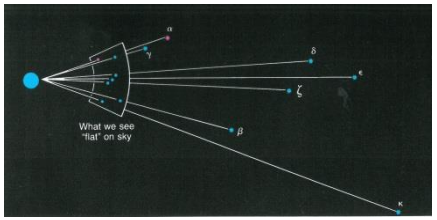
A word of Caution: since we are describing the sky as seen from the Earth, many of the descriptions in this chapter are Earth-Centered. We know this is not physically the case, and we'll occasionally look at a more correct view. Also, these simple facts have only been known for about the last 400 years – we'll take up that story soon.

Constellations

When you look at the sky at night, the stars seem to form patterns and shapes. These patterns are called **constellations**. We get the names for constellations visible in the northern hemisphere from Greek mythology, although most of the names are Latin. But an important questions is this:

Are the stars in a constellation physically related and near to each other?

No, they are just in similar directions as seen from the Earth.



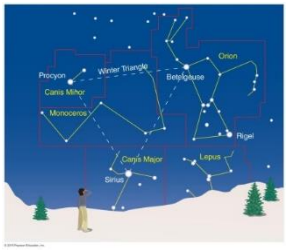
Consider: the distances to stars of Orion

Or, the long term motion of the Stars of The Big Dipper (part of Ursa Major):

(all the stars that we see in the sky slowly move since they (and us too) are orbiting around the center of the Milky Way galaxy.)

Constellations & Star Names

So, what do we use constellations for today?



- Help us find our way around the Sky
- Identify 88 separate regions of the Sky (like states on a map of the U.S.)

What about star gazing phone apps? *I started with the free SkyView Lite and then purchased SkyView, but I'm considering trying Stellarium.*

Star Names:

There are three common ways to name stars . . . That's why you many times hear multiple names for the same star.

1. **Constellation Name** (like an address):

Greek Letter - Latin genitive form of the constellation name

$$\alpha \Rightarrow \text{brightest star}$$
$$\beta \Rightarrow \text{next brightest star } etc.$$

For example: $\alpha - \text{Orionis (a.k.a Betelguese)}$

$\beta - \text{Orionis (a.k.a Rigel)}$

Constellations & Star Names

2. Proper Arabic Name:

During the middle ages, Arabic astronomers gave proper names to the brightest few thousand stars in the sky.

e.g. $\text{Betelguese is } \alpha - \text{Orionis}$

$\text{Sirius is } \alpha - \text{Canis Majoris}$ (the brightest star in the sky)

$\text{Polaris is } \alpha - \text{Ursae Minoris}$ (the north star)

3. Stellar Catalog Name

Many, many catalogs of stars have been compiled over the years, especially for faint stars that don't have any other names.

The star's name is then the catalog abbreviation followed by some numbers, e.g.

$\text{BD } +38^\circ\ 3238$ (Vega in the Bonner Durchmusterung catalog)

$\text{HD } 172167$ (Vega in the Henry Draper Catalog)

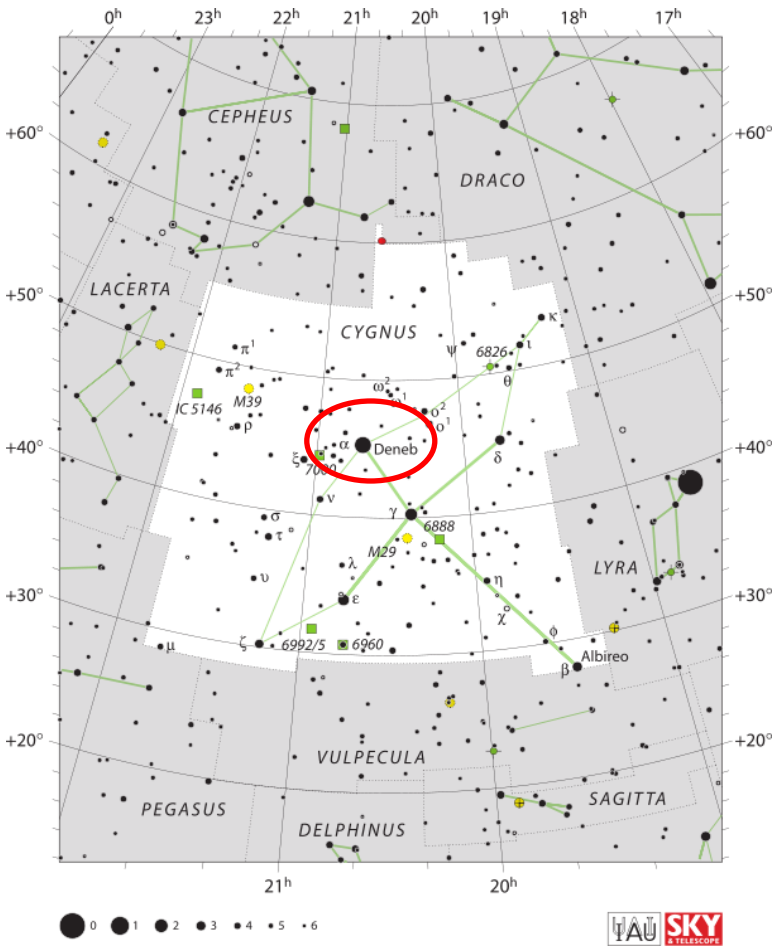
$(\text{Vega is also } \alpha\text{–Lyrae})$

Constellations & Star Names (LC)

Below is a photograph of the constellation Cygnus, “The Swan”.
At the **LC** prompt, click on the star

α Cygni

Answer

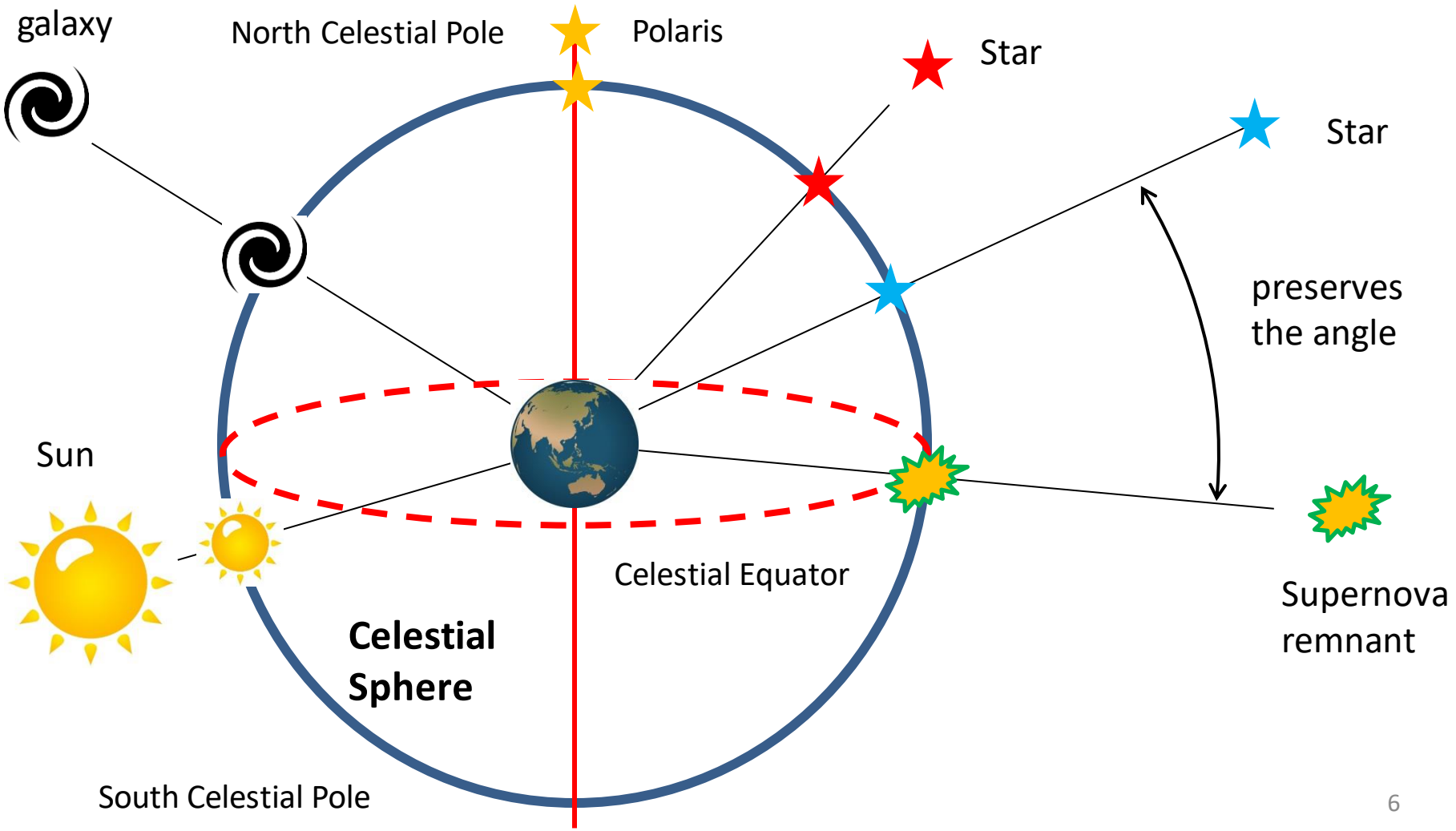


magnitudes - later

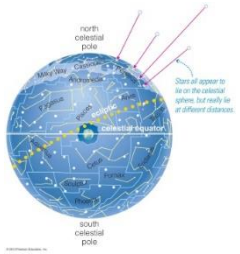
The Celestial Sphere

The **Celestial Sphere** is an **Earth-Centered Imaginary Sphere** that contains everything in the sky, stars, galaxies, planets, etc.

– it's not real; it just provides a description of the sky.



The Celestial Sphere

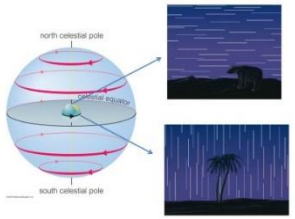


The Celestial Sphere provides a **Map of the Sky**

The Daily Motion of the Sky

We "picture" the Celestial Sphere rotating around the Earth once per day *(but what's really happening?)*

What do we see? It depends on your Latitude on Earth



If you're at a pole, you see stars going around the celestial pole, never rising or setting. The celestial equator is on horizon.

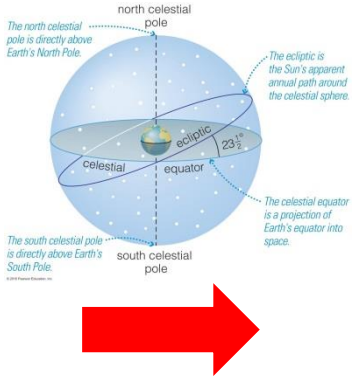
If you're on the equator, you see stars rising straight up in the east and setting straight down in the west. The celestial poles are on your horizon.

If you're at mid-latitude, you see a combination of this.

The Yearly Motion of the Sun on the Celestial Sphere

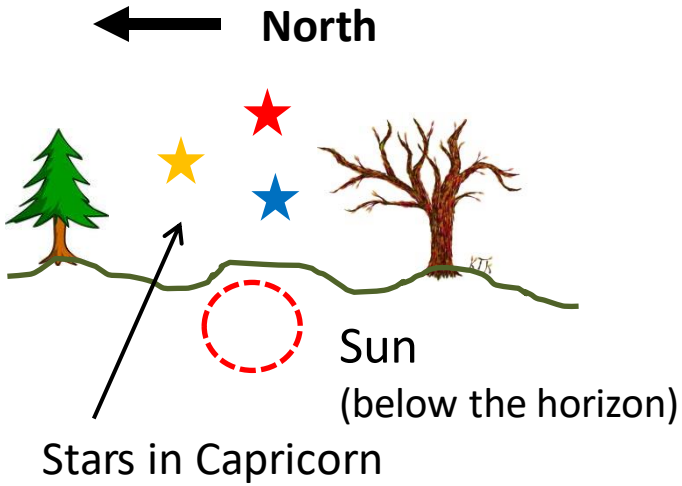
Over the course of a year, the Sun moves relative to the stars on the Celestial Sphere.

It traces out a circle, inclined 23.5° to the celestial equator, called **The Ecliptic**.

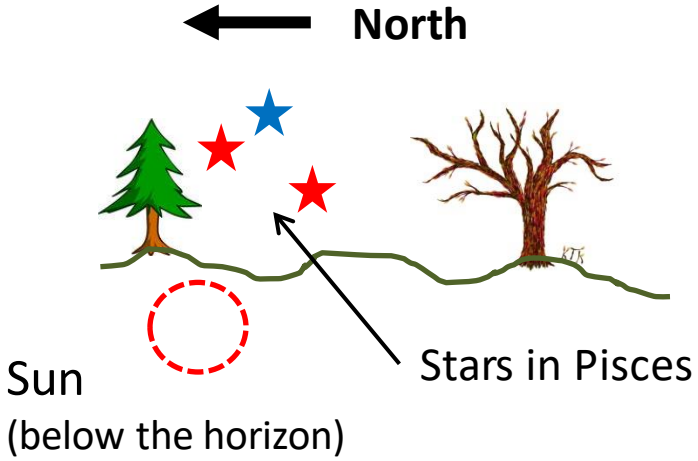


When you look at the Sun, you can't see the background stars,
so how could you figure out that the Sun moves through the stars?

Looking East at Sunrise in **January**:



Looking East at Sunrise in **March**:

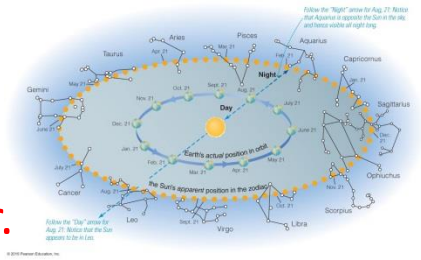


Observing Project . . see Canvas Site

The Yearly Motion of the Sun on the Celestial Sphere

What's really going on here? Is it the Sun that is moving?

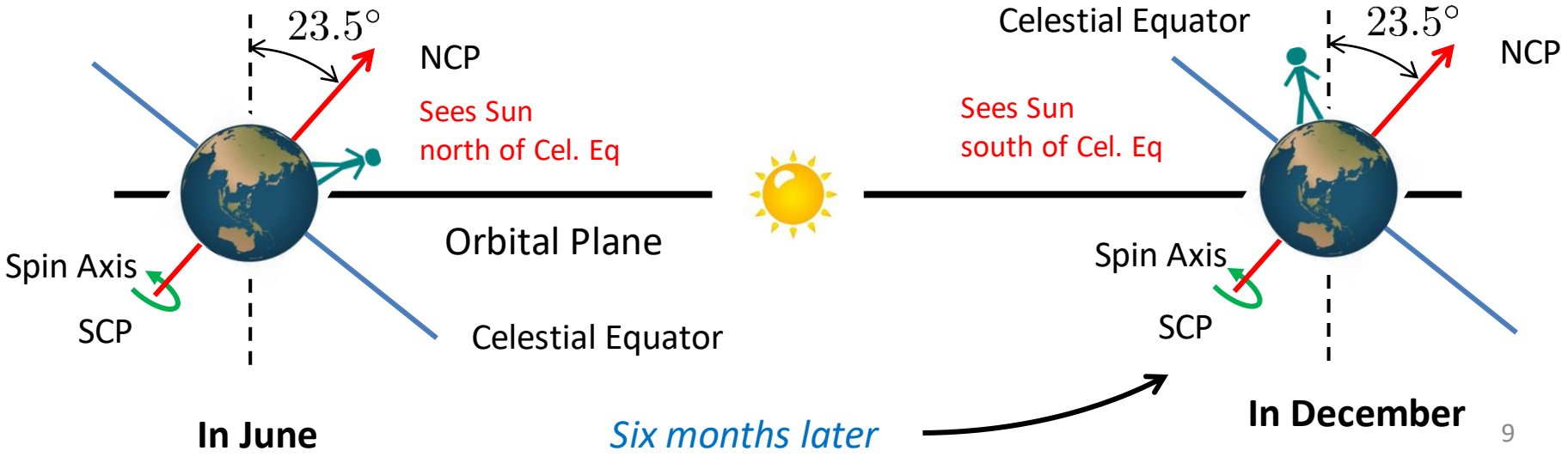
No, it's the Earth that's moving around the Sun, so we see different stars behind the Sun at different times of the year.



This also explains why we see different constellations in the night sky at different times of the year.

Why is the Ecliptic tilted 23.5° from the Celestial Equator?

Actually, it's the tilt of the **Earth's Spin Axis** from the perpendicular to it's orbital plane.



LC Question: The Seasons

Which of the following best describes why we have seasons on Earth?

A. The tilt of Earth's axis causes the northern hemisphere to be closer to the Sun than the southern hemisphere in summer, and visa versa in winter.

B. Earth's elliptical orbit means we are closer to the Sun and therefore receive more intense sunlight at some times of year than at others.

C. The varying speed of Earth in its orbit around the Sun gives us summer when we are moving fastest and winter when we are moving slowest.

D. The tilt of Earth's axis causes different portions of the Earth to receive more or less direct sunlight at different times of year.

E. the Earth is closer to the Sun in summer and further away in winter.

The Seasons

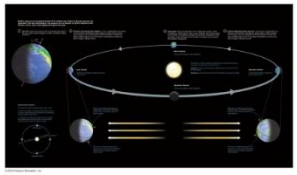
One of the most common misconceptions about Astronomy is the **Cause of the Seasons** that we experience on the Earth.

A Private Universe

The Seasons **ARE NOT** caused by the Earth being closer to the Sun in Summer and further away in Winter! *(In fact, the Earth is slightly further away from the Sun during the Northern hemisphere Summer!)*

Seasons on the Earth (and other planets) **ARE** caused by the **tilt of the Earth's Spin Axis which causes different parts of the Earth to receive more or less direct sunlight at different times of the year. (So choice D on previous slide)**

Study the Excellent Cosmic Context Figure 2.15 in your text
(*especially the narrated figure, The Reason for the Seasons Video, in the study area – it's really good . . . and it's part of your HW!*)

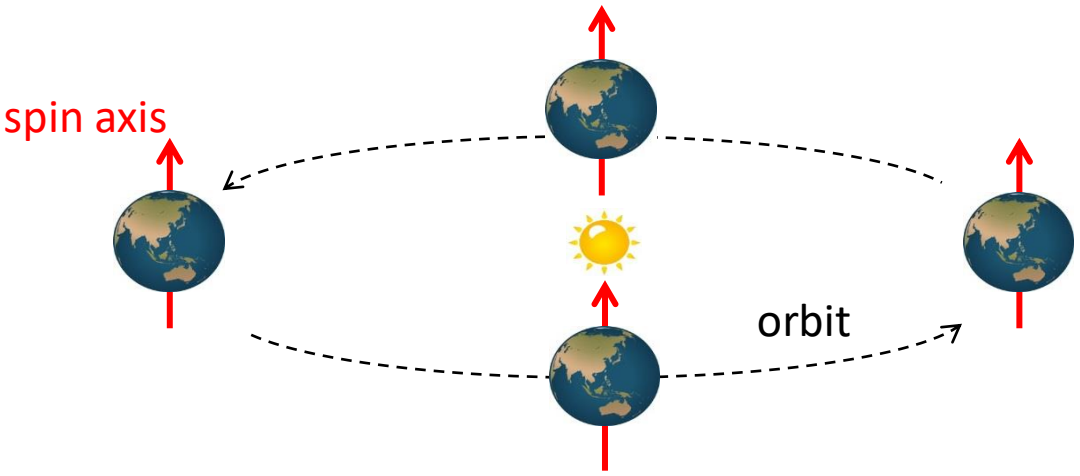


Also, play with this Interactive Figure, **The Seasons**.

The Seasons; What if Games (LC)

Some What If LC group exercises: discuss and try to answer the following questions with classmates around you.

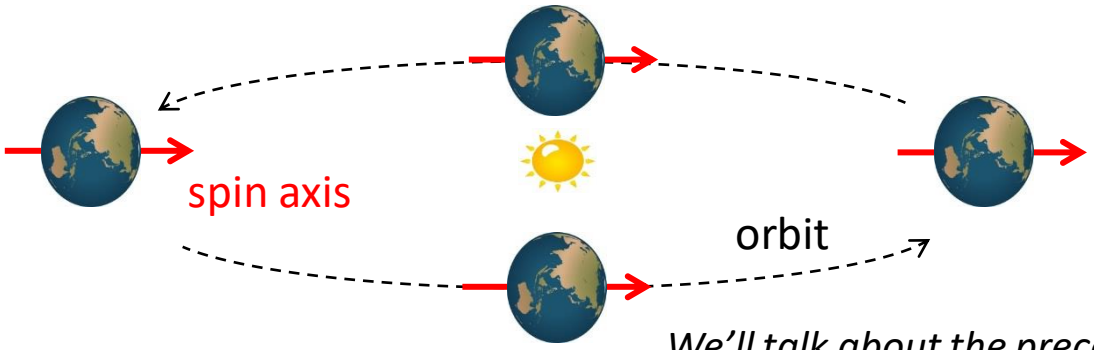
1. What would the seasons be like if there was no tilt to the spin axis?



Discuss and make your choice on LC

Answer: No Seasons

2. What would the seasons be like if there was a 90° tilt to the spin axis?



Discuss and make your choice on LC

Answer: Extreme Seasons
(like Uranus)

We'll talk about the precession of the spin axis later