

The seasons

Astronomy 101
Syracuse University, Fall 2020
Walter Freeman

September 10, 2020

*And that inverted Bowl we call The Sky,
Whereunder crawling coop't we live and die,
Lift not thy hands to it for help – for It
Rolls impotently on as Thou or I.*

–Omar Khayyám (1048-1131), translated into English by Edward FitzGerald (1859)

*I'm cheating death
In Stellarium
I'm peeking ahead
To stars I will never see.*

–Poetic text message from K. Alice Lindsay, used with permission

Announcements

- Project 1 is due tomorrow at midnight
- Submission instructions are on the groups page
- Lots of discussion on Piazza and at my help hours
- More discussion hours: tomorrow, 10am-noon on the steps of Hendricks

Group changes?

Something wrong with your lab group?

- You still don't have one
- You need to switch times or modes

Email suastronomy101@gmail.com and put what you need in the subject line

Group changes?

Something wrong with your groupmates?

If someone in your group hasn't contributed much to either Lab 1 or Project 1:

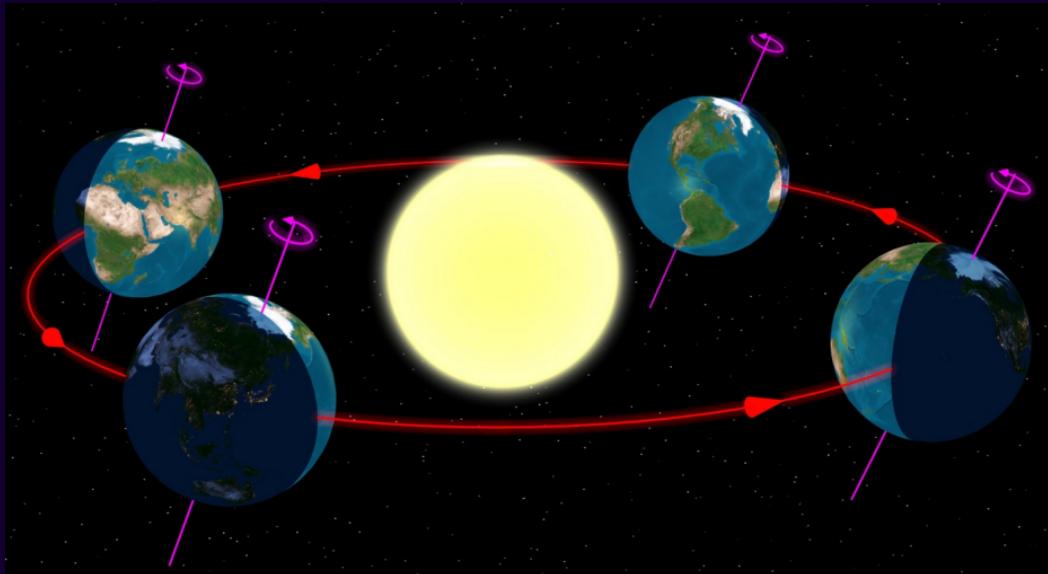
- Put “did not contribute” by their name in your submission for Project 1
- Send a note to suastronomy101@gmail.com, cc: fchahili@syr.edu and your groupmembers who did contribute, and describe what has happened
- We'll work with you to fix the problem

A review from before: the seasons

The Earth's axis of rotation is not lined up with its orbital axis.

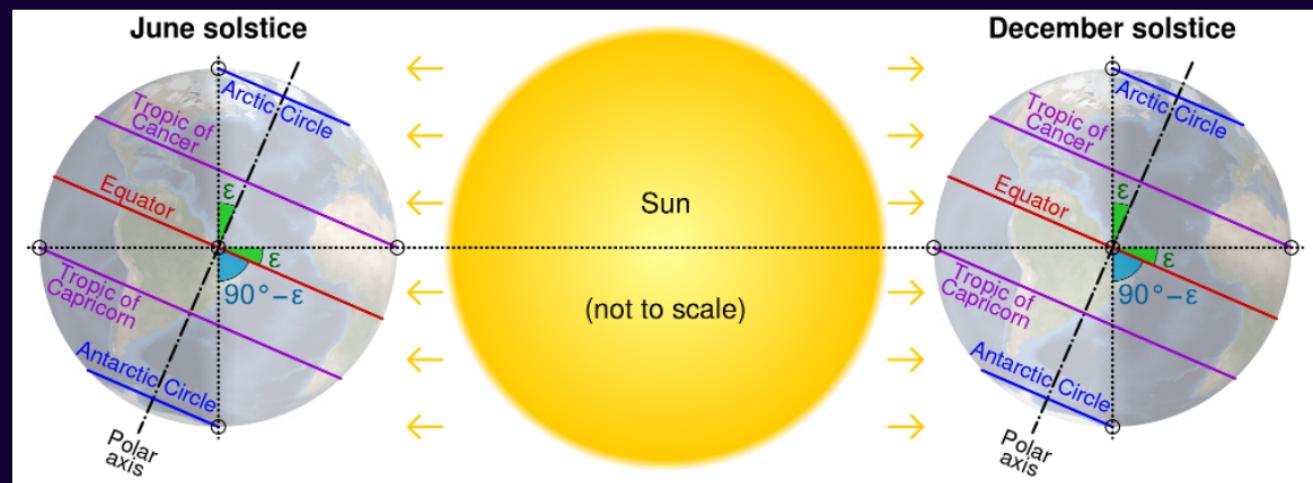
It's tilted by 23.4 degrees.

The axis of rotation changes **only** very slowly (over millennia).



Let's look at this in animations

Last time we drew a diagram and saw some animations – but I went too fast through the explanation since I got low on time. Let's review that.



The solstices and equinoxes

Many cultures have ascribed significance to the annual movement of the Sun.

Perhaps the most famous artifact of this is Stonehenge:



The solstices and equinoxes

There are modern variants of this, too:



"Manhattanhenge", by Neil DeGrasse Tyson

Taking stock

We now understand the motion of the stars, and the combined effects of the Earth's axial tilt, rotation, and orbit have on the seasons.

Our goal in this first segment of the course was to understand the night sky. What's left?

- The Moon (today)
- How these cycles combine to help us keep time (next Tuesday)
- Oddities: comets, meteors, novas, eclipses, *planets*... (next Thursday)









6 second exposure, 14mm f/1.8, ISO 6400. What is going on here?





“Orange-Slice Moon”, Michael Leyne (current AST101 student)

The phases of the Moon

The Moon has often been a symbol of change.

That change is regular, though: every 29.5 days, the pattern of phases repeats.

This is orderly enough that it is the basis of many calendars:

- Hebrew calendar
- Traditional Chinese calendar
- Babylonian calendar

... but not the traditional calendars of Europe. (Why might that be?)

The phases of the Moon

Everything else in the sky seems to be a constant size and shape, but the Moon waxes and wanes. Why?

The phases of the Moon

Everything else in the sky seems to be a constant size and shape, but the Moon waxes and wanes. Why?

The Moon differs from the stars in that it doesn't make its own light.

It orbits the Earth 400,000 km (1/500 AU!) away, once every 29 days or so, orbiting counterclockwise when looking down at the North Pole.

What consequences does this have?

Comment on the following statements...

The phases of the Moon happen because the Moon's motion around the Earth causes it to receive different amounts of light from the Sun, varying from completely lit (full moon) to not lit at all (new moon)

Comment on the following statements...

The phases of the Moon happen because the Moon's motion around the Earth causes it to receive different amounts of light from the Sun, varying from completely lit (full moon) to not lit at all (new moon)

The phases of the Moon happen because the Earth blocks part of the light from the Sun, resulting in a shadow on the Moon's face

Comment on the following statements...

The phases of the Moon happen because the Moon's motion around the Earth causes it to receive different amounts of light from the Sun, varying from completely lit (full moon) to not lit at all (new moon)

The phases of the Moon happen because the Earth blocks part of the light from the Sun, resulting in a shadow on the Moon's face

The phases of the Moon happen because the Earth moves around the Moon each day, and we see a different part of the Moon

Comment on the following statements...

The phases of the Moon happen because the Moon's motion around the Earth causes it to receive different amounts of light from the Sun, varying from completely lit (full moon) to not lit at all (new moon)

The phases of the Moon happen because the Earth blocks part of the light from the Sun, resulting in a shadow on the Moon's face

The phases of the Moon happen because the Earth moves around the Moon each day, and we see a different part of the Moon

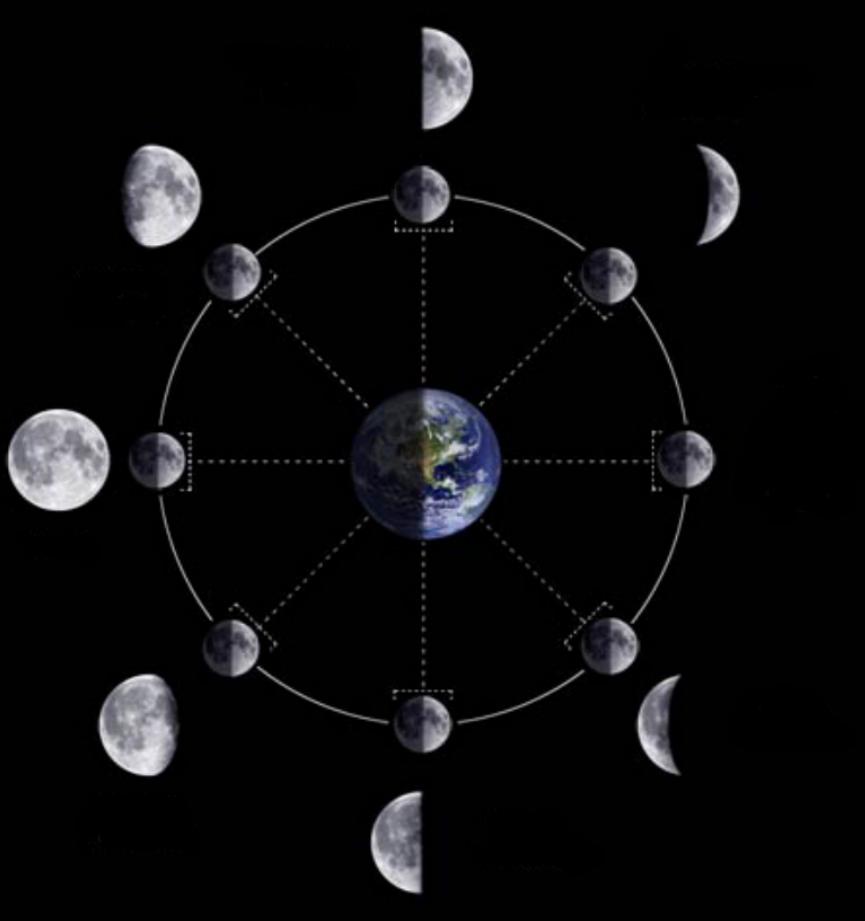
The phases of the Moon happen because half of the Moon is always lit by the Sun, but our perspective changes how much of that half we see

Do any of these explain why we see the phases of the Moon?

Some new words for the moon phases...

- New moon: nothing visible
- Crescent: less than half visible
- Half moon: half of the moon's surface is visible
- Gibbous: more than half visible
- Full moon: all visible

- Waxing: Tomorrow we will see more of the full Moon than today
- Waning: Tomorrow we will see less of the full Moon than today



You can figure all of this out by drawing pictures.

Do this whenever you need to figure something out about the Moon...

Let's make a doodle on the board and see how much we can figure out...

When the full moon is high in the sky, what time of day is it?

What phase of the moon is mostly seen during the day?

When the waxing half moon is just rising over the horizon, what time of day is it?

As seen in the Northern Hemisphere, which part of a waning crescent moon will be lit?

As seen in the Northern Hemisphere, which part of a waning crescent moon will be lit?

What about the Equator?