The phases of the Moon

Astronomy 101
Syracuse University, Fall 2018
Walter Freeman

September 18, 2018

Announcements

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  - No office hours Friday (out of town Fri-Sun)
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- Coaches will have some clinic hours:
  - 5:15-6:45 Wednesday; 5:30-6:45 Thursday
  - Sunday 12-3? (We're trying to find a room)
  - More?

The upcoming exam

Exam 1 will be held a week from today during your regular class time.

- Format: around 30 multiple choice questions
- You may bring:
  - A single-sided page of notes that you handwrote yourself
  - Your inflatable Earth with things (polar circles, tropics, etc.) labeled on it
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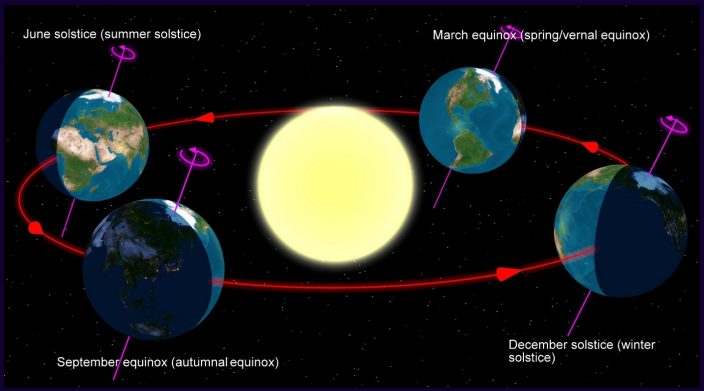
- Last year's exam (and our key) is posted on the website
- ... as is the study guide for the first unit

The seasons



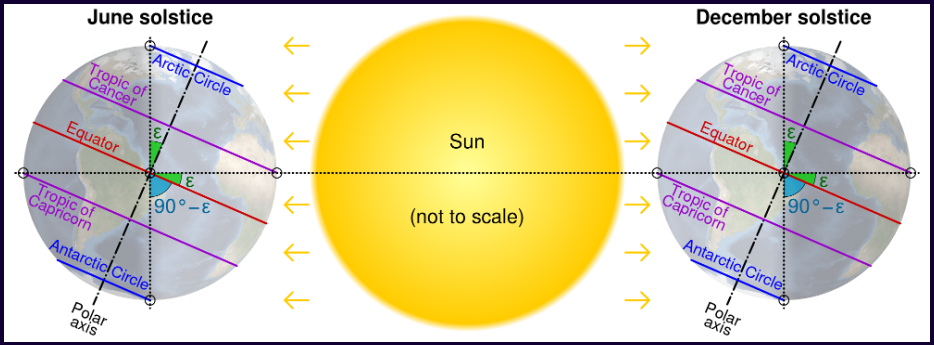
Axial tilt is why the Earth is hotter in summer.
It has nothing to do with the distance from the Sun!

From last year's exam

What if the Earth's axial tilt were increased to 30° from 23°?

A: Syracuse would have hotter summers
B: Syracuse would have colder winters
C: More of Earth would be in the tropics
D: More of Earth would be in the arctic
E: All of the above

Complete Lecture Tutorials pp. 93-98.



We will talk about the Moon after this (and hear some music...)

O Fortune, like the Moon you are changeable, ever waxing and waning...

O Fortuna, velut Luna, statu variabilis, semper crescis et decrescis...

O Fortune, like the Moon you are changeable, ever waxing and waning; hateful life first oppresses and then soothes as fancy takes it; poverty and power, it melts them like ice.

O Fortuna, velut Luna, statu variabilis, semper crescis aut decrescis; vita detestabilis nunc obdurate et tunc curat ludo mentis aciem; egestatem, potestatem, dissolvit ut glaciem.

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Fate, monstrous and empty, you whirling wheel, you are malevolent: wellbeing is vain and always fades to nothing. Shadowed and veiled you plague me too; now through the game I bare my back to your villainy.

Sors immanis et inanis, rota tu volubilis, status malus: vana salus, semper dissolubilis. Obumbrata et velata michi quoque niteris; nunc per ludum dorsum nudum fero tui sceleris.

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So at this hour without delay pluck the vibrating strings: since Fate strikes down the strong, everyone weep with me!

Hac in hora sine mora corde pulsum tangite; quod per sortem sternit fortem, mecum omnes plangite!

From *Carmina Burana*, a 13^{th}-century manuscript found in an abbey south of Munich. This manuscript contained poetry written in Latin and German by clergy in their off-duty hours, when they were decidedly not being holy!

Set to music by Carl Orff (1937).

Other movements talk about springtime, sexuality, satire of the corrupt, drunkenness, and more sexuality; the work both opens and closes with this movement.

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)
- The planets (Tuesday)
- Oddities: comets, meteors, novas, eclipses... (Tuesday)

The phases of the Moon

As in *O Fortuna*, 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
- Islamic hijra calendar

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

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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?

Which is true?

A: 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)

B: 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

C: 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

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

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E: The phases of the Moon happen because sometimes people eat the green cheese that it is made of

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 the Moon will be lit more than today
- Waning: Tomorrow the Moon will be lit less than today

How does this work?

Half of the Moon is always sunlit, just like the Earth!

- Sometimes that half is pointed toward us: full moon!
- Sometimes that half is pointed away from us: new moon!

How does this work?

Note that:

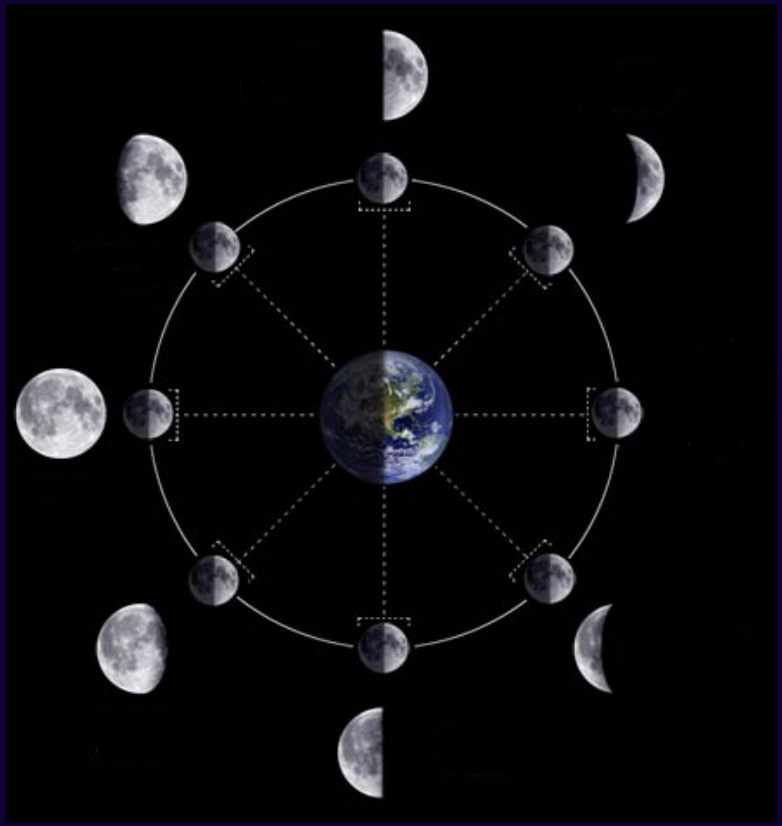
- Half of the Moon is always sunlit (facing toward the Sun)
- Half of the Moon is always visible from Earth (facing toward the Earth)
- The Moon orbits the Earth counterclockwise as seen from above the North Pole once a month
- The Earth rotates counterclockwise as seen from the North Pole (from west to east) once a day

To figure out the phase of the Moon:

- Draw the Earth, lunar orbit, Moon, and direction of sunlight
- Figure out which half of the Moon is lit and label it
- Figure out which half of the Moon we can see, and determine what it looks like

To know when it rises and sets:

- Figure out which half of the Earth is lit and label it, to tell you night/day
- Remember how the horizon works (I'll demonstrate)
- This will tell you what time of day the Moon rises and sets



You can figure all of this out by drawing pictures.

Do this on warmup problems, tutorials, exams...

My desk is covered with little cartoons I drew preparing for today's class!

Complete *Lecture Tutorials pp. 81-84.*

When the full moon is high in the sky, it is closest to:

A: 6AM
B: Noon
C: 6PM
D: Midnight

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

A: Crescent
B: Full
C: Half
D: Gibbous

Complete *Lecture Tutorials* pp. 85-88.

When the waxing half moon is just rising over the horizon, it is closest to:

A: 6AM
B: Noon
C: 6PM
D: Midnight

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

A: The right part
B: The left part
C: It depends on the time of day