

# The phases of the Moon

Astronomy 101  
Syracuse University, Fall 2017  
Walter Freeman

September 14, 2017

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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poverty and power, it melts them like ice.

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.

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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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Fate is against me in health and virtue, driven on  
and weighted down, always enslaved.

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

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

From *Carmina Burana*, a 13<sup>th</sup>-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!

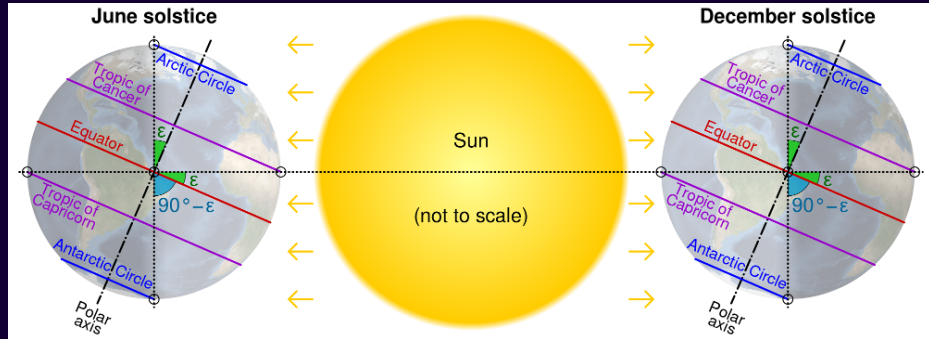
Set to music by Carl Orff (1937).

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

- My coaches will be holding clinic hours next week to help you all study. Times announced by email!
- I will be holding extended clinic hours next Wednesday to help anyone with last-minute questions.



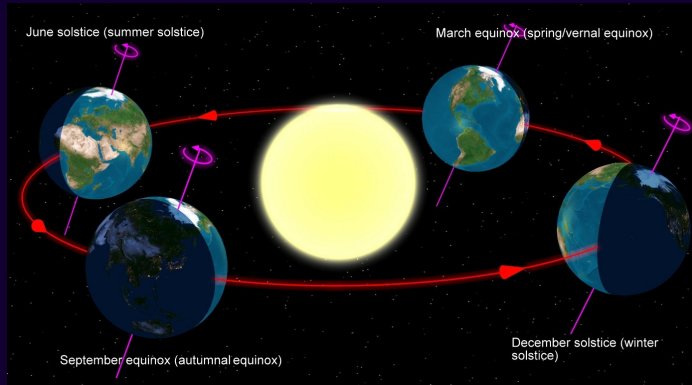
## Complete Lecture Tutorials pp. 93-98.



What if the Earth's axial tilt were increased to  $30^\circ$  from  $23^\circ$ ?

- 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

# The seasons



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

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
- 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?

## 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



Let's look at this two different ways:

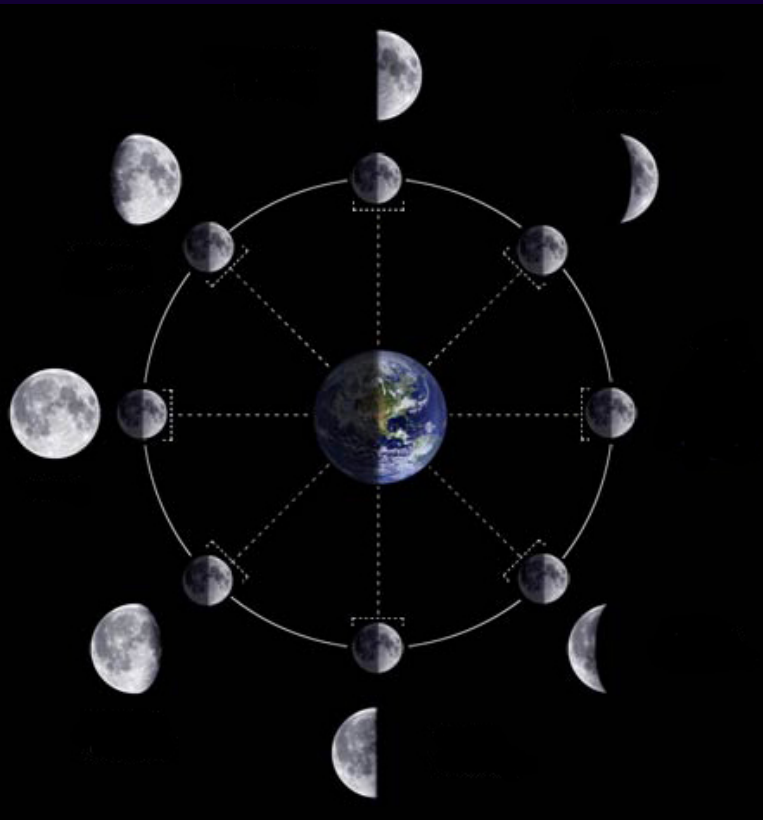
- With *Celestia*
- With things in this room

# 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

Notice:

- Half of the Moon is always sunlit
- Sometimes that half is pointed toward us: full moon!
- Sometimes that half is pointed away from us: new moon!



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

Don't answer this with your cards! Draw a picture illustrating your answer, then turn it in with your SUID/name. (Use your email if you've forgotten your SUID.)