

The phases of the Moon

Astronomy 101
Syracuse University, Fall 2022
Walter Freeman

September 15, 2022

Announcements

The prelabs for next week are in the Physics Clinic and available online.

Homework quiz 1

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- Some people did very well; others did less well.
- Remember in our class that 80-100% is an A, 65%-80% is a B, etc.
- We ask you to do difficult things, and don't expect you to do them all perfectly
- We will have opportunities for you to redo the homework quizzes:
 - At least one opportunity late in the semester
 - As part of Exam 1
 - In office hours
- The idea is that we want you to have these skills by the end of the semester; if you learn them “late”, you still learned them, and you should get credit.

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If you don't have the skills you need – gain those skills, don't fake them. We'll give you another chance.

Homework 2

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(We expect the logistics to be smoother this time!)

Exercise from last time

Work on the exercise we handed out last time on the seasons.
(We have a few more copies.)

As always, raise your hand if you have questions and we'll chat with you.

We'll take about 20 minutes on this, and then reconvene to talk about the Moon.

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.

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.

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 13th-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.

Tell me about this picture...



Tell me about this picture...



14mm f/1.8, 6 second exposure, ISO 6400

For those who aren't photographers: this means it was very dark.

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 (next week)
- Oddities: comets, meteors, novas, eclipses... (next week)



Image from SU AST101 student Comrade Wilhelm (on Discord), Fall 2020

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:

- Traditional Chinese calendar (what is today?)

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

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Image from AST101 student Timmyney (on Discord):

“Why do I see the Moon during daytime?”

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

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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?

The phases of the Moon

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

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!

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?

Note that:

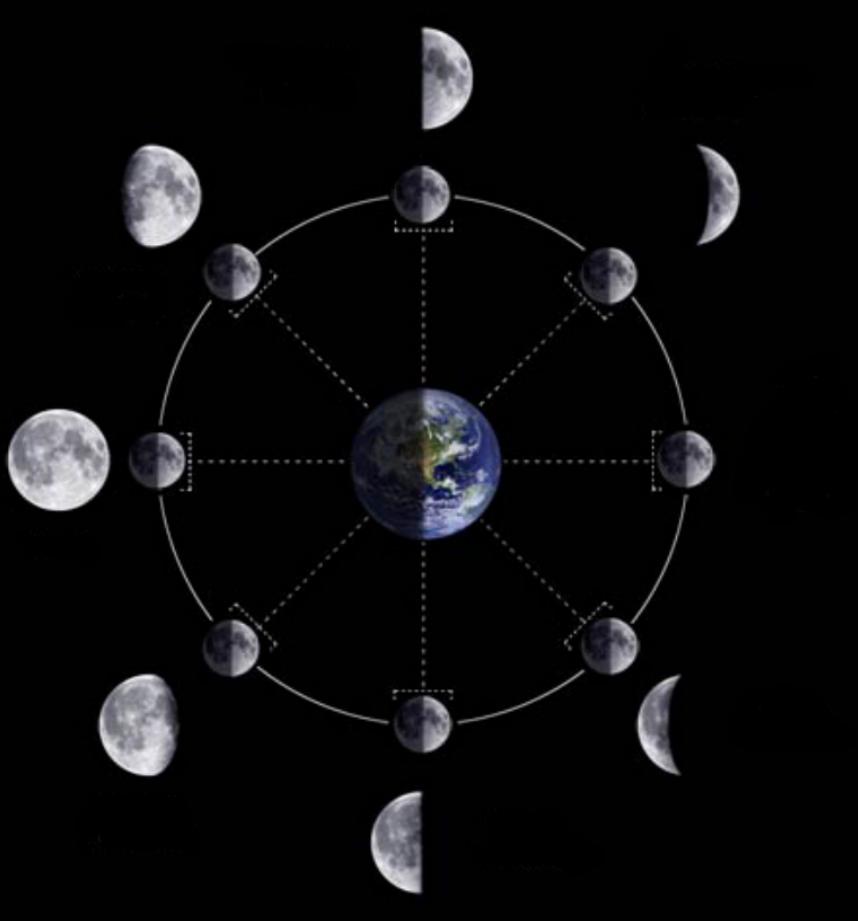
- Half of the Moon is always sunlit (facing toward the Sun)
- Half of the Moon is always visible from Earth (facing toward the Earth)
- The Moon orbits the Earth counterclockwise as seen from above the North Pole once a month
- The Earth rotates counterclockwise as seen from the North Pole (from west 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 inclass problems, your lab, exams...

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

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

What time of day does a full moon rise?

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A past test question

In *The Lord of the Rings*, Frodo and Sam traveled with Sméagol to Mordor. During part of their journey, they needed to hide from the Nazgûl, so they could only travel during absolute darkness – when neither the Sun nor the Moon were visible in the sky.

If the Moon was waxing gibbous, during what part of the day could they travel?

- A: For a short time after sunset
- B: For a short time before sunrise
- C: During the first half of the night
- D: During the last half of the night?

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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 from Syracuse, 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