The yearly motion of the sky

Astronomy 101
Syracuse University, Fall 2019
Walter Freeman

September 5, 2019

The Sun and the stars: the zodiac

This is the excellent foppery of the world, that, when we are sick in fortune, often the surfeit of our own behaviour, we make guilty of our disasters the sun, the moon, and the stars; as if we were villains on necessity; fools by heavenly compulsion... An admirable evasion of whore-master man, to lay his goatish disposition to the charge of a star!

—William Shakespeare, *King Lear*

For in that event [the stars dictated our fates], every single individual would lack the power to do anything he set his mind to, since something else draws him on – against his will – to be this and not to be that...

—Maimonides (c. 1135-1204),
Spanish / North African Sephardic scholar

Announcements

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- The takehome labs will also be assigned next Tuesday

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- The takehome labs will also be assigned next Tuesday
- What should you do if you must miss your lab?
  - If it's for a *good reason* (illness, emergency, academic/professional conflict, family commitment)...
  - Look at the lab schedule and find another section/sections you might want to attend
  - Email or Slack-message both your TA and the TA the other section
  - Tell them what is going on, and ask if there are any empty seats in their section
  - If both TA's approve the swap, attend the other section
  - We will take care of entering grades; it is your responsibility to get your work back from the other TA

Ask the Physicist: non-carbon-based life?

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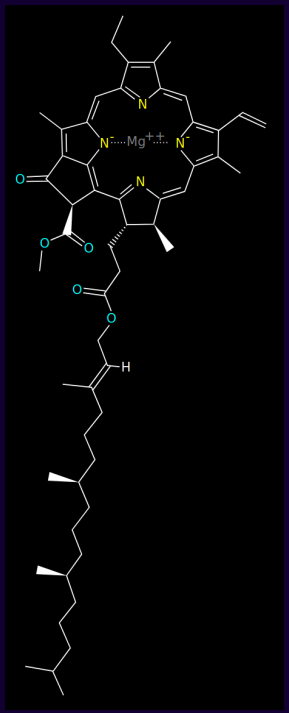

Biochemistry on Earth needs:

- A way to make complicated structures
- Something to dissolve them in so they can move around

Carbon is our ticket to complicated structure:

- It can form four bonds at once (4/8 valence electrons)
- Carbon chains are the backbone of organic molecules

Water is a good solvent:

- It is liquid at temperatures on Earth
- It dissolves most things
- It is made of very common atoms (hydrogen and oxygen)

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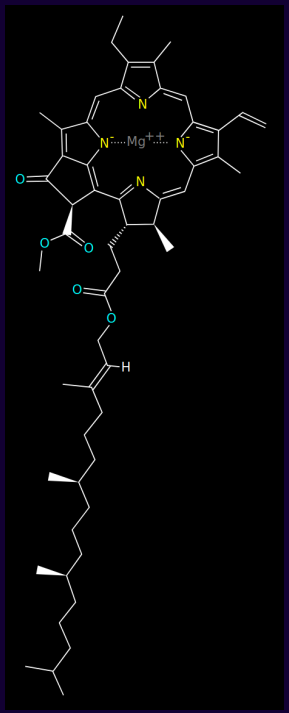


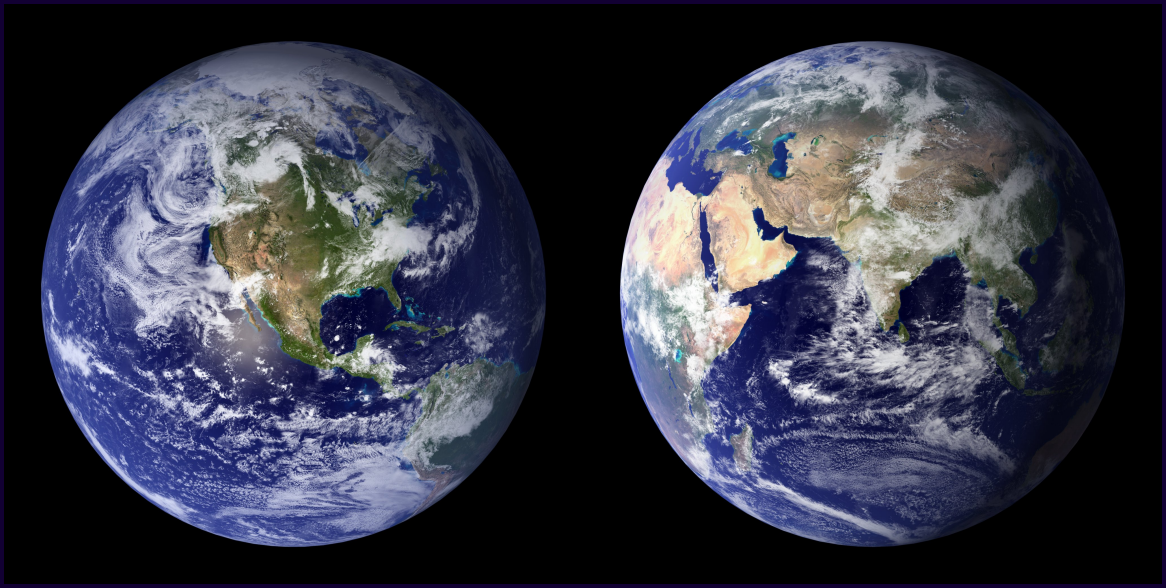
Other "tetravalent" (four-bond) atoms could also be the basis for structures:

- Silicon and germanium are both also tetravalent
- Silicon is 1/10 as common as carbon and germanium is 1/200,000 as common
- Complex carbon molecules have been observed in space...
- ... but silicon ones haven't.

There are other solvents:

- Ammonia is another possibility of an ionic solvent
- There are methane and ethane lakes on the surface of Titan

Complex chemistry based on these would need very different temperatures and pressures than carbon/water life!



What kind of world is this? What *can't* you see?

Help sessions

Questions about the *Lecture Tutorials?* Come ask us for help.

This is the absolute very best thing you can do to study for my class.

Come by the Clinic, Physics Building 112, and ask questions!

I also have office hours from 9:30-12; come see me in room 215!

Today: consequences of the Earth's **revolution**:

- How is the Sun different from the other stars?
- What's this zodiac business?
- What does it mean for the Sun to be "in Aries"?

Today: consequences of the Earth's **revolution**:

- How is the Sun different from the other stars?
- What's this zodiac business?
- What does it mean for the Sun to be "in Aries"?
- We will see how this is only complicated because of **how we keep time**

Which is true about the Sun?

A: The celestial sphere model predicts its motion exactly

B: The celestial sphere model predicts its daily motion, but isn't accurate for longer times

C: The celestial sphere model is completely wrong for the Sun

Why is the celestial sphere model a bit wrong for the Sun?

A: The Sun is close enough that the Earth's movement matters, unlike for other stars

B: The Sun lies on a different celestial sphere than the stars, which turns at a different rate

C: Angels push the Sun around on the celestial sphere, so it moves

D: The Sun is close enough that we notice its movement, unlike the other stars

A demonstration

Let's use *Stellarium* to revisit the same time every night – say, midnight.

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... What's wrong?

... isn't the celestial sphere supposed to rotate once per day?
... Why are the stars moving?
... What's wrong?

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Now let's look at the sky during the *daytime*, pretending the atmosphere is gone.

Which moves more, the sun or the stars?

- The Sun just moves up and down a little bit, and the stars spin!
- ... why is this?

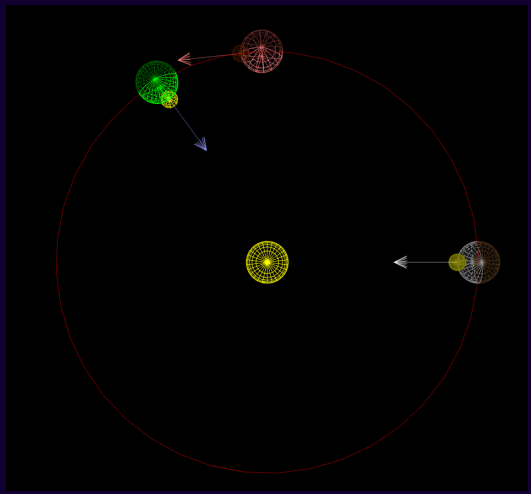
Let's animate this and try to understand.

Work through the *Lecture Tutorials*, pp. 7-9.

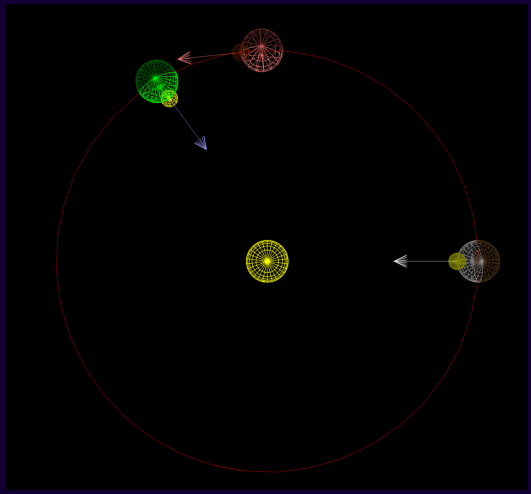
We will talk about something else after this.

If the Earth is in the white position here, and the observer is the yellow dot (with the arrow sticking out of their head), what time is it?

A: Noon
B: Midnight
C: Sunrise
D: Sunset



Which image shows the position of the Earth **exactly** one day later?



A: The red one

B: The green one

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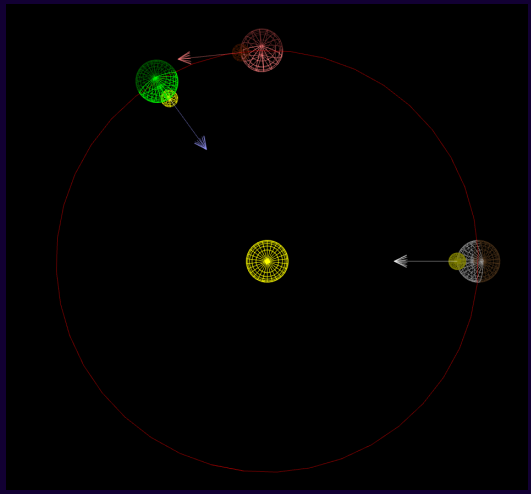

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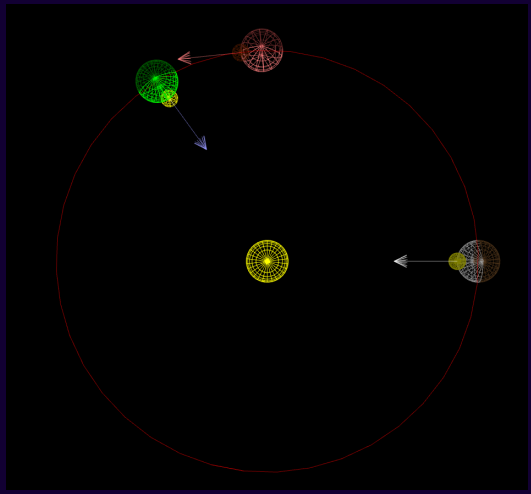

A: The red one
B: The green one
C: Depends on what you mean by “a day”
D: The Earth moves? BURN THE HERETIC!

There are *two kinds* of day!

- Solar day: judged by the position of the Sun
- Sidereal day (sih-dee-ree-al): judged only by the rotation of the Earth with respect to the stars

Work through the *Lecture Tutorials*, pp. 11-12.

We will talk about something else after this.

Two kinds of day!

Demo in *Stellarium:*

In one solar day...

- The stars move a lot
- ...since the Earth isn't pointed in the same direction
- The Sun moves higher or lower in the sky a little bit
- Exactly 24h

In one sidereal day...

- The stars don't move at all
- ... since the Earth is pointed in the same direction
- The Sun moves a lot, since the Earth has moved
- A little bit less than 24h

Complete pp. 12-16.

If you don't have time to finish, that's okay. Finishing this is great practice at home, though!