

The yearly motion of the sky

Astronomy 101
Syracuse University, Fall 2018
Walter Freeman

September 13, 2018

Winter is coming.

—Watchwords of House Stark
(*A Song of Ice and Fire*, George R. R. Martin)

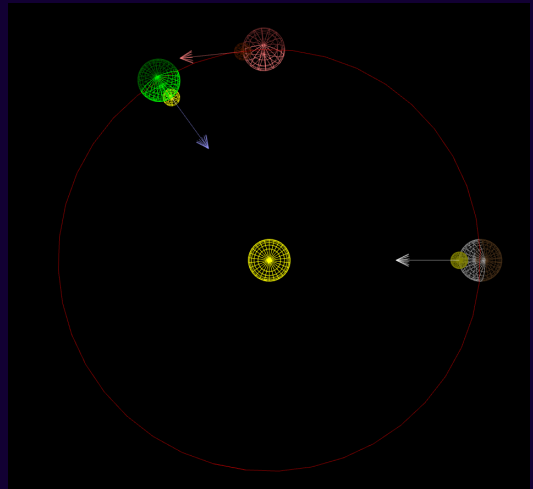
- Paper 1 assignment is up – description is on the website.
Due: October 1
- Exam 1 date: Tuesday, September 25
- Course calendar updated to reflect this change

Today's agenda

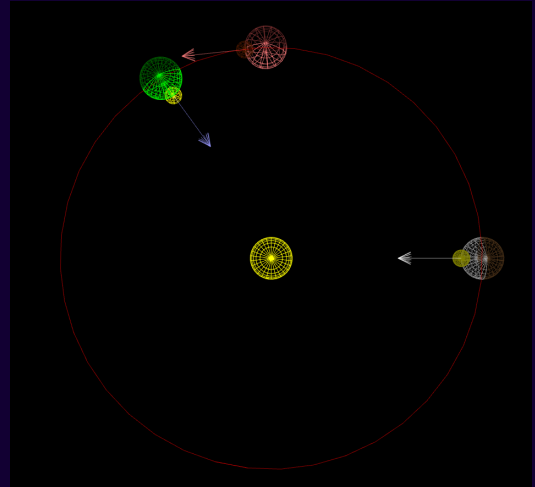
- Review issues related to the definition of a day
 - We started this for the 12:30 section, but not for the 2:00 section
 - This is the Lecture Tutorial section on the *Solar and Sidereal Day*
- Talk about the seasons:
 - Why are there seasons?
 - Why are they different in different parts of the world?

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



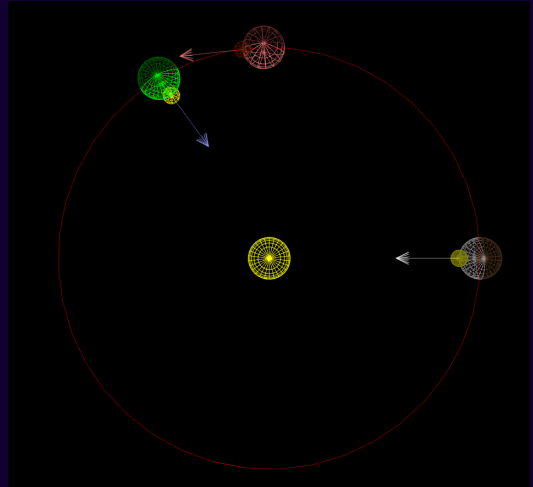
Which image shows the position of the Earth **exactly** one day later?



A: The red one

B: The green one

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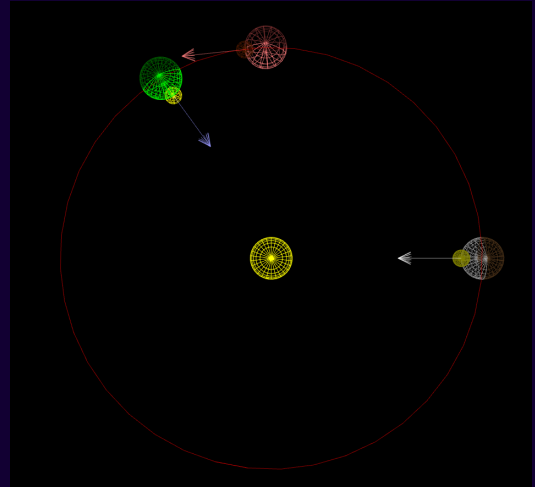


A: The red one

B: The green one

C: Depends on what you mean by “a day”

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



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.

After this, we'll talk about the seasons.

People often think that the seasons are caused by the changing distance to the Sun, but this isn't the case. How can we know this?

The maximum height of the sun in the sky is lower in winter than summer. It is more important how direct the sunlight is based on the tilt of the earth, rather than distance.

–James

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The seasons are opposite in the southern hemisphere so how could it be summer here but winter in the Southern Hemisphere if we are closer to the sun?

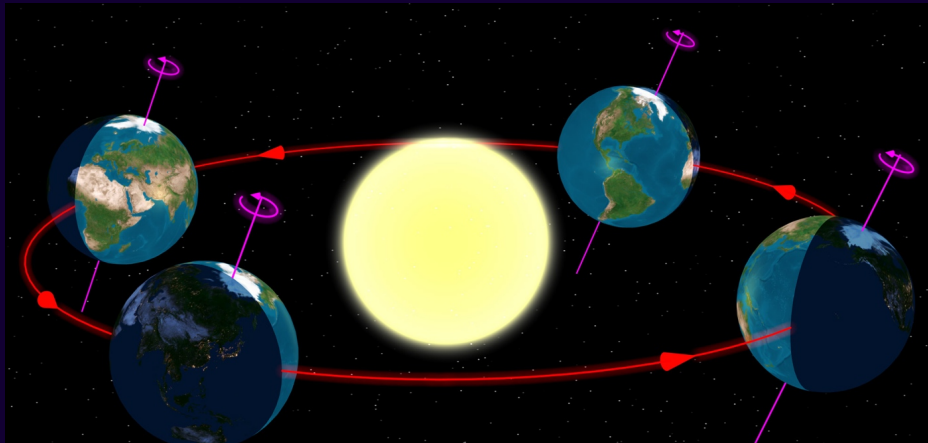
–Zachary

The tilt of the Earth's axis

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

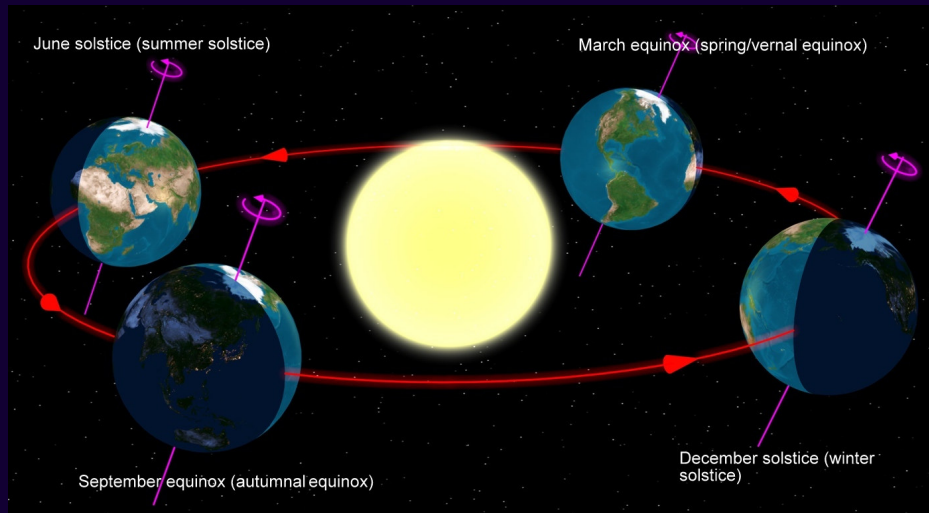
It's tilted by 23.4 degrees.

The axis of rotation changes **only very slowly** (over millennia) – we talked about this last time in response to your questions about the Zodiac.



The solstices and equinoxes

We give special names to the points in Earth's orbit where the Earth's axis is tilted directly toward/away from the Sun:



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:



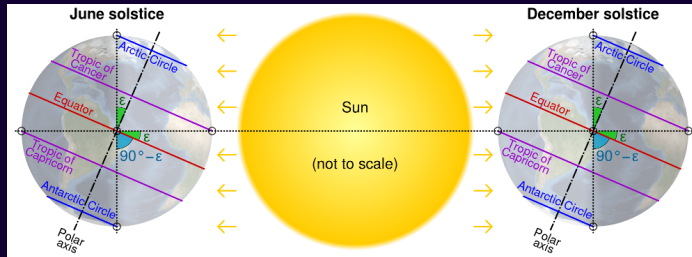
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Many cultures have ascribed significance to the annual movement of the Sun.

... but another is El Castillo, in Chichen Itza (Yucatán, Mexico)



The tropics

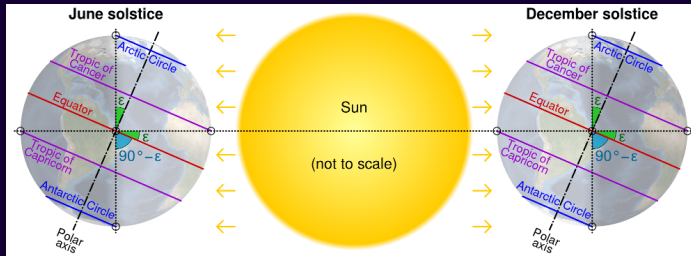


The region on Earth where the Sun alternates between the northern sky and the southern sky is called the **tropics**.

- The northern boundary is called the **Tropic of Cancer**
- The southern boundary is called the **Tropic of Capricorn**
- These occur at 23.4° N/S latitude

On the June solstice, the sun reaches the zenith along the Tropic of Cancer.
On the December solstice, the sun reaches the zenith along the Tropic of Capricorn.

The Arctic and Antarctic



The region where the sun either never rises or never sets during part of the year is called the Arctic (north) or Antarctic (south).

- North of the Arctic Circle, the sun never rises on the December solstice, and never sets on the June solstice.
- South of the Antarctic Circle, the sun never sets on the December solstice, and never rises on the June solstice.
- These occur at $90 - 23.4^\circ = 66.6$ N/S latitude

What consequences does this have on Earth?

Thinking only about noontime (when the sun is highest in the sky), will the sun ever reach the zenith in Syracuse (latitude 43° N)?

A: Yes

B: No

What consequences does this have on Earth?

Thinking only about noontime (when the sun is highest in the sky), will the sun ever reach the zenith in Lima, Peru (latitude 12° S)?

A: Yes

B: No

What consequences does this have on Earth?

Which is true about the Sun on June 21 in Svalbard (latitude 78° N)?

A: It will never rise

B: It will never set

C: It will reach the zenith of the sky

D: It will travel from east to west in the northern sky

E: It will travel from east to west in the southern sky

Complete Lecture Tutorials pp. 93-98.

What would happen 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: Another Stark would meet a bad end