The seasons

Astronomy 101
Syracuse University, Fall 2019
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September 12, 2019

Announcements

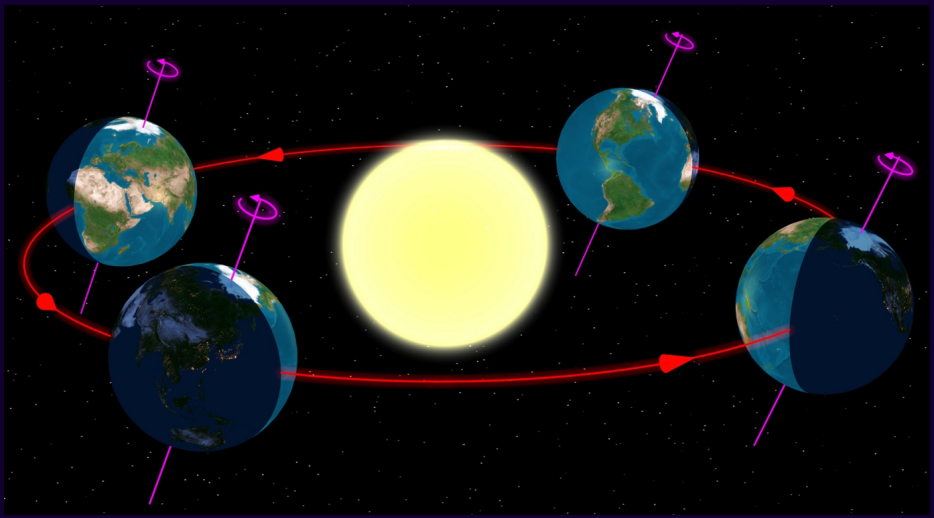
- Paper 1 has been assigned (and we'll talk about it)
- If you want to get a head start on studying for Exam 1, the study guide is up
- The prelab isn't quite finished yet; it will be done this afternoon or evening

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).



Let's look at this in animations

What consequences does this have for the sky?

As the year progresses, thinking only about noon, will the Sun:

I. Move higher and lower in the sky
II. Move east/west relative to the stars

A: I only
B: II only
C: I and II
D: None of the above

A demonstration in Stellarium

Let's use *Stellarium* to examine the Sun at different times of year.

Notice:

- The Sun is higher or lower in the sky depending on the time of year
- The Sun moves westward with respect to the stars:
  - Every *solar day*, the Sun's east/west position (azimuth) stays fixed, but the stars move East
  - Every *sidereal day*, the stars' position stays fixed, but the Sun moves West

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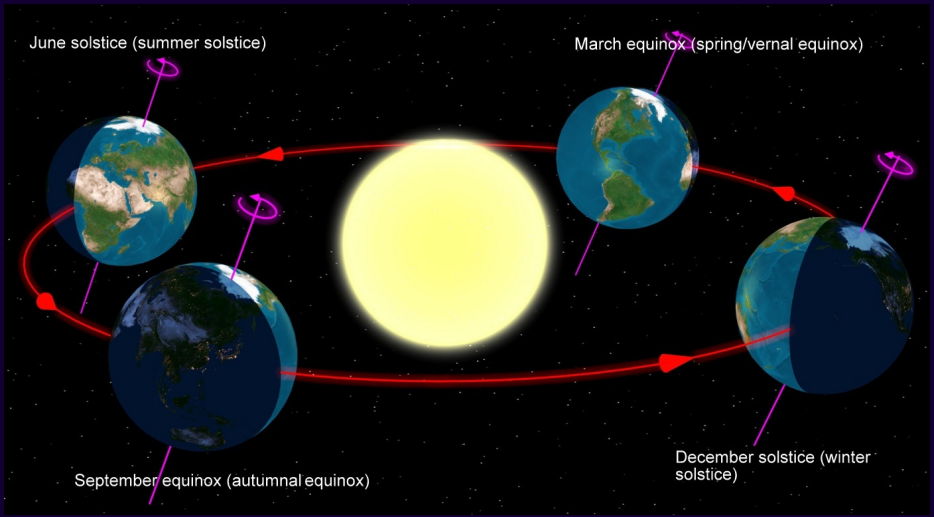
  - Every *solar day*, the Sun's east/west position (azimuth) stays fixed, but the stars move East
  - Every *sidereal day*, the stars' position stays fixed, but the Sun moves West
  - "One solar day is a bit more than one sidereal day"
  - "One sidereal day is a bit less than one solar day"

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:

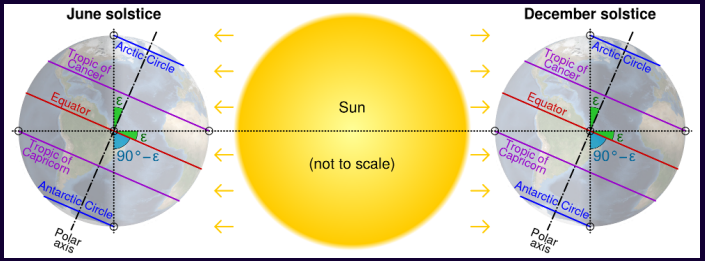


The solstices and equinoxes

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

Perhaps the most famous artifact of this is Stonehenge:

The tropics

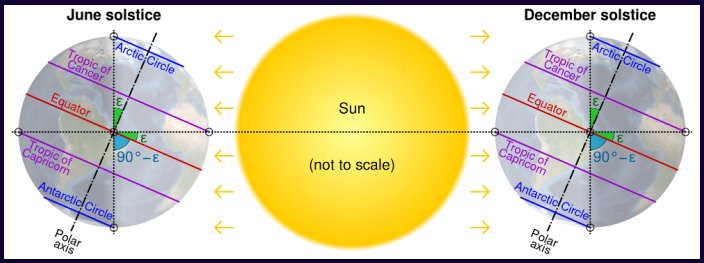


The region on Earth where the Sun alternates between the northern sky and the southern sky is called the tropics.

- 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)?

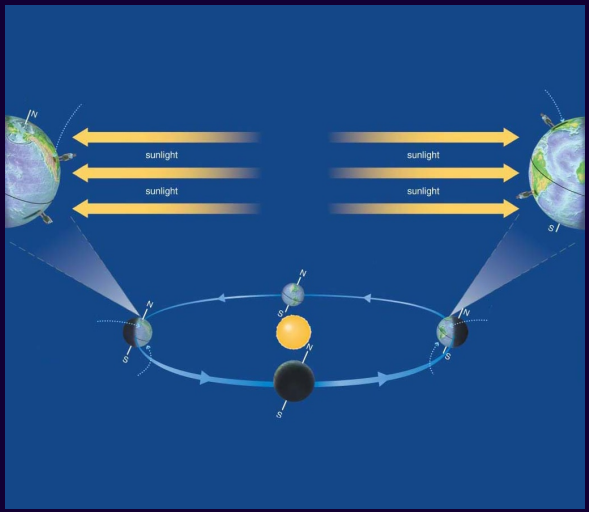
A: It will never rise
B: It will never set
C: It will reach the zenith of the sky
D: It will travel from east to west in the northern sky
E: It will travel from east to west in the southern sky

The seasons

The tilt of the Earth toward/away from the Sun controls the amount of sunlight we get at different times of year!

This happens for two important reasons. Thinking about the Northern hemisphere...

- The Sun is visible in the sky for longer in June than in December
- Sunlight strikes the Earth more directly in June than in December



Complete Lecture Tutorials pp. 93-98.

The seasons

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

Let's look at some questions from last year's Exam 1...