

Astronomy 122



This Class (Lecture 4):

The Glorious Dance

Next Class:

The Solar System

Homework #1 due Sun night!

Music: *Under the Milky Way* – The Church

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Outline



- Seasons
- Precession
- The Moon's Phases

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Celestial Sphere



- [..\..\..\animation\celsphere1.avi](http://brahms.phy.vanderbilt.edu/~rknop/astromovies/celsphere1.avi)



<http://brahms.phy.vanderbilt.edu/~rknop/astromovies/celsphere1.html>

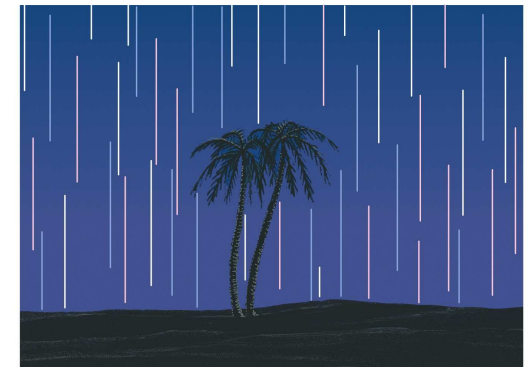
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At the Equator



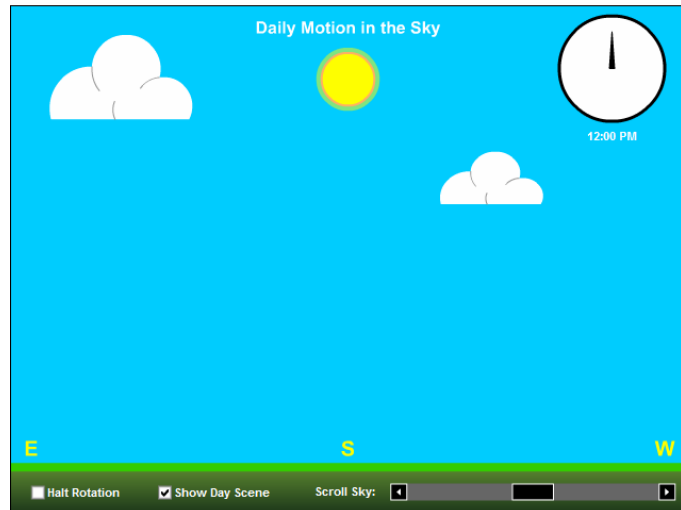
- Polaris is right on the horizon
- Stars rise straight up from the eastern horizon and set straight down on the western horizon



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Diurnal Rotation



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Question



You observe a star rising directly to the East from Urbana. When this star reaches its highest position above the horizon, where will it be?

- High in the northern sky
- High in the eastern sky
- High in the southern sky
- High in the western sky
- Directly overhead

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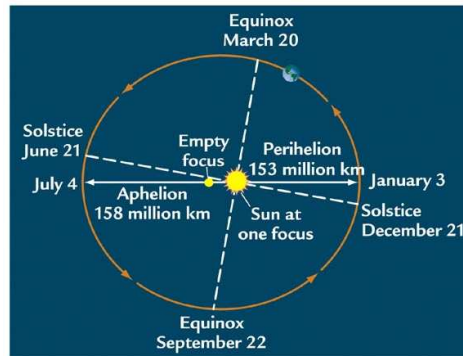
What Causes the Seasons?



~~The Earth is closer to the Sun in the summer.~~

No!

- While the Earth's orbit is not perfectly circular, it is actually closest to the Sun in *January*
- Also, summer in Northern Hemisphere is winter in Southern and vice versa



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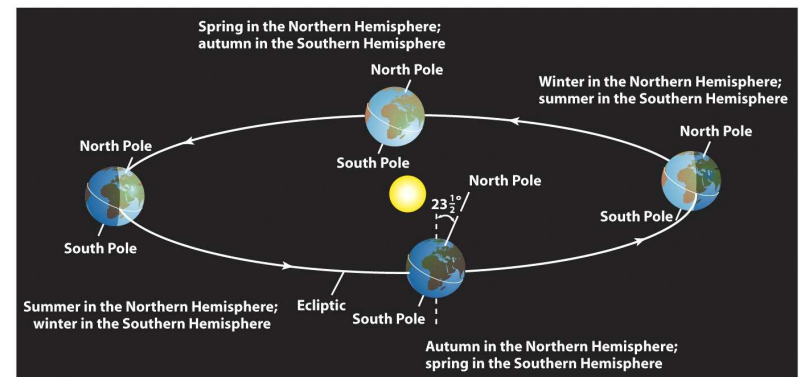
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What Causes the Seasons?



So what does cause the seasons?

- It's the tilt of the Earth's spin axis
 - Affects the length of day **and** intensity of sunlight



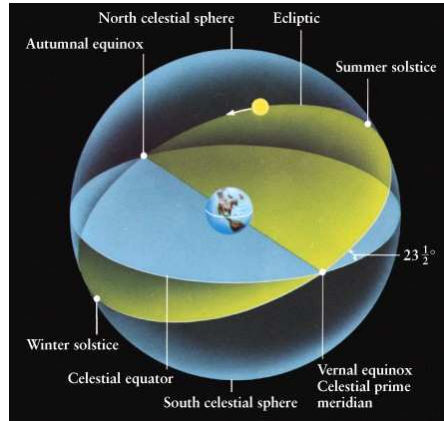
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The Sun's Path: The Ecliptic



- If the Earth was not tilted, the Sun would always be on the celestial equator.
- BUT, we are tilted. This makes the path that the Sun seems to move on (over the Year) tilted at 23.5 degrees.
- The constellations the Sun blocks are the Zodiac constellations.



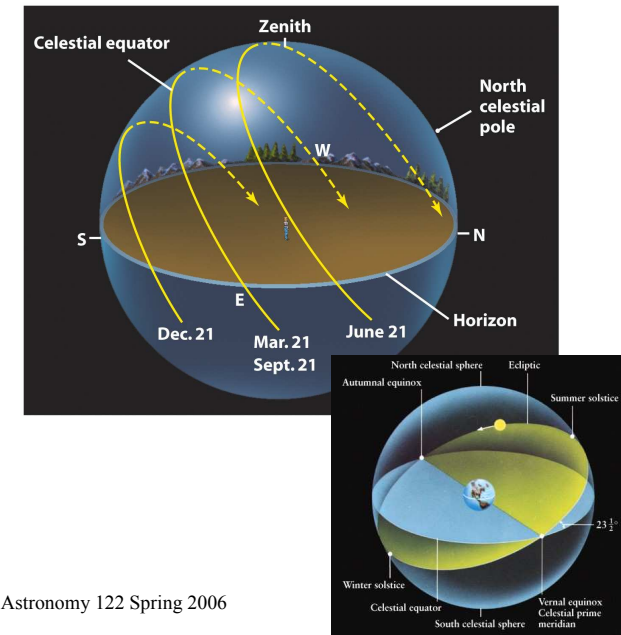
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Sun's Daily Paths



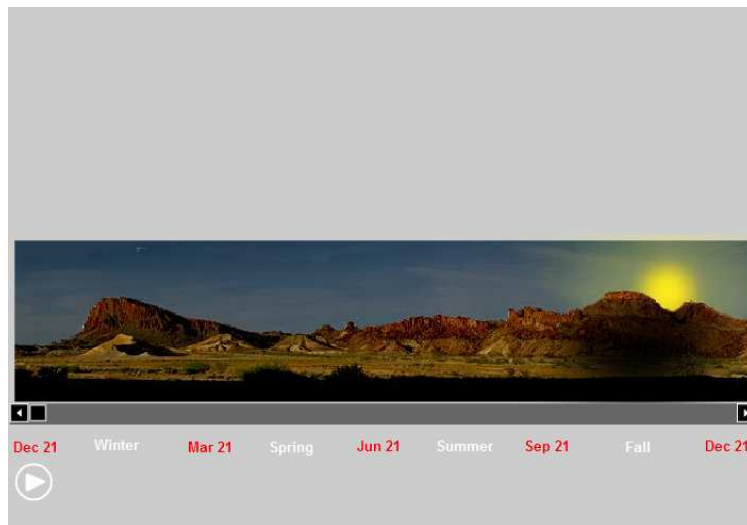
- In the summer, the Sun is north of the celestial equator
 - Long days
 - High in the sky
 - Direct sunlight
- In the winter, it is south of the celestial equator
 - Short days
 - Low in the sky
 - Indirect sunlight



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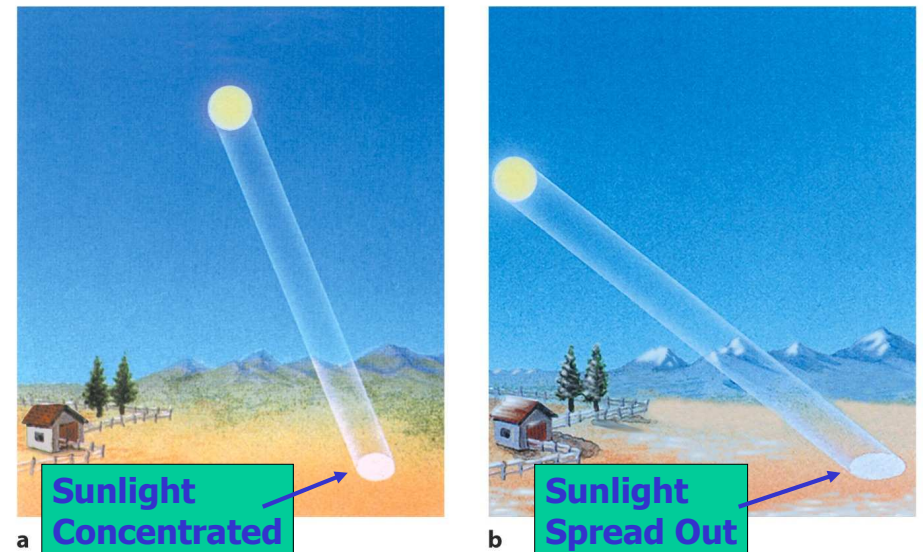
Watching the Sun



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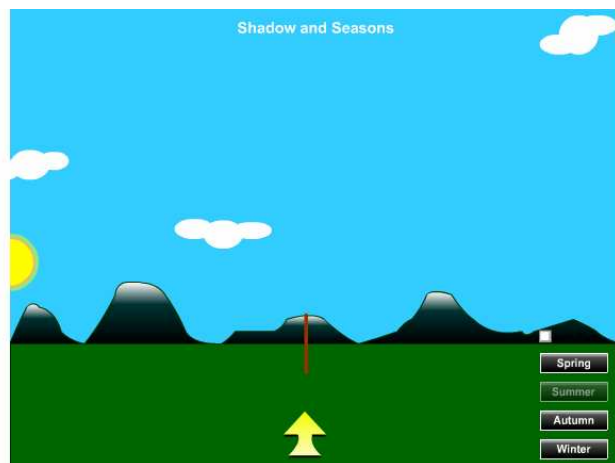
Summer vs. Winter



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The Shadows of Seasons



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Seasons Around the World



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Question



Where is the Sun at noon in December from Urbana.

- a) The Sun is low in the Southern Sky.
- b) The Sun is low in the Northern Sky.
- c) The Sun is low in the Eastern Sky.
- d) The Sun is low in the Western Sky.
- e) The Sun is directly overhead (the Zenith).

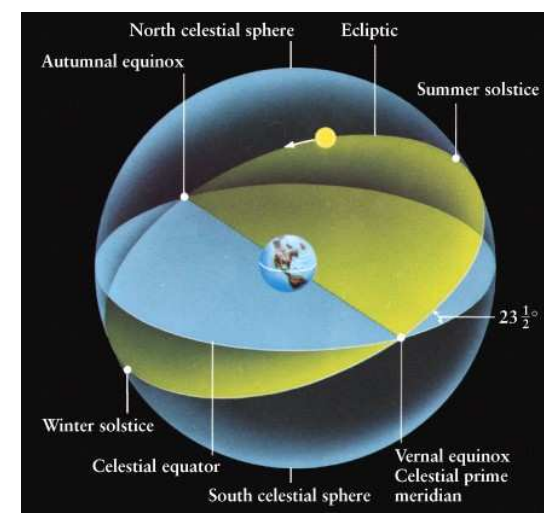
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Solstices and Equinoxes



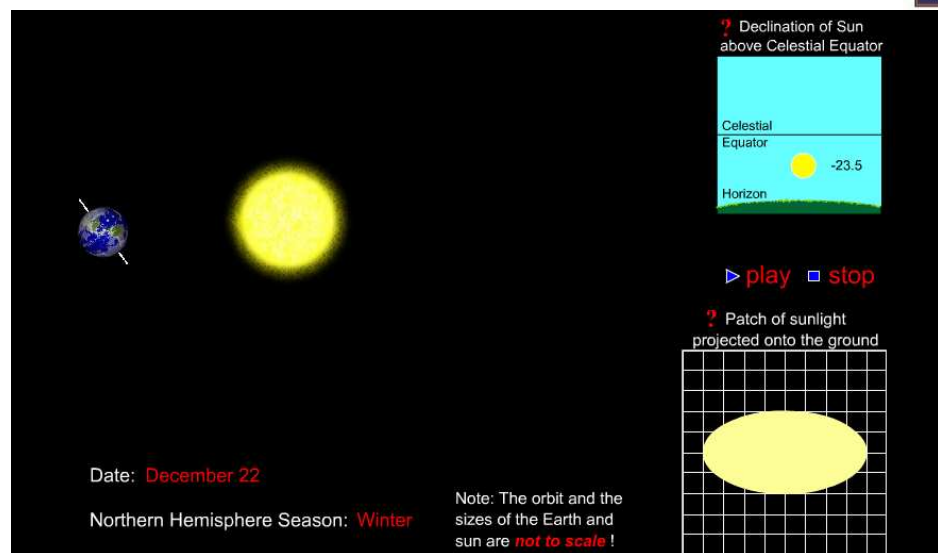
- *Solstices*
 - Most northern and southern points on the ecliptic
 - Longest and shortest amounts of daylight
- *Equinoxes*
 - When the ecliptic crosses the celestial equator
 - Daytime and nighttime equal



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Seasons Animation



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Solstices and Equinoxes



- Winter Solstice – December 21
 - 9 hours of daylight, 15 hours of night
- Spring (“Vernal”) Equinox – March 21
 - 12 hours of daylight, 12 hours of night
- Summer Solstice – June 21
 - 15 hours of daylight, 9 hours of night
- Fall (“Autumnal”) Equinox – Sept 21
 - 12 hours of daylight, 12 hours of night

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Question



What causes it to be so cold in Urbana in the Winter?

- The Sun is farther away.
- The Sun goes through 1 year cycles of hot and cold.
- The Earth’s rotation axis is tilted.
- The Sunlight is less concentrated and the days are shorter.
- The Sunlight is more concentrated and the days are longer.

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The Tropics



- Over the year, the Sun varies from 23.5° north to 23.5° south of the celestial equator
 - If you live between 23.5° N and 23.5° S latitude, the Sun can reach the zenith – directly overhead
 - Sun never gets directly overhead in Urbana, 40° N
- Between 23.5° N and 23.5° S latitude is called the tropics
 - 23.5° N – Tropic of Cancer
 - 23.5° S – Tropic of Capricorn

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The Arctic and Antarctic



- Above 66.5° N and below 66.5° S latitudes ($90 - 23.5 = 66.5$), the Sun can be *circumpolar*!
- North of 66.5° N
 - The Arctic
- South of 66.5° S
 - The Antarctic

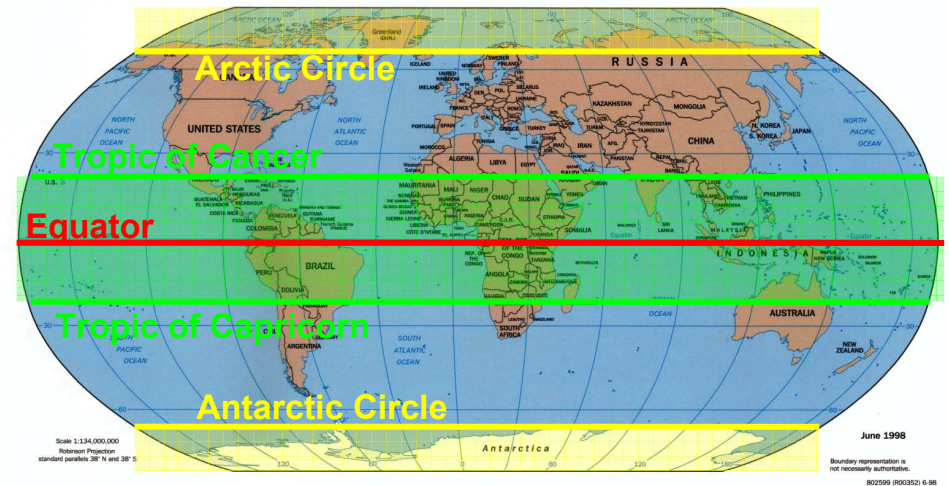


Midnight Sun in Barrow, Alaska

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Tropics and Arctics



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Question



We've argued today that the two effects that cause the seasons are:

- The duration of the day
- The tilt of the Earth's axis wrt the plane of the Ecliptic: indirect vs. direct sunlight

Which one of the two do you think is the dominant effect and why?

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Question



What do you think is the dominant effect, length of day or concentration of sunlight?

- a) Length of Day.
- b) Concentration of sunlight.

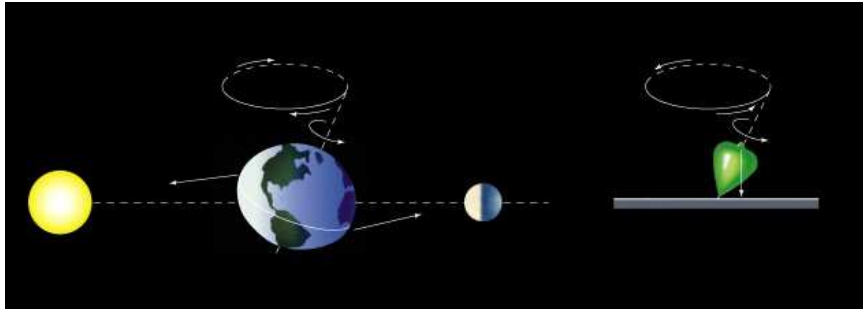
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Precession



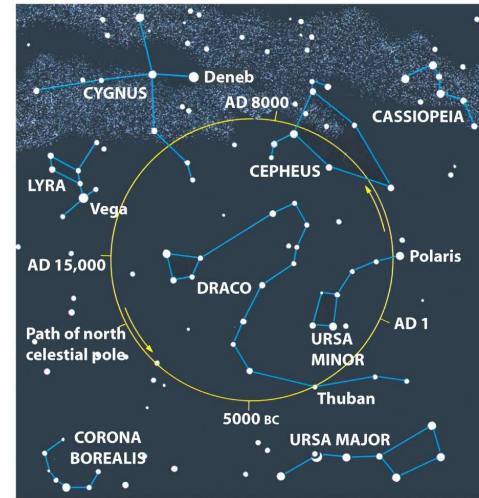
- As the Earth spins it also wobbles slowly, like a top
 - This wobble takes 26,000 years
 - Geek-speak: Called **precession**



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What Does This Mean?



- Polaris won't always be the North Star!
- In the time of the Egyptian pharaohs, it was Thuban
- In about 13,000 AD it will be Vega (sort of)

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“Thinking Cap” Question



June 21st is the summer solstice and December 21st is the winter solstice. However, they are not the hottest and coldest days of the year (those occur in July and January, on average). Why is this?

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