

Astronomy 122

Section 1– TR 1300-1350

1320 Digital Computer Laboratory

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Office: Astro Building #218
Office Hours:
T 10:30-11:30 a.m. or
by appointment

This Class (Lecture 2):

The Night Sky

Next Class:

The Glorious Dance

Homework #1 due next Fri!

<http://eeyore.astro.uiuc.edu/~lwl/classes/astro122/spring06/>

Music: *Fly Away* – Lenny Kravitz

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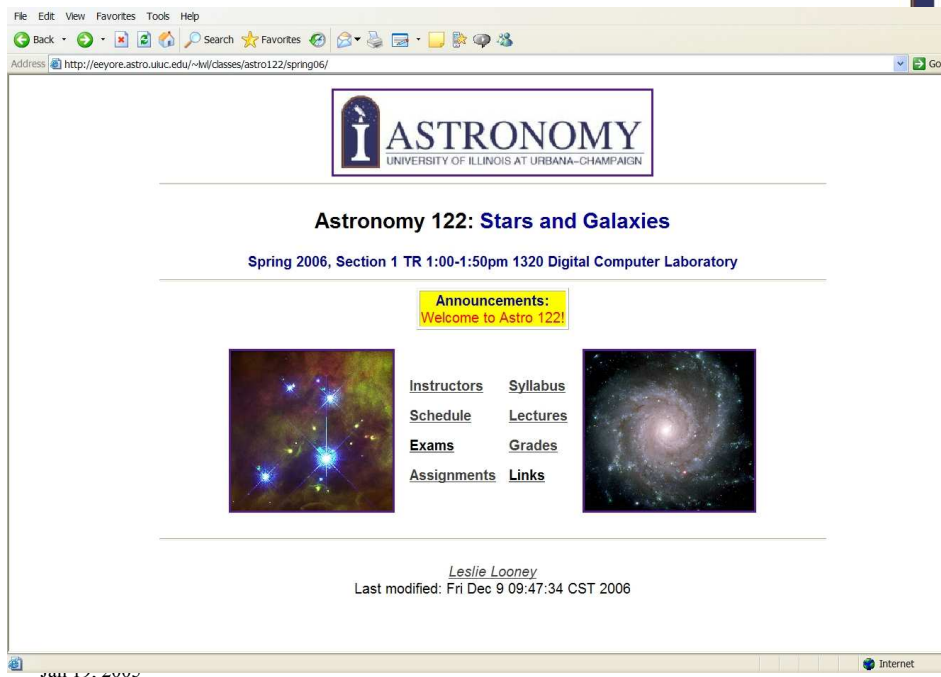
Outline

- Constellations
- The Celestial Sphere
- Motions of the Sky
- Seasons

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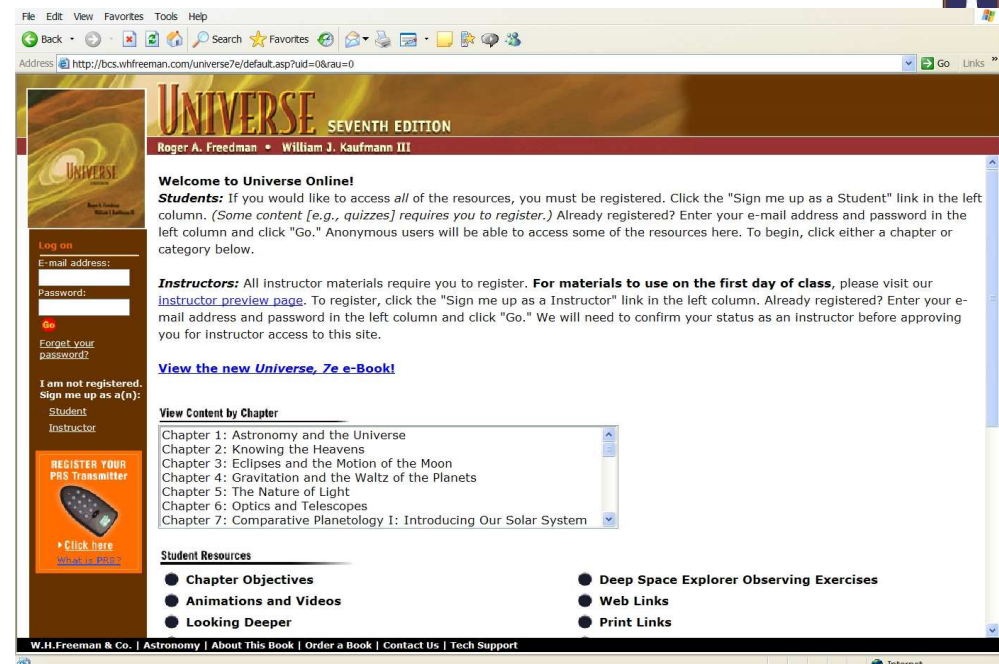
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Class Webpage



The screenshot shows a web browser window with the address <http://eeyore.astro.uiuc.edu/~lwl/classes/astro122/spring06/>. The page features the Astronomy 122 logo (a stylized 'I' with a star) and the text "ASTRONOMY UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN". Below the logo, the page title is "Astronomy 122: Stars and Galaxies" and the subtitle is "Spring 2006, Section 1 TR 1:00-1:50pm 1320 Digital Computer Laboratory". A yellow box contains the announcement: "Announcements: Welcome to Astro 122!". To the left of a central navigation menu is a small image of a star field, and to the right is a small image of a spiral galaxy. The navigation menu includes links for Instructors, Syllabus, Schedule, Lectures, Exams, Grades, Assignments, and Links. At the bottom, it says "Leslie Looney" and "Last modified: Fri Dec 9 09:47:34 CST 2006".

Book Website



The screenshot shows a web browser window with the address <http://bcs.whfreeman.com/universe7e/default.asp?uid=0&rau=0>. The page features the "UNIVERSE SEVENTH EDITION" logo by Roger A. Freedman and William J. Kaufmann III. Below the logo, the text "Welcome to Universe Online!" is followed by instructions for students and instructors. A "Log on" section includes fields for E-mail address and Password, and a "Go" button. A "View the new Universe, 7e e-Book!" link is also present. A "View Content by Chapter" dropdown menu is shown, listing chapters from 1 to 7. At the bottom, there are "Student Resources" including Chapter Objectives, Animations and Videos, Looking Deeper, Deep Space Explorer Observing Exercises, Web Links, and Print Links. The footer includes the publisher's name "W.H. Freeman & Co." and various links like "About This Book", "Order a Book", "Contact Us", and "Tech Support".

Grades



Requirement	Percentage of Grade		Points
Class Participation Exercises (will drop 1 or 2 or 3)		10%	100
Homework Assignments (best 10 out of 11)	10 x 3% each	30%	300
Night Observing Report	5% each	5%	50
Midterm Hour Exam		20%	200
Final Exam		35%	350
Total		100%	1000

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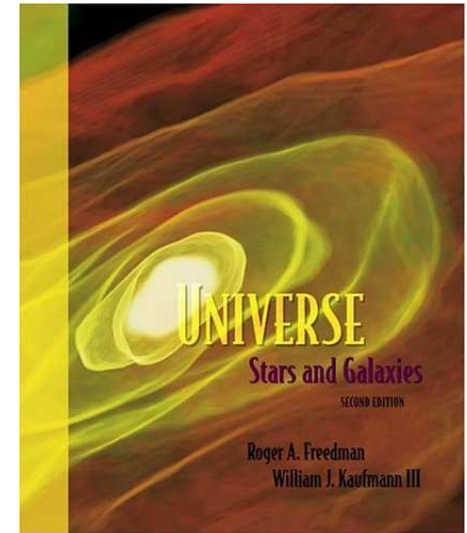
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Text



Text: *Universe: Stars and Galaxies*, by Roger Freedman & William Kaufmann III, W.H. Freeman & Co., 2004.

A solid text and average priced. There is also an electronic version available that is cheaper than a new copy.



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Homework



- There will be 11 homework assignments. The best 10 will be **30%** of your final grade!
- These are meant to sharpen your thinking on the material covered in lecture, to develop physical intuition and quantitative skills, and to help prepare you for the exams.
- Homework is due Friday night (assuming we do Compass). Check assignment for details.
(<http://eeeyore.astro.uiuc.edu/~lwl/classes/astro122/spring06/hw.html>)

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Night Observing



- Sessions will be held at the Campus Observatory
- **Night:** Check web for posted dates 8-10pm (1 hr)
- Report:** A PDF form is available on the class website
 - Print it out and **bring it with you**
- **Weather:** Some sessions may be cancelled if cloudy
 - Check the website for updates



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Yuck-- Exams



Exams

- Exams will consist of problem solving and essay questions. There will be a single midterm and a comprehensive final exam. Dates are as follows.
- Midterm: Thursday, March 9th
- Final Exam:
1:30-4:30 pm, Friday May 5th

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A Sky Full of Stars



On a clear night at a dark site (away from city lights), about how many stars can we see with the naked eye?

- 1) **Hundreds**
- 2) **Thousands**
- 3) **Millions**
- 4) **Billions**

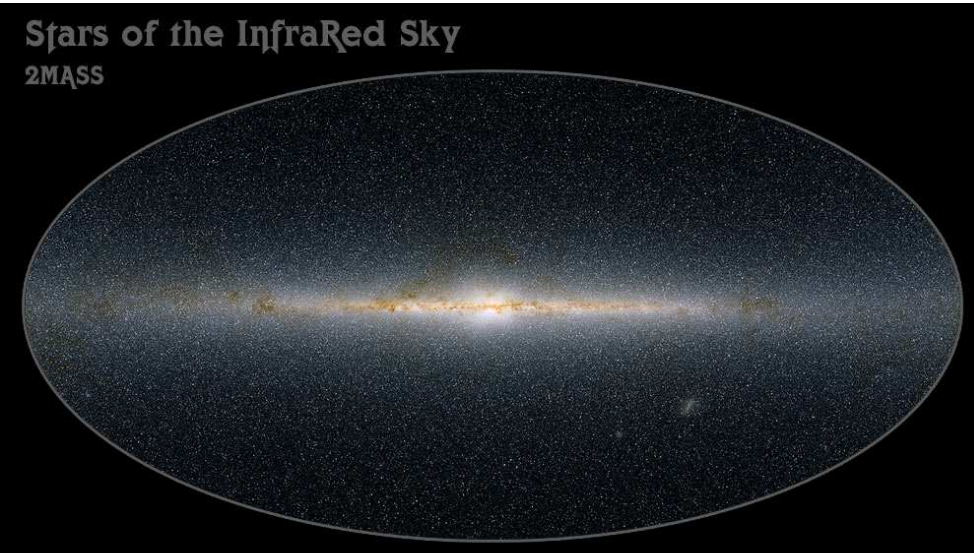
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It's Full of Stars!



Stars of the InfraRed Sky
2MASS



http://coolcosmos.ipac.caltech.edu/image_galleries/legacy/2m_allsky_stars/
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A Sky Full of Stars



- **The average person on a clear night can see about 3000 stars**
 - 6000-8000 total visible (about half are below the horizon)
 - All in our Galaxy and relatively close to us
- **In late July 2003, the total number of stars in the observable Universe was estimated to be:**
 - 70 sextillion (70 thousand million million million or 7×10^{22})
 - About 10 times the number of grains of sand on all of the Earth's beaches and deserts

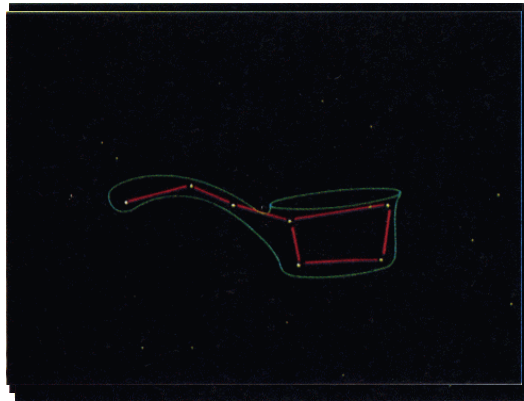
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Constellations

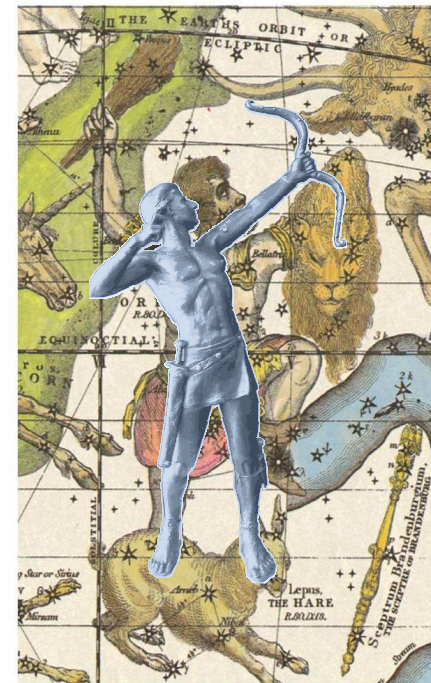
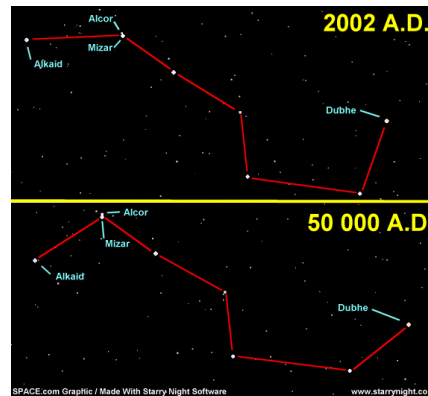


- **Constellations** -- a visual grouping of stars
 - named after gods, heroes, and animals



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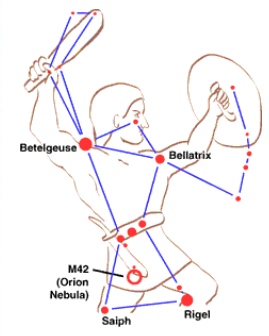
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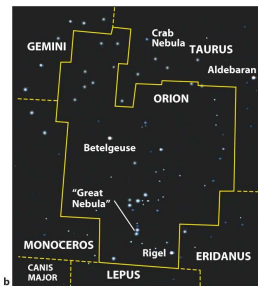
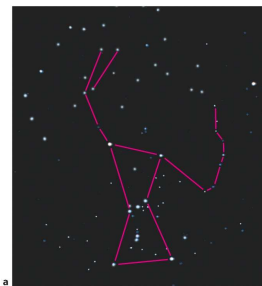
Orion: The Hunter



Constellations & Asterisms



- Today we have 88 “official” constellations
 - 50 ancient, 38 modern
 - Every region of the sky “belongs” to an official constellation



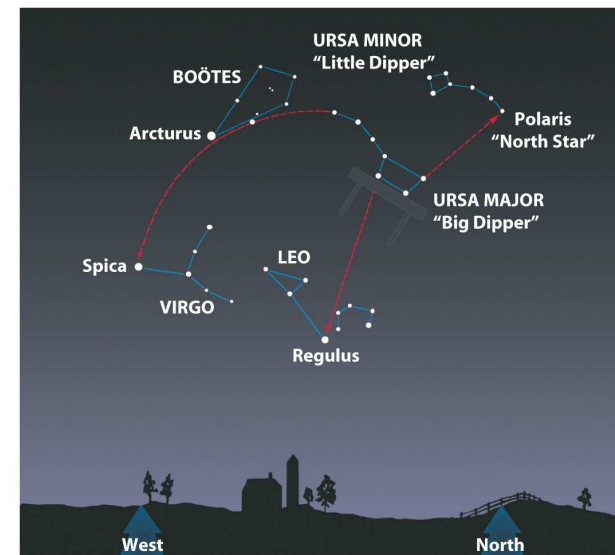
- Commonly recognized, but “unofficial” patterns are called **asterisms**
 - Parts of constellations
 - Big Dipper, Great Square, etc..
 - Cross-constellation patterns
 - The Summer Triangle, etc..



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Lions, Virgins, and Bears



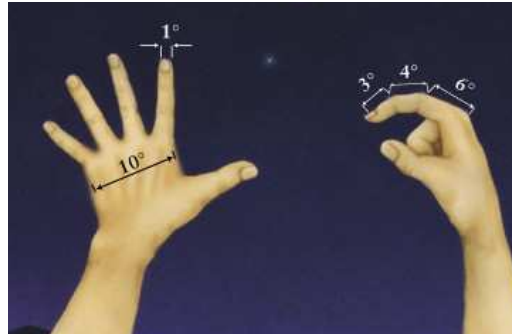
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Angular Sizes on the Sky



- Diameter of Sun or Moon roughly half a degree
- Jupiter is about 45 arcseconds
- Earth rotates at 360 degrees/24 hours or 15 degrees per hour
- 1 arcsecond is the angular size of a dime from about 2.5 miles away

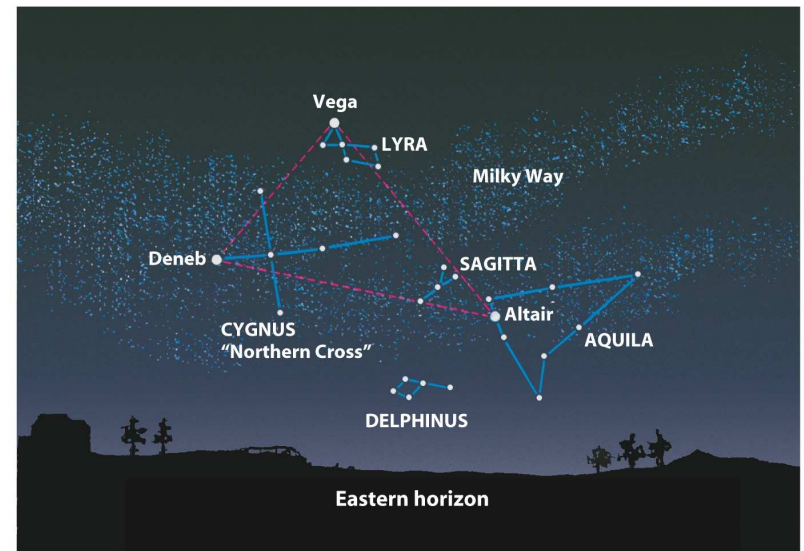


2.5 miles!



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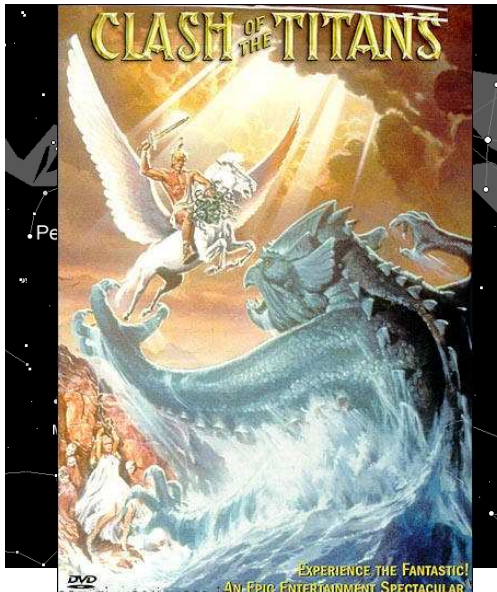
The Summer Triangle



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Clash of the Titans (Fall Sky)



- The fall sky tells the tale of Andromeda and Perseus
- An entire Greek myth in the sky!
- Also a major motion picture!

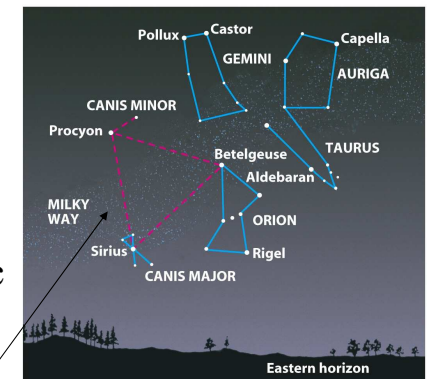
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Star Names



- Many bright stars have **proper names**
- Examples
 - Sirius – from Greek for “scorching”
 - Betelgeuse – from Arabic for “the armpit of the central one”



The winter triangle

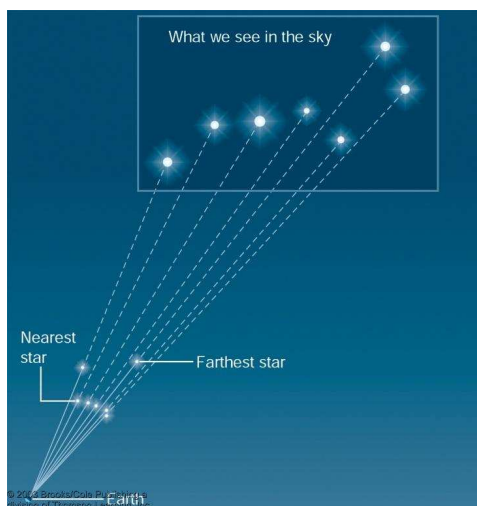
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Constellations Are Patterns



- Remember, the constellations are *patterns*
 - Usually not physically associated
 - Stars in a constellation can be *very* far away from each other
- The sky would look very different from another solar system



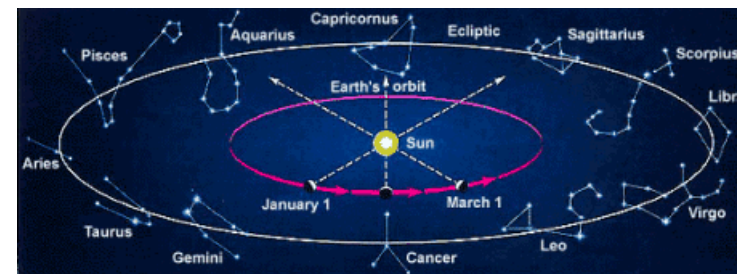
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The Zodiac



- The most famous of ancient constellations
 - Origins deep in our agricultural past
 - Many constellations symbolize planting or harvesting
 - 12 constellations (sort of), one for each lunar cycle per year.



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The Real Zodiac



Table 1-1
The 13 Constellations of the Zodiac

Constellation	Dates of Sun's Passage Through
Pisces	March 13–April 20
Aries	April 20–May 13
Taurus	May 13–June 21
Gemini	June 21–July 20
Cancer	July 20–August 11
Leo	August 11–September 18
Virgo	September 18–November 1
Libra	November 1–November 22
Scorpius	November 22–December 1
Ophiuchus	December 1–December 19
Sagittarius	December 19–January 19
Capricorn	January 19–February 18
Aquarius	February 18–March 13

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The Data



- Look up at the night sky.
- What are the **Data**?
 - Where does the day, the month, and the year come from?
 - What are the motions of the Earth, Moon, and Sun?



<http://www.ex-astris-scientia.org/gallery/stmagazine/data-queen-kiss.jpg>
<http://atropos.as.arizona.edu/aiz/teaching/a250/lecture1.html>

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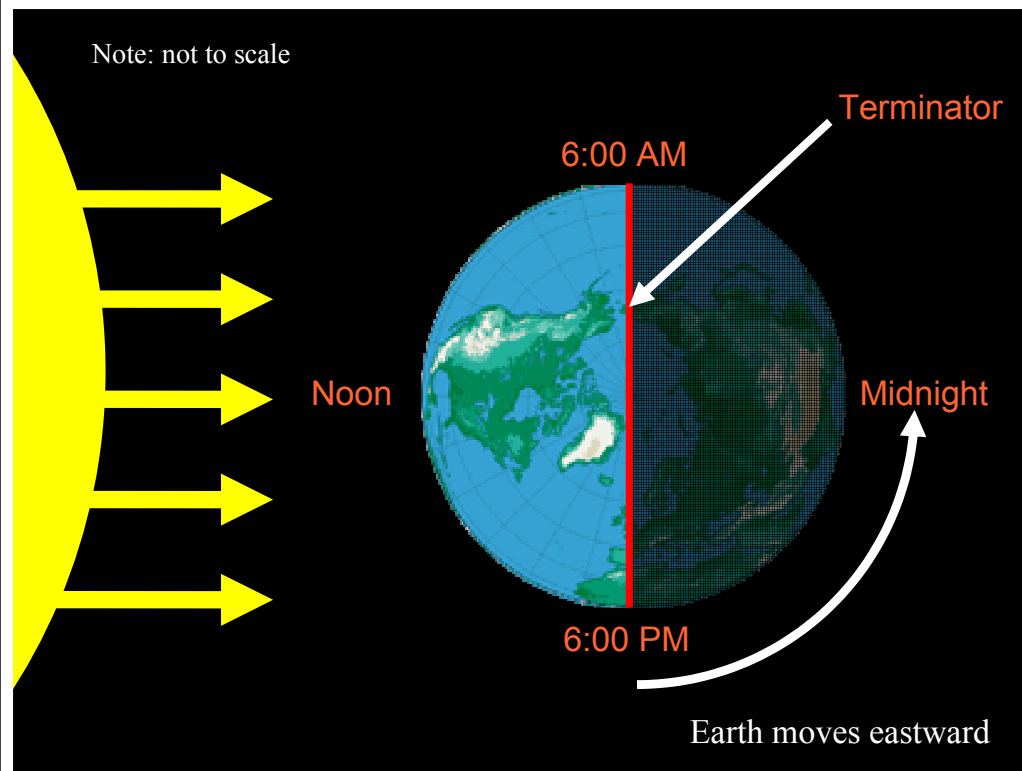
A Day



- What causes a day to be 24 hours?
- The Earth is rotating around its axis.

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Point of View



- So the Earth is rotating, and that gives the illusion that the Sun rises and sets.
 - This is not obvious.
- Also the Earth's rotation makes the stars, Moon, and planets seem to rise and set.
- Are there any objects that do not seem to rise and set?

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Polaris, the Pole Star, the North Star



- Polaris does not rise or set.
(in the northern hemisphere)
- If you stood on the North Pole and looked straight up (also called the North Celestial Pole), you would see Polaris.
- If you find Polaris, you know North.
- Is it the brightest star in the Sky?



NO!

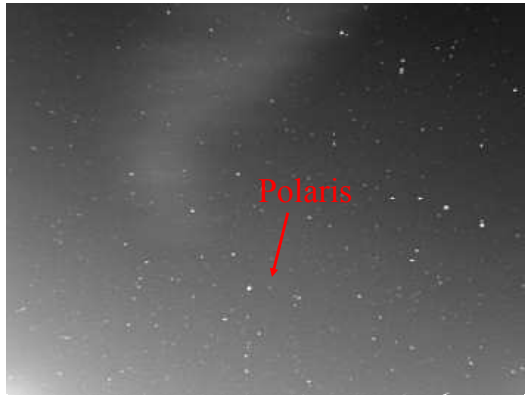
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Question



If we took a time-lapse photo of the starry night sky toward Polaris, what would it look like? Hint: The Earth is rotating (eastward).



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Daily Paths

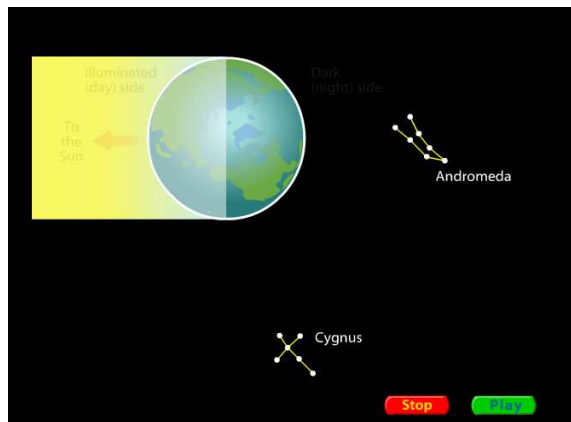


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- Earth's rotation creates daily (diurnal) motion of the stars, Sun, Moon, & planets
- Earth spins eastward, so stars appear to move westward – **daily paths**

The Earth is Rotating



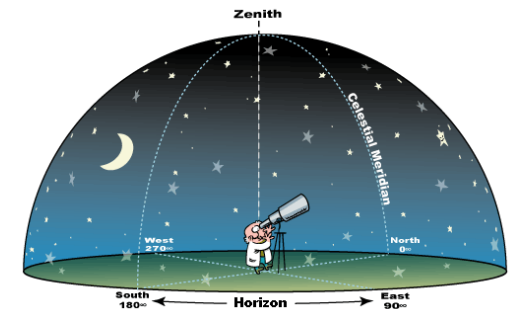
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Your View of the Sky



- **Zenith** – point directly overhead
- **Horizon** – marks the intersection of Earth and sky
- **Meridian** – from North to South through the zenith



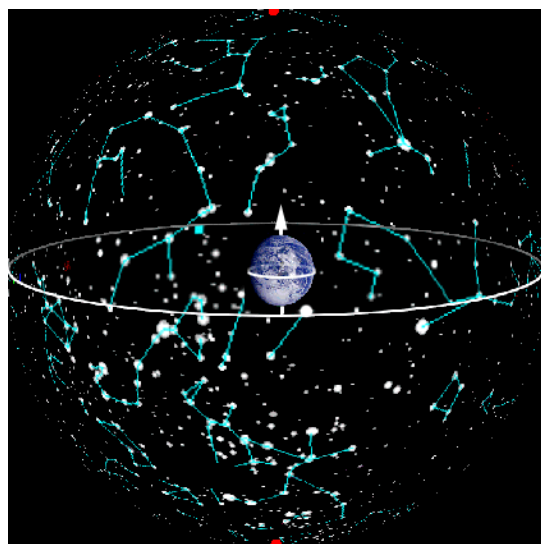
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The Celestial Sphere



Imagine the Sun, Moon, & stars glued on a transparent globe around the Earth



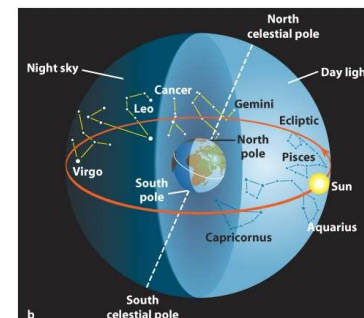
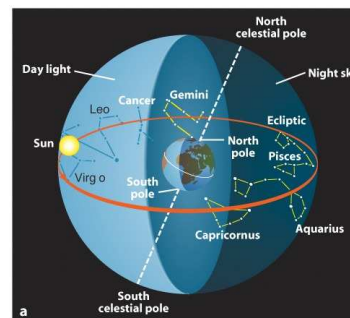
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Seasonal Motion



- As the Earth orbits the Sun, the stars visible at night change— The constellations are different in every season.
- A star crosses the meridian one hour earlier every two weeks.



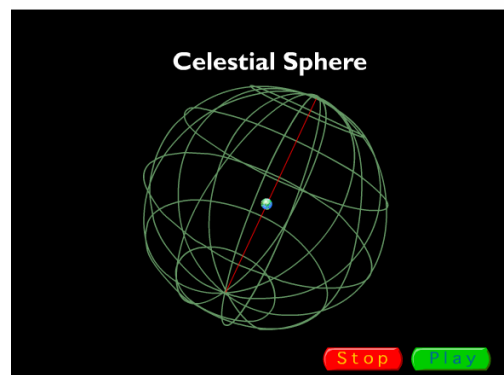
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Celestial Poles and Equator



- **Celestial poles** — extensions of the Earth's axis onto the celestial sphere
- **Celestial equator** — project the Earth's equator onto the celestial sphere



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Celestial Coordinates

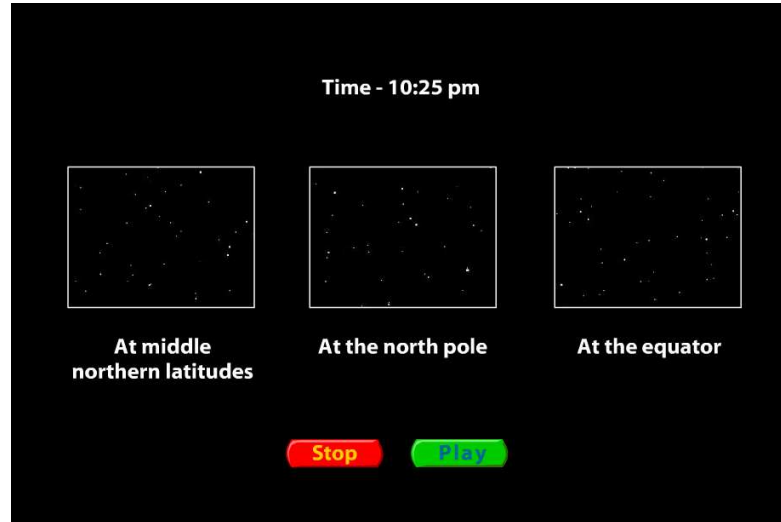


- Measuring North-South
 - **Earth:** Latitude, measures from the equator
 - **Sky:** Declination, measures from the celestial equator
- Measuring East-West
 - **Earth:** Longitude, measured from Greenwich, England
 - **Sky:** Right Ascension, measured from the Vernal Equinox (position of the Sun on first day of Spring)

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Stars motion depend on your Latitude!



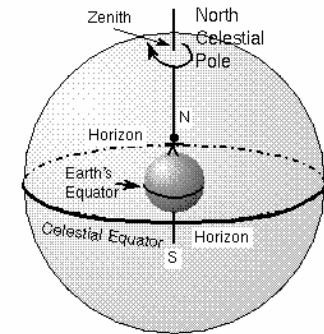
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Changes with Latitude



- The positions of the celestial poles and celestial equator on the sky depend on your latitude (GPS anyone?)
- Note: The celestial equator always crosses the horizon at due east and due west



Latitude = 90° N (at North Pole)
altitude of NCP = 90°

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At the North Pole



- Polaris is directly overhead
- The sky appears to spin around it
- Stars don't rise or set (circumpolar), they just go around
- All stars are circumpolar at the pole!



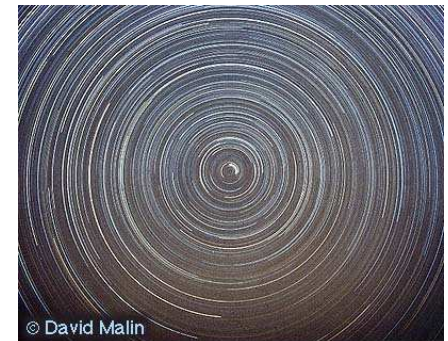
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Circumpolar Stars



- The sky appears to spin around Polaris.
- Earth's rotation is counter clockwise, if you were to look down on the North Pole
- Most stars' daily paths rise in the east and set in the west
- But, some are so close to Polaris, they can't reach the horizon!
- Called *circumpolar stars*



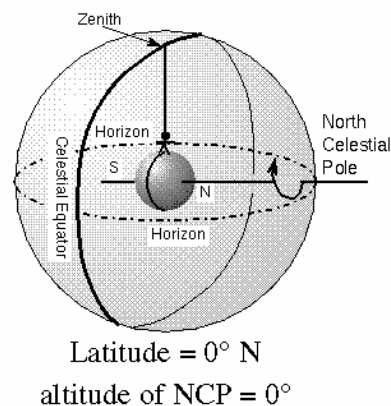
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Changes with Latitude



- The positions of the celestial poles and celestial equator on the sky depend on your latitude (GPS anyone?)
- Note: The celestial equator always crosses the horizon at due east and due west



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At the Equator



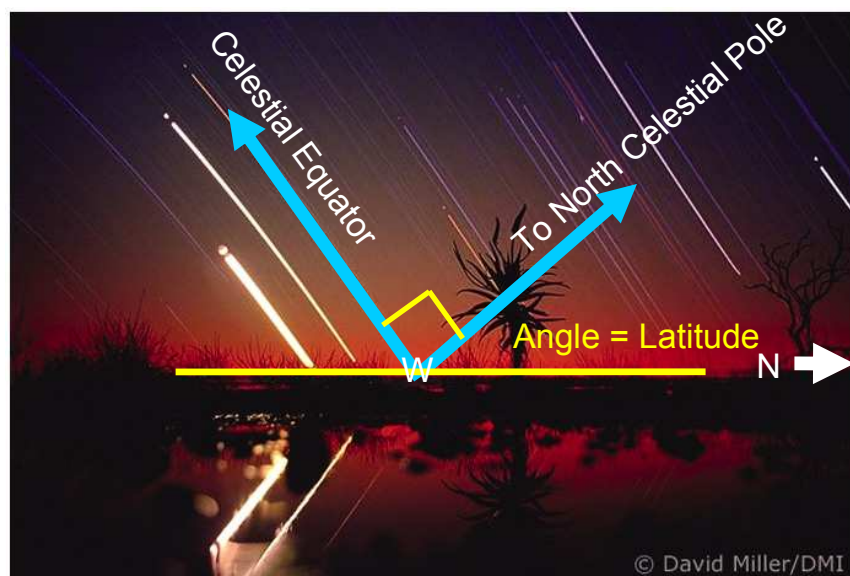
- Polaris is right on the horizon
- Stars rise straight up from the eastern horizon and set straight down on the western horizon
- No stars are circumpolar at the equator!



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Motions in the Sky



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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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South of the Equator



- South of the equator, you can't see Polaris
- You do see the South Celestial Pole
- But nothing is there.



<http://antwrp.gsfc.nasa.gov/apod/ap040911.html>

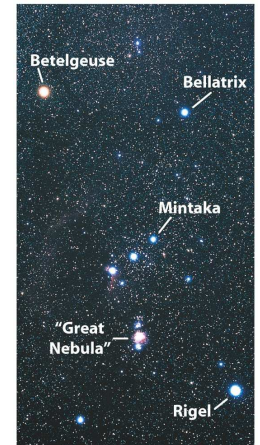
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Earth's Orbit



- The Earth's rotation explains the motions of the stars over a day, but why does the sky change over many nights? (i.e. Why can you see Orion only from Dec-March?)



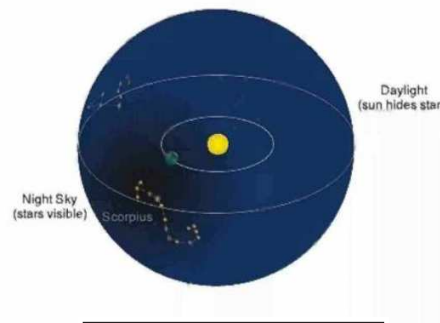
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Free Trip Around the Sun

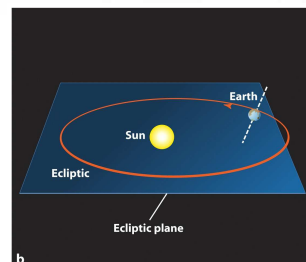


- The Earth orbits the Sun every 365 days
- The plane of the Earth's orbit is called the **ecliptic**



"Living on Earth may be expensive, but it includes an annual free trip around the sun."

-Asleigh Brilliant



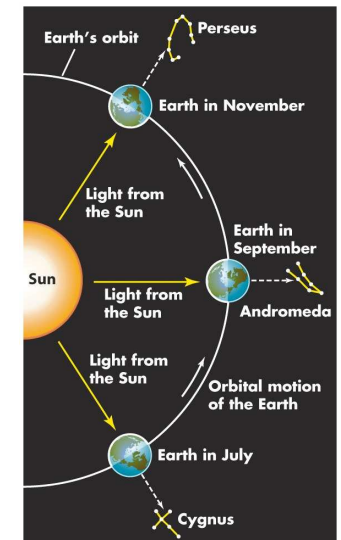
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Orbiting for Fun



- The Earth moves around the Sun.
- And the stars are far away.
- This makes the stars appear to move slightly every day.
- A star will rise about 4 mins early every day or about 2 hours earlier every month.



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The Gregorian Calendar



- Actually, the revolution period is 365.2422... days long
- A regular calendar year is 365 days long
- Accounting for difference
 - Leap years: 1 extra day every 4 years = 365.25 days
 - No leap years every 100 years = 365.24 days
 - Add leap year every 400 years = 365.2425 days



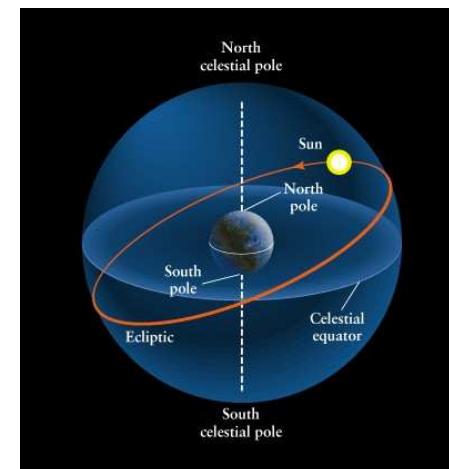
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The Ecliptic on the Celestial Sphere



- Similarly, from our point of view, the Sun moves a little each day with respect to the stars.
- This path (the ecliptic) can also be drawn on the celestial sphere
- Note, the ecliptic and the celestial equator are not the same circles
- What would cause that?



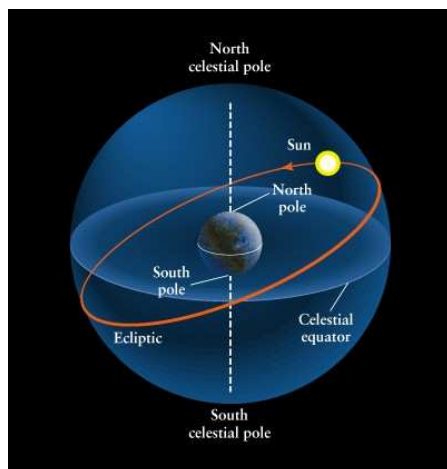
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The Ecliptic on the Celestial Sphere



- You're tilted.
- You're whole freakin' world is tilted.
- The Earth's axis is tilted to the ecliptic plane by 23.5°



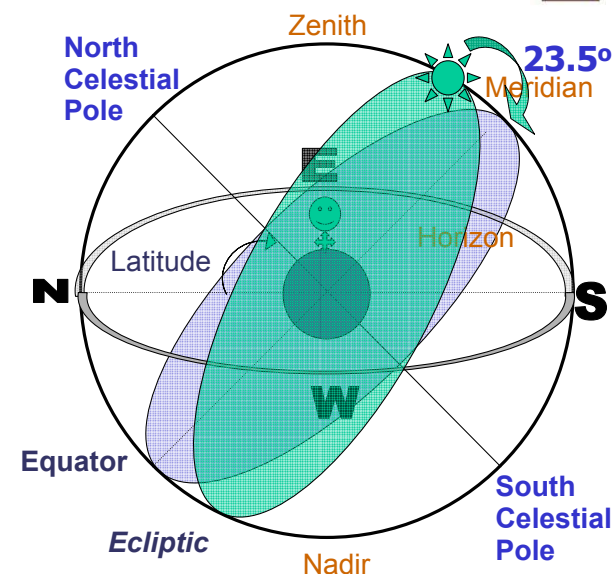
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Building A Celestial Sphere



- NCP is up from horizon at an angle equal to your latitude
- Equator is 90° from NCP
- Ecliptic is 23.5° tilted from equator



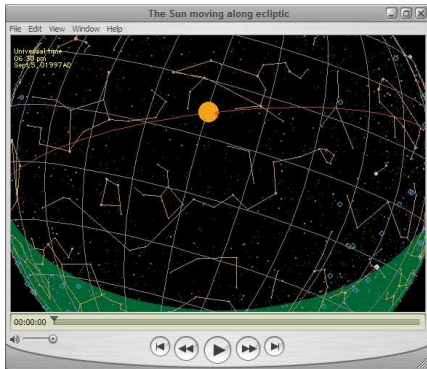
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The Sun Moves in the Sky



[http://planck.phys.uwosh.edu/mike/exercises/
anim/ecliptic_movie.mov](http://planck.phys.uwosh.edu/mike/exercises/anim/ecliptic_movie.mov)



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