Announcements/Reminders

- **Cell phones off please!**

- **New student?** Forgot to pickup ABCD card/syllabus/schedule last week? See me after class.

- **Class ID Grade-Posting Form:** Turn in if still interested.

- **In-class planetarium visit Oct 5th OR 7th. Details next week.**

- **If you haven’t yet done it, get your account on masteringastronomy.com.**

Last Time on
Survey of Astronomy

The “big picture”: The earth is:

- A single planet around a single star of hundreds of billions of stars....

- In a single galaxy of hundreds of billions of galaxies.

The earth, the sun, our solar system, our patch of the galaxy, and the galaxy itself are all moving at hundreds of thousands of km/h through the universe.

All of human history has occurred in the last minute of the calendar of the history of the universe.
Yesterday, on APOD
Assignments

For next week: Finish reading Chapter 1 & 2.

Finish up the “introduction to Mastering Astronomy” practice exercise. 1% course extra credit for completing intro assignment by Friday!
Assignments

For next week: Finish reading Chapter 2.

Finish up the “introduction to Mastering Astronomy” practice exercise.
A FEW NOTES ON Mastering Astronomy

- At least one practice problem and one extra credit problem each homework.

- Full Credit for answering correctly. $1/(n-1)$ off for each incorrect answer (better than regular multiple choice!).

- 2% "bonus" for not using a hint: rarely worth it!

- Stuck or need help? See me after class.
The Universe

The Hubble Deep Field

Thursday, August 26, 2010
The Universe

The sum total of all matter and energy; that is, everything within and between all galaxies.

This picture is the size of a dime, 75 feet away.

How many stars do you see?

A) 4
B) 100
C) 2,000
D) 6 billion
The Universe

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How many stars do you see?

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The Hubble Deep Field
The scale of the Universe
Today’s Menu

- Units and numbers.
- Patterns of stars.
- Rising and Setting.
- Angles on the sky.

Thursday, August 26, 2010
Units...

Not nearly as exciting as the Big Bang, but necessary

In the U.S., we basically use the British, or imperial, system of measurements

- Length = feet, yards, miles, etc.
- Mass = ounces, pounds
- Time = seconds, minutes
Scientists use the metric system

- length = meters (m)
- mass = gram (g)
- time = seconds (sec)
Some Useful Conversions

- A meter is about the length of a yard
  - 1 m = 1.094 yards

- A kilometer (km) is 1000 m, a bit less than a mile
  - 1 km = 0.62 miles

- A meter per second (m/s) is about walking speed
  - 1 m/s = 2.2 mph
  - 1 km/s = 2,200 mph
Metric Prefixes

- **kilo** = 1000 (kilometer, kilogram, kilobuck)
- **milli** = 1/1000th (millimeter)
- **mega** = 1,000,000 (megabyte)
- **micro** = 1/1,000,000th (micrometer)

For more see Appendix C.4
Astronomers deal with very **large** and **small** numbers.

**VERY VERY BIG**

**very very small**
Examples of Large and Small Numbers

- 2,560
- 456,000,000
- 36,000,000,000
- 0.1
- 0.00049
- 0.000000567

Warning: Writing these numbers out can induce hand cramping
Scientific Notation to the Rescue

Write a number like 3,456 as

\[ 3,456 = 3.456 \times 10^3 \]

How do we do that?

\[ 3.456 \times 1,000 = 3.456 \times (10 \times 10 \times 10) = 3.456 \times 10^3 \]
Examples of Scientific Notation

318,000,000  0.000067
Examples of Scientific Notation

318,000,000 0.000067
31,800,000 \times 10 0.00067 \times 10^{-1}
3,180,000 \times 10^2 0.0067 \times 10^{-2}
318,000 \times 10^3 0.067 \times 10^{-3}
31,800 \times 10^4 0.67 \times 10^{-4}
3,180 \times 10^5 6.7 \times 10^{-5}
318 \times 10^6
31.8 \times 10^7
3.18 \times 10^8

Confused? See Appendix C
Observing the Sky:
The birth of astronomy

Thursday, August 26, 2010
Why look at the sky?

- **Knowing the time of day:** Survival skill
  (many predators hunt at dusk!)

- **Predicting seasons is a survival skill.**
  - Migration
  - Food storing (like a squirrel)
  - Crop planting (last frost?)
  - Rains and droughts

- **Nothing on TV.**

- **Eventually navigation, mapping.**
What are constellations?

- Patterns of stars.
- Examples: Ursa Major, Orion.
- Not: physical groups or clusters.
- A product of human imagination.

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- Patterns of stars.
- Examples: Ursa Major, Orion.
- Not: physical groups or clusters.
- A product of human imagination.
- See also “that cloud looks like a bunny”.

Thursday, August 26, 2010
The history of constellations

Most ancient peoples had a system. They were not the same.

Ours came down from the Greeks, who got it from the Sumerians and Babylonians.

The International Astronomical Union recognizes 88 “official” constellations.
The history of constellations

Most ancient peoples had a system. They were not the same.

Ours came down from the Greeks, who got it from the Sumerians and Babylonians.

The International Astronomical Union recognizes 88 “official” constellations.
Which of these is **not** a constellation

A) **Cassiopeia**
B) **Ursa Major**
C) **Camelopardalis**
D) **Big Dipper**
Which of these is **not** a constellation

**A)** Cassiopeia  
**B)** Ursa Major  
**C)** Camelopardalis  
**D)** Big Dipper
Chinese star chart
When we look out at the night sky, it appears we are sitting in a large sphere.

The moon and stars all seem to be fixed on this (imaginary) ‘celestial sphere’
The Celestial Sphere

The 3D Universe becomes two dimensional due to our perspective on Earth.

The north and south pole of the Earth extend out to the north and south celestial poles.

The equator of the Earth extends out to the celestial equator.
The Celestial Sphere

- The 3D Universe becomes two dimensional due to our perspective on Earth.

- The north and south pole of the Earth extend out to the north and south celestial poles.

- The equator of the Earth extends out to the celestial equator.
The “North Star”

- Nothing special, just where the celestial north pole happens to point.

- Not the brightest star in the sky.

- Will not always be the north star: tune in next week to find out why.
Why do the stars move?

- The Earth Rotates (from W to E)

- It appears to us as if the sky (the Celestial Sphere) rotates (from E to W)

Path of Stars

- Stars “attached” to celestial sphere

- Path is a circle (like latitude circle)

- Called diurnal circle (diurnal = daily)
**Time of Day**

- **Meridian:**
  - Circle halfway between east and west
  - Stars, etc. are highest when they “Transit” the meridian

- **Time of day = solar position w.r.t transit (noon):**
  - AM = ante meridian
  - PM = post meridian

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![Diagram showing the movement of the sun relative to the meridian during different times of the day.](image)
Rise / Set / Transit

- **Rise** - move above horizon (appear)
- **Set** - move below horizon (disappear)
- **Objects** rise “in the east” and set “in the west”
- **Transit** - moving past highest point in path
Circumpolar

Some stars never rise or set

These stars are circumpolar
Circumpolar

- Some stars never rise or set
- These stars are circumpolar

Polaris, The North Star
Coordinates on the Celestial Sphere

Just as points on the Earth’s surface have coordinates (longitude & latitude, e.g. you are at 41°39'44.92"N, 83°36'42.14"W), points on the celestial sphere do too.


Declination (Dec for short): analogous to latitude.
Why do the stars and Constellations you see depend on your latitude?
How to Locate Objects in the Sky

- Find NS / EW.

- Objects are located by altitude above the horizon and direction along the horizon (e.g., NW)

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How much of the celestial sphere can an Earth observer see at one time?

A) LESS THAN HALF
B) EXACTLY HALF
C) MORE THAN HALF
D) NONE
The Celestial Sphere

How much of the celestial sphere can an Earth observer see at one time?

A) Less than half
B) Exactly half
C) More than half
D) None
Imagine you are standing at the North Pole. Of the stars that you can see, roughly how many of these stars are circumpolar?

A) None
B) Less than half
C) More than half
D) All
Imagine you are standing at the North Pole. Of the stars that you can see, roughly how many of these stars are circumpolar?

A) None
B) Less than half
C) More than half
D) All

The Celestial Sphere

Thursday, August 26, 2010
Review of Small Angles

- Full circle = 360 degrees
- 1 degree = 60 arcminutes
- 1 arcminute = 60 arcseconds
How many arcseconds in 1 degree?

60 arcsec/arcmin x 60 arcmin/degree = 3600"

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Angular size of the Moon is 0.5 degree.
Some Other Useful Angular Sizes

- **Sun** = 0.5 degree = 30 arcminutes
- **Moon** = 0.5 degree = 30 arcminutes
- **Resolution of your eye** = 1 arcminute
How “big” is an object in the sky?

- Can you use inches or miles to estimate the size of the moon by looking at it?

- Angular size depends on distance.

- If you don’t know the distance to an object, you can’t know the true size.

- If you don’t know the true size, you can’t know the distance to it.
How can the Sun and Moon have the same angular size (30´)?

A) The Sun and the Moon are the same size (in kilometers, for example)

B) The Sun is much larger than the moon, but is also much farther away
How can the Sun and Moon have the same angular size (30´)?

A) The Sun and the Moon are the same size (in kilometers, for example)

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Recap

- We assign objects positions on the “celestial sphere”, which stars appear to be fixed to.

- Our position on earth determines the constellations we see, and when we see them.

- Stars, the sun, the moon, and all the objects in the sky “rise” and “set” due to the rotation of the earth.

- Sizes of objects on the sky are measured as angles, not distances.
Assignments

For next week: Finish reading Chapter 2.

Finish up the “introduction to Mastering Astronomy” practice exercise by Friday evening.