

Suggested Study Habits

Science usually advances by building on previous work:

“If I have seen farther than other men, it is because I have stood upon the shoulders of giants”

–Newton

Just as in science in the real world, in this class we will often draw upon concepts encountered earlier.

Important to keep up!

Come to class

However, I shouldn't be your sole source of information.

Read the assigned material *before* class.

Don't expect to understand everything, but note points about which you are unsure.

You will then have a better idea about what to look for in class.

Read the assigned material again *after* class.

Copies of my transparencies are (or will be) available in the library and on their web site.

However, you should *NOT* consider them a replacement for your own notes—take notes!

This is a *college* level course—standards will be higher than high school.

You should expect to spend about 2 hours outside class for each hour in class on this course.

I (and I hope you) expect more from you out of this course than just the ability to regurgitate facts.

For example:

Factual: Terrestrial planets are rocky, giant planets gaseous.

Conceptual: Why? What processes lead to this?

Factual: Big Bang theory is currently the generally accepted theory for the formation of the universe.

Conceptual: Why? What evidence has led to this conclusion?

Do not struggle in silence.

Form study groups, use each other as resources.

If you are having trouble, please come to see me.

That is what office hours are for!

Better to seek help sooner rather than later.

Teacher Expectations

Expect me to come and start class on time.

Expect me to treat you with respect.

Expect me to maintain order in the classroom.

Expect me to get your papers back within a week.

Expect me to answer your e-mails and phone messages within 24 hours (except on weekends).

Student Expectations

Come to class on time.

Come to class prepared:

—Do the reading ahead of time.

—Be prepared to begin class on time.

Participate in class.

Treat me and others with respect.

Maintain order in the classroom.

Goals for the course:

1. Gain some knowledge of astronomy:

Practical Uses

Not-so-practical uses

2. Gain some insight into astronomical and scientific methods

Critical thinking—

“An ability to skeptically analyze something to assess its credibility or truthfulness. Does it make sense? How much weight do I give to some line of evidence?”

3. Finally, I hope you find the course stimulating and fun!

Scale of the Universe

It's Big!!!

On human scales the Earth is quite big, yet:

the sun is over 300,000 times as massive as the Earth.

Yet the sun is a typical star, just one of about 100 billion (10^{11}) in the Milky Way galaxy.

The Milky Way galaxy is just one amongst billions of galaxies in the universe.

The universe is truly astronomical in size!

Scientific Notation

In astronomy we often deal with objects on immensely different scales.

Because of this we often must deal with extremely large and/or small numbers.

Scientific notation provides a convenient method for writing and dealing with such numbers.

In standard scientific notation numbers are written

$$x.xxx \times 10^y$$

To convert to standard notation the decimal must be moved y spaces either right (if y positive) or left (if y negative).

The Scientific Method

1. Take observations—look for patterns
 - a. Classification
2. Develop an hypothesis (or more) which can explain the observations.
3. Make predictions based on the hypothesis.
4. Design and carry out experiments or observations to check the predictions made.

5. Compare results to the hypothesis:

- a. If the predictions are borne out it strengthens our belief in the hypothesis.
- b. If predictions are not borne out the hypothesis needs to be abandoned or modified. Back to the drawing board!

Implicit assumptions:

The Universe follows a set of rules.

Divine intervention is not allowed!

However, it seems to work pretty well!

The Scientific Method in Action:

Origin of the Moon

Initial observations:

The Earth - Moon system is very unusual.

Other terrestrial planets do not have satellites like our Moon.

The Moon is very large compared to its primary.

Suggests the Moon may not have formed like other satellites in the Solar System.

How might it have formed?

Hypotheses for the Formation of the Moon

Three main hypotheses:

1. Moon formed along with the Earth.
2. Moon formed elsewhere in the Solar System and was later captured by the Earth.

3. Earth formed first then the Moon either knocked off the Earth or thrown off.

- a. Fission hypothesis—Earth spinning too fast leading to some material thrown into space (the Moon).
- b. Giant impact hypothesis—late in its history the Earth was hit by a large object throwing material into space (eventually to become the Moon).

Predictions:

1. Binary planet hypothesis:

If the Earth and Moon formed together from the same cloud of dust and gas in a similar way, what composition would we expect for the Moon?

2. Capture hypothesis:

If formed further from the sun than the Earth:

If formed closer to the sun:

3a. Fission hypothesis:

Problem: Even if we recombine the Earth and Moon, the Earth should not have been spinning fast enough to break up.

Thus, the initial fission hypothesis had fallen into disfavor in favor of a modified version:

3b. Giant impact hypothesis:

Testing the predictions

The models all make different predictions.

How might we check the predictions?

Alas, before Apollo we could not obtain the necessary data to distinguish between the models.

An answer had to wait until the analysis of the material and observations made by Apollo in the 1970s.

By the mid-1980s a coherent picture had started to emerge:

What did Apollo find?

Evidence supports which hypothesis?

How likely is such a giant impact?

Idea of giant impact meshes well with evidence for early heavy bombardment.

Modelling suggests that large bodies might be available at the end of planetary formation.

The planet Uranus.

So, we now know that the Moon was formed following a giant impact with the Earth, right?

The testing continues...

As computers have improved researchers have run computer simulations of the impact hypothesis.

Input the physical laws, mass and velocities of the bodies and see what happens.

Suggest that the impact hypothesis is feasible.

Current models suggest Moon should form in low Earth orbit.

Should form very quickly (~100 years).

==> Moon should initially be very hot.

Observations of the night sky

Watch the stars for some time and what do they appear to do?

Looking south, stars will appear to revolve in which direction?

Looking north, stars appear to revolve in which direction?

Example of circumpolar stars?

(Note that stars which never rise are also considered circumpolar stars).

Constellations

While all stars participate in the daily motion, they do not move with respect to each other.

Stars always maintain the same patterns on the sky

Ancient peoples gave names to these familiar patterns in the sky.

Astronomers now use constellations to delineate the sky into 88 regions.

Coordinate Systems

In general, one needs three coordinates to uniquely identify a location in space.

However, it is very difficult to determine the distance to astronomical objects.

Indeed, all astronomical objects appear to be essentially at infinite distance.

If we don't worry about distance, it takes two coordinates to uniquely identify an objects location on the sky.

Several possible systems could be used. For example, you want to point out an object to a friend. How might you do this?

Altazimuth System

Azimuth: Angle along the horizon ($0 - 360^\circ$).

Altitude: Angle up into the sky.

Zenith: Point directly overhead.

Advantage is its simplicity.

Problems?

Right Ascension – Declination

Coordinate system usually used by astronomers is analogous to latitude and longitude on Earth.

Latitude is the north-south location. It ranges from -90° (south pole) to 90° (north pole).

Longitude is the east-west position. By convention, 0° longitude runs through Greenwich, England.

Extend the lines of latitude and longitude onto the Celestial sphere.

The equivalent of latitude is called declination:

N.C.P. would be at a declination of what?

S.C.P.?

Point directly above the Earth's equator?

Directly above Aberdeen (latitude 47°)?

The equivalent of longitude is called the right ascension:

Right Ascension ranges from 0 to 24 hours (0 to 360°).

Why use hours instead of degrees?

Conversion between hours and degrees:

$$24 \text{ hours} = 360^\circ$$

$$1 \text{ hour} = 15^\circ$$

Where do we set R.A. = 0° ?

Time

The time of day is set by the position of the sun.

As we move eastwards, will the sun rise earlier or later?

Westwards?

The Earth rotates 15° in an hour \implies the time changes by an hour for every 15° change in longitude.

Before the advent of railroads, each town kept its own standard time.

Railroads provided the impetus to standardize time zones.

24 time zones centered 15° apart in longitude.

Time is the same within each zone.

Time changes by one hour between time zones.

Most astronomical events are referenced to the time in a common time zone: that of Greenwich (at 0° longitude).

Called "Universal Time"

Because we are at 124°W longitude, we are in the Pacific Time Zone (centered on 120°W longitude).

Daylight savings time is advanced one hour from standard time.