CLASSNOTES 3
Basic concept from Chapter 2 and 3 to be grasped include:

- Constellations, star names
- Brightness of Stars: magnitude scale (outline only). I shall try to avoid 'magnitudes,' but a little understanding is essential as some diagrams are labelled using magnitudes for apparent (and absolute) brightnesses of stars. At the moment it is very useful to know that the magnitude scale is 'backwards': fainter stars are assigned a larger numerical magnitude than brighter stars. The brightest star in the sky (Sirius) has an apparent magnitude of -1.5. The faintest stars visible to the eye are of +6th magnitude. A difference of 5 magnitudes corresponds to an intensity (amount of light received) ratio of 100.

- The Celestial Sphere, its poles and equator
- The apparent daily motion of the stars
- Circumpolar stars
- The visible sky as seen from different points on the Earth's surface, e.g., the poles, equator, and a mid-latitude position such as Austin
- The motion of the Sun and planets across the celestial sphere
- Precession
- The 23.5-degree tilt of the Earth's rotation axis and its consequences for the Sun's yearly motion around the celestial sphere and the origin of the seasons
- Phases of the Moon and planets
- Solar and lunar eclipses

Do not worry the small-angle formula (Page 41) sections. Consider the *questions* on page 31, the review questions 1-29, *discussion questions* #1 and 2, and the *problems* 1, 3, and 13.

ANGLES
The mathematical content of the course will be kept to a bare minimum; note the almost complete absence of equations in the text. However,
we shall need to refer to the size of various angles.

An angle is formed whenever two straight lines meet. The size of an angle, often expressed in degrees, indicates how widely spread the two lines are. If the two lines meet at a right angle, they are said to be perpendicular. Two such lines form a 90° angle; the symbol ° denotes degrees. If a 90° angle is placed in a circle with its corner at the circle's center, it marks off quarter circles. A half circle is marked off by a 180° angle. One says that a full circle represents 360°.

Now, if one were to divide up a quarter circle into 90 parts, each part would represent 1°. Often angles even smaller than 1° are measured. One degree is further divided into 60 parts. Each part is called a minute of arc, or 1/60 of a degree. The symbol ′ denotes a minute of arc. One should be careful to include the words 'of arc' to avoid confusion with minutes of time.

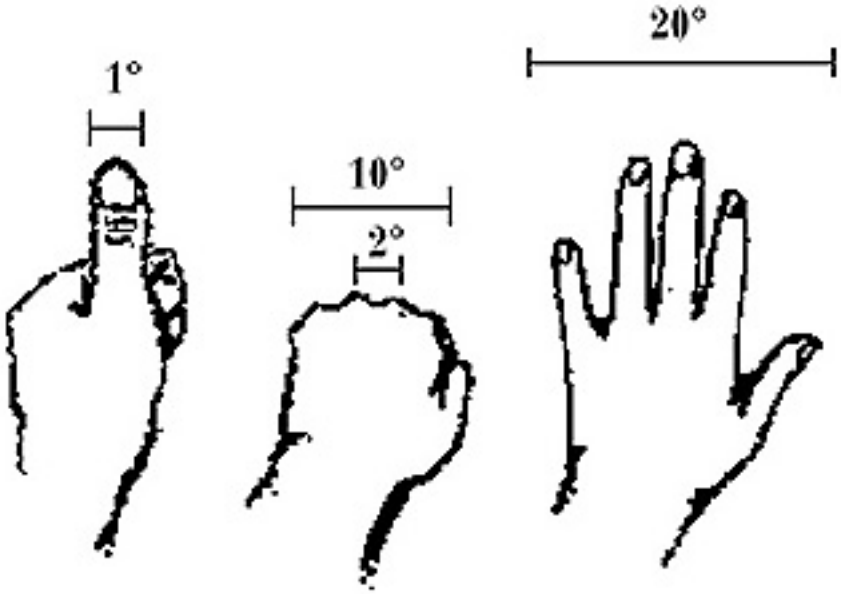
In making very precise measurements, it may become necessary to sub-divide the minute of arc. A second of arc is 1/60 of a minute of arc, or 1/3600 of a degree. The symbol ″ denotes a second of arc.

This summary is worth remembering: 60 seconds of arc make 1 minute of arc; 60 minutes of arc make 1°; 360° make one full circle.

As reference marks,

- 1" = the angle subtended by a quarter at a distance of 2 miles.
- the Sun and Moon subtend at Earth an angle of about 1/2°.

These views of your hand on an outstretched arm may help you appreciate the size of angles 1° to 20°.



SHORTHAND NOTATION

We shall use standard notation such as =, ~,≡ , ≠, >, >>, or < and <<. In order they are:

=	means equal
~	means approximately equal
≡	means identically equal
≠	means not equal to
>	as in $a > b$ means that a is numerically larger than b
>>	as in $a >> b$ means that a is numerically much larger than b
< and <<	are obviously the reverse of > and >>

EXERCISES FOR YOU TO TRY

1. Angles. Can you explain to a young friend (say age 10) the quantities: a degree, a minute of arc, and a second of arc.
2. List the following angles in order of decreasing angular size: 129", 240', 1°20', 85', 2'10", 5.0°, 5.5°

3. Tell where you are on the Earth from the following:
   a. the stars rise and set perpendicularly to the horizon.
   b. the stars circle the sky parallel to horizon.
   c. the celestial equator passes directly overhead.
   d. in the course of a year, all stars are visible.

You are ***not*** required to hand in your answers. Some answers appear below.

2. Correct order is: 5.5°, 5.0°, 240' (= 4°), 85' (= 1°25'), 1°20', 2'10", 129" (= 2'9")
3. I give the answers.
   You are expected to be able to add a sentence by way of explanation.
   a. = the equator.
   b. = the N or S pole.
   c. = the equator.
   d. = the equator.

A NOTE ON THE 'SCIENTIFIC METHOD' (adapted from *Explorations* by T. T. Arny)

In its simplest form the scientific method is the procedure by which scientists construct their view of the Universe and its contents, regardless of whether those ideas concern stars, planets, living things, or matter itself. In the scientific method a scientist proposes an idea about some property of the Universe -- a hypothesis -- and then tests the hypothesis by experiment. Ideally the experiment either confirms the hypothesis or refutes its, causing the hypothesis to be rejected.

This same procedure may be applied to any scientific idea. In fact, what makes an idea "scientific" is to some extent whether it can be verified by either a real or imagined experiment. Astronomers, however, face a special difficulty in applying the scientific method because they cannot experiment with their subject matter directly: In virtually all cases, they can only passively observe. Nevertheless, they try – like all scientists – to use the scientific method.

Application of the scientific method is no guarantee that its results will be believed. For example, the Greek philosopher Aristotle taught that the Earth is a sphere. Yet despite his "proofs" supporting this hypothesis, many people continued to believe the Earth to be flat. Even today, some scientific hypotheses may be rejected in the face of their experimental verification, and others may be accepted though untrue. For example, astronomer "A" may find evidence supporting hypothesis "B," but astronomer "C" may claim the experiment was done incorrectly, or the data were analyzed improperly. In fact, some historians of science have argued that old ideas are discarded not so much through proof of their incorrectness but rather by the death of their proponents.

We need therefore to keep in mind that when we discuss ideas, they are not all "proved" or universally accepted. This is especially true of ideas at the frontiers of our knowledge; for example, those dealing with the origin and structure of the Universe or those dealing with black holes. However, the tentativeness of such ideas does not always stop astronomers from being very positive about them, leading the Soviet physicist Lev Landau to state that astrophysicists are "often in error, but never in doubt." Therefore, keep in mind that some of the ideas we discuss will be proved wrong in the future. That is not a failing of science, however. It is its strength.

Natural science does not simply describe and explain nature; it is part of the interplay between nature and ourselves; it describes nature as exposed to our method of questioning.

Werner Heisenberg (1901-1976)

What really makes science grow is new ideas, including false ideas.

Sir Karl Popper (1902-1994)

Science means simply the aggregate of all the recipes that are always successful. The rest is literature.

Paul Valéry (1871-1945)

A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it.

Max Planck (1858-1947)

There is a story that once, not long after he came to Berlin, Planck forgot which room had been assigned to him for a lecture and stopped at the entrance office of the university to find out. 'Please tell me,' he asked the elderly man in charge, 'In which room does Professor Planck lecture today?' The old man patted him on the shoulder. 'Don't go there, young fellow,' he said 'You are much too young to understand the lectures of our learned Professor Planck'.
