constellations, star names, and star charts

Purpose:

To become familiar with the constellations, star names, and the star charts that you will be using throughout the class.

Apparatus:

SC001 and SC002 Constellation charts, ruler, colored pencils

Introduction:

Before you can observe and analyze any astronomical object, you have to be able to find it. This task is complicated by the fact that you live on the Earth, a planet that rotates daily and travels around the Sun yearly. In some cases, we may not be able to see the object we are looking for with the naked (unaided) eye. Clearly, we need a way to describe the position and brightness of the stars and other celestial objects. Astronomers have developed position systems, whether they be ancient constellation patterns or modern star charts. The brightness of a star is determined from rough estimates by eye to precision “photometry” using high technology telescopes. We will explore the use of star charts for this and the following lab.

Constellations

Just as the United States is divided into fifty states, the sky is divided into 88 irregularly shaped regions called constellations. In general, the stars that make up a constellation are not physically associated, but are just patterns that resemble or honor animals, mythological characters, etc. Many of the constellations are of Greek origin (Orion & Andromeda for example), while others are more contemporary in nature (Microscopium & Telescopium).

Constellations serve a useful purpose in allowing you to specify the general location of an object in the sky. Just as it is sufficient and easier to say that you live in Charlotte rather than at longitude 82° West, latitude 36°, it is easier to say that a star is in Orion than it is to specify its exact coordinates. There will be cases, however, when those exact coordinates are necessary. Appendix 1 lists the 88 constellations with their respective nominative form, genitive (possessive) form, and accepted abbreviation.

Star Names

Stars are named using several different systems and many stars have several names. Most of the prominent stars have proper names, like Bob, usually Arabic in origin (the Arabs preserved a ton of ancient knowledge while the Greeks were busy killing themselves and the Europeans were killing everybody else). These names may be as familiar as Sirius (yes, that is where the satellite radio company gets its name) or as obscure as Zubenelgenube (not to be
confused with Zubenesschamali)! The brightest stars in each constellation are also named using the Greek alphabet. The brightest star in the constellation is given the designation \( \alpha \) (alpha), the first letter of the Greek alphabet (which is given below).

| \( \alpha \) Alpha | \( \upsilon \) Iota | \( \rho \) Rho |
| \( \beta \) Beta | \( \kappa \) Kappa | \( \sigma \) Sigma |
| \( \gamma \) Gamma | \( \lambda \) Lambda | \( \tau \) Tau |
| \( \delta \) Delta | \( \mu \) Mu | \( \upsilon \) Upsilon |
| \( \epsilon \) Epsilon | \( \nu \) Nu | \( \phi \) Phi |
| \( \zeta \) Zeta | \( \xi \) Xi | \( \chi \) Chi |
| \( \eta \) Eta | \( \omicron \) Omicron | \( \psi \) Psi |
| \( \theta \) Theta | \( \pi \) Pi | \( \omega \) Omega |

Thus Sirius is also known as Alpha Canis Majoris (or \( \alpha \) CMA), since it is the brightest in Canis Major. It is not correct to simply call Sirius “Alpha”, just like your first name alone does specify completely who you are! Note also that the genitive (possessive) case of the constellation name is used.

**The SC001 and SC002 Constellation Charts**

The SC001 and SC002 Constellation Charts that we will use show the brighter stars, constellation patterns, and other celestial objects visible to the naked eye. The constellation names are provided in all **CAPITALS**, while the proper names of some stars are given with the First Letter Capitalized. The Greek letter designations are also provided. There are some stars, generally faint ones, which are designated by number only. In addition, the position of brighter star clusters, galaxies, and nebulae are shown. Many of these have an “M” number (such as M13), indicating they are from the Messier catalog of non-stellar objects. Objects which change position “quickly” (planets, the moon, comets) are not shown on these charts.

The relative brightness of the stars is indicated by the size of the “dots” that mark them—brighter stars have larger dots. Astronomers rank star brightness in **magnitudes**, where increasing magnitude corresponds to fainter stars. The brightest stars visible are near magnitude zero, while the faintest visible to the unaided eye are 6th magnitude. The apparent magnitude system will be discussed later.

Stars which change their brightness (variable stars) are indicated by a white dot at the center of the star symbol. Stars with a line through the symbol are actually *two stars* very close together in the sky, and are referred to as double stars.

These charts also indicate the alignment of the **equatorial coordinate system**. This system is analogous to the latitude and longitude system that mark positions on the Earth. The
equatorial system is based on angles measured from special lines or points on the celestial sphere, just as our geographic system of latitude and longitude is based on special places on Earth. Notice along the top and bottom of the chart are divisions marked off (starting from the right) as 12h, 13h, and so on. This is called **right ascension**. Going vertically along the edges, starting from the bottom are divisions of -60°, -50°, etc. This is called **declination**. We will use these coordinates to locate specific constellations and stars on the charts. We will use them in greater detail in the next lab.

First we will define some terms used in connection with the sky. Examine the figure below. The “sky” appears as half of a sphere centered on the Earth and bordered by the **horizon**. Your “actual” horizon having trees, mountains, and buildings may block out part of the sky. The point located directly over your head is called the **zenith point**, or usually just the **zenith**.

The compass directions of north, south, east and west are indicated in the picture above. The point on the horizon which is due north is called the **north point**. If you were to aim your finger in the direction of the north point and move it up and over your head (the zenith) in a big circle to the south point, the line traced by your finger would be the **celestial meridian**, or your **meridian** for short. Now is a good time to point out that nothing we have defined so far has anything to do with any astronomical object. They are all just properties of the “sky” in relation to you, at your present location, on Earth. Your friends in California would have their own unique meridian.
If you were to aim your finger to the north point and turn in place 360° you would be tracing out your horizon. The angular measure moving to the east from due north would be noted as the azimuth. Of course, as with any angle, the measurement could be made from any reference point and the angle in either clockwise or counterclockwise direction.

You can think of all astronomical objects as laying on their own sphere (the “celestial sphere”), just outside of the sky as illustrated in the figure below. Of course, astronomical objects are all at different distances, but that is not important at this point. You, in a sense, look through the “sky sphere”, whose reference points and lines never move, at a moving sphere of stars. Any stars below your horizon will not be visible. If you lived at the geographic North Pole you would never see any of the stars that lay below the “Celestial Equator.”

What stars and constellations you can see on a given night depends on a number of things. The three main factors are: (1) where you are on the Earth, (2) what time it is, and (3) what the date is.

The following figure shows how individuals at three different latitudes have their “sky spheres” at different orientations with respect to the celestial sphere (not shown). A star which is

LAB-Constellations
at the zenith for person 1 ($Z_1$) will not be at the zenith for person 2 ($Z_2$) or person 3 ($Z_3$). Some stars that are above the horizon for person 1 will be below the horizon for person 2, and vice versa. Now imagine the Earth rotating and you can see that ($Z_1$) and ($Z_2$) will constantly change where they are pointing. From the perspective of the person at those places looking up at the zenith, they will see various stars and constellations “passing through” their zenith. Just lay down on the sidewalk and look straight up…as time goes by a different star will be right above you, at least here in Charlotte anyway.

There are only two places on the Earth, the North Pole and the South Pole ($Z_3$), where the zenith is always pointed at the same spot on the celestial sphere. The line to ($Z_3$) is an extension of the Earth’s axis of rotation.

We have said that astronomical objects are distributed across the celestial sphere. The Earth is a sphere, but maps of the Earth generally are not. A globe is the only true “map” of the Earth, but it is inconvenient to carry and use, and thus flat maps are used. “Maps” of the celestial sphere in the form of globes are made (you will see one in class or you can buy one at Target), but generally star maps (usually called charts) are flat. Your SC001 and SC002 charts are such star maps.

The following diagram shows how these two charts relate to the celestial sphere. The left-hand figure represents the celestial sphere, similar to an orange. Imagine that you are able to
peel off parts of its skin, making an imaginary cut around the sphere along dotted line B. When you view this cap section from above you are looking at your SC002 chart.

Now, starting over, you make two imaginary cuts around the sphere along lines A and A°. You then make a vertical cut on one side along dotted line X. Peel off the skin, flatten it out and now you have your SC001 chart. What’s the “?” for then? Well, for the most part the stars that would be on that chart are never visible from our latitude so we do not need it.

Using the SC001 and SC002 Charts

The SC001 chart is used by facing due south and looking up. Only about half of the width of the chart (about 12° using the horizontal scale) is above the horizon at any time. The question is, what half? Along the bottom of the chart, below the scale, are dates. As an example, find August 21. If you face due south at 8:00 PM (EST) on August 21, the stars on the vertical line (from the lower 18° mark to the upper one) will lie along your meridian. Those stars to the right of that line will be to the west of your meridian and moving away from it (setting). Stars to the left of that line are to the east of your meridian and are moving toward it (rising).

But what if it isn’t 8:00 PM? Then you must adjust where on the chart your meridian be. Suppose it is 9:00 PM EST, August 21. The stars which were one hour east (left) of your meridian at 8:00 PM would be on your meridian one hour later, that is 9:00 PM. Thus a line along 19° would be the location of your meridian. The star γ (Gamma) Lyrae would, for example, be on your meridian. What about at 1:00 AM that same night? At that time (5 hours after 8:00 PM) your meridian would lie at 23°. The star Fomalhaut would be on your meridian. For times earlier than 8:00 PM, your meridian would lie west (right) of 18°.
Now look at your SC002 chart. To use it you must face north. The star at the center of the chart is Polaris, the “pole star.” It is located 36° above the northern horizon (for us in Charlotte) and always remains there. The explanation for this will be given in the next lab. The rest of the stars on the chart circle Polaris (counterclockwise) once every 24 hours. Thus we need to know how to rotate the chart to the proper position for a given date and time.

This is done in a similar manner to the SC001 chart. Notice that around the edge appear the hours and dates that were at the top and bottom of the SC001 chart. Find August 21 (18ʰ) and put it at the top. Everything along the vertical line from 18ʰ to Polaris to 6ʰ at the bottom is on your meridian at 8:00 PM on August 21. Note that one hour later, at 9:00 PM, the chart will have rotated 1 hour counterclockwise so that the line 19ʰ to 7ʰ will be on your meridian. The star γ Lyrae again shows up on the meridian.

Other Comments on the SC001 and SC002 Charts

There is one other prominent feature of your SC001 chart which will be introduced here and dealt with in more detail in the next lab. That is that “wavy” line that runs across the center of the chart. This is the path that the Sun follows as it changes position against the background stars during a year. The path is referred to as the **ecliptic** and just below it are the dates that the Sun occupies particular positions. On our sample date of August 21 the Sun is in the constellation of Leo, appearing in almost the same direction as the bright star Regulus (α Leonis).

Finally, a comment should be made concerning the lines that connect/join various stars on these charts. In some cases lines join stars which are in different constellations. Look, for example, at the so-called “Great Square” of Pegasus (at about 0ʰ and +20°). Two of the corner stars, Markab and Alpheratz, both have the letter Alpha (α) next to them. But they both can’t be α Pegasi. Alpheratz is not in Pegasus, but is α Andromedae. There are other cases as well.