Sky Familiarization

I. Objectives

1. Familiarization with the celestial coordinate system
2. Use star charts to determine zeniths, meridians, visible constellations, etc.
3. Use star charts to predict celestial events

II. Resources and Readings

5. Calculator

III. Introduction

The constellations carry us back to the beginning of astronomy. The arrangement of the stars with respect to one another and their apparent brightness have remained essentially unchanged for centuries; in fact, many of the star figures we recognize today were known to the Mesopotamians 5000 years ago.

For the modern astronomer a constellation is primarily an area of the sky having boundaries that tend to preserve the shapes of mythological figures that the ancients saw in the sky. We now have 88 such arbitrarily divided areas in the sky, these areas differing greatly in size and in shape. The stars that compose a constellation generally have no physical connection with one another and are usually at quite different distances from the Earth. When we say that a celestial body is “in” a given constellation, we mean that the body is seen in the general area of the sky represented by that constellation.

These 88 constellations may be conveniently divided into two categories: the Circumpolar Constellations, and the Equatorial Constellations.

There are two groups of Circumpolar Constellations, one that we can always see and one that we never see. The extent of these groups depends upon the terrestrial latitude of the observer. For us here in Tucson, the North Circumpolar Constellations, which never set below the horizon, lie between the declinations (celestial latitude) +58° and +90°. The South Circumpolar Constellations, which we never see, all lie within 32° of the South Celestial Pole.

The Equatorial Constellations are those which are left over. They are the constellations which are distributed close enough to the celestial equator so that they rise and set each day. The Zodiacal Constellations are part of this group.
The **Zodiacal Constellations** are those which lie along the ecliptic. There are approximately two hours of right ascension (celestial longitude) for each of the Zodiacal Constellations along the ecliptic. (The constellation Ophiuchus is an exception. It lies along the ecliptic but is not a “sign of the Zodiac.”)

We usually associate different constellations with different times of the year. This is due to the yearly orbital motion of the Earth about the Sun, which causes us to see different constellations at the same time of night during the year. The motion of the Earth in its orbit causes our view of the nighttime background stars to be constantly changing as our ever-changing perspective of the Sun causes it to block out successive background constellations. Hence we associate Gemini and Leo with spring, Scorpius and Hercules with summer, Cygnus and Lyra with fall, and Orion and Taurus with winter.

**Star Naming**

There are several different methods of naming the stars in the constellations. The ancients gave the brightest 275 stars personal names, about 50 of which are still called by their personal names today. Aldebaran, the brightest star in Taurus, is an example.

<table>
<thead>
<tr>
<th>The Greek alphabet</th>
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<tbody>
<tr>
<td>$\alpha$ Alpha</td>
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<tr>
<td>$\beta$ Beta</td>
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<tr>
<td>$\gamma$ Gamma</td>
</tr>
<tr>
<td>$\delta$ Delta</td>
</tr>
<tr>
<td>$\epsilon$ Epsilon</td>
</tr>
<tr>
<td>$\zeta$ Zeta</td>
</tr>
</tbody>
</table>
Other methods, which are more useful to the astronomer, are those in which the stars are designated in some systematically ordered manner. Bayer, in 1603, designated the brighter stars in each constellation by a Greek letter. The stars were usually lettered in order of brightness, $\alpha$ being the brightest and $\omega$ being the faintest possible. When the Greek letters were exhausted, Bayer employed further schemes of letters and numbers.

Another plan, introduced by Flamsteed in 1725 (Flamsteed’s British Catalogue) numbered the stars visible to the naked eye consecutively from west to east across the constellation. The convention used in designating stars by any of the various systematic methods is to denote any lettered or numbered star in a constellation by the letter or number, followed by the genitive case of the Latin name of the constellation. For example, $\alpha$ Canis Majoris (Sirius is its personal name) is the Bayer designation of the brightest star in Canis Major, and 61 Cygni is the Flamsteed designation of the star in the Flamsteed catalogue which is numbered 61 from the western boundary of Cygnus.

The SC-1 Constellation Chart

The constellation chart SC-1 is a projection of the portion of the sky between the declinations +60° and -60°. It shows a region of the sky centered on the Celestial Equator (CE). The heavy dashed curve represents the Ecliptic (ECL), the apparent annual path of the Sun through the Zodiacal constellations. (Join the two ends of your map together to form a cylinder and in so doing see that the CE and ECL are two circles which cross at an angle of 23.5°) The Vernal Equinox is located at the center of the map, where the CE and ECL cross. The Sun’s location on successive days throughout the year is given by the dates listed just below the ECL curve.

This chart can be used to find the Right Ascensions (RA) and Declinations (Dec) of objects on it or to locate the position of an object that is not shown on the chart by plotting its coordinates. The small numbers along the vertical edges and down the center of the chart are scales of Dec. Objects with positive Dec’s lie on the top half of the chart, and objects with negative Dec’s lie on the bottom half of the chart. The smallest division on the Dec axis is equal to 1°.

The numbers along the horizontal edges and along the equator are the scale for RA with 0 hours (the VE) the center-center position on the chart and increasing to the left (east). Each smallest division of the RA axis is equal to 5 min. For example, the Sun’s coordinates on March 8 are RA = 23h 11m, Dec = -5.5°; or, as another example, the position marked by the coordinates RA = 17h 12m, Dec = +10.5° is the point halfway between Alpha ($\alpha$) and Kappa ($\kappa$) Ophiuchi.

To determine which portion of the sky is visible when you want to observe, you first determine the position of your Celestial Meridian at 8:00 PM on that date. The meridian is a circle running through the celestial poles and the zenith and becomes a vertical line on the SC-1. The position of your meridian with respect to the constellations depends upon the dates along the bottom of the chart. Each RA hour circle is labeled with the date on which it will coincide with the observer’s meridian at 8:00 PM local time. (If you are in a location where Daylight Savings Time is utilized, the time is 8:00 PM standard time, or 9:00 PM daylight savings time) Find the date at the bottom of the chart. For example, the constellation Cygnus is on your meridian at 8:00 PM standard time on September 20.
All stars and planets rise 4 minutes earlier each day due to the orbital motion of the Earth. This means that they reach your meridian 4 minutes earlier each day. This effect accumulates to 2 hours of RA over the course of a month and is then quite easily observed. To find your meridian on a date not shown on the chart you will have to estimate between labeled dates. Your meridian also moves left (east) along the chart by 1 hour for every actual hour that passes.

Once you have found your meridian at the time of your observations, face south and hold the chart slightly above your head with your chart meridian centered in front of you. The chart will then show you the constellations in their proper orientations in the sky for that time of night on that date.

Along the CE you will be able to see exactly 12 hours of RA from horizon to horizon at any one time, 6 hours to the east of your meridian and 6 hours to the west of your meridian. For example, on April 13 at 8:00 PM standard time you will be able to see a span of RA from 3 hours 28 minutes to 15 hours 28 minutes along the CE. North of the CE you will be able to see more than 12 hours of RA and south of the CE you will be able to see less than 12 hours of RA.
Name:

IV. Lab

1. What is today’s date?

2. Using the SC-1 chart, find the RA of the meridian for 8:00 PM on this date.

3. The latitude of Tucson is 32° N. What is the Dec of the Zenith at Tucson?

4. What constellation(s) will be at or near the Zenith at 8:00 PM on this date?

5. What constellation will be on the eastern horizon at 8:00 PM on this date?

6. What constellation will be on the western horizon at 8:00 PM on this date?

7. What will be the RA of the meridian for 11:30 PM on this date?
8. What constellation(s) will be at or near the Zenith at 11:30 PM on this date?

9. What constellation will be on the eastern horizon at 11:30 PM on this date?

10. What constellation will be on the western horizon at 11:30 PM on this date?

11. What are the coordinates of the Sun on this date?

12. In what constellation is the Sun located on this date?

13. Your instructor will inform you of the current lunar phase. With this information and the current coordinates of the Sun, approximate the current RA of the Moon.

14. In what constellation(s) is the Moon likely to located currently?