INTRODUCTION TO THE NIGHT SKY

What will you learn in this Lab?

This lab will introduce you to the layout of the night sky: constellations and stars, their names and the patterns they make, and the cardinal directions that allow you to orient yourself relative to the stars. You will be asked, probably for the first time, to critically look up and draw or chart what you see. In particular you should learn how to match the stars on a chart with what you see in the night sky.

What do I need to bring to the Class with me to do this Lab?

For this lab you will need:

- A copy of this lab script
- A pencil
- Audubon Sky Guide
- SC sky maps (both of them)
- Star wheel
- Red Flashlight

Introduction

In this lab, you will begin exploring the night sky. You will be introduced to constellations, asterisms, the magnitude system and stellar nomenclature. In addition, you will be introduced to the tools that you will use in upcoming night sky labs.

Even on the roof in the middle of the Phoenix metropolitan area, the primary thing you see when you look up in the sky are stars. It is very natural to see patterns in the stars. It is from this that the idea of constellations was developed.

Constellations

Constellations are areas of the sky where a group of stars form a recognizable pattern. The entire sky has been broken up into 88 constellations. Most of the names of the constellations are based upon mythology from several thousand years ago. Some of the constellations look like the objects they are named for, many do not. However, many of the southern constellations (which can not be seen from Tempe) have more modern names indicative of the Industrial Revolution taking place at the time when they were first noticed by European explorers. Plates 69-211 in the Audubon Guide show maps and photographs of the 88 constellations. Pages 421-621 provide more information on the constellations.

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When you consider the geography of the United States, every place in the U.S. is part of a state. Similarly, every point in the sky is part of a constellation. If an object (e.g. Moon or planet) appears in front of a constellation, it is referred to being within that constellation.

Special Constellations

For this class, we have two separate classes of special constellations: Circumpolar and Zodiacal.

Circumpolar Constellations
Circumpolar constellations are those constellations that are close enough to the NCP (North Celestial Pole) that they never set below your horizon. It can easily be shown that for an object to be circumpolar it must be closer to the NCP than the observer's latitude. Here in Tempe, the latitude is 33º, so any object within 33º of the NCP is circumpolar in Tempe. The importance of these constellations is that they can be seen at any time of the night, although they do continue to appear to rotate around the NCP as the Earth rotates on its axis.

Zodiacal Constellations
Most people know the names of these constellations. The reason for this is not that they are bright, but that they are placed in a very specific location. An observer on the Earth "sees" the Sun travel around the sky, passing through a variety of constellations, once a year. It is the motion of the Earth around the Sun that causes this apparent motion. There are 13 constellations in which the Sun appears throughout the year. These are the zodiacal constellations.

The twelve formal Zodiacal constellations are :

> Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius and Pisces.

The Sun also passes in front of Ophiuchus (the 13th mentioned above). The apparent path of the Sun defines the ecliptic and is shown on your SC charts as well as your star wheel.

Asterisms

Constellations are often recognized by the pattern of stars that are located within them. There are also other prominent groups of stars that are not formal constellations. They can be larger than the constellations or subsets of the stars within a particular constellation. Some well known examples visible from Tempe during the year are:

- The Big Dipper (part of Ursa Major)
- The Little Dipper (part of Ursa Minor)
- The Winter Hexagon
- The Summer Triangle (Altair, Deneb, and Vega)
- The Great Square of Pegasus
- The Sickle of Leo
- The Keystone of Hercules

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Magnitudes

When one looks at the sky, or at the photos in the Audubon Guide, one quickly notices that all stars do not appear the same. There is a very wide range in brightness. Stars also appear in different colors. Astronomers occasionally use an archaic method of specifying the brightness of an object. This system is called the magnitude system. The brightness of a star as seen in the night sky is called its apparent magnitude. For a more detailed explanation of the magnitude system and how the numbers work, refer to p.24 of the Audubon Guide.

One will also notice, with some of the brightest stars, that one can see colors (binoculars may help for some students). Wien's Law (see your textbook) shows that the wavelength (or color) of peak brightness of a star depends upon the temperature of the star. You may have noticed this when looking a campfire or other fire sources. In general, they are red when at a lower temperature and as the temperature increases the color slowly changes from orange to yellow to white and finally to blue. However, there are exceptions to this rule based on what is being burned! In the sky, the color of a star indicates its surface temperature. Blue stars are hottest; red stars are coolest.

Stellar Nomenclature

Many of the brightest stars in the sky have proper names. Your TA will introduce you to a dozen or so of these on the roof. You can also see that the brightest stars are named on your star wheel or in the Audubon Guide. One realizes that if all 6000 naked eye stars and the enormous number of fainter stars all had proper names, nobody would be able to figure out which star someone was talking about.

Astronomers developed a naming system for the brighter stars. The stars that are named within this system include nearly all of the stars visible from within the city. The name consists of two parts. The name of the constellation in which the star is in and a greek letter. See the lower case greek alphabet below. The greek letters generally correspond to the brightness of the star (i.e. the brightest star is α, the second brightest β and so on through to ω).

The Lower-case Greek Alphabet

α	alpha	ι	iota	ρ	rho
β	beta	κ	kappa	σ	sigma
γ	gamma	λ	lambda	τ	tau
δ	delta	μ	mu	υ	upsilon
ε	epsilon	ν	nu	ϕ	phi
ζ	zeta	ξ	xi	χ	chi
η	eta	o	omicron	ψ	psi
θ	theta	π	pi	ω	omega

Since this system was done by estimating, there are many constellations where this simple rule is violated due to the presence of variable stars, or other contributing factors.

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The Star Wheel

One of the most useful items that will be used this semester is your star wheel. Your TA will spend some time tonight explaining to you how to use this device.

Red Flashlights

Another item that you will need to bring to every outdoor lab is a **red flashlight**. You will be out on the roof, but since we are in the city, it won't be really dark, but too dark to read your labs. Make sure you bring a red flashlight that just gives enough light that you can read the labs and see what you have written. Your eyes are less sensitive to red light than to white light, so your eyes will dilate less when using a red flashlight. Ask your TA for some red cellophane if you do not have a way of making your flashlight red.

Procedure

Part I – Drawing a Constellation

Allow your eyes to get dark adapted, this should take about 15 minutes. Your TA will give you a constellation tour to introduce you to the brighter stars and constellations visible this semester.

Choose a bright constellation that you know is up tonight. Draw it on the provided page.

- Identify N, S, E and W on your diagram, and the direction you think it will move as the night progresses.

- Compare your drawing with the Audubon Guide. Did you see all the stars?

- Make an estimate from the legend on the charts as to what was the faintest magnitude star you could see? Did you miss any bright stars?

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Part II – Specific Objects in the Night Sky

Using your star chart choose 5-10 bright stars (TA will specify the number of objects). Locate the stars both in the sky and on your chart so you get used to reconciling the chart with what appears in the night sky. Record the stars' names or designations (see above) in Table 1. What constellations are they in? What color are the objects?

Table 1 – Bright Stars

Star name	Constellation	Color

Is the Moon out tonight? If so, which constellation is it in? What is the closest bright star to it tonight? Ask your TA if there are any bright planets out tonight. If so, locate them. Describe their apparent color, and locate the closest bright star and name the constellation they appear to be in. List your findings in Table 2.

Table 2 – Moon and Planets

Object name	Color	Nearest star	Constellation

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Part III – Using the Star Wheel and finding the Milky Way

Use your star wheel to locate that constellations are in the Milky Way. Find these same constellations on the night sky. Use a pair of binoculars to look at these Milky Way constellations and others that are some distance away from it.

- Name the constellations that are visible in the Milky Way tonight.

- Compare the Milky Way constellations and the constellations that are further away. Describe the differences in what you see.

- Can you see the Milky Way with your naked eye? If so, what does it look like with the naked eye. If not, describe what may interfere with your ability to observe it.

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Part IV – Sky Sketches

Southern Sky Sketch. Draw an area of the sky about 70-80º high and wide. Your TA will designate a specific star for you to observe near the southern meridian.

- Include all of the brighter stars.
- Label the constellations that you draw the bright stars for.
- Include any bright objects like planets or the Moon.
- Draw a line representing the ecliptic.
- Make sure you fill in the date and time of the observations.

Northern Sky Sketch. Do the same as for the Southern Sky Sketch. The ecliptic should not appear in your northern sky sketch. Be very careful in doing these drawings. You will need to use them in a future lab. Your TA will designate a star for you to observe near the meridian.

Conclusion:

Indoor alternative

In the event of poor weather, you will be taken to the Planetarium where a lot of the activities you would have done on the roof will be conducted. Some of the observations will be harder to make consistently because of the differences between the Planetarium experience and standing under the open sky.

Specifically, you should complete Parts I and II in the Planetarium easily. You will be given opportunities to draw your constellations and select, locate and identify your stars.

Part III will be essentially impossible and will be omitted from the exercise.

Part IV will be possible but difficult because of viewing directions within the Planetarium. Listen to the Planetarium Director for specific instructions to optimize your viewing conditions.

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Choose a constellation, or two adjacent constellations, located **high** above the *horizon*, consisting of at least **eight** or more stars visible to your eye. Carefully draw this/these constellation(s) below. Indicate the brightnesses of the stars with different sized dots, using larger dots for brighter stars and smaller ones for the fainter stars.

Constellation Name(s): _____

Date and Time: _____

Instructor or T.A. Verification: _____

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Southern sky sketch Name: _____

Date: _____ Time: _____

Instructor verification: _____

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Northern sky sketch Name: _____

Date: _____ Time: _____

Instructor verification: _____

North

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