

LET THE STARS GET IN YOUR EYES

Astronomy, like anything, takes practice. To learn your way around the sky, it is best to get as far away from lights as possible and to observe when the Moon is not present in the sky. Lights and the Moon vastly diminish how much you are able to see. It takes your eyes about 20 to 30 minutes to fully dark adapt so be patient and just keep enjoying the view. Look for patterns of stars you might recognize or hazy spots in the sky. You will be amazed at what you can see that you never noticed before. (A good way to learn the sky is by coming to a Cheyenne Astronomical Society observing session. They are already familiar with the sky and will be glad to give you a tour of what constellations and planets are visible that evening.)

One of the first steps in sky watching is learning to recognize constellations. Learning constellations requires a constellation chart, a red flashlight and your willingness to explore the sky. A red flashlight is a basic tool of astronomers because it won't ruin your night vision. You can paint your light red, or cover your light with a red filter. Red flashlights can also be purchased from astronomy dealers such as Orion Telescope. To use a star chart hold the chart over your head with it facing the same direction you are looking; the map should roughly match the sky overhead. Start by picking out the brighter stars you see by finding the corresponding circles marking their location on your star chart. Next try to pick out the rest of the stars which make up the stick figure you see on your star chart. Remember, they won't look a thing like what they are supposed to -- the most recognizable part of Ursa Major, the Great Bear is the Big Dipper! Locating constellations takes practice, patience, and perseverance, but once you find them you should be able to pick them out more quickly your next time out observing.

Many constellations are obvious and will catch your attention immediately; others are small and dim so they will take more time to pop into view. Learning the constellations will make it easier for you to know your way around the sky if you decide to get binoculars or a telescope. There are "deep sky objects" which cannot be seen with the unaided eye that are easier to find by learning where they lie within a specific constellation.

Some constellation charts like the ones you find in magazines like "Astronomy" or "Sky and Telescope" will show you an area called the Milky Way. The Milky Way is made up of stars, gas and dust that are part of our giant spiral Milky Way Galaxy. We are seeing parts of the disk like shape of our galaxy - it is kind of flattened out like a giant pancake - as we look out from the inside of one of our galaxy's spiral arms.

The patterns you see in constellations are essentially the same as they have been for thousands of years. If you notice a star that moves from week to week relative to other stars, you are seeing a "wanderer"; also known as a planet. Mercury, Venus, Mars, Jupiter and Saturn are all easily visible to the unaided eye.

There are many objects other than stars visible to the naked eye. Some of them are clusters of stars, some of them are giant gas and dust clouds and one of them is another galaxy much like our own. Many of the "Deep Sky Objects" appear as no more than a hazy, fuzzy patch on the sky and are best seen with averted vision. This is an observing trick that enables you to see more detail in things by looking at them out of the corner of your eye. Try it, you'll be amazed!

SKY MOTIONS

The motion of the night time sky is one which can be confusing. The Earth rotates daily on its axis, turning counterclockwise from the west to the east. This daily motion causes the stars to appear to rise in the east and set in the west. As a star rises higher in the sky, it appears to move upward at an angle. When a star reaches its highest point in the sky it is on the meridian; after crossing the meridian the star begins slowly descending towards the western horizon. As the star goes down it follows the same slant that it rose at but in the opposite direction until it finally sets below the western horizon. After a star sets below our horizon it cannot be seen again until it rises the next day. From our vantage point in the northern hemisphere some stars never set below the horizon making them visible all night long. These stars are called circumpolar. The Big Dipper, the Little Dipper and Cassiopeia are all circumpolar and can be seen on any clear night of the year from Wyoming. From Wyoming we can see about 2/3 of all the stars. In order to see all the stars during the course of the year you would have to live on the equator.

Certain constellations are associated with each season of the year. After you get familiar with the different constellations you will find you have your favorites in every season. Stars rise 4 minutes earlier each day causing them to gradually change during the course of the year. As we revolve around the Sun during our 365 day year, the Sun lies between us and the more distant stars causing those constellations to be blocked from view. The stars we see at night are opposite the Sun and during the course of a year we see the constellations change as we pass through the seasons.

STAR LIGHT, STAR BRIGHT

Stars come in all sizes and colors. Betelgeuse in Orion is one of the largest stars known. It is over 800 times larger than our Sun. The smallest visible stars are white dwarfs which are about the size of the Earth. Neutron stars are about the size of a city but are only detected by radio waves. Our Sun is an average star. It is a yellow star and is brighter than most of the stars in our galaxy. The most common stars in our galaxy are red dwarfs. They are much smaller and dimmer than our Sun. Red dwarf stars are so dim only those nearest to the Sun can be seen. The giants of the Milky Way are rare, but they light up the night time sky. Stars like Rigel in Orion and Deneb in Cygnus are true beacons among stars. They are about 60,000 times brighter than our Sun. They lie at great distances from the Earth, yet they are in the list of the brightest stars seen from Earth.

A careful study of the stars will show you all stars do not appear to be the same color. The color of a star is a direct indicator of that star's temperature. A red star is cool, a yellow star is warm and a blue star is hot.

All stars do not appear equally bright to us. How bright a star appears is known as its magnitude. Star magnitudes vary because they are all not equally bright and they are all located at vastly different distances from us.

The magnitude system originated over 2000 years ago by a Greek astronomer named Hipparchus. The brightest stars he could see were 1st magnitude; the dimmest stars he could see were 6th magnitude with the other stars placed in between. When the telescope came along in the 17th century the magnitude limit was dropped to 9th magnitude.

Today's magnitude scale is still pretty much the same except some stars are obviously brighter than 1st magnitude; to account for brighter magnitudes than 1 the brighter objects were assigned 0 and then negative numbers. The brightest star in our sky is Sirius, in Canis Major -- the Great Dog, which has a magnitude of -1.4. Venus is brighter still at -4.4 magnitude. The full Moon shines at -14 magnitude and the Sun shines at -26 magnitude. A

pair of binoculars can see down to 9th magnitude. A 6" telescope can see down to 13th magnitude. Today's largest and finest scopes in the world can see down to about 28th magnitude.

DEEP SKY OBJECTS (DSO)

Deep sky objects generally require optical aid to see. They are things like double stars, open clusters, globular clusters, nebulae and galaxies.

Double stars appear to be one star until you look at them through binoculars or a telescope. A visual double is actually a true pair of stars gravitationally bound together in space. Other double stars are simply an optical chance alignment and just appear to be close in space. Alberio is a popular double star which shows a pretty pair of yellow and blue stars.

Open clusters are loose groups of stars usually relatively young and slowly moving through space together. One of the prettiest and best known open clusters is the Pleiades, also known as M-45 or the Seven Sisters. This cluster of stars shimmers as a bluish patch of light and looks like a tiny dipper of stars. This cluster is fantastic in binoculars! Many clusters can be seen with the unaided eye.

Globular clusters are tight, compact groups of stars and are some of the oldest stars in our galaxy. They were some of the first stars to form in our galaxy and are found in the halo of our galaxy; lying above and below the disk-like plane of our galaxy. Globulars contains between tens of thousands to hundreds of thousands of stars. The most famous globular cluster in the northern hemisphere is M-13, the Hercules Cluster. It is awesome!

Nebulae are clouds of gas and dust glowing from their own charged particles or from the reflected light of nearby stars. Nebulae are where stars are born and where the remains of old stars gather in order for new generations of stars to be born. M-42, the Orion Nebula is a wonderful example of such a stellar nursery.

Galaxies are millions or billions of stars all tied together by the force of gravity. There are spiral galaxies, elliptical galaxies (spheroid shaped) and irregular galaxies. M-31, The Andromeda Galaxy, is visible to the naked eye and is located over 2 million light years away. The universe is made up of 100's of billions of galaxies.

These DSO objects are usually referred to with a "M" (Messier) number or a "NGC" (New General Catalog) number. Finding these deep sky objects is where your knowledge of constellations will come in handy. An example is M-4, a globular cluster located 1 degree west of Antares. If you know where to find Antares, then M-4 should be easy to find.

MEASURING THE SKY

Distances in the sky cannot be measured in inches, feet or yards. The sky is considered infinite, with no finite distance involved. Instead we determine distances in the sky by angular measurements rather than linear. The angular size of an object is the amount of area that object covers in the sky. For instance, the distance between the two "pointer" stars of the Big Dipper is 5 degrees. At any given time we can see 180 degrees of the sky from horizon to horizon. It is 90 degrees from the horizon to zenith - the point directly over your head in the sky. The Moon and Sun both have an angular size of 1/2 degree. Each degree is made up of 60 arc minutes, and each arc minute is made up of 60 arc seconds. The Big Dipper covers 25 degrees of the sky.

Use your hand, fist and fingers to get a fairly accurate method to determine distances in the sky. Your outstretched hand held at arm's length will cover 25 degrees of the sky. A fist held at arm's length will cover 10 degrees of the sky. Three fingers held at arm's length will cover 5 degrees of the sky and one finger held at arm's length will cover one degree of the sky. An aspirin held at arm's length will cover 1/2 degree of the sky.

A handy guide can be found [here](#)

RIGHT ASCENSION AND DECLINATION

Finding objects in the night time sky would be almost impossible without some type of celestial coordinate system. It is the counterpart of Earth's latitude and longitude system. Each object in the sky has a cosmic address. For example the star Vega can be found at the coordinates 18 hours 36 minutes right ascension and 38.8 degrees north declination. This is usually abbreviated R.A. 18h 36m, dec. +38.8 degrees. With this information it is easy to find Vega on any star map that has the coordinate system marked.

OUR PLACE IN SPACE

As planets go, the Earth is small at only 8000 miles in diameter. It orbits the Sun once a year at an average distance of 93 million miles. This distance is known as an astronomical unit (AU).

The other known planets in orbit around the Sun are as close as .39 AU for Mercury and as far as 50 AU for minor planet Pluto. Other, smaller bodies are found in our solar system including 60 known satellites, countless asteroids and millions of comets.

The Moon is practically in our own back yard as it orbits the Earth only 250,000 miles away. Most of the other planets in our solar system have moons as well.

The Sun is by far the largest and most massive body in our solar system. It is a star, a ball of hot gas, made primarily of hydrogen and is about 865,000 miles in diameter. You could line the Earth up 109 times across the surface of the Sun.

To help you understand the vast size of our corner of the universe, you can make your own scale model of the solar system. This scale uses 1 yard for every million miles. The Sun would be a 31" beach ball and the Earth would be a pea 93 yards away from the beach ball. The Moon would be a pinhead 8 1/2 inches from the pea. Mercury would be a BB found at 36 yards from the beach ball. Venus would be a pea 68 yards from the beach ball. Mars would be a smaller pea 140 yards from the beach ball. Jupiter would be represented by a tennis ball 1/4 miles from the beach ball. Saturn would be a slightly smaller tennis ball 1/2 mile from the beach ball. Uranus would be a golf ball 1 mile from the beach ball. Neptune, also a golf ball, would be found at 1.6 miles from the beach ball. Pluto would be a BB 2.1

miles from the beach ball and the nearest star would be another beach ball 15,000 miles away.

This demonstrates the solar system is made up of mostly empty space. The distances covered between stars is so great we use the speed of light to tell how far away they are. Light travels at 186,000 miles per second. It takes the light of the Sun 8.3 seconds to reach the Earth. The light of the Moon reaches us in 1/4 second, and the light of Jupiter reaches us in about 40 minutes. The light from Pluto has traveled for over 5 hours before it is seen by telescopes here on Earth. Incredibly, the nearest star is still 8000 times farther away than Pluto.

Stars are so far away we measure distance to them in light years. Light travels about 6 trillion miles in one year. The nearest star is Alpha Centauri, a triple star system, and it is located about 4 light years away.

THE MOTIONS OF THE EARTH

The Earth rotates daily on its own axis. The Earth spins around in a counterclockwise motion once every 24 hours in relation to the background of stars. At our 42 degree northern latitude we are turning at about 820 miles per hour.

The Earth revolves around the Sun during a period of one year in 365 Earth days. Our orbital motion is at about 66,000 miles per hour. In one day's time we travel about 1.5 million miles. An average human on Earth travels 45 billion miles during their lifetime on board the Spaceship Earth.

Gravitational tugs on the Earth by the Sun and the Moon cause a tidal pull on our planet causing it to very slowly change the orientation of the axis of our planet. This causes the Earth to wobble like a top rather than just spin straight up and down. This gradual changing of the direction of our north and south pole is known as precession. It takes 26,000 years for the entire cycle to repeat itself. Right now our north pole star is Polaris. Vega will be our pole star in 12,000 years as our north pole axis carves out a cone shaped wedge in the sky. When the pyramids were built about 4000 years ago the north star was Thuban in Draco.

The Earth shares the motion of the Sun and the rest of the solar system along with our neighboring stars. This solar motion is about 12 miles a second.

The Sun and the solar system are traveling towards the star Vega in Lyra. This direction is known as the solar apex and we are moving towards it at 12 miles per second.

The Sun, along with its neighboring stars, are orbiting in elliptical, almost circular, orbits around the center of our galaxy. We are orbiting the galactic center at about 154 miles per second or 490,000 miles per hour. It will take the Sun 250 million years to orbit the galactic center one time.

All other galaxies are in motion. We are moving at about 307 miles per second relative to all the other matter in the universe around us.

The Milky Galaxy, of which the Sun is but one star out of billions, is an outlying member of the Virgo Supercluster of Galaxies. We are being pulled towards that cluster at 150 miles per second.

The Virgo Supercluster and all other galaxy clusters in our neighborhood are being pulled towards a massive wall of galaxies known as the "Great Attractor". We are being pulled in that direction at 700 miles per second.

The universe is expanding and all galaxies are moving away from each other. This universal expansion seems to come from the Big Bang -- what is thought to be the beginning of the universe. Everything seems to be rushing away from this initial explosion. We are rushing away from the Big Bang at 322 miles per second.

TELESCOPES

Telescopes are made of either mirrors or lenses. The main mirror or lens of a telescope is known as the primary mirror. It bends or reflects the light striking its surface back to where it can be focused. The place where the object comes into focus is known as the focal point. The distance between the primary mirror and the focal point determines the telescope's focal length. The focal length is usually measured in millimeters. An eyepiece is used at the focal point to magnify the focused image. The amount of magnification is determined by dividing the focal length of the eyepiece into the focal length of the telescope. For example, a 800 mm focal length telescope with a 20 mm eyepiece will magnify things 40 times. To change the magnification of a telescope, you only need to change the size of your eyepiece.

The three powers of a telescope are its ability to gather light, its capacity to magnify an object, and its proficiency to resolve that object. Different aspects of the telescope control these "powers".

The scope's field of view determines the number of times an object can be magnified. Typical binoculars cover about 7 degrees of the sky, wide field telescopes like the Edmund Astroscan cover 3 degrees of the sky and schmidt-cassegrains like the Celestron Classic C-8 cover 1/2 degree of the sky. A wide field scope covers larger areas of the sky giving you smaller images. A narrower field of view covers smaller areas of the sky and giving you larger images. Many telescopes are advertised for their ability to magnify objects a specific number of times. However, the more you enlarge an object, the more you are spreading out its light making it dimmer and harder to see. This is why the ability to gather light is more important than magnification in a telescope.

The light gathering ability of a scope is determined by the size of the primary mirror or lens. The diameter of the primary is known as aperture. The larger the aperture of your telescope the more light it gathers. The ability to gather light becomes crucial when magnifying objects because enlarging them makes dimmer objects harder to see. The "f" focal ratio of a telescope is found by dividing the telescope's focal length by the aperture. It is important to note telescopes with the same size aperture gather the same amount of light, regardless of their focal ratio.

The resolution of a telescope determines how sharp of an image you can see in your telescope and how fine of detail it can resolve. The critical factors involved here are again the telescope's aperture and the quality of the primary. A 6" telescope can resolve about 1 arc second. The human eye can resolve 1 arc minute. The best any ground based telescope can resolve limited by our atmosphere is 1/2 arc second.

The performance of any telescope is helped or hindered by what astronomer's refer to as "seeing". Seeing is how steady the atmosphere is and the transparency of the sky. A turbulent atmosphere will cause the images to shimmer and jump around. The sky's transparency is measured by the clarity of the atmosphere. If the stars seem to really twinkle and shimmer to the unaided eye, the seeing is usually not good. Telescopes are capable of magnifying objects 50 times per inch of aperture. However, this only works when the seeing is incredible. More likely a telescope can magnify things only about 30 to 40 times per inch.

The two basic types of telescopes are refractors and reflectors. A refractor is made of lenses. Refractors are limited in size because they are made of glass, a heavy material. The lenses of a refractor should be perfect to optimize their light gathering ability. A drawback with refractors is chromatic aberration; a condition where red and blue light do not focus at the same focal point.

The average refractor for amateur use is 2 to 4 inches with common focal ratios of f/12 to f/15. They are ideal for looking at brighter images like the moon, planets, and double stars.

This type of scope is generally maintenance free, provides sharp images to the edge of the field and gives you excellent images for planetary study. Refractors are more expensive per inch of aperture than any other type of scope and will give you false color images on brighter objects.

A reflector can be made cheaper per inch than a refractor. It is made of mirrors so the surface area doesn't have to be perfect. The primary mirror can be supported allowing it to be made larger. Reflectors do not suffer aberration and it's surface can get special coatings to enhance it's light gathering ability.

The average reflector for amateur astronomy is from 3 to 12 inches with focal ratios of $f/4$ to $f/8$. They are the least expensive telescope per inch of aperture. They are more compact than refractors, offer excellent color correction, and many offer wide fields of view giving you excellent observing for star clusters, nebulae and the Milky Way. Disadvantages of reflectors include the turbulence caused by their open tubes and dust which enter freely. Reflectors often suffer optical aberration causing fuzzy images around the edge.

A popular telescope for amateurs is a schmidt-cassegrain telescope. This scope uses mirrors to double the focal length of the scope, offering longer focal lengths in a more compact design. Typical schmidt-cassegrain scopes have focal ratios of $f/10$ to $f/15$. They come in sizes of 4 inches and upward. They are the most compact type of telescope, have images sharp to the edge of the field and are useful over a wide range of magnifications. Your typical 8" telescope can have useful power magnifications of over 1000 times. This type of telescope is more expensive per inch than a typical reflector.

Binoculars are certainly not to be overlooked for observing the sky. A common pair of binoculars is 7 x 50, meaning they magnify things 7 times, and have an aperture of about 2". Seven x 50 binoculars will give you fine detail on the moon, can resolve many double stars, and offer great views of star clusters and nebulae. The rich Milky Way will jump right out at you through binoculars. Binoculars take in about 7 degrees of the sky with some wide field binoculars covering about 11 degrees of the sky. Binoculars are compact, require no set up time, and can be used for almost anything. They have a set magnification but are still a handy astronomical tool. Several comets and nova have been discovered by amateur astronomers patrolling with sky with binoculars. Binoculars over 10 x 50 need to be mounted on a tripod in order to offer steady viewing. If you don't have a lot of money to spend for a telescope, you may consider binoculars until you can save money and decide which telescope is best for you. Binoculars may also be a wise choice for people who aren't sure how interested or committed they are to observing the night time sky since they can be used almost anywhere.

IT PAYS TO INCREASE YOUR COSMIC VOCABULARY

Altitude: The height of an object measured in degrees from the horizon.

Aphelion: The point in an orbit when the object is farthest from the Sun.

Apogee: The point in the Moon's orbit when it is farthest from the Earth.

Asterism: An association of stars often well known, but not an official constellation.

Examples: The Big Dipper, Summer Triangle & Pleiades.

Asteroid: Small, irregular shaped bodies most often found between the orbits of Mars and Jupiter.

Astronomical Unit: (Abbreviation -- AU), used as a way to measure distances in the solar system. It is based on the average distance between the Earth and the Sun and is equivalent to 93 million miles.

Celestial Coordinates: Declination and Right Ascension are used to locate objects in the sky.

Celestial Equator: The projection of the Earth's equator onto the sky. It divides the celestial sphere into a northern and southern hemisphere.

Celestial Pole: The point in the sky where the north and south pole of the Earth is pointing. Right now the star Polaris is very near our North Pole making it the "Pole Star".

Comet: A classic dirty snowball which melts as it orbits the Sun to form a tail visible through many telescopes.

Conjunction: When two or more bodies appear close to each other in the sky as seen from Earth

Constellation: A grouping or pattern of stars with which an imaginary picture is associated.

Declination: Measures the distance north or south of the celestial equator in degrees, minutes and seconds. Declination is used much like latitude is used on the Earth. Degrees north of the celestial equator are (+) degrees and those found south of the celestial equator are (-) degrees.

Degrees: Used to measure the angular size of an object in the sky. Each degree can be broken down into 60 arc minutes and each arc minute can be broken down into 60 arc seconds.

Direct Motion: The eastward motion of a planet across the background of stars.

Ecliptic: The apparent path of the Sun across the sky. All the planets lie very near the ecliptic.

Electromagnetic Radiation: All the forms of energy - Radio, Microwave, Infrared, Visible Light, Ultraviolet, X-ray, & Gamma Ray.

Elongation: Angle of degrees an object is in the sky from the Sun.

Emission Nebula: or Bright Nebula. These are nebula where young stars or stars-to-be are becoming so hot they are causing the gas and dust surrounding them to glow.

Fireball: A meteor brighter than any planet or star.

Inferior conjunction: When an inferior planet (Mercury or Venus) passes between the Sun and the Earth.

Light Year: The distance light travels in one year, roughly 6 trillion miles. Light travel time is used to measure distances to stars and galaxies because it is the fastest anything can travel.

Luminosity: The true brightness of a star; it is compared to the Sun.

Magnitude: How bright a star appears to us from here on Earth.

Messier Objects: A list of 110 nebulae, galaxies and star clusters.

Meteors: "Falling stars" are small rocky material that burn up from friction when they encounter our atmosphere.

Milky Way: An irregular band of soft light that stretches across the sky; in actuality it is our own disk-shaped galaxy seen from the inside.

Occultation: When one solar system body passes in front of another object blocking it from sight.

Opposition: When an object is directly opposite the Sun as seen from our point of view.

Perigee: The closest point in the Moon's orbit around the Earth.

Perihelion: The closest point in an object's orbit around the Sun.

Planetary Nebula: Looks like a cosmic smoke ring around stars. It is actually the end of an average star's life when it puffs away most of it's mass to space in a shell of gas and dust.

Reflection Nebula: Young, hot stars reflect the gas and dust left over from their formation.

Retrograde motion: When a planet stops direct motion and begins moving westward (backwards) in front of the background of stars.

Right Ascension: The angular position of the sky measured in 24 hours from the first point of spring. The measurements are made in hours, minutes and seconds with each hour covering about 15 degrees of the sky. Right ascension is used like longitude is used on the Earth.

Satellite: A small planetary body or spacecraft in orbit around a planet.

Seeing: How steady and clear the Earth's atmosphere is when observing.

Sidereal Time: Time relating to the rotation of the Earth in relation to the stars. A sidereal day, based on the stars, is 23 hours and 56 minutes.

Solar Time: Time relating to the rotation of the Earth in relation to the Sun. A solar day is 24 hours.

Stars: A self-luminous celestial object we see because they are burning through a process known as nuclear fusion.

Superior Conjunction: When a planet is on the opposite side of the Sun from the Earth.

Supernova: The explosion of a massive star, it can rival galaxies in brightness.

Supernova Remnant: The gas and dust blown out by a supernova visible in telescopes.

Terminator: The line between the sunlit and dark parts of the Moon; it is the best place to study the Moon for greater detail.

Transparency: The clarity of the Earth's atmosphere when observing.

Variable Stars: A star whose magnitude changes.

Zenith: The point most directly overhead in the sky.

Zodiac: The 13 constellations where the ecliptic is centered on the celestial equator.

INTRODUCTION TO WYOMING SKIES

The next few chapters contain an introduction to the stars and constellations visible in the Wyoming sky. The constellations are divided into those visible in spring, summer, fall, winter and the ones we call circumpolar. Circumpolar stars are the stars and constellations visible all night long; they never rise or set, but appear to circle clockwise around the North Pole Star, Polaris. How much of the sky is circumpolar is determined by your latitude. We are at +42 degrees North so any star within 42 degrees of Polaris will be visible all night. Polaris will also be found at 42 degrees off our northern horizon.

The constellations are introduced to you by first giving you to a brief description of the history or legend behind the constellation. Then the constellation and major stars are outlined. After which unusual stars, star clusters, nebulae or galaxies found in that constellation may be introduced. This booklet describes only a small part of what is visible in our night time skies. Once you become familiar with the stars they will become like old friends to you. The key to learning what is out there begins with your curiosity and the willingness to go out and study the stars.

Constellations are the landmarks of the sky. In order to find a star, planet or deep sky object (DSO), it is helpful to know in which constellation that object is located. Constellations have been handed down to us through many cultures since as early as 5000 B.C. Ancient constellations were centered around myths, gods, water, animals and monsters. More than half of the constellations such as Scorpius, Taurus, Leo, and the Great Bear have been around since recorded history. The Ancient Babylonians identified the 12 constellations of the Zodiac, the constellations where you will find the Sun, planets and the Moon. Today we identify these constellations more by their stick outlines rather than "seeing" their pictures on the sky.

A few centuries ago the entire sky was divided so each object or star would be assigned to an official constellation. There are a total of 88 constellations some of which have modern names and were used only as "filler" material in mapping the sky. Many of the new constellations are in the Southern Hemisphere. The 88 constellations have definite boundaries much like the United States is divided into individual states.

An asterism is an association of stars which may be from one or more constellation. It is not an official constellation; many asterisms are well known such as the Big Dipper, The Sickle, The Pleiades, and the Summer Triangle.

Many stars have proper names which are well known but more often you will see Greek letters used to name the stars in a constellation. The brightest star in a constellation is labeled with the Greek letter alpha. The first five bright stars of a constellation would be called alpha, beta, gamma, delta, and epsilon. For instance, the brightest star in Orion is Alpha Orion also known as Betelgeuse.

Another object you will see on star maps is a "M" followed by a number. This is a Messier object which is a catalog containing 110 deep sky objects. This list was made by Charles Messier in the 18th century as he searched for comets. He marked down the position of anything he saw in his telescope which he might confuse with a comet. Most Messier objects can be found in binoculars and are often the first challenges for beginning amateur astronomers to find.

When a constellation is found in a "Milky Way" region of the sky, this refers to the hazy band of light we see stretching across our summer and winter evening skies. This glow of light is actually unresolved stars, dust and gas of our own galaxy seen edge-on from inside. The "Milky Way" contains more and brighter stars. During the evening skies of the spring and fall we are looking out of our Milky Way Galaxy to the open space between galaxies.

To use your star maps, hold them above your head with the direction you are facing placed the same way. If you are facing north, have the north end of the map facing north as well. The sky should roughly match the stars and constellations on your star map. Remember, the star maps are very compressed and somewhat distorted compared to the sky overhead.

WYOMING SKIES 20 BRIGHTEST STARS

Sirius -1.4 Mag.
Arcturus -0.1
Vega 0
Capella 0.1
Rigel 0.2
Procyon 0.4
Betelgeuse 0.4
Altair 0.8
Aldebaran 0.9
Antares 1.0
Spica 1.0
Fomalhaut 1.2
Pollux 1.2
Deneb 1.3
Regulus 1.4
Castor 1.6
Adhara 1.6
Bellatrix 1.6
Shaula 1.6
Elnath 1.7

SUGGESTED ASTRONOMY BOOKS:

The Stars: A New Way to See Them by H. A. Rey

Pocket Sky Atlas by Roger W. Sinnott

The Cambridge Photographic Star Atlas by Alex Mellinger and Ronald Stoyan

Nightwatch by T. Dickinson

The Edmund Mag. 6 Star Atlas by Dickinson, Costanzo and Chaple

Peterson Field Guide to the Stars and Planets by D. Menzel and J Pasachoff

Norton's 2000 Star Atlas and Reference Handbook edited by Ian Ridpath

Sky Atlas 2000 by Wil Tirion, field edition

Burnhams's Celestial Handbook by Robert Burnham, Jr. Set of 3

Uranometria 2000 by Wil Tirion, Barry Rappaport and George Lovi,

365 Starry Nights by Chet Raymo

The Astronomical Companion by Guy Ottowell

Also a Planisphere for +42 degrees northern latitude

CIRCUMPOLAR CONSTELLATIONS

Ursa Major, the Great Bear, has myths associated with it going back to the earliest civilizations. It was envisioned as a great bear with native North American Indians and ancient Greeks. The British have referred to it as a Plough since medieval times. The Greek myth tied to the Great Bear is that Zeus fell in love with Callisto and they had a son, Arcas. Zeus's wife, Hera, became very jealous and turned Callisto into a bear.

URSA MAJOR is a very large constellation. It's best known for the asterism the BIG DIPPER. The Big Dipper is a group of 7 conspicuous stars shaped in the form of a dipper. Other than Orion; it is one of the most impressive and best known star patterns in the sky.

Dubhe and Merak, the stars in the end of the bowl of the Big Dipper, are known as "the pointers". If you draw a line straight through these stars and continue on northward, the next brightest star you will run into is Polaris, the North Star.

The second star in the handle of the Big Dipper is actually a multiple star system. They are MIZAR and ALCOR and can be seen as a double star with the unaided eye. Mizar and Alcor are also known as the "Horse and Rider". The ability to see these two stars was once used as a vision acuity test.

Ursa Major offers many fine galaxies such as M81 and M82, a spiral and an irregular galaxy which can be seen in the same field of view in a telescope. Another unusual deep sky object in Ursa Major is M97 known as the Owl Nebula for it's unusual likeness to an owl.

Ursa Minor, the Little Bear, has existed in mythology for centuries along with the myth concerning the Great Bear. When Arcas reached manhood he was about to shoot a bear not realizing it was his mother, Callisto, whom had been turned into a bear by Hera. To protect his son from the horror of killing his mother, Zeus changed Arcas into a bear and carried them both to the heavens where they became constellations. Zeus carried the bears to the skies by their tails causing them to stretch out. Hera was outraged at the honor bestowed on Callisto and Arcas so took revenge on them by making them never able to dip beneath the sea of stars to rest; that is why you will always see the Little and Big Bear circling forever around the north star.

URSA MINOR, the LITTLE DIPPER, resembles a dipper, but is much less conspicuous than the Big Dipper. It contains POLARIS, the most important star in our skies.

Polaris is the north pole star which always remains in the same spot (nearly) while all the other stars appear to circle clockwise around it once a day. Polaris is not one of our brightest stars since it shines at only 2nd magnitude; nor is it always the star closest to the north pole. Due to the precession, or the wobbling of the Earth on it's axis; the celestial pole slowly shifts as the centuries go by, and different stars then become the north pole star. One entire precession of the galactic pole takes 26,000 years.

Besides Polaris most of the Little Dipper stars are faint. Only the two stars at the end of the bowl are fairly bright. They are called the "Guardians of the Pole" as they march around the pole like sentries. The brighter star of the Guardians, KOCHAB, was the Pole Star at the time of Plato, about 400 B.C.

Draco, the Dragon, has been associated with a dragon in most western mythology. It has sometimes been identified as the guard for the golden apples of the garden of Hesperides who was killed by Hercules when he came to fetch the apples as his 11th labor. In ancient Egyptian mythology, Draco was portrayed as a hippopotamus or crocodile.

DRACO is a large constellation of not very bright stars. A string of stars winding around the Little Dipper makes up it's long tail, and two pairs of stars mark the legs. It's most conspicuous part is the head, an irregular quadrangle about half the size of the Big Dipper's bowl. The Dragon's head is referred to as the Lozenge. The four stars making up the

dragon's head have different magnitudes: 2.5, 3, 4, and 5. The faintest of the four head stars is Nu which can be split by keen eyesight into two components. The stars in this real binary system are so distant from each other it takes at least a million years for them to complete a single revolution around each other.

The faint star in the Dragon's tail halfway between Mizar and the Guardians is THUBAN. Thuban was the pole star when the pyramids were built some four to five thousand years ago. It will be the pole star again some twenty thousand years from now.

Cassiopeia, the Queen, is one of the most ancient constellations. She is the Queen of Ethiopia, married to Cepheus, the King of Ethiopia. They have a daughter, Andromeda, and you will find them all residing in the same area of the sky in the "Queen's court." Cassiopeia was very vain and boasted about her daughter's great beauty. Poseidon the god of the Sea was enraged by this since it slighted the beautiful sea nymphs. To punish Cassiopeia for being vain, he sent a sea serpent to kill Andromeda and ravage the land. Cassiopeia was forced to chain Andromeda up along the coast to try and appease the sea monster. Perseus the hero came by on his great winged horse, Pegasus, and rescued Andromeda. Perseus and Andromeda were later married.

CASSIOPEIA is an important constellation which lies in the Milky Way. The small constellation appears as a "W" or "M" depending on the season and the time of night. Cassiopeia is circumpolar so it can be seen all night year round. This small constellation is formed by 5 fairly bright stars. To find Cassiopeia you draw a line from the star where the handle joins the Dipper's bowl on to the Pole star and continue on until you hit the middle star of Cassiopeia.

The center of the "W" is marked by Gamma Cassiopeia, an erratic variable star. Cassiopeia was also host to a supernova explosion in 1572. This supernova was the brightest supernova ever recorded as it became brighter than Venus and could be seen in daylight. It became known as Tycho's Star after the great astronomer Tycho Brahe who kept an accurate record of the star for 17 months until it faded beyond the limit of naked eye visibility.

The constellation is rich in star clusters which can easily be seen in binoculars. M52 is an open cluster lying above the tip of the W.

Cepheus, the King, was married to the Queen of Ethiopia, Cassiopeia.

CEPHEUS is much dimmer than his wife and is made up with five 3rd and 4th magnitude stars forming the shape of a stick house with a steep roof. Part of Cepheus lies in the Milky Way. To find Cepheus continue the line from the Pointers beyond the Pole Star and it will hit the roof of the stick house outline of Cepheus.

Mu Cephei is known as the Garnet Star and is one of the reddest stars visible with the unaided eye.

Delta Cephei is the prototype of the important Cepheid Variable stars. It varies in magnitude from 3.7 to 4.6.

Three of the brighter stars of Cepheus will be the pole stars 2000, 4000, and 6000 years from now.

SUMMER CONSTELLATIONS

Ophiuchus, the serpent bearer, has been identified with several mythological creatures over the ages. Since the serpent sheds its skin every year, it has become a symbol of renovation and healing. The Greek god of medicine, Asclepius, was the son of Apollo and Coronis, and according to myth, during his years as an earthly doctor he was able to bring the dead back to life. He is generally shown as a mature figure in control of Serpens, the snake he is holding, which remains the symbol of western medicine.

SERPENS and OPHIUCHUS is a vast and mixed up pair of constellations. Ophiuchus should have been a constellation of the zodiac since the Sun, Moon and planets spend more time here than in Scorpius just below it.

Serpens contains the variable star known as R Serpi which rises to fifth magnitude about once a year and then fades away to unaided eye visibility.

Beta Serpi lies near a brilliant field of stars.

The globular cluster M5 can be found about 5 degrees to the southwest of Alpha Serpens and right beside a 5th magnitude star.

Ophiuchus has been noted for many novae during history. In 1604 Kepler's Star blazed out brighter than the planet Jupiter. RS marks the location of a recurrent nova. In 1898 it suddenly rose to 4th magnitude and did the same thing again in 1933, 1958, 1967 and 2006. It rests at 11th magnitude and may rise in magnitude again at any time. The outburst in 1933 saw RS brighten about one magnitude per hour.

Barnard's Star is located in Ophiuchus. Barnard's star is the fourth closest star to the Sun. It is a red dwarf star and shows the largest proper motion of any star in the sky moving 1/2 degree (same as the diameter of a full moon) every 180 years. Planetary hunters announced in 2018 they are 99% sure Barnard's star has a planet..

Sweeping this region with binoculars will reveal many bright patches of stars and star clouds. Ophiuchus contains several impressive globular clusters such as M10 and M12.

Hercules, the Hero, is shown in the Assyrian texts of 3000 B.C. with a foot on the head of Draco, the dragon. Hercules was celebrated since early Greek times as being the strongest man who ever lived. He was celebrated for accomplishing twelve seemingly impossible tasks or labors. He was the son of Zeus and a mortal mother. Hercules later became a full god.

HERCULES is a large and rather dim constellation whose asterism the Keystone is the easiest part to find. The Keystone is made up of four 3rd and 4th magnitude stars.

Alpha Hercules is a red giant star and is one of the largest stars known. It is a variable star and fluctuates between 3rd and 4th magnitude.

On the western side of the Keystone you will find the grandest globular cluster in the northern hemisphere. The Great Hercules Cluster, or M13, is visible to the naked eye in really dark skies and jumps out at you in binoculars or small telescopes. Moderate sized telescopes can begin to resolve the cluster into individual stars. M92 is another fine globular cluster located above the Keystone.

Scorpius, the Scorpion, was a double constellation in pre-Roman times when it was combined with Libra, the Scales, as the insect's claws. It was then called Scorpius with Claws. Scorpius has always been associated with death, darkness and as an evil omen. The scorpion was the creature sent by Apollo to kill Orion, the Hunter, since he had become boastful and vowed to kill all animals on Earth. The gods told Scorpius to sting the giant and put an end to his bloody sport. The resulting bloody battle caused the death of Orion so the gods placed them both among the constellations on opposite sides of the sky so they could never do battle again. The scorpion is being threatened by the arrow of Sagittarius, the Archer, which is aimed straight at Antares, the heart of the scorpion. Scorpius' figure has

been recently shown as a kite with a long tail. This pattern fits the stars equally as well as the scorpion.

SCORPIUS is a beautiful constellation of the Zodiac. It lies just above the horizon for viewing from our mid northern latitude; but still it is one of the most impressive constellations. It really does look like a Scorpion and is made of several bright stars.

Alpha Scorpii is ANTARES a red supergiant star shining at first magnitude. Antares means the "Rival of Mars" and appears distinctly red. This supergiant star is believed to be at least 800 times the diameter of the Sun. If Antares were located where the Sun is, it would fill the area past the orbit of Mars. Antares is located about 500 light years away. Antares lies about 4 degrees south of the celestial equator so you will see the Moon and planets traveling near the red supergiant.

The CATS EYES is a close pair of stars in the Scorpion's tail which appear to be exactly that when viewed through binoculars or a telescope.

The globular cluster M4 lies two degrees directly west of Antares. A smaller and fainter globular cluster can be found halfway between Antares and Beta Scorpii. The star Zeta Scorpii lies in a field of bright stars including a misty patch of stars resembling the more famous Pleiades. In the tail of the Scorpion there are two open clusters known as M6 and M7. These clusters can be seen as hazy patches with your unaided eye and are gorgeous in binoculars. The southern region of Scorpius is rich in stars, star clusters and nebulae well worth a look on any clear night of star gazing.

Libra, the Balance or Scales, was once part of Scorpius.

LIBRA has no bright stars and the shape of a pair of scales is hard to find. The star lowest to the right on the scales has a very faint greenish hue, the only green naked eye star.

Sagittarius, the Archer, originated in ancient Babylon or Assyria and was well known by the time of the Greeks. The figure appears with a lion's head on the zodiac of the Egyptian sky. The centaur was a favorite creature of the Assyrians, seen as warlike and uncivilized, unlike his cousin to the west, Centaurus. He is depicted as holding a bow and arrow which is pointed at Antares, the heart of the Scorpion. Today it is often pictured as a ladle or a teapot.

SAGITTARIUS is more familiar to those in the northern latitudes as the TEAPOT or milk dipper. The ecliptic and the zodiac pass entirely through the constellation. The teapot is made of 8 bright stars with the handle on one side and the spout on the other side pointing directly towards the center of our Milky Way Galaxy.

This area is the richest region of the Milky Way. So numerous are the star fields, clusters and nebula you could spend an entire evening studying one object after another and not see them all. Near the western border M8, The Lagoon Nebula, and M20, The Trifid Nebula, will be found. These well known nebula are stellar nurseries which appear as hazy patches on top of star clusters. Other well known nebulae found in Sagittarius are the Eagle, the Omega nebula and a dark nebula known as the Ink Spot. M22 is an impressive globular cluster found to the east of the teapot. Fifteen of the 110 Messier objects are found in the constellation of Sagittarius.

Lyra, the Lyre, was the instrument given to Orphus by Apollo. Orphus was the most famous poet and musician in Greek legends. When Orphus' wife Eurydice died, he was told he could bring her back from the underworld on the condition he not look back until she was in the light of the Sun. Orphus led her out with music from his lyre, but when he reached the Sun he turned to see her. She had not reached the sunlight so he lost her forever. He was inconsolable and refused the advances of many women trying to win his love. One day a group of women attacked him, tore him apart and threw his head and lyre into the Hebrus

River. Apollo intervened and placed his head in a cave, his limbs were buried at the foot of Mount Parnassus and his lyre was placed among the stars.

LYRA is a small but important constellation because of its brightest star, VEGA. Vega is a brilliant bluish-white main sequence star and is our 5th brightest star. Vega is below the horizon only 7 hours a day so it can be seen some time during the night any time of the year. Vega is a close star at only about 27 light years away. It is 50 times as luminous as our Sun and is 3 times larger than our Sun. The solar apex (the direction our Sun is traveling) is towards the star Vega at 12 miles a second. Vega will be the pole star in 12,000 years. Vega was the first star to ever be captured on a photograph taken over a hundred years ago in 1850. Vega was also found to have a possible solar system forming around it when IRAS found a ring of debris circling the star in 1983; this has not yet been confirmed as of 2019. Vega is one of the stars making up the Summer Triangle.

The first star east of Vega is Epsilon Lyra known as the "double-double". On a clear night your naked eye can divide the pair. A telescope will divide each star into another pair of stars.

Beta Lyra is a variable star containing a binary system. The pair are nearly touching with their atmospheres intermingling causing the stars to be egg shaped.

A famous planetary nebula can be found in the middle between the stars gamma and beta Lyra. It is known as M57, the Ring Nebula.

Cygnus, the Swan, is an ancient constellation which appears in Ptolemy's Almagest in 2nd century A.D. It had been known for centuries as a bird and was often referred to as a hen in ancient mythologies. One of the most enduring legends suggests that it was the image of the bird into which Zeus transformed himself while visiting Leda, the wife to the king of Sparta. Leda daily laid an egg, from which hatched not only the twins Castor and Pollux (Castor being the son of the king and Pollux being the son of Zeus) but also Helen of Troy.

CYGNUS is more commonly known for its asterism, NORTHERN CROSS. The two arms of a cross can easily be traced out the longest of which follows directly down the Milky Way. Cygnus is a large and rich constellation.

The brightest star in Cygnus is DENEK found at the top of the cross. This star is a true stellar beacon with the luminosity of over 60,000 Suns. Deneb is a blue-white supergiant star about 1600 light years away. If Deneb were at the distance of Sirius (about 8 light years away) it would rival the full moon in brightness. If it was as close as Alpha Centauri (about 4 light years away) we would be able to read by its light at night. Deneb is only below the horizon for 5 hours each day. Deneb is a member of the Summer Triangle.

Beta Cygnus; Alberio, and is one of the finest examples of a binary star showing distinct color contrasts. The pair contains a 3.2 and 5.4 magnitude pair of stars which appear distinctly gold and blue.

61 Cygni was the first pair of stars whose distance was directly measured by stellar parallax. The 5.6 and 6.3 magnitude stars lie only 10.5 light years away.

Omicron Cygnus is another yellow and blue double star system.

Chi Cygnus is a variable star that brightens to about 4th magnitude.

Cygnus X-1 is believed to be a primary candidate for a black hole.

The region around Gamma Cygnus shows an intense nebulosity of rich Milky Way. The Great Rift starts right under the cross of Cygnus. This is a region of dark nebula, opaque dust which blots out the brighter starlight behind it. The Veil Nebula is a supernova remnant found in Cygnus. The North American Nebula is an emission nebula near Deneb. They both can be seen in binoculars.

A nova appeared in Cygnus in 1992 that reached naked eye visibility.

Aquila, the Eagle, was rewarded a place in the heavens for having brought the handsome Ganymede from Earth to serve as a cupbearer to the gods.

AQUILA is a large constellation which is easily picked out by finding its brightest star, Altair. ALTAIR is a member of the Summer Triangle. Altair is the middle of three stars in a row marking the head of the Eagle. Altair is only 16 light years away and closing in on us at 1000 miles a minute. Altair is a white main sequence star about 1 1/2 times the size of the Sun with about 11 times its luminosity. Altair rotates once every 6 hours which has caused it to flatten into an ellipsoid shape.

Aquila contains Van Briesbroek's star the least brightest star known. It has 1/500,000 the luminosity of our Sun and is smaller than Jupiter.

A nova occurred in Aquila in 1918 which rivaled Sirius, our brightest star, for a couple of nights. Today that star shines at 11th magnitude.

Scutum, the shield, is a modern constellation sprinkled with luminous star clouds and clusters, the brightest of which is M11, the Wild Duck Cluster. M11 can be detected with the naked eye and is a fine sight in binoculars.

Sagitta, the arrow, has been associated with several different arrows, including the one Apollo used to slay the three one eye giants called the Cyclops.

SAGITTA is between Altair and Alberio and lies in a nice region of the Milky Way. It is a small but striking constellation with four fairly bright stars making up the arrow shape. Sagitta contains some unusual stars.

WZ Sagitta is a reoccurring nova which had outbursts in 1913, 1946 and 1978. The star is usually around 15th magnitude and reaches around 7th magnitude during outbursts.

FV Sagitta is an erratic variable star shining between magnitude 9.5 and 13.9 with 3 overlapping periods of variability. The star may have been or soon will be a nova.

U Sagitta is an eclipsing binary star. The eclipse occurs every 3 days, 9 hours and 8 minutes. The 6.4 magnitude star is quickly dimmed to 9.0 for an hour and 40 minutes when the dimmer companion star passes in front of the primary star.

M71 is a globular cluster found in the middle of the stick of the arrow.

Vulpecula, the Little Fox and Goose, lies between Cygnus and Sagitta. It is long and dim but contains a noteworthy Messier Object, M27. M27 is known as the Dumbbell Nebula and is the brightest planetary nebula in the sky. A number of nova have been discovered in this obscure little constellation. The asterism "The Coat Hanger" can be found on the Vulpecula-Sagitta border and is made up of 6th and 7th magnitude stars which resembles an upside down coat hanger.

Delphinus, the Dolphin, successfully convinced the sea goddess Amphitrite to marry Poseidon, from whom she had been fleeing. As a reward the Dolphin was placed among the stars by Poseidon.

DELPHINUS the Dolphin is a small but striking constellation. It looks more like a tiny kite and is seen on clear nights.

Capricornus, the Sea Goat, has been associated with Pan, a goat in Roman mythology and as a symbol of fertility. Other civilizations associated this region with water. The ancient Chinese, Babylonians and Egyptians all connected Capricornus with the rainy season. The Aztecs portrayed it as a horned whale.

CAPRICORNUS is a constellation of the Zodiac. It lies too far south for much attention from us since it has primarily faint stars. Neptune was found near Delta Capricornus in 1846. M30 is a faint globular cluster found to the west of Capricornus.

AUTUMN CONSTELLATIONS

Perseus, the Hero, armed with a polished shield given to him by Athena, killed Medusa, the only one of the Gorgons who was mortal. The three Gorgons were three monsters so horrible to behold that all who looked upon them were turned into stone. Athena told Perseus to use the shield as a mirror and thus avoid looking directly at the Gorgons. After he cut off Medusa's head, the winged horse Pegasus sprang from her blood. The head of Medusa enabled Perseus to overcome many enemies, as well as to kill the monster Cetus. Medusa's eye is imagined to be Algol, the demon star.

PERSEUS is a nice constellation found in the Milky Way.

Beta Persei is ALGOL, the Demon Star, long known for changing magnitudes. Algol is the proto-type for eclipsing binary stars, a system where one star blocks all or part of the light from the other star dimming its magnitude. Algol dims from 2.2 to 3.4 magnitude about every 70 hours. The dimming of Algol is easily noticeable with the naked eye by careful comparison of Algol to surrounding stars.

The open cluster M34 is found above Algol.

The Perseus Double Cluster is found between Perseus and the end of Cassiopeia. It appears as a hazy patch to the unaided eye and is resolved into a glorious double cluster of stars in binoculars and wide field telescopes.

Alpha Persei, Mirfak, lies in the midst of a nice rich open cluster easily seen in binoculars.

The radiant of the Perseid Meteor shower is found near the Double Cluster. The Perseid Meteor Shower is one of the most reliable and active meteor showers of the year. It peaks on about August 12th and averages about 60 meteors an hour.

Perseus had a Nova appear in 1901 which became as bright as the star Vega.

Piscis Austrinus is primarily made up of faint stars not visible from our latitude. The brightest star in the Southern Fish is FOMALHAUT, one of the twenty brightest stars visible. Fomalhaut is the most southern first magnitude stars visible from here. It is located about 22 light years away and is about 13 times as luminous as our Sun. When you are looking at Fomalhaut, you are looking out of the flat spiral of the Milky Way Galaxy where only 1000 light years separates us from the vast emptiness of intergalactic space.

Pegasus, the Winged Horse, sprung up from the blood of Medusa after Perseus killed her. Bellerophon tamed Pegasus and rode him to slay the monster Chimaera. Bellerophon riding upon Pegasus had such great success against monsters and enemies he became rather vain and arrogant. Bellerophon decided to ride Pegasus to Mount Olympus which offended the gods. Zeus sent a gadfly to sting Pegasus, the horse reared in pain causing Bellerophon to fall off causing him to become lame and blinded. Pegasus continued to climb to Olympus where he earned a place among the stars.

PEGASUS is more commonly recognized as the GREAT SQUARE of Pegasus. This asterism is one of the great landmarks of the sky and is made up of four 2nd magnitude stars, three stars from Pegasus and one star from Andromeda. The Great Square covers a good deal of sky and is easy to pick out in the sparse autumn skies. The two stars that form the west side of the Great Square can be extended downward to find the bright star Fomalhaut.

Enif is the bright star which marks the nose of the great flying horse. Above Enif is the globular cluster M15.

Aquarius, the water carrier, is an ancient constellation. Artifacts depict the constellation as a man or boy pouring water from a bucket. It also represented the rainy season.

AQUARIUS is a faint and complicated member of the zodiac. Near Delta Aquarii is where Tobias Mayer discovered Uranus in 1756 but he recorded it as a fixed star and it was not rediscovered until twenty five years later when William Herschel discovered the 7th planet of our solar system when it was located in Gemini.

M2 is a globular cluster found in Aquarius. Also in Aquarius you can find the Helix Nebula, one of the largest planetary nebulae, and NGC 7009, a planetary nebula that when viewed through a large telescope resembles the ringed planet Saturn.

Pisces, the Fishes, is a very old constellation and appears as a fish or two fishes in several ancient cultures. In Roman mythology, the fishes represented Venus and her son Cupid, who plunged into the Euphrates during an attack by Typhon the monster. Venus and Cupid became fishes whose images were raised into the sky.

PISCES is another large and faint zodiacal constellation. The Northern Fish is a small triangle of faint stars just below Andromeda. The Western Fish or Circlet is a little brighter and can be seen as a ring shape south of the Great Square. The Knot tying the two fishes together is real faint and can be traced out only in dark skies.

Pisces is where the point of the Vernal Equinox occurs. When the Sun reaches this spot on or about March 21, spring begins in the Northern Hemisphere. This point is where the Sun traveling along the ecliptic crosses the celestial equator into the northern hemisphere. The Zero Hour Circle also goes through this point. This is where the celestial coordinates for right ascension start on the celestial sphere. All star positions in right ascension are measured east of this point on the sky.

Cetus, the Whale, is the sea monster that tried to devour Andromeda. Cetus appeared in Ptolemy's Almagest.

CETUS is a large and dim constellation. Beta Cephei, Deneb, is the brightest star in Cepheus shining at second magnitude. The small pentagon marking the whale's head is made of 3rd and 4th magnitude stars.

MIRA is one of the most famous variable stars known. It is listed as omicron Cetus and was the first variable star discovered when in 1596 an astronomer noted omicron as a 3rd magnitude star but it then disappeared from visibility. Mira fades to about 13th magnitude before brightening again to about 3rd magnitude every 330 days.

Tau Ceti is the third nearest star visible to the naked eye from our latitude. Only Sirius and Procyon are nearer. It is 10 light years away and about 1/3 as luminous as our Sun. Among the 20 nearest stars only Sirius and Procyon are bigger and brighter than our Sun. Alpha Centauri is about the same size and temperature as our Sun and all the other neighboring stars are dimmer and smaller than our Sun.

M77 is a nice elongated spiral galaxy which can be found near the head of the whale.

Andromeda, the chained lady, is the daughter of Cassiopeia and Cepheus. When Cassiopeia boasted her beauty exceeded that of the sea nymphs, the slighted beauties asked Neptune, god of the sea, to punish her. Neptune sent the sea monster Cetus to ravage the kingdom of Cepheus. Cepheus was told by the oracle only the sacrifice of Andromeda to Cetus would appease the gods. Andromeda was chained to a rock by the sea but her fate was averted by the arrival of Perseus who turned Cetus into stone by flashing the face of Medusa before the monster.

ANDROMEDA is easy to find since the northeast corner star of the Great Square of Pegasus is actually Alpha Andromeda. From this starting point Andromeda sweeps out in long curving lines resembling a large, loose "V".

Almak, Gamma Andromedi, is a nice double star system made up of an orange and blue pair of stars.

A remarkable object located in Andromeda is M31, the Great Andromeda Galaxy, a giant spiral galaxy located 2.2 million light years away. When we say we are looking at the Andromeda Galaxy 2.2 million light years away we are actually looking at how that Galaxy looked when that light left there over 2 million years ago. We are really looking back in time. The Great Andromeda Galaxy is a neighboring galaxy to our Milky Way Galaxy and is a member of our local group of galaxies. It can be seen as a hazy patch of light and is the farthest the unaided eye can see.

Triangulum, the triangle, is a small constellation which looks like a small acute triangle made up of 3rd and 4th magnitude stars. A relatively nearby galaxy is located here known as M33, the Triangulum Galaxy. This face on spiral galaxy is a member of our local group of galaxies.

Ceres, the largest and first asteroid discovered, was found in Triangulum in 1801.

Aries, the Ram, has been associated with a Ram for at least 2000 years. It was also given the title of "prince of constellations" when it was the position of the vernal equinox about 1000 B.C.

ARIES is a small zodiacal constellation shaped more an obtuse triangle. Aries is made up of a 2nd, 3rd and 4th magnitude star. Aries was the point of the vernal equinox 2000 years ago. Today this point is found in Pisces a fact which is largely ignored by astrologers.

WINTER CONSTELLATIONS

Orion, the Hunter, is the the most obvious constellation in the sky and is visible from any location on Earth. It contains two 1st magnitude stars and four 2nd magnitude stars. At least part of Orion can be seen from anywhere on Earth since it's three central belt stars lie near the celestial equator. Orion is large and impressive and is probably the best known constellation.

The two brightest stars of Orion are BETELGEUSE and RIGEL. Betelgeuse marks the left shoulder of the giant. It is a red supergiant star about 800 to 1000 times the diameter of our Sun. It was the first star whose diameter was actually measured. Betelgeuse is a star in the last stages of life.

Rigel marks the right foot of the giant. Rigel is a blue-white supergiant star with about 50,000 times the luminosity of our Sun. Rigel is a massive supergiant star who will exhaust all its fuel quickly with a life span of only about 500 million years. Stars like our Sun burn for about 10 billion years.

Orion contains 5 supergiant stars, the most found in any constellation.

The three stars below the belt of Orion contain one of the grandest sights in the sky. The middle star appears hazy to the naked eye, but through binoculars or a telescope it reveals itself as M42, the Great Orion Nebula; a region of gas and dust where about 10,000 stars are forming. The Orion Nebula is about 1500 light years away. Four of these stars are actually bright enough to be visible through all the nebulosity surrounding the stellar nursery. These four bright stars are known as the Trapezium.

B33 is better known as the Horsehead Nebula and is one of the most famous dark nebulae found in the sky. It shows in long exposure photographs just below the lower belt star.

Taurus, the Bull, is a very ancient sign of the zodiac. The bull was worshipped in several ancient civilizations and associated with many stories involving the gods. The bull is seen as threatening Orion who is holding up his shield to ward it off. The fire red eye of the bull is Aldebaran. In Greek mythology, Taurus was the snow white bull which carried Europa off only to be revealed as Zeus in disguise.

The Pleiades have their own myths as the Seven Sisters. The Seven Sisters were associated with spring and agriculture and were worshipped by many ancient people.

TAURUS is a constellation of the Zodiac and is best known for the asterism M45, the Pleiades. The Pleiades is an open cluster which appears as a tiny silver cloud of 6 or 7 stars. This tiny cluster appears to look like a little dipper and is often mistaken for Ursa Minor for that reason. The Pleiades contains numerous double and triple stars which can be seen with binoculars. They also lie along the ecliptic so they are occasionally occulted by the Moon.

The brightest star in Taurus is Aldebaran. It is a red giant star about 36 times the diameter of our Sun. Aldebaran makes up the red eye of the bull and it's face is outlined by the open cluster shaped like a "V" known as the Hyades. Aldebaran is actually a foreground star and not an actual member of the Hyades. The Hyades and Pleiades are each actual clusters of stars traveling through space together presumably from the same origin.

The horns of the bull are marked by the star beta and zeta Taurus. Near Zeta Taurii you will find M1, the Crab Nebula. The Crab Nebula is a supernova remnant left from the explosion of a supermassive star which was seen in 1054. This supernova was so bright it was visible in daylight for 27 days. The remains of this supermassive star is known as the Crab Pulsar. In the core of the Crab nebula a pulsar or neutron star that is spinning around 30 times a second. A neutron star is about the size of Cheyenne yet is so dense a teaspoon of it would weigh about 50 billion tons on Earth.

Canis Major, the Great Dog, represents one of Orion's hunting dogs and lies close to the mighty hunter in the sky. It contains Sirius which means the "Dog Star"; it is the brightest star in our sky. The star is more important than the constellation since the rising of Sirius prompted harvests and celebrations in some ancient cultures. The first appearance at dawn of Sirius in ancient Egypt led to celebrations for a new year and the coming of the annual flooding of the Nile.

CANIS MAJOR is a fairly bright constellation but too far south for us to enjoy all of its treasures. Its brightest star, however, outshines all others in our sky. SIRIUS blazes at -1.4 magnitude. Sirius is one of our closest neighbors at 8.8 light years away. Sirius has a companion star known as the Pup. The Pup is a white dwarf star only about three times the size of the Earth, yet a teaspoon of the Pup would weigh a ton on Earth. The Pup is what is left of a star who started life with about 1 to 3 solar masses.

The rich open cluster M41 can be found just below Sirius.

Canis Minor, the Little Dog, is the second hunting dog of Orion. Canis Minor was always associated with Orion and Canis Major in mythology. Procyon the brightest star in Canis Minor means "before the dog".

CANIS MINOR is a small, but important constellation because it contains one of the brightest stars in our skies, the yellow white PROCYON. Procyon rises about 40 minutes before Sirius. Procyon is about 10 1/2 light years away. It has a white dwarf companion star.

PUPPIS is too far south for us to enjoy its brightest star, Canopus, the second brightest of all stars visible. The Milky Way flows richly through Puppis and offers us many open clusters which are fine sights even from northern skies. M46 and M93 are very impressive and well worth a look through binoculars or telescopes.

Monoceros, the Unicorn, contains no bright stars to attract your attention, but offers the fine open cluster M50 and the Rosette emission nebula as great objects to view with binoculars.

Gemini, the Twins, is an ancient constellation associated with the stars Castor and Pollux. The Romans identified the twins with Romulus and Remus, the twins who traditionally founded Rome. The Greeks said they were the sons of Leda, born of the same egg but had separate mortal and divine fathers. Poseidon made them the protectors of sailors and they were associated with St. Elmo's fires (static ball lightning discharges) that sometimes played among the rigging on some sailing ships. They have also been attributed to the opposing sides of war (Castor) and peace (Pollux.)

GEMINI is a member of the Zodiac and can be picked out by the bright twin stars CASTOR and POLLUX. Castor is actually a system of six stars. Pollux is slightly brighter than Castor and there is speculation the twin stars were closer in magnitude thousands of years ago.

Eta Gemini is a red giant star which varies from 3rd to 4th magnitude in a period of about eight months.

The rich open star cluster M35 can be found off the western foot of the twins.

William Herschel discovered Uranus in Gemini in 1781 and Clyde Tombaugh discovered Pluto in Gemini in 1930.

An unusual looking nebula can be found with larger telescopes in Gemini and is known as the Eskimo or Clown Face Nebula. It has a remarkable resemblance to a face.

Auriga, the Charioteer, has been known since ancient times and was originally portrayed complete with chariot. The brilliant star, Capella represents the charioteer's left shoulder

and was thought to represent Amalthea, the she goat that suckled the infant Zeus. The three stars above Capella are known as the kids.

AURIGA appears as a pentagon formed by five fairly bright stars.

Alpha Auriga is CAPELLA and is the most northern first magnitude star. It is below the horizon only 5 hours a day. Capella is a yellow giant star and is the fourth brightest star visible in our night sky. Capella is 16 times larger than our Sun, and 150 times more luminous. It is located about 42 light years away.

Near Capella you will find a small acute triangle of 3rd and 4th magnitude stars called the Kids. Epsilon, found at the base of the triangle, is a most remarkable star. Epsilon is an eclipsing binary star like Algol in Perseus, but it takes 27 years to complete one cycle and the primary star dims for a period of two years. It was long believed the companion star was one of the largest stars known; but recent studies indicate the companion star is a binary star system surrounded by a massive, opaque disk of dust.

Auriga is a constellation rich with some of our finest open clusters. M36, M37 and M38 can all be found easily with binoculars.

SPRING CONSTELLATIONS

Leo, the Lion, is one of the more readily recognizable patterns on the sky. It has been associated with the lion since ancient times and represents the Nemean lion slain and flayed by Hercules as the first of his twelve labors. Hercules wears the lion's skin in many Greek or Roman pictures.

LEO lies in a barren section of the sky so it is not surprising its asterism, the Sickle, sticks out dramatically. The Sickle looks like a giant backwards question mark and is where the head of the Lion is found. The bottom star of the Sickle is the first magnitude star REGULUS. Regulus lies almost on the ecliptic so it is occasionally occulted by the Moon. Leo is also a constellation of the Zodiac. Directly east of the Sickle you will find a conspicuous triangle of stars making up the hindquarters of the lion. The brightest star in the triangle is Denebola which means tail of the lion.

The constellation of Leo is the home of one of the finest meteor showers known. The shower averages about 20 meteors per hour every year. However, every 33 years after the parent comet passes through the inner solar system, we are usually treated to a meteor storm. The Leonid shower in 1966 had reports of over 140 meteors per second.

Leo contains a red dwarf star, Wolf 359, which is the third star nearest to our Sun.

The hindquarters of Leo contains and points to the "Realm of Galaxies", one of the richest regions of galaxies visible in amateur sized telescopes.

Cancer, the Crab, is an ancient constellation with a colorful legend. In Greek mythology, Hera the Queen of Olympus, was jealously aware of the amorous liaisons of King Zeus. After an affair with Zeus which lasted a mere three days, Alcmena bore an illegitimate son, Hercules. Hera learned of his birth and vowed to destroy him so he was given 12 impossible tasks to accomplish known as his 12 labors. One labor forced him to destroy the multi-headed monster, Hydra, which he did. This annoyed Hera because this gave Hercules fame and glory, so she sent a sea crab to bite his foot. Hercules stepped on the crab and killed it. Hera placed its image in the skies.

CANCER is a faint zodiacal constellation which offers M44 as one of the finest open clusters in the sky. M44 is also known as the Beehive or Praesepe and can be spotted on the darkest nights as a hazy glow in the sky. Below M44 you will find another very nice open cluster known as M67.

Hydra, the Water Snake or Sea Snake, has been associated with this group of stars for centuries. Other legends associated it with the many headed monster killed by Hercules as his second labor. The Ancient Egyptians saw it as the river Nile.

HYDRA is the largest constellation stretching across 1/4 of the sky but has little to offer other than being elongated. The only bright star in Hydra is Alphard a 2nd magnitude star which means the "Solitary one". When we look in this direction we are looking out back of our galaxy.

M83 is a nice face on spiral galaxy found in Hydra.

Corvus, the Crow, is an ancient constellation. Corvus was associated with a crow or raven in western mythologies. In Greek myths, a white crow was sent by Apollo to watch over his lover, Coronis. The bird failed to prevent her from being unfaithful, and for this was cursed by Apollo, who turned the crow black forever.

CORVUS is a small but fairly bright quadrangle of stars easily found below the constellation of Virgo.

The Sombrero Galaxy M104 is found in Corvus.

A fine but compact globular cluster known as M68 is also found in Corvus.

Virgo, the Virgin, is one of the oldest zodiacal constellations. She appears as a mother goddess, sometimes a wife to a creator or god. In most cases she carried a sheaf of wheat in honor of the harvest.

VIRGO is a large and mostly faint constellation. Alpha Virgo is the blue-white 1st magnitude star, Spica. To find Spica you follow the arc of the handle of the Big Dipper to Arcturus, then draw a spike down and you will run into the star Spica. Virgo is a constellation of the zodiac.

Virgo is important because above the open "Y" of the constellation and below the star Denobola in Leo is what is referred to as the Realm of Galaxies. This region offers a wealth of galaxies visible in moderate sized telescopes. M87 is a giant elliptical galaxy in Virgo.

Coma Berenices, Hair of Berenices, was proposed by the great Danish astronomer Tycho Brahe in 1602, and was based on a legend of Berenice, the wife of Euergetes, the King of Egypt. She vowed to sacrifice her beautiful hair if her husband was successful in waging war on the Assyrians. Upon his return, Berenice placed her hair in the temple of Aphrodite, but Zeus immortalized the tresses by placing them in the sky.

COMA BERENICES is just above the Realm of Galaxies. The constellation is made of three faint stars and on really dark nights away from lights you can see a dozen or more stars making a loose cluster of stars. Examining the area with a moderate telescope will show you that the Leo\Virgo Realm of Galaxies continues into Coma Berenices.

Near Alpha Coma Berenices you can find M53, a small globular cluster, with binoculars. About 4 degrees north of Alpha is M64, the Black Eye Galaxy.

The north pole of the Milky Way Galaxy points towards a place in Coma Berenices.

Canes Venatici, the Hunting Dogs, originated in 1690 by Hevelius. The two hunting dogs, Asterion and Chara, are usually depicted as greyhounds held on a leash by Bootes, the Herdsman. He is thought to be protecting his flocks from the marauding bears, Ursa Major and Ursa Minor. The dogs appear to chase the bears around the sky.

CANES VENATICI has one notable star, Cor Caroli. It is a nice double star.

An impressive compact globular cluster, M3, is found in Canes Venatici.

The incredible M51 Whirlpool Galaxy is found in Canes Venatici about 3 degrees below the end star of the Big Dipper's handle.

Bootes, the Herdsman, in mythology was the son of Arcas, son of Callisto. When Callisto was changed into a bear, Arcas, not recognizing her as his mother was about to slay her when Zeus trying to avert tragedy changed Arcas into a bear and placed both of them in the sky. Homer mentions Bootes in the Odyssey where he is regarded as the Bear Driver, chasing the Great Bear and the Little Bear across the sky.

BOOTES resembles a large ice cream cone or kite. The second brightest star in our skies is found in Bootes; it is Arcturus. You can find Arcturus easily by following the arc of the handle of the Dipper. Arcturus is a orangish red giant star more than a hundred times brighter than our Sun. Arcturus moves more rapidly than any other bright star we can see. It moves about 1/2 degree (the same area covered by a full moon) across the sky every 2000 years as it travels at about 200 miles per second across our line of sight. Arcturus is what is known as a high velocity star; it is intersecting the plane of our galaxy and passing on through. Arcturus is located about 40 light years away.

Corona Borealis, the Northern Crown, is a small, but nice constellation. It looks like a tiara with the 2nd magnitude star Gemma as the crown jewel. The constellation looks like a C in the sky and can be located between the 2 bright stars Arcturus and Vega. The Northern

Crown has a reoccurring nova which rose from about 10th magnitude to about 2nd magnitude in 1866 and again in 1946. It recently brightened again on 2015. This star that goes nova is T Coronae Borealis and is also known as the Blaze Star.

PHASES OF THE MOON

NEW MOON: A new moon occurs when the moon is located between the Sun and the Earth from our point of view. It rises and sets with the Sun. We don't see it because the light of the Sun is reflecting off the dark side of the Moon. The dark side of the Moon is the back side which we can never see here from Earth. The Moon itself does not shine, it only reflects the light of the Sun which shines upon it.

WAXING CRESCENT: A few days after a new Moon, the moon rises a few hours later than the Sun and is seen as a narrow crescent in the Western evening sky soon after sunset. The right side of the moon is lit. The Moon is in the sky all day, following the Sun across the sky. The waxing crescent moon sets a few hours after the Sun.

FIRST QUARTER: 7 or 8 days after a new moon, the Moon rises about noon roughly 6 hours after the Sun rises. It shines half by day and half by night. It is 1/4 of a day behind the Sun, and 1/4 of the way in it's revolution around the Earth. This phase is known as first quarter. The right half side of the Moon is now brightly reflecting light.

GIBBOUS MOON: As the Moon continues to become more fully illuminated on it's way towards a full Moon, it rises later in the day and shines early into the morning hours. The left fourth crescent of the Moon is the only part of the Moon not shining. A gibbous Moon outshines most stars.

FULL MOON: 2 weeks after a new Moon, a beautiful, fully illuminated Moon rises as the Sun sets. It shines all night long until the Sun rises. It is 12 hours later in the sky than the Sun and 1/2 of it's way through it's revolution around the Earth. A full Moon outshines all but the brightest of stars.

WANING GIBBOUS: As the Moon begins to wane and lose light on the right side, it rises later each day after sunset and shines later in the morning sky. It still is brighter than many stars.

THIRD QUARTER: It is also known as a last quarter moon. Three weeks after a new Moon, one week after a full Moon, and one week before a new Moon, the last quarter Moon rises at midnight. It is 3/4 of the way through it's orbit around the Earth. The entire left side of the Moon is now illuminated. The third quarter Moon sets at noon.

WANING CRESCENT: As the moon continues to lose light on it's right side, it becomes a narrow crescent again. The waning crescent Moon rises only hours before the Sun. The Moon spends more time in the daylight sky on it's way towards becoming a new Moon and beginning a new orbit around the Earth.

*We always see the same side of the Moon because it rotates on it's axis in the same period of time it takes to rotate around the Earth causing the same side to always face towards the Earth.



METEOR SHOWERS

On any given night of the year, if you are away from city lights and there is no interference from a bright moon, you will see about 5 sporadic meteors every hour. On certain nights of the year meteors seem to come from a certain area of the sky at a higher frequency. These special occasions are called meteor showers and are named after the constellation where the meteors seem to be coming from; this area of the sky is known as the shower's radiant.

Meteor showers were demonstrated to be linked to the orbits of comets in the late 1800's. A comet leaves behind a trail of meteoroid particles no bigger than a tiny grain of sand as it orbits the Sun. As the Earth passes through the orbit of a comet, these meteoroids collide with our atmosphere and the resulting friction heats them to the point where we see them streak across our sky.

Meteor showers can have a broad range, slowly rising to a maximum peak and then falling off again; or they can be over in a matter of hours. Meteor showers have a wide range of velocities determined by how fast the meteoroid particles are traveling through space. Meteors in a shower can range in brightness from telescopic to fireballs (brighter than any planet). There are even meteor showers which peak in daytime hours. The best time for viewing meteor showers is from 1 A.M. to 4 A.M. when the night side of the Earth is plowing directly into the path of the meteor shower.

The best and most reliable meteor showers of the year have been the August Perseids and the December Geminids. Both showers average about 60 meteors per hour; but the Perseids are swift where the Geminids are medium speed and tend to have more fireballs. The fastest meteors come from the Leonids closely followed by the Orionids. The slowest meteors come from the Taurids. The Quadrantids have a very short range since they peak in about 3 hours time. The Perseids, Aquarids and Geminids can be seen for weeks at about 1/4 the rate expected during the meteor shower's peak. The Leonids had one of the most spectacular meteor showers ever recorded in 1866 when as many as 200,000 meteors could be seen from one place within a few hours time. The last good Leonid meteor shower was in 1966 when up to 140 meteors were observed per second. The next spectacular Leonid meteor shower should be in November, 2032.

MAJOR METEOR SHOWERS

Quadrantids - January 03
Lyrids - April 21
Eta Aquarids - May 04
Delta Aquarids - July 30
Perseids - August 11
Draconids - October 09
Orionids - October 20
Taurids - October 31
Andromedids - November 14
Leonids - November 16
Geminids - December 13
Ursids - December 22

The 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	\omicron Omicron	ψ Psi
θ Theta	π Pi	ω Omega