Take Your Family Stargazing

by **Eric J Schreur**

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Acknowledgments

This guide to stargazing was born in the 1990s, when I was the Planetarium Coordinator at the Kalamazoo Valley Museum planetarium. I was working on a show titled "Treasures of the Milky Way" in which the audience was recruited by the pirate Beardless Red to come aboard his ship to seek celestial treasures. In producing the show, I needed photographs of many objects as they would appear in binoculars or small telescopes. I began imaging the Messier Catalog objects with an 8" telescope. I also created star maps and star hop sequences for the audience to take home.

I shared many images with the Kalamazoo Astronomical Society. The images seeded an idea to create a photographic binocular atlas. I slowly accumulated images until I had completed photographing the Messier Catalog, wide angle views of constellations, and other objects and events.

In July, 2019, I traveled to Chile so I could photograph a total eclipse of the sun. On that trip I met Lora Blasius, a fellow traveler making her first journey into the Moon's shadow. After the eclipse she asked what would be a good telescope for her "grandbabies" and if there were any guides available. The information request changed the guide from a simple atlas of objects for binoculars into a beginner's guide for family stargazing.

I began work on an initial draft within a few days. I shared early pages on Facebook for suggestions from family members and friends including Doug Bock, Susan Button, and Melinda O'Malley. I brought the initial draft to the Great Lakes Planetarium Association conference in Toledo, Ohio. At the conference I shared the project with a panel of presenters who spoke about hosting star parties. I believe the guide would make a good handout at these sessions. Participants included Mark Webb, Mike Smail, Michael McConville, and Paulette Epstein. They provided encouragement and suggested additional ideas. I also shared the pages with Chris Janssen who recommended I share it with Julieta Aguilera Rodriguez for formatting advice.

In September 2020, JoAnne Westphal took time to preview and comment on the project while attending a Night Sky Photography workshop offered by Shawn Malone of http://lakesuperiorphoto.com.

Support (pressure) for publishing was provided by Rob Cobez, Shelly Garneau, Ione Lake who purchased the first copy, and by Karen Klamczynski who gave me guidance along the path to finding a publisher.

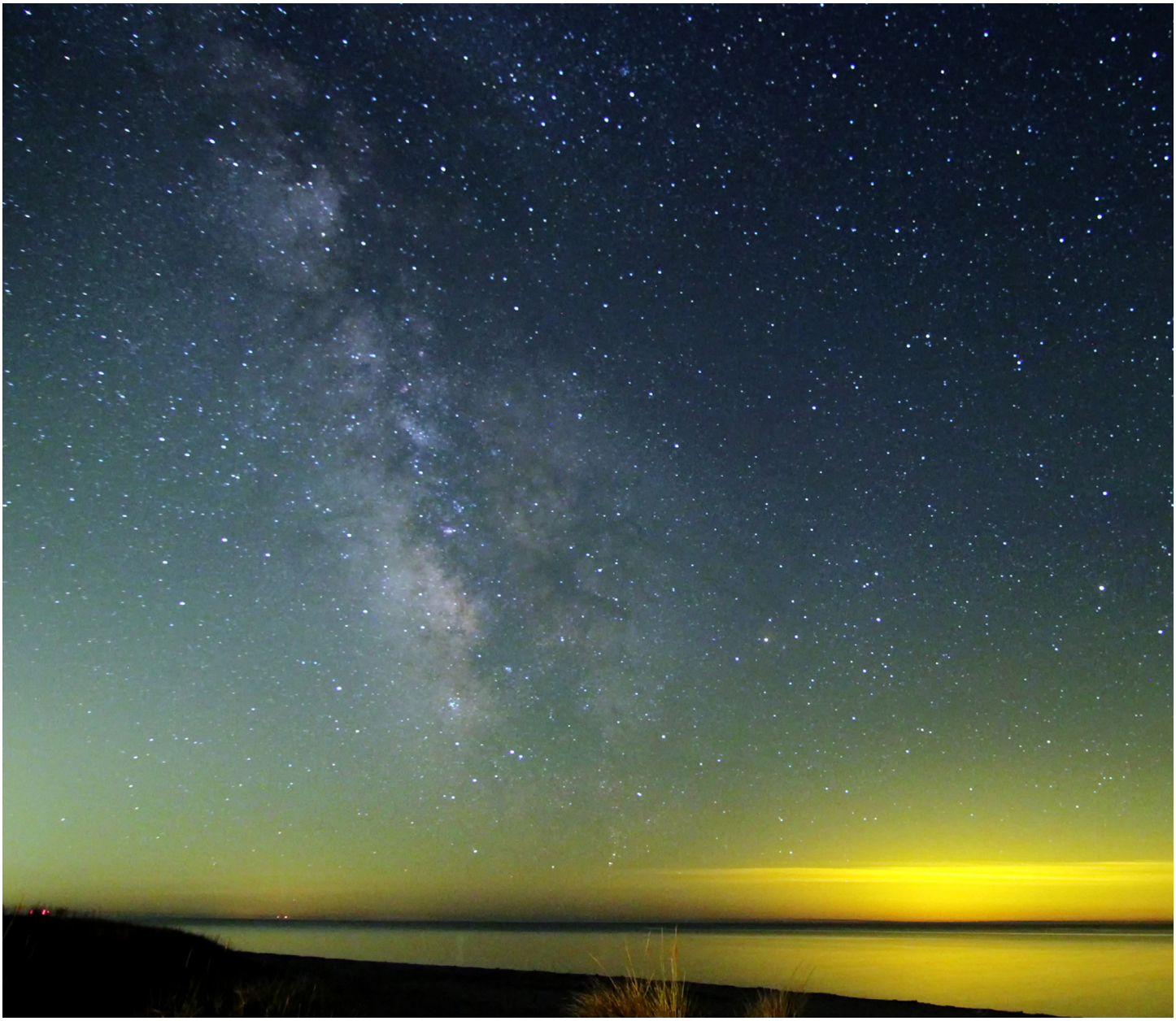
Aubrey Marron volunteered to proofread the the final document.

I would like to extend my sincere thanks for the support offered by these friends and members of my family.

Eric J Schreur

Try to imagine a warm mid-August night, sitting beside the glowing coals of a fading campfire on a beach far from city lights. Overhead, twinkling stars appear one by one in a deepening blue sky. Hidden all around you are frogs and insects singing their twilight songs. Far in the distance a lonely train whistle rolls across the countryside. A coyote howls at a sliver of the moon disappearing behind the treetops. The air is cooling as night settles in.

Nearby, your children gaze at the last flames licking the charred coals of the fire. With a pop, a burst of red sparks rises over the fire, drawing everyone's attention skyward. There are so many stars that counting them seems as though it would be an endless task.



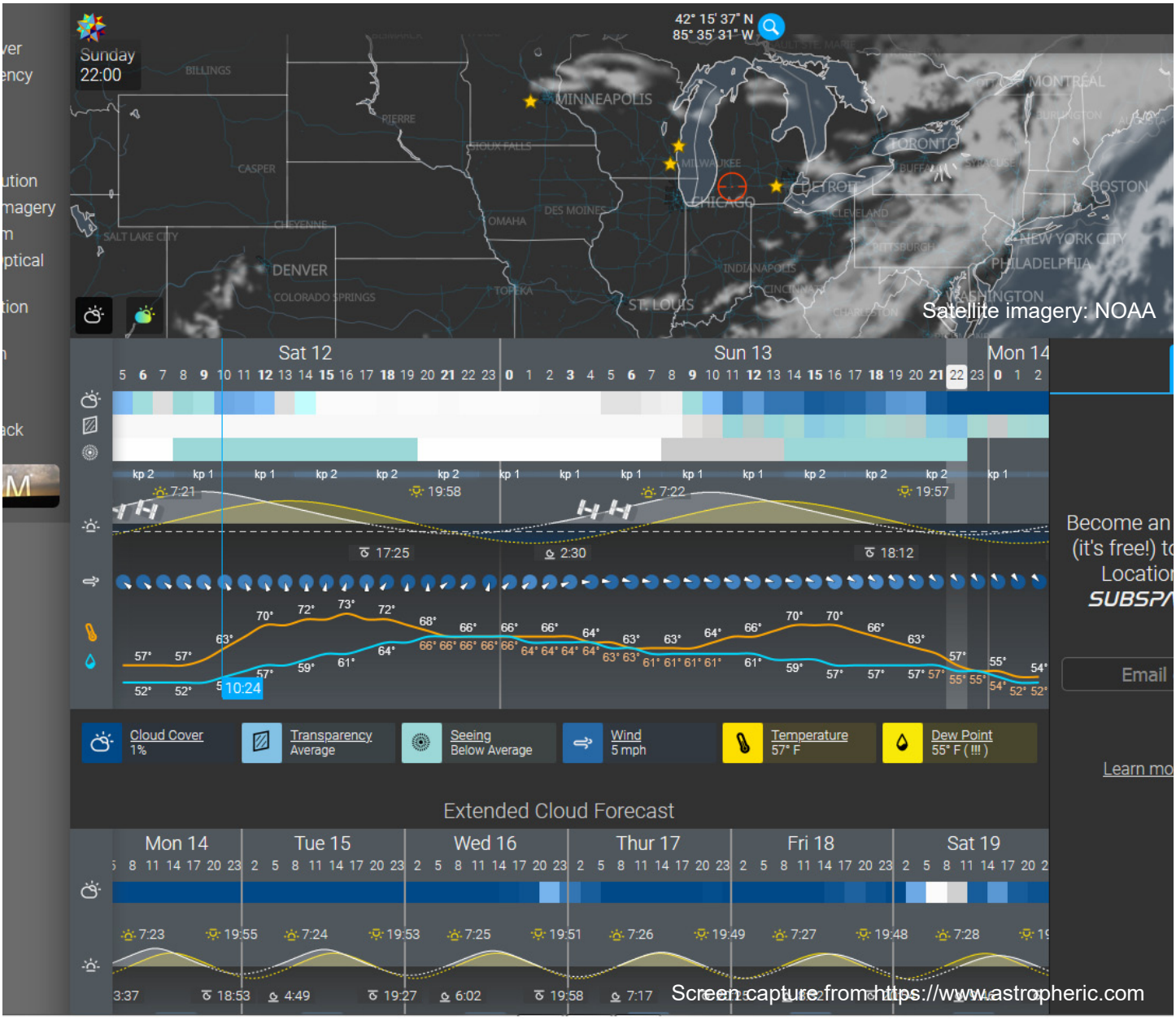
As your eyes begin adjusting to the darkness you become aware of a faint glowing band of light crossing the sky. “Kids,” you announce, “that’s the Milky Way.”

Before you can look away a bright streak of light races along the side of the Milky Way leaving a quickly fading trail in its wake. The children shout together, “Wow! Did you see that? A shooting star!” Wishes are made and in the silence of the next moments, a sensation of awe fills you and the children.

The night sky is amazing. Even with no knowledge of the constellations or the names of stars, it can grab and hold your attention. As you begin to learn stories behind the ancient patterns, and the brightest stars become friends with familiar names, motions are revealed that will guide you through the night and the seasons.

The Moon and planets glide across constellations where clusters of stars and glowing nebulae are waiting for your eyes to discover them. There are a variety of observing techniques and equipment family stargazers use for viewing astronomical objects and events including unaided eyes, binoculars, telescopes, and cameras.

Now, we embark on a journey to discover the night sky.



Do a little planning in advance. Get on your computer and check the weather forecast. Look for clear skies with average or better transparency and average or better seeing. Transparency is a measure of dust and water vapor that dim stars, and seeing is a measure of how much stars twinkle.

Next, check to see if there are any events of special interest, like bright planets near the moon or meteor showers. They are published in the astronomy magazines available at local bookstores.

https://www.astrospheric.com is a useful website which provides information about observing conditions.

https://www.ventusky.com is a website which will allow you to look at weather predictions up to three weeks in advance.

Sky & Telescope and **Astronomy** magazines are good references for upcoming astronomical events. They can be purchased at many news stands.

When the weather looks good you need to find a place with a clear view of the sky. If you are fortunate, your own yard will be the first place that comes to mind. There may be actions you can take to increase your stargazing pleasure.

Make your observing site safe. Clear objects like hoses, sprinklers, yard tools, and children's toys so they won't be hazards. Next, make it comfortable. Have a chair to rest in. Set up a table where you can keep charts, flashlights, and binoculars. Light a citronella candle or have insect repellent if mosquitoes are present.

Finally, make it as dark as you can. Turn off lights shining out windows. If someone indoors needs light, close the curtains or use a shade. Switch off, unscrew, or open circuit breakers for any exterior lights to eliminate their interference.

If a neighbor's porch or security light shines in your yard, invite them to join you to have a look at the sky. Gently point out specific lights that are an issue, and ask if they would be willing to turn them off for an evening if you give them a call.

Waiting for the sun to set and darkness to reveal the stars is a peaceful time for stargazers. Most try to set up their equipment while it is still light, so they can recover a dropped bolt, or get everything in place while they can still see what they are doing.

For photographers, this is the golden hour. Scenes take on a warm glow and shadows enhance detail. Then the sun dips below the horizon and the blue hour begins. The warm colors are gone, replaced by the cooler blue light of dusk, and the scene becomes softer in appearance.

This first period of darkening is what astronomers call Civil Twilight, and it lasts until the Sun is 6 degrees below the horizon. Halfway through Civil Twilight, planets and the brightest stars peek out in the darkening sky. By the end of Civil Twilight the sky is filled with stars.

Civil Twilight is followed by Nautical Twilight. The sky is dark enough to view the constellations, but the faintest stars are still not visible. It is called Nautical Twilight because mariners at sea can still see a difference between the sea and sky. It lasts until the Sun is 12 degrees below the horizon.

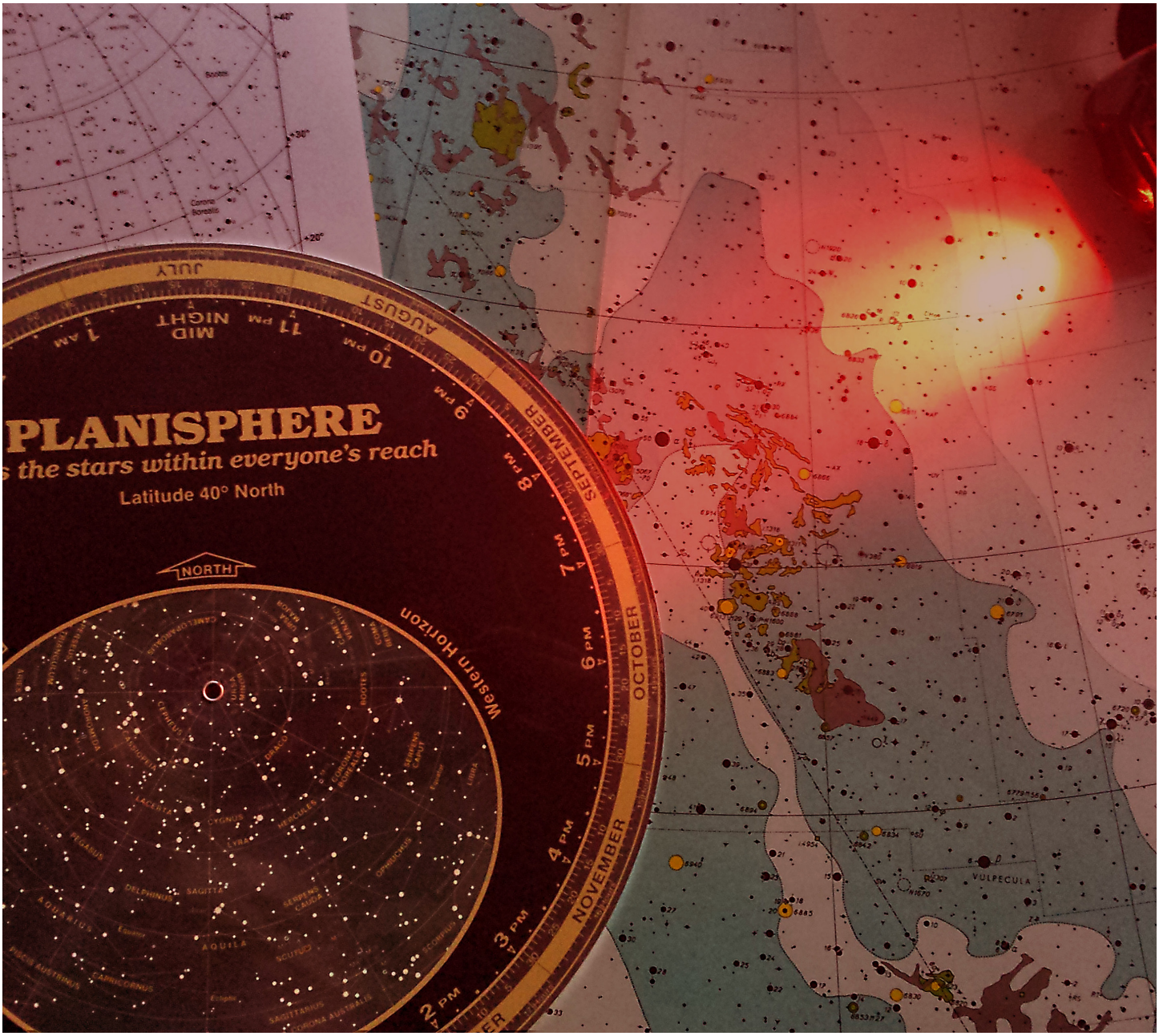
The final stage is Astronomical Twilight. This is the time when the Sun is between 12 and 18 degrees below the horizon. As astronomical twilight draws to an end, the band of the Milky Way is clearly visible against the dark night sky.

Time and the sky are locked together. The rotation of Earth determines the time of day. Months are connected to the Moon's orbit around Earth, and years result from the tilted Earth revolving around the sun. Time is important for stargazers, but there are many clocks that need our attention.

Mean Solar Time is what is we read on clocks. It helps us know when to wake, when to do activities, and when to crawl back into bed. It is divided into 24 time zones around the world so we have to change our clocks as we move East or West so the sun will be overhead at noon.

Universal Time is the time astronomers use for events. It's the same around the entire world, and is the time at 0 degrees longitude. When an event takes place at 21 hours UT you must adjust the time to your local time zone. For Eastern Standard Time you must subtract 5 hours from UT to get the event's local time. During the months of Daylight Saving Time, subtract 1 hour less.

Siderial Time is the Right Ascension (East/West lines on a star atlas) that is on the Local Meridian (an imaginary North/South line passing directly over your head). It's about 4 minutes later each day compared to Mean Solar Time. Think of Siderial Time as star time.



There are many kinds of star maps. Most are intended for use by stargazers with binoculars or telescopes. They show the sky with a lot of detail and include double stars, variable stars, star clusters, nebulae, and galaxies. If you are just getting started, these overwhelming maps may discourage you.

Go to the local bookstore's magazine rack and pick-up a current issue of an astronomy magazine. The centerfold will have a star map that will help you identify bright stars and constellations. Many planetariums and nature centers offer simple seasonal star maps that visitors can take home. These circular star maps are easy to use.

Also consider purchasing a planisphere. It is similar to a circular star map, but it can be set for the time of night on any day of the year so you don't have to make mental adjustments to match the map to the sky. It may cost a little more than a monthly astronomy magazine, but it will last for years.

The center of a circular star map is the zenith, the point in the sky located directly overhead. Stars near the edge of the map are close to the horizon. The directions East and West are flipped on star maps because they are intended to be used while looking up at the sky.

Use this procedure for finding stars and constellations with circular star maps. Locate the object on the map. Find which direction to face, then put that at the bottom of the map. Turn your body to face that direction. Estimate how high to look. Finally, look at the shape of the constellation, and for any bright stars that may guide you.

Example: Finding Sagittarius.

Note that East and West are flipped on the map. Star maps are designed to be used facing upward at the sky.

On the map Sagittarius is in the South, so put South at the bottom of the map and turn your body to face South.

Sagittarius is near the edge of the map, so it will be low. Look near the treetops.

There are no bright stars in Sagittarius, but the constellation has the shape of a teapot, and it is below the Milky Way.

If there is a nearby astronomy club, consider attending one of their observing sessions or "Star Parties". It will give you a chance to look through a variety of telescopes, see several objects, and discuss tricks for observing.

Etiquette at "Star Parties"

Park away from the telescopes and walk in to the viewing area. Car headlights should not fall on the observing area when you depart. Nearby parking is for the amateur astronomers bringing heavy telescopes.

Bring a flashlight with a red filter. It will be sufficient for your needs, and it will not interfere with other people's enjoyment of the night sky.

Don't touch the telescopes, particularly the eyepieces. Most telescopes are balanced and a slight touch will move the telescope off target. If an object slips out of view, ask for assistance from the telescope's owner.

If you feel unsteady, have someone stand beside you and put your hand on their shoulder for support.

Describe to the operator what is visible in the telescope. They may be able to guide you to more details. And be sure to ask the experienced stargazers a lot of questions.

Each year there are regular meteor showers when Earth passes through particle streams left behind by passing comets. Meteor showers repeat around the same date each year. Because showers are predictable, astronomy clubs schedule star parties near the dates of meteor showers.

Meteors or shooting stars are specks of interplanetary dust that fall into Earth's atmosphere at tremendous speeds. They interact with the upper atmosphere making the air glow, forming a brief streak in the sky.

Most particles are the size of a grain of sand, and their remains settle to Earth as a fine dust. Larger particles light the whole sky as they fall, and a few survive the fall to become meteorites.

Observing Tips:

• To reduce the strain on your neck, lay on a blanket or a lounge chair while observing meteors.

• For best viewing on moonless nights, get away from light polluted city skies.

Observing Projects:

• Keep a half-hour count of meteors for three to four hours. When do you see the most meteors?

• Draw the paths of meteors on a star map to find the radiant point of the shower.

Annual Meteor Showers

SHOWER	PEAK DATE	RADIANT CONSTELLATION	HOURLY RATE
Quadrantids	Jan 3	Draco	120
Lyrids	Apr 22	Lyra	20
h Aquarids	May 6	Aquarius	60
d Aquarids	Jul 29	Aquarius	20
Persieds	Aug 12	Perseus	90
Orionids	Oct 21	Orion	20
S Taurids	Nov 5	Taurus	10
N Taurids	Nov 12	Taurus	15
Leonids	Nov 17	Leo	20
Geminids	Dec 14	Gemini	120
Ursids	Dec 22	Ursa Minor	10

The Moon is an excellent object on which to try out each observing method.

With just your eyes you can see the dark patches called maria or seas. From one hour to the next the Moon appears to glide westward with the stars because of Earth's rotation. From one night to the next the Moon drifts eastward past stars and planets as the Moon orbits the Earth.

From night to night you can also observe the cycle of changing lunar phases.

Observing Pojects:

• Sketch the bright and dark areas you can see with just your eyes.

• Note the Moon location at dusk, and again a couple hours later.

• See where the moon is compared to a bright star and check again one night later.

• Starting when the thin Crescent Moon first appears after sunset, keep a calendar showing the Moon's shape and what time it sets for two weeks.

Binoculars enhance your view of the dark seas and reveal the largest craters on the Moon.

Craters stand out at the terminator, where the sun is rising or setting on the Moon. Because the sun is low in the sky on that part of the Moon, it casts long shadows making craters and mountains stand out.

In the Northern Hemisphere the terminator slides from right to left across the Moon. New craters come into view as the shadows of craters seen the night before fade. After a few days, a crater's shadow disappears.

Observing Project:

• Find a crater on the terminator and see how many nights the crater remains visible.

Observing Tip:

• Hold binoculars steady by bracing your elbows on a car. Better yet, mount your binoculars on a camera tripod.

The Moon is often the first object stargazers view through a telescope because it's bright and easy to find.

Telescopes reveal more features on the Moon's surface. Some craters are surrounded by streaks called rays, others have mountains at their centers. There are low hills called wrinkle ridges and valleys called rills in the dark seas. A map of the moon will help you learn names of the different lunar features.

Observing Tips:

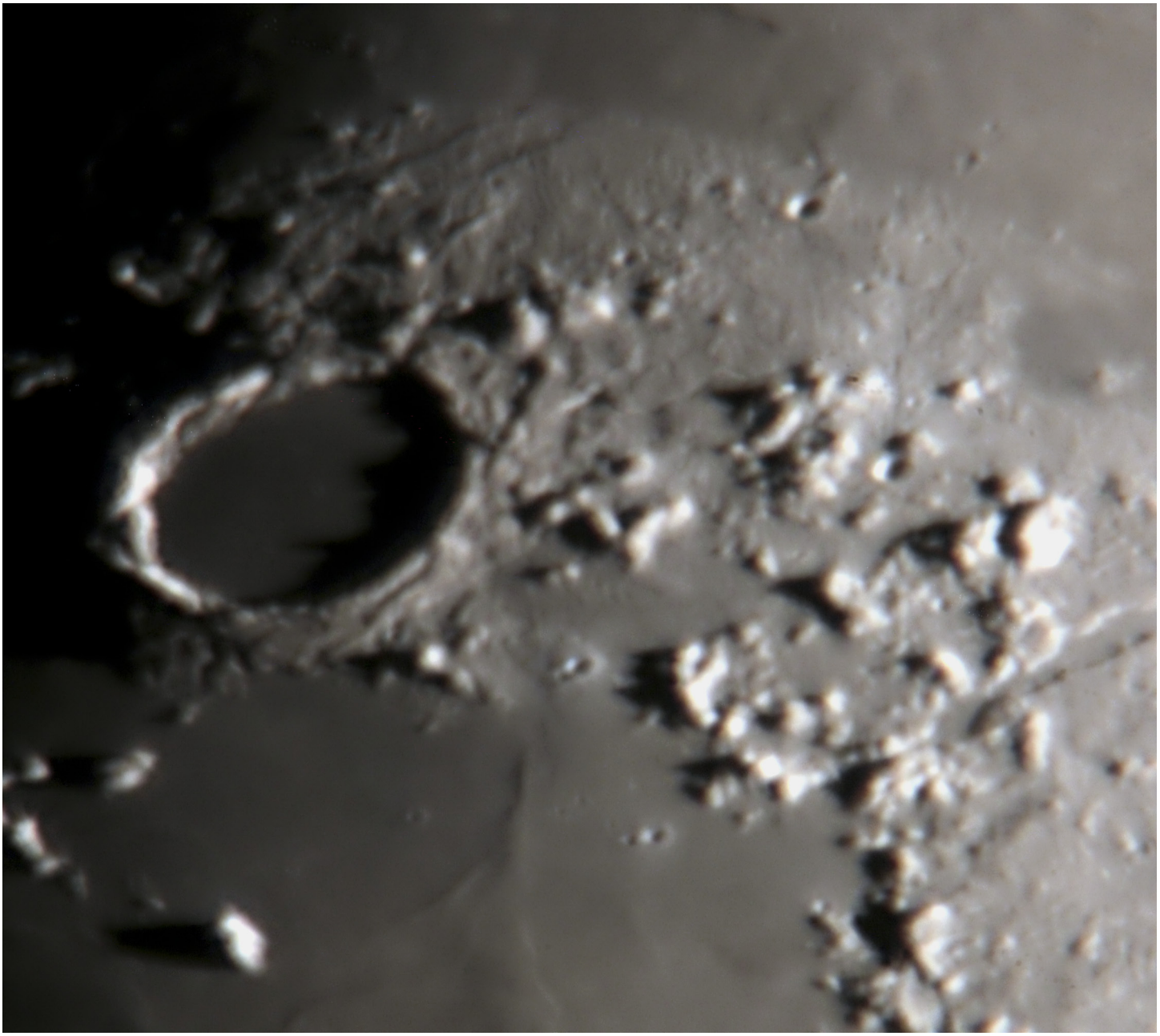
• Start viewing with the eyepiece marked with the largest focal length (mm) and center the feature you want to see. Change to eyepieces with smaller focal lengths (mm) to increase the magnification.

• If you are using a telescope without tracking, position the feature you want to observe on the east side of the field, then let the feature drift while your hands are off the telescope. The more you magnify the image, the faster the feature will drift.

The Moon is easy to photograph because it is large and bright. Exposure times are short, so tracking is not necessary for pictures that show the whole moon. Use a tripod to hold the camera steady. A telephoto lens will show what you see through binoculars.

Example Lunar Photograph
with a telephoto lens
Sigma 70 - 300 mm telephoto lens
Canon 60 Da camera body
prime focus
300 mm focal length, f/8
1/200 second, ISO-800
Set-up on a camera tripod, unguided

Example Lunar Photograph
through a telescope - low power
Orion 90mm Maksutov telescope
Canon 60 Da camera body
prime focus
1250 mm focal length, f/13.9
1/30 second, ISO-800
Set-up on a camera tripod, unguided



Example Lunar Photograph
through a telescope - high power
Celestron Ultima 8” telescope
Canon 60 Da camera body
eyepiece projection
2032 mm focal length, f/10 x 10mm eyepiece
25 x 1/10 second, stacked in RegiStax6, ISO-1600
Set-up on telescope pier, guided

After observing the moon, bright planets are the next step for a stargazer. Most planets are brighter than the surrounding stars, so they are the first points of light that shine through the twilight.

The Moon is useful for finding planets because it passes all the planets each month. Find when the moon is nearest each planet in an astronomy magazine, at a planetarium, or an astronomy club website.

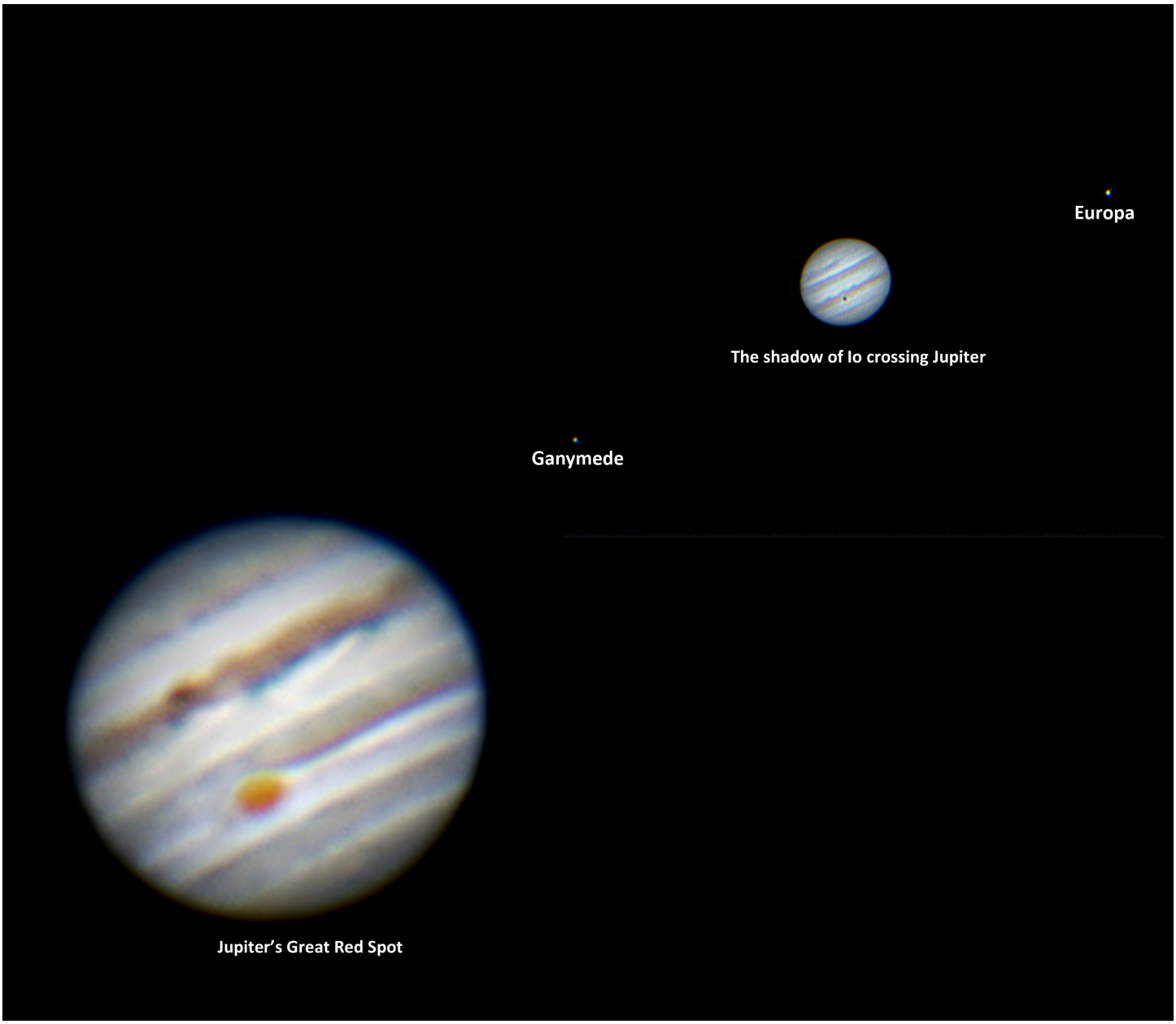
Once you have determined the location of a planet, you can get a better look with binoculars or a telescope.

Observing Project:

• Mark the position of the planet on a star map, and repeat for several nights to see the movement of the planet through the stars.

Observing Tip:

• Look over the telescope to line up the planet, then use the guide telescope. Look through the telescope eyepiece and center the planet at low power, then increase the power to view planet details.



Jupiter is the largest planet. It is farther from the Sun than Earth, so it takes longer to orbit the Sun. Every 13 months Earth passes Jupiter, an event called opposition. At that time Jupiter rises as the sun sets, and sets as the sun rises. At opposition, Jupiter is closest to Earth so it is brightest and appears largest in a telescope.

Binoculars show Jupiter is different from bright stars. Jupiter appears as a tiny circle of light, while stars are pinpoints. If you hold your binoculars steady enough, you may see tiny stars to the sides of the planet. These are Jupiter's four largest moons: Io, Europa, Ganymede, and Callisto. From night to night they change places around the planet.

A telescope reveals Jupiter's cloud belts and Great Red Spot. These details are easier to see while there is a little twilight and less contrast with the sky background. Jupiter rotates quickly, so the position of features on the planet change noticeably with the passage of time.

Observing Project:

• While looking at Jupiter through a telescope, determine the position of a surface marking. View Jupiter again an hour later to see the planet's rotational movement.

Low power view of Saturn and its moons.

High power view of Saturn and its rings.

Saturn is the most distant planet you can see with unaided eyes. It is the slowest moving of the planets, shifting just half a constellation eastward from one year to the next. It takes nearly thirty years to make one trip around its orbit, visiting each of the zodiacal constellations. The planet is at opposition a year and two weeks after the previous opposition.

Saturn is known for its rings. To see the rings, you need a telescope that can magnify the planet 30 times. For a telescope that is considered to be low magnification. Look for a few moons near the planet before increasing the telescope's magnification.

With a medium magnification of 120 times you can see some faint bands across the planet, and a gap in the rings called the Cassini Division. On the very best nights when high power eyepieces have a steady view, a second gap near the edge of the outer ring called the Encke Division may be visible.

Most of the time the red planet, Mars, appears small in a telescope. The planet is small, about half the diameter of Earth, and it is far away.

At opposition while Earth passes between Sun and Mars, Mars swells in brightness and apparent size. It appears larger than Saturn, but smaller than Jupiter. Oppositions take place a little over two years apart. During summer oppositions, Mars is closer to the Sun, and therefore Earth, offering the largest apparent size. Unfortunately for those of us living in the Northern Hemisphere, Mars is low in the southern sky so Earth's atmosphere dims and blurs the view.

Spring and autumn oppositions take place higher in the sky, and though the planet does not appear as large or bright, the view is steadier and more detail can be seen. Mars rotates in nearly the same time as Earth, so from one night to the next the surface features are in nearly the same position.

Observing Project:

• When Mars is near opposition, attempt to view the planet at two-week intervals to watch the surface features moving across the planet.

Venus is unmistakable because it is the brightest object in the night sky after the moon.

Venus is an inferior planet, one of the planets that orbit the Sun inside of Earth's orbit. Inferior planets are only seen in the evening or morning sky, never in the late hours of the night. When farthest from the Sun, Venus sets about three hours after sunset, or rises about three hours before the sun.

When it first appears in the evening sky, it is a small disk coming out from behind the Sun. As weeks pass it moves closer to Earth, growing larger. Just after elongation, the maximum distance from the sun, it becomes bright enough to see in daylight if you know where to look. Then it moves closer to the sun growing larger and turning into a thin crescent.

Passing between Earth and the Sun, Venus begins a journey in the morning sky, mirroring the changes in shape and size, eventually passing behind the Sun where it starts the cycle again.

In an interesting coincidence, Venus orbits the sun thirteen times in almost exactly eight years, so where you see Venus one night, you will find it in nearly the same place eight years later.

Mercury is the most difficult of the visible planets to find. It is always low in the twilight sky at dusk or dawn.

Mercury is the planet that orbits closest to the Sun. We never see Mercury separated more than 18 degrees from the Sun. At elongation, its greatest distance from the sun, Mercury sets an hour after the sun or rises an hour before the sun.

The planet is as bright as the first magnitude stars. Because it is always low in the sky, Earth's atmosphere makes it appear fainter.

Because of the orientation of the ecliptic, the path of the Sun and planets through the sky, Mercury appears best in the evening during early spring and best in the morning during late summer.

About once a decade a moderately bright comet travels through the inner solar system. Because of their rare visits, they generate a lot of excitement when they appear in the night sky.

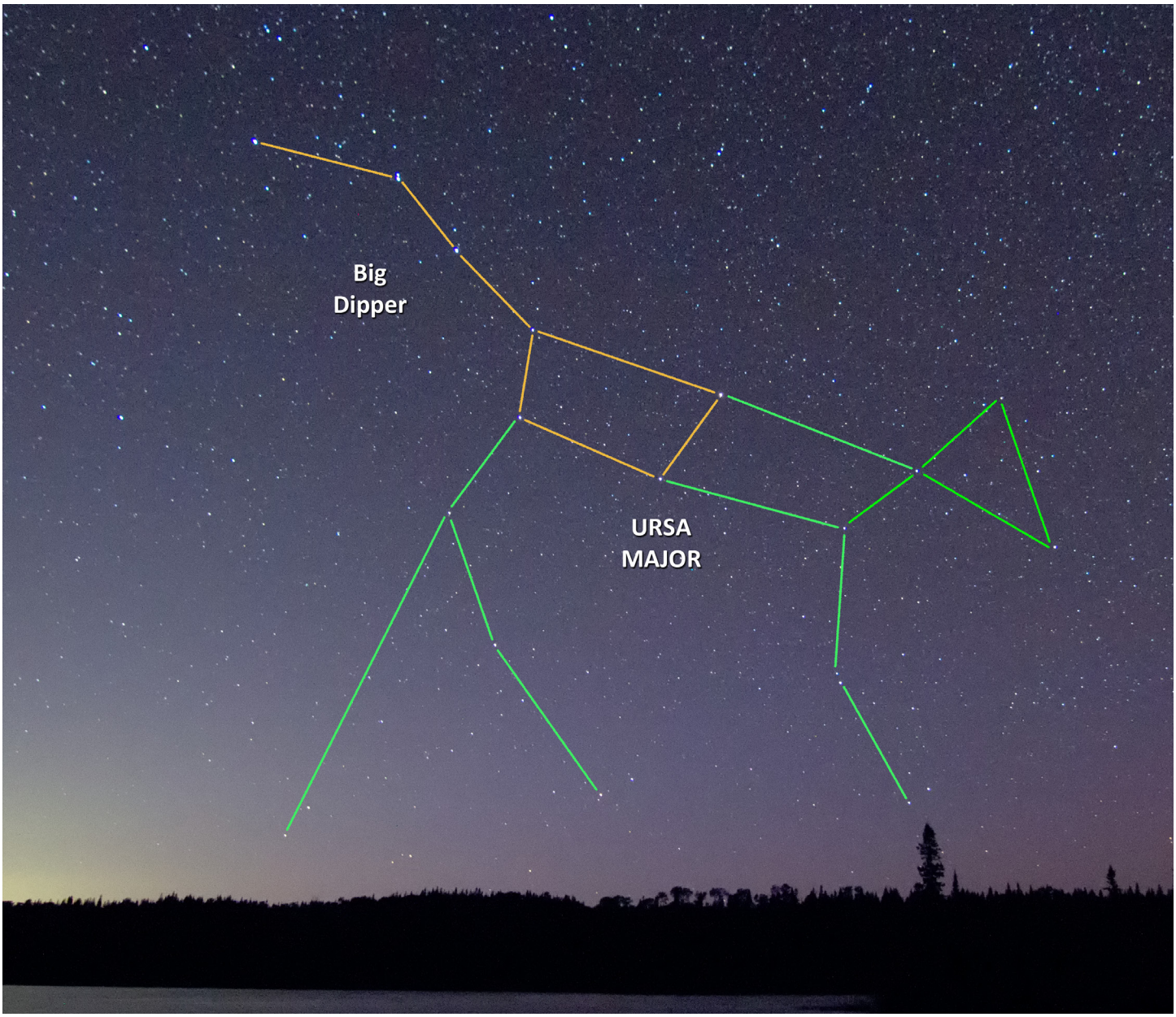
Comets remain in the sky for a few weeks, then disappear as they depart the inner solar system.

These objects are mountain sized chunks of frozen gases that sublimate when they are closer to the sun than Mars. The Sun releases a weak "wind" of charged particles that push cometary gas and dust away, forming their tails. Many times two tails are seen, a yellowish dust tail and a bluish ion tail of charged particles driven away by the solar wind.

Comet 2020F3 (NEOWISE)

Comets are named for their discoverer. In this case it was found by the *Near-Earth Object Wide-field Infrared Survey Explorer*, a NASA space telescope.

Photographed from West Side County Park, Allegan County, Michigan on July 27, 2020.



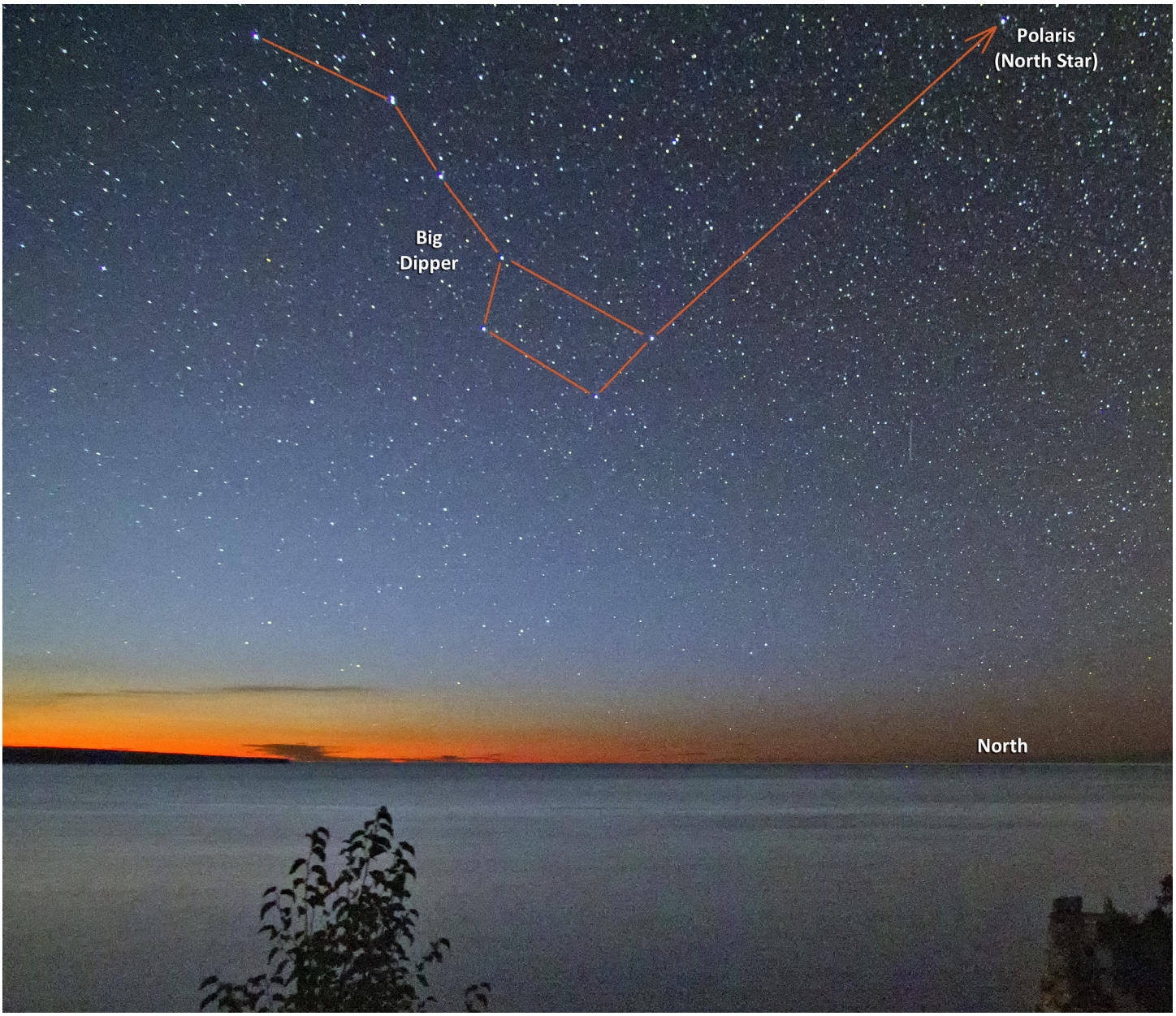
It takes about a year to learn the bright stars and constellations. It is not a difficult task, but slow changes in the sky take a year to reveal all the constellations. During summer months you can see the seasonal stars in the evening, autumn stars late at night, and early winter stars just before sunrise. Take your time and build a deep knowledge base because you will find it easier to remember when the summer stars return in a year.

Where should you start exploring the night sky? If you live in the Northern Hemisphere, start in the North. There is a region of the sky visible every clear night, all night long. Five constellations are found here, and one is easy to identify. That constellation is Ursa Major, the great bear. Within it is the more familiar Big Dipper, an informal star grouping called an asterism. The Dipper consists of seven bright stars; four in a rectangle, and three forming the curved handle. Almost everyone recognizes the Big Dipper when they first look at it.

Observing Tip:

There are many informal star groupings called asterisms that are part of a larger constellation, or that connect bright stars from several constellations.

Asterisms, like the Big Dipper, the Keystone, the Summer Triangle, or the Winter Hexagon, are useful sky guides for finding constellations and other astronomical objects. Take time to become familiar with the seasonal asterisms.



To find the Big Dipper you need to look in a northerly direction. It is not precisely in the north, but through the night it traces part of a circle around the north point in the sky. There is another marker much closer to the north point, the star Polaris which is also known as the North Star.

Using the Big Dipper, it is easy to find Polaris. Imagine a line drawn between the two stars farthest from the Dipper's handle, extended above the Dipper to the next star of similar brightness. The two stars in the Dipper are called the Pointer Stars, and the star they point to is Polaris, the North Star.

Facing Polaris, North is on the horizon below the star. Behind you is South. If you raise your right arm and point away, you are pointing East. In the same way your left arm will point West.

The Big Dipper is your guide to finding Polaris, and Polaris is your guide to finding directions around the horizon. Once you have found your directions, you can use a star map to find anything else in the sky.

There are five major constellations in the northern sky that never set below the horizon. Through the night their stars trace out circular paths around Polaris, the North Star. Because they are visible every night of the year, all night long, they are a good place to begin learning the constellations.

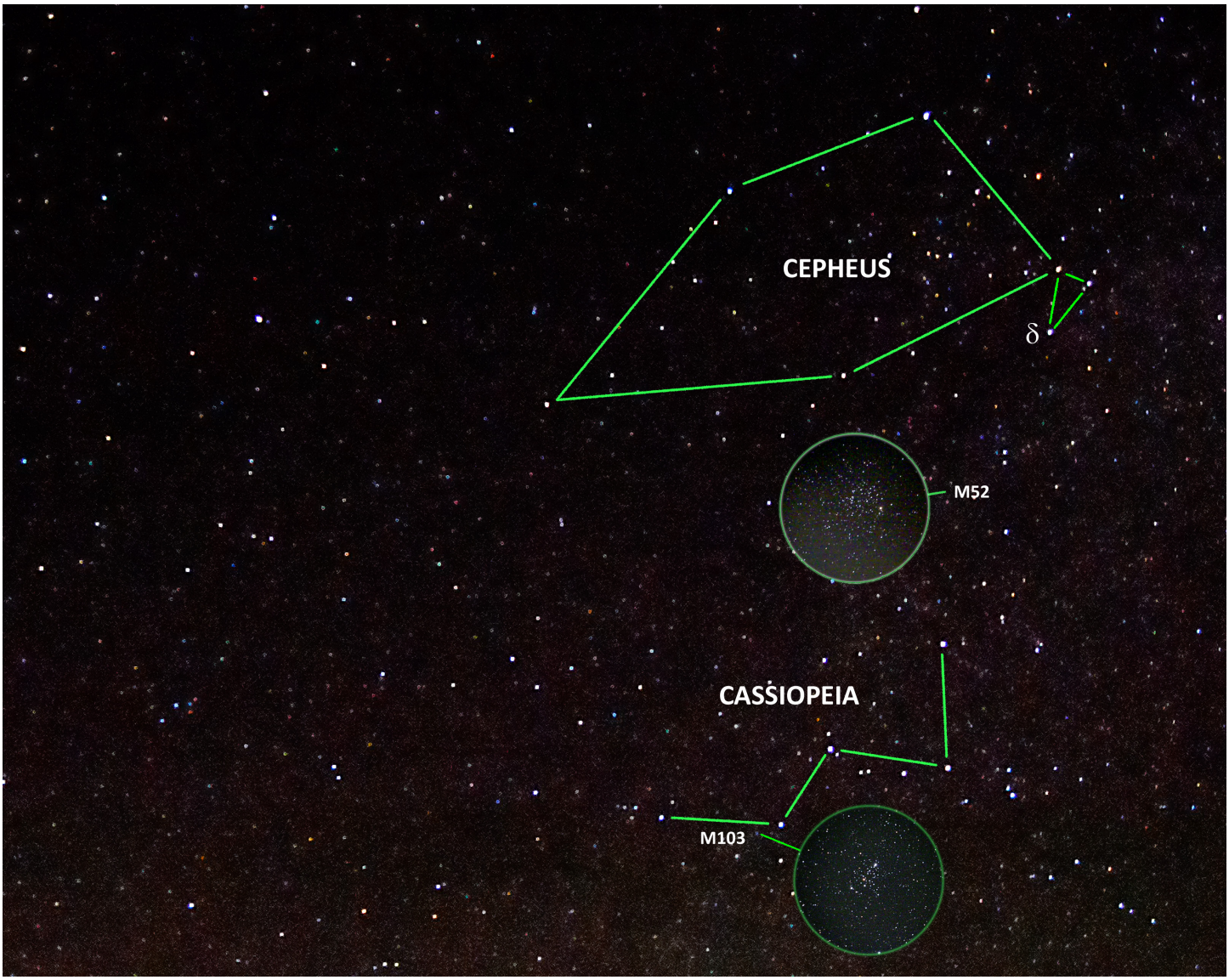
First, learn to recognize Ursa Major (containing the Big Dipper), Ursa Minor (containing the Little Dipper), and Cassiopeia (shaped like a "W"). These constellations are easy to find because they contain bright, second magnitude stars.

Draco and Cepheus are composed of dimmer stars making them a little more difficult to find. Use the easier constellations to determine where to look for the fainter stars of Draco and Cepheus.

Observing tips:

The tip of Draco's tail is the brightest star between the Big Dipper's pointer stars and Polaris. Draco runs between the Dippers, bends around the Little Dipper, and then bends back, keeping its head below the Little Dipper's bowl.

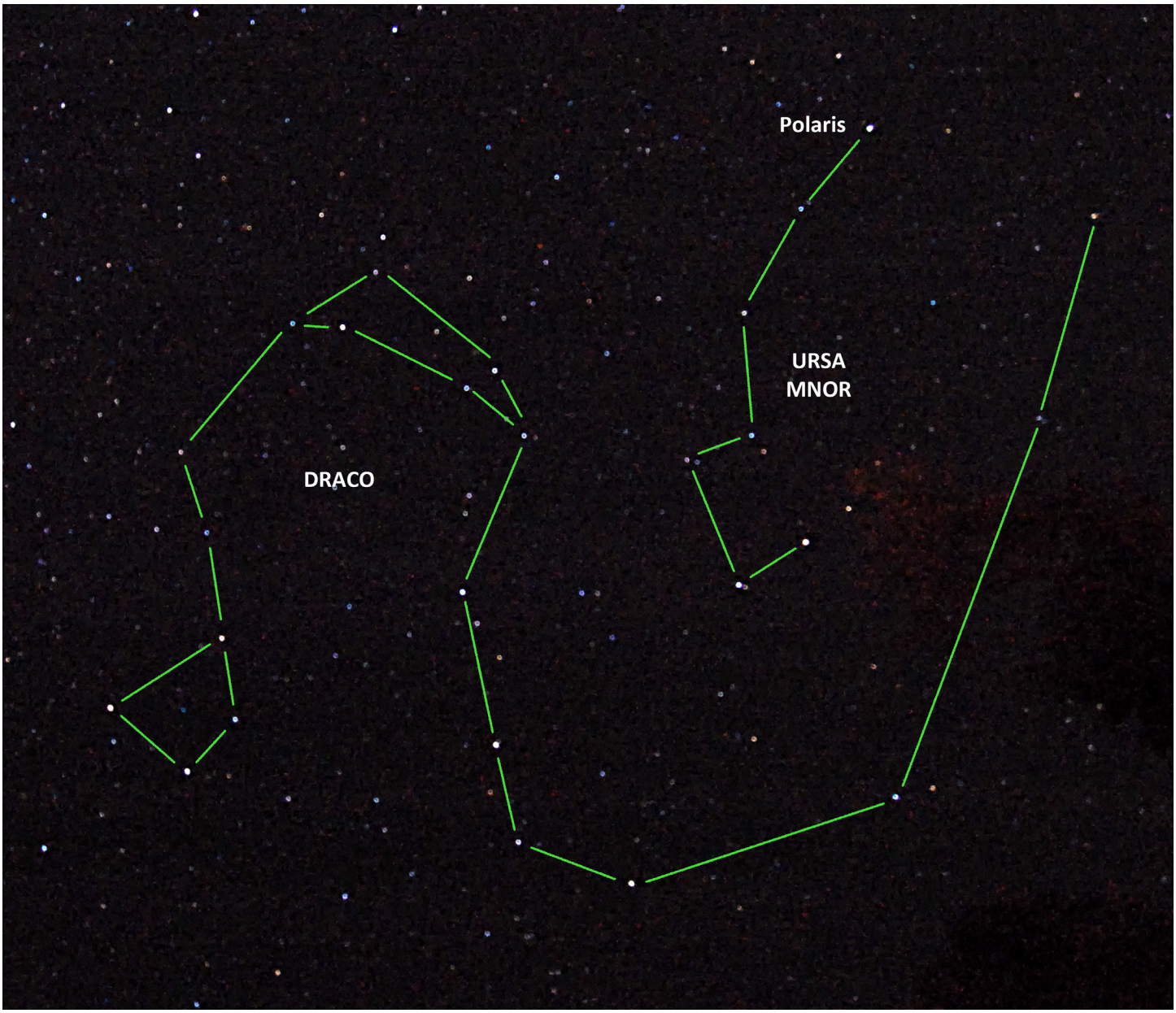
Cepheus is located across the Milky Way from the top of Cassiopeia's "W" shape. Look for the shape of a house with a small triangle of stars at the lower left corner.



Cassiopeia, the Queen, and Cepheus, the King, are high in the Northeast and North as late summer comes to an end and leaves on the trees change color. The King and Queen of autumn sit on opposite sides of the faint outer edge of the Milky Way.

Cassiopeia is easier to recognize, her bright stars forming a "W" in the sky that rotates around Polaris, becoming an "M" six months later. There are several galactic star clusters in the area of Cassiopeia that are visible in binoculars including M52 and M103.

Cepheus looks a little like a child's drawing of a house turned on its side. The star δ Cepheii is a variable star that can be observed with unaided eyes.

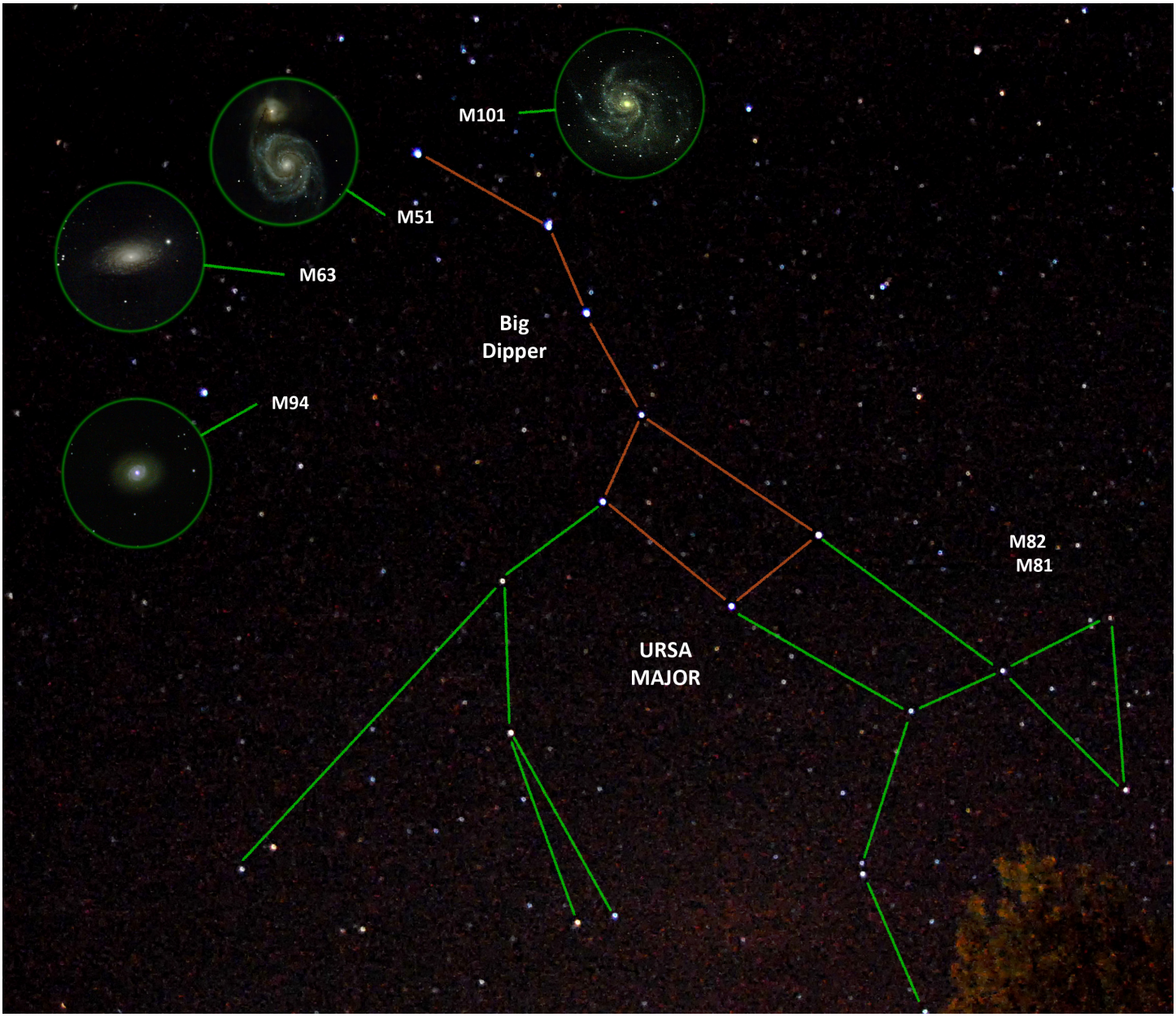


In addition to helping find directions Polaris, the North Star, marks the end of the Little Dipper's handle, which is also the end of the tail of the Little Bear, Ursa Minor.

Wrapped around the Little Dipper is Draco, the Dragon. It is a constellation of faint stars, so it is important to get away from city lights to see it.

While visible all year long, Ursa Minor and Draco are highest in the northern sky from late spring until mid-summer.

The objects in these constellations are too small and faint to be viewed with binoculars.

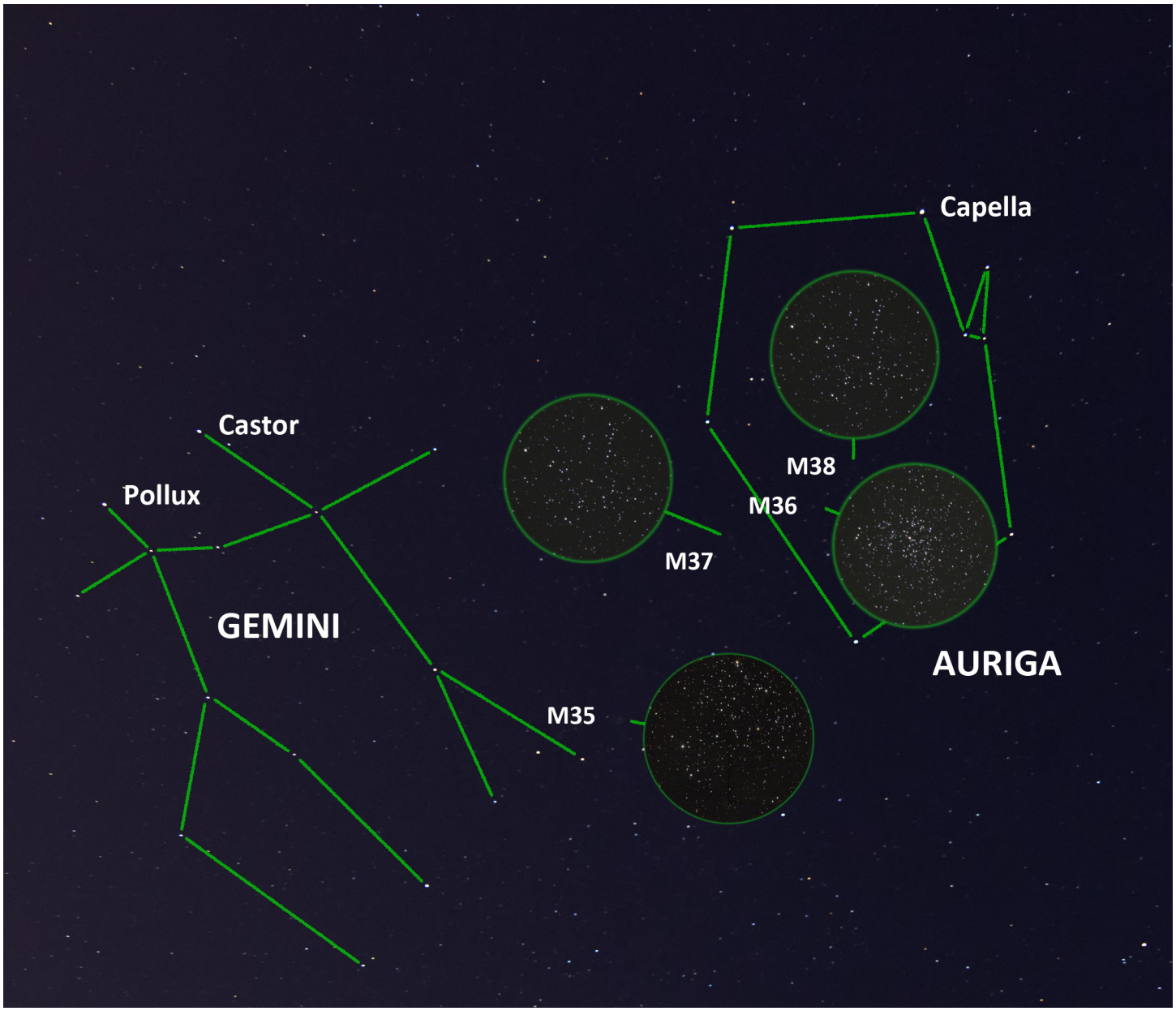


After using the Big Dipper in Ursa Major to find the North Star, take a closer look at the starry bear. The middle star in the Bear's tail is a double star named Mizar-Alcor. Through a telescope Mizar itself can be seen as a double with Alcor off to the side.

Binoculars will show the faint glow of several galaxies near the Big Dipper. They appear as indistinct patches in binoculars, but begin to show details in 6" and 8" telescopes.

This map shows the sky as it appears at approximately

12:00 Midnight in December
10:00 PM in January
8:00 PM in February



The northern part of the Winter Hexagon is made up of the bright stars Capella in Auriga, the Charioteer, and Castor and Pollux in Gemini, the Twins.

The winter Milky Way passes over the shoulder of Orion, under the feet of Gemini, and through Auriga. Along this part of the Milky Way are several galactic, or open star clusters, that are easily seen with binoculars. These clusters contain hundreds of stars that are traveling together in their orbit around the center of our galaxy.

Spend some time gazing at each cluster to see their similarities and differences. M35 in Gemini is larger and brighter than the others, and M36 in Auriga is the smallest, but it outshines nearby M38.

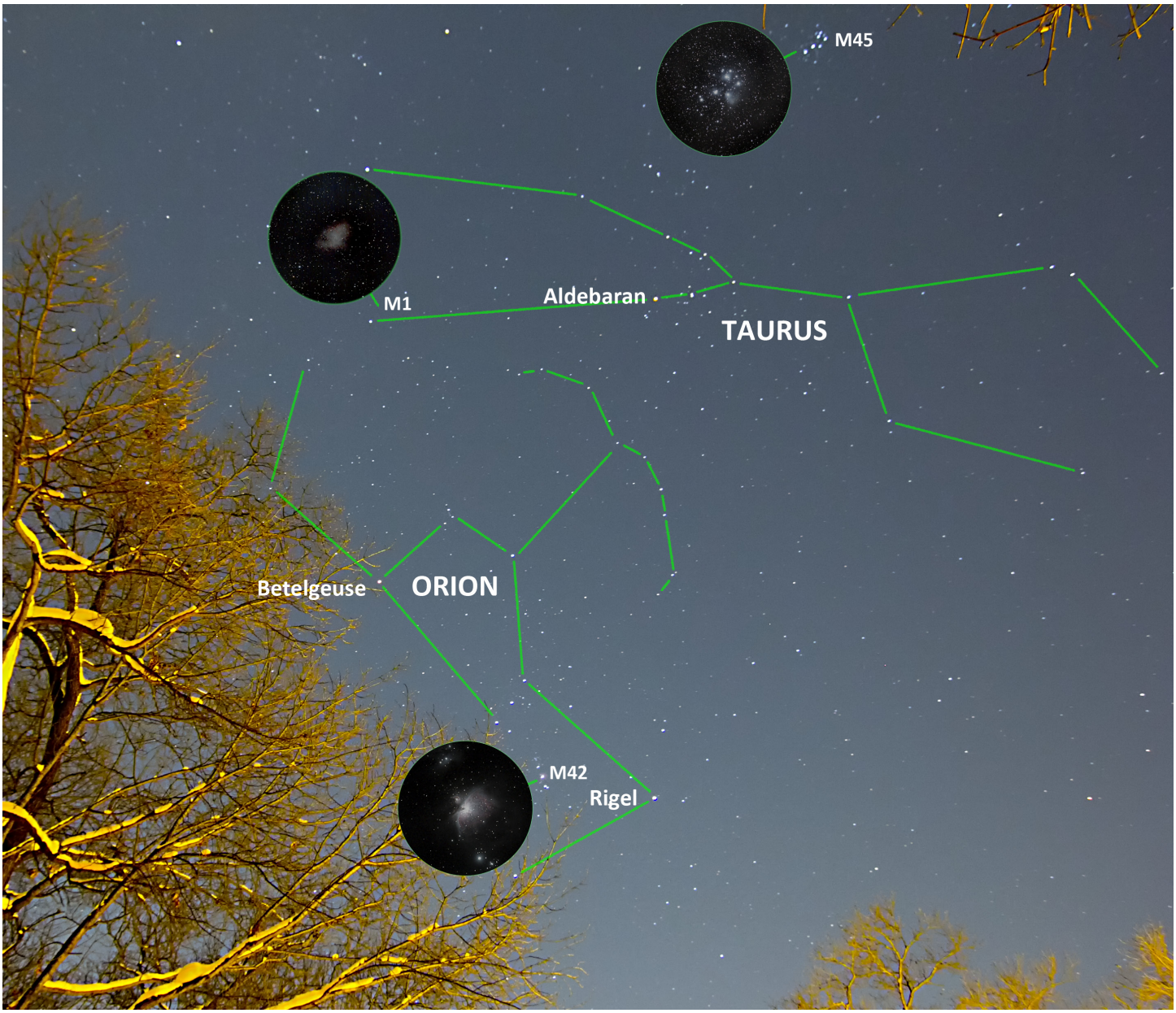
Observing Project:

While viewing the open star cluster M35 through binoculars or a small telescope, try to make a sketch of the cluster.

Are the stars evenly spaced, or are they arranged in straight or curved lines?

Are the stars all the same brightness, or are some brighter than others?

Can you spot the faint (magnitude 8.6) star cluster NGC 2158 at the side of M35?



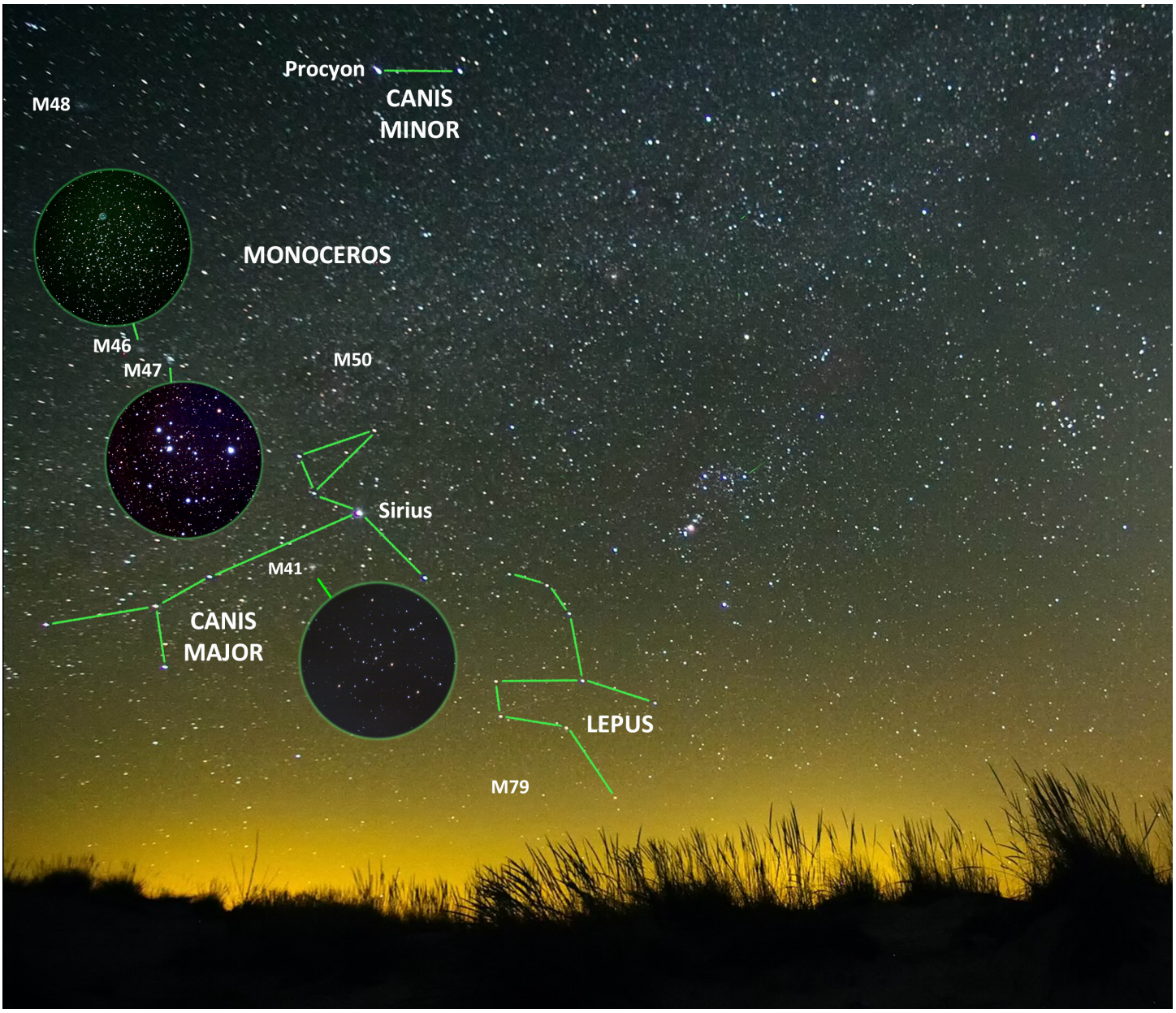
Taurus is home to M45, the Pleiades or Seven Sisters star cluster. It is easy to make out a half dozen stars with the unaided eye. The handful of stars multiplies into several dozen when viewed in binoculars.

Binoculars also show a faint glow at the location of M1, the first object in the Messier Catalog. It is a supernova remnant, what is left behind when a star runs out of fuel, collapses on its core, then explodes. The explosion of this star was witnessed in the year 1054, when a new star of great brightness appeared. It was bright enough to be seen in daylight for a few weeks, then it faded from view. Now we find M1, the Crab Nebula, at that spot in the sky.

The most familiar wintertime constellation is Orion, the Hunter. The bright stars Betelgeuse and Rigel are colorful to your unaided eyes. Betelgeuse has a reddish-orange color, while Rigel has a hint of blue.

The three stars of Orion's belt are about halfway up the sky in the South. They point left to the brightest star in the sky, Sirius, and right toward Aldebaran in Taurus. The northern most star in the belt, Mintaka, is positioned on the celestial equator, a projection of Earth's equator into space.

Below Orion's belt is his sword. At the middle of the sword is a star that looks a little fuzzy. In binoculars there are several stars here embedded in M42, a faint cloud of interstellar gas. Within this cloud new stars are forming.



Following Orion across the sky are his dogs, Canis Major and Canis Minor. Canis Major does look a little like a dog, but Canis Minor has only two stars, which leaves the figure to your imagination.

Below Orion is Lepus, the Hare. The hare was Orion's favorite game on the hunt.

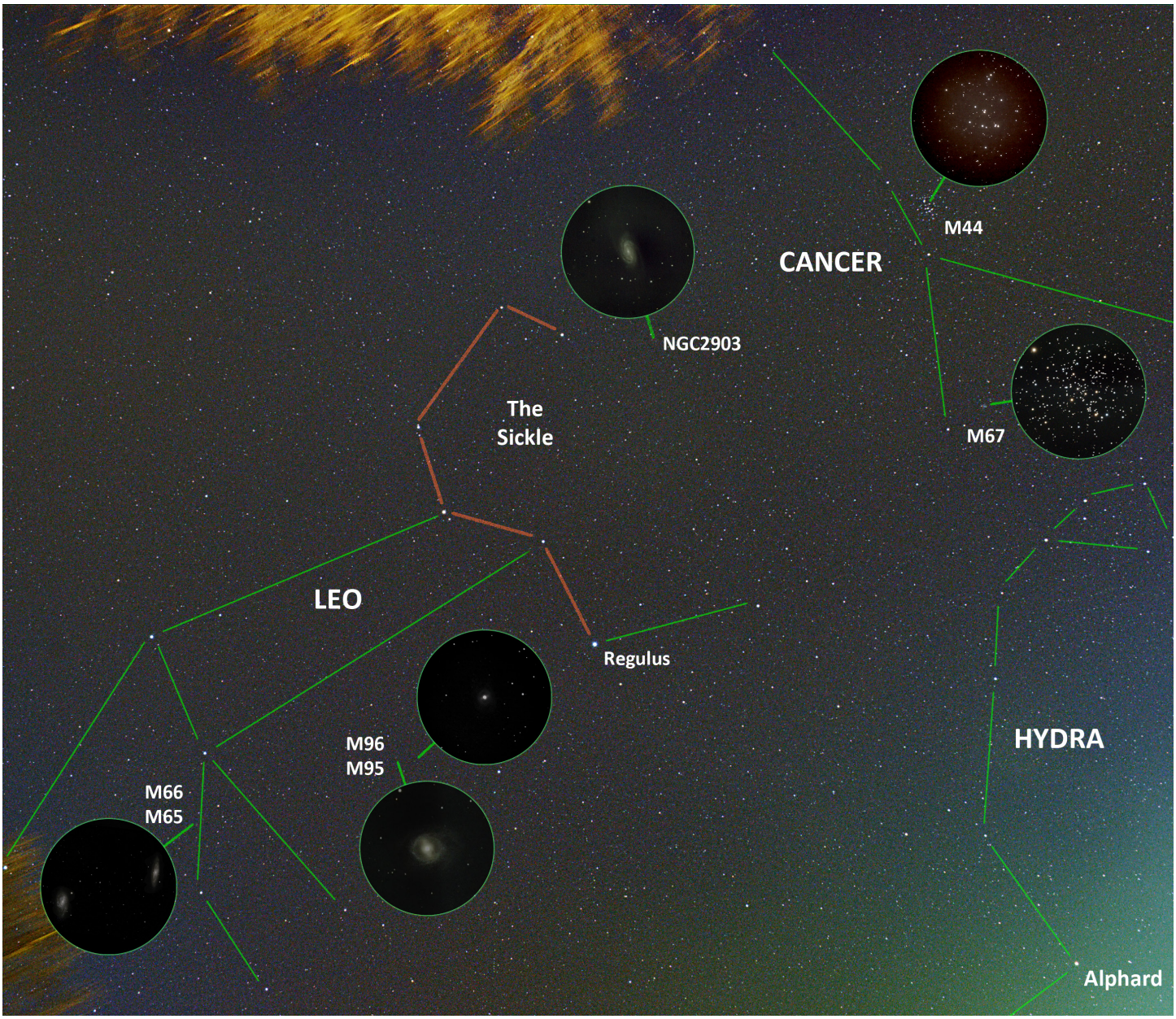
The winter Milky Way passes above Canis Major, through the faint constellation Monoceros, the Unicorn, and over the shoulder of Orion. There are many galactic, or open, star clusters in this part of the sky.

The most interesting of these galactic clusters is M46 in Monoceros. A 6 or 8 inch telescope will reveal a tiny shell of gas called a planetary nebula in this cluster.

Planetary nebulae are the outer atmospheres of sun-like stars, released late in the star's life. The core of the star collapses, becoming a dense white dwarf star which gives off large amounts of ultraviolet light. The ultraviolet light makes the surrounding shell of gas glow.

This map shows the sky as it appears at approximately

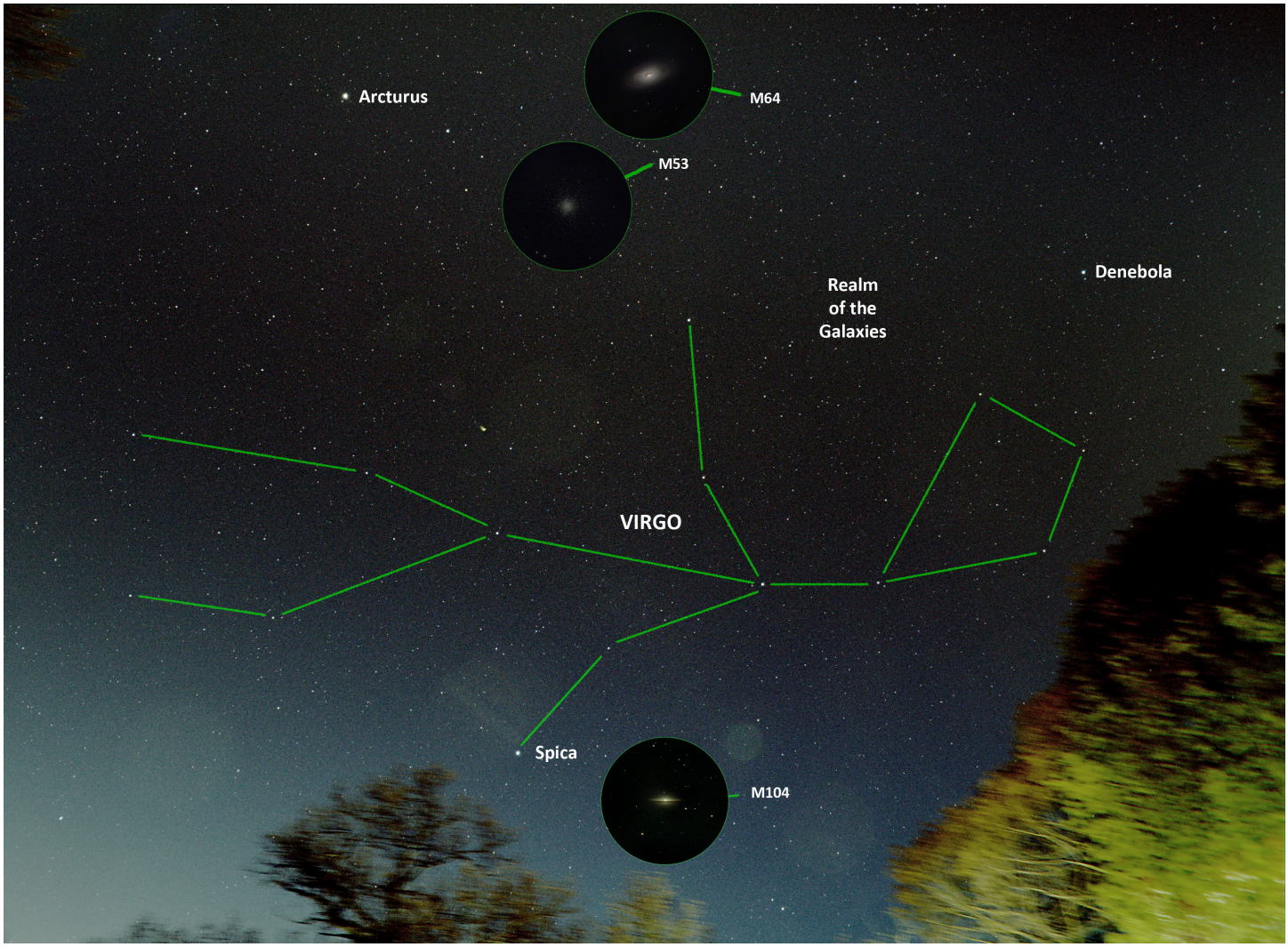
11:30 PM in March
9:30 PM in April
7:30 PM in May



Locate Leo the Lion by looking for the Sickle asterism, which resembles a backward question mark, and triangle about halfway up the sky.

Tangled in the lion's legs are M65 and M66, a pair of galaxies that are visible in binoculars. Under the lion's belly are M95 and M96 which are also visible, but a little more difficult to see. One more galaxy, NGC 2903, is located west of the lion's head.

To the west of Leo is a faint upside down "Y" shape that is Cancer, the Crab. Near the center is the Beehive star cluster, M44. Near a claw of the crab is M67, another star cluster visible in binoculars.



The Milky Way galaxy hugs the northern horizon while Virgo skims the treetops in the south. Above Virgo is Coma Berenices, where the galaxy's North Pole is located. The disk shaped Milky Way is one-tenth as thick as the distance from edge to edge, so there are fewer stars and dust clouds between our eyes and external galaxies in this direction.

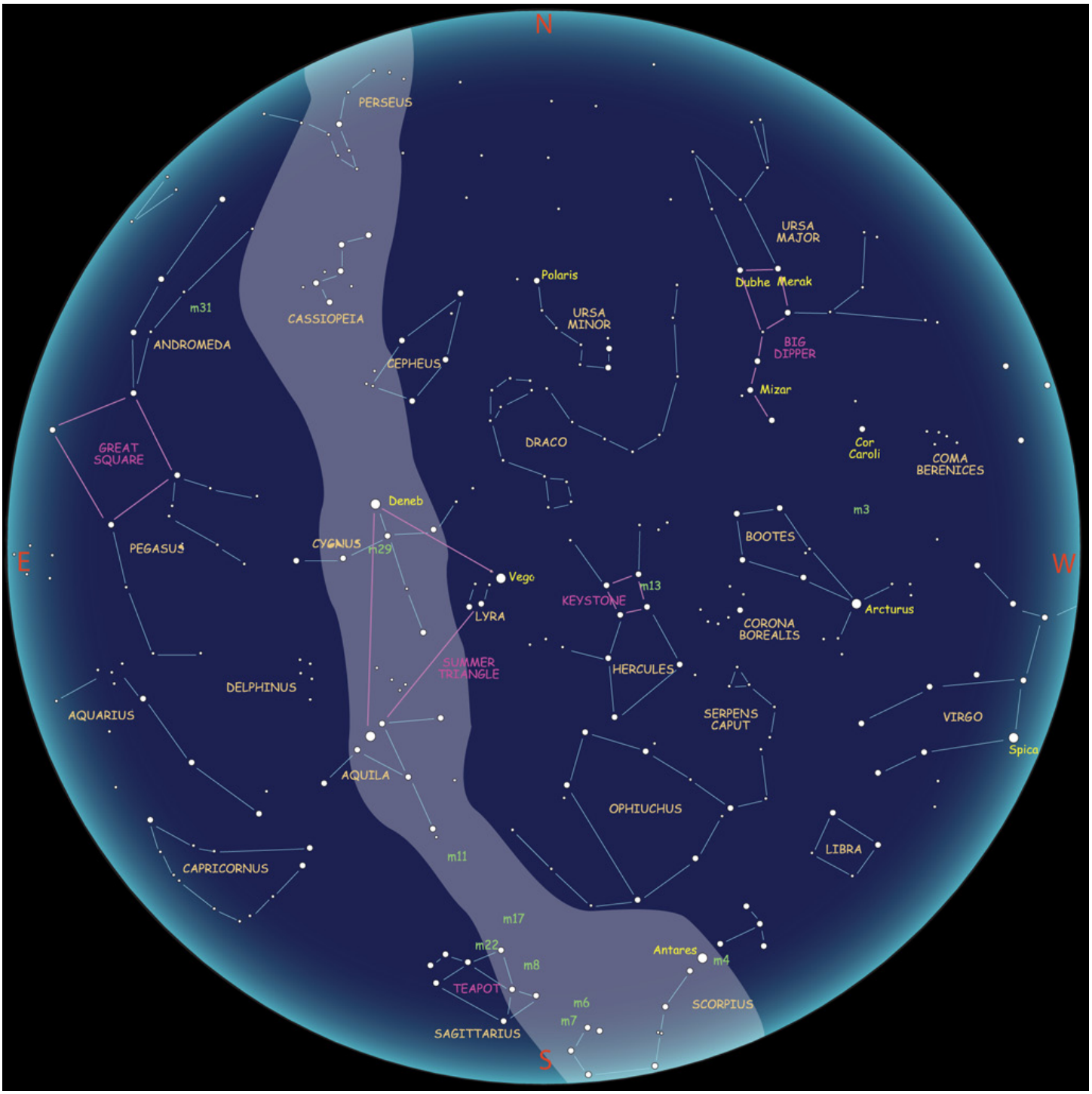
Hidden in the darkness beyond our sight is the Virgo Supercluster of Galaxies. Our own galaxy, the Milky Way, belongs to an association of a few dozen galaxies called the Local Group. The Local Group is one of many galaxy clusters that in turn make up the Virgo Supercluster of Galaxies.

M104 in Virgo and M64 in Coma Berenices are galaxies that appear as fairly bright smudges in binoculars. Binoculars will also show several fainter galaxies of the Virgo Cluster in the area labeled Realm of the Galaxies.

Looking through binoculars at the area called the "Realm of the Galaxies" will require a dark sky observing site, far from city lights. The galaxies appear as faint smudges near the limit of your vision.

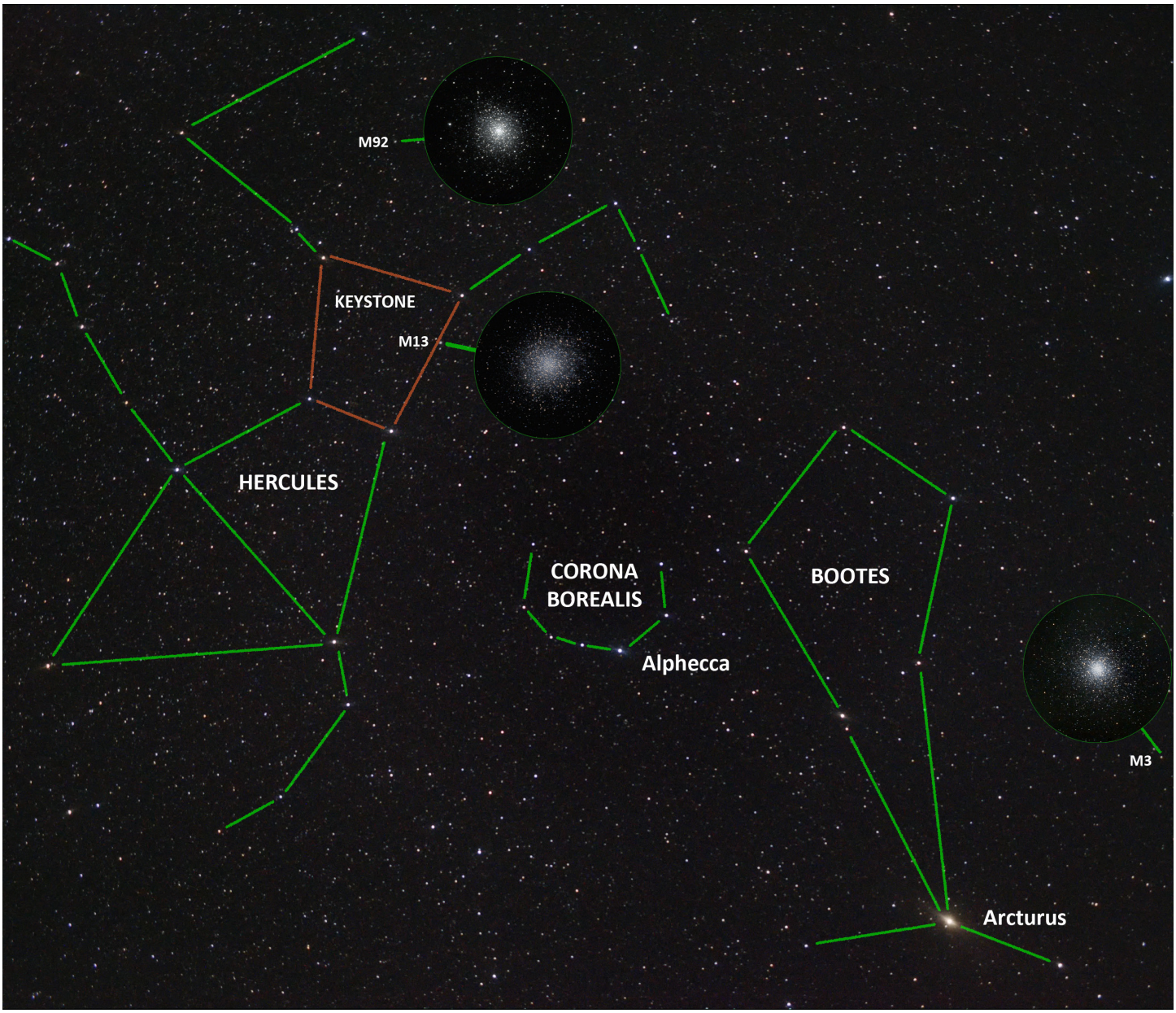
While several of these galaxies are bright enough to see with binoculars under good conditions, it will require using averted vision to see the richness of this area.

Averted vision is learning to look a little to the side of your target, so an object's light falls on the most sensitive part of your retina. The center of your vision is sensitive to color and needs more light than the outer areas of your retina. The outer region is more sensitive to faint light. As your vision moves to center on a dim object, it fades from view. With practice you can train yourself to keep the object in the more sensitive area of your vision.



This map shows the sky
as it appears at approximately

12:30 AM in June
10:30 PM in July
8:30 PM in August

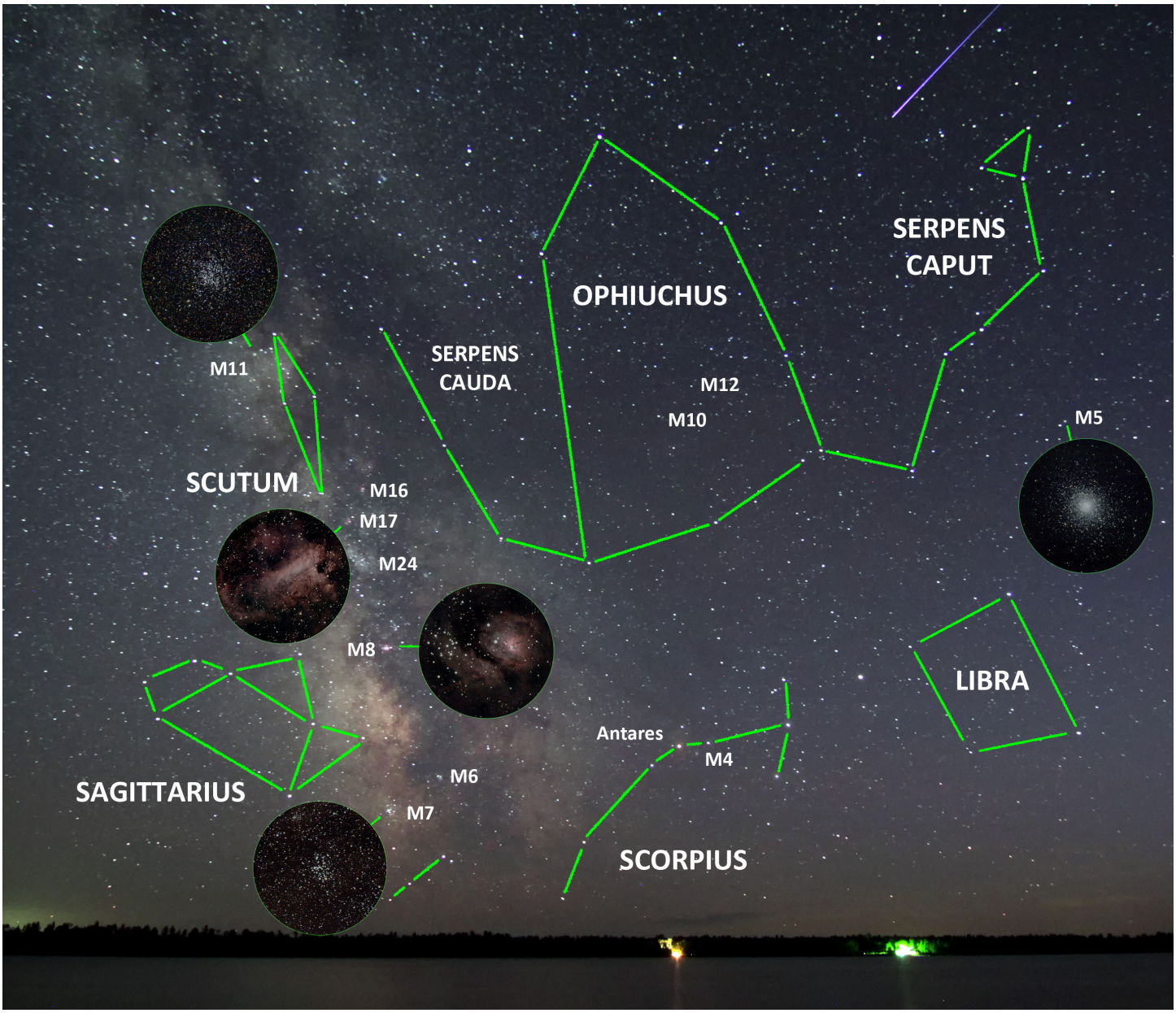


The late spring, early summer sky has one of the brightest stars, Arcturus, high in the western sky. Arcturus is distinctly orange in color. It is located at the bottom of the kite shaped constellation, Bootes, which some people describe as an ice cream cone. To the left is a ring of stars, Corona Borealis, resembling a scoop of ice cream that has fallen off the top of the cone to the right. Trace a line from Arcturus through Corona Borealis and you will arrive at the Keystone asterism in Hercules.

Once you identify the Keystone, use binoculars to look along the western side for a star that does not come into focus. The fuzzy star is M13, one of three bright globular star clusters in this part of the sky. A 6 or 8 inch telescope will reveal the ball of faint stars that makes this kind of a cluster.

Observing Project:

Look at several different globular star clusters through a small telescope. Compare the size of the clusters, the brightness of the clusters, and how condensed they appear (is the cluster evenly bright or does it have a bright center).

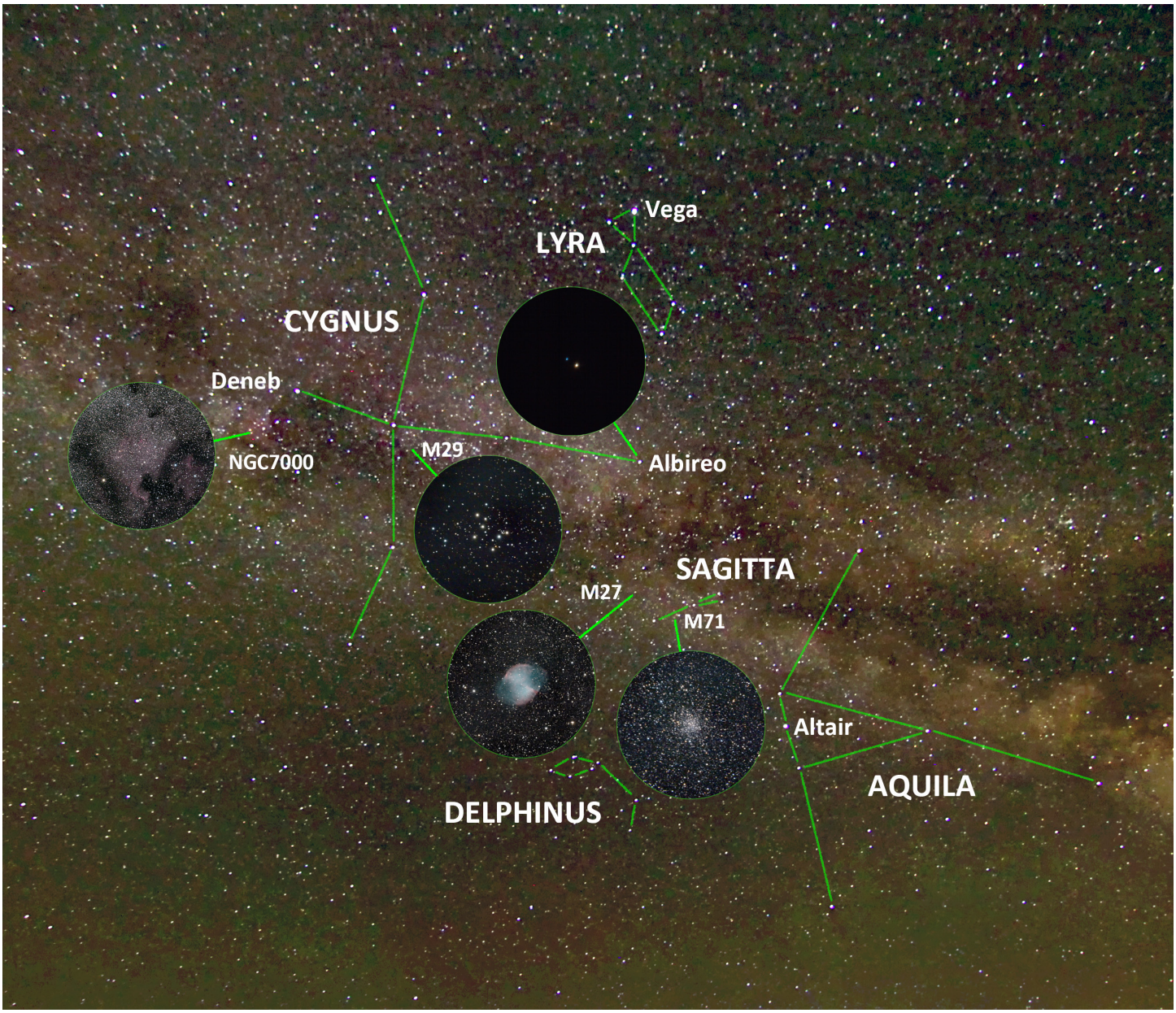


We find the core of the Milky Way at the southern horizon on warm summer nights. The glow is divided by dark clouds of interstellar dust. Scattered throughout the Milky Way are clusters of stars and glowing clouds of gas.

Start sweeping your binoculars upward from the tail of Scorpius. The open star clusters M7 and M6 are first in line. Higher are the diffuse nebulae M8, M17 and M16. These glowing clouds are regions where new stars are forming.

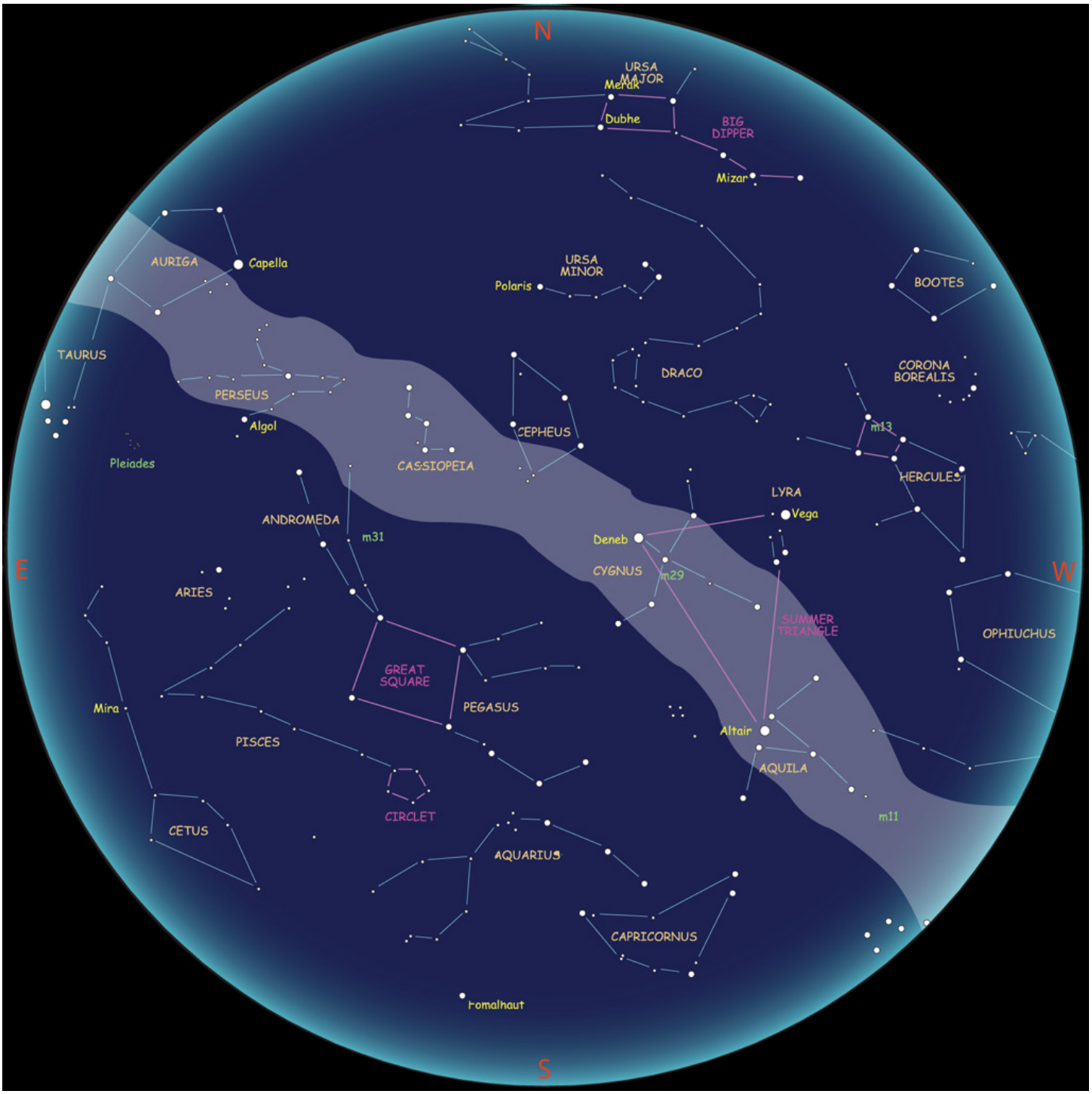
M24 appears as a bright patch in the Milky Way. In reality we are looking through a thin spot in a dust cloud that obscures the next arm of our galaxy, allowing us to see the stars beyond .

To the west in Ophiuchus are a few globular star clusters including M5, M10, and M12.



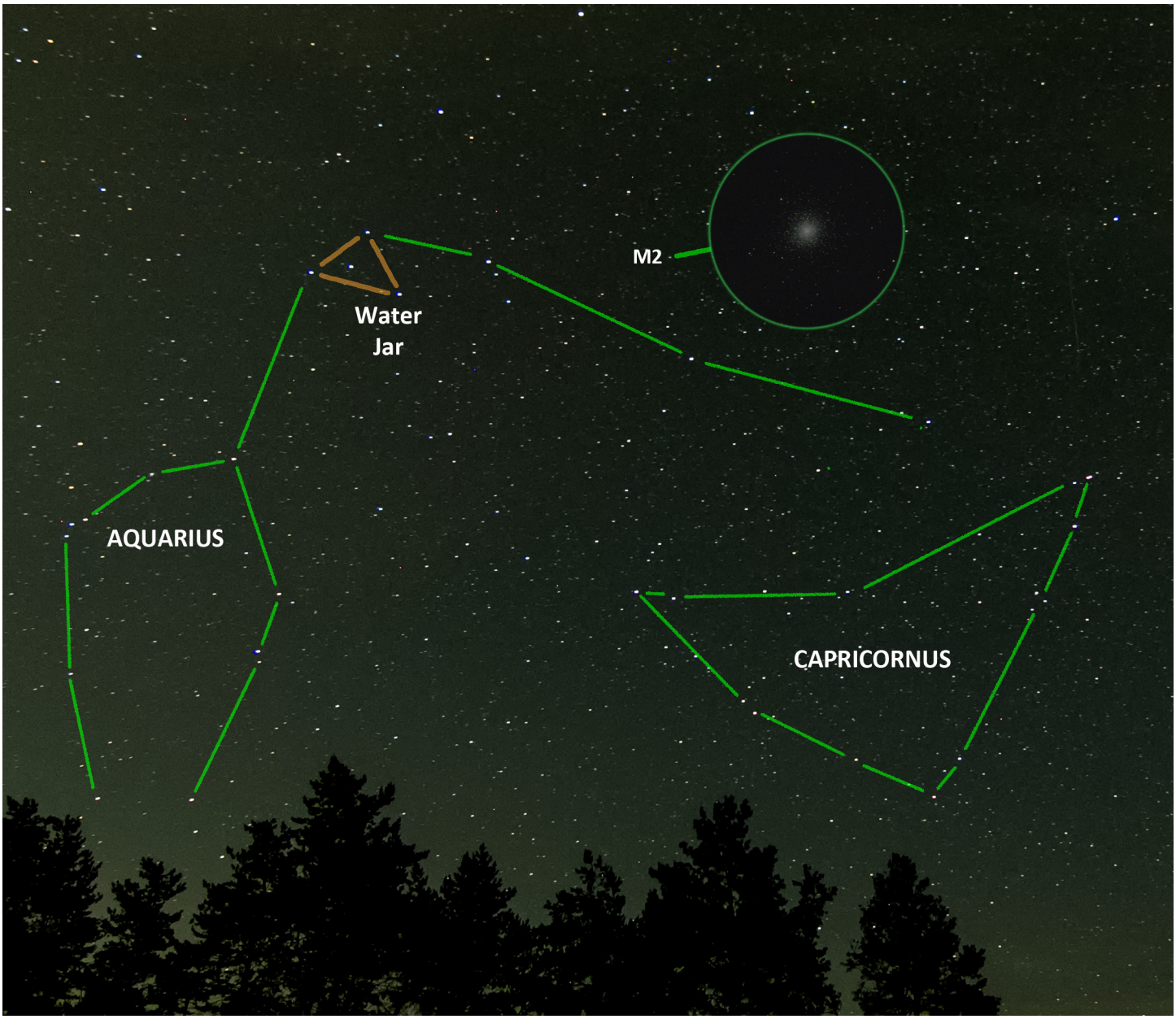
The Milky Way is overhead marked by the three bright stars of the Summer Triangle - Vega, Deneb, and Altair. Each star is the brightest in its own constellation. Vega is at the top of Lyra, the Lyre. Deneb is the tail of Cygnus, the Swan. Altair is the head of Aquila, the Eagle.

Binoculars reveal all kinds of objects including double stars (Albireo), galactic star clusters (M29), globular star clusters (M71), diffuse nebulae (NGC 7000), and planetary nebula (M27), set against the background of the Milky Way's faint stars. The five objects shown here are only a sample to start on.



This map shows the sky
as it appears at approximately

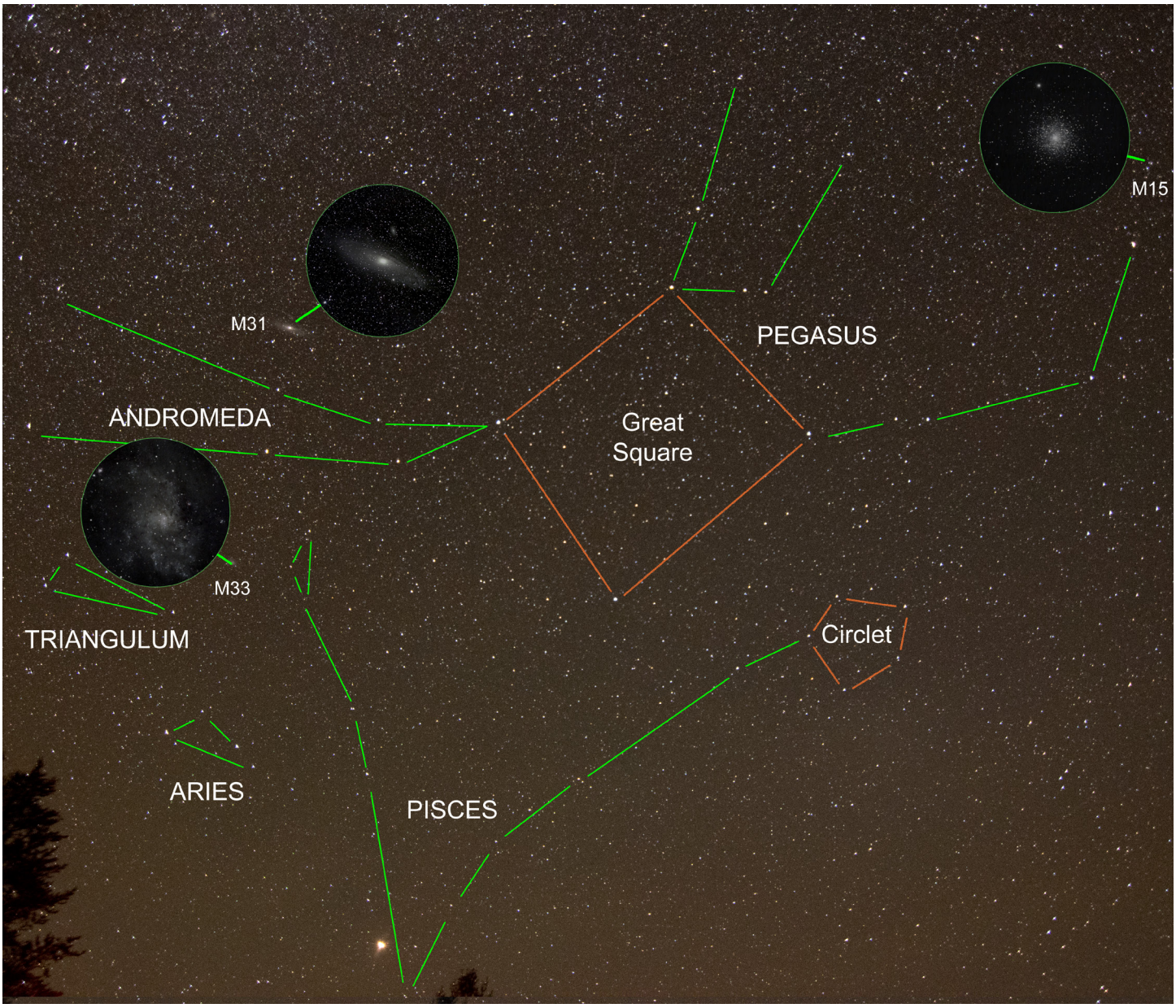
11:00 PM in September
9:00 PM in October
7:00 PM in November



Skimming over the treetops in the autumn sky are the constellations Capricornus and Aquarius. Neither constellation contains a bright star to help you locate it, but there is a small asterism in Aquarius that stands out, the "Water Jar", an equilateral triangle with an extra star at its center.

While these constellations do not contain bright stars, there are times when they have a bright planet passing through. The constellations belong to the band of the zodiac - the path the Sun, Moon, and planets follow across the sky.

Both constellations are home to Messier Catalog objects, but the low altitude makes finding these objects in binoculars difficult. The exception is M2, a globular cluster that is higher above the horizon than the others.

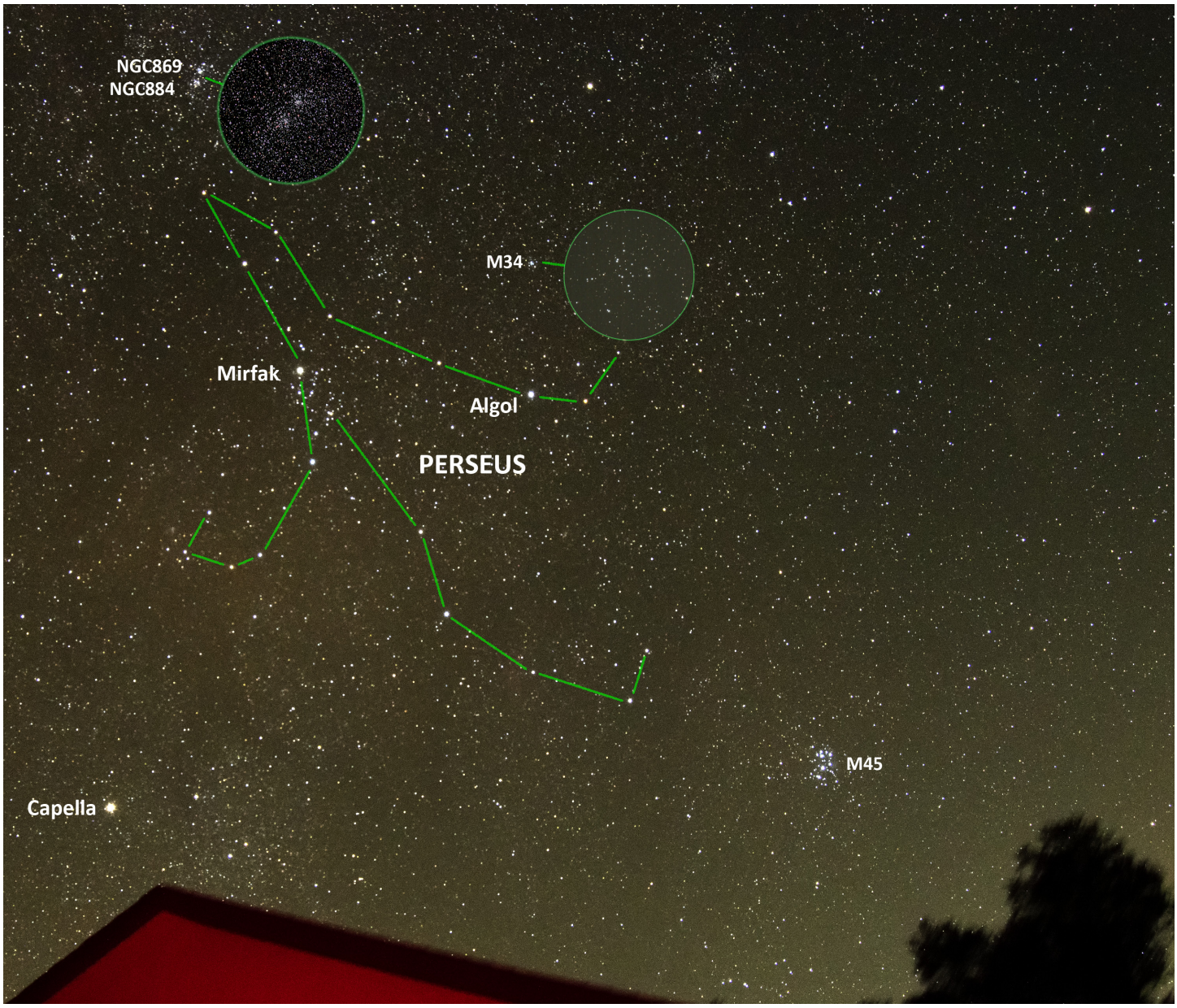


The Great Square asterism is a starting place for discovering the autumn constellations. It forms the body of Pegasus, a flying horse which Perseus rode to rescue Andromeda. M15, a bright globular star cluster is sometimes refered to as a fly on the nose of Pegasus.

East of the Great Square is Andromeda and M31, a spiral galaxy visible to unaided eyes in a dark sky. The faint galaxy appears larger than the moon.

Below Andromeda is Triangulum. Between the point of the triangle and Andromeda you may find a faint glow, M33, another spiral galaxy viewed "face-on" showing its pinwheel structure.

The Circlet is a ring of stars below the right side of the Great Square. It helps you find Pisces, the Fish, one of twelve zodiacal constellations. Aries, the Ram, is another.



Perseus is the mythological hero who rescued Andromeda from the sea monster Cetus. The constellation is shaped like a closed umbrella.

Near the constellation are several star clusters, including NGC 869 and NGC 884, commonly known as the double star cluster. The cluster is located between the top of Perseus and the circumpolar constellation Cassiopeia.

Another cluster of widly scattered stars is M34, located in the right side of the umbrella shape.

The largest cluster is the Perseus OB Association, a swarm of bright stars surrounding Mirfak, the brightest star in Perseus.

Observing Project:

The star Algol is actually two stars in orbit around each other. At intervals a little longer than two and a half days the fainter star eclipses the brighter star for about 8 hours, dimming Algol noticeably.

Observe Algol each clear autumn night you are out. Compare it with Mirfak and with the stars on the right side of the umbrella shape.

For help catching the dimmed star, refer to the monthly observing guide in Sky & Telescope magazine for the times of Algol's minimum brightness.

There are a few nights each year when a faint glow appears above the northern horizon. At first the glow resembles a band of clouds illuminated by distant city lights, but they appear where there should be no lights. This glow is the Aurora Borealis or Northern Lights.

With binoculars you can see the glow does not obscure stars the way a cloud would. It forms in the highest layers of Earth's atmosphere where electric currents make atoms of oxygen and nitrogen glow.

Most nights the aurora is an unimpressive, smooth arc of faint light. On a few nights the aurora becomes brighter and forms curtain-like folds and bright vertical columns called rays or pillars that glide westward. These brief events are called substorms.

Observing Project:

If the aurora is visible, you can attempt to photograph it using the following manual camera settings:

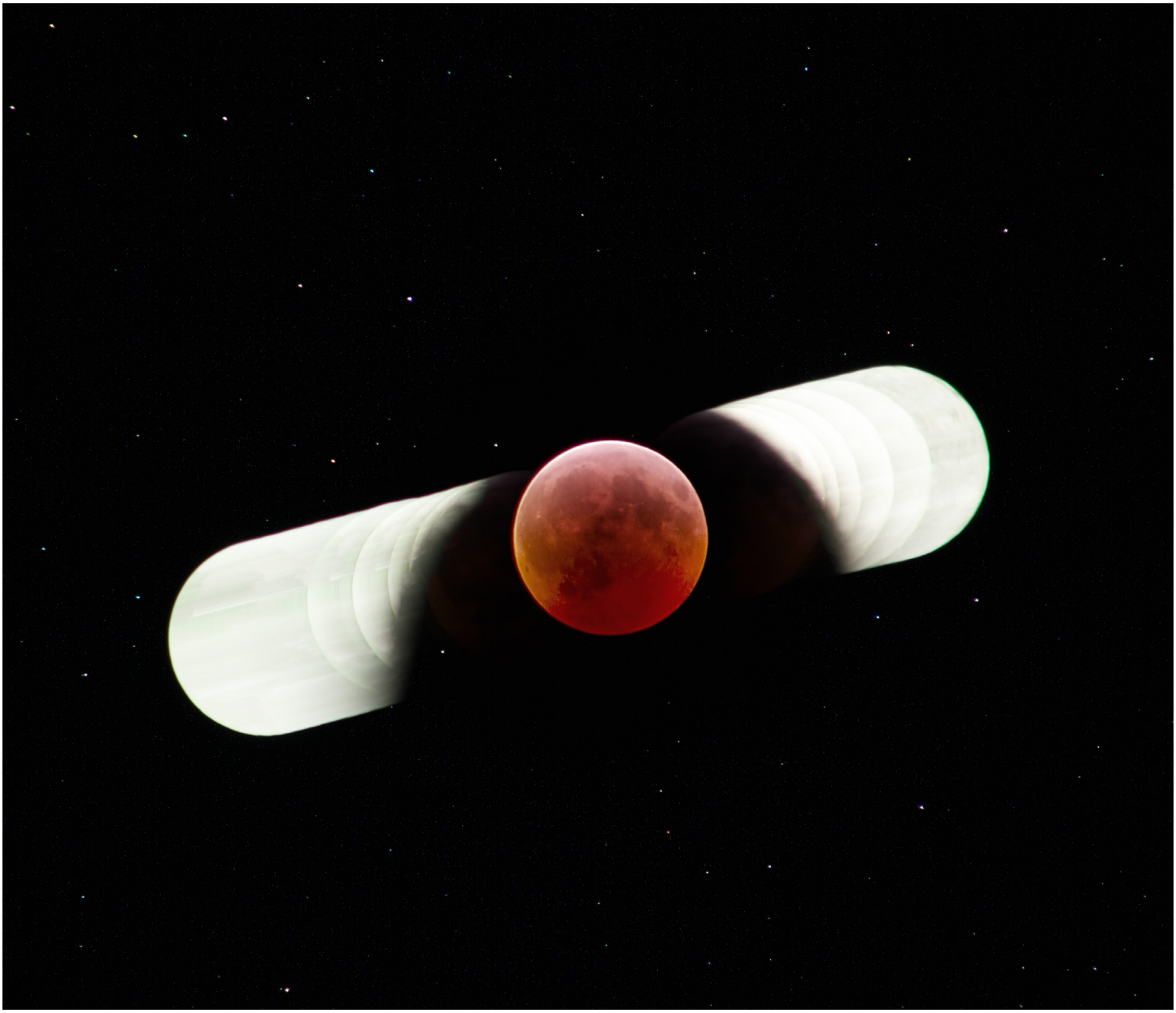
Lens:	8 - 50 mm
F-stop:	F/1.8 - F/4
ISO:	1600 - 3200
Exposure:	10 to 15 seconds

The camera should be on a tripod for stability.

The focus should be set at infinity, and checked on a test image. Zoom in to be sure the stars are focused points.

On moonless spring evenings or autumn mornings there is a cone shaped glow that resembles the Milky Way. The glow follows the setting Sun in March and leads the rising Sun in September. It is known as the Zodiacal Light because it is aligned along the Zodiac - the twelve constellations along the path of the Sun, Moon, and planets across the sky.

The cone of light is from a cloud of dust that surrounds and is illuminated by the Sun.



As the Moon orbits Earth, it crosses the Sun's path twice each month. The crossing points are called nodes. If the moon is full as it crosses the node, it will be eclipsed. The eclipse results from the Moon passsing through Earth's shadow.

Eclipses of the Moon, or Lunar eclipses, are visible from the entire side of Earth facing the moon at the time of the eclipse. Lunar eclipses usually last for a few hours. Times are shorter if the eclipse is partial. Sometimes the eclipse will begin before the moon rises or end after the moon has set.

Eclipse observations can be made standing in your own back yard. You can see the event with unaided eyes, although a pair of binoculars will enhance viewing significantly.

Observing Project:

Observe one or more of these lunar eclipses visible from North America:

2022, May 16	Total
2022, November 8	Total
2024, September 18	Partial
2025, March 14	Total
2026, March 3	Total
2028, January 12	Partial
2029, June 26	Total
2029, December 20	Total

If the moon is new when it crosses the Sun's path, the moon will eclipse the sun. Total solar eclipses are spectacular events to view.

The umbral shadow of the moon traces a thin line across Earth's surface. To see the totally eclipsed sun, you must be someplace along this narrow path of totality.

For most observers, viewing a total solar eclipse requires planning a trip. The easiest way is to join an eclipse travel group. The groups fill up about a year in advance, so plan early. If traveling independently, make reservations as soon as possible because many other observers will be making their own plans.

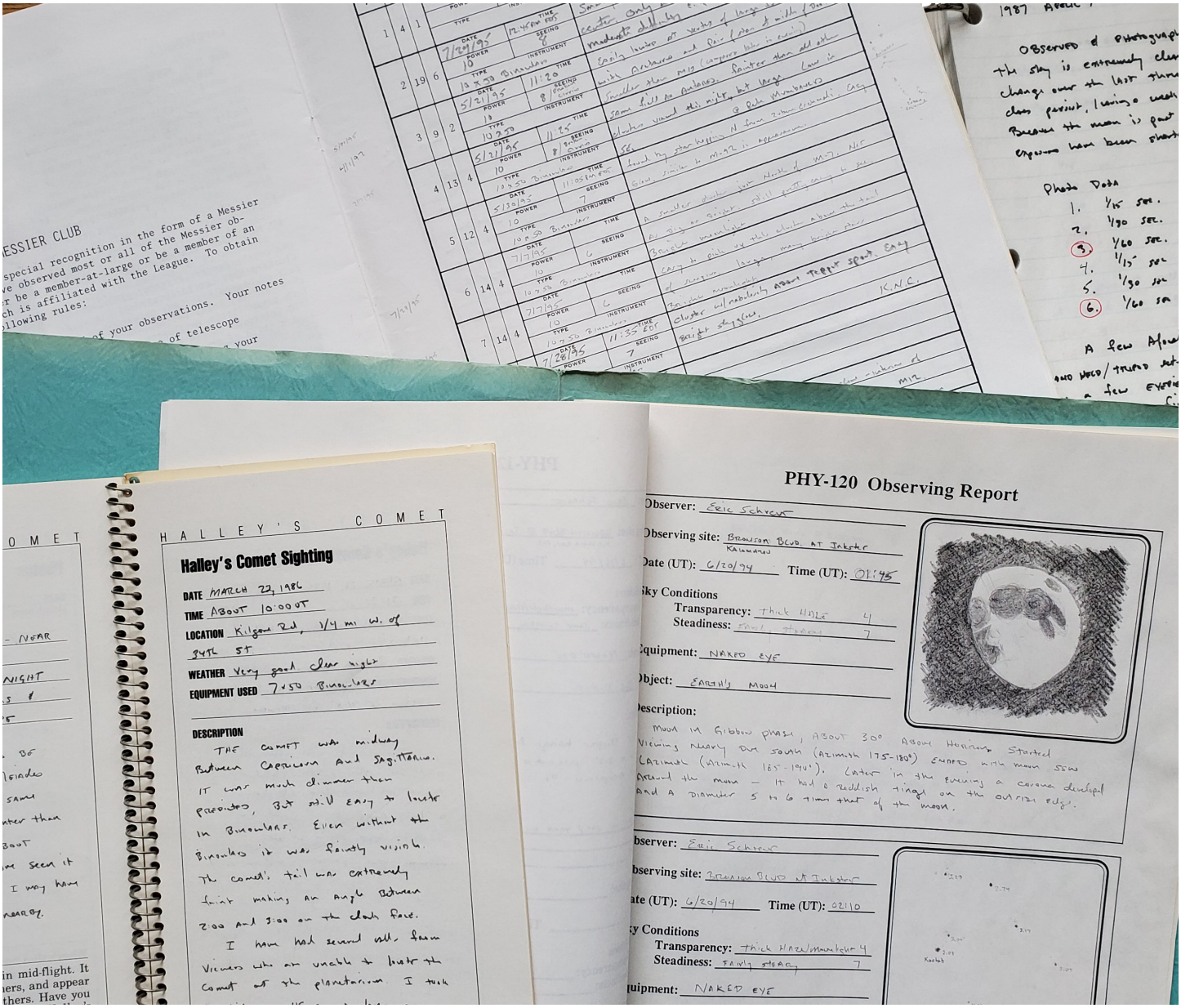
Observing Project:

Research travel arrangements to view one or more of the following total solar eclipses:

2024, April 8	USA, Mexico
2030, November 25	Australia
2035, September 2	Japan

Research travel arrangements to view this nearby annular solar eclipse:

2023, October 14	western USA



It helps to keep a written record of your observations as you become familiar with the night sky. A written record made at the time of your observations is much more reliable than a memory from the past.

If you make drawings of the objects you are observing, you will spend more time allowing your eyes to make out details that you would miss with a quick glance. Once you become familiar with the details, it becomes easier to see them the next time you look at the same object.

Make an observing notebook using copies of the next page of this guide. Use a three hole punch and collect your observations in a loose leaf notebook.

Family Stargazing

Observation Record

Your name:

Your location:

Date of observation:

Time of observation:

Sky Conditions

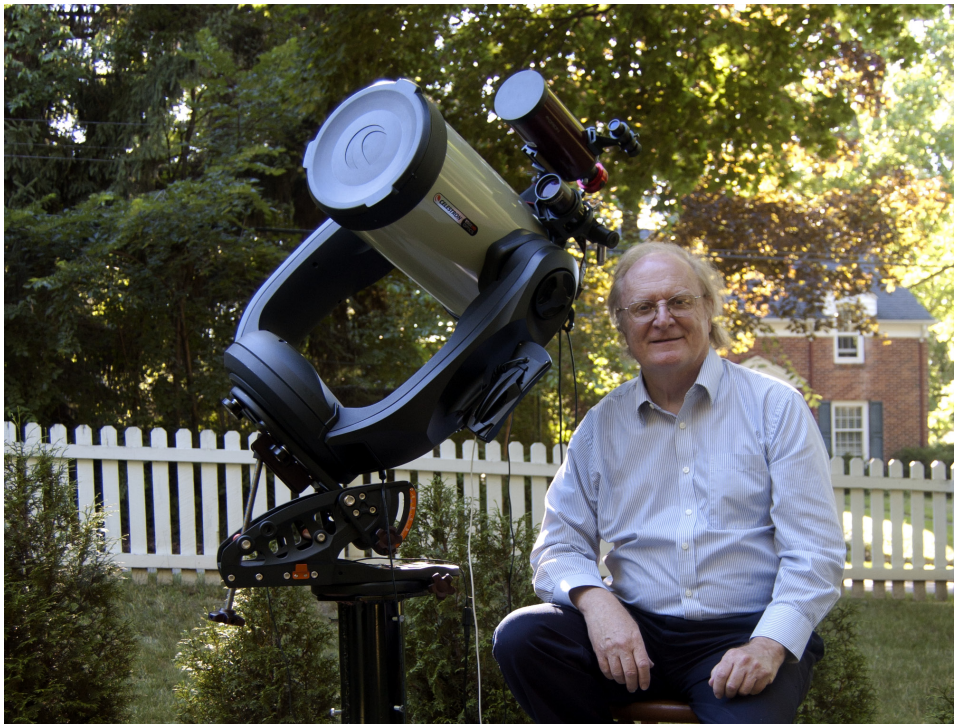
Clouds
clear - - - - - - - - - - - - - - - - - - - cloudy

Clarity
clear - hazy

Seeing
steady - - - - - - - - - - - - - - - turbulent

Describe any equipment used:

Describe or make a drawing of what you saw:



About the Author

Eric Schreur has been an active amateur astronomer since 1968 when he took an Astronomy class at Loy Norrix High School in Kalamazoo, Michigan. The astronomy class made weekly trips to the Kalamazoo Public Museum's Hans Baldauf Planetarium, where Eric took a position as a weekend volunteer presenter in the summer of 1969. That same summer, Eric photographed his first images of the constellations visible from a school yard in his neighborhood.

In 1983, Eric was offered the position of Planetarium Coordinator at the planetarium. There he began writing, illustrating, and presenting programs for school and public audiences. Each week there was a live presentation about discovering what could be seen in the current evening sky.

Eric also shared the night sky in Family Stargazing classes offered through community education, and entry level astronomy classes offered at Kalamazoo Valley Community College.

In 2015, Eric retired from the Kalamazoo Valley Museum. In retirement, he built a backyard observatory where he continues to photograph celestial objects to share the night sky with friends and family through his Facebook and Twitter accounts.