Kalamazoo Astronomical Society

Looking Up Since 1936

Introduction to Amateur Astronomy

Part 3: *Binocular Basics*

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Binoculars: The Ideal Starter Instrument

Binoculars are often underestimated and unappreciated by beginners fixated on the idea of getting a telescope. Binoculars are actually two telescopes put together, but they are more compact than a customary telescope because the light path is compressed by the use of a series of prisms built into the instrument. They also have a unique place in observational astronomy. Binoculars fill in the gap between the unaided eye and the telescope in terms of power, field-of-view, and convenience. Even veteran amateur astronomers should have a good pair of binoculars at their side every time they venture out under the stars.

Benefits of Binoculars

Binoculars are the ideal instrument for beginners because they are so simple to use; no assembly or special alignment is required; you can use them right out of the box. The images they provide are right-side up and in front of you, and their large field-of-view makes objects easy to find. The observing and chart-reading skills you will gain from tracking

down deep-sky objects are the same skills you will need to put your telescope to good use.

The brain is more adept at receiving messages from both eyes. Therefore, when observing with binoculars, objects at the limit of vision register as real, whereas one-eyed detection produces momentary and vague cerebral messages. Experts estimate a 40% increase over single-eye vision. Two eyes really are better than one!

Binoculars are extremely portable instruments; you can take them virtually anywhere. Plus, if you aren't able to setup a telescope or just don't have the time, binoculars can be ready in an instant for a quick observing session or to take a closer look at astronomical phenomena like Earthshine or planetary conjunctions.

A quality pair of binoculars can be purchased for the price of the cheapest telescope. Not to mention, binoculars are much more versatile than most telescopes. They can also be used for sporting events, wildlife observations, and much more.

Binocular Types

Porro-Prism binoculars are the most common design. Light coming in through the two sets of objective (front) lenses is focused by a pair of prisms so that the path is folded in a zigzag pattern and out through the eyepieces, which produces an image that is seen right-side up.

Roof Prism binoculars are a more modern design. Instead of "folding" the prisms and zigzagging the light path, roof prism binoculars allow for a "straight -through" design, which helps prevent a tenuous loss of light. Because of their straight-through design, roof prism binoculars can be made into more compact sizes. They tend to be more expensive when compared to porro-prism binoculars of equal specifications.

Porro Prism Binoculars

Image-stabilizing binoculars are of the roof prism variety and contain microprocessors coupled to motion sensors that compensate for the shuddering imparted by the user's arm with the push of a button. The larger-aperture models are outstanding performers but tend to be a little expensive. Models from Canon that are suitable for astronomy, 10×42, 12×36, and 15×50, cost $1,499, $799.99, and $1,249, respectively!

Choosing Binoculars

Power

Every pair of binoculars has a two-number designation denoted somewhere on the body, such as 10×50 or 20×80. The first number is the magnifying power, or magnification. The second is the diameter of the objective lenses in millimeters.

High magnification will increase the instability of hand-held binoculars and give a narrower field of view. Therefore, 7× or 10× are the generally accepted maximum magnification for hand-held astronomical binoculars.

Aperture

Binoculars with larger objective lenses do help make

Roof Prism Binoculars

deep-sky objects brighter and sharper, but there is a limit for hand-held binoculars because the larger apertures are heavier and therefore harder to hold steady. Generally, 50 mm is the maximum aperture of hand-held binoculars. **Therefore, 7×50 or 10×50 binoculars are regarded as the best type to use for astronomy.**

Exactly which style of binocular to get depends on your age. Most people under the age of 30 have pupils that dilate to 7 or 8 mm in dark conditions. After the age of 30, everyone generally loses about 1 mm of dilation every 20 years. A pair of 7×50 binoculars have exit pupils 7.1 mm in diameter (50 ÷ 7 = 7.1), while 10×50's only have exit pupils 5 mm in diameter. You wouldn't take full advantage of your binoculars' light-gathering capacity if your pupils only di-

late to 5 mm and you use 7×50 binoculars with a 7.1 mm exit pupil.

Field-of-View

This is the angle of coverage visible through the binoculars. Most 7×50 binoculars have a field-of-view of 7°, while 10×50's generally have fields-of-view between 5° and 6°. Some binoculars boast a wide-angle or ultra-wide-angle field of view, generally around 8° - 12°. These models can have severe optical distortions around the edge of the field; be sure to test them thoroughly.

Anti-reflection Optical Coatings

Because glass surfaces reflect back up to 7% of any light that passes through, a binocular built without an anti-reflective coating on its lens surfaces would deliver very poor, darkened views. Most better-quality binoculars coat all or most of the lens surfaces with vacuum-deposited layers of magnesium fluoride (MgF) and other exotic elements to reduce light loss through reflection, which increases light transmission and delivers a bright, clear view. Typically, the more lens and prism surfaces that are coated, the brighter and clearer the image, but at an incremental increase in cost.

Most astronomical binoculars will be labeled "multi-coated" or "fully multi-coated." Multi-coated binoculars mean that the manufacturer applied multiple coats of anti-reflective layers to most of the lens and prism surfaces. If done properly, this can increase light transmission to 97%. Fully multi-coated binoculars are the brightest and most expensive option, where all surfaces are treated with multiple layers for optimum light transmission (up to 99%).

You can check the optical coatings yourself by shining a bright light into the binoculars from the objective (front) end. Looking down into the glasses, tilt them slowly back and forth and watch for multiple reflections from the coated lens surfaces. All should be equally subdued blue, green, or purple, depending on the coatings used. Noticeably brighter white reflections are a sign of uncoated surfaces.

Glass Types

The glass used to make the prisms in a pair of binoculars can have a bearing on the overall image quality. The two main types are Borosilicate Crown Glass (Bk7) and Barium Light Crown Glass (BaK4). Generally, BaK4 prisms are found in higher-end optics and provide better light transmission, color reproduction, and reduced distortion at the edges of the field -of-view.

Focusing Styles

Most binoculars focus by turning a knob in the center. This focuses both eyepieces at the same time and amount. However, the precise focal point can

be slightly different for each eye. To accommodate this, the right binocular eyepiece usually has a separate focusing capability with a scale and a zero point. This is called the ***diopter adjustment*** and is set by first focusing with the left eye only using the center focus wheel. Then focus with the right eye only, using only the right eyepiece. You'll only have to do this once unless you share your binoculars with other observers.

Larger binoculars (typically 20×80's and up) have individual focusing at each eyepiece. This may seem inconvenient, but everything in astronomy focuses at infinity, so you shouldn't have to make too many adjustments.

Testing Binoculars

Inspect the Workmanship

Pick up the instrument and compare its overall workmanship with other brands; some will seem better made than others. Hold the two barrels and try to twist them slightly. If there is any flexure in the joints or anything that rattles, reject the pair. Move the barrels together and apart; the hinges should work smoothly with steady resistance. So should the focusing motions for both eyepieces. On center-focus binoculars, the eyepiece frame should not tilt back and forth when you turn the focus in and out.

Inspect the Optics & Coatings

(Also see Anti-reflection Optical Coatings above.)

Look into the large objective lenses with a light shining over your shoulder so the inside of the barrel is illuminated. Reject the pair if a film of dirt or mildew is visible on any glass surface. (Dust on the outside is not a problem.)

Check Eyepieces & Exit Pupils

Holding the glasses a foot or so in front of you, aim them at the sky or a bright wall. Look at the exit pupils - the little disks of light seen floating just outside the eyepieces. If they have four shadowy edges, rendering them squarish instead of round, the prisms are not the best and are cutting off some light. In good binoculars, the exit pupils are uniformly bright to their round edges. Also, they should be surrounded by darkness, not by reflections from inside the barrels.

Look Through Them!

Adjust the separation of the barrels to match the separation of your eyes, and then focus each side separately. A noticeably filmy or gray image indicates an unacceptable contrast problem. If you have to wear glasses to correct for astigmatism, make sure you can get your eyes close enough to view the full field with the glasses on. If your glasses do not correct for astigmatism, you can take them off.

Each barrel should point in the same direction! If you see a double image or feel eyestrain as your eyes compensate for the binoculars' misalignment, you have a reject. The eyestrain would soon become a real headache.

For a better test, first make sure the barrels are adjusted exactly for the separation between your eyes, and then look at something distant through the binoculars. Slowly move them a few inches out from your eyes while still viewing the object. It should not become double. This test is a bit tricky because your eyes will automatically try to fuse a double image. At the same time, even a correctly aligned pair of images will look double for a brief moment before your eyes get them into register.

Misalignment due to flimsy prism supports is the worst problem with cheap binoculars; even a small knock can render a working pair worthless. More expensive instruments should survive minor accidents better.

Notice the size of the field-of-view: the wider the better. But the edges of a wide field usually have poor optical quality. Sweep the field at right angles across a straight line, such as a door frame or telephone wire. Watch whether the line bows in or out near the edges. This distortion should be slight.

Look at sharp lines dividing light and dark, such as dark tree limbs or the edge of a building against a bright sky. Do they have red or blue fringes? No instrument is perfectly free of this ***chromatic aberration***, but some are better than others (more on this in Part 4).

A star at night is the most stringent test of optical quality, so try the binoculars on real stars if you get a chance. If not, look for an "artificial star," such as sunlight glinting off a distant piece of shiny metal. Center it in the field-of-view. Looking with one eye at a time, can you bring it to a perfect point of focus? Or, as you turn the knob, do tiny rays start growing in one direction before they have shrunk all the way in the direction at right angles? This astigmatism is especially bothersome when viewing stars, and binoculars that are completely free of it can forgive some other faults.

Move the star from the center of the field to the edge. It will go out of focus unless you have a perfectly flat field and freedom from various other aberrations. As a rule of thumb, no degradation should be visible until the star is at least halfway to the edge of the field.

Finally, as Always. . .Compare Prices!

Many of the brand-name binoculars listed on page 18 (i.e., Celestron) are available from numerous dealers around the country. Make sure you visit as many of their websites as possible to get the best deal. Use the extra cash for accessories!

Observing Tips

Holding Binoculars Properly

There's one thing I (Richard Bell) have noticed over the years...When it comes to hand-held binoculars, *everyone* holds them wrong! Once you achieve good focus, place your hands around the front objective lenses. This better supports the weight of the binoculars.

Lawn Chair

An ordinary lawn chair is something you probably already own, so it's one of the easiest and cheapest ways to hold binoculars steady. By resting both elbows on the chair's arms and the eyepieces against your face, the jiggling is greatly reduced. It also makes observing near the zenith much more comfortable. Viewing from a lawn chair also allows you to keep a star atlas in your lap!

If you would still prefer to have your hands free in your lawn chair, then consider trying a Monfrotto Variable Friction Magic Arm. This is a fully articulated arm with 90° pivotable and 360° rotatable ends and an elbow that rotates 360°. The knob allows partial loosening for safe and precise positioning. The supplied camera platform can be easily fitted with a binocular tripod adapter (see the next section); it requires a Super Clamp for use.

Binocular Mounts

Binoculars cannot be beat for those short observing sessions at the spur of the moment. However, for more prolonged outings under the stars, it is best to mount them. Mounting binoculars in some fashion brings out their full capabilities and offers several advantages. First and foremost, mounted binoculars relieve you of the strain of holding them during a prolonged session and help reduce fatigue. The quality of views through binoculars has also increased since they're being held steady. Mounted binoculars will also maintain their position in case you need to reference a star atlas while tracking down an elusive deep-sky object. Lastly, mounted binoculars make it easier to share views with your friends and family!

Standard Camera Tripod

Many binoculars come equipped with a threaded socket to accept a tripod adapter using a standard 1/4-inch x 20 thread. A variety of binocular tripod adapters exist, including the "old-school" L-shaped design. They are all quite affordable and work on any combination of binoculars and tripods. Just be sure you purchase one made of sturdy aluminum as opposed to plastic.

If your binoculars don't have a threaded socket, then you can purchase a universal binocular tripod adapter. These feature either a buckle system or "hook and loop" (a.k.a. Velcro) strap to secure your binoculars in place and include the 1/4-inch x 20 thread for your tripod.

Tripod-mounted binoculars do make it possible to use larger models such as 9×63 or 15×70. However, the biggest disadvantage of this option is that it is very difficult, if not impossible, to point to any target at or near the zenith. Plus, if you can, it is very strenuous on the neck.

Parallelogram Mounts

Parallelogram mounts permit the use of 20×80, 25×100, or even larger binoculars (depending upon their capacity) and are much easier to point at the zenith. These mounts position binoculars away from the tripod, allowing the observer to stand or sit comfortably while aiming it overhead. Parallelogram mounts also enable binoculars to be raised and lowered while keeping a given target in the field, a wonderful feature when people of different heights are viewing together.

Orion Telescope's & Binoculars offers the Paragon-Plus Binocular Mount and Tripod (#05379) for $319.99 and is compatible with binoculars featuring

objective lenses up to 80mm in aperture. It has a weight capacity of 6 lbs., and when fully assembled, it weighs 19.8 lbs. If you would like an American-made alternative, then consider **Farpoint Astro's** Universal Binocular Mount (UBM). This mount has double the weight capacity of Orion's model and will support 80mm to 100mm aperture binoculars. The mount itself sells for $438.90, and an optional carbon-fiber tripod is an additional $318.70. Another downside is that they rarely seem to be in stock.

If you want beauty and brawn all rolled into one, then check out **Oberwerk's** PM2 Parallelogram Mount (made in Dayton, Ohio). It is made from maple, stainless steel, and aluminum. They also support binoculars up to 100mm in diameter, but they cost $699.95 for just the parallelogram mount alone. The optional TR3 maple tripod costs an additional $499.95, while two padded cases from Oberwerk cost $250. Beauty doesn't come cheap!

If you have a large pair of binoculars and money is no object, then consider Italian-based 10Micron's **Leonardo BM100**. This exquisitely machined mount enables you to observe any astronomical or terrestrial object conveniently by utilizing its 4-axis pointing system. Its maximum instrument load is 30 lbs. (13.5 kg), and retails at a staggering $3,700!

While technically not a parallelogram mount, one much less expensive option is the **EZ Binocular Mount Kit** from Peterson Engineering. This mount works on almost any size binocular from 7×50 to 25×100, and its 5-axis design allows comfortable viewing from any position – seated, standing, or fully reclining. The initial kit, costing $159.99 (plus shipping), contains all parts that require machining, welding, drilling, or thread tapping. You'll then need to purchase additional pipe and fittings at your local hardware store for $80 - $90.

For the true do-it-yourselfer, build a parallelogram mount of your very own! There are a wealth of designs online. Here are a couple to get you started:

- **AndyTalksAstro**
- **IceInSpace**

Designs for two binocular mounts can also be found in the book *Star Ware* by Philip Harrington (3rd Edition), pages 294 – 300. One design is an interesting binocular cradle, while the other is a parallelogram mount made from crutches.

Binocular Chairs

Observing with a parallelogram mount from a lawn chair is quite comfortable and easy on the neck.

However, you must get up and reposition everything if you want to move, for example, from the eastern to the western sky. And what if you're off on your pointing by more than a few degrees? That's where a binocular chair comes into play! Pivot from any azimuth or altitude position in the sky without ever leaving your chair.

The simplest design uses a beach chair equipped with a fully adjustable crossbar support structure consisting of aluminum and PVC tubing that is fully adjustable using friction joints constructed of polyethylene tubing and hose clamps. If you use heavy binoculars, a counterweight can be added to the opposite end. The chair rests on a wooden plywood platform, which in turn is mounted on a large lazy Susan bearing.

Perhaps the coolest commercially available binocular chair ever produced was the Starchair 3000 by Chris Floyd. Plant yourself in the padded seat and drive yourself in azimuth and altitude using a joystick on the right armrest. They are now out of production, but they were often seen in the Market Place section of *Sky & Telescope* in the early 2000s. There was a rumor that an upgrade was coming, but that was some time ago. (The domain name is also for sale, which isn't a good sign.) Brand new, these costed around $4,000. The advertisements often showed the Starchair being used with Fujinon 25×150 MT-SX binoculars. That's basically two 6-inch refracting telescopes together. Yuji Hyakutake used a pair of these to discover his famed comet on Christmas Day in 1995. Today, these binoculars sell for $6,500.

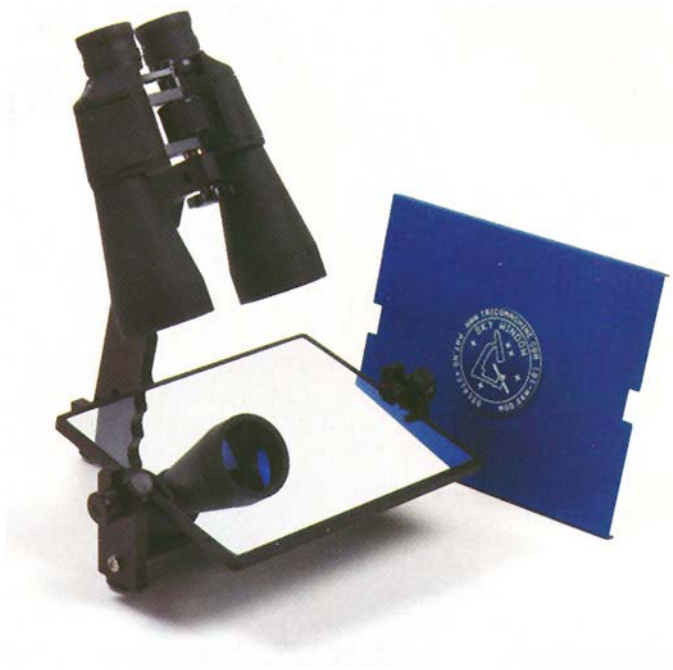
How about a binocular chair with GoTo capability? None are commercially available (that I know of), but a homemade rig was featured in Gary Seronik's "Telescope Workshop" column in the July 2012 issue of *Sky & Telescope*. It was created by California Amateur Telescope Maker (ATM) Norman Butler. He crafted his GoTo Binocular Chair out of a discarded Ikea recliner and utilized two Celestron NexStar 4SE dual servomotors for the drive system. After the standard star alignment, Norm's binocular chair will automatically slew to 40,000 deep-sky objects while he goes along for the ride!

There are many more ingenious designs online, but hopefully one point is made clear. Binocular observing is a fantastic way to spend a night under the stars, and people go to great lengths to make it as comfortable as possible.

Downward-Looking Mounts

Downward-looking binocular mounts have the portability of a camera tripod but the convenience of a parallelogram mount. They can be used in both standing and seated positions, but they are not a strain on your neck. In fact, the experience is a lot like viewing through a microscope!

The first and only one commercially available was Sky Window from Trico Machine Products. They are no longer manufactured, but they can be found on the used market. Sky Window holds binoculars up to 70mm in aperture at a downward angle so that the sky can be viewed in an adjustable mirror. Scanning the sky from horizon to zenith is said to be as comfortable as sitting at a desk and reading a book. A seated observer can use Sky Window placed on a table or mounted on a tripod.



Rod Nabholz has **detailed instructions** on building a downward-looking binocular mount on his *Home Built Astronomy Projects* website.

KAS member Joe Comiskey built his own version of a downward-looking binocular mount and debuted it at "Gadget Night" in 2016. (Gadget Night is a long-standing KAS tradition dating back to the 1950s.) Joe made many modifications to the original design in 2018. First, he switched to a first-surface mirror for better image quality. The newer version also allows him to observe from a seated position, and he can now quickly release his binoculars in case he wants to take a direct look at something in the sky.

One thing you'll have to get used to if you choose to observe with a downward-looking mount are the upside-down and mirror-reversed images. This is standard fare with telescopes, though. Finally, if you don't have easy access to a hair dryer and live in a humid area, it is recommended that you build some sort of dew prevention system into your mount; otherwise, your nights will be short!

Binocular Targets

The Sun

Observing our local star, the Sun, is totally safe **SO LONG AS YOU USE APPROVED SOLAR FILTERS OVER <u>BOTH</u> FRONT OBJECTIVE LENSES AND INSPECT THEM FOR DAMAGE BEFORE <u>EACH</u> USE**.

Safe solar filters for binoculars can be purchased from many dedicated astronomical product manufacturers, such as Baader Planetarium, Kendrick Astro Instruments, Orion Telescopes & Binoculars, and Thousand Oaks Optical.

Lunt Solar Systems in Tucson, Arizona, produces SUNoculars, dedicated solar binoculars. They have built-in front-mounted, fully dense white-light glass filters, making solar observation 100% safe. The 6×30 SUNoculars only cost $24.95, while the larger 8×32 pairs cost $129.

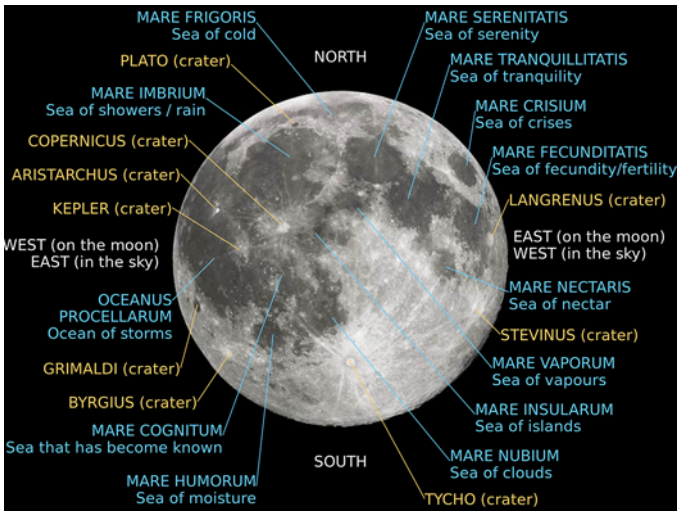
Properly equipped binoculars make it possible to quickly check on sunspot activity or view a transit of Mercury or Venus (unfortunately, the next transit of Venus isn't until 2117).

Solar-filtered binoculars can be used to monitor the progress of partial or annular eclipses. Only the brief moments of totality during a total solar eclipse are safe to view with unfiltered binoculars. **Be sure to turn away at the first glimmer of the Sun's return.**

The Moon

Binoculars will show as much detail as Galileo Galilei saw in his primitive telescope when he first observed the Moon on November 30, 1609. Countless hours can be spent exploring the Moon's desolate surface. The most obvious features are the vast, flat volcanic plains, the maria. The larger the aperture of the binoculars you use, the more craters you will see. Even entire mountain ranges can be observed.

The Moon's appearance will change every night as it goes through its monthly set of phases. Binoculars offer a quick and easy way to keep track of its changing face every clear night. The annotated image of the Moon below is just a sampling of what can be observed. *Sky & Telescope* offers a laminated **Moon Map** for only $6.95, which identifies more than 300 features.



Earth's shadow slowly moving across the Moon during a total lunar eclipse can also be witnessed with a pair of binoculars. Totality is thrilling to observe as the Moon takes on a much more three-dimensional appearance.

The Planets

The innermost planet, **Mercury**, never strays more than 27° 50′ from the Sun. Therefore, as seen from Earth, it is only observable in the light of dusk or dawn. It is not difficult to spot Mercury with the unaided eye, but binoculars make the task easier.

Venus' waxing or waning crescent phase can be observed in binoculars. Planetary conjunctions are always a grand sight in binoculars, but especially when they involve a young or old crescent Moon

and Venus. The two look breathtaking together, and binoculars reveal Earthshine on the Moon in much grander detail.

Mars only looks like a bright orange star, but conjunctions of the Red Planet with other worlds of the solar system or even deep-sky objects are great sights in binoculars.

Most binoculars won't reveal any of **Jupiter**'s belts and zones, but seeing all four Galilean moons at once with binoculars is one of the big thrills in astronomy. Watch **Io, Europa, Ganymede, and Callisto** slowly orbit the giant planet. You need at least a magnification of 30× to see the rings of **Saturn** and **Titan**, which is a challenge to spot with binoculars.

Distant planets **Uranus** and **Neptune** can be spotted in binoculars, along with half-a-dozen **asteroids**. They may not look like much in binoculars, but sometimes the challenge in astronomy is just finding the object and being able to say you saw it!

Bright Comets

On average, a bright comet is visible from the skies of Earth every 10 years. Northern Hemisphere observers enjoyed two bright comets, Hyakutake and Hale-Bopp, in 1996 and 1997, respectively. Those in the Southern Hemisphere were treated to comets McNaught (C/2006 P1) in 2007 and Lovejoy (C/2011 W3) in 2011.

All four were considered "great comets" and were spectacular sights with both the unaided eye and binoculars. While a fine comet by any measure, NEOWISE (C/2020 F3) wasn't the showpiece object compared to those icy visitors mentioned previously. It put on a fine show in July 2020, but wasn't a naked-eye spectacle from areas that suffered even modest light pollution. However, it was greatly enhanced by binoculars. Other comets, even more modest than NEOWISE, become bright enough to view with binoculars every couple of years. You just have to know when and where to look.

Top Ten Deep Sky Objects

(See included finder charts.)

10. Beehive or Praesepe Cluster (M44)

M44 is located near the center of the faint upside-down Y-shaped constellation **Cancer**, the Crab. At 525 light-years, it is one of the nearest open clusters to Earth and has an angular diameter of 95′ (over 3 times that of the Full Moon). It has an apparent magnitude of 3.1 and can be seen as a nebulous patch with the unaided eye from dark sites. At least 20 stars can be seen with 10×50 binoculars. In all, this cluster has at least 1,000 members.

9. North America Nebula (NGC 7000)

Emission nebula NGC 7000 is one of those objects that actually looks like its namesake. In binoculars, you can clearly make out the east and west coasts, Florida, and Mexico regions of the nebula. It can be found 3° east of the bright star **Deneb** in the constellation **Cygnus**, the Swan. With an angular diameter of 120′ it is four times the Moon's apparent diameter. This nebula is part of a massive complex and is thought to be 3,000 light-years distant.

8. Double Cluster (NGC 869 & 884)

NGC 869 and NGC 884 really <u>are</u> a double cluster. Both are found in the constellation **Perseus** at a distance of 7,500 light-years. They can be seen with the unaided eye between the tip of Perseus and the W-shaped constellation **Cassiopeia**, the Queen. Each cluster has about 300 stellar members each. How

many can you see with binoculars? The double cluster also forms the slash in a large Q-shaped grouping of stars, as seen in 7×50 binoculars.

7. Triangulum Galaxy (M33)

M33 is part of the Local Group of Galaxies, which includes the Milky Way Galaxy as a member. It can be found 7° southeast of **Mirach** (Beta Andromedae) in the constellation **Triangulum**, the Triangle. M33 is inclined at 54°, providing us with a "face-on" view of this spiral galaxy. It has a diameter of about 60,000 light-years and contains 40 billion stars. M33 may only appear as a "faint fuzzy," but it is 2.73 million light-years distant. Not bad for an ordinary pair of binoculars!

6. Open Clusters M6 & M7

These two open clusters are not related but can be seen together in 7×50 and 10×50 binoculars. Both can be spotted with the unaided eye to the upper left (northeast) of the "stinger" stars in the constellation **Scorpius**, the Scorpion. M7, known as **Ptolemy's Cluster**, is the larger and brighter of the two, with up to 80 stars visible. M6 is called the **Butterfly Cluster**. Approximately 60 of the cluster's brightest members should be visible in binoculars.

5. Lagoon & Trifid Nebulae (M8 & M20)

Both of these fabulous objects are located 4,100 light-years away in the constellation **Sagittarius**, the Archer, about 6° north of the **Teapot** asterism's spout. Both are visible with the unaided eye and in the same field-of-view of 7×50 and 10×50 binoculars. The Lagoon and Trifid Nebula are "stellar nurseries," regions of active star formation. On its long axis, the Lagoon is three times the diameter of the Full Moon. The Trifid has a comparable angular diameter to the Moon. In addition to nebulosity, clusters of stars can be seen within both objects.

4. Andromeda Galaxy (M31)

This "island universe" of stars is the largest member of the Local Group. Often considered the most distant object visible with eyes alone at 2.54 million light-years, it can be located 4° southwest of the star **Mu Andromedae**. Even at that great distance, it has an angular diameter of over 3° (that translates to 6 Full Moons). This mammoth spiral galaxy is at least 130,000 light-years in diameter and contains an estimated 1 trillion stars. Larger binoculars may reveal

Andromeda's two bright satellite galaxies (both dwarf ellipticals), **M32** and **M110**.

3. Hyades & Pleiades (M45)

The Hyades and Pleiades are not observable together in binoculars, but both of these open clusters are located within the borders of **Taurus**, the Bull. In fact, the V-shaped Hyades cluster forms the bull's face, with the red-orange giant star **Aldebaran** representing his eye. Aldebaran is not a member of the Hyades but rather a foreground star located along our line of sight. At a mere 153 light-years, the Hyades is the nearest open cluster to Earth. At least three dozen stars are visible in binoculars, many of which are close doubles or true binaries.

Many people mistake the Pleiades with the Little Dipper, as it does have that general shape. In fact, the Pleiades are the famous "Seven Sisters," or Subaru in Japan. Over three dozen stars can be seen in 10×50s, and as many as 300 in larger binoculars. Many of the stars shine with a dazzling blue hue, and a faint hint of nebulosity can be seen under dark skies. M45 is 444 light-years away and 100 million years old.

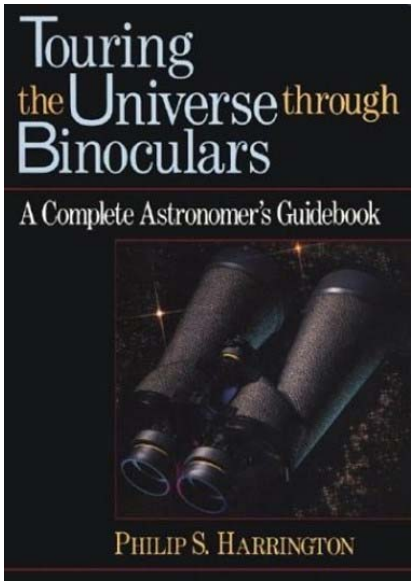
2. Great Nebula in Orion (M42 & M43)

M42 and M43 are part of the same complex within the sword of **Orion**, the Hunter. The Orion Nebula is not the closest region of star formation to Earth, but it is the nearest *large* stellar nursery. Its famous shape, seen in numerous astrophotos, is clearly visible in binoculars. Like all deep-sky objects, though, it appears as a cloud of pearl gray light. Our eyes are not sensitive enough to reveal its pinkish clouds of gas and dust. It is easily the most fabulous sight in binoculars on a cold winter night.

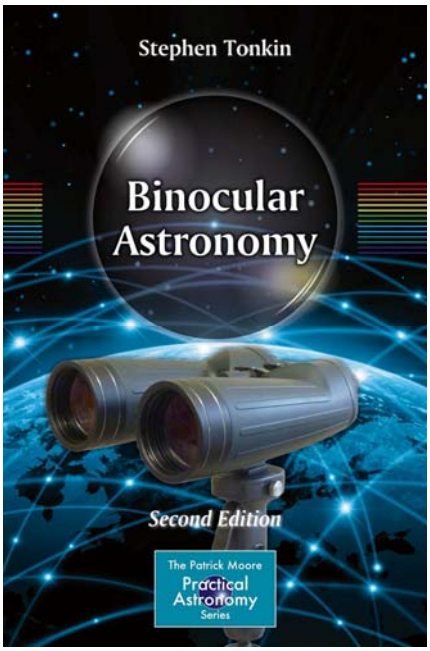
1. The Milky Way itself!

We often don't think of the Milky Way as a deep-sky object, but it is a great spiral galaxy. We just happen to live within it! Both the summer and winter Milky Way have a lot to offer, but the summer portion of our galaxy is much brighter since we're looking toward the galactic center. Only hand-held binoculars give you the freedom to sweep up and down the galactic plane in search of numerous other deep-sky objects. Take advantage of every clear, moonless night.

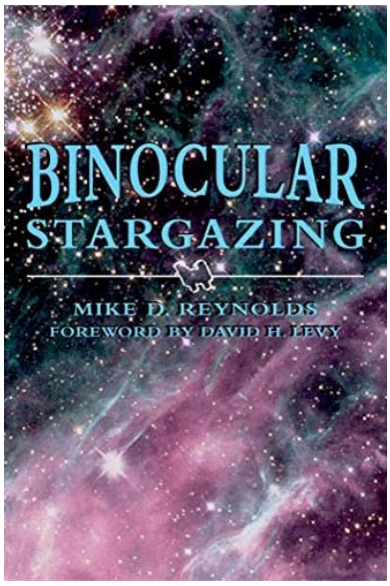
Some Recommended Binocular Books



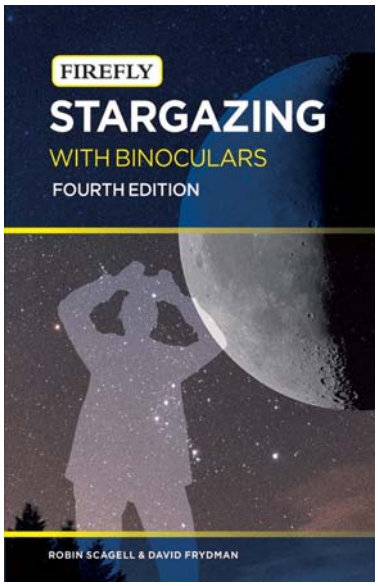
Touring the Universe...
by Philip Harrington
John Wiley and Sons, 1990
Price: **$36.95**



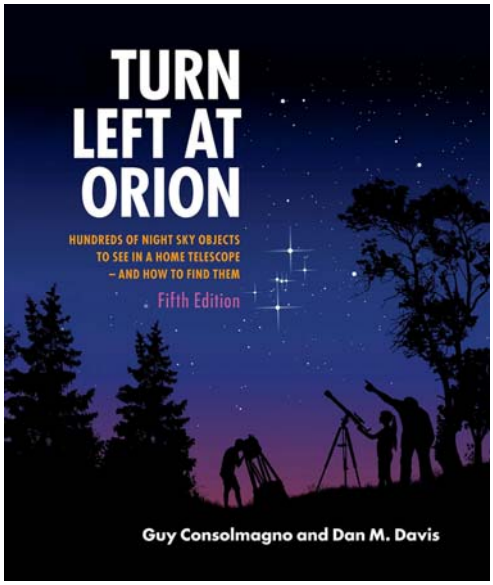
Binocular Astronomy
by Stephen Tonkin
Springer, 2014
Price: **$44.99**



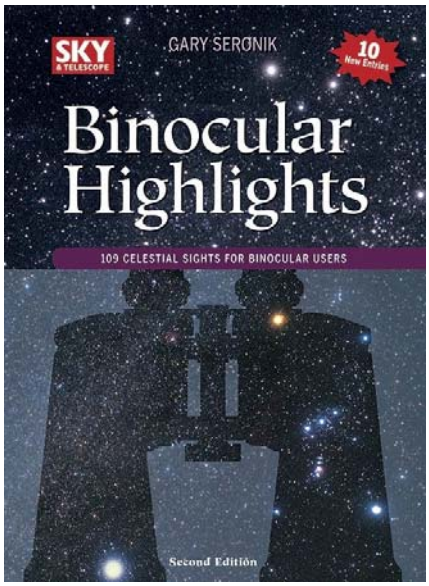
Binocular Stargazing
by Mike D. Reynolds
Stackpole Books, 2005
Price: **$14.95**



Stargazing with Binoculars
by R. Scagell & D. Frydman
Firefly Books, 2014
Price: **$44.99**

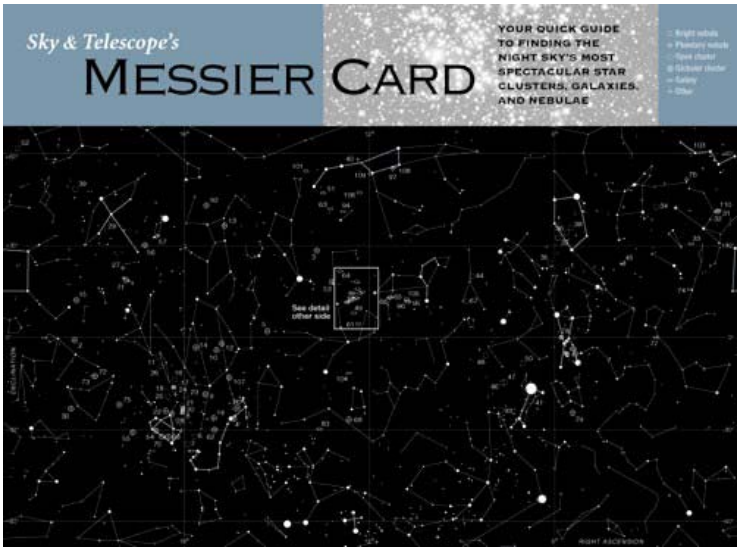


Turn Left at Orion
by G. Consolmagno & D. Davis
Cambridge University, 2019
Price: **$36.99**



Binocular Highlights
by Gary Seronik
Sky Publishing, 2018
Price: **$24.99**

Some Recommended Maps & Star Atlases



Sky & Telescope's Messier Card

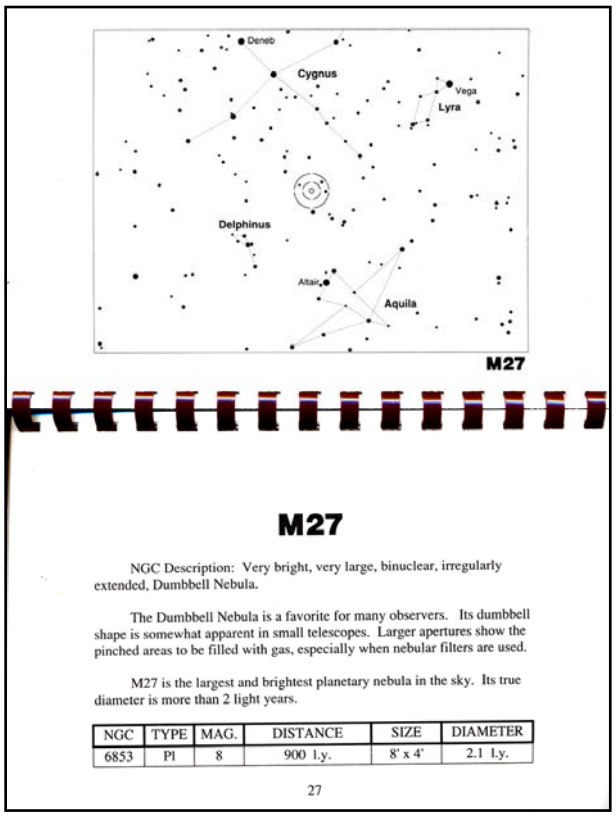
This quick-reference sky chart shows the location of all the Messier objects on the front and tabulates their coordinates, sizes, and visual magnitudes on the back. It is printed on synthetic material to protect against moisture and wear.

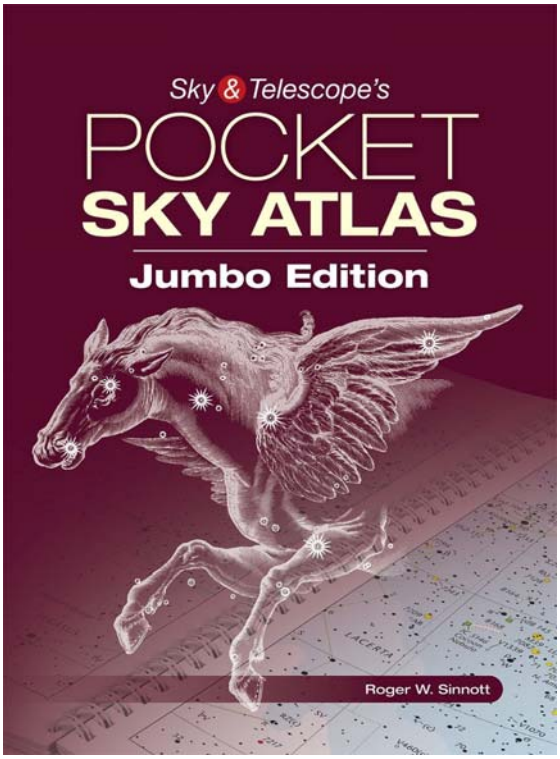
Price: **$6.95**

The Messier Objects (2 volumes)

This two volume set from **Sky-Spot** is designed for Tel-Rad finders, but they also work great for binoculars. A sample of one of the charts is shown below. Other finder charts are available for Overlooked Objects, Bright Telescopic Objects, and Select Double Stars.

Price: **$39.99**





Sky & Telescope's Pocket Sky Atlas

This is a very portable atlas and is wire-bound with easy-to-read labels. It had 80 charts total with 10 close-up charts. Over 30,000 stars and 1,500 deep sky objects are plotted.

Price: **$41.95**

Some Recommended Brand Names & Dealers

Brand Names

Astro-Physics
https://www.astro-physics.com/

Canon
https://www.usa.canon.com/

Celestron
https://www.celestron.com/

Fujinon
https://www.fujifilmusa.com/

Leica
https://us.leica-camera.com/

Meade Instruments
https://www.meade.com/

Nikon
https://www.nikon.com/

Oberwerk
https://oberwerk.com/

Opticron
https://www.opticronusa.com/

Orion Telescopes & Binoculars
https://www.telescope.com/

Pentax
https://us.ricoh-imaging.com/

Swarovski
https://www.swarovskioptik.com/

Vixen
https://global.vixen.co.jp/en/

Zeiss
https://www.zeiss.com/

Dealers

Adorama
https://www.adorama.com/

Agena Astro
https://agenaastro.com/

Anacortes Telescope & Wild Bird
https://www.buytelescopes.com/

Astronomics
https://www.astronomics.com/

B&H Photo
https://www.bhphotovideo.com/

Binoculars Plus
https://www.binocularsplus.com/

High Point Scientific
https://www.highpointscientific.com/

Norman Camera
https://www.normancamera.com/

Skies Unlimited
https://www.skiesunlimited.com/

Starizona
https://www.starizona.com/

Astronomical League Observing Programs for Binoculars

Have you had the experience of waiting days for clear viewing weather and then finding excuses for not setting up all of your equipment when a good night finally presents itself? One way to maintain enthusiasm for getting out under the sky is to have a long-range viewing plan or goal. Members of the Astronomical League (either through an affiliate astronomy club or as a member-at-large) are eligible to receive observing awards from a large variety of observing clubs. Each club has a set of required observations or activities to be carried out and documented. After verification of the observing logs, A.L. awards a certificate and a pin.

There are appropriate clubs for every level of experience and equipment. Whatever program is chosen, it is important to learn the details of the requirements from the A.L. website before beginning observations, because the rules differ. Programs that want to teach recognizing the skies and finding deep-sky objects may prohibit using GoTo telescopes and computers to find the objects. Those that concentrate more on observing the objects may allow any method of finding them. Some are strictly visual, while others may allow or even recommend imaging.

All require keeping observing logs that include specified data fields. Most of the targets can be downloaded as lists from the A.L. website, but a few require buying a guidebook. Finally, some certificates are awarded based on confirmation of the observations by your club's Astronomical League Correspondent (ALCOR), while others require a copy of the observing log to be submitted to a specified A.L. representative. So, find a club that fits with your interests, learn the rules, and get out there under the skies!

Binocular Messier

Observe 50 of the 110 Messier Objects with binoculars

https://www.astroleague.org/binocular-messier-observing-program/

Deep Sky Binocular

Observe 50 designated non-Messier Deep Sky Objects

https://www.astroleague.org/binocular-double-star-observing-program/

Lunar Club

1/3 of this program involves binoculars

https://www.astroleague.org/lunar-observing-program/

Sky Puppy

Designed for the young observer...

https://www.astroleague.org/sky-puppy-observing-program/

Southern Sky Binocular

Going down under? Observe 50 of 73 designated objects visible south of the equator.

https://www.astroleague.org/southern-sky-binocular-observing-program/

Universe Sampler

Object List II can be done using binoculars or a telescope.

https://www.astroleague.org/universe-sampler-observing-program/

Urban Observer

Observe 100 objects from a light polluted location.

https://www.astroleague.org/urban-observing-program/

Charles Messier

Ferret of Comets *Founder of the Catalog*

by **Mark Miller**

Charles Messier came to Paris in 1751 at the age of 21. He was hired by the astronomer Joseph Delisle as a draftsman and as a recorder of astronomical observations. By 1754, he was also an accomplished observer, and at about that time, he took a position at the Marine Observatory in Paris as a clerk.

This was the time when astronomers were anticipating the first predicted arrival of Halley's Comet. Delisle had made a map of the routes by which the comet could approach to arrive at its predicted perihelion, and Messier, his observing assistant, thus had the inside track to discovering (or rediscovering) it. He searched for 18 months, but in vain - Delisle had in fact miscalculated.

Meanwhile, on Christmas night, 1758, a German farmer named Johann Georg Palitzsch discovered the comet. A month later, Messier did as well, having not heard of Palitzsch's success (no Internet). Delisle would not let Messier announce his discovery until after Palitzsch's news finally reached Paris. This loss of 'credit' may well have forged Messier's determination to discover more comets.

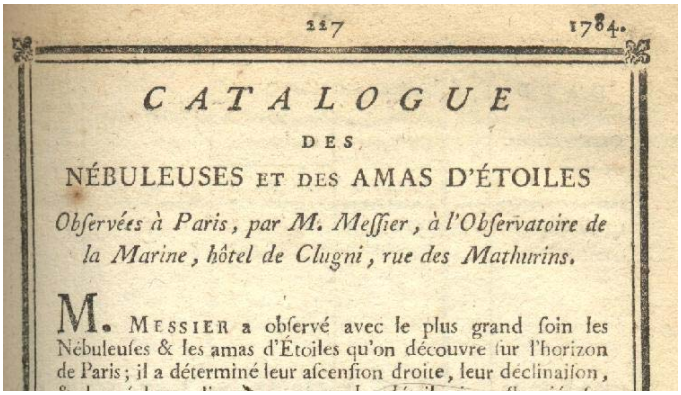
After Delisle's retirement, Messier continued observing from the Hôtel de Cluny. He discovered the comet of 1764 and with the naked-eye, saw the comet of 1766. Over the next 15 years, nearly all comet discoveries were made by Messier. One perhaps apocryphal story relates that while Messier sat at his wife's deathbed, a rival astronomer discovered a comet. When a friend consoled him on his loss, he said, "Alas! I have discovered a dozen of them; Montagne had to take away the 13th!" Only then did he realize that his friend was talking about the loss of his wife!

Messier did more than look for comets; he observed occultations, transits, eclipses, and sunspots. He was no theoretician, however; for all his comet discoveries, his assistants reduced his observations to the orbital elements.

In 1758, he wrote, "When the comet of 1758 was between the horns of Taurus, I discovered above the southern horn and a short distance from the star Zeta Tauri a whitish light, extended in the form of a candle light, which contained no stars. This light was a little like that of a comet I had observed before; however, it was a little too bright, too white, and top-elongated to be a comet, which had always appeared to me almost round,..." It was the Crab Nebula in Taurus (M1), and was duly plotted on the chart of the comet. The next object, the globular cluster in Aquarius (M2), was observed in 1760.

By 1764, Messier had accumulated a number of such 'false comets' and began to make a list of them. In seven months, Messier cataloged 40 objects, including the Hercules Cluster (M13), the Omega (M17) and Trifid (M20) nebulas, the Dumbbell planetary nebula (M27), and the Andromeda Galaxy (M31). To make his list as complete as possible, he added objects from previous catalogs by Edmund Halley (only five objects), William Derham, and Lacaille.

In 1765, he discovered the open cluster near Sirius (M41). In 1769, he also determined the positions of the previously-known Orion Nebula (M42, M43), the Pleiades (M45), and Praesepe (the Beehive Cluster) to bring his list to 45 in time for his admission to the Academie Royale des Sciences in 1770,



227 1784.

CATALOGUE
DES
NÉBULEUSES ET DES AMAS D'ÉTOILES
Observées à Paris, par M. Messier, à l'Observatoire de la Marine, hôtel de Clugni, rue des Mathurins.

M. MESSIER a observé avec le plus grand soin les Nébuleuses & les amas d'Étoiles qu'on découvre sur l'horizon de Paris; il a déterminé leur ascension droite, leur déclinaison,

A portion of the original version of the Messier Catalog of 1781 as printed in Connaissance des Temps for 1784. View scans of the entire catalog on the SEDS website.

where it was published as *Catalogue des Nebuleuses et des amas d'Etoiles, que l'on decouvre parmi les Etoiles fixes, sur l'horizon de Paris* in 1771. Three nights after presenting this memoir, he recorded the positions of four more clusters!

In the years following, a few more objects were discovered in connection with comet searches. A break took place in 1779, when the comet of that year passed across the Coma-Virgo region, leading to the first sightings of the brighter galaxies in that area. The next year, he observed the M65 and M66 galaxies in Leo, bringing his list to 68 in time for the publication of the French almanac, *Connaissance des Temps*.

A few of the Messier objects have been mysterious or controversial, although it seems that most of the problems have been worked out by now. For example, the description given by Messier of M47:

> *7h 44m 16s, -1° 16' 42". Cluster of stars a short distance from the preceding, (M46 cluster) the stars are brighter; the middle of the cluster was compared with the same star, 2 Navis. The cluster contains no nebulosity.*

Messier's descriptions of his telescopes are rather unsatisfying; he usually says something like "easily visible in a telescope of two feet" (focal length). In fact, his favorite telescope was actually a Gregorian reflector with a focal length of 32 inches and an aperture of 7½ inches. The mirrors were of polished speculum metal, which would mean a light-gathering power about equivalent to a three-inch modern aluminized glass mirror. (I think we should do Messier Marathons using 80-mm telescopes!)

By this time, Messier had a new rival, Pierre Méchain, an astronomer at the naval map archives in Paris who was 14 years his junior. In 1781, Méchain discovered two new comets, and in the course of his searches, also found 32 new nebulous objects, which he communicated to Messier. Messier would then observe the new objects and add them to his list in the order he (Messier) observed them. Méchain discovered many new Virgo cluster galaxies. In light of Messier's previous jealousy about comet discoveries, it is surprising that the historical record betrays no such jealousy towards Méchain.

In April of 1781, the list stood at 100, with 24 of these having been referred from Méchain. That November, Messier had a serious fall into an icehouse, breaking his arm, leg, and two ribs. Messier did not resume observing until a year later. In 1784, the list was republished, including three new objects from Méchain that Messier had not had time to verify. M102 is another 'mystery' object, although it turns out that Méchain sent a letter to Bernoulli stating that it was actually a mistake, being identical to M101. (In the modern list, M102 is assigned to NGC 5866, which matches Méchain's position and description.) In this letter, Méchain also describes six new objects, bringing the list to 107 (discounting 102). In 1787, the list was republished in its final form during Messier's lifetime, this time edited by Méchain. The printed description of the Owl Nebula (M97) makes reference to three more undescribed objects in the vicinity. This, together with marginal notes on a copy of the 1787 list in Messier's hand and a few other objects known to have been observed by Messier, has been used to extend the list to the present 110 objects.

By 1790, revolution and economic turmoil had brought trying times for Messier, who had lost his navy pension and salary. In spite of circumstances, he managed to discover another comet in 1793. As the political situation stabilized, Messier was elected to the new Academy of Sciences and received the Legion of Honor from Napoleon. He lived to the age of 86, dying on April 12, 1817.

Looking back on his interest in nebulae, Messier wrote in the *Connaissance des Temps* for 1801:

> *What caused me to undertake the catalogue was the nebula I discovered above the southern horn of Taurus on September 12, 1758, while observing the comet of that year.... This nebula had such a resemblance to a comet, in its form and brightness, that I endeavored to find others, so that astronomers would not confuse these same nebulae with comets just beginning to shine. I observed further with the proper refractors for the search of comets, and this is the purpose I had in forming the catalogue. After me, the celebrated Herschel published a catalogue of 2,000 which he has observed. This unveiling of the sky, made with instruments of great aperture, does not help in a perusal of the sky for faint comets. Thus my object is different from his, as I only need nebulae visible in a telescope of two feet [length]. Since the publication of my catalogue I have observed still others; I will publish them in the future, according to the order of right ascension, for the purpose of making them more easy to recognize, and for those searching for comets to remain in less uncertainty.*

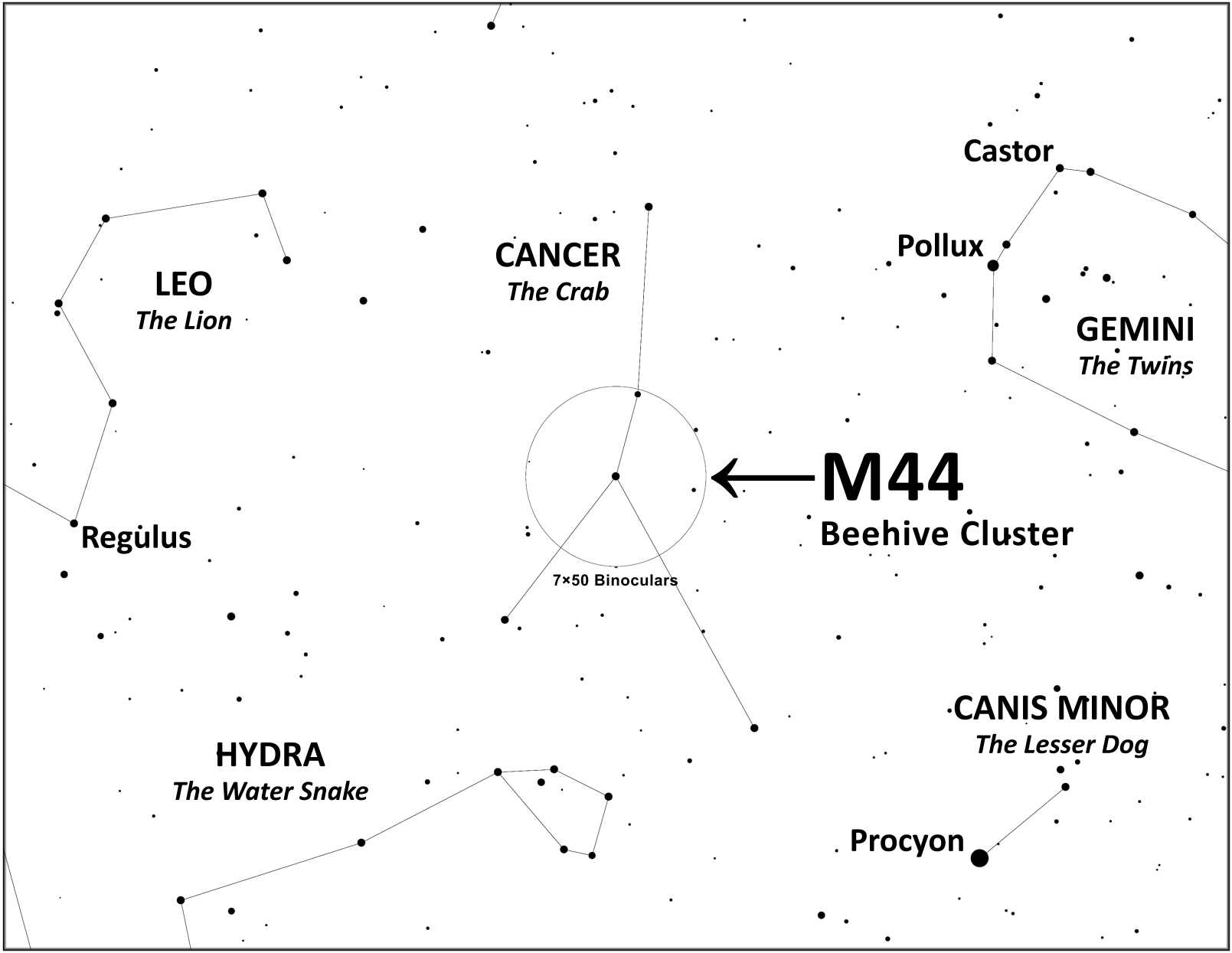
(This article is largely abstracted from *Messier and His Catalogue* by Owen Gingerich, to which the interested reader is referred for further details.)

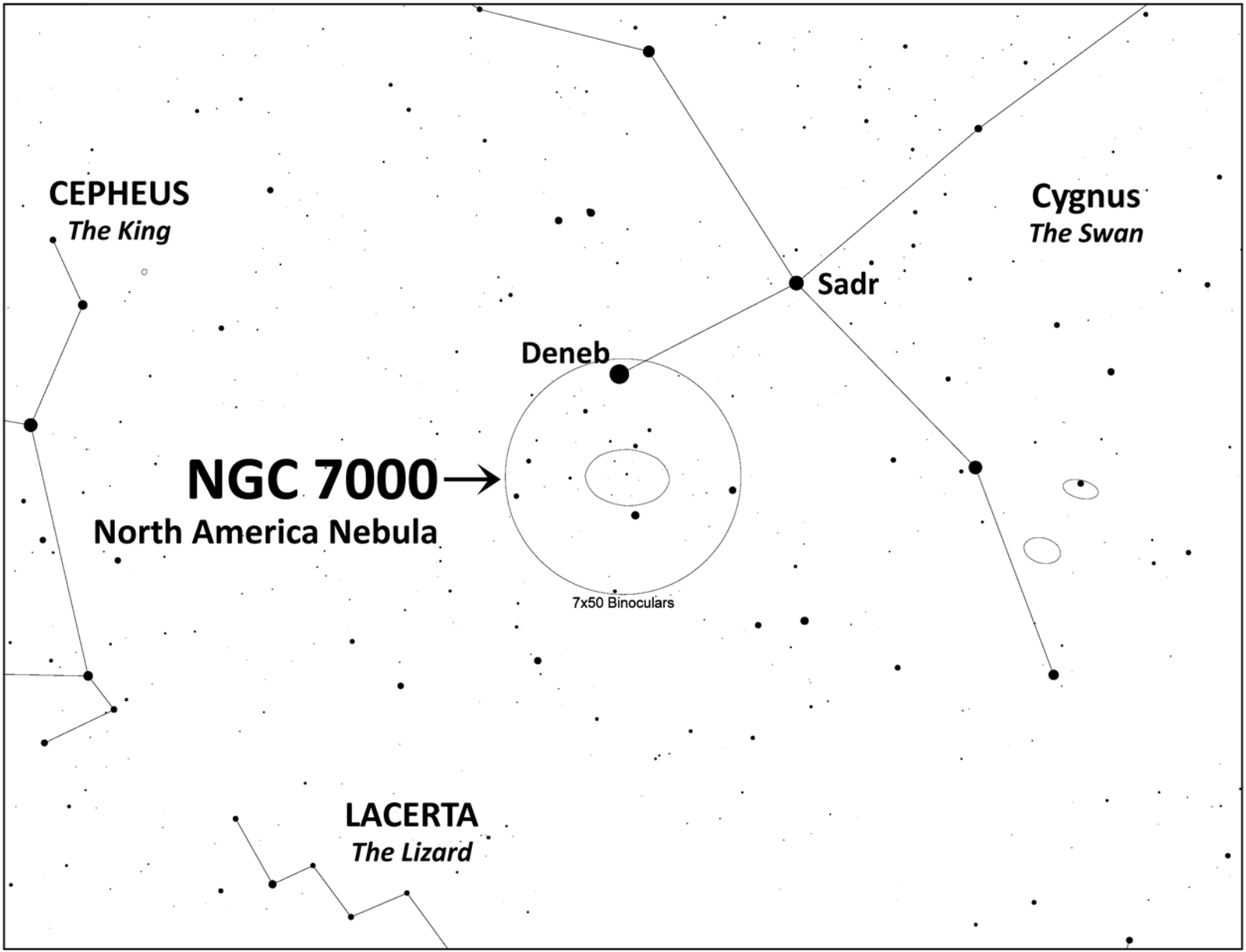
Deep Sky Targets for Binoculars

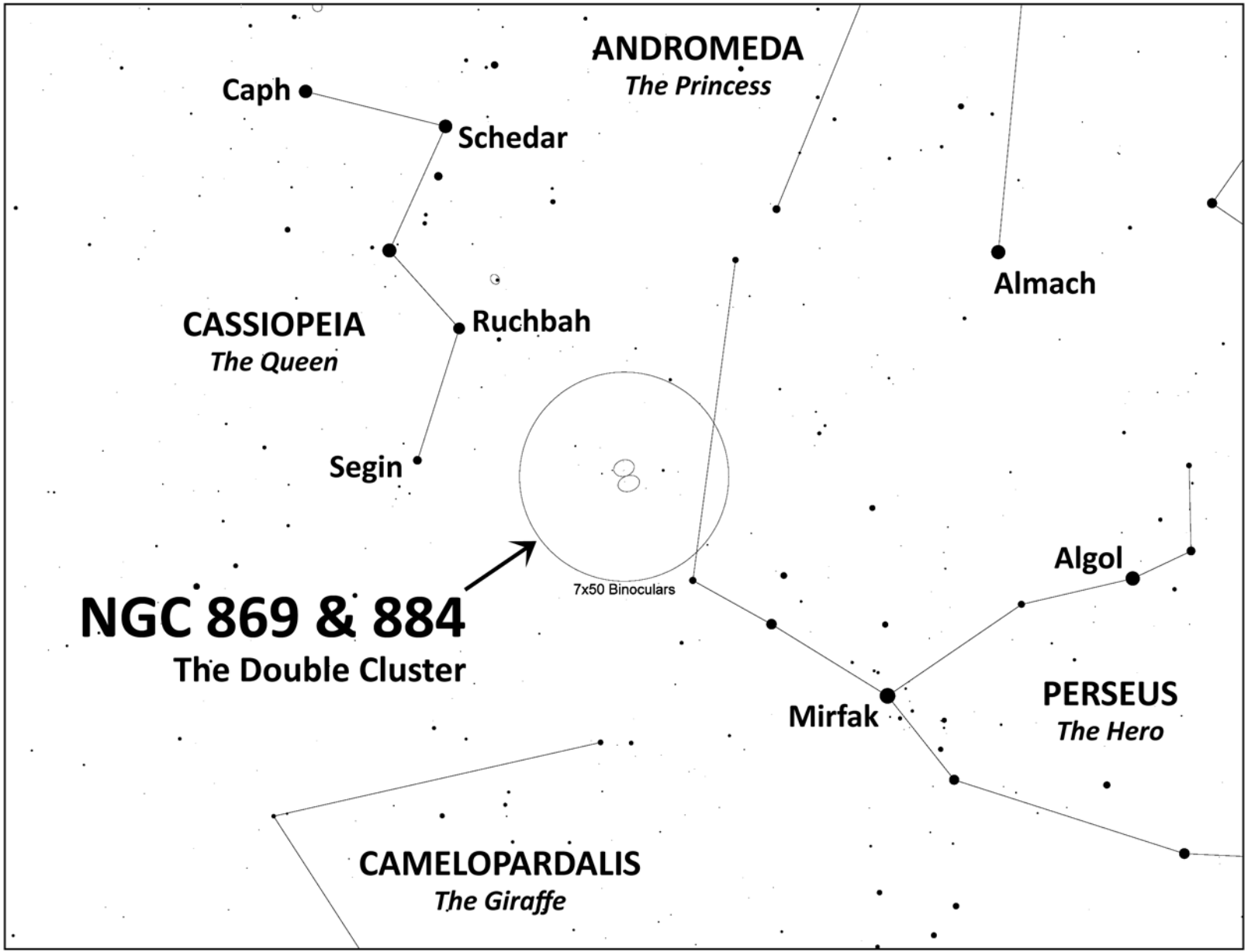
Assembled by

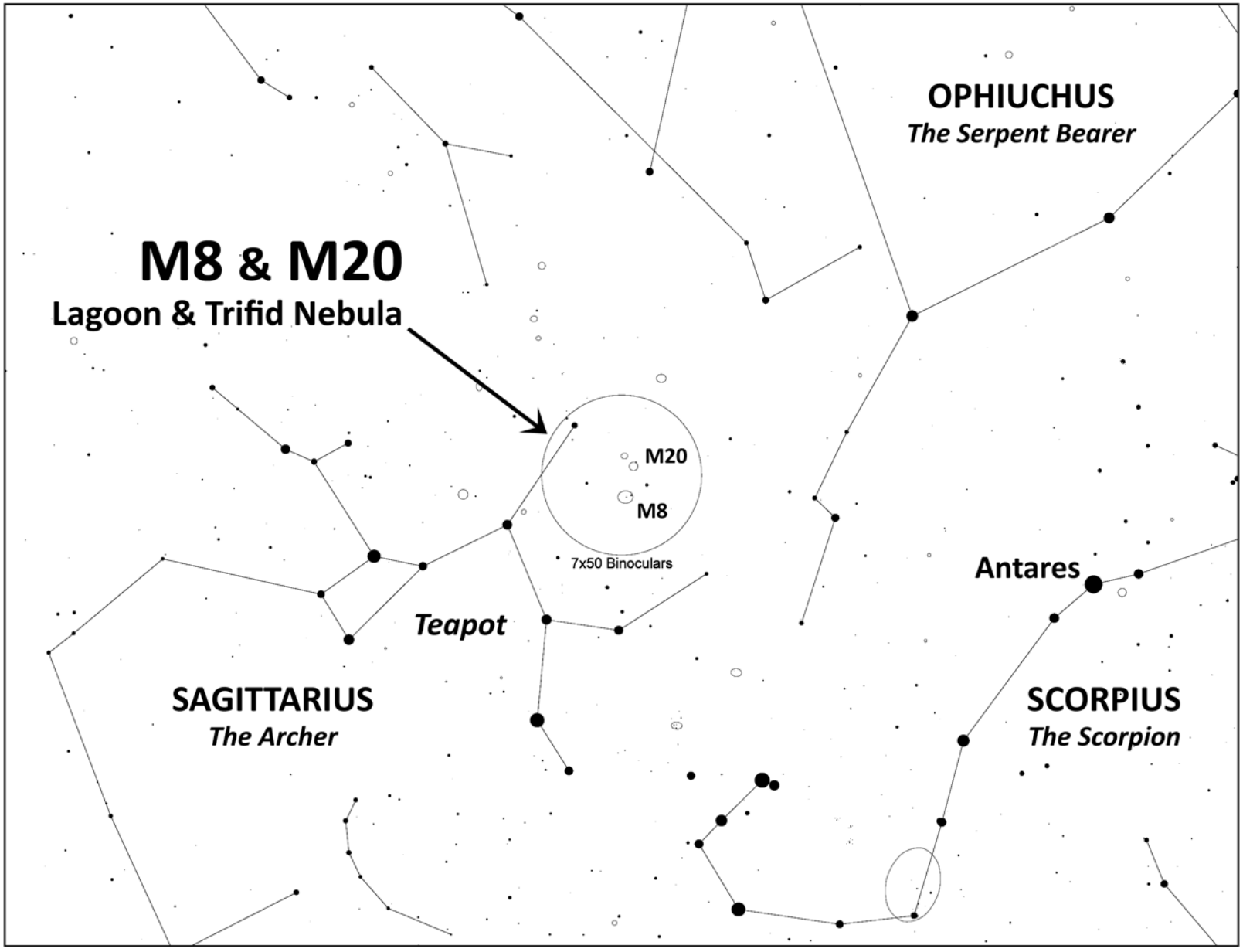
Richard S. Bell

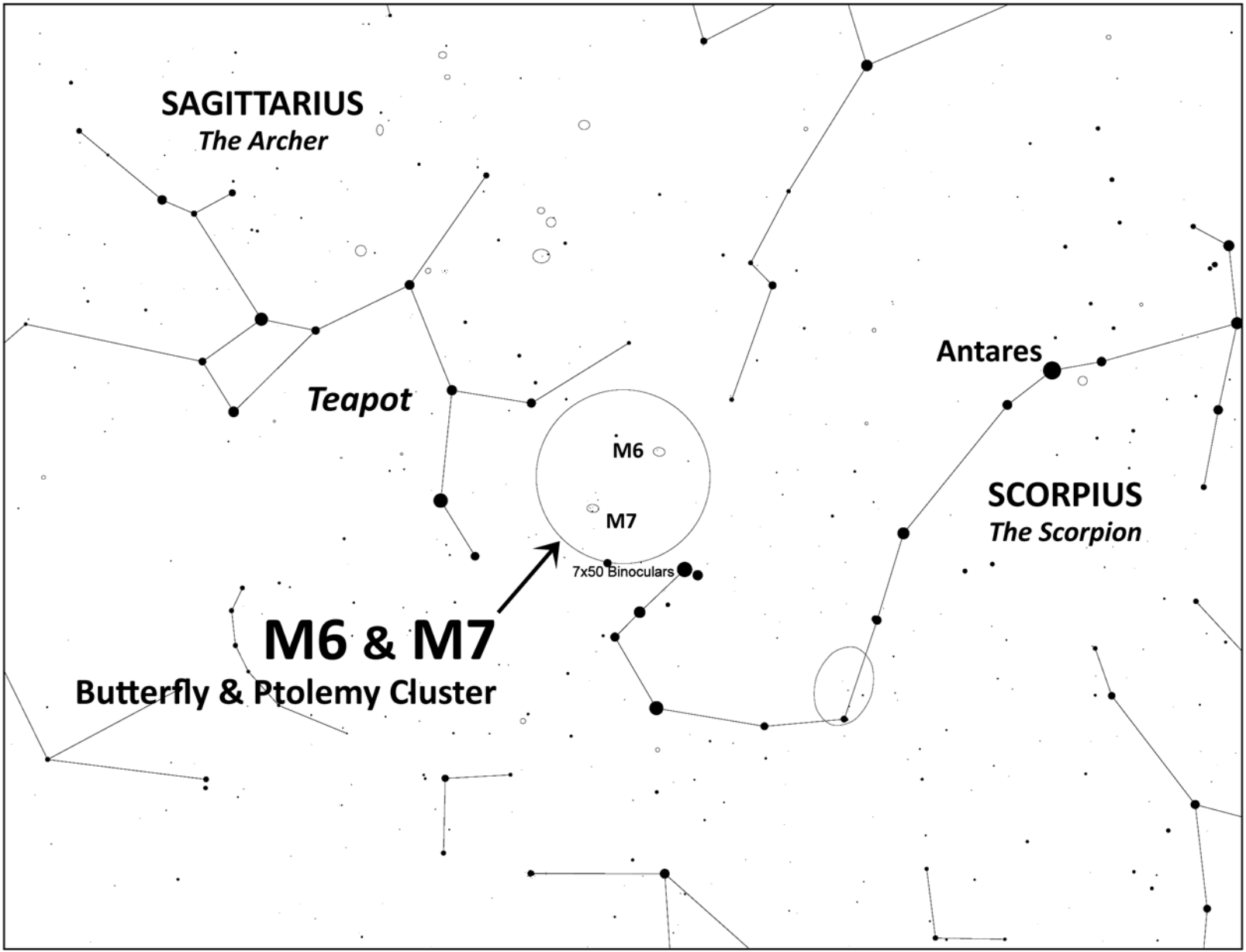
Kalamazoo Astronomical Society

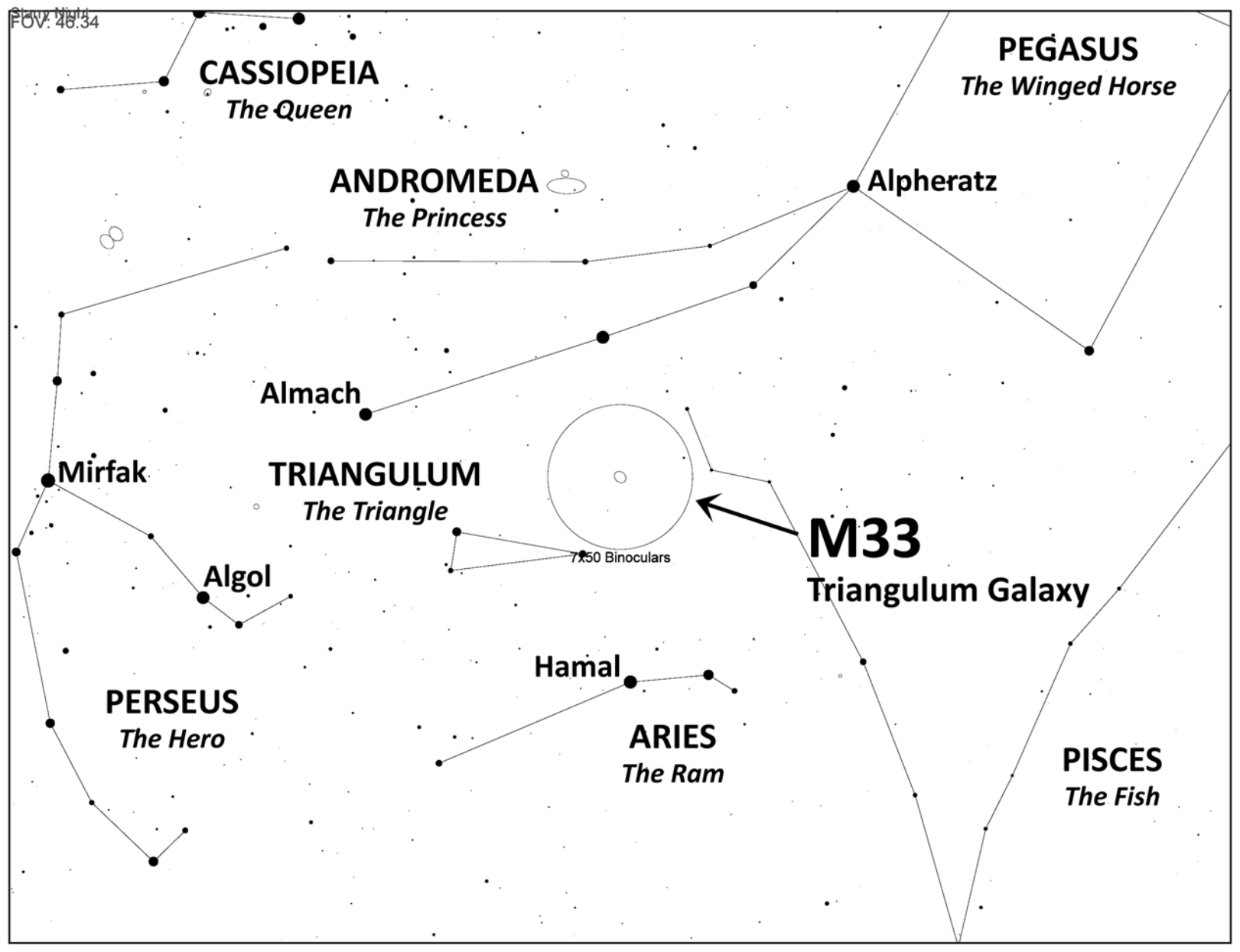

Castor
Pollux
CANCER
The Crab
LEO
The Lion
GEMINI
The Twins
M44
Beehive Cluster
Regulus
7×50 Binoculars
CANIS MINOR
The Lesser Dog
HYDRA
The Water Snake
Procyon

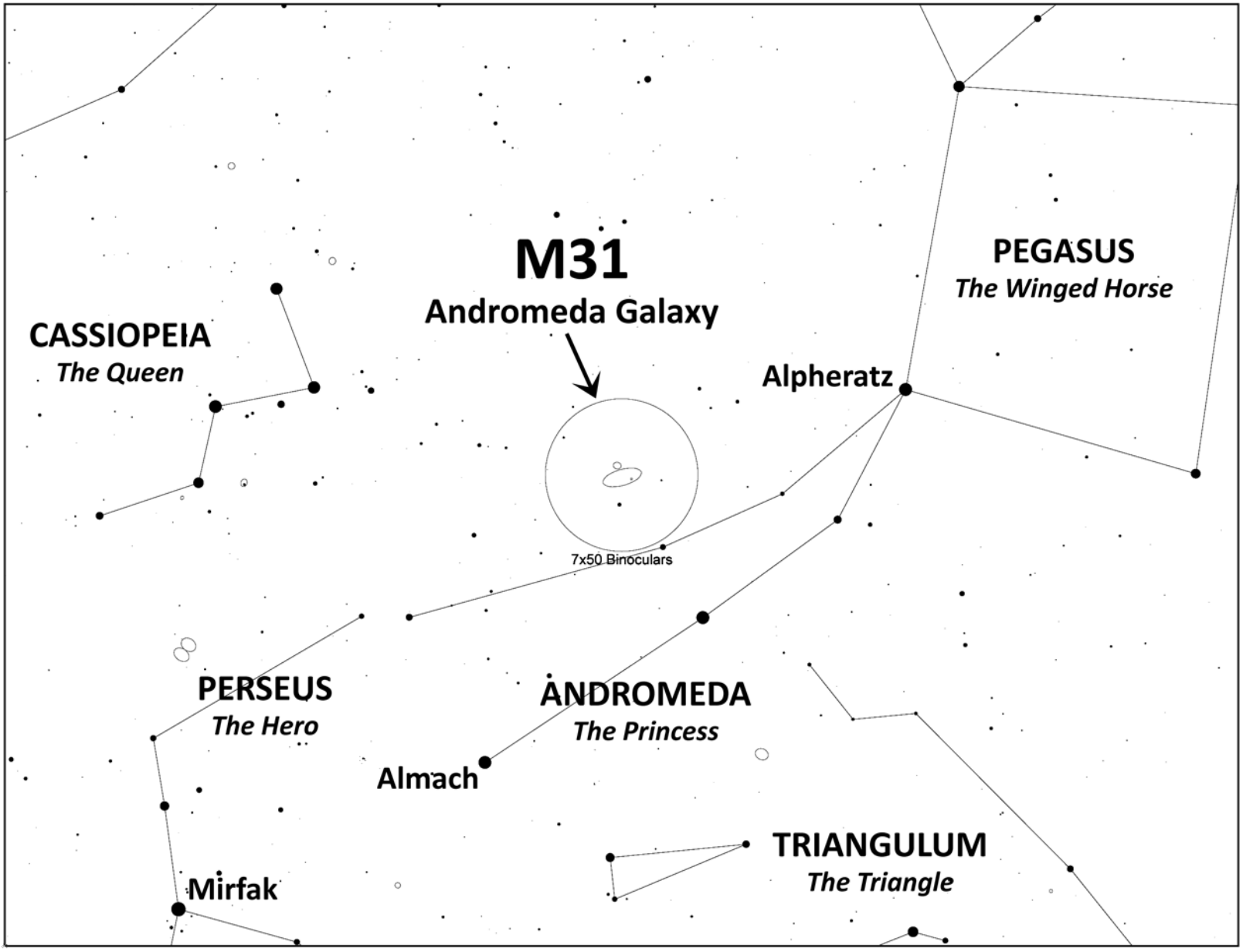

CEPHEUS
The King
Cygnus
The Swan
Sadr
Deneb
NGC 7000
North America Nebula
7x50 Binoculars
LACERTA
The Lizard

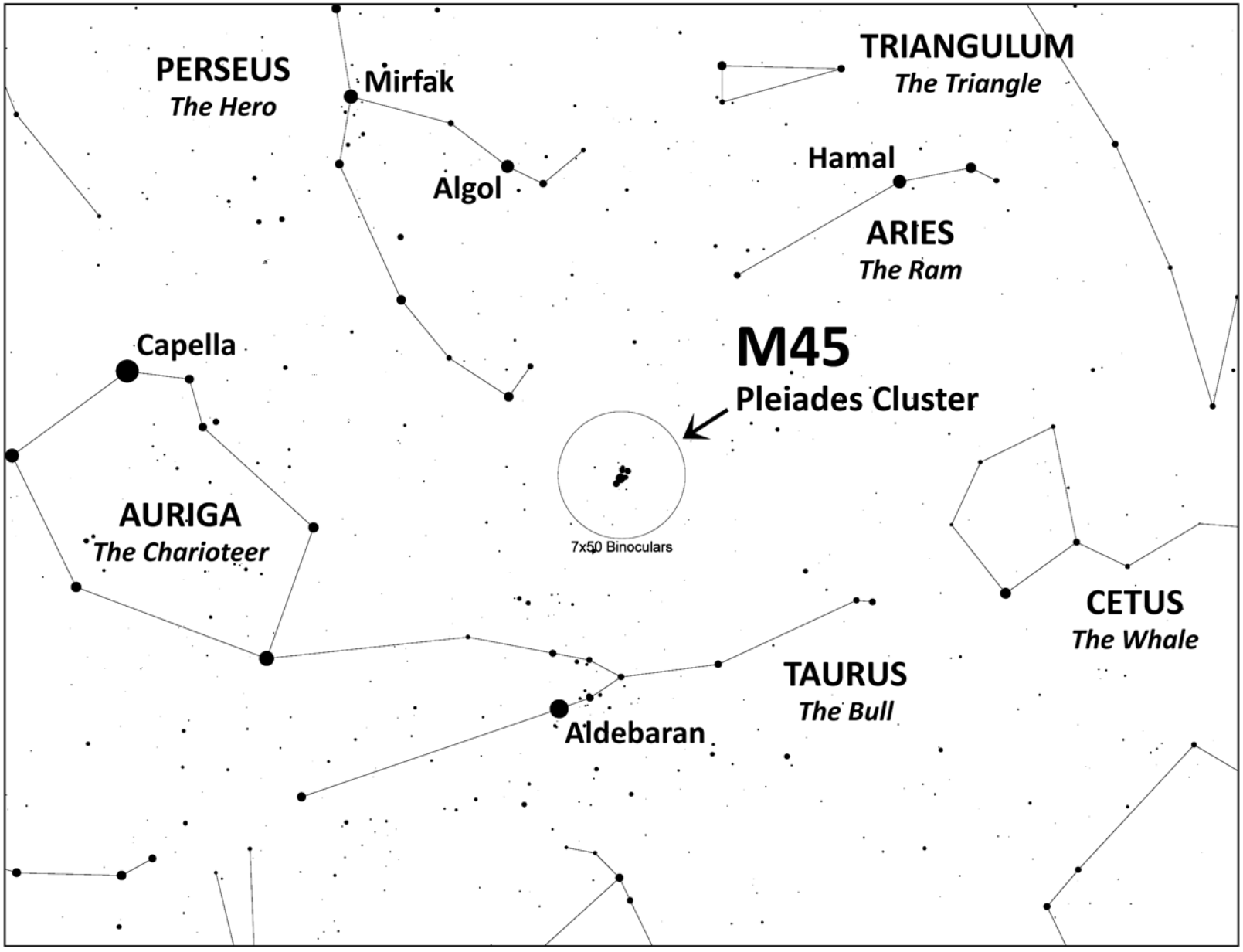

ANDROMEDA
The Princess
Caph
Schedar
Almach
CASSIOPEIA
The Queen
Ruchbah
Segin
7x50 Binoculars
NGC 869 & 884
The Double Cluster
Algol
Mirfak
PERSEUS
The Hero
CAMELOPARDALIS
The Giraffe

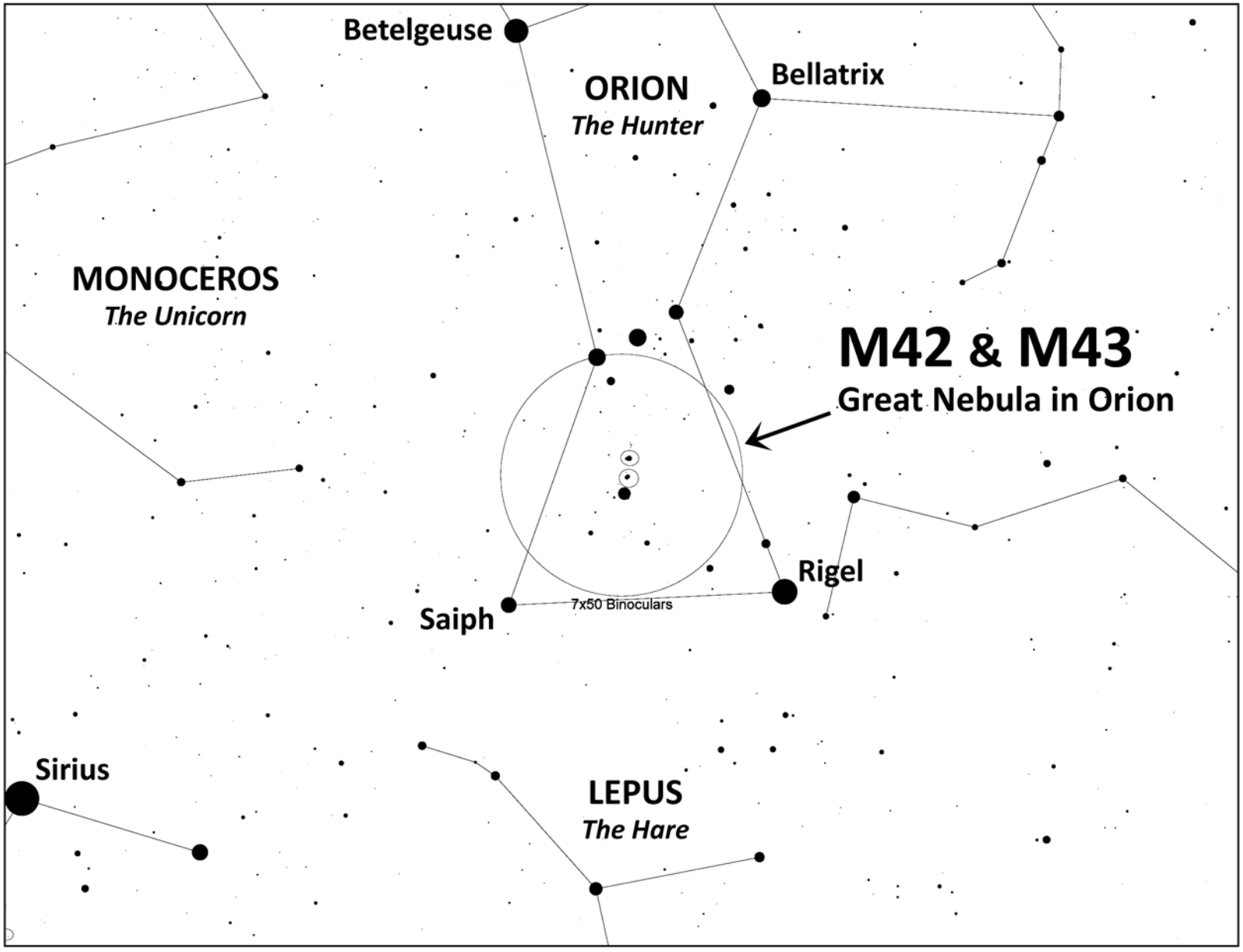

M8 & M20
Lagoon & Trifid Nebula
OPHIUCHUS
The Serpent Bearer
M20
M8
7x50 Binoculars
Antares
Teapot
SAGITTARIUS
The Archer
SCORPIUS
The Scorpion


SAGITTARIUS
The Archer
Teapot
Antares
M6
M7
7x50 Binoculars
SCORPIUS
The Scorpion
M6 & M7
Butterfly & Ptolemy Cluster


Sky: Night
FOV: 46.34
CASSIOPEIA
The Queen
PEGASUS
The Winged Horse
ANDROMEDA
The Princess
Alpheratz
Almach
Mirfak
TRIANGULUM
The Triangle
7x50 Binoculars
M33
Triangulum Galaxy
Algol
Hamal
PERSEUS
The Hero
ARIES
The Ram
PISCES
The Fish


M31
Andromeda Galaxy
PEGASUS
The Winged Horse
CASSIOPEIA
The Queen
Alpheratz
7x50 Binoculars
PERSEUS
The Hero
ANDROMEDA
The Princess
Almach
TRIANGULUM
The Triangle
Mirfak


PERSEUS
The Hero
Mirfak
Algol
TRIANGULUM
The Triangle
Hamal
ARIES
The Ram
Capella
M45
Pleiades Cluster
7x50 Binoculars
AURIGA
The Charioteer
CETUS
The Whale
TAURUS
The Bull
Aldebaran


Betelgeuse
ORION
The Hunter
Bellatrix
MONOCEROS
The Unicorn
M42 & M43
Great Nebula in Orion
Rigel
Saiph
7x50 Binoculars
Sirius
LEPUS
The Hare