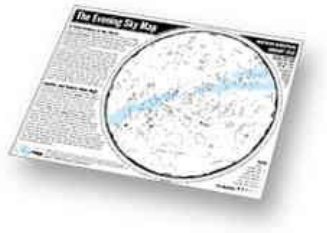
Supercharged Science

Astronomy & Stargazing

Welcome to our Astronomy and Stargazing Session! We're going to discover objects you can see with your naked eyes as well as with binoculars on a clear night.

We are going to focus on deep sky objects you can see with your eyes, with binoculars or even a small telescope, so after our session together, you can simply walk outside, look up, and understand what you're looking at.



Before our session starts:

Step 1: Download your free map of the night sky: *www.SkyMaps.com* available for Northern and Southern hemispheres.

Step 2: Print out this document and use it to take notes during our time together. This document highlights the objects we will focus on. On the last page, find my notes about using binoculars for stargazing and my best astronomy equipment recommendations.

What we're going to discover:

We're going to cover over several celestial objects, including galaxies, star clusters and double stars. You'll learn not only what these objects are, but where you can find them in the night sky!

The only materials you need is this handout, your sky map for your hemisphere, and a pencil or highlighter. If you have a pair of binoculars, feel free to use them after class is over (find my notes on binoculars near the end of this handout).

Celestial Objects:

M51: Whirlpool Galaxy

Double Stars (Mizar & Alcor, Albireo)

M31: Andromeda Galaxy

Large & Small Magellanic Clouds

M45: Pleiades Open Star Cluster

M42: Orion Nebula

M13 & M92: Globular Clusters

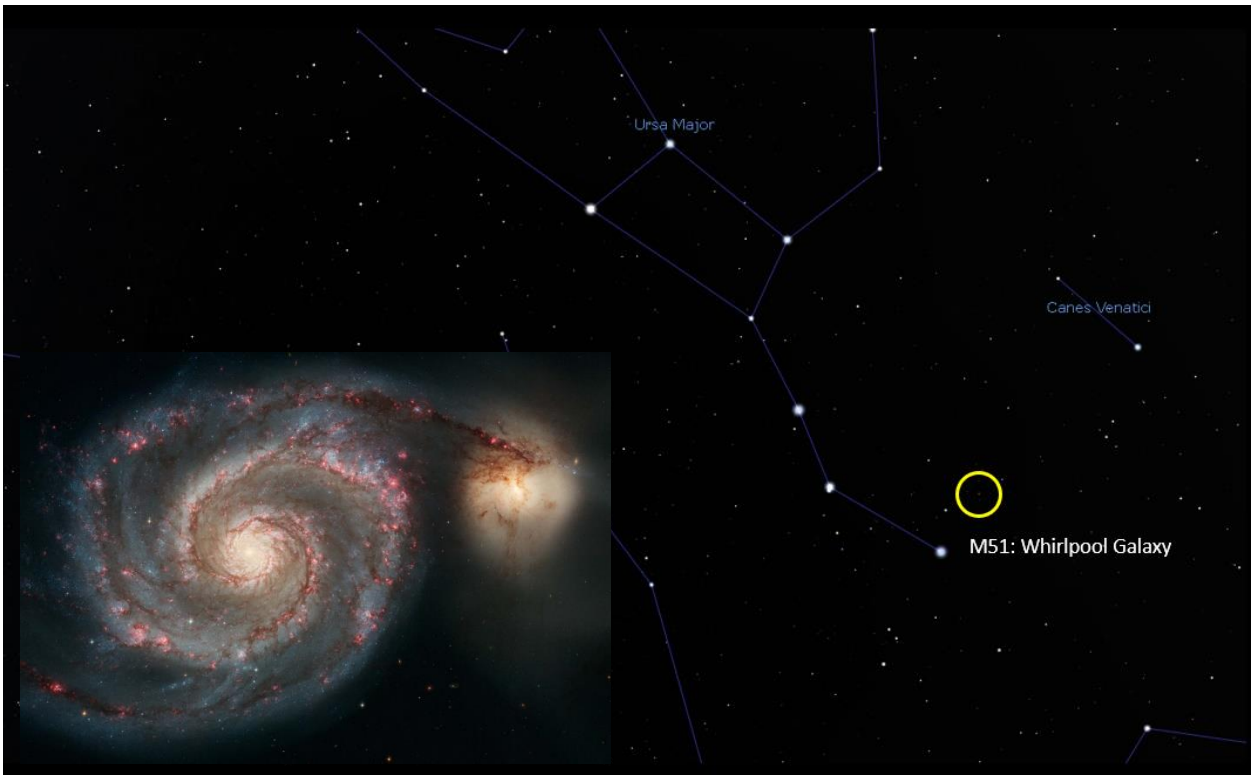
Owl Cluster is Cassiopeia

Galaxies

Galaxies are vast collections of stars, gas, dust, and dark matter bound together by gravity. Astronomers classify galaxies into several types based on their shapes and characteristics:

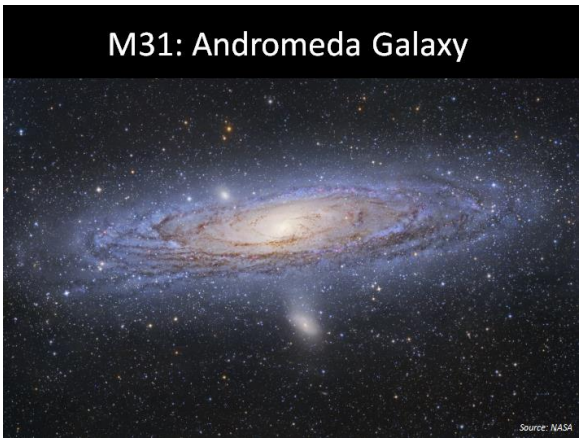
- **Spiral Galaxies:** These have a flat, disk-like shape with spiral arms winding out from a central bulge. Our Milky Way Galaxy is a spiral galaxy.
- **Elliptical Galaxies:** These range from nearly spherical to elongated shapes and lack the structure of spiral arms.
- **Irregular Galaxies**: As their name suggests, these galaxies don't have a defined shape. They often appear chaotic, and many have been distorted by gravitational interactions with other galaxies.
- **Lenticular Galaxies:** These are a hybrid of spiral and elliptical galaxies, with a central bulge and a disk-like structure but no prominent spiral arms.

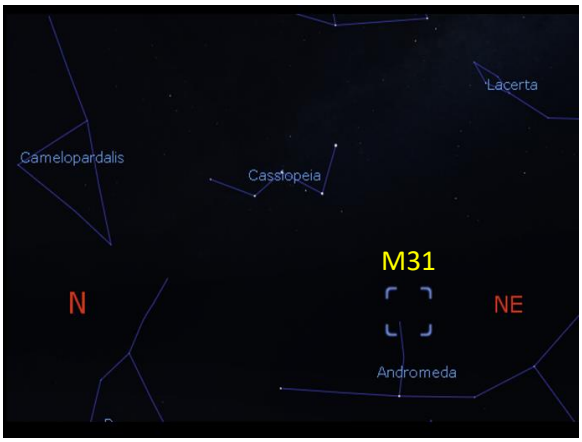
The Whirlpool Galaxy, also known as M51, is one of the most stunning spiral galaxies in the universe. Located in the constellation Canes Venatici, the Whirlpool Galaxy is interacting with a smaller companion galaxy, NGC 5195, which can be seen tugging at one of M51's spiral arms. This interaction enhances the Whirlpool's structure and triggers bursts of star formation, making it a favorite target for astronomers!

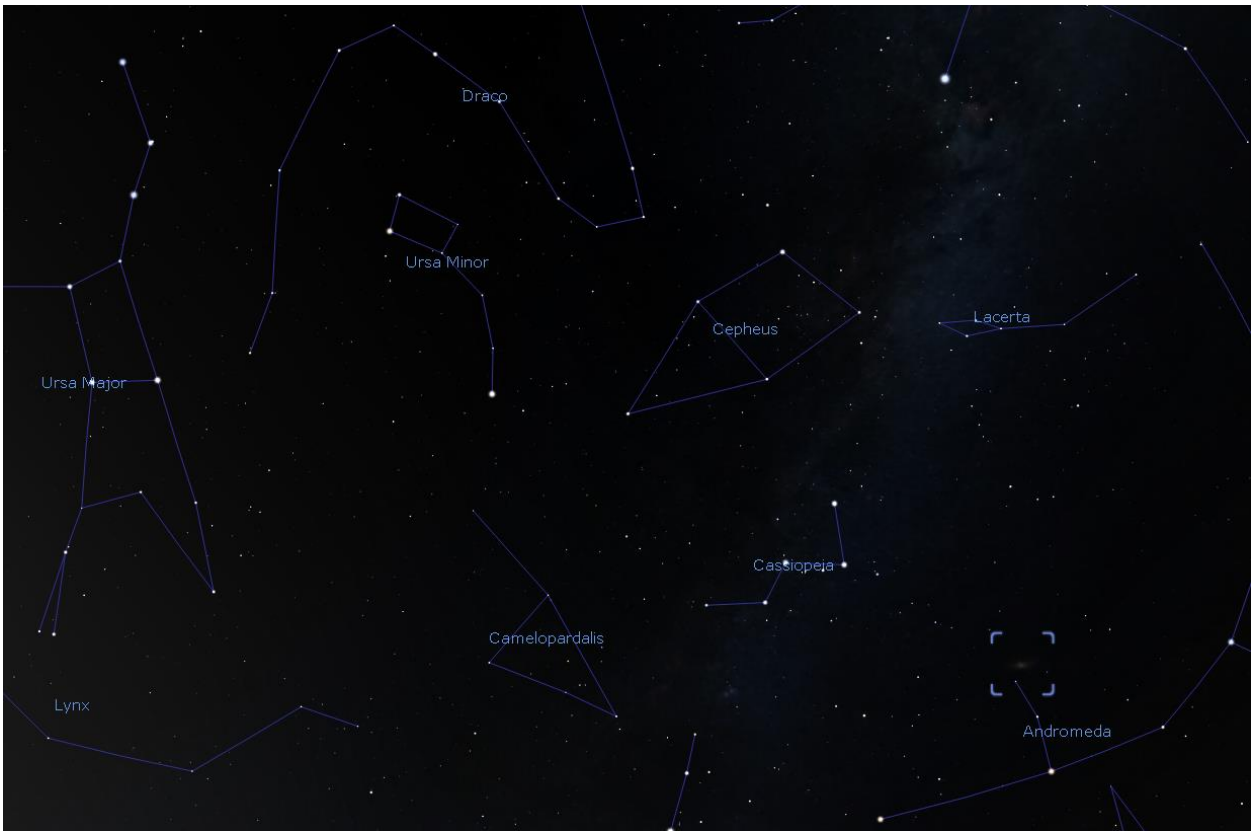


The Andromeda galaxy is a spiral galaxy, and is the largest one in our local group. It's more than twice the size of our own Milky Way, and it would take our rocket ship over 40 billion years to travel there. This galaxy is pretty close - you can see this object near the constellation Cassiopeia without binoculars on a dark night! (mag 3.4)

Notice that surrounding Andromeda are other galaxies. The smaller satellite galaxies are their own collection of stars and solar systems.







Double Stars

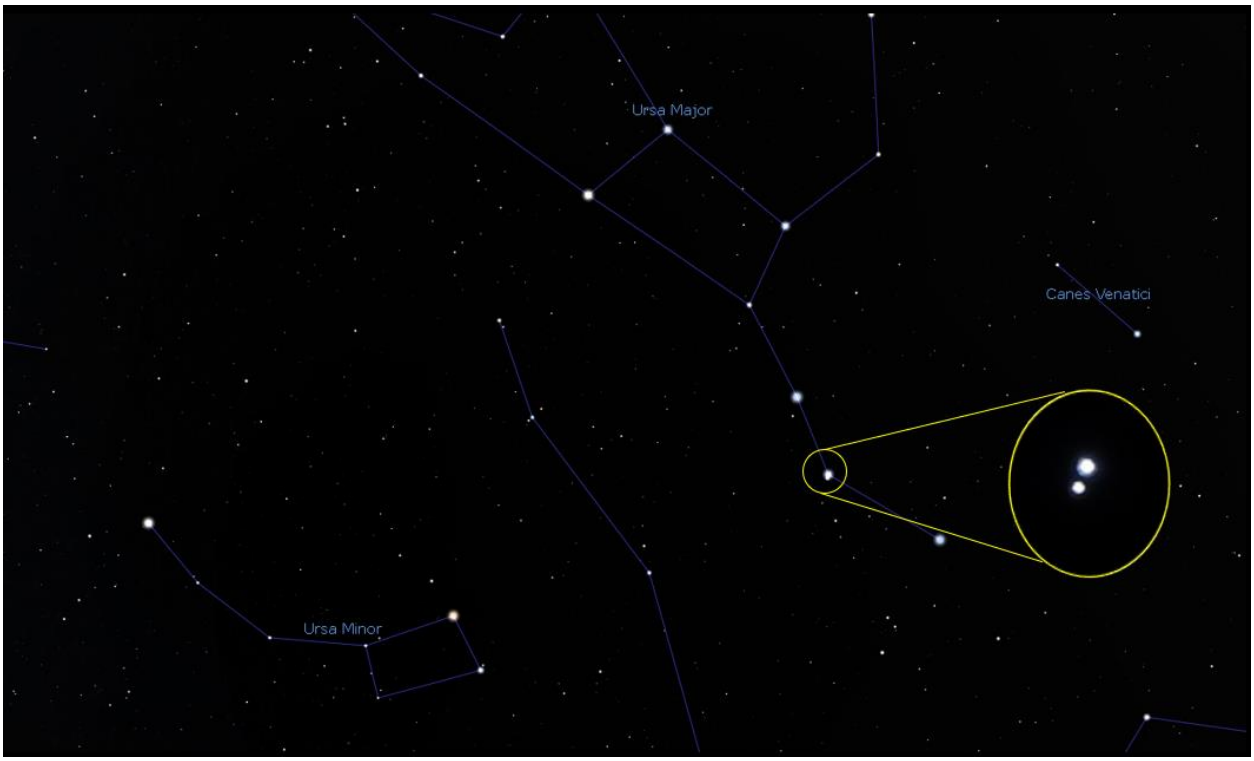
Double stars are more common than single stars! A binary system is one where there are two suns that orbit around a common center of mass and are also gravitationally bound to each other. Astronomers estimate about 85% of the stars are in binary systems, some with triple suns or even higher!

There are also visual doubles, where two stars appear close together in the sky but are not actually bound or orbiting each other—they just line up that way from our viewpoint.

Mizar and Alcor are two stars forming a double you can see with your naked eye in the handle of the Big Dipper in the constellation of Ursa Major.

Mizar is the second star from the end of the Big Dipper's handle, and Alcor its fainter companion. You can see this with your binoculars! You'll see Mizar and Alcor separated with about 12 minutes of arc (about 700 seconds of arc) when you use your naked eyes.

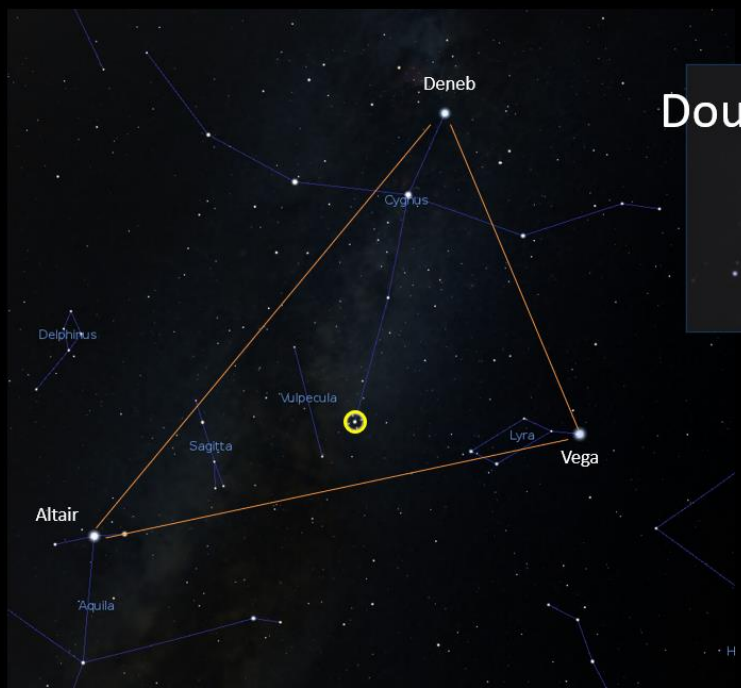
Mizar is actually four stars, and Alcor is really two stars, so you have six stars when you think you're seeing the double!



Double Stars: Mizar and Alcor

Source: Wiki

Summer Triangle

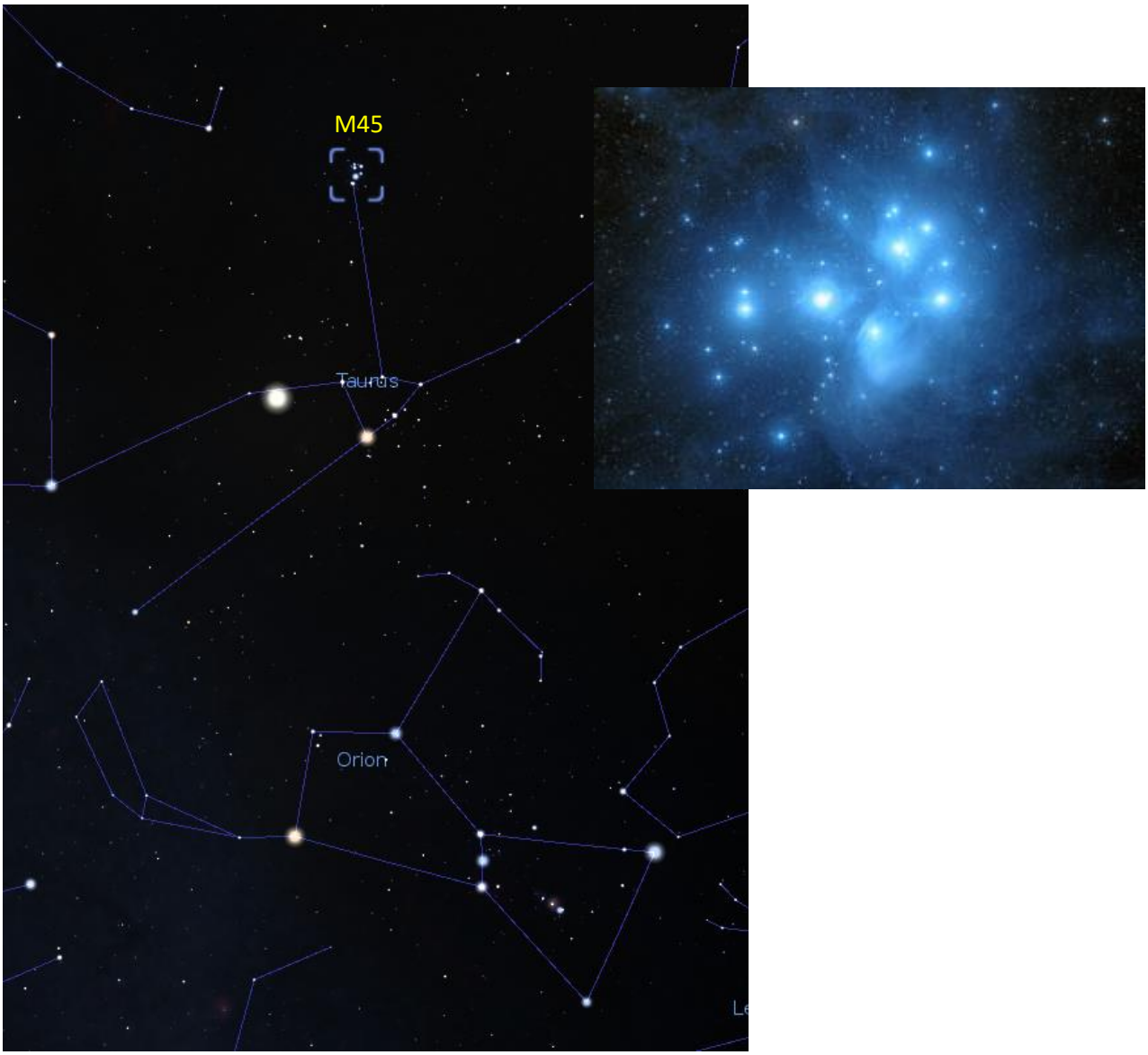


Double Stars: Albireo

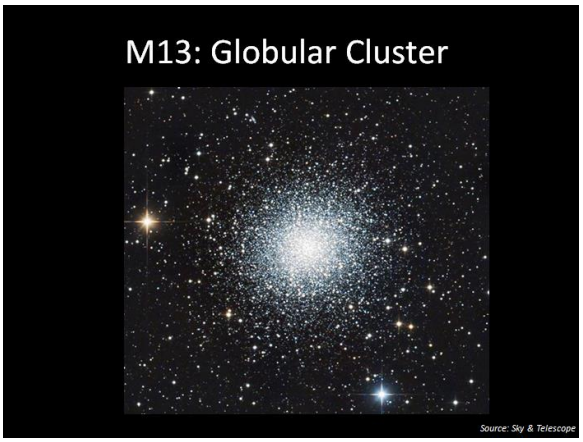
Star Clusters

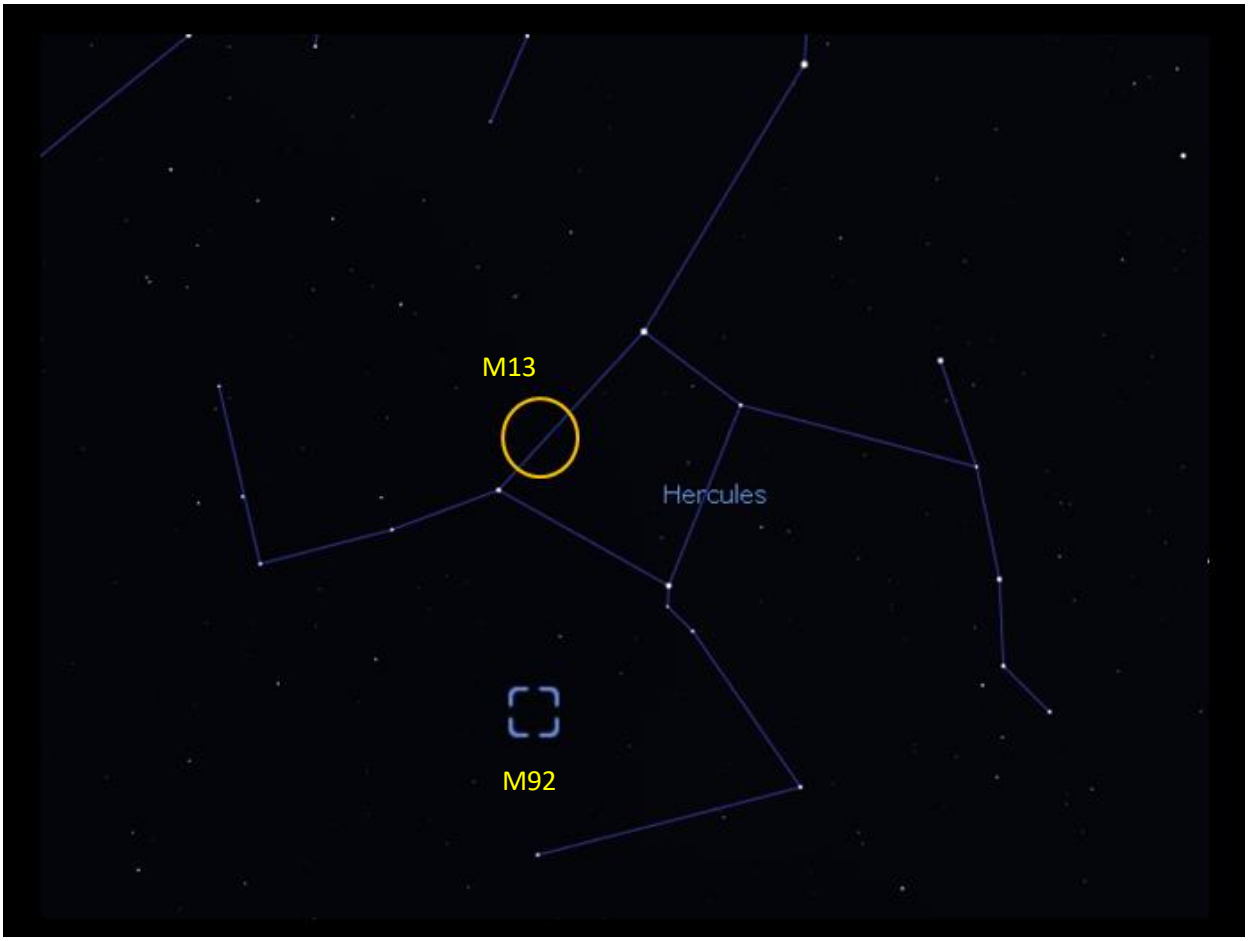
Open clusters are one type of star cluster. Open clusters are dazzling groups of young stars that form together from the same cloud of gas and dust, bound loosely by gravity. One of the most famous open clusters is the Pleiades (or the "Seven Sisters").

Easily visible to the naked eye, this stunning cluster is located in the constellation Taurus and features bright, blue stars surrounded by faint, wispy nebulosity.



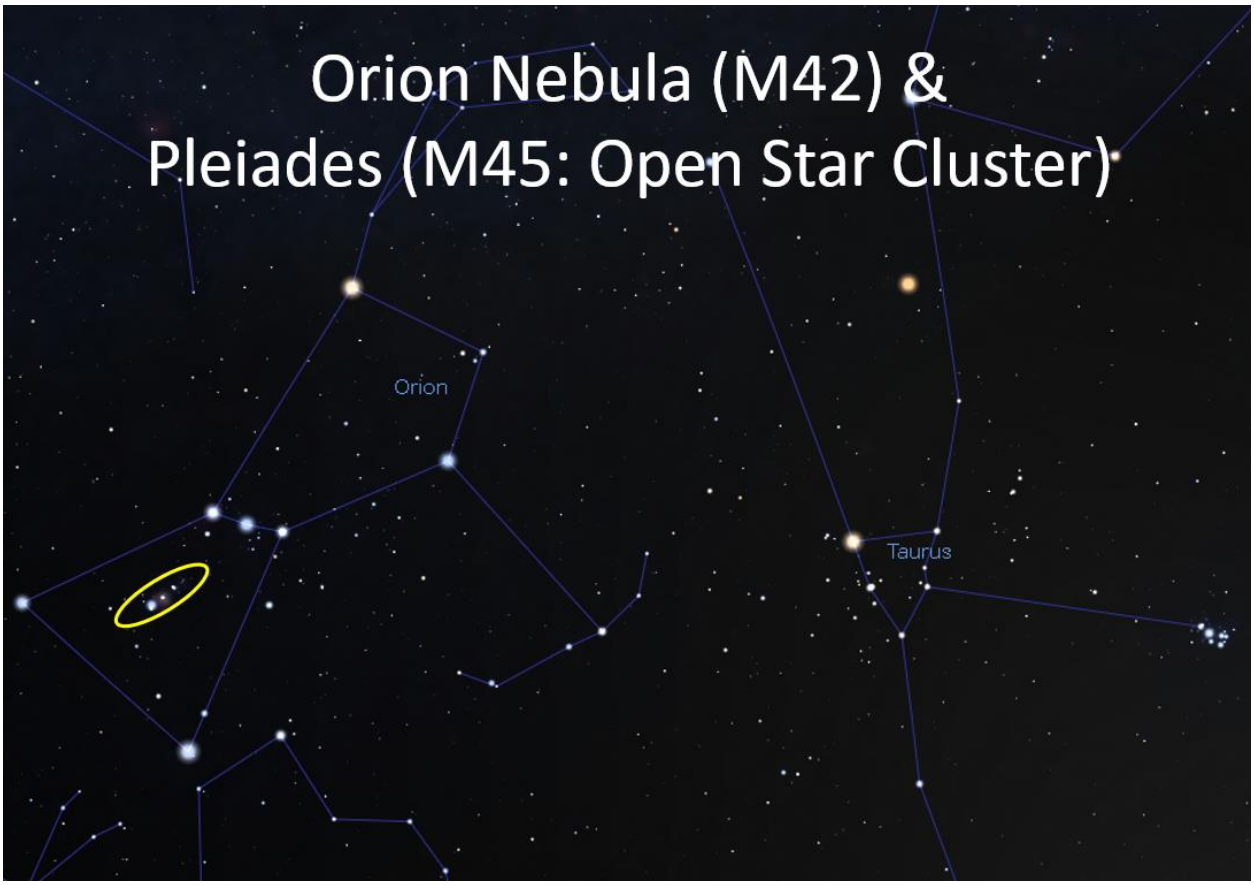
Globular clusters are another type of star cluster. These stars are packed in a tight ball by gravity. M13 is in the constellation Hercules, and you can it see with binoculars (mag 5.8). M13 contains several hundred thousand stars.. wow! Globular star clusters are small, only about 10-30 light years across.

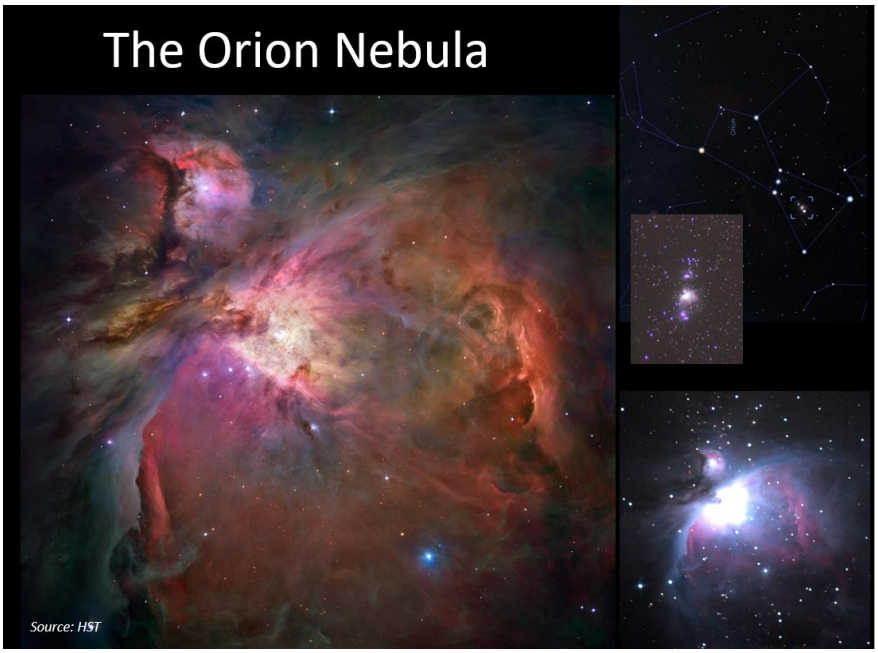




Nebulae

The Orion Nebula is a diffuse nebula and one of the brightest in the sky (mag 4), which is visible to the naked-eye if it's dark and clear! The vast cloud of gas and dust is glowing from the light and energy of the young, hot stars forming inside.





How to use Binoculars for Stargazing:

How can you tell if your pair of binoculars are good for stargazing? And what's the difference between a $50 pair and a $500 pair that are the same size and magnification? Does it really matter? Let's take a look at all of these things together!

How big should I get? Stargazing binoculars generally are between a magnification of 7x to 10x. The objective lenses (the larger lenses) are usually between 35mm to 60mm, although I don't recommend anything larger than 50mm because it gets hard to hold steady the longer you look through them. After only 10 minutes of stargazing, binoculars can feel very heavy and cumbersome. 7x50 or 10x50 are a perfect size for astronomy. I wouldn't go any smaller than 7x35 for stargazing.

How much should I spend? The more expensive pair will have clearer, crisper images, especially around the edge of the view. More expensive binoculars will have *BAK-4* prisms which will continue to be clear without any distortion right out to the edges. Less expensive binoculars will have *BAK-7* prisms, which have less optical quality. If you're not sure which type you have, hold the binoculars away from your eyes and up toward a light, and when you look through them, you'll noticed that the circular exit holes in the eyepieces will be squared off and non-circular for the cheaper models.

There are good binoculars that use either *BAK-7* and *BAK-4*, because the squaring off isn't as important for stargazing as it is for day use. A little out of focus is okay. If the edge is way out of focus, try a different brand or model.

Porro Prism

Roof Prism

You will get a better pair of binoculars with a porro prism design than a roof prism for the same amount of money. If you only have $100 to spend, the porro prism model will out-perform the roof prism model. You *can* get great roof prism binoculars, but they generally cost more. The other consideration is pure optics – because the path of the incoming light zigzags, you get greater depth perception with porro prisms than the straight-through roof design. It's like looking at something in 3D (porro) versus 2D (roof).

Does my age matter? For older stargazers, it's the exit pupil size that matters. This is the size of the bright disk of light you see in the eyepiece when you hold up the binoculars. A 7x50 pair of binoculars will have an exit pupil of 50 ÷ 7 = 7mm.

If this number is larger than the size of your pupil when adapted to the dark (stay outside for several minutes before you measure this), then that will be light that doesn't enter your eye. If that's you, then look for binoculars with an exit pupil of 5-6mm.

You can easily (and carefully) have someone measure the size of your pupils using a ruler by holding it right up to your eye to measure your pupil's diameter.

Do I keep my glasses on? In general, you don't use eyeglasses when you look through the binoculars. The binoculars can adapt to your eyes, unless you have an astigmatism. Try looking both with glasses on and off to see if you need to keep them on when stargazing. If you find you do need to wear eyeglasses when using binoculars, then look for a pair that has at least 15mm of eye relief (most binoculars will have this already).

What is eye relief? Eye relief is the amount of distance between the piece of glass you look through and your eye. The greater the eye relief, the more comfortable it will be, you won't have to bury your eye in the eyepiece in order to look through the binoculars. Less than 7mm, and you won't be able to use your binoculars with glasses on.

Find something between 16-20mm for excellent eye relief that will be comfortable to use with glasses. Some binoculars even have special rubber eyecups that twist to change the distance. When you twist the eyecups up, you can use them comfortably without glasses, and twist them down to use them with glasses.

Why are lenses of binoculars different colors? Binoculars have coatings on the lenses. Coatings help with contrast and reflections. The more contrast you have, the better you'll be able to see a deep sky object. With reflections, every piece of light that is reflected off is light that doesn't make it to your eye.

When you pick up a pair of binoculars, look at the larger end and notice the light reflected in the objective lenses. They should be mostly dark, if they are white or red, try a different brand.

Now look through the lens at the prisms inside. If they have a good anti-reflection coating, you'll see a rainbow-colored surface. The more expensive the pair, the more

surfaces have been coated and the better the binoculars will perform. If it's white, try a different brand.

Inside the binoculars, there is air and glass. There are four descriptors for coatings: coated (some air-to-glass have a coating), multi-coated (one or more air-to-glass has multiple coatings), fully coated (every air-to-glass surface is coated), and fully multi-coated (every air-to-glass surface has multiple coatings). The best choice here is the last one – you want as many coatings as possible for your set of optics.

Which options are a big deal for astronomy? The L-adapter is the best option to go for, and most binoculars are equipped with the screw-hole to accept this adapter. Other options, like nitrogen-filled and being waterproofed aren't that big of a deal in astronomy.

What about fogging up? Since binoculars are small, they don't take nearly as much time as telescopes do to acclimate to lower temperatures. This means that if you normally keep your binoculars inside your house, you might find that it takes a few minutes for them to adjust to the cooler temperature outside. They might fog up a bit, but it's not nearly as big of a deal as it is with telescopes.

How do I focus my binoculars? It's easy to do with these simple steps. Before we start, on the right eyepiece, find the diopter. Our two eyes are not the same, and the binoculars can account for this difference using the diopter. Make sure it's set to zero.

1. Set the right lens diopter to zero.
2. Take the LEFT lens cap off (keep the right lens cap on).
   You should only be able to see through the left side.
3. Look through the binoculars, use the CENTER WHEEL to get the image sharp.
4. Put the left lens cap back on.
5. Take the RIGHT lens cap off. You should only be able to see through the right side now.
6. IMPORTANT: Do NOT touch the center focus wheel!
7. Now use the DIOPTER to make the image sharp.
8. Now your binoculars are set to your eyes, and you can use the center focus wheel to adjust the focus if you need to.

Equipment Recommendations:

Binoculars for Astronomy:

Celestron Cometron 7x50 Bincoulars ($35)
(Don't go larger than 10x50 without a tripod)

Beginner telescopes:

For kids: 6-8" Dobsonian Telescope

For adults - it's going to depend what you want to look at, what your typical "seeing conditions" are, and where you are on the planet. Here are a few general guidelines:

- 8" Newtonian Reflector is easy to use, good all-around scope for deep sky objects, planets, and moon.
- 8" Schmidt-Cassegrain is a more compact, good all-around scope for planets, galaxies, nebulae, and astrophotography.
- 90mm Refractor is a bit harder to use, best for planets and moon observing.