

Explore the Universe Observing Certificate

Welcome to the Explore the Universe Observing Certificate Program. This program is designed to provide the observer with a well-rounded introduction to the night sky visible from North America. Using this observing program is an excellent way to gain knowledge and experience in astronomy. Experienced observers find that a planned observing session results in a more satisfying and interesting experience. This program will help introduce you to amateur astronomy and prepare you for other more challenging certificate programs such as the *Messier* and *Finest NGC*.

The program covers the full range of astronomical objects. Here is a summary:

| Observing Objective | Requirement | Available |
|---------------------------------|-------------|------------|
| Constellations and Bright Stars | 12 | 24 |
| The Moon | 16 | 32 |
| Solar System | 5 | 10 |
| Deep Sky Objects | 12 | 24 |
| Double Stars | 10 | 20 |
| Total | 55 | 110 |

In each category a choice of objects is provided so that you can begin the certificate at any time of the year. **In order to receive your certificate you need to observe a total of 55 of the 110 objects available.** Here is a summary of some of the abbreviations used in this program

| | | | |
|--------------------|---|--|----------------------|
| Instrument | V – Visual (unaided eye) V/B - Visual/Binocular | B – Binocular B/T - Binocular/Telescope | T – Telescope |
| Season | Season when the object can be best seen in the evening sky between dusk. and midnight. Objects may also be seen in other seasons. | | |
| Description | Brief description of the target object, its common name and other details. | | |
| Cons | Constellation where object can be found (if applicable) | | |
| BOG Ref | Refers to corresponding references in the RASC's <i>The Beginner's Observing Guide</i> highlighting this object. | | |
| Seen? | Mark each item with a check mark when you have observed it. | | |
| Log Page | Cross reference to your Visual Observing Log or other logbook entry where you have recorded your observations. | | |

Binoculars are an ideal first observing instrument and this program has been designed so that it can be completed using binoculars alone. By mounting your binoculars on a tripod you will find that you can see more detail and observe more comfortably. While a telescope can show many objects on this list in more detail, experienced observers always have a pair of binoculars handy. For more information see *The Beginner's Observing Guide* p. 86.

The Bayer Catalogue

First published in 1603, the Bayer Catalogue was based solely on bright visual stars that could be seen with the unaided eye in each constellation. Using the Greek alphabet, starting with Alpha, stars are labelled mainly (with certain exceptions) according to how bright they are. Thus the brightest star in Ursa Minor is called "Alpha Ursae Minoris" and written α UMi. Here is a list of all the 24 Greek letters used in astronomy:

| | | | | | | | |
|------------------|------------------|--------------------|----------------------|----------------------|----------------|----------------------|-------------------------------|
| α - Alpha | β - Beta | γ - Gamma | δ - Delta | ϵ - Epsilon | ζ - Zeta | η - Eta | θ - Theta (θ) |
| ι - Iota | κ - Kappa | λ - Lambda | μ - Mu | ν - Nu | ξ - Xi | \omicron - Omicron | π - Pi |
| ρ - Rho | σ - Sigma | τ - Tau | υ - Upsilon | ϕ - Phi | χ - Chi | ψ - Psi | ω - Omega |

The Flamsteed Catalogue

Another major catalogue is the Flamsteed Catalogue compiled in 1725. This catalogue lists stars visible to the unaided eye by constellation in Right Ascension order from west to east. Thus the higher the number, the further east in a constellation is a given star. For more information on the Bayer and Flamsteed catalogues see *The Beginner's Observing Guide* page 23.

Reference Sources

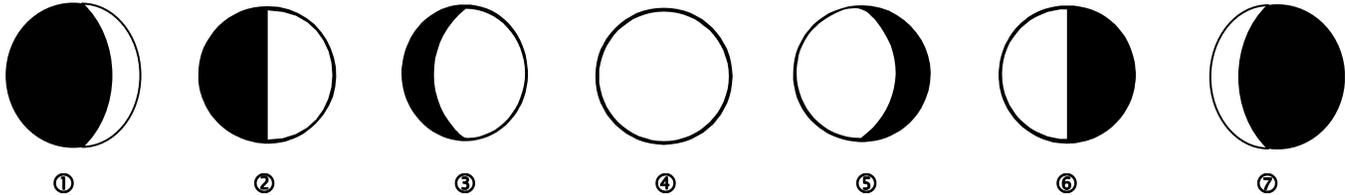
The Explore the Universe Observing Certificate program can be used in conjunction with *The Beginner's Observing Guide*. This publication of the Royal Astronomical Society of Canada provides a clear introduction to the observation of astronomical phenomena and appropriate observing techniques. In addition to this type of guide you will need a **star map** or **atlas** to assist you with locating a number of the objects in this program. For specific recommendations refer to *The Beginner's Observing Guide* pages 134-135.

Constellations and Bright Stars (12 of 24)

| Season | Name | Abbr. | Observing Notes | Bright Star (s) | Mag. | Bayer | Flam- steed | BOG? | Seen? ✓ | Log Page |
|--------|--|-------|--|------------------------------------|--------------|-----------------------|------------------|-------|--------------------------|-------------|
| Spr | Ursa Major The Great Bear | UMa | Ursa Major has important pointer stars leading to Polaris, Arcturus. | Dubhe Merak | 1.81 2.34 | Alpha (α) Beta (β) | 50 UMa 48 UMa | 14 | <input type="checkbox"/> | |
| Spr | Leo The Lion | Leo | Prominent constellation includes the bright star Regulus.. | Regulus Denebola | 1.36 2.14 | Alpha (α) Beta (β) | 32 Leo 94 Leo | 33 | <input type="checkbox"/> | |
| Spr | Virgo The Maiden | Vir | Virgo contains the giant Virgo cluster of galaxies, visible in telescopes. | Spica | 0.98 | Alpha (α) | 67 Vir | 42 | <input type="checkbox"/> | |
| Spr | Libra The Scales | Lib | Alpha & Beta Librae are prominent but other stars need darker skies. | Zuben El Genubi Zuben Eschamali | 2.75 2.61 | Alpha (α) Beta (β) | 9 Lib 27 Lib | 49-50 | <input type="checkbox"/> | |
| Spr | Bootes The Herdsman | Boo | Arcturus is the 4 th brightest star. Take the arc to Arcturus from UMa. | Arcturus | - 0.05 | Alpha (α) | 16 Boo | 41-42 | <input type="checkbox"/> | |
| Spr | Ursa Minor The Lesser Bear | UMi | Contains Polaris the Pole Star. Needs darker skies to stand out. | Polaris Kochab | 1.97 2.07 | Alpha (α) Beta (β) | 1 UMi 7 UMi | 27 | <input type="checkbox"/> | |
| Sum | Scorpius The Scorpion | Sco | Runs roughly north to south with bright red Antares at its heart. | Antares | 1.06 | Alpha (α) | 21 Sco | 50 | <input type="checkbox"/> | |
| Sum | Hercules Hero of Greek Myth | Her | Ras Algethi is south of Hercules' distinctive four star polygon. | Ras Algethi | 2.78 | Alpha (α) | 64 Her | 47-48 | <input type="checkbox"/> | |
| Sum | Sagittarius The Archer | Sgr | Distinctive teapot pattern, marks the centre of the Milky Way. | Nunki | 2.05 | Sigma (σ) | 34 Sgr | 57 | <input type="checkbox"/> | |
| Sum | Lyra The Lyre or Harp | Lyr | Beautiful starfields in binoculars, Vega is the 5 th brightest star. | Vega | 0.03 | Alpha (α) | 3 Lyr | 48 | <input type="checkbox"/> | |
| Sum | Aquila The Eagle | Aql | Look for a diamond-shaped pattern, Altair is the 12 th brightest star. | Altair | 0.76 | Alpha (α) | 53 Aql | 49 | <input type="checkbox"/> | |
| Sum | Capricornus The Sea Goat | Cap | A wide V-shaped star field, Alpha Cap is a wide visual double star. | Al Giedi Dabih | 3.60 3.05 | Alpha (α) Beta (β) | 6 Cap 9 Cap | 58 | <input type="checkbox"/> | |
| Sum | Cygnus The Swan | Cyg | Rich in Milky Way stars, look for the outline of a bird in flight. | Deneb Albireo | 1.25 3.36 | Alpha (α) Beta (β) | 50 Cyg 6 Cyg | 56-57 | <input type="checkbox"/> | |
| Aut | Pegasus Winged Horse | Peg | Look for the Great Square of Pegasus w/ Markab opp. Alpheratz. | Markab | 2.49 | Alpha (α) | 54 Peg | 29 | <input type="checkbox"/> | |
| Aut | Andromeda Cassiopeia's child | And | Look for two lines of stars extending from Alpheratz. | Alpheratz | 2.07 | Alpha (α) | 21 And | 28-29 | <input type="checkbox"/> | |
| Aut | Cassiopeia The Queen | Cas | Cassiopeia has a distinctive "W" shaped pattern in the N. Milky Way. | Schedar | 2.24 | Alpha (α) | 18 Cas | 28 | <input type="checkbox"/> | |
| Aut | Aries The Ram | Ari | Look for Alpha & Beta Arietis between Andromeda & Taurus. | Hamal Sheratan | 2.01 2.64 | Alpha (α) Beta (β) | 13 Ari 6 Ari | 31-32 | <input type="checkbox"/> | |
| Aut | Perseus Rescuer of Andromeda | Per | The rich starfield near Mirfak is great in binoculars. | Mirfak | 1.79 | Alpha (α) | 33 Per | 29 | <input type="checkbox"/> | |
| Win | Taurus The Bull | Tau | The wide open cluster, the Hyades, is the head of Taurus the Bull. | Aldebaran | 0.87 | Alpha (α) | 87 Tau | 31 | <input type="checkbox"/> | |
| Win | Auriga The Charioteer | Aur | Look for a Pentagon-shaped asterism. Capella is the 6 th brightest. | Capella | 0.08 | Alpha (α) | 13 Aur | 30 | <input type="checkbox"/> | |
| Win | Orion The Hunter | Ori | Prominent constellation with a rich starfield around the 3 Belt Stars. | Betelgeuse Rigel | 0.45 0.18 | Alpha (α) Beta (β) | 58 Ori 19 Ori | 30 | <input type="checkbox"/> | |
| Win | Canis Major The Big Dog | CMa | Located southeast of Orion, Canis Major contains the brightest star. | Sirius | - 1.44 | Alpha (α) | 9 CMa | 30-31 | <input type="checkbox"/> | |
| Win | Canis Minor The Little Dog | CMi | A small constellation with the star Procyon as its mascot. | Procyon Gomeisa | 0.41 2.89 | Alpha (α) Beta (β) | 10 CMi 3 CMi | 34 | <input type="checkbox"/> | |
| Win | Gemini The Twins | Gem | The stars Castor and Pollux are the twins. | Castor Pollux | 1.58 1.16 | Alpha (α) Beta (β) | 66 Gem 78 Gem | 32-33 | <input type="checkbox"/> | |

Observing the Moon (16 of 32)

As the closest major celestial object to the earth, the moon reveals more detail to observers than any other object. So much so, in fact, that a large number of lunar features can be clearly identified in binoculars. To observe the moon successfully requires a good Moon map, an understanding of lunar phases and sturdy tripod-mounted binoculars. East and West on the Moon are opposite from our earthly viewpoint, so the western hemisphere of the Moon will appear to face east and the eastern hemisphere will appear to face west, while north and south remain the same. Binoculars with 10X magnification will work best although observers can easily complete this phase with 7X magnification.



Lunar Phases (4 of 8 observations are required)

The RASC Observer's Calendar and other observing resources provide detailed information on the daily phase of the moon and exact times of First Quarter, Full, Third Quarter and New Moon.

| Sea- son | Approx Day | Object | Inst. | Observing Notes | BOG? | Seen? ✓ | Log Page |
|-------------|---------------|-------------------|-------|---|------|--------------------------|-------------|
| Any | 3 | Waxing Crescent ① | V | Visible within 3 hours of sunset. | 107 | <input type="checkbox"/> | |
| Any | 7 | First Quarter ② | V | Within 18 hours before or after exact time of phase. | 107 | <input type="checkbox"/> | |
| Any | 11 | Waxing Gibbous ③ | V | Visible 3-4 days after First Quarter. | 107 | <input type="checkbox"/> | |
| Any | 14 | Full Moon ④ | V | Within 18 hours before or after exact time of phase. | 107 | <input type="checkbox"/> | |
| Any | 17 | Waning Gibbous ⑤ | V | Visible 3-4 days after Full Moon. | 107 | <input type="checkbox"/> | |
| Any | 21 | Last Quarter ⑥ | V | Within 18 hours before or after exact time of phase. | 107 | <input type="checkbox"/> | |
| Any | 26 | Waning Crescent ⑦ | V | Visible within 3 hours of sunrise. | 107 | <input type="checkbox"/> | |
| Any | Any | Orbital Motion | V | Over 1-2 days track the Moon's orbital motion against background stars. | | <input type="checkbox"/> | |

Lunar Basins / Maria (6 of 12 observations are required)

The dark lava plains known as lunar basins or *maria* are the most easily visible feature on the moon. The following features are listed in order from East to West and will become visible as they rise each night during a lunar cycle and all maria can be seen at Full Moon. Note the relative sizes ranging from 55,000 km² to over 2 million km².

| Sea- son | Best Phase | Object | B/T/T | Size km ² | Lat | Long | Observing Notes | BOG? | Seen? ✓ | Log Page |
|-------------|---------------|----------------------|-------|----------------------|-----------|-----------|---|---------|--------------------------|-------------|
| Any | ④ | Mare Crisium | B/T | 176,000 | 17°N | 59°E | Sea of Crises. Size of Great Britain, Large impact basin 570 km in diameter. | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Mare Fecunditatis | B/T | 326,000 | 4°S | 50°E | Sea of Fertility | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Mare Nectaris | B/T | 100,000 | 15°S | 35°E | Sea of Nectar, 350 km in diameter. | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Mare Tranquillitatis | B/T | 421,000 | 8°N | 32°E | Sea of Tranquillity, Size of Black Sea, Apollo 11 landing site. | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Mare Serenitatis | B/T | 370,000 | 28°N | 22°E | Sea of Serenity bordered by Lacus Somniorum & Lacus Mortis | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Mare Vaporum | B/T | 55,000 | 13°N | 3°E | Sea of Vapours; circular basin 230km in diameter located SE of the Apennines Mountains. | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Mare Frigoris | B/T | 436,000 | 58°N | 45°W-45°E | Sea of Cold, northmost mare near the crater Plato. | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Mare Imbrium | B/T | 830,000 | 51°N-14°N | 40°W-6°E | Sea of Rains, large impact basin, 1250 km in diameter. | 113-114 | <input type="checkbox"/> | |

| Sea- son | Best Phase | Object | B/T/T | Size km ² | Lat | Long | Observing Notes | BOG? | Seen? ✓ | Log Page |
|-------------|---------------|------------------------|-------|----------------------|-----------|---------------|--|---------|--------------------------|-------------|
| Any | ④ | Mare Nubium | B/T | 254,000 | 20°S | 15°W | Sea of Clouds | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Sinus Iridum | B/T | 53,000 | 45°N | 32°W | Bay of Rainbows flooded partial crater 260 km in diameter extending into Mare Imbrium. | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Mare Humorum | B/T | 113,000 | 24°S | 39°W | Sea of Moisture; 380km in diameter, nicely paired with Mare Nubium | 113-114 | <input type="checkbox"/> | |
| Any | ④ | Oceanus Procellarum | B/T | 2,102,000 | 42°N-14°S | 68°W- 27°W | Ocean of Storms, largest continuous feature covers the midwestern part of the Moon. | 113-114 | <input type="checkbox"/> | |

Impact Craters (6 of 12 observations are required)

For many years the craters on the moon were thought to be volcanic in nature. Our understanding of them now indicates that most of them are a result of major impacts by asteroids and comets. This has contributed greatly to our understanding of the formation and evolution of the solar system.

“Best Phase” shows approximately when the objects will be near to the terminator and thus easiest to see with detail. Note that there is a complementary phase during the waning period when the same object will also be on the terminator but lit at sunset instead of at sunrise.

| Sea- son | Best Phase | Object | V/B/T | Dia- meter | Lat | Long | Observing Notes | BOG? | Seen? ✓ | Log Page |
|-------------|---------------|-------------|-------|---------------|-------|-------|---|---------|--------------------------|-------------|
| Any | 3-4 | Petavius | B/T | 177 km | 25°S | 60°E | Prominent crater with central peak; look for Wrottesley nearby | 111-113 | <input type="checkbox"/> | |
| Any | 3-4 | Cleomedes | B/T | 126 km | 28° N | 56° E | Located near Mare Crisium; Easily seen in binoculars. | 111-113 | <input type="checkbox"/> | |
| Any | 4-5 | Posidonius | B/T | 95 km | 32° N | 30° E | Located on the edge of Mare Serenitatis; Crater walls 2300m high. | 111-113 | <input type="checkbox"/> | |
| Any | 5-6 | Theophilus | B/T | 100 km | 11° S | 26° E | Prominent crater with 1400m central peak; Cyrillus and Catharina nearby. | 111-113 | <input type="checkbox"/> | |
| Any | 5-6 | Aristoteles | B/T | 87 km | 50° N | 17° E | In Mare Frigoris; has deep terraced walls; Look for Eudoxus nearby at the border of Frigoris. | 111-113 | <input type="checkbox"/> | |
| Any | 8-9 | Ptolemaeus | B/T | 153 km | 09° S | 02° W | Prominent walled plain; Alphonsus and Arzachel to the south. | 111-113 | <input type="checkbox"/> | |
| Any | 8-9 | Plato | B/T | 101 km | 52° N | 09° W | Outstanding crater that is easy to spot due to its dark floor. | 111-113 | <input type="checkbox"/> | |
| Any | 8-9 | Tycho | B/T | 85 km | 43° S | 11° W | Famous crater featuring spectacular rays that are best observed at or near full moon. | 111-113 | <input type="checkbox"/> | |
| Any | 9-10 | Clavius | B/T | 225 km | 58° S | 14° W | Very large crater encompassing several smaller craters. | 111-113 | <input type="checkbox"/> | |
| Any | 8-9 | Copernicus | B/T | 93 km | 10° N | 20° W | Spectacular crater with 3760m deep terraced walls; Also features prominent rays at or near full moon. | 111-113 | <input type="checkbox"/> | |
| Any | 11-12 | Gassendi | B/T | 110 km | 18° S | 40° W | Prominent crater on the northern edge of Mare Humorum. | 111-113 | <input type="checkbox"/> | |
| Any | 13-14 | Grimaldi | B/T | 222 km | 05° S | 67° W | Very large dark floored crater located near the western edge of the moon. | 111-113 | <input type="checkbox"/> | |

The Solar System (5 of 10)

Our solar system contains the planets, asteroids, comets, the sun and other wonders.

| Sea- son | Object | V/B/T | Observing Notes | BOG Ref | Seen? ✓ | Log Page |
|-------------|--|-----------------|---|------------|--------------------------|-------------|
| † | Mercury | V/B/T | Mercury is the closest planet to the Sun. Unlike other planets Mercury is visible only for a few weeks at a time; so check an annual guide such as <i>The Observer's Handbook</i> for the best times to spot this fast-moving, elusive object. | 117-118 | <input type="checkbox"/> | |
| † | Venus | V/B/T | The brightest planet. Telescope users can see Venus go through phases similar to those of the Moon. | 118-119 | <input type="checkbox"/> | |
| † | Mars | V/B/T | Known as the "Red Planet", it is best observed at opposition about every 26 months, although it can be seen often at other points of its orbit. | 125-126 | <input type="checkbox"/> | |
| † | Jupiter | V/B/T | The largest planet in the solar system with four bright moons nearby that can be seen in binoculars. Each moon can be identified by name using <i>The Observer's Handbook</i> but this is not mandatory. | 126 | <input type="checkbox"/> | |
| † | Saturn | V/B/T | This planet can be seen in binoculars, but to reveal the beautiful rings a telescope of 80mm or more is recommended. Saturn has one bright moon named Titan and several fainter ones visible in telescopes. | 126-127 | <input type="checkbox"/> | |
| Sum | Uranus | B/T | This planet can be seen clearly in binoculars particularly when they are mounted on a tripod. A detailed finder chart is published annually in <i>The Observer's Handbook</i> . Telescopes will reveal the small round disc of this far away world. | 127 | <input type="checkbox"/> | |
| Sum | Neptune | B/T | Neptune is similar to Uranus, but even further away and fainter. It also can be seen in binoculars using the same method as for Uranus. Seeing the disc of Neptune is more difficult but well within the reach of good amateur telescopes. | 128 | <input type="checkbox"/> | |
| Any | Orbital Motion | V | Plot the orbital motion of a Planet: This can be done easily by drawing the starfield round a planet on two or more separate nights and recording the movement of the planet against the background stars, which do not move. Orbital motion can be plotted visually, through binoculars or telescopes, with the outer planets being the easiest to plot. | | <input type="checkbox"/> | |
| Any | Artificial Satellites & Meteors | V | Observe at least 3 Earth orbiting artificial satellites (including spacecraft and the International Space Station) and 3 meteors (either sporadics or from a meteor shower). | 144-148 | <input type="checkbox"/> | |
| Any | Sunspots | T (Filtered) | WARNING! For telescopes only. No binoculars. USE OF A GOOD QUALITY FULL APERTURE SOLAR FILTER REQUIRED! This observation may best be done through the telescope of an experienced solar observer who has one set up for public viewing or club events. | 154-156 | <input type="checkbox"/> | |

† Mercury, Venus, Mars, Jupiter and Saturn have relatively short orbital periods and their visibility varies from one year to the next. Consult *The Observer's Handbook* or *The Beginner's Observing Guide* for details on current positions and visibility.

Optional Observations

| Sea- son | Object | V/B/T | Observing Notes | BOG Ref | Seen? ✓ | Log Page |
|-------------|-----------------|-------|--|------------|------------|-------------|
| Sum | Pluto | T+ | A tour of the solar system would not be complete without mentioning the planet Pluto. It is the smallest and most distant planet and therefore quite faint. It cannot be seen in binoculars or small telescopes and usually requires a 200mm or larger instrument. A finder chart can be found in <i>The Observer's Handbook</i> for those who have a large enough telescope and want to complete their observations of all the planets. | 128-129 | | |
| Any | Eclipses | V | Eclipses occur when one solar system object passes in front of and hides another solar system object. A solar eclipse occurs when, on passing between the sun and | 132-133 | | |

| Sea- son | Object | V/B/T | Observing Notes | BOG Ref | Seen? ✓ | Log Page |
|-------------|-----------------------|-------|--|------------|------------|-------------|
| | | | the earth, the moon is closely enough aligned to hide at least part of the sun, as viewed from the earth. A lunar eclipse occurs when, on passing between the sun and the moon, the earth is closely enough aligned to hide at least some of the moon. For both solar and lunar eclipses, use the predictions listed in <i>The Beginner's Observing Guide</i> and <i>The Observer's Handbook</i> to plan your observations. | | | |
| Any | Conjunctions | V | When two or more celestial objects appear close together in the sky it is called a conjunction. These are regular occurrences that are listed in <i>The Beginner's Observing Guide</i> , <i>The Observer's Handbook</i> and in popular astronomy magazines. | | | |
| Any | Meteor Showers | V | Sporadic meteors can be seen on most dark clear nights. Meteor showers are regular events occurring at different times throughout the year with high rates of meteors appearing to come from a specific zone or radiant in the sky. Look for a dark moonless night and be prepared to stay up late as the best observing is usually after midnight. | 144-148 | | |
| Any | Aurorae | V | Aurorae borealis (or the Northern Lights) are caused by streams of solar particles striking the upper atmosphere and causing it to glow. Best in dark skies. | 148-151 | | |
| Any | Comets | V/B/T | Small bodies left over from the birth of the solar system, comets are usually quite faint and require a medium to large size telescope to observe. Occasionally a comet will appear that is bright enough to be seen through binoculars or even visually. | 151-152 | | |
| Win Fall | Zodiacal Light | V | For mid-northern latitude observers the best time to view this pyramid of light is after dusk in the western sky during February and March or in the pre-dawn eastern sky during September and October. | 152-154 | | |
| Any | Asteroids | B/T | There are several asteroids that are bright enough to be seen in small instruments. You can locate these objects by using a finder chart in <i>The Observer's Handbook</i> or by using the co-ordinates listed there. | OH | | |

Deep Sky Objects (12 of 24)

“Deep Sky Objects” is the catch-all description applied to some of astronomy’s most interesting sights including:

Open Clusters – Loose agglomerations of stars, recently emerged from the giant molecular clouds that gave them birth.

Globular Clusters – Ancient spherical clusters of stars, often containing hundreds of thousands of stars.

Emission/Reflection Nebulae – Glowing clouds of interstellar gas or dust, often marking the birth or death of stars.

Planetary Nebulae / Supernova Remnants – Glowing clouds of gas and dust marking the death of stars.

Galaxies – Huge “Island Universes”, like the Milky Way, containing hundreds of billions of stars but so distant that they are merely hazy patches of light.

All of the deep sky objects on this list can be observed with binoculars and many can be sighted visually. Larger telescopes will reveal more detail. The Season indicates best viewing during the evening hours but many objects can also be sighted before and after the suggested time.

| Sea- son | Cons | Object | Mag. | RA | Dec | Observing Notes | BOG? | Seen? ✓ | Log Page |
|-------------|------|--|------|---------|--------|--|------|--------------------------|-------------|
| Spr | Cnc | M44 The Beehive | 3.10 | 08:40.1 | +19:59 | Open cluster, 95', With a magnitude of 3.1 this cluster is bright enough to be quite easily seen with the unaided eye from a dark sky. To locate it try scanning along an imaginary line from Regulus in Leo to Pollux in Gemini. | 38 | <input type="checkbox"/> | |
| Spr | Com | Coma Cluster Melotte 111 | 1.80 | 12:25.0 | +26:00 | Open cluster, 275', This rather large group of stars lies between 40 (Map) Leo and Bootes. It's made up of several chains of mag. 5-6 stars that are said to be the amber tresses of Queen Berenice's hair offered to the god Aphrodite for the safe return of her beloved king from battle. | | <input type="checkbox"/> | |
| Spr | Ser | M5 NGC 5904 | 5.70 | 15:18.6 | +02:05 | Globular cluster, 17.4' : A globular that is as big and bright as the more famous M13. It is located about 2½ binocular fields north of Beta Librae, the northernmost bright star in Libra. | 52 | <input type="checkbox"/> | |
| Sum | Her | M13 Hercules Cluster | 5.70 | 16:41.7 | +36:28 | Globular cluster, 17', This well-known globular cluster contains hundreds of thousands of stars. Look for an out of focus star below Eta, the upper-right Keystone star in Hercules. Note the two 7 th magnitude stars lying on either side. | 59 | <input type="checkbox"/> | |
| Sum | Sco | M4 NGC 6121 | 5.80 | 16:23.6 | -26:32 | Globular cluster, 26', Located a degree west of Antares in Scorpius, this globular cluster is easily found under a dark sky. However, because most of its individual stars are quite dim, it can prove difficult from light polluted skies. | 59 | <input type="checkbox"/> | |
| Sum | Ser | M16 Eagle Nebula | 6.00 | 18:18.6 | -13:58 | Emission nebula & open cluster 35'x28', Located 4 degrees north of the M24 (see below) this nebulous open cluster contains between 20 and 30 stars ranging from magnitude 8 to 10. | | <input type="checkbox"/> | |
| Sum | Sgr | M8 Lagoon Nebula | 5.80 | 18:03.8 | -24:23 | Emission nebula, 45' x 30', This huge cloud of gas is bisected at one end by a dark lane. To find this deep-sky object, first locate the spout of the Sagittarius “teapot” and simply slew your binoculars upward 6 degrees. | 59 | <input type="checkbox"/> | |
| Sum | Sgr | M17 Swan Nebula | 6.00 | 18:20.8 | -16.11 | Emission nebula, 20' x 15', also known as the Omega Nebula. It is located about halfway between M24 & M16. You may also note the open cluster M18 just below it. | 59 | <input type="checkbox"/> | |
| Sum | Sgr | M22 NGC 6656 | 5.10 | 18:36.4 | -23.54 | Globular cluster, 24', This globular cluster is almost a magnitude brighter than the well-known M13. Look for a nebulous disk two degrees north-east from the top of the teapot lid. | 59 | <input type="checkbox"/> | |
| Sum | Sgr | M23 NGC 6494 | 5.50 | 17:56.8 | -19.01 | Open cluster, 27', Nearly 5 degrees west of M24 (see below) lies this rich open cluster made up of over 120 faint stars. Under dark skies you may be able to resolve some of them with a pair of 10x50 binoculars. | | <input type="checkbox"/> | |
| Sum | Sgr | M24 Sagittarius Starcloud | 4.60 | 18:16.5 | -18:50 | Open cluster, 95' x 35', The small Sagittarius star cloud lies a little over 7 degrees north of the teapot lid. On some charts it's mislabeled as the small open cluster NGC 6603. It's actually the large cloud surrounding NGC 6603. | | <input type="checkbox"/> | |
| Sum | Sgr | M25 IC 4725 | 4.60 | 18:31.6 | -19:15 | Open cluster, 32', Slew your binoculars about 3 degrees eastward of M24, and you'll be rewarded with a view of this | | <input type="checkbox"/> | |

| Season | Cons | Object | Mag. | RA | Dec | Observing Notes | BOG? | Seen? ✓ | Log Page |
|--------|------|---|------|---------|--------|---|--------|--------------------------|-------------|
| | | | | | | attractive little cluster containing several bright stars. | | | |
| Sum | Sct | M11 Wild Duck Cluster | 5.80 | 18:51.1 | -06:16 | Open cluster, 13', You can find the "wild duck" cluster, as Admiral Smyth called it, nearly three degrees west of Aquila's beak lying in one of the densest parts of the summer Milky Way: the Scutum Star cloud. | 59 | <input type="checkbox"/> | |
| Sum | Vul | Collinder 399 The Coathanger | 3.60 | 19:25.4 | +20.11 | aka Brocchi's Cluster, 60', Popularly known as The Coathanger this unmistakable collection of 10 stars lies a little over 7 degrees below Beta Lyrae, the head of the swan. | | <input type="checkbox"/> | |
| Aut | And | M31 Andromeda Galaxy | 3.40 | 00:42.7 | +41.16 | Nearest major galaxy, 185' x 75', How easy or difficult this object is to observe will depend mostly on the darkness of the sky. Follow the outline of Andromeda to the second pair of stars and scan the area just to the north for an elongated fuzzy patch of light. | 73 | <input type="checkbox"/> | |
| Aut | Per | Alpha Persei Group | 1.20 | 03:22.0 | +49.00 | Open cluster, 185', Also known as Melotte 20, this large beautiful group of stars is located near Alpha Persei (proper name Mirfak) and is best seen in binoculars. | | <input type="checkbox"/> | |
| Aut | Per | Double Cluster NGC 869/884 | 5.30 | 02:19.0 | +57.09 | Double open cluster, 29' ea. If you scan the Milky Way between Cassiopeia and Perseus under a dark sky, these two beauties will be hard to miss. Even without binoculars, you'll probably see a misty patch that betrays the presence of one of the northern sky's grandest sights. | 60, 73 | <input type="checkbox"/> | |
| Win | Tau | M45 Pleiades | 1.20 | 03:47.0 | +24:07 | Visual open cluster, 110'. Known since ancient times, this spectacular cluster is best viewed through binoculars or a wide field telescope. | 73 | <input type="checkbox"/> | |
| Win | Tau | Hyades | 0.50 | 04:27.0 | +16:00 | Unaided eye open cluster, 330'. This is the group of stars that form the V-shaped head of Taurus the bull. Although it's easily visible with the unaided eye, you should take a closer look with your binoculars and you'll see the beautiful and colourful double stars Theta (1&2) and Delta (1&2). | 36 | <input type="checkbox"/> | |
| Win | Cam | Kemble's Cascade | 4.00 | 03:57.0 | +63:00 | String of stars, 180'. From Alpha Persei, go two binocular fields towards Polaris and you will see a long string of stars resembling a waterfall. The asterism is named after the late Fr. Lucian Kemble, of the RASC's Regina Centre. You may also see the small open cluster NGC1502 at the end of the string. | | <input type="checkbox"/> | |
| Win | Aur | M37 NGC 2099 | 5.60 | 05:52.4 | +32:33 | Open cluster, 20', If you follow an imaginary line northward along the feet of Gemini for a couple of fields of view, you should see this cluster. Although you won't be able to resolve many of this cluster's faint stars with binoculars, if you look closely, you should notice how much more concentrated it becomes toward the centre. You may see M36 & M38 nearby. | 73 | <input type="checkbox"/> | |
| Win | Ori | M42 Orion Nebula | 4.60 | 05:35.4 | -05:27 | Great Nebula in Orion, 65' x60', The brightest nebula visible in the northern hemisphere. Appears as a bright green cloud surrounding Theta 1 and Theta 2 Orionis, the middle stars in Orion's sword. Once you find M42, just look at the top of the field of your binoculars and you'll see an attractive little group of 7 stars shaped like an aardvark; this is NGC 1981. | 36 | <input type="checkbox"/> | |
| Win | Gem | M35 NGC 2168 | 5.10 | 06:08.9 | +24:20 | Open cluster, 28', Another open cluster, this one lies at the feet of Gemini. Its appearance is best under dark skies, but it can be seen fairly well with 10x50 binoculars from a suburban location. | 36 | <input type="checkbox"/> | |
| Win | Pup | M47 NGC 2422 | 4.40 | 07:36.6 | -14:30 | Open cluster, 29', Starting from Sirius, look about two binocular fields eastward for a little splash of stars. In dark skies, you may also see the faint wisp of M46 (NGC 2437) in the same field. | 37 | <input type="checkbox"/> | |

Magnitude: Magnitudes are expressed in the same way as stars but deep sky objects often appear fainter because they are diffuse or spread out over the sky.

Size: Measured in arc-minutes. Once you have identified the object make a note of its relative size in arc-minutes. This will help you gain a feel for angular measurements used in astronomy. Deep Sky Objects are often extended in nature and can cover significant areas in the sky. For comparison the full Moon is about 30' in diameter or $\frac{1}{2}^\circ$.

Right Ascension – "RA" is the equivalent of longitude used on maps of the earth. The 360 degrees of sky, measured around the celestial sphere, is used as the basis for 24 hourly sections of Right Ascension as seen on star maps.

Declination – The 90 degrees of sky measured north and south of the celestial equator, is written on star maps as +1 to +90 (degrees north) and -1 to -90 (degrees south) with 0 degrees marking the celestial equator.

Double & Multiple Stars (10 of 20)

Double stars appear to the unaided eye as a single star but when viewed through binoculars or a telescope they can be split into two components. **Optical doubles** are a chance alignment in space that are adjacent to one another when viewed from Earth. **Physical doubles** are near one another (as part of an open cluster) while **binaries** are known to orbit around a common centre of mass. For certain double stars you can detect this orbital motion over a period of a few years.

Double stars offer interesting colour contrasts, magnitude differences and separations and many can be viewed easily from locations with moderate to heavy light pollution. To complete this section it is suggested that you work with binoculars mounted on a tripod. To find the stars listed you will need a good star atlas where you can plot their location using the co-ordinates listed for each one. A good way to confirm that you are observing the double star you where looking for is to check their magnitudes, separation and position angle.

Note: **Separation** is measured in arc-seconds. The larger the separation, the more easily you can discern the split between the stars. The **Position Angle** is the apparent angle measured from the brighter star to the dimmer one where due north is 0° and 90° is measured counter-clockwise from 0 degrees north as seen on a star atlas. The north point can be found on a star map by using the lines of Right Ascension (RA) that always point north. Be sure to carefully orient the map when checking your position angles to match your eyepiece view.

| Sea- son | Cons | Object | Mag. | Sep. | Pos. Angle | RA | Dec | Observing Notes | BOG? | Seen? ✓ | Log Page |
|-------------|------|-----------------------------|---------------------------|------------------|---------------|---------|--------|---|------|--------------------------|-------------|
| Spr | Leo | Zeta-36 | 3.5 & 5.8 | 325.9" | 340° | 10:16.7 | +23:25 | Proper name; Aldhafera. Secondary is 35 Leonis; Optical pair. | | <input type="checkbox"/> | |
| Spr | Com | 17 Com | 5.3 & 6.6 | 145.4" | 251° | 12:28.9 | +25:55 | In Coma Cluster; Common proper motion pair. | | <input type="checkbox"/> | |
| Spr | Com | 32 & 33 Com | 6.3 & 6.7 | 95.2" | 49° | 12:52.2 | +17:04 | Located south of the Coma Cluster near the star Alpha Comae Berenices. | | <input type="checkbox"/> | |
| Spr | CVn | 15 & 17 | 6.3 & 6.0 | 284.0" | 277° | 13:09.6 | +38:32 | Nice even magnitude pair located near Alpha CVn. | | <input type="checkbox"/> | |
| Spr | UMa | Zeta 79&80 | 2.4 & 4.0 | 708.7" | 71° | 13:23.9 | +54:56 | Middle star in the Big Dipper handle; 79 is also a telescopic double. | | <input type="checkbox"/> | |
| Spr | Lib | Alpha 2&1 | 2.8 & 5.2 | 231.0" | 314° | 14:50.9 | -16:02 | Proper name; Zuben El Genubi. Common proper motion pair. Look for colour. | | <input type="checkbox"/> | |
| Spr | Boo | Mu 51 | 4.3 & 7.0 | 108.3" | 171° | 15:24.5 | +37:23 | Located near Beta and Delta Bootis, a nice contrast of magnitudes. | | <input type="checkbox"/> | |
| Spr | CrB | Nu-1&2 | 5.4 & 5.3 | 364.4" | 165° | 16:22.4 | +33:48 | Look for the half circle of CrB then starhop from 13-Epsilon. | | <input type="checkbox"/> | |
| Spr | Dra | 17&16 | 5.4 & 5.5 | 90.3" | 194° | 16:36.2 | +52:55 | Find the 4 star "Head of the Dragon" pattern then use 23-Beta and 33-Gamma as pointers. | | <input type="checkbox"/> | |
| Spr | Dra | Nu-24&25 | 4.9 & 4.9 | 61.9" | 312° | 17:32.2 | +55:11 | Located in the 4 star "Head of the Dragon" pattern. An outstanding even magnitude double! | | <input type="checkbox"/> | |
| Sum | Lyr | Epsilon | 5.4 & 5.1 | 207.7" | 173° | 18:44.3 | +39:40 | Wide easy binocular pair. Telescope users can try splitting each star again to see the Double-Double. | | <input type="checkbox"/> | |
| Sum | Lyr | Zeta 6&7 | 4.3 & 5.9 | 43.7" | 150° | 18:44.8 | +37:36 | Zeta, Epsilon and Vega form a wide triangle. Use tripod-mounted binoculars or a telescope. | | <input type="checkbox"/> | |
| Sum | Lyr | Delta 11&12 | 5.6 & 4.5 | 630.0" | n/a | 18:53.7 | +36:58 | Very wide, easy binocular double with color. From Vega go to Zeta then on to Delta. | | <input type="checkbox"/> | |
| Sum | Cap | Alpha 2&1 | 3.6 & 4.2 | 377.7" | 291° | 20:18.1 | -12:33 | Wide visual or binocular double in nice starfield. | | <input type="checkbox"/> | |
| Sum | Cap | Beta 1&2 | 3.4 & 6.2 | 205.3" | 267° | 20:21.0 | -14:47 | Look for Beta just below Alpha. Nice magnitude contrast with secondary star. | | <input type="checkbox"/> | |
| Sum | Cyg | Omicron 31 (Triple!) | 3.8 - 6.7 4.8 - 337.5" | 107.0" - 323° | 173° | 20:13.6 | +46:44 | Beautiful triple star for binoculars. Look for colour. | | <input type="checkbox"/> | |

| Sea- son | Cons | Object | Mag. | Sep. | Pos. Angle | RA | Dec | Observing Notes | BOG? | Seen? ✓ | Log Page |
|-------------|------|-------------------------------------|-----------|--------|------------------|---------|--------|--|------|--------------------------|-------------|
| Sum | Cyg | Albireo (Beta Cygni) | 3.1 & 5.1 | 34.3" | 54 ^o | 19:30.7 | +27:58 | Albireo is one of the most beautiful double stars in the sky. Use tripod-mounted binoculars or a telescope. | | <input type="checkbox"/> | |
| Aut | Cyg | 16 Cygni | 6.0 & 6.2 | 39.5" | 133 ^o | 19:41.8 | +50:32 | Impressive pair located in the area of 10-Iota Cyg.(3.8m) and just next to 13-Theta (4.5m) Use tripod-mounted binoculars or a telescope. | | <input type="checkbox"/> | |
| Win | Tau | 78&77 Tauri | 3.4 & 3.8 | 337.4" | 346 ^o | 04:28.7 | +15:52 | Located in the beautiful Hyades star cluster. | | <input type="checkbox"/> | |
| Win | Cep | Delta 27 | 3.4 & 7.5 | 40.7" | 191 ^o | 22:29.2 | +58:25 | This famous Cepheid variable is also a very pretty double star. Use tripod-mounted binoculars or a telescope. | | <input type="checkbox"/> | |

Variable Stars (Supplementary)

Observing variable stars is one of the ways that backyard astronomers can contribute information that is helpful to professional astronomers. Because of the great number of observations required for variable stars, large observatories cannot provide enough observing time for experts to monitor them all. Many of these stars are among the most interesting and beautiful stars in the night sky, and it is well worth the effort to find them. There are four main categories of variable stars including **Pulsating**, **Eruptive**, **Eclipsing** and **Rotating**. Each major category has several specific groups within it.

The **Pulsating** category includes Cepheid variables, RR Lyrae type stars, RV Tauri type stars, Omicron Ceti (Mira) type stars that are also known as Long Period Variables (LPV). Also included in the Pulsating group are Semi-Regular and Irregular variable stars. The **Eruptive** category includes Supernovae, Novae, Recurrent Novae, U Geminorum type stars, Z Camelopardalis type stars, SU Ursae Majoris type stars, R Coronae Borealis type stars and Symbiotic stars. The **Eclipsing** category (two or more stars passing in front of one another from our point of view) includes Beta Persei (Algol) type stars, Zeta Aurigae type stars, Beta Lyrae type stars, W Ursae Majoris type stars and Ellipsoidal variables. The **Rotating** category includes RS Canum Venaticorum type stars that undergo small amplitude changes. More information about these specific groups of stars can be found in *The Observer's Handbook* or in other fine observing guides. Another excellent source of information is the American Association of Variable Star Observers (AAVSO). Variable star charts are available from the AAVSO on their website.

All of the stars listed here are from the Pulsating and Eclipsing categories. It is important when recording variable star magnitudes to observe the star regularly and to make a note of the date and time of each observation. Magnitude information includes "Ex" magnitudes that are extreme variations and "Av" which are long-term average variations. If your time is limited it is recommended that you make better observations of a moderate number of variable stars regularly than trying to observe a large number sporadically.

Visual / Binocular Objects

| Season | Cons | Star | Variable Type | Magnitude Range | Period (days) | Spectral Range | RA | Dec | Notes |
|--------|------|------------------------|----------------------|-----------------|---------------|----------------|---------|--------|---|
| Sum | Lyr | Beta 10 Lyrae | E (Eclipsing Binary) | 3.3-4.3 | 12.94 | B8-A8 | 18:50.1 | +33:22 | Bright EB; Proper name Sheliak; use Gamma Lyrae (Mag.3.3) for comparison. |
| Sum | Aql | Eta 55 Aquilae | DCEP (Delta Cepheid) | 3.5-4.4 | 7.17 | F6-G4 | 19:52.5 | +01:00 | Bright Cepheid; use Beta Aquilae (Mag.3.7) for comparison. |
| Aut | Cep | Mu Cephei | SR (Semi-Regular) | 3.4-5.1 | 730 | M2 | 21:43.5 | +58:47 | Known as Herschel's "Garnet Star". Compare color to the white star Alpha Cephei. |
| Aut | Cep | Delta 27Cephei | DCEP(Delta Cepheid) | 3.5-4.4 | 5.36 | F5-G2 | 22:29.2 | +58:25 | First Cepheid discovered; use Epsilon Cephei (Mag. 4.2) and Zeta Cephei (Mag.3.4) for comparison. |
| Aut | Per | Beta 26 Persei (Algol) | E (Eclipsing Binary) | 2.1-3.4 | 2.86 | B8+G5 | 03:08.2 | +40:57 | Proper name Algol; use Epsilon Per (Mag. 2.9), Delta Per (Mag.3.1), Kappa Per (Mag.3.8) and Gamma And (Mag.2.2) for comparison. |
| Win | Tau | Lambda-35 Tauri | E (Eclipsing Binary) | 3.5-4.0 | 3.95 | B3+A4 | 04:00.7 | +12:29 | Bright eclipsing binary; use Gamma Tauri (Mag. 3.6) and Xi Tauri (Mag. 3.7) for comparison. |
| Win | Gem | Zeta 43 Geminorum | DCEP (Delta Cepheid) | 3.6-4.2 | 10.15 | F7-G3 | 07:04.1 | +20:34 | Bright Cepheid; use Kappa Gem (Mag. 3.6) and Upsilon Gem (Mag. 4.2) for comparison. |

Binocular / Small Telescope Objects

| Season | Cons | Star | Variable Type | Magnitude Range | Period (days) | Spectral Range | R.A. | Dec. | Notes |
|--------|------|-----------------------|--------------------------------|-------------------------------|---------------|----------------|---------|--------|--|
| Spr | CVn | Y Canum Venaticorum | SR (Semi-regular) | 4.8-6.4 | 157 | C5-4J (N3) | 12:45.1 | +45:26 | Known as "La Superba", it is a deep red carbon star with a semi-regular period. |
| Sum | Oph | X Ophiuchi | M (Mira, Long Period Variable) | 6.8-8.8 (Av) 5.9-9.2 (Ex) | 334 | M6-K1 | 18:38.3 | +08:50 | Good example of a long period variable for small instruments; variable star chart recommended. |
| Sum | Scu | R Scuti | RV (RV Tauri) | 5.0-7.0 (Av) 4.5-8.6 (Ex) | 140 | G0-K0 | 18:47.5 | -05:42 | RV Tauri type variable with cycles of shallow and deep minima. |
| Sum | Lyr | RR Lyrae | RR (RR Lyrae) | 6.9-8.1 | 0.56 | A8-F7 | 19:25.5 | +42:47 | Interesting short period variable that goes through a complete cycle in less than one day. |
| Aut | Cet | Omicron 68Ceti (Mira) | M (Mira, Long Period Variable) | 3.4-9.5 (Av) 2.0-10.1 (Ex) | 332 | M5-M9 | 02:19.3 | -02:59 | Proper name Mira; has the brightest maxima of all LPV's and is the prototype of its class. |
| Win | Mon | T Monocerotis | DCEP (Delta Cepheid) | 5.6-6.6 | 27.02 | F7-K1 | 06:25.2 | +07:05 | Located near the Rosette Nebula, just north of the star Epsilon Monocerotis. |

Small/Medium Telescope

| Season | Cons | Star | Variable Type | Magnitude Range | Period (days) | Spectral Range | RA | Dec | Notes |
|--------|------|------------|----------------------|--------------------------------|---------------|----------------|---------|--------|---|
| Spr | Leo | R Leonis | M (Mira, LPV) | 5.8-10.0 (Av) 4.4-11.3 (Ex) | 313 | M8 | 09:47.6 | +11:26 | Bright LPV that is well placed for observing in the spring season. |
| Spr | Vir | R Virginis | M (Mira, LPV) | 6.9-11.5 (Av) 6.0-12.1 (Ex) | 146 | M4.5 | 12:38.5 | +06:59 | A LPV with a shorter than average period of just 145 days. |
| Sum | Aql | R Aquilae | M (Mira, LPV) | 6.1-11.5 (Av) 5.5-12.1 (Ex) | 284 | M5-M9 | 19:06.4 | +08:14 | The brightest LPV in Aquila. Its red colour intensifies around minima. |
| Aut | Cep | S Cephei | M (Mira, LPV) | 8.3-11.2 (Av) 7.4-12.9 (Ex) | 486 | C7(N8) | 21:35.2 | +78:37 | A carbon star that is one of the reddest known. Look for it between Kappa and Gamma Cephei. It will be reddest around minima. |
| Win | Tau | RW Tauri | E (Eclipsing Binary) | 7.9-11.4 | 2.76 | B8+K0 | 04:03.9 | +28:08 | An interesting EB that drops 3.5 magnitudes during eclipse. It is located near the star 41 Tauri. |
| Win | Lep | R Leporis | M (Mira, LPV) | 6.8-9.6 (Av) 5.5-11.7 (Ex) | 432 | C6 | 04:59.6 | -14:48 | Known as Hind's "Crimson Star", it is a red carbon star that displays a deep red crimson hue around minima. |
| Win | Ori | U Orionis | M (Mira, LPV) | 6.3-12.0 (Av) 4.8-12.6 (Ex) | 372 | M6.5 | 05:55.8 | +20:10 | An excellent LPV that features a large range in brightness. Find it near 54 and 57 Orionis. |