Yoders Constellation Guides



James Yoder

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About the Author

James Yoder

James is an active member of the East Valley Astronomy Club (EVAC) in the Phoenix metropolitan area of Arizona. He has developed a beginner-level astronomy course, offered by the club, that covers the fundamentals of observational astronomy and teaches beginners how to use a telescope. He has also co-authored the Star Hopper's Guide to the Universe.

Introduction

The intent of creating this book is to provide a reference to many of the interesting objects located in each of the constellations detailed here. The ultimate plan is to cover all 88 constellations, and to that end this is an ever-evolving book. Recently (2026-04-01), I have modified the format of the guides to provide a more functional constellation map clearly identifying the objects covered in the guide, and also have started to replace the 4° finder scope views with a star-hop chart to name a few changes. I intent on implementing these and other changes in future guides and eventually going back to update guides already created in the older format.

Visual astronomy (as opposed to astrophotography) is about what you are looking more than what you see. Putting this another way most deep sky objects are fuzzy spots; what you see is generally not very impressive, the fact that the fuzzy spot you are looking at may be billions of stars, millions of light years away is mind blowing.

Select the Appropriate Targets

There are a few factors that need to be considered when deciding what objects to observe.

- How dark is your night sky
- What objects/constellations are well positioned for viewing
- What is the aperture size of your telescope?
- The field of view (FOV) of your optical train (hardware configuration)?

Understanding these factors and using them to help determine what targets you want to view will help cut down on frustrations you might experience for your viewing session. Let's explain each of these points in more detail.

How Dark is your night sky

Light pollution can really limit what objects can be seen, this is especially true with deep sky objects such as Galaxies, Globular Clusters, and Nebula. The darker the sky the easier it is to distinguish did objects from the background (Contrast). Observing in an area with lots of light pollution? Focus on targets that light pollution will not impact as much; planets, the moon, multiple star systems, and open clusters.

What Objects/constellations are well positions for viewing

The higher an object is in the sky the less atmosphere the light has to travel through, so generally try to keep to targets that are 30 degrees or so above the horizon. Another factor to consider is your telescope mount. Every telescope design has weak spots where observing can be awkward; For equatorial mounts this is around the north star, for Alt/Az mounts it tends to be directly overhead (especially for GoTo mounts). Try to time your viewing to avoid these awkward positions when possible.

What is the aperture size of your telescope

Size can matter, but especially so in dark skies when it comes to galaxies. Nothing beats a dark sky and larger aperture for viewing galaxies. Larger apertures (8" and bigger) really don't bring much more to the table if the skies are bright. So, the rule for in-city viewing regardless of aperture size is keep to the brighter targets (Moon, planets, multiple star systems, and on rare occasions globular clusters). Dark skies will help smaller telescopes locate galaxies, but generally, you only start seeing structure in many of the galaxies when your aperture start exceeding 11 inches.

The field of view (FOV) for your optical train (hardware configuration)

The combination of the Aperture size and focal length of your Optical Tube Assembly (OTA) along with the eyepiece characteristics will define the magnification and size of the field of view. For most binoculars these are fixed values, for telescopes these changes based on what eyepiece you are utilizing. Understand what the range of FOV is for your equipment so you can select targets that are appropriate for your equipment. Some objects are very large and will never fit in a telescope but look fantastic in a good pair of binoculars; those same binoculars may have no hope of resolving components of a many multiple star systems.

Adjust Your Targets Based on Your Seeing conditions and Hardware

Living in a suburb of Phoenix Arizona, I have also found that in less-than-ideal conditions and with a modest size telescope most of the deep sky objects are out of reach. I have learned to select my targets and set my expectations according to what the night sky conditions will allow. When viewing in my back yard, in the city I will focus more on objects that are not as impacted by light pollution, such as the planets, the moon, multiple star systems and open clusters. When going to a relatively dark site I then focus more on the deep sky objects such as galaxies globular clusters nebula, etc. When focusing on open clusters binoculars may perform best, focusing on multiple star systems and the planets telescopes will generally perform better

James Yoder

References, Resources and Tools used to create Book

Many resources were utilized in identifying objects of interests for each constellation. Similarly, a number of applications were used to research and generate the images and notations associated with targets in this list.

- Books
  - Objects in the Heavens: Peter Birren
  - Touring the Universe through Binoculars: Philip Harrington
  - The Deep Sky: Philip Harrington
  - Double and Multiple Stars and How to Observe Them: James Mullaney
  - Celestial Portraits: Tom Polakis
  - Star Clusters: Bret Archinal, Steve Hynes
  - Sky Spot Books
    - Bright Telescopic Objects: Brent Watson
    - Select Double Stars: Brent Watson
    - Overlooked Objects: Brent Watson
- Asterisms
  - Astronomical League: Asterisms observing program List
  - Asterisms: Demeiza Ramakers
  - Pattern Asterisms: John Chiravalle
  - Milwaukee Astronomical Society: Binocular Asterisms
  - Deep-Sky.co.uk: Observing Asterisms (David Ratledge)
- Saguaro Astronomy Club
  - Asterisms List
  - 110 Best of the NGC
  - Red Stars List
- Online
  - Wikipedia
  - The Garden Astronomer: Double, Multiple, and Special Star Observations List
  - Sky & Telescope: Colored Double Stars, Real and Imagined
  - In-The-Sky.org
  - Constellation-guide.com
  - Claude AI – See next section on Utilization of Large Language Models for more details.

Applications

- SkyTools 4.1 Visual Professional
- AstroPlanner Version 2.4
- Cartes du Ciel Version 4.3
- Sky Safari Pro 7
- Microsoft Office Home and business 2021 - Word
- Microsoft Visio Professional 2021
- IrfanView Version 4.72

Utilization of Large Language Models (Claude AI)

Claude AI (AKA Claude) is a series of large language models developed by Anthropic and has been utilized to help automate and develop a number of aspects including some of the illustrations, tables and calculated values in Yoder's Constellation Guides.

While not all utilization of Claude AI will be identified in this document some of the more important ones are noted here with a one-line summary of what Claude AI performs. More details information on each of these items can be located on the Yoders' Constellation Guides webpage on the ArtCentrics.com website.

Most of the tasks assign to Claude include generating illustrations, generating tables, and automating data collection and calculations for the constellation guides.

Tables and Illustrations

- Approximate Separation Limit Table – Calculate the angular separation limit for multiple stars give the telescope size and difference in magnitude between stars.

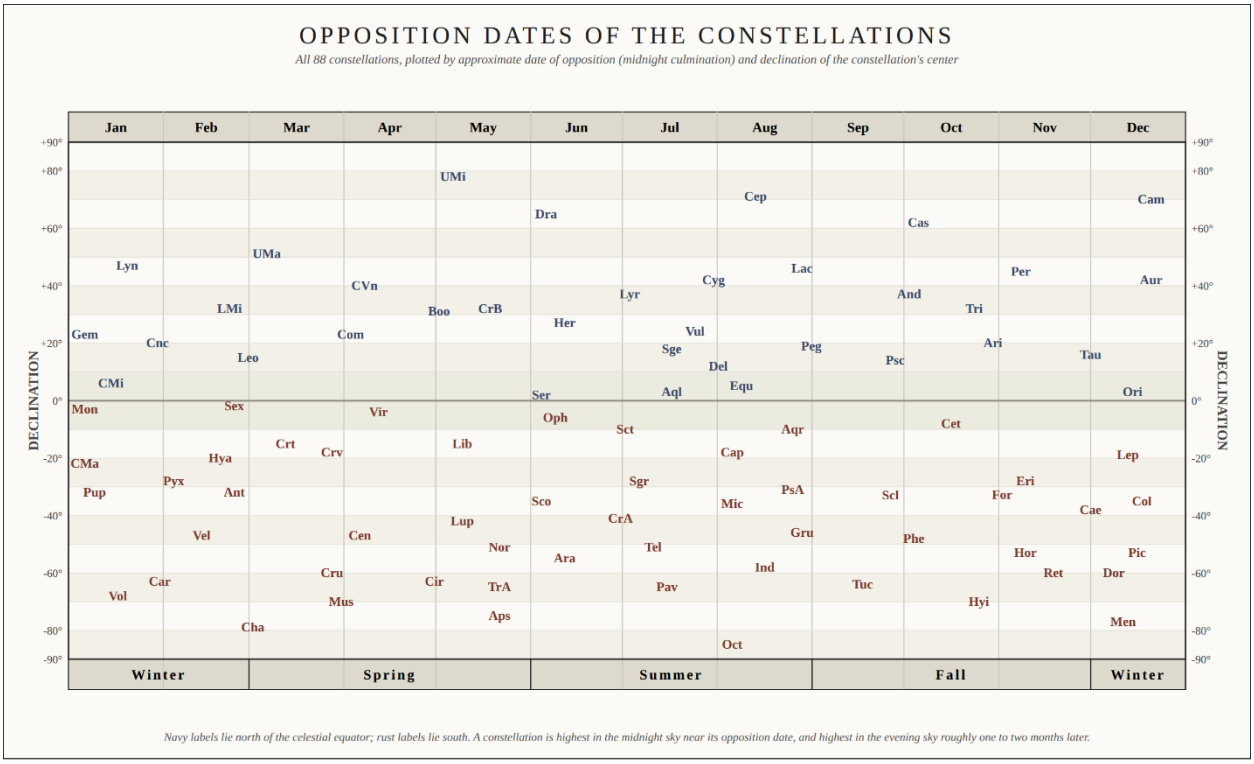
Constellation Guide Lookup and Automation

- Alias Lookup – Web-based alias search for astronomical targets.
- Statistics Lookup – Web-based statistics (magnitude, size, etc.) search for astronomical targets.
- Morphology Lookup – Web-based lookup for morphology classifications of astronomical targets.
- Maximum Bortle Sky Calculation – Rough estimate of what the highest Bortle sky rating is possible to still identify an object in a 6" telescope.
- Minimum Aperture Calculation – Rough estimate of what the minimum aperture size is required to still identify an object in a Bortle 4 sky.

Constellations, Seasons and Greek Alphabet

Northern Hemisphere Constellations List (Alphabetical)								
Abr.	Constellation	Season	Abr.	Constellation	Season	Abr.	Constellation	Season
And	Andromeda	Fall	Crt	Crater	Spring	Peg	Pegasus	Fall
Ant	Antlia	Spring	Cyg	Cygnus	Summer	Per	Perseus	Fall
Aqr	Aquarius	Fall	Del	Delphinus	Summer	Phe	Phoenix	Fall
Aql	Aquila	Summer	Dra	Draco	Summer	Psc	Pisces	Fall
Ari	Aries	Fall	Equ	Equuleus	Summer	PsA	Pisces Austrinus	Fall
Aur	Auriga	Winter	Eri	Eridanus	Fall	Pup	Puppis	Winter
Boo	Bootes	Spring	For	Fornax	Fall	Pyx	Pyxis	Winter
Cae	Caelum	Winter	Gem	Gemini	Winter	Sge	Sagitta	Summer
Cam	Camelopardalis	Winter	Gru	Grus	Fall	Sgr	Sagittarius	Summer
Cnc	Cancer	Winter	Her	Hercules	Summer	Sco	Scorpius	Summer
CVn	Canes Venatici	Spring	Hya	Hydra	Spring	Scl	Sculptor	Fall
CMa	Canis Major	Winter	Lac	Lacerta	Fall	Sct	Scutum	Summer
CMi	Canis Minor	Winter	Leo	Leo	Spring	Ser	Serpens	Summer
Cap	Capricornus	Summer	LMi	Leo Minor	Spring	Sex	Sextans	Spring
Cas	Cassiopeia	Fall	Lep	Lepus	Winter	Tau	Taurus	Winter
Cen	Centaurus	Spring	Lib	Libra	Spring	Tri	Triangulum	Fall
Cep	Cepheus	Fall	Lup	Lupus	Spring	UMa	Ursa Major	Spring
Cet	Cetus	Fall	Lyn	Lynx	Winter	UMi	Ursa Minor	Spring
Col	Columba	Winter	Lyr	Lyra	Summer	Vel	Vela	Winter
Com	Coma Berenices	Spring	Mic	Microscopium	Summer	Vir	Virgo	Spring
CrA	Corona Australis	Summer	Mon	Monoceros	Winter	Vul	Vulpecula	Summer
CrB	Corana Borealis	Spring	Oph	Ophiucus	Summer			
Crv	Crovus	Spring	Ori	Orion	Winter			

This chart maps the declination of constellations and their date of opposition. It is a graphic representation of when a constellation and contained objects are best positioned for viewing.



Greek Alphabet																		
	Low	Up	Name		Low	Up	Name		Low	Up	Name		Low	Up	Name		Low	Up	Name
01	α	Α	alpha	06	ζ	Ζ	zeta	11	λ	Λ	lambda	16	π	Π	pi	21	φ	Φ	phi
02	β	Β	beta	07	η	Η	eta	12	μ	Μ	mu	17	ρ	Ρ	rho	22	χ	Χ	chi
03	γ	Γ	gamma	08	θ	Θ	theta	13	ν	Ν	nu	18	ς	Σ	sigma	23	ψ	Ψ	psi
04	δ	Δ	delta	09	ι	Ι	iota	14	ξ	Ξ	xi	19	σ	Τ	tau	24	ω	Ω	omega
05	ε	Ε	epsilon	10	κ	Κ	kappa	15	ο	Ο	omicron	20	τ	Υ	upsilon	25			

Online Resources

Below are some additional astronomy related resources.

- Skyledge.net website: Jim Mazur's website contains not only star hop charts but also many excellent examples of astrophotography.
    - Star Hopping
- ArtCentrics.com website: James Yoder's website contains astronomy and other hobby related resources.
    - Beginner's Guide to Small Telescopes: Course materials and Zoom meeting recordings for practical telescope use for people looking to purchase or who have just purchased a telescope.
- Stellarium Web: Free online planetarium program for planning your observation sessions.
- FreeStarCharts.com: Free online charts for constellations, select stars, Messier, NGC and IC catalogs.
- The Sky Live: Guide to the solar system and the night sky
- Astronomy Tools: Various online calculators.
- MoonConnection.com: All things related to the moon including a moon phase calendar.
- Carbon, Binary and Multiple Star Systems
    - Wikipedia: Star System
    - Cloudy Nights: Double Star Observing
    - Cloudy Nights: Double your pleasure (Sketches)
    - Stelle Doppie – Search engine to the Washington Double Star Catalog (WDS)
    - Bright Star Catalogue Online search for bright stars.
    - Wikipedia: Carbon Star
    - Mahoning Valley Astronomical Society: 116 Best Carbon Stars List (PDF).
- Additional Observing Resources
    - Astronomical League Log Books (PDF) complements of Mathew Wedel
        - Double Star Club
        - Deep Sky Binocular Observing Club
        - Binocular Messier Club
        - Binocular Double Star Club
- Deep-sky.co.uk: Observing Asterisms
- The Seven Sisters Observatory: The Star List

Conventions and Catalogs

Constellation Summary Sheet

Each featured constellation sheet includes the name of the constellation, the constellation abbreviation, the number of objects featured in the constellation, links to online information, and a summary table.

Example Constellation Summary Table

Object (Type)	Links	Gear	Aliases	Stats
Messier 10 (GC)	1	B, T	M-10; NGC-6254; GCl-49	| Mag=6.6 | Size=20.0' | SB=21.7 | mBortle=7 | mApt=50mm | MC=VII |
Rasalhague (DS)	1, 2	T	SAO-102932; HIP-86032; Alpha Ophiuchi; 55 Ophiuchi; HD 159561; HR 6556; BD+12 3252; FK5 656	**AB**| Mag=2.1,5.0 | Sep=0.8" | PA=24° | mBortle=? | mApt=250mm | Period=8.6y | Spec=A5III, K5V | Color=white, orange |
IC 4665 (OC)	1	B	Collinder 349; Mel 179; Summer Beehive Cluster; Poseidon's Trident	| Mag=4.2 | Size=70' | mBortle=9 | mApt=50mm | MC=III2p |
Barnard's Star (Star)	1	B, T	HIP-87937; V2500 Oph; GJ 699; BD+04 3561a; LHS 57; LTT 15309; Proxima Ophiuchi; Velox Barnardi	| Mag=9.6 | Spec=M4V | Color=red |
Bull of Poniatowski (AS)	1	B	Taurus Poniatovii; Taurus Poniatowski; Poniatowski's Bull; [66, 67, 68, 70, 72] Oph	| Size=210' | Stars= 7|
NGC 6572 (PN)	1	T	Emerald Nebula; Blue Racquetball Nebula; Turquoise Orb Nebula; Green Nebula	| Mag=8.1 | Size=0.25' | SB=13.7 | mBortle=9 | mApt=50mm | MC=Elliptical |
TY Ophiuchi (CS)			J183123.29+042253., HD170831, Sky18310086	| Magnitude Range= 6.5 to 9.8 | Spec=C5,5 | Color=red |

The summary table contains the following columns:

- **Object (Type)**: Name of the object along with the type of object. Object types include:

Abr	Object	Abr		Abr	
AS	Asterism	**DS**	Double Star system	**EN**	Emission Nebula
OC	Open Cluster	**MS**	Multiple Star System	**PN**	Planetary Nebula
GC	Globular Cluster	**CS**	Carbon Star	**RN**	Reflection Nebula
G	Galaxy	**DN**	Dark Nebula	**SNR**	Supernova Remnant
GX	Galaxy Cluster	**Star**	**Individual star**		

- **Links**: The link(s) provided in this column depend on the target. For double and multiple star systems the first link is to the Stelle Doppie website for the star system. This website has extensive details on double and multiple star systems. The second link (if provided) is to the Wikipedia website where more information on the target is provided. For all other objects the first (and usually only) link is to the Wikipedia website.
- **Gear**: This is a quick and dirty listing of what gear may be best for observing the target.
  - **B**: Binoculars – For multiple star systems a separation of at least 15" (arcseconds) and deep space objects larger than 15' (arcminutes) are considered appropriate targets.
  - **T**: Telescope – Objects smaller than 60' (arcminutes) are generally considered good telescope targets.
- **Aliases**: Alternate identification(s) for the featured object.

- **Stats**: Further details on the object. Information is separated by the pipe (|) symbol. What values are reported in the Stats column depends on the Object Type. Values that may appear include:
    - **Mag**: Magnitude of object. For multiple star systems, a magnitude is supplied for each component in the system.
    - **Size**: For non-stellar objects the size of the object measured, in arcminutes (') or degrees (°).
    - **SB**: Surface Brightness is provided for most of the non-stellar objects to help indicate how easily the object is to distinguish from the background.
    - **mBortle**: This is a ball-park estimate of the maximum Bortle Scale sky that is required to have a chance of seeing the object. This estimate has a lot of assumptions, including the assumption of a 6" telescope is being used. See Claude AI Models section for more details.
    - **mApt**: The Minium aperture size required to identify an object. Another estimated value with many assumptions including that the observation is in at Bortle 4 sky. See Claude AI Models section for more details.
    - **Sep**: Separation is provided for multiple star systems; these distances are provided in units of arcseconds (").
    - **Magnitude Range**: For Carbon Stars the range of magnitude the star can exibit.
    - **Period**: For multiple star systems this is the orbital period in years of the stars. For Carbon Stars this represents the period of osculation of the star.
    - **Spec**: For stars including double star systems the spectra class of the star(s).
    - **BV**: For Carbon Stars the B-V color index, a numeric value that predicts how "red" a star may appear when viewed. Higher positive values above 2.5 indicate they may be quite red. B-V values can be as high as 6.0.
    - **Color**: For stars, the associated color with the spectra class of the star(s).
    - **MC**: Morphological Classification. Different classification schemes have been developed for many deep sky objects including galaxies, open clusters, globular clusters, stars, dark nebula and planetary nebula. See the Morphological Classification section of this guide for more details of each classification. Briefly these are the classifications used:
        - Globular Clusters: Shapley–Sawyer Concentration Class
        - Open Clusters: Trumpler Classification
        - Dark Nebula: Lynds Opacity (1–6)
        - Planetary Nebula: Balick morphology (Round / Elliptical / Butterfly)
        - Galaxies: De Vaucouleurs class
        - Stars, Carbon, Double and Multiple Star systems: Harvard spectral type (+ C-system subtype for carbon stars)

Stellar Naming Conventions

Stars may be identified on a map or in documentation in a number of ways. The most common methods, listed in order of preference are: proper names, Bayer designations, and Flamsteed designations.

- Proper Names: These are the traditional names assigned to bright stars through history; most have Arabic origins.
- Named After Individuals: A few select stars are named after people.

- Catalogue Designations: There are a number of catalogs used to identify stars. Two common catalogs and their methods include:
    - Bayer designation: Brighter stars in a constellation are assigned Greek letters beginning with the brightest, alpha (α), and decreasing in brightness to the final Greek letter, omega (ω).
    - Flamsteed designation: Lists stars by constellation, but by number rather than letter, ordering them by increasing right ascension rather than by decreasing brightness.

Astronomical Catalogs

Various astronomical catalogs are used to identify stars and other deep sky objects. Some of the most common catalogs, along with their object identification notations, include:

- Abell Catalog of Rich Clusters of Galaxies (**Abell, ACO, A**): A catalog of 4,073 rich clusters of galaxies.
- Aitken Double Star Catalog (**ADS**): A catalog of 17,180 double stars north of declination -30°.
- Barnard Catalogue (**B**): A catalog of 349 dark nebulae.
- Bright Star Catalogue (**BS**, **BSC**, **HR**): First published in 1930, lists stars down to magnitude 6.5 and contains 9,110 objects and 9,095 stars.
- Collinder Catalog (CR): A catalogue of 471 open cluster compiled by Swedish astronomer Per Collinder. Published in 1931.
- Caldwell Catalogue (**C**): A catalog of 109 deep sky objects including star clusters, nebulae, and galaxies. Developed as a supplement to the Messier Catalog.
- Henry Draper Catalogue (**HD**): Named after Henry Draper, covers the entire sky and captures almost all stars down to an apparent photographic magnitude of about 9.
- Index Catalog (**IC**): The first major update to the NGC is the Index Catalogue of Nebulae and Clusters of Stars and serves as a supplement to the NGC, and contains an additional 5,386 objects.
- Hipparcos Catalogue (**HIP**) – A high-precision catalogue of more than 118,200 stars, published in 1997.
- Lynds' Catalogue of Dark Nebulae (**LDN**): Contains a list of 1802 dark nebulae.
- Messier Objects (**M**): A list of 110 astronomical objects catalogued by Charles Messier in his search for comets.
- Melotte Catalog (**Mel**): A catalog of 245 star clusters.
- New General Catalogue (**NGC**): List of 7,840 deep sky objects.
- Ruprecht Ru) — Jaroslav Ruprecht (open star clusters).
- Small Telescope Asterism Roster (STAR) Roster - A total of 29 Asterisms initially started by Philip Harrington.
- Smithsonian Astrophysical Observatory Star Catalog (**SAO**): Initially compiled in 1966 and contains approximately 259,000 stars. Since most GoTo telescopes include this catalog, SAO numbers are provided for stars in this document whenever possible.
- Sharpless Catalog (**Sh**): A list of 313 emission nebulae.
- Struve (STF, Σ) – Catalog of double stars compiled by Friedrich Georg Wilhelm von Struve.

Hints and Tricks

Units of Measure

Some of the most common units of measure used in astronomy include:

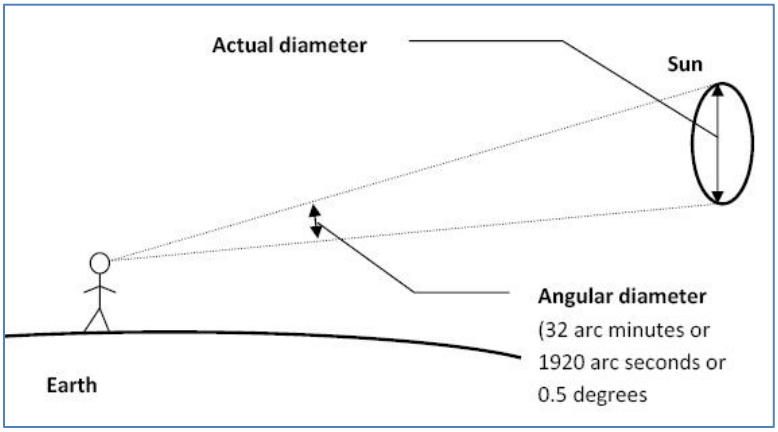
- Distances
  - Astronomical Unit (**AU**) – The Average Earth-Sun Distance. 1 AU is approximately 150 million kilometers or about 93 million miles. Light takes approximately 8 minutes to reach the earth from the sun.

    1 AU ≈ 150 million km **1 AU ≈ 93 million miles**

  - Light Year (**ly**) – The distance light travels in one year. 1 ly is approximately 9.46 trillion km or about 5.88 trillion miles. The closest sun to our own sun is Proxima Centauri at about 4.25 ly from earth.

    1 ly ≈ 9.46 trillion km **1 ly ≈ 5.88 trillion miles** **1 ly ≈ 63.2 thousand AU**

- Angular Diameter Also called angular size, apparent diameter, apparent size. The angular diameter of an object is how large an object appears from a point of view. We are interested in the angular diameter of celestial objects from earth.



  - Degree (°) –Generally degrees are used to describe the size of larger objects in the sky such as open clusters or distances between constellations. 360° form a full circle. The Sun has an angular diameter of about ½° in the sky.
  - Arcminute (’) – Also called minute of arc, arc minute, minute arc. The angular diameter of globular clusters, planets, nebulae and galaxies are usually expressed in arcminutes. There are 60 arcminutes in one degree.
  - Arcsecond (”) – Also called second of arc, or arc second. Arcseconds are typically used to describe the apparent distance between stars in multiple star systems or the angular diameter of a planet in our solar system. There are 60 arcseconds in one arcminute; 3,600 arcseconds in one degree. Jupiter’s angular diameter varies between about 30 arcsec to 60 arcsec.

    1° = 60’ = 3,600” **1’ = 60”**

Field of View

It's important to understand the field of view (FOV) for your particular optical train configuration. The optical train refers to all the hardware that the light from the source travels through to get to your eye. This will typically include your Optical Tube Assembly (OTA) aka your telescope and the equipment attached to it. Some examples of equipment that may be attached to the back of a telescope may include a star diagonal, visual back, extension tube, focal reducer, Barlow lens, filter, and of course the eyepiece.

Understanding the FOV for your optical train will help give you an idea of how large an object will appear when you observe it; You may discover that the object is entirely too large to fit in your field of view. For multiple star systems it will give you an idea of how far apart the stars may appear in your eyepiece when viewing them. Understanding your field of view and the size of your target can be very informative when deciding what objects to view, or what eyepiece you may want to use to view an object.

There are websites such as Atronomy.Tools that provide a FOV Calculator. These are great for a first approximation, you just provide a few parameters of the telescope and eyepiece(s) and it will calculate your field of view for you. For most reputable telescopes and eyepieces this data is readily available. However, if you don't have this data or if you have introduced another component in your optical train between the telescope and the eyepiece (which is usually the case) that increases the optical path length (such as a star diagonal or extension tube) these calculated values will not be accurate. It is probably best just to measure the FOV for yourself so you know exactly what this value is. Please keep in mind the FOV will change whenever you change your optical path such as changing an eyepiece, adding a focal reducer, changing your star diagonal, etc. Most casual observers will usually only have a few configurations they use for viewing objects.

Measuring the Field of View

One technique for measuring the field of view for a given configuration of optical train is called the **drift method**. Follow the procedure below to calculate your FOV:

- Locate a star within 20° of the celestial equator (ie should have a RA between +20° to -20°.
- Locate the star in your eyepiece, turn off the tracking on your mount (if you have tracking) and observe the direction of drift of the star.
- Position the star so that when it drifts through your eyepiece the path it travels will take it through the center of the eyepiece (this will ensure it will travel the most distance as it drifts through your eyepiece).
- Place the star just outside of the field of view of the eyepiece so it will drift into and across the field of view.
- Time the amount of time it takes for the star to drift across the field of view, from when it enters the field of view to when it exits the field of view – this is called the **drift time**. The star should pass through the center of the field of view if you have this setup correctly. Record this value in seconds.
- For a more accurate calculation, repeat this measurement three times and calculate the average time it takes for the star to travel the length of the field of view.
- Calculate the Field of View by plugging the travel time (seconds) into this equation:

Field of View Calculation

$$FOV'(inarcminutes) = (Drift\ Time\ in\ Seconds) \times \cos(Star\ Declination°) \times 0.2507$$

An example:

- Star = Prycon
  - Declination = 5° 10’ = (5 + (10/60))= **5.167°** (Converted deg, min to decimal degrees)
  - Cos (5.167) = 0.996
- Drift Time
  - Reading 1: 130 sec
  - Reading 2: 128 sec
  - Reading 3: 134 sec
  - Average drift time = (130 + 128 + 134)/3 = **131 sec**

FOV’ = (131 sec) x (0.996) x (0.2507) = **32.7’**

Resolution Limit

Equally important to understanding the field of view (FOV) of your optical system (binoculars or telescope) is understanding the resolution limit for your equipment. This information is particularly relevant when viewing multiple star systems. For resolving components in a multiple star system, telescopes/binoculars with aperture of 180mm (7”) or greater and excellent optics will likely be limited by seeing conditions. Exceptional seeing conditions will allow separation as low as 0.5”, but more typical atmospheric limits will vary between 1” to 3”. The Equation $\boldsymbol{R = \frac{134}{D}}$ where ***R*** is the resolution limit in arc seconds (“) of the telescope and ***D*** is the diameter of the telescope in mm is a good approximation Some examples are provided below:

Diameter (mm/inch)	Limit (“)
20mm/0.79”	6.7”
40mm/1.6”	3.4”
50mm/2.0”	2.7”
60mm/2.4”	2.2”
70mm/2.8”	1.9”
80mm/3.1”	1.7”

Diameter (mm/inch)	Limit (“)
90mm/3.5”	1.5”
120mm / 4.7”	1.1”
150mm / 5.9”	0.89”
180mm / 7.1”	0.75
<200mm / 7.9”	Atmosphere

When considering separating components in a star system there is more to determining if the components will be able to be resolved than atmospheric conditions and aperture size, the difference in magnitude between stars also comes into play. There doesn’t seem to be a quick and dirty equation defining this but the table below may serve as a good approximation when trying to get a handle of what a typical telescope may be able separate.

Approximate Separation Limit Table

Diam (mm)	50	60	70	80	90	100	120	150	180	200	250
Δ mag = 0.0	2.3”	1.9”	1.7”	1.5”	1.3”	1.2”	1.0”	0.8”	0.6”	0.6”	0.5”
Δ mag = 0.5	2.7”	2.3”	1.9”	1.7”	1.5”	1.4”	1.1”	0.9”	0.8”	0.7”	0.5”

Diam (mm)	50	60	70	80	90	100	120	150	180	200	250
Δ mag = 1.0	3.2”	2.6”	2.3”	2.0”	1.8”	1.6”	1.3”	1.1”	0.9”	0.8”	0.6”
Δ mag = 1.5	3.7”	3.1”	2.6”	2.3”	2.0”	1.8”	1.5”	1.2”	1.0’	0.9”	0.7”
Δ mag = 2.0	4.3”	3.6”	3.1”	2.7”	2.4”	2.1”	1.8”	1.4”	1.2”	1.1”	0.9”
Δ mag = 2.5	5.0”	4.2”	3.6”	3.1”	2.8”	2.5”	2.1”	1.7”	1.4”	1.2”	1.0”
Δ mag = 3.0	5.8”	4.9”	4.2”	3.6”	3.2”	2.9”	2.4”	1.9”	1.6”	1.5”	1.2”
Δ mag = 3.5	6.8”	5.7”	4.9”	4.2”	3.8”	3.4”	2.8”	2.3”	1.9”	1.7”	1.4”
Δ mag = 4.0	7.9”	6.6”	5.7”	5.0”	4.4”	4.0”	3.3”	2.6”	2.2”	2.0”	1.6”
Δ mag = 4.5	9.2”	7.7”	6.6”	5.8”	5.1”	4.6”	3.8”	3.1”	2.6”	2.3”	1.8”
Δ mag = 5.0	10.8”	9.0”	7.7”	6.7”	6.0”	5.4”	4.5”	3.6”	3.0”	2.7”	2.2”

Detecting Deep Sky Targets and Sky Brightness

The surface brightness of an object is the magnitude divided by the apparent area of the object. This can be of assistance in determining how dim an object will appear. However, this measurement has real limitations, measurements of the area of the object can vary and the assumption that the object is homogeneous in appearance is usually a gross oversimplification.

Bortle Scale — Telescopic Surface Brightness Detection Limits

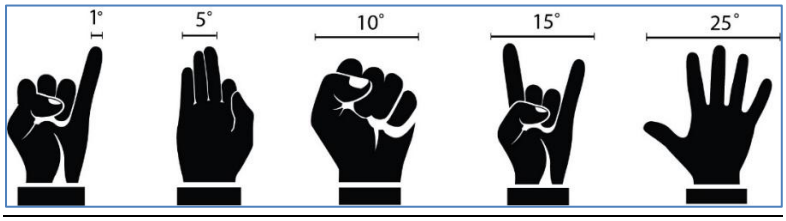
Detection limits use the ~3.25 mag contrast threshold (5% rule) from Clark (1990). Practical limit = theoretical − 0.5 mag for real-world conditions. Units: mag/arcsec² (larger number = fainter). Source: Wikipedia Bortle Scale; Crumey (2014); Torres.

Bortle Class	Sky Type	SQM Sky Brightness (mag/arcsec²)	Theoretical Detection Limit (mag/arcsec²)	Practical Detection Limit (mag/arcsec²)	Example Detectable DSOs
1	Excellent dark	21.76 – 22.00	~25.0	~24.5	Faint galaxy filaments, Stephan's Quintet, IFN patches, galactic cirrus
2	Truly dark	21.60 – 21.75	~24.8	~24.3	Leo Triplet halos, faint galaxy groups, outer spiral arms of M33
3	Rural	21.30 – 21.60	~24.6	~24.1	Virgo Cluster faint members, large faint nebulae, M33 directly visible
4	Brighter rural	20.80 – 21.30	~24.1	~23.6	Most Messier nebulae, bright Virgo members, large face-on spirals
5	Suburban	19.25 – 20.30	~23.1	~22.6	Bright Messier objects (M42, M31, M8), obvious globular clusters
6	Bright suburban	18.50 – 19.25	~22.1	~21.6	M42 core, M13, M31 nucleus region, bright planetary nebulae
7	Suburban/urban	18.00 – 18.50	~21.4	~20.9	M42 bright core, compact globulars, bright planetary nebulae only
8	City sky	<18.00 (~17–18)	~20.8	~20.3	Only the very brightest objects: Orion Nebula core, M13 (barely), Moon/planets
9	Inner city	<17.00 (~16–17)	~19.8	~19.3	Only very high surface brightness cores: M42 Trapezium region, bright planetary nebulae with filter

How limits are calculated: The sky SQM midpoint for each Bortle class is taken from the Wikipedia/Crumey (2014) table. The theoretical detection limit adds 3.25 mag to the sky brightness (the "5% contrast threshold": an object must be ~5% brighter than the sky, or ~3.25 mag brighter in log terms) per Clark (1990) and Torres. The practical limit subtracts ~0.5 mag to account for less-than-ideal conditions, object morphology, and observer variability. For Bortle 8–9, SQM values are extrapolated as the scale becomes less precisely defined. These limits assume a large enough object (≳5–10 arcmin) and optimum magnification; small/compact objects are harder.

Estimating Angular Distances

A convenient way of estimating large distances between objects in the sky is illustrated below. By extending your hand out at arm's length to the various configurations shown below you can estimate distances in the sky.



Framing Objects

The angular diameter of various deep sky objects and the apparent distance between stars (separation) in multiple star systems is provided for most objects (in this book in the constellation summary page in the stats column). It is important that the equipment you are using has an appropriate field of view to enable you to see the object(s) and details you would like to observe. There are online calculators that can help calculate the field of view for your specific equipment configuration. Understanding the angular diameter (or separation) of potential viewing targets and the field of view of your equipment will be informative when deciding the best eyepiece for viewing an object or if a pair of binoculars may be more appropriate to observe the object.

Log Book

Keeping a log book is a great way of keeping track of what objects you have observed and recording any notes that may prove helpful for future observations. In the Appendix of this book, you will find a Log Book Section that includes the following forms:

- Astronomy Observation Log Summary – Used as an index to summarize your log entries.
- Astronomy Observation Log – Where you can record your observations.
- Astronomy Sketch Log – Where you can record your observations and sketch what you see.

You can use these forms to create your own log book or print out copies that you can disperse throughout the book. You may want to consider placing the index pages at the end of the book and copies of the observation log and/or sketch log after each constellation summary page. Do what will work best for you.

Using Surface Brightness Values

The Magnitude of an object is a measure of the total light output from an object. Magnitude values can very useful when viewing point sources such as stars. However, for extended objects such as nebulae, open clusters, globular clusters and galaxies the magnitude of the object may be deceiving since this light is spread out over the size/area of the object. Surface Brightness values help address this problem in that these values represent the average brightness of an object in the area that the object covers in the sky. Once one becomes familiar with usage of surface brightness, it can be used as a guide to indicate how difficult it will be to distinguish the object from the background glow (light pollution). However, it should be remembered that most deep sky objects do

not have a homogeneous illumination, so surface brightness values should be considered a very rough guideline when trying to decide if you think you might be able identify an object in a field of view.

Multiple Star System Basics

It is estimated that approximately 50% to 85% of stars in the night sky are actually multiple star systems. These are systems with two or more stars gravitationally bound to each other. Most of these star systems are so far away from us and close to each other, that it is not possible to visually observe a separation between them. However, there still are many systems in the night sky that can be resolved (separated) by small telescopes.

There are a number of terms used to describe multiple star systems. The generic term **Double Star System** is commonly used to describe both **Optical Doubles** (stars that appear within the same line of site but are not gravitationally bound together) and **Binary Systems** (Two stars that are gravitationally bound to each other in an orbit). Technically the term **Multiple Star System** could be used to describe star systems that contain two or more stars that are gravitationally associated with each other, but generally the term Multiple Star System is reserved for physical star systems containing more than two stars. Multiple Star Systems can also be described as triple(3), quadruple(4), quintuple(5), sextuple(6), septuple(7) or octuple(8) based on how many stars are in the physical system. Systems with eight stars are very rare indeed.

One of the benefits of observing multiple star systems is that they are generally not impacted by light pollution, so this is a perfect hobby for the observer in a big city. However, navigating and locating theses stars can be more challenging in a bright night sky due to less stars overall being visible to the naked eye for navigation (GoTo mounts neglect this issue).

Two measurements utilized in the study of multiple star systems are the **Separation** (the apparent distance between stars measured in arc seconds) and **Position Angle** (PA) (the location of the secondary star relative to the primary star measured in degrees). Generally, I ignore the Position Angle values since the orientation of your telescope and equipment within the optical path (such as star diagonals) ensure there is no standard positions this value will indicate the secondary star will appear when viewing it.

The technique of observing multiple star systems generally follows the sequence of utilizing the lowest power eyepiece to locate the system and progressing to higher power magnification to resolve the components of the system.

Carbon Stars

Carbon stars are large cool stars with temperatures of less than 4,000k at their surface and have an abundance of carbon in their atmosphere. As a result, the atmosphere contains many carbon compounds giving the star a red appearance. Carbon stars are near the end of their life cycle and tend to be variable stars - stars that vary in brightness over a period of time due to their instability. Carbon stars can range in color from a pale pink to blood red.

Since the appearance of these stars are generally not impacted by light pollution, they are well suited for in-city observing.

Morphological Classifications of Astronomical Objects

There are a number of types of deep-sky objects you can observe through a telescope these break down into the following types of objects

- Stellar Classification
- Carbon Stars
- Nebula
    - Emission Nebula
    - Reflection Nebula
    - Dark Nebula
    - Planetary Nebula
    - Supernova Remnant
- Open Clusters
- Globular Clusters
- Galaxies

As astronomy developed it was realized that there was variation within many of these types of objects. Morphological Classification is the system(s) that have been developed to efficiently describe these variations. Each system had its own evolution, so there is no common pattern between the various systems. Here we provide a brief introduction to the following morphological classifications and how to interpret them:

- Stars: Morgan-Keenan (MK) system
- Open Clusters: Trumpler Calssification
- Globular Clusters: Shapley-Sawyer Concentration Class
- Galaxies: Hubble-De Vaucouleurs Cassification
- Dark Nebula: The Lynds Opacity Classification
- Planetary Nebula: Balick Classifications

Stellar Classification

Ref: Wikipedia – Stellar Classification

Stellar classification is the classification of stars based on their spectral characteristics. Electromagnetic radiation from the star is analyzed by splitting it with a prism or diffraction grating into a spectrum exhibiting the rainbow of colors interspersed with spectral lines. Each line indicates a particular chemical element or molecule, with the line strength indicating the abundance of that element. The strengths of the different spectral lines vary mainly due to the temperature of the photosphere, although in some cases there are true abundance differences. The spectral class of a star is a short code primarily summarizing the ionization state, giving an objective measure of the photosphere's temperature.

Most stars are currently classified under the Morgan–Keenan (MK) system using the letters O, B, A, F, G, K, and M, a sequence from the hottest (O-type) to the coolest (M-type). Each letter class is then subdivided using a numeric digit with 0 being hottest and 9 being coolest (e.g., A8, A9, F0, and F1 form a sequence from hotter to cooler). The sequence has been expanded with three classes for other stars that do not fit in the classical system: W, S and C. Some stellar remnants or objects of deviating mass have also been assigned letters: D for white dwarfs and L, T and Y for brown dwarfs (and exoplanets).

Different colors, masses and sizes of main-sequence stars

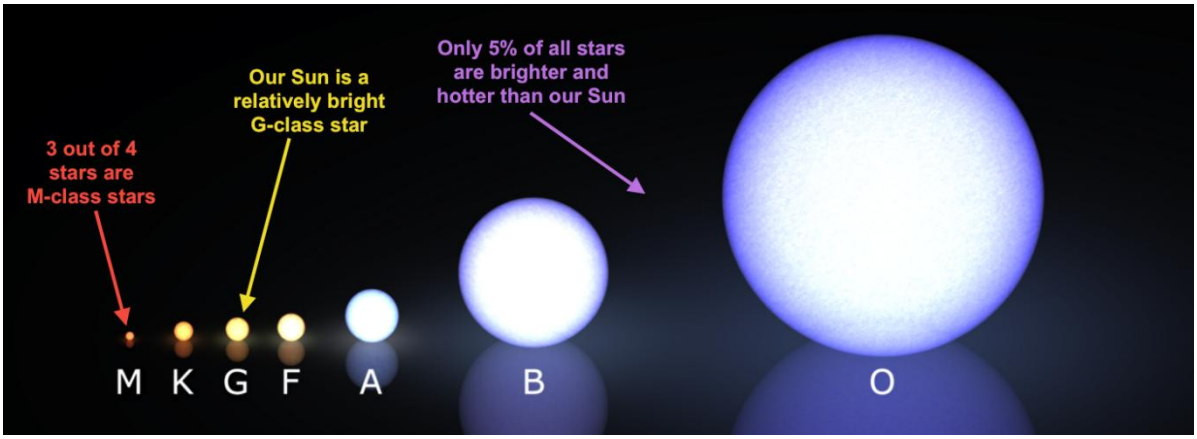


Image credit: Morgan-Keenan-Kellman spectral classification, by wikipedia user Kieff; annotations by E. Siegel.

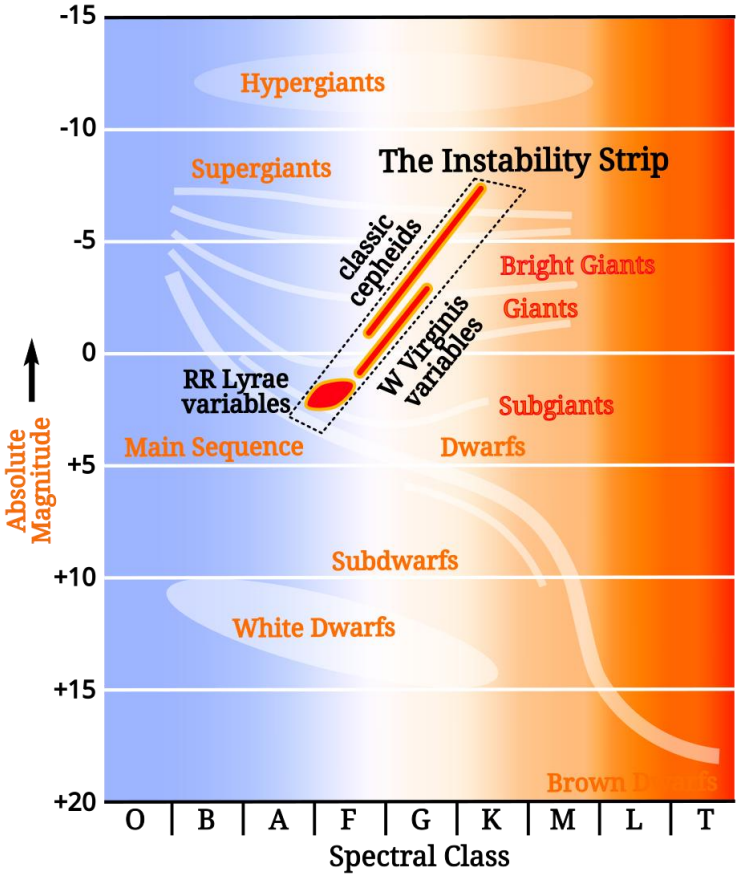
In the MK system, a luminosity class is added to the spectral class using Roman numerals. This is based on the width of certain absorption lines in the star's spectrum, which vary with the density of the atmosphere and so distinguish giant stars from dwarfs. Luminosity class 0 or Ia+ is used for hypergiants, class I for supergiants, class II for bright giants, class III for regular giants, class IV for subgiants, class V for main-sequence stars, class sd (or VI) for subdwarfs, and class D (or VII) for white dwarfs. The full spectral class for the Sun is then G2V, indicating a main-sequence star with a surface temperature around 5,800 K.

Yerkes luminosity classes

Luminosity Clas	Description
0 *or* Ia^{+}	hypergiants or extremely luminous supergiants
Ia	luminous supergiants
Iab	intermediate-size luminous supergiants
Ib	less luminous supergiants
II	bright giants
III	normal giants
IV	subgiants
V	main-sequence stars (dwarfs)
sd (*prefix*) *or* VI	subdwarfs
D (*prefix*) *or* VII	white dwarfs[d]

The classification of a star has a direct correlation to the mass, temperature, luminosity, color and age of a star.

Hertzsprung-Russell Diagram



By Rursus - Own work, CC BY-SA 3.0

Carbon Stars Classification

Ref: Wikipedia – Stellar Classification, Color Index, Claud AI

Carbon stars are cool, evolved giants whose atmospheres contain more carbon than oxygen, the reverse of ordinary stars like the Sun. In a normal star, nearly all the carbon binds with oxygen into carbon monoxide (CO), and the remaining oxygen forms metal oxides. In carbon stars excess carbon forms carbon-bearing molecules such as C_2, CN, and CH which dominate the spectrum and give these stars their signature spectra and color. Carbon molecules absorb strongly in the blue, so many glow a deep ruby or orange-red and are among the reddest stars in the sky.

Carbon stars lose mass heavily through strong stellar winds, seeding the interstellar medium with carbon and soot-like carbon-rich dust grains. They are major contributors to the carbon budget of galaxies and to the raw material for future planetary systems. They are short-lived precursors to planetary nebulae and white dwarfs, marking a brief and informative window in the process of stellar death.

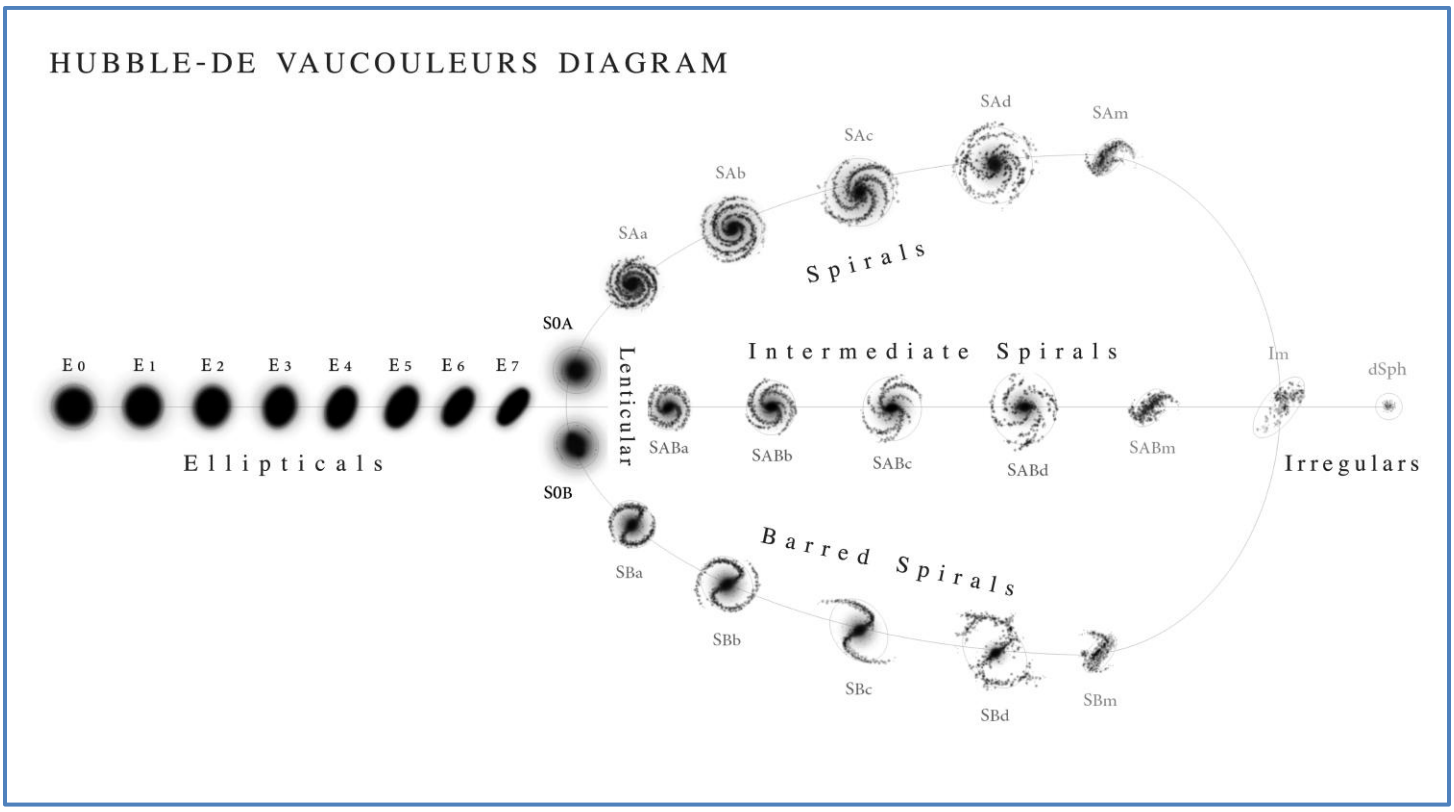
The B-V color index can be a good predictor of how red a carbon star will appear when observing it. B–V is the difference between a star's brightness through a blue (B) filter and a visual/green (V) filter; a larger, more positive B–V means a redder star. For ordinary stars, B–V is an excellent thermometer that tracks surface temperature. Carbon stars have very large B–V values, often 2.5 to 6.

The table below list some of the reddest stars in the sky. In addition, I would recommend **WZ Cas**, while it only has a B-V index of +3.0, it is an optical double with a beautiful blue companion, one of my favorite doubles!

Top 15 Reddest Carbon Stars (maximum brightness ≤ mag 8.0)							
Rank	Star	Constellation	Max V mag	Min V mag	B–V	Spectral type	Note
1	U Cyg	Cygnus	5.9	12.1	+5.95	C9,2e	
2	DY Cru	Crux	8.0	12.0	+5.80	C-N5.5	
3	R Lep	Lepus	5.5	11.7	+5.75	C7,6e	Hind's Crimson Star
4	V Oph	Ophiuchus	7.3	11.6	+5.61	C-N:4	
5	R For	Fornax	7.5	13.0	+5.44	C4,3e	
6	V Hya	Hydra	6.5	12.0	+5.43	C-N:6	
7	T Lyr	Lyra	7.5	9.3	+4.90	C-J4:p	
8	S Cep	Cepheus	7.4	12.9	+4.73	C7,3e	
9	T Cnc	Cancer	7.6	10.5	+4.47	C-N5	
10	RY Mon	Monoceros	7.5	9.2	+4.44	C-N5	
11	VX And	Andromeda	7.8	9.3	+4.43	C-J4.5	
12	SS Vir	Virgo	6.0	9.6	+4.19	C-N4.5	
13	V Aql	Aquila	6.6	8.4	+4.19	C-N5	
14	TW Oph	Ophiuchus	7.0	9.0	+4.16	C-N5	
15	R Scl	Sculptor	5.8	8.8	+3.87	C-N5+	

Galaxy Classification
Wikipedia – Galaxy Morphological Classifications

A galaxy is a system of stars, stellar remnants, interstellar gas, dust, and dark matter bound together by gravity.



The Hubble sequence is a classification scheme for galaxies published by Edwin Hubble in 1926. It is also known as the **Hubble tuning-fork diagram** (Developed by John Henry Reynolds and Sir James Jeans) because the shape in which it is traditionally represented resembles a tuning fork.

The tuning fork scheme divided regular galaxies into three broad classes – **ellipticals**, **lenticulars** and **spirals** – based on their visual appearance. A fourth class contains galaxies with an **irregular** appearance. The Hubble sequence is the most commonly used system for classifying galaxies, both in professional astronomical research and in amateur astronomy.

- **Ellipticals** – This class of galaxies have relatively smooth, featureless light distributions and appear as ellipses in photographic images. They are denoted by the letter E, followed by an integer n representing their degree of ellipticity in the sky. The ellipticity increases from left to right on the Hubble diagram, with near-circular (E0) galaxies situated on the very left of the diagram. It is important to note that the ellipticity of a galaxy on the sky is only indirectly related to the true 3-dimensional shape (for example, a flattened, discus-shaped galaxy can appear almost round if viewed face-on or highly elliptical if viewed edge-on).

- **Lenticulars** – This intermediate class of galaxies are given the symbol **S0**. These galaxies consist of a bright central bulge, similar in appearance to an elliptical galaxy, surrounded by an extended, disk-like structure. Unlike spiral galaxies, the disks of lenticular galaxies have no visible spiral structure and are not actively forming stars in any significant quantity.
- **Spirals** - On the right of the Hubble sequence diagram are two parallel branches encompassing the spiral galaxies. A spiral galaxy consists of a flattened disk, with stars forming a (usually two-armed) spiral structure, and a central concentration of stars known as the bulge. Roughly half of all spirals are also observed to have a bar-like structure, with the bar extending from the central bulge, and the arms begin at the ends of the bar. In the tuning-fork diagram, the regular spirals occupy the upper branch and are denoted by the letter **S**, while the lower branch contains the barred spirals, given the symbol **SB**. Both type of spirals are further subdivided according to the detailed appearance of their spiral structures. Membership of one of these subdivisions is indicated by adding a lower-case letter to the morphological type, as follows:
    - Sa (SBa) – tightly wound, smooth arms; large, bright central bulge
    - Sb (SBb) – less tightly wound spiral arms than Sa (SBa); somewhat fainter bulge
    - Sc (SBc) – loosely wound spiral arms, clearly resolved into individual stellar clusters and nebulae; smaller, fainter bulge
- **Irregulars** - Galaxies that do not fit into the Hubble sequence, because they have no regular structure (either disk-like or ellipsoidal), are termed irregular galaxies. Hubble defined two classes of irregular galaxy:
    - **Irr I** galaxies have asymmetric profiles and lack a central bulge or obvious spiral structure; instead, they contain many individual clusters of young stars
    - **Irr II** galaxies have smoother, asymmetric appearances and are not clearly resolved into individual stars or stellar clusters

Globular Cluster Classifications

Ref: Wikipedia – Globular Cluster, Shapely-Sawyer Concentration Class

A globular cluster is a spheroidal conglomeration of stars that is bound together by gravity, with a higher concentration of stars towards its center. It can contain anywhere from tens of thousands to many millions of member stars, all orbiting in a stable, compact formation.

The Shapley–Sawyer Concentration Class is a classification system for globular clusters on a scale of one to twelve using Roman numerals for globular clusters according to their concentration. The most highly concentrated clusters such as M75 are classified as Class I, with successively diminishing concentrations ranging to Class XII, such as Palomar 12. (The class is sometimes given with numbers [Class 1–12] rather than with Roman numerals.)

Class	Description	Example
I	High concentration toward the center	Messier 75
II	Dense central concentration	Messier 2
III	Strong inner core of stars	Messier 54
IV	Intermediate rich concentrations	Messier 15
V	Intermediate concentrations	Messier 30
VI	Intermediate mild concentration	Messier 3
VII	Intermediate loose concentration	Messier 22
VIII	Rather loosely concentrated towards the center	Messier 14
IX	Loose towards the center	Messier 12
X	Loose	Messier 68
XI	Very loose towards the center	Messier 55
XII	Almost no concentration towards the center	Palomar 12

Open Cluster Classifications: The Trumpler Classification

Ref: Wikipedia – Open Cluster,

An open cluster is a type of star cluster made of tens to a few thousand stars that were formed from the same giant molecular cloud and have roughly the same age. More than 1,100 open clusters have been discovered within the Milky Way galaxy, and many more are thought to exist. Each one is loosely bound by mutual gravitational attraction and becomes disrupted by close encounters with other clusters and clouds of gas as they orbit the Galactic Center. This can result in a loss of cluster members through internal close encounters and a dispersion into the main body of the galaxy. Open clusters generally survive for a few hundred million years, with the most massive ones surviving for a few billion years.

Open clusters are often classified according to a scheme developed by Robert Trumpler in 1930. The **Trumpler scheme** gives a cluster a three-part designation, with a Roman numeral from I-IV representing the degree of concentration, an Arabic numeral from 1 to 3 for the range in brightness of members (from small to large range), and p, m or r to indication whether the cluster is poor, medium or rich in stars. An 'n' is appended if the cluster lies within nebulosity.

- Degree of Concentration (I to IV)
  - I - Detached clusters with strong central concentration
  - II - Detached clusters with little central concentration
  - III - Detached cluster with no noticeable concentration
  - IV - Clusters not well detached, but has a strong field concentration
- Range of Brightness (1 to 3)
  - 1 - Most of the cluster stars are nearly the same apparent brightness
  - 2 - A medium range of brightness between the stars in the cluster
  - 3 - Cluster is composed of bright and faint stars
- Number of Stars in the Cluster (p, m, r)
  - p - Poor clusters with less than 50 stars
  - m - Medium rich clusters with 50 – 100 stars
  - r - Rich clusters with over 100 stars
- Nebulosity Indicator (n)
  - n – Clusters with any type of nebulosity, including light and dark nebula are indicated with an “n” at the end of the classification.

Dark Nebula Classifications: The Lynds Opacity Classification

Ref: [Wikipedia: Lynds' Catalogue of Dark Nebula]

In the Lynds Catalogue of Dark Nebulae, "Opacity" is a visual estimate of how dark a dark nebula appears by comparing the neighboring fields on Palomar blue and red photographic plates: the clouds just detectable on both prints are 1, and the darkest clouds are 6.

What each value means (practically)

- Opacity 1 (lightest): clouds just detectable on both the red and blue prints, showing only a slight decrease in the surface intensity of the general field.
- Opacity 2: darker than 1; show more noticeable suppression of background starlight/surface intensity versus nearby clear regions (intermediate between the "slightly decreased" detectability and the "darkest" cases).
- Opacity 3: moderate obscuration; the nebula is clearly affecting the field relative to neighboring regions, but not as extreme as 4–6.
- Opacity 4: strong obscuration; background stars are reduced substantially compared to adjacent clear sky.
- Opacity 5: very strong obscuration, approaching the darkest category.
- Opacity 6 (darkest): nebulae where the star density averages ~120 stars/deg² down to the limiting magnitude of the red photograph, and which also appear darkest—often darker than the general background in neighboring clear regions.

If a larger dark nebula has regions of different opacity, Lynds subdivides it into separate catalog entries for those regions while keeping a common identifier where appropriate.

Opacity values for many dark nebulae seem to be missing.

Planetary Nebulae Classifications: Balick classifications

Ref: The Shapes and Shaping of Planetary Nebula by Bruce Balick

Balick's classification is a morphological scheme for planetary nebulae, aimed at describing the nebula's shape more systematically than older visual labels It usually groups nebulae into a few broad forms:

- **Round**: nearly circular symmetry
- **Elliptical**: stretched but still fairly smooth and symmetric
- **Bipolar**: two lobes separated by a narrow waist
- **Multipolar / irregular**: more complex, asymmetric, or multiple outflows
- **Point-symmetric**: structures that rotate around the center in a symmetric way, often suggesting precession or jets

A useful feature of this system of classification is that it tries to tie morphology to evolutionary and physical processes. For example:

- Bipolar nebulae often suggest shaping by dense equatorial material and fast polar outflows
- Point symmetry can hint at precessing jets or binary interactions
- Round nebulae are often interpreted as having less dramatic shaping influences

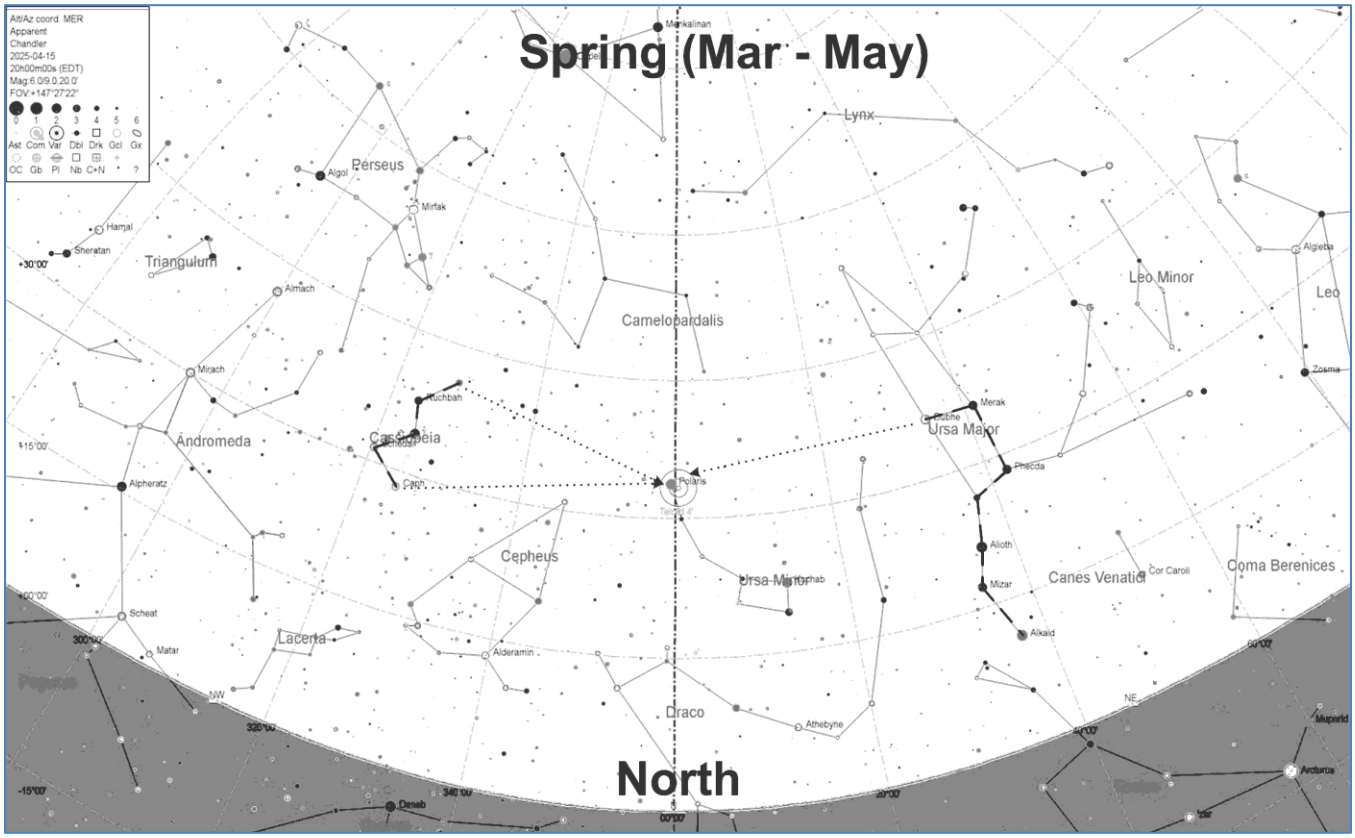
The Night Sky

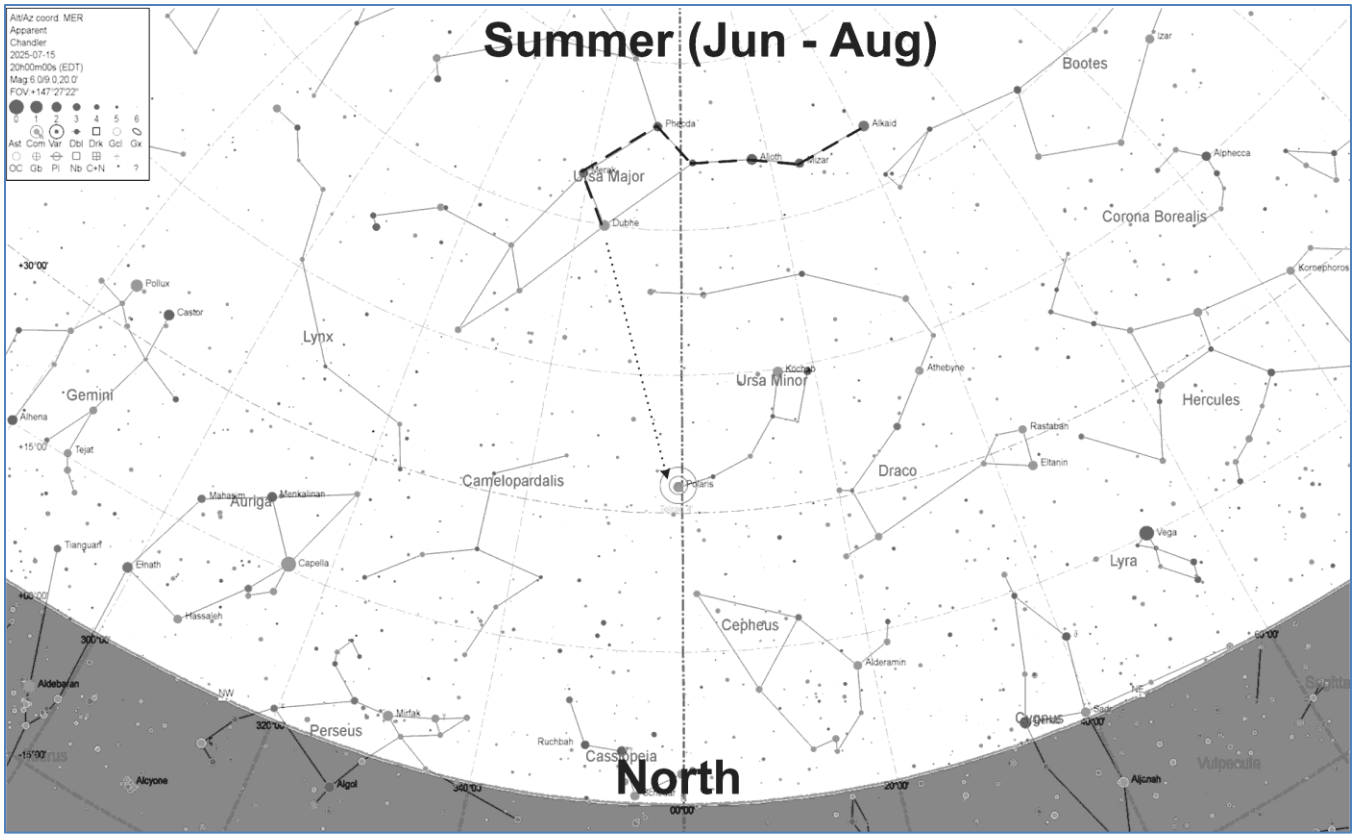
Before beginning an observation session, it is important to get oriented with the night sky. We have included seasonal charts with asterisms that will assist in understanding the night sky as it changes with each season. Take note that the outer ring of the bullseye in the center of each of the provided images has a 4-degree diameter to help provide a scale of distances in each of the diagrams.

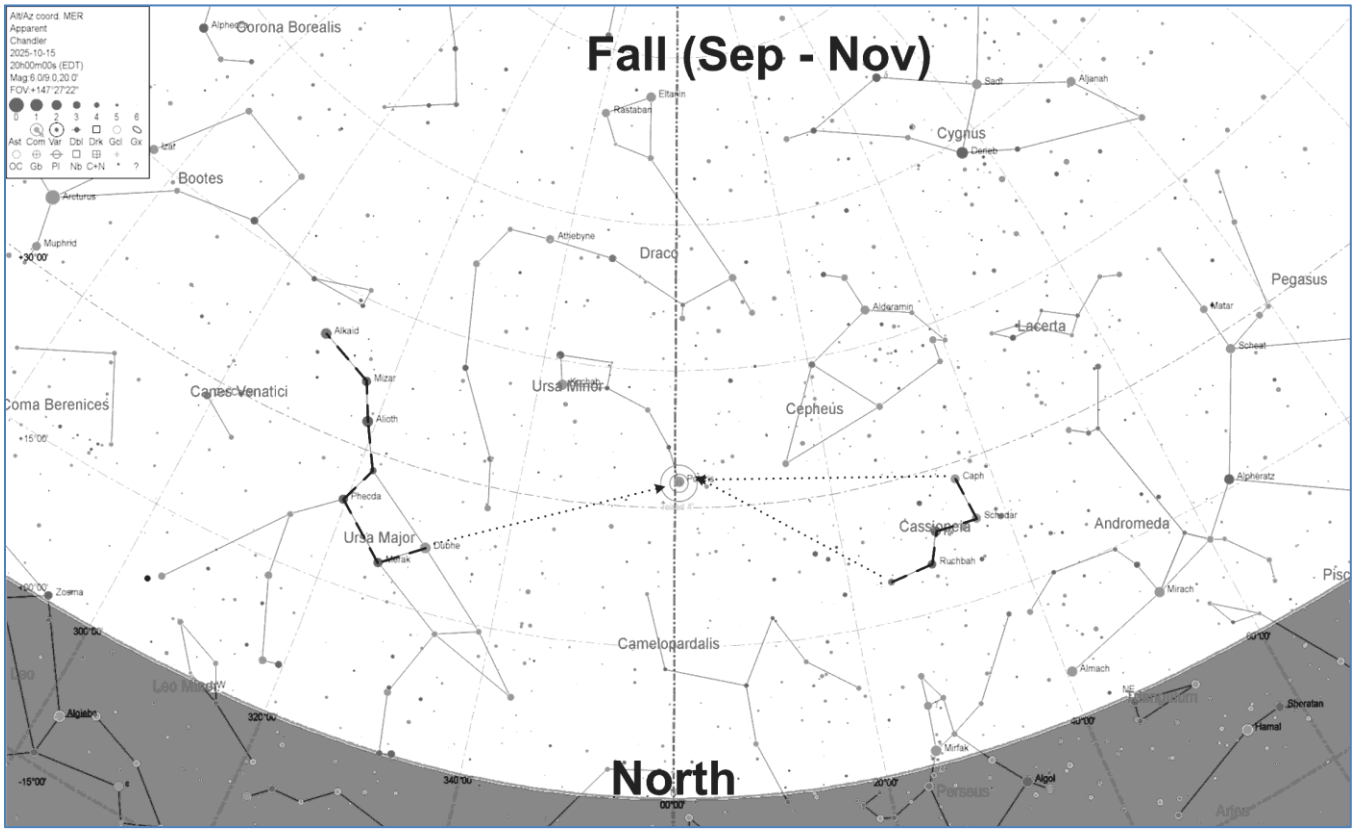
Orientation North

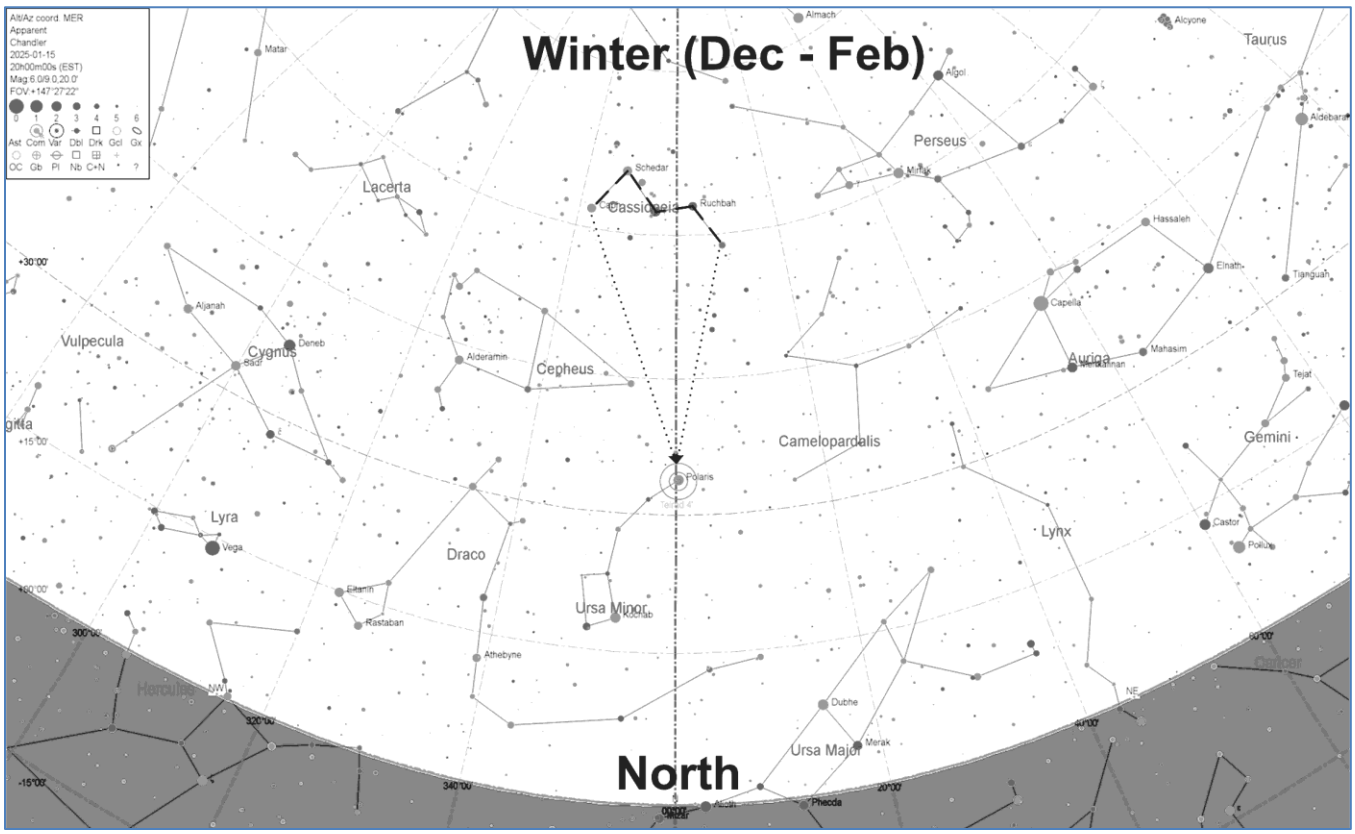
To find true north, first identify which direction faces north. Next, find Polaris (the North Star), which is the last star in the handle of Ursa Minor (the Little Dipper). In the Spring and Summer, the Big Dipper can help in locating the North Star. After finding the Big Dipper, locate the two pointer stars, Merak and Dubhe, found in the Dipper's scoop or bowl. Follow these two pointer stars approximately 30 degrees to Polaris.
Since the Big Dipper is near or below the horizon in Fall and Winter, Cassiopeia may be best for finding Polaris. To find Cassiopeia, look for an asterism in the north that looks like a "W" or "M". Locate the two stars, Caph and Segin, found at each of the ends of the constellation. Follow Caph and Segin until they meet at a point, creating a triangle with Polaris

Locating Polaris






Fall (Sep - Nov)
Corona Borealis
Bootes
Arcturus
Muphrid
Eltanin
Rastaban
Cygnus
Deneb
Sadr
Aljanah
Draco
Athebyne
Alderamin
Lacerta
Pegasus
Matar
Scheat
Alkaid
Mizar
Alioth
Canes Venatici
Coma Berenices
Ursa Minor
Cepheus
Polaris
Caph
Schedar
Cassiopeia
Ruchbah
Alpheratz
Andromeda
Phecda
Ursa Major
Dubhe
Merak
Mirach
Zosma
Camelopardalis
Almach
Algieba
Leo Minor
Algol
Mirfak
Perseus
Sheratan
Hamal
Aries
North

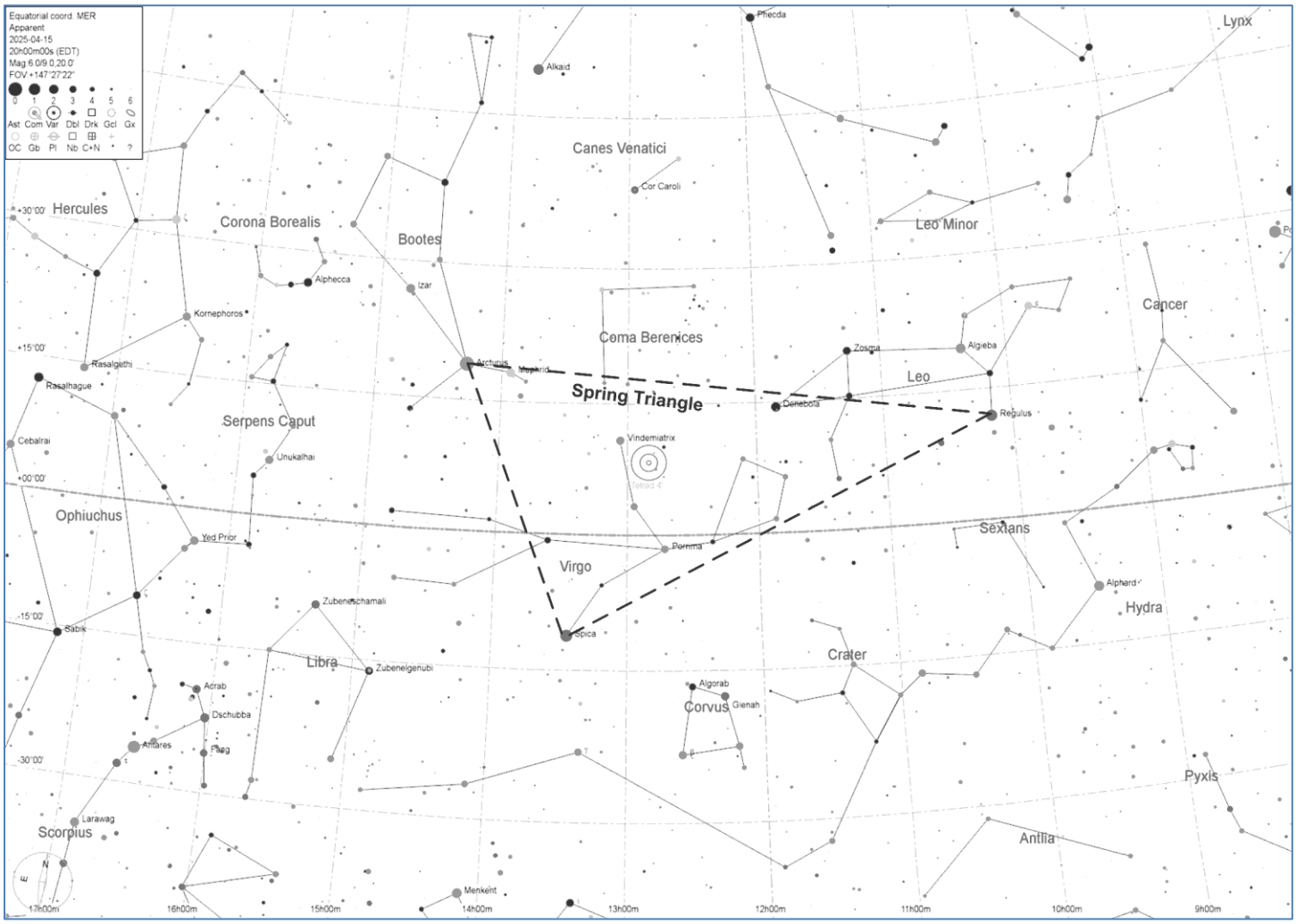

Winter (Dec - Feb)
Matar
Almach
Algol
Alcyone
Taurus
Aldebaran
Perseus
Mirfak
Lacerta
Schedar
Cassiopeia
Ruchbah
Hassaleh
Elnath
Tianguan
Capella
Auriga
Mahasim
Menkalinan
Tejat
Gemini
Aljanah
Vulpecula
Cygnus
Deneb
Sadr
Alderamin
Cepheus
Polaris
Camelopardalis
Lynx
Castor
Pollux
Lyra
Vega
Draco
Eltanin
Rastaban
Athebyne
Ursa Minor
Kochab
Hercules
Dubhe
Merak
Ursa Major
Phecda
Alioth
Mizar
North

Seasonal Asterisms

An asterism is a recognizable pattern in the night sky that contains stars from one or more constellations. The seasonal asterisms identified below can be easily located, even in locations with high light pollution, and they serve as reference points for navigating the night sky. As the seasons change, the asterism that appears prominent in the evening sky changes. The order of progression is from Spring (Spring Triangle), to Summer (Summer Triangle), to Fall (The Great Square), and finally to Winter (The Winter Hexagon). Along with the seasonal Asterisms, some prominent constellations may be used when star hopping; Cassiopeia, The Big Dipper, Orion and Leo are among these.

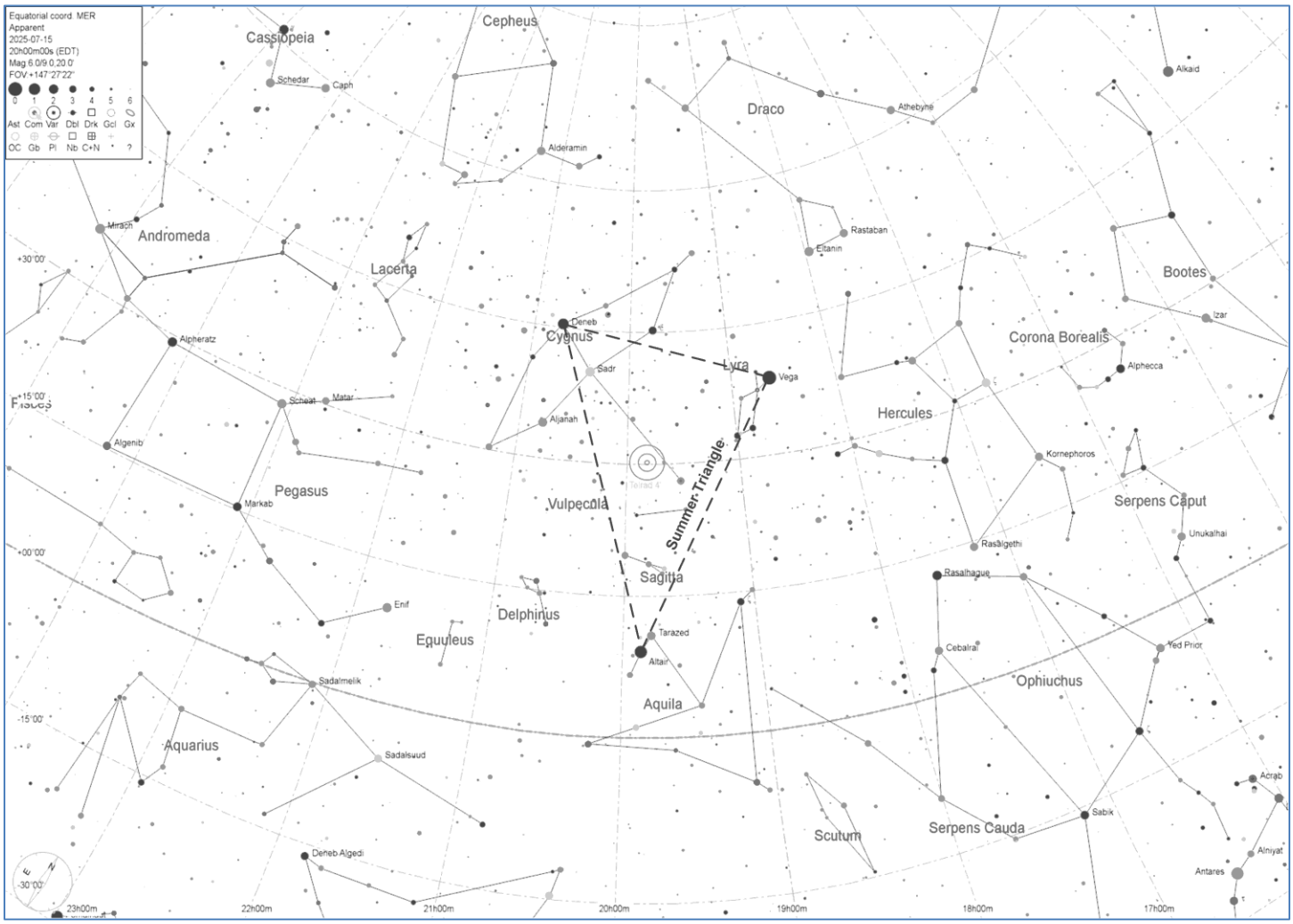
Spring Triangle

The Spring Triangle is easily identified from March through May and is composed of the brightest stars in each of the constellations: Arcturus in Bootes, Regulus in Leo, and Spica in Virgo.



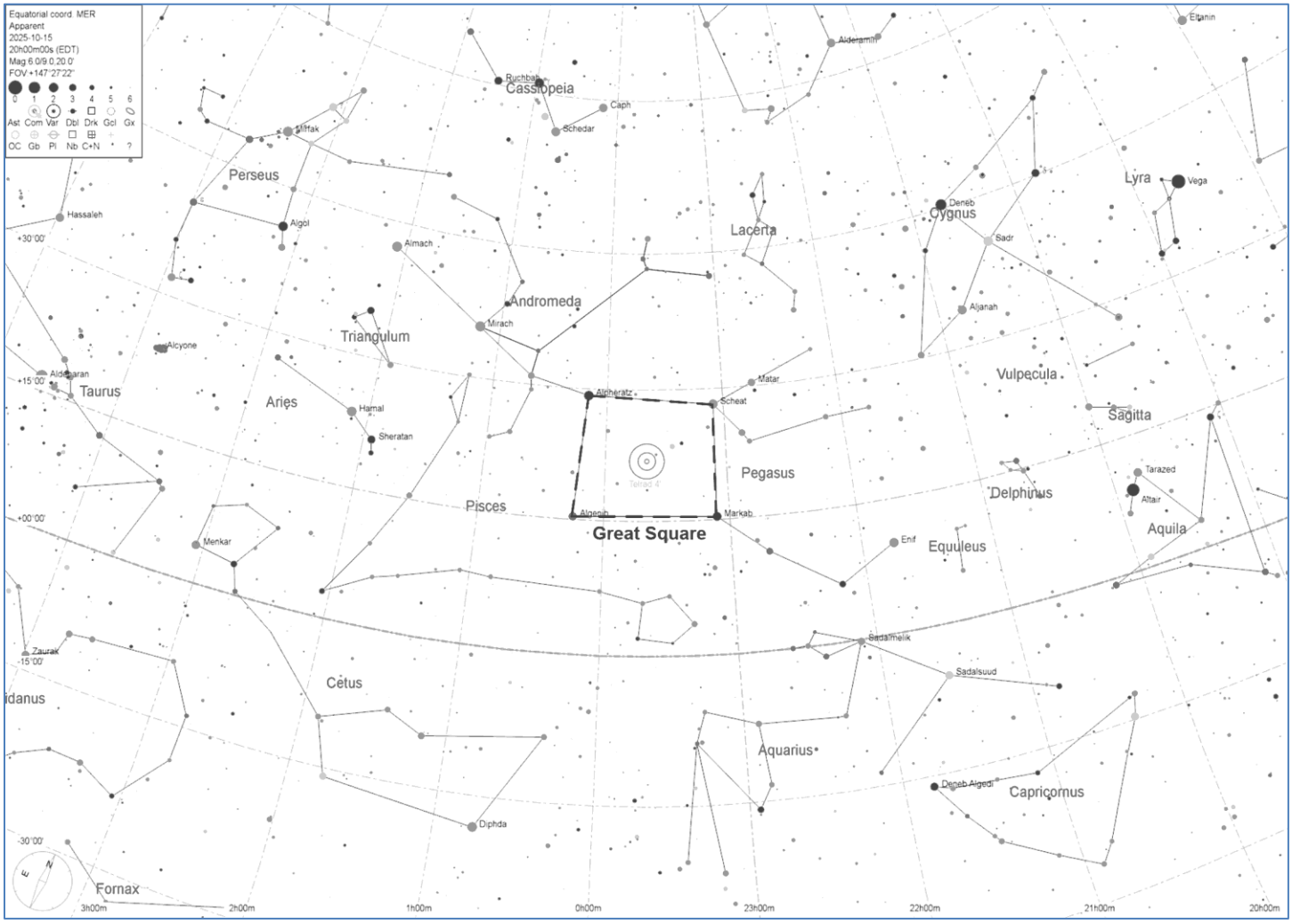
Summer Triangle

The Summer Triangle can be found from June through August. The three stars creating the Summer Triangle include Deneb from the constellation Cygnus, Vega from the constellation Lyra, and Altair, the brightest star in the constellation Aquila.



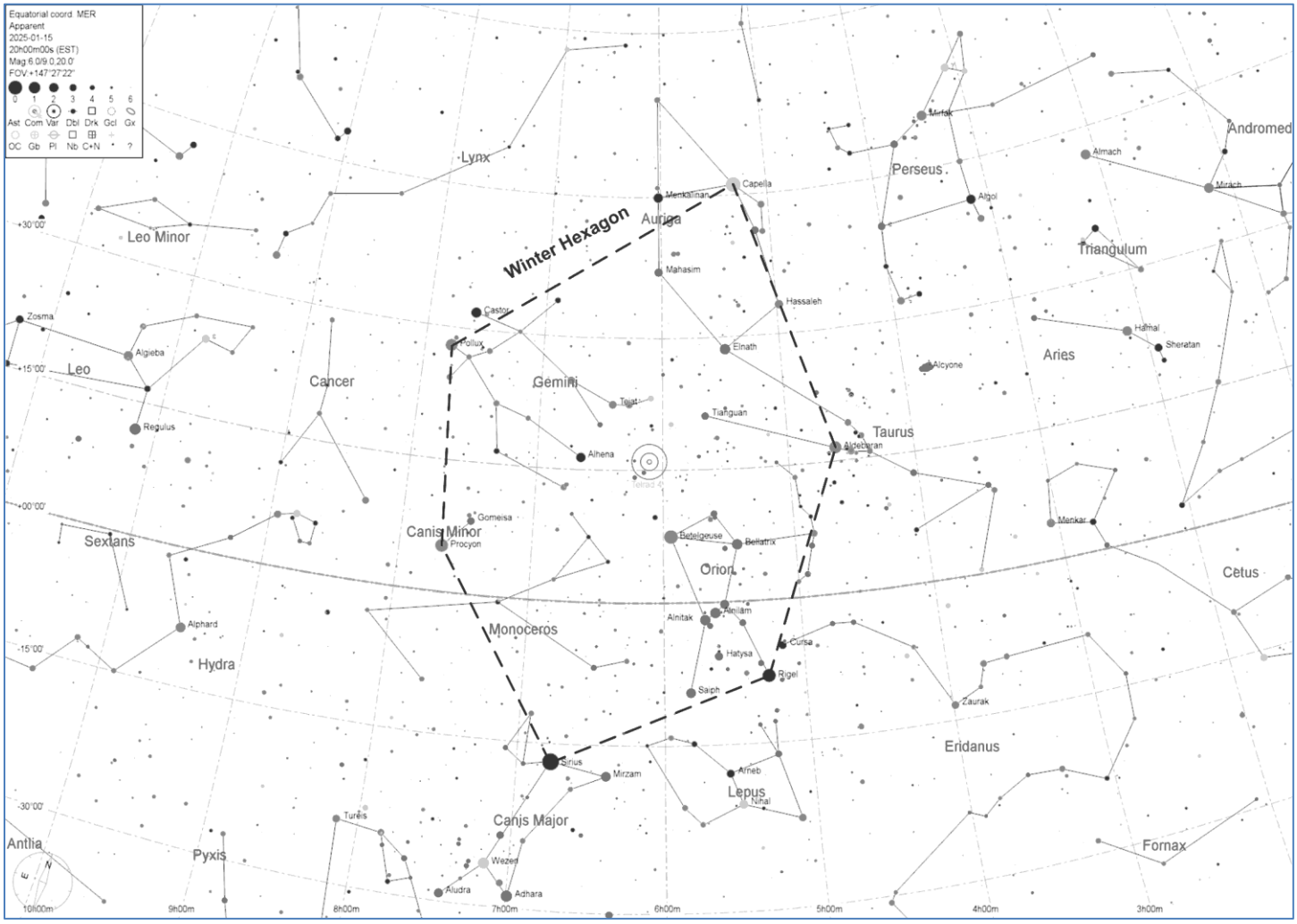
Fall - Great Square of Pegasus

The Great Square of Pegasus is an asterism found from September through November. The four stars that build the Great Square are Algenib, Markat, and Scheat from the constellation Pegasus, and Alpheratz from the constellation Andromeda. To determine how the Great Square is oriented, find the two stars outside the northwest corner of the square, forming a triangle with Scheat.



Winter Hexagon

The Winter Hexagon is prominent from December through February. This asterism forms a hexagon with the following stars: Rigel in Orion, Aldebaran in Taurus, Capella in Auriga, Pollux in Gemini, Procyon in Canis Minor, and Sirius in Canis Major. Sirius and Procyon also form the Winter Triangle with Betelgeuse, the brightest star in Orion.



Monthly Star Charts

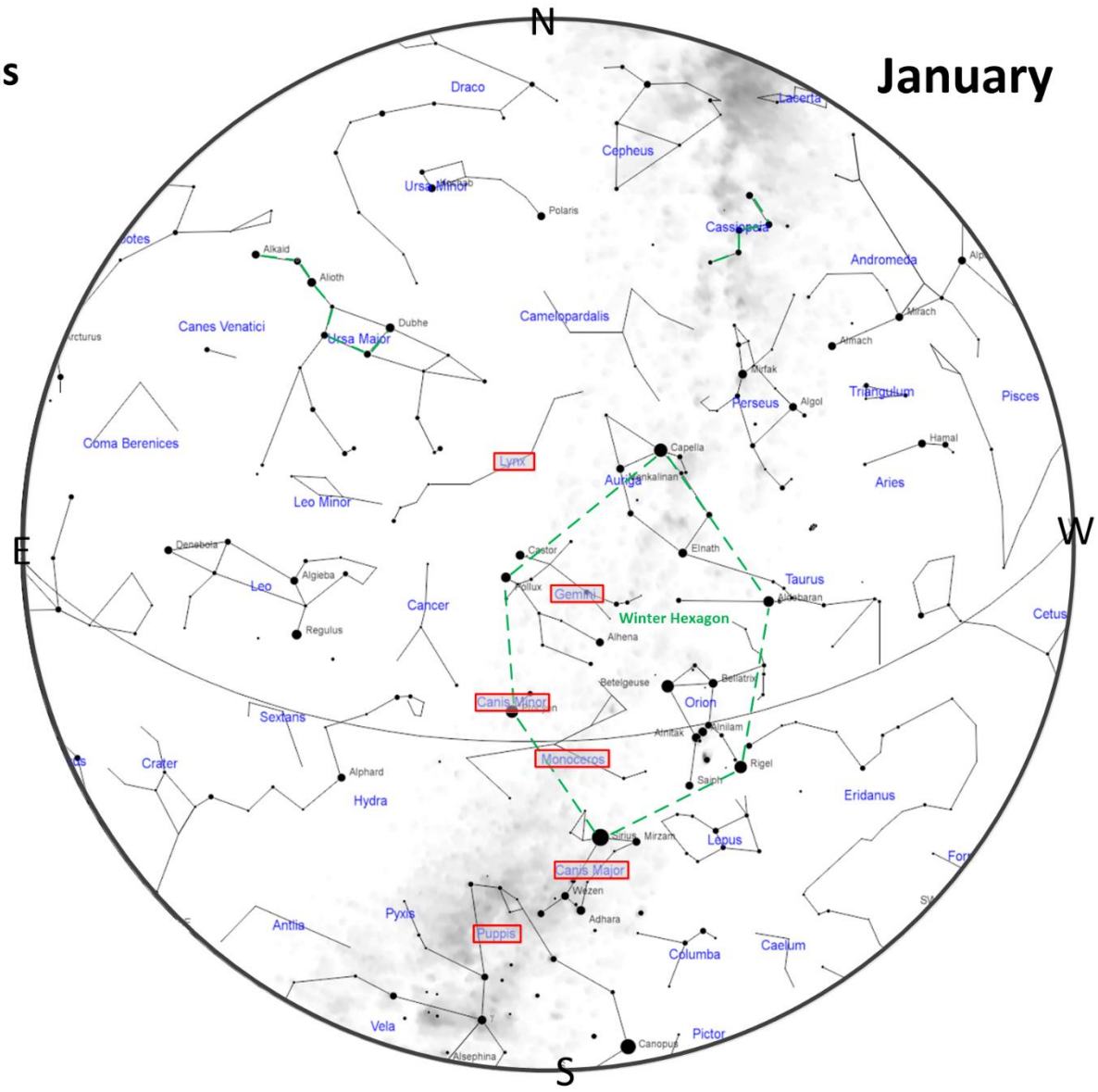
Here are provided monthly star charts that represent the night sky at midnight on the 15th of the month. The carts were generated for a latitude of 33° North. The charts highlight (in green) asterisms and major constellations that are easily identified even in light polluted skies. Also, the constellations that are well placed for observation are identified (Constellations of Interest).

Constellations of Interest

Evening
Taurus (Tau)
Caeium (Cae)
Lepus (Lep)
Columba (Col)
Orion (Ori)
Camelopardalis (Cam)
Auriga (Aur)

Prime Time
Canis Major (Cma)
Monoceros (Mon)
Gemini (Gem)
Canis Minor (Cmi)
Puppis (Pup)
Lynx (Lyn)

Morning
Cancer (Cnc)
Pyxis (Pyx)
Vela (Vel)
Leo Minor (Lmi)
Antlia (Ant)

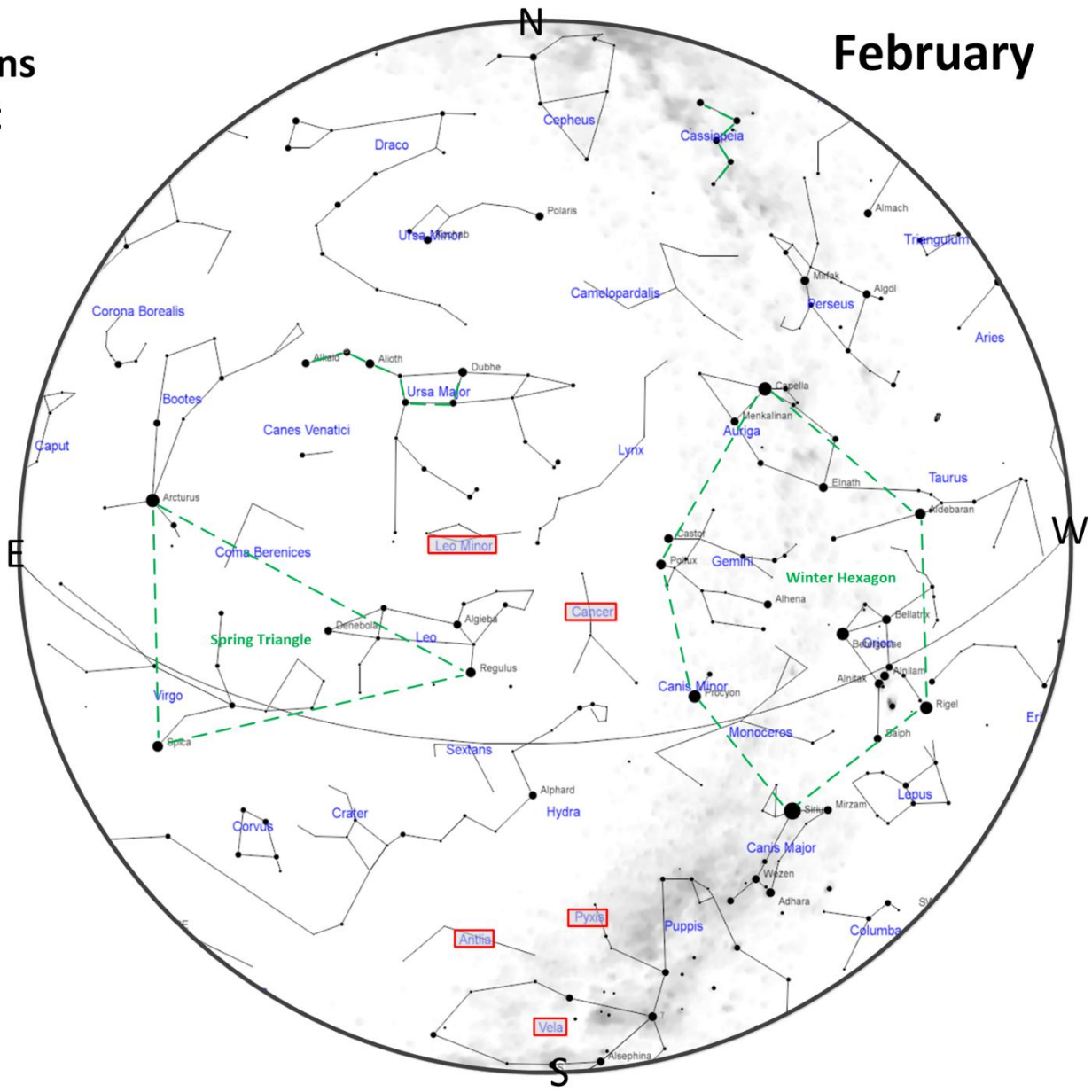


Constellations of Interest

Evening
Canis Major (Cma)
Monoceros (Mon)
Gemini (Gem)
Canis Minor (Cmi)
Puppis (Pup)
Lynx (Lyn)

Prime Time
Cancer (Cnc)
Pyxis (Pyx)
Vela (Vel)
Leo Minor (Lmi)
Antlia (Ant)

Morning
Sextans (Sex)
Leo (Leo)
Hydra (Hya)
Ursa Major (UMa)
Crater (Crt)



Constellations of Interest

March

Evening

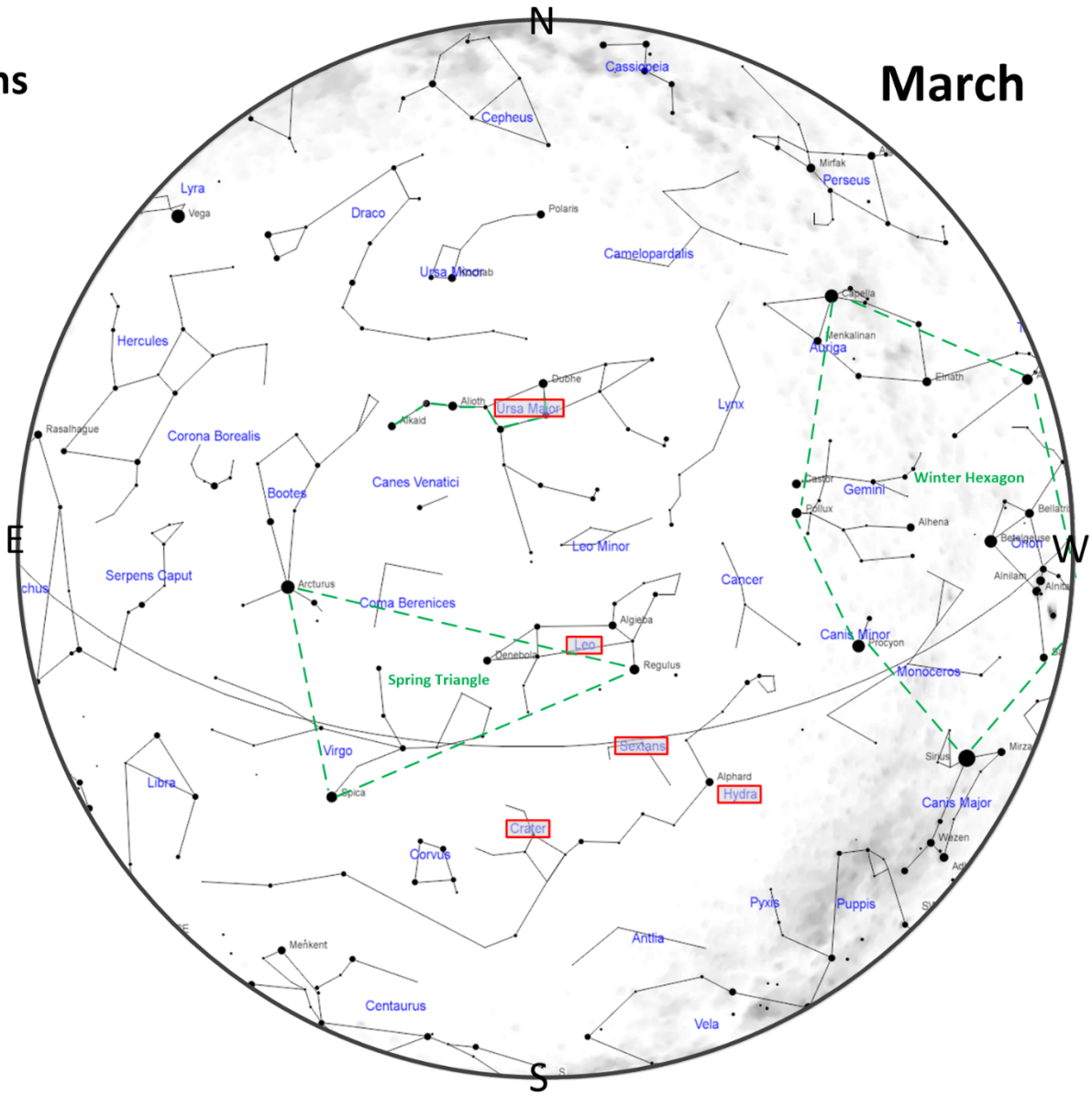
- Cancer (Cnc)
- Pyxis (Pyx)
- Vela (Vel)
- Leo Minor (Lmi)
- Antlia (Ant)

Prime Time

- Sextans (Sex)
- Leo (Leo)
- Hydra (Hya)
- Ursa Major (UMa)
- Crater (Crt)

Morning

- Crovus (Crv)
- Coma Berenices (Com)
- Canes Vebnatici (CVn)
- Centaurus (Cen)
- Virgo (Vir)



Constellations of Interest

April

Evening

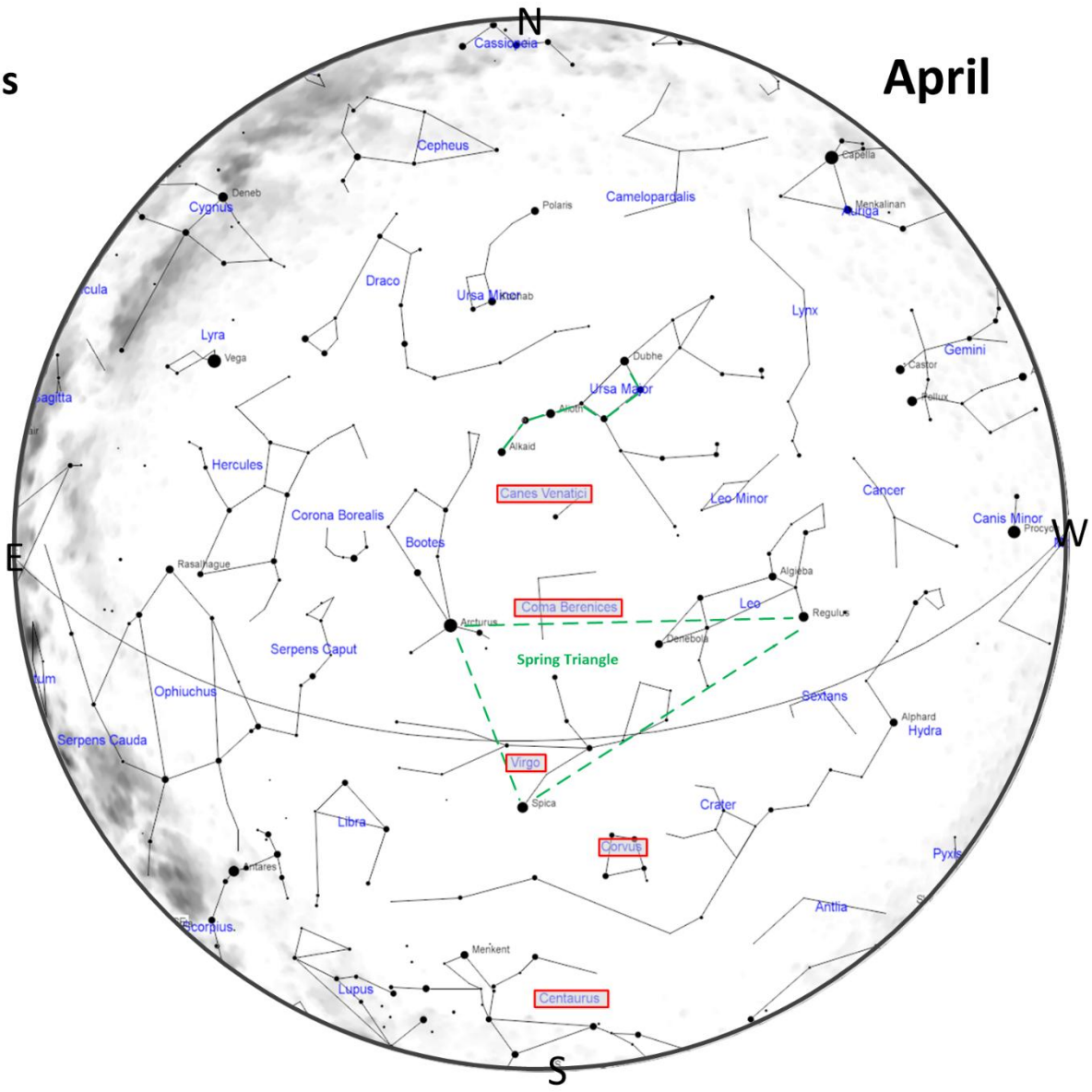
- Sextans (Sex)
- Leo (Leo)
- Hydra (Hya)
- Ursa Major (UMa)
- Crater (Crt)

Prime Time

- Crovus (Crv)
- Coma Berenices (Com)
- Canes Vebnatici (CVn)
- Centaurus (Cen)
- Virgo (Vir)

Morning

- Bootes (Boo)
- Ursa Minor (UMi)
- Libra (Lib)
- Lupus (Lup)
- Corana Borealis (CrB)



Constellations of Interest

Evening

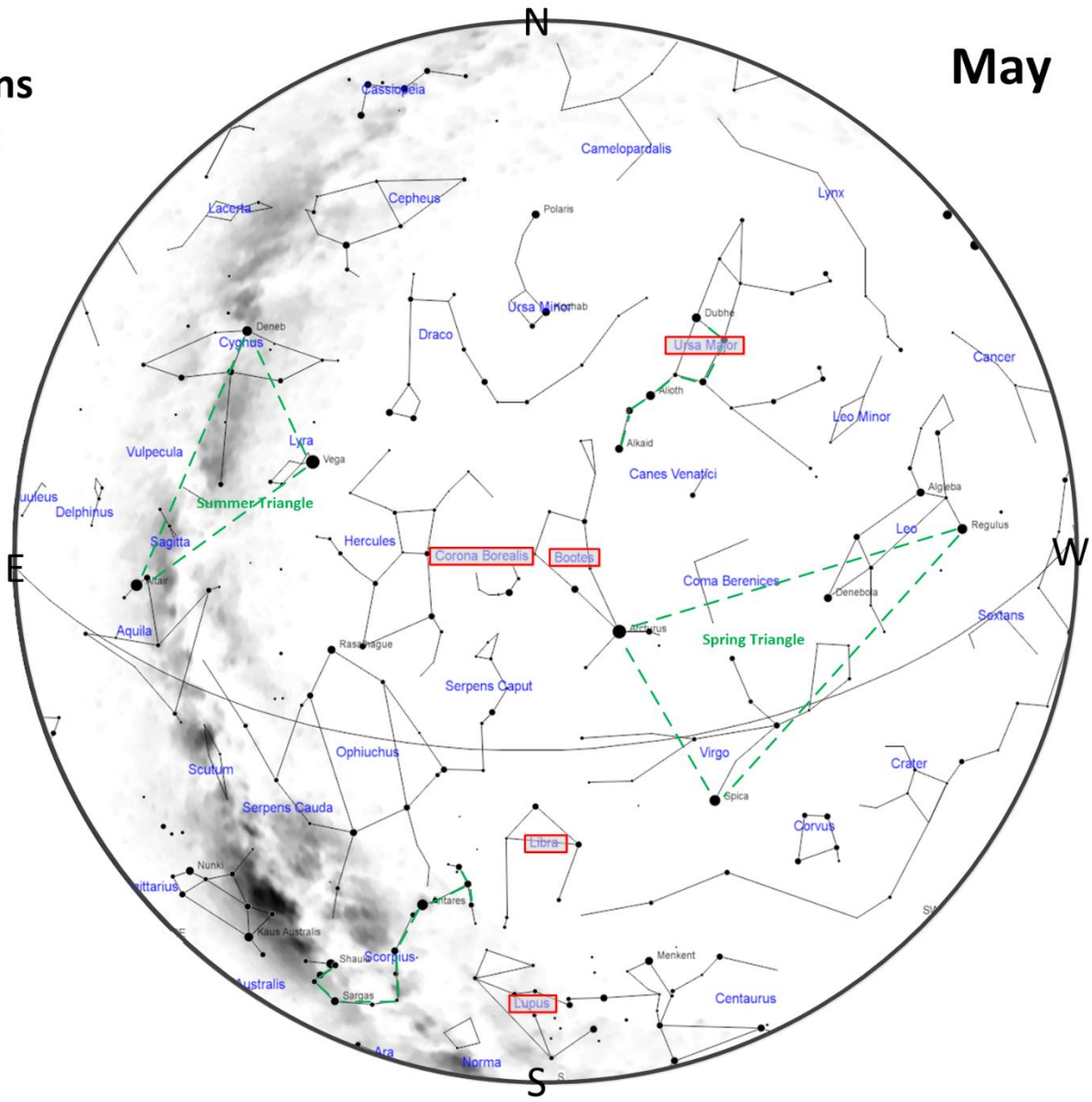
- Crovus (Crv)
- Coma Berenices (Com)
- Canes Vebnatici (CVn)
- Centaurus (Cen)
- Virgo (Vir)

Prime Time

- Bootes (Boo)
- Ursa Minor (UMi)
- Libra (Lib)
- Lupus (Lup)
- Corana Borealis (CrB)

Morning

- Scorpius (Sco)
- Draco (Dra)
- Serpens (Ser)
- Ophiuchus (Oph)
- Hercules (Her)



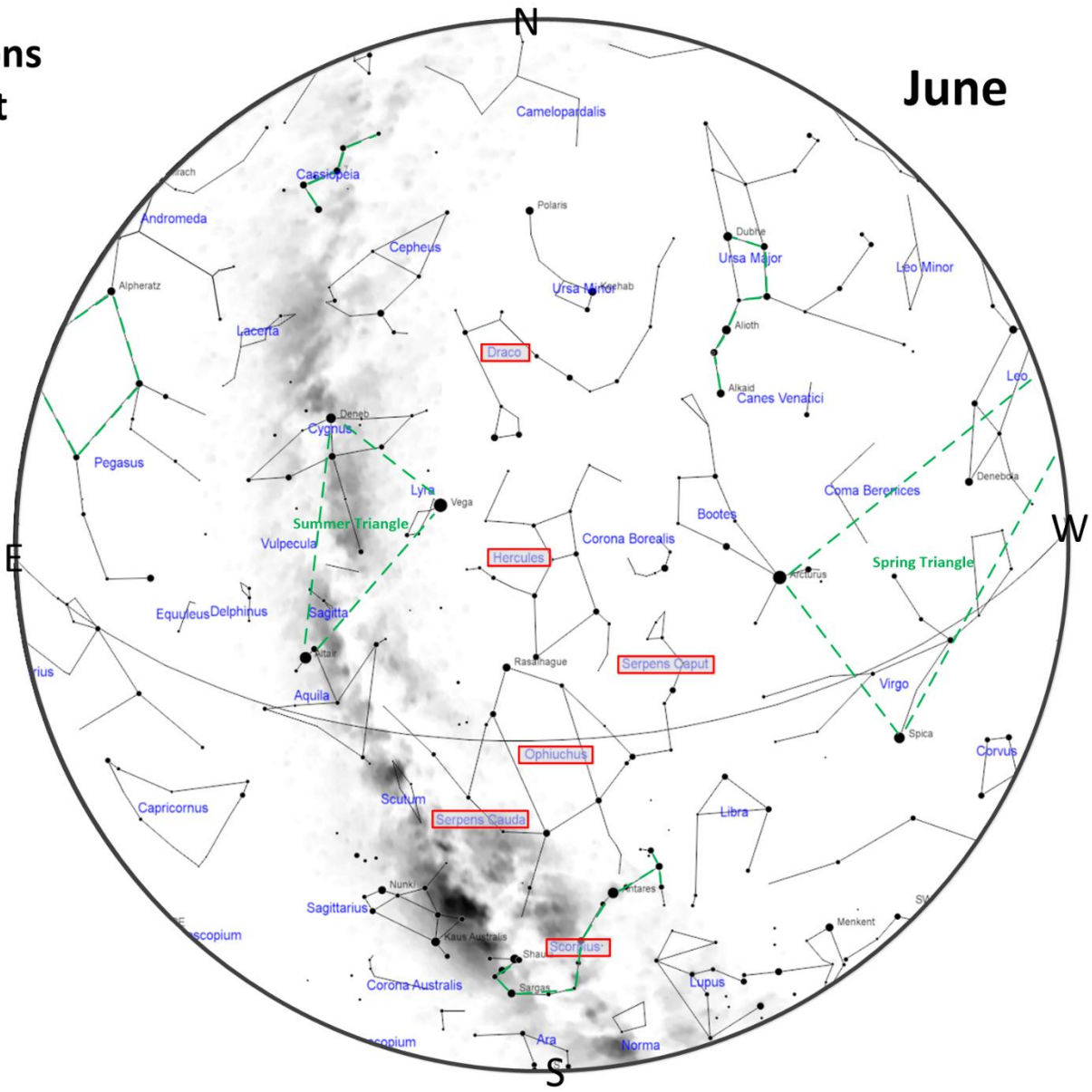
Constellations of Interest

June

Evening
- Bootes (Boo)
- Ursa Minor (UMi)
- Libra (Lib)
- Lupus (Lup)
- Corana Borealis (CrB)

Prime Time
- Scorpius (Sco)
- Draco (Dra)
- Serpens (Ser)
- Ophiuchus (Oph)
- Hercules (Her)

Morning
- Scutum (Sct)
- Corona Australis (CrA)
- Lyra (Lyr)
- Sagittarius (Sgr)
- Aquilia (Aql)
- Cygnus (Cyg)
- Vulpecula (Vul)

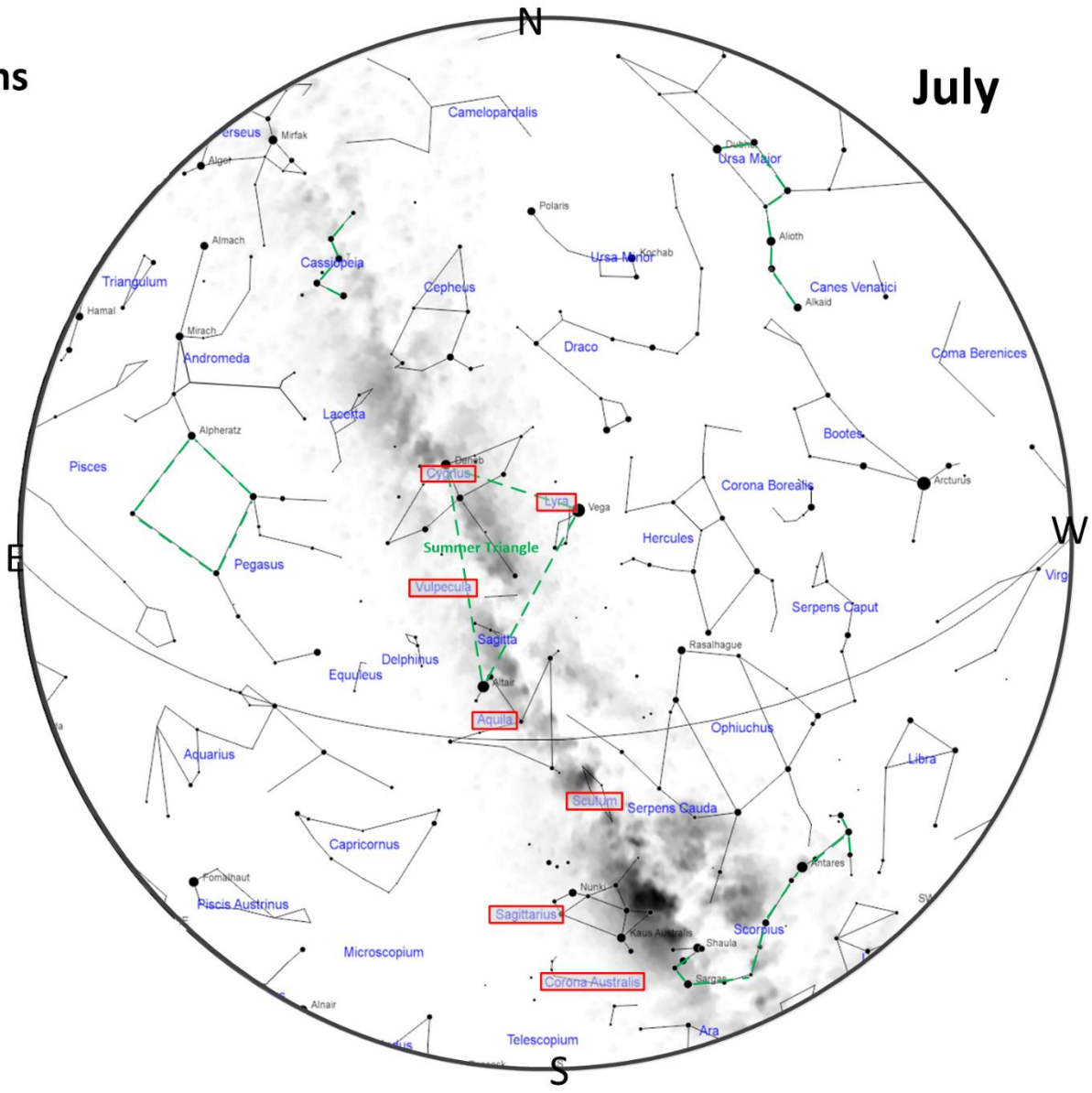


Constellations of Interest

Evening
Scorpius (Sco)
Draco (Dra)
Serpens (Ser)
Ophiuchus (Oph)
Hercules (Her)

Prime Time
Scutum (Sct)
Corona Australis (CrA)
Lyra (Lyr)
Sagittarius (Sgr)
Aquilia (Aql)
Cygnus (Cyg)
Vulpecula (Vul)

Morning
Delphinus (Del)
Equuleus (Equ)
Capricornus (Cap)
Microscopium (Mic)
Pisces Austrinus (PsA)

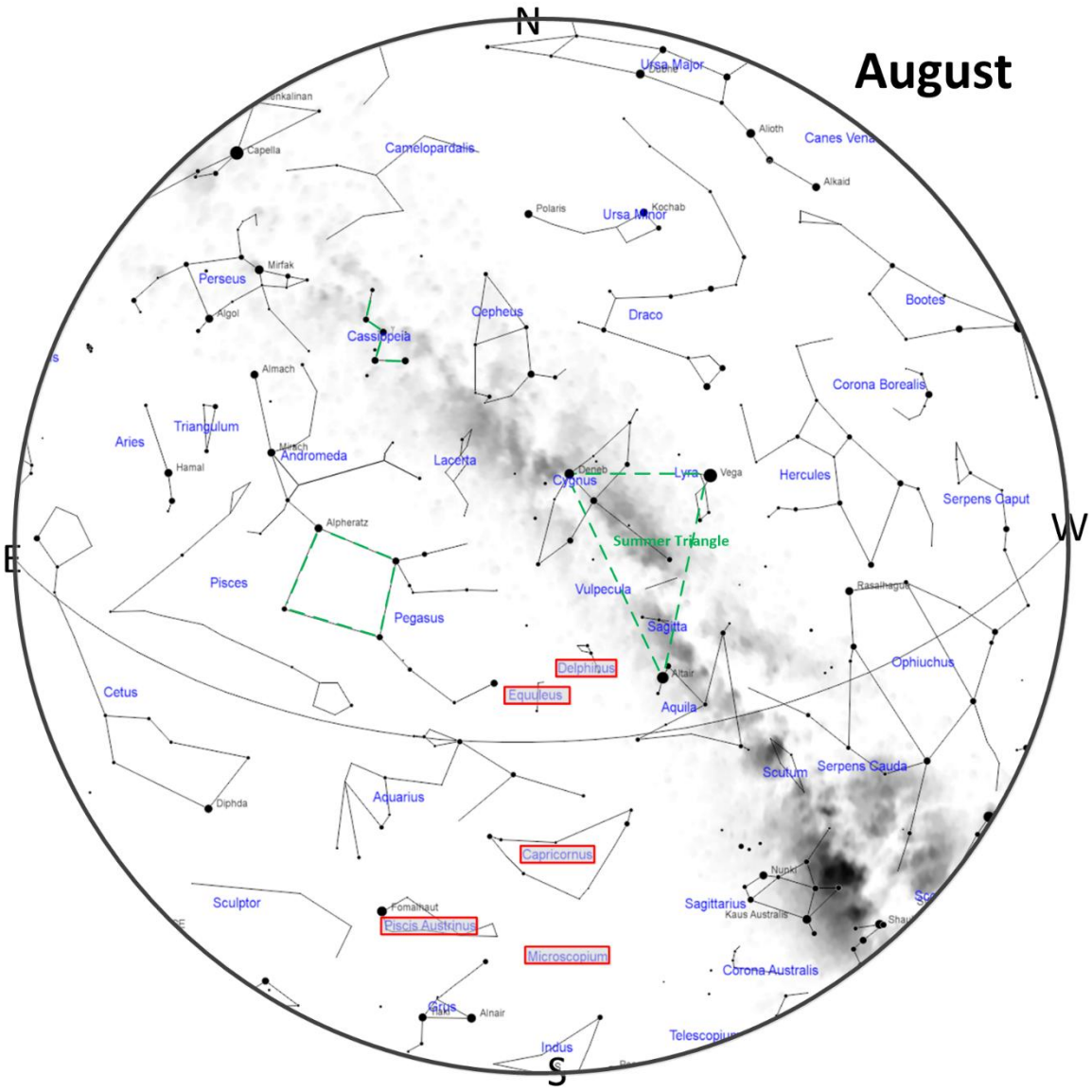


Constellations of Interest

Evening
Scutum (Sct)
Corona Australis (CrA)
Lyra (Lyr)
Sagittarius (Sgr)
Aquilia (Aql)
Cygnus (Cyg)
Vulpecula (Vul)

Prime Time
Delphinus (Del)
Equuleus (Equ)
Capricornus (Cap)
Microscopium (Mic)
Pisces Austrinus (PsA)

Morning
Lacerta (Lac)
Cepheus (Cep)
Aquarius (Aqr)
Grus (Gru)
Pegasus (Peg)
Sculptor (Scl)



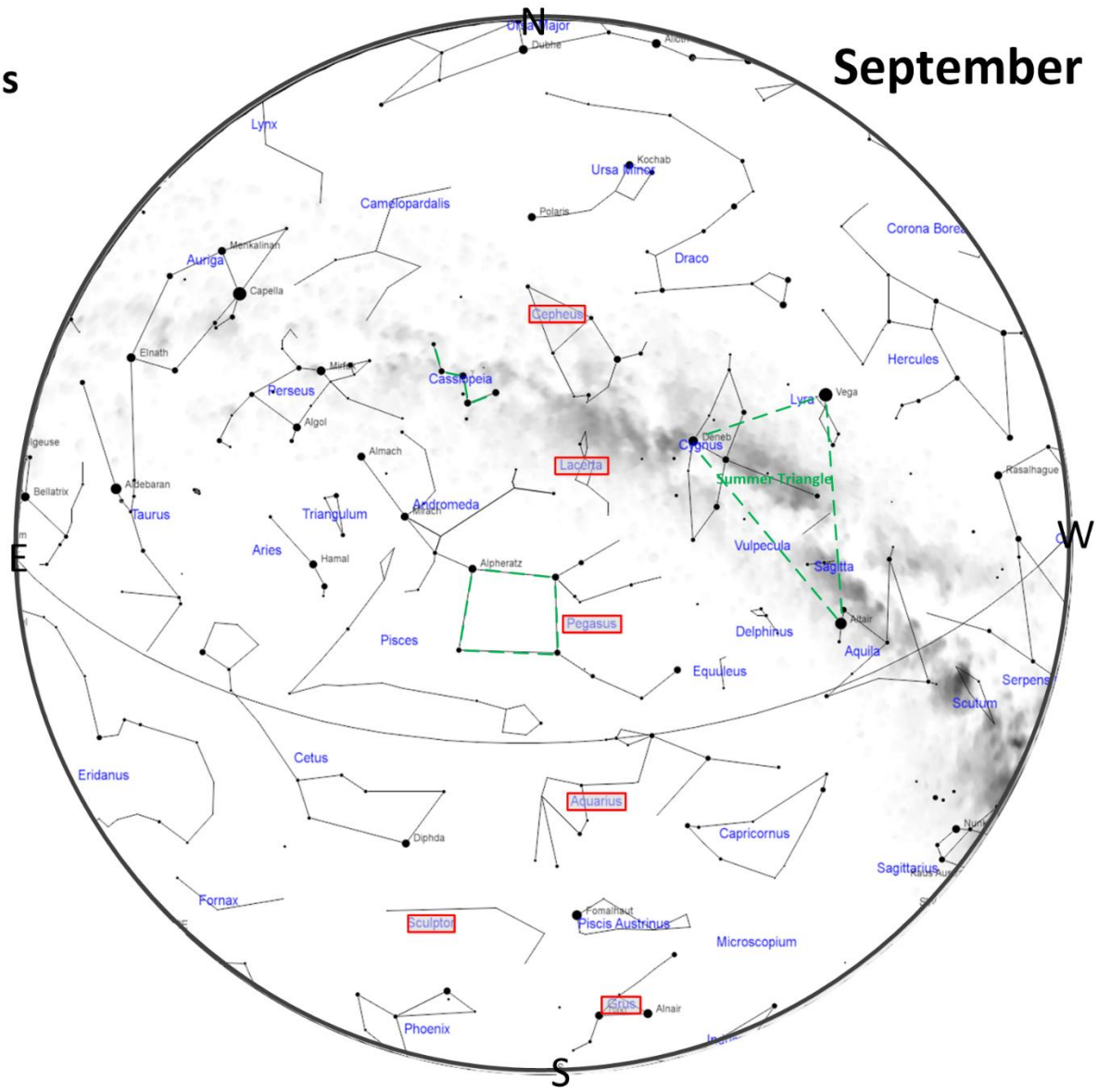
Constellations of Interest

September

Evening
Delphinus (Del)
Equuleus (Equ)
Capricornus (Cap)
Microscopium (Mic)
Pisces Austrinus (PsA)

Prime Time
Lacerta (Lac)
Cepheus (Cep)
Aquarius (Aqr)
Grus (Gru)
Pegasus (Peg)
Sculptor (Scl)

Morning
Andromeda (And)
Pisces (Psc)
Phoenix (Phe)
Cassiopeia (Cas)
Cetus (Cet)
Triangulum (Tri)



Constellations of Interest

Evening

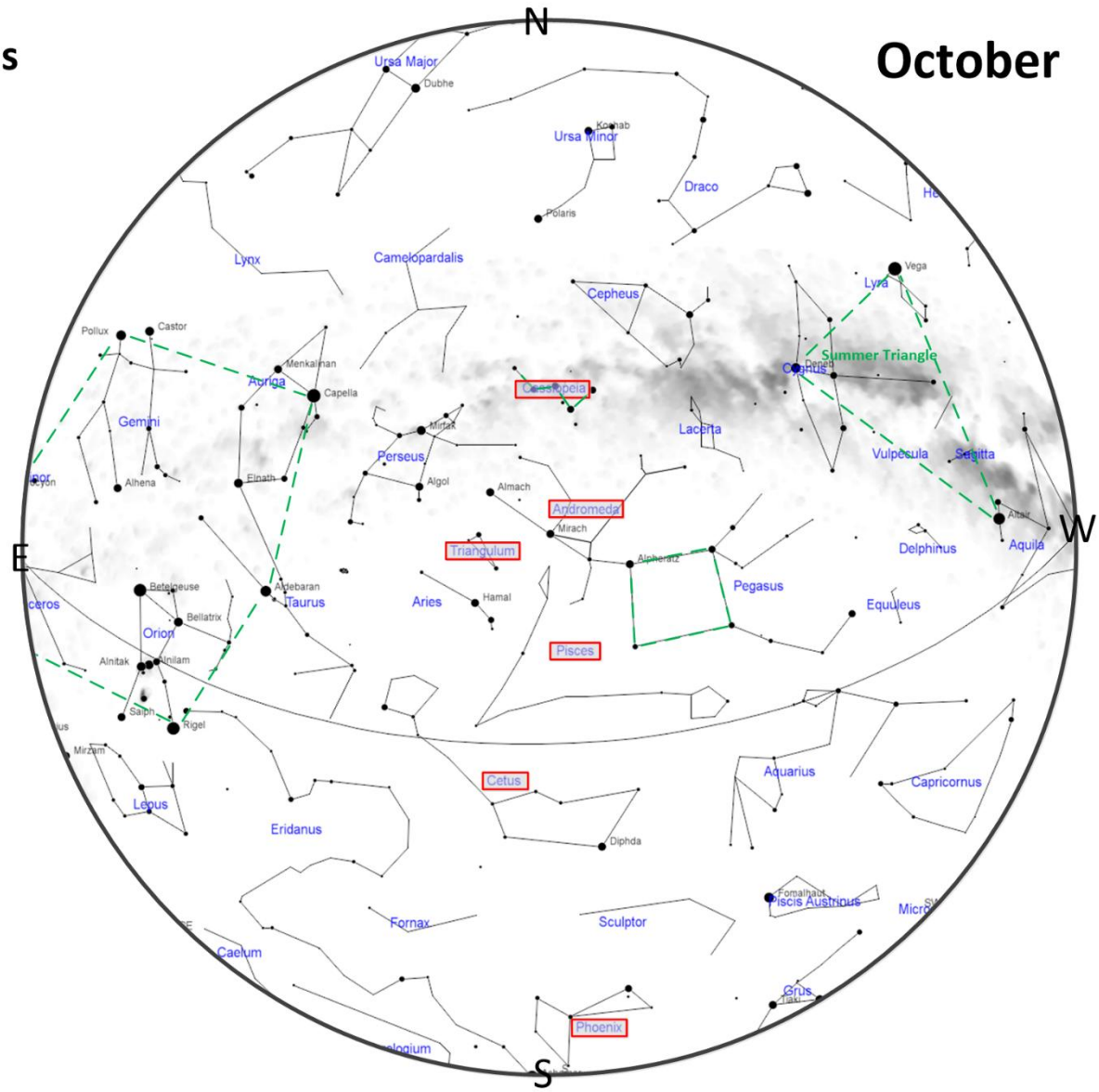
- Lacerta (Lac)
- Cepheus (Cep)
- Aquarius (Aqr)
- Grus (Gru)
- Pegasus (Peg)
- Sculptor (Scl)

Prime Time

- Andromeda (And)
- Pisces (Psc)
- Phoenix (Phe)
- Cassiopeia (Cas)
- Cetus (Cet)
- Triangulum (Tri)

Morning

- Fornax (For)
- Aries (Ari)
- Perseus (Per)
- Eridanus (Eri)



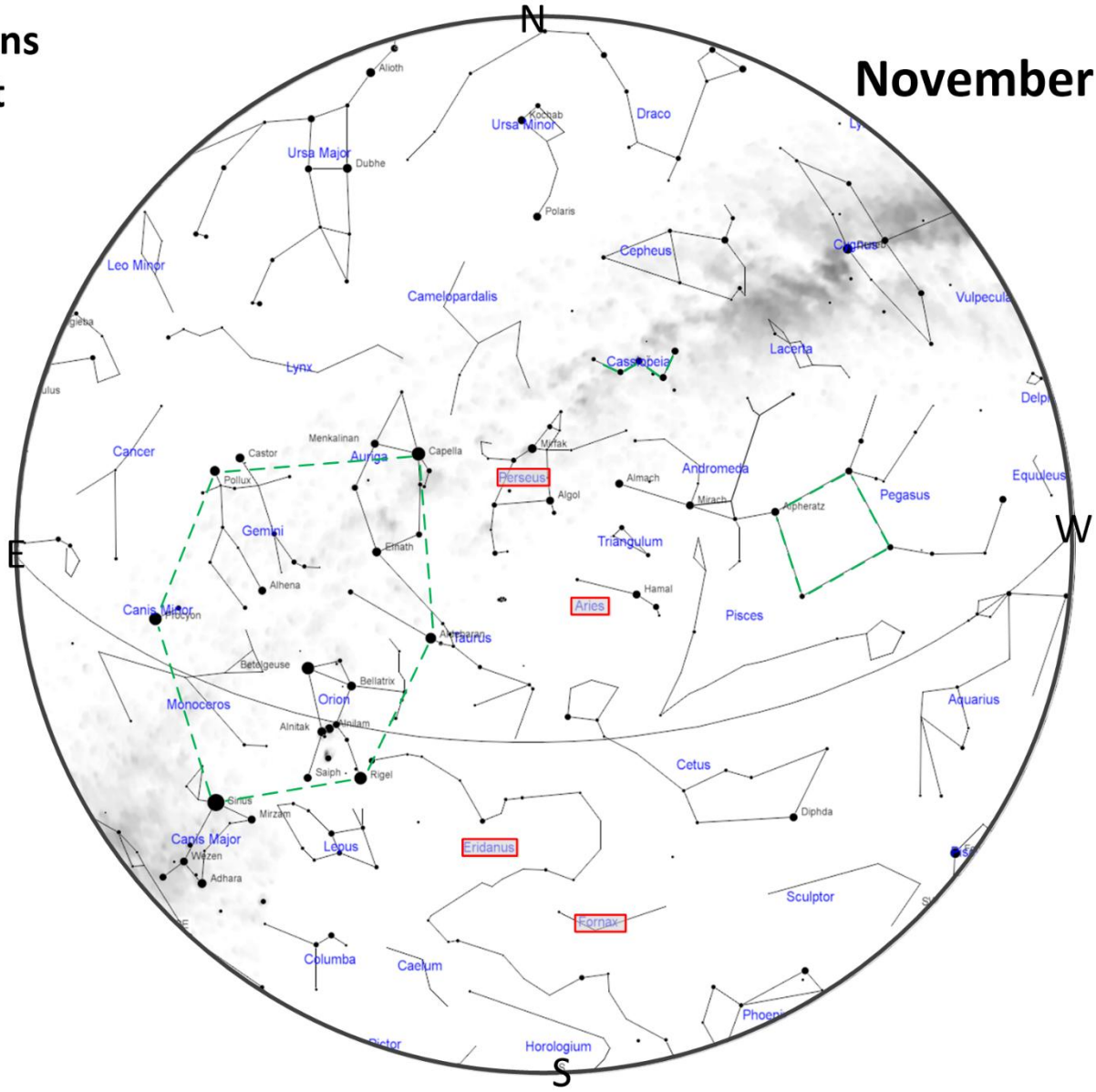
Constellations of Interest

November

Evening
- Andromeda (And)
- Pisces (Psc)
- Phoenix (Phe)
- Cassiopeia (Cas)
- Cetus (Cet)
- Triangulum (Tri)

Prime Time
- Fornax (For)
- Aries (Ari)
- Perseus (Per)
- Eridanus (Eri)

Morning
- Taurus (Tau)
- Caeium (Cae)
- Lepus (Lep)
- Columba (Col)
- Orion (Ori)
- Camelopardalis (Cam)
- Auriga (Aur)



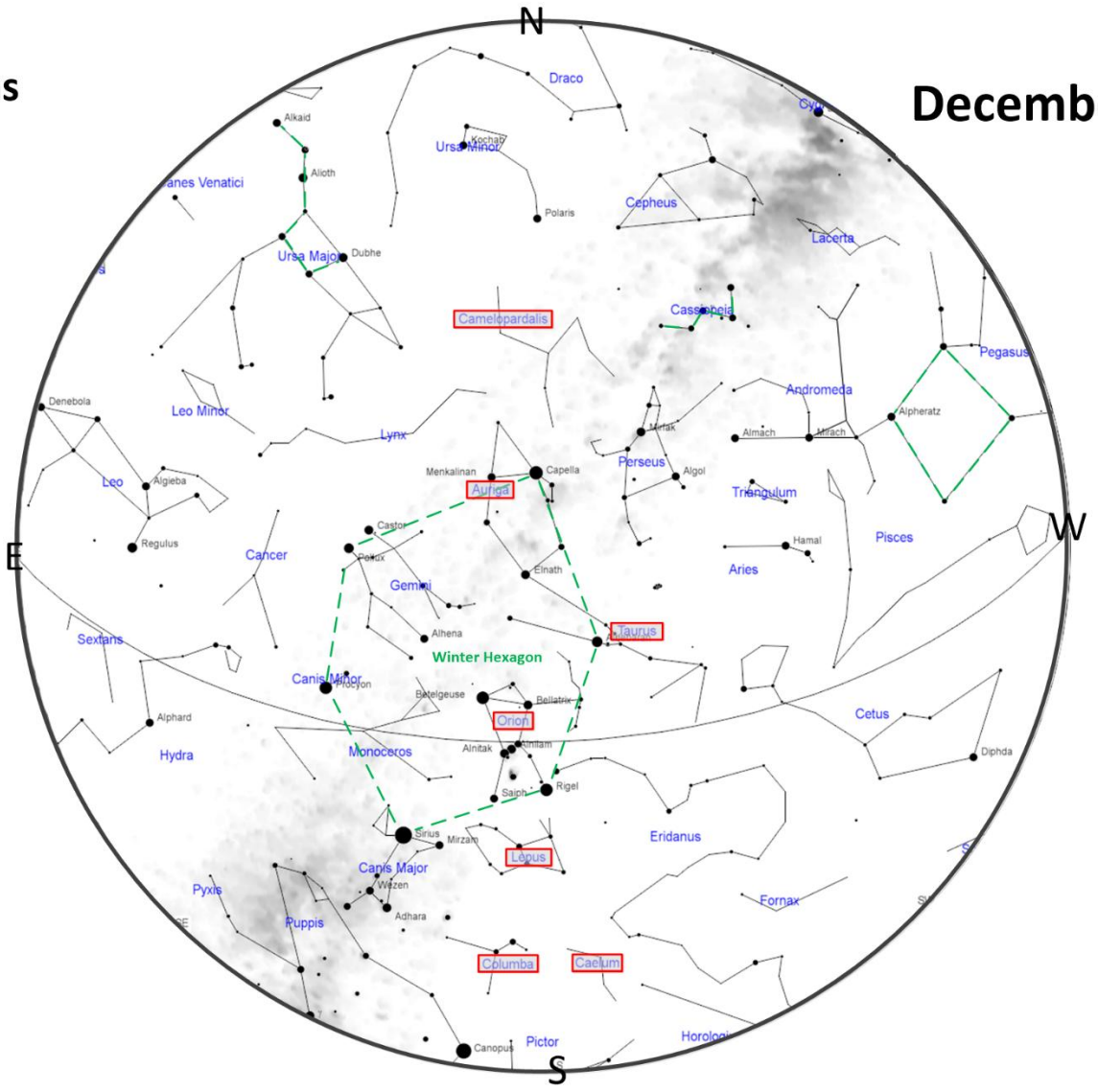
Constellations of Interest

December

Evening
Fornax (For)
Aries (Ari)
Perseus (Per)
Eridanus (Eri)

Prime Time
Taurus (Tau)
Caelum (Cae)
Lepus (Lep)
Columba (Col)
Orion (Ori)
Camelopardalis (Cam)
Auriga (Aur)

Morning
Canis Major (Cma)
Monoceros (Mon)
Gemini (Gem)
Canis Minor (Cmi)
Puppis (Pup)
Lynx (Lyn)



Targets Index

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Deep Sky Highlights

The objects listed below represent some of the best objects in the northern sky.

Object/Type	ID/Ref	Constellation	Description
Andromeda Galaxy (G)	M 31	Andromeda (And)	Best Galaxy in Northern Sky
Izar (DS)	SAO 083500	Boötes	Orange and Green Pair
Kemble's Cascade (AS)		Camelopardalis (Cam)	Ref: AB 15
Beehive Cluster (OC)	M 44	Cancer (Cnc)	Large Open Cluster
HD-56578 (MS)		Canis Major (CMa)	Albireo of Winter
Iota Cassiopeiae (MS)	HIP 11569	Cassiopeiae (Cas)	Excellent Tripple Star
E.T./Owl Cluster (AS)	NGC 457	Cassiopeia (Cas)	PAB: 18
WZ Cassiopeiae (CS/DS)	SAO 021002	Cassiopeiae (Cas)	Red/Blue pair in field of stars
Omega Centauri (OC)	NGC 5139	Centaurus (Cen)	Best Globular in the sky (if you can see it)
Garnet Star (CS)	SAO 033693	Cepheus (Cep)	Red Star
The Cosmic Question Mark (AS)		Cetus (Cet)	Ref: AB 24
The Fairy Ring (AS)		Cygnus (Cyg)	Ref: AB 20
Bent Fan/Red Necked Enu (AS)		Cygnus (Cyg)	PAB: 150
Albireo (DS)	SAO 087301	Cygnus (Cyg)	Gold/Blue pair
Mini-Cassiopeia (AS)		Draco (Dra)	Ref: AB 35
Keid (MS)	SAO 131063	Eridanus (Eri)	Triple star system
Hercules Cluster (GC)	M 13	Hercules (Her)	Best GC in Northern Sky
V-Hydrea (CS)	SAO 179278	Hydra (Hya)	Stop-Light Red
U-Hydrea (CS)	SAO 156110	Hydra (Hya)	Blood Red
Double-Double (MS)	SAO 067310	Lyra (Lyr)	4 Star System
Ring Nebula (PN)	M 57	Lyra (Lyr)	
Christmas Tree Cluster (AS. OC)	NGC 2264	Monoceros (Mon)	PAB: 72
IC 37 (AS, OC)	NGC 2169	Orion (Ori)	AL: 2
Orion Nebula (EN, OC)	M 42	Orion (Ori)	
Sigma Orion (MS)	SAO 132406	Orion (Ori)	Quintuple Star System
Delphinus Minor (AS)		Pegasus (Peg)	Ref: AB 51
M 15 (GC)	M 15	Pegasus (Peg)	
Perseus Double Cluster (OC)	NGC 869, 884	Perseus (Per)	
Messier 22 (GC)	M 22	Sagittarius (Sgr)	
Lagoon Nebula (EN, OC)	M 8	Sagittarius (Sgr)	
False Comet (AS)		Scorpius (Sco)	PAB: 122
Butterfly Cluster (AS, OC)	M 6	Scorpius (Sco)	PAB: 124
Pleiades (OC, RN)	M 45	Taurus (Tar)	The 7 Sisters
Haydes (OC)	C 41	Taurus (Tau)	Large open cluster

Object/Type	ID/Ref	Constellation	Description
Bodes Galaxy (Galaxy) Cigar Galaxy (Galaxy)	M 81 M 82	Ursa Major (UMa)	Galaxy pair visible in wide field view
Mizar (DS)	SAO 028737	Ursa Major (UMa)	Wide Double Star
Engagement Ring (AS)		Ursa Minor (UMi)	Ref: AB 69
The Coathanger (AS, OC)	Col 399	Vulpecula (Vul)	Ref: AB 74
Sombrero Galaxy (G)	M 104	Virgo (Vir)	
Dumbbell Nebula (PN)	M 27	Vulpecula (Vul)	

In City Viewing

Some interesting targets made in the Phoenix Metro area with Bortle 8 skies using either my Celestron C-6 SCT or Meade 7” Maksutov-Cassegrain telescope.

Object/Type	Const	Description
Albireo (DS)	Cygnus	Gold & Blue double star system
HD-56578 (MS)	Canis Major	“Albireo of Winter” – Gold/Blue Pair
V-Hydrea (CS)	Hydra	Stop-Light red in color
U-Hydrea (CS)	Hydra	Blood red color star

Messier Catalog

The Messier catalog was compiled by Charles Messier and contains 110 deep sky objects. Just about every type of deep sky object can be found in this list including galaxies (G), emission nebulae (EN), open clusters (OC), globular clusters (GC), supernova remnants (SNR), planetary nebulae (PN), and dark nebulae (DN). All 110 objects are included in this document. "V" in the table below is for "Viewed" for your records.

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
M-001		Tau	PN	Crab Nebula	12/21	Winter
M-002		Aqr	GC	NGC-7089	08/21	Fall
M-003		CVn	GC	NGC-5272	04/24	Spring
M-004		Sco	GC	Spider Globular Cluster	06/04	Summer
M-005		Ser	GC	NGC-5904	05/18	Summer
M-006		Sco	OC	Butterfly Cluster	06/23	Summer
M-007		Sco	OC	Ptolemy's Cluster	06/27	Summer
M-008		Sgr	EN, OC	Lagoon Nebula	06/29	Summer
M-009		Oph	GC	NGC-6333	06/18	Summer
M-010		Oph	GC	NGC-6254	06/12	Summer
M-011		Sct	OC	Wild Duck Cluster	07/11	Summer
M-012		Oph	GC	NGC-6218	06/10	Summer
M-013		Her	GC	Great Hercules Cluster	06/08	Summer
M-014		Oph	GC	NGC-6402	06/22	Summer
M-015		Peg	GC	Great Pegasus Cluster	08/20	Summer
M-016		Ser	EN, OC	Eagle Nebula	07/03	Summer
M-017		Sgr	DN	Omega Nebula	07/03	Summer
M-018		Sgr	OC	Black Swan Cluster	07/03	Summer
M-019		Oph	GC	NGC-6273	06/14	Summer
M-020		Sgr	EN, OC	Trifid Nebula	06/29	Summer
M-021		Sgr	OC	Webb's Cross	06/29	Summer
M-022		Sgr	GC	Great Sagittarius Cluster	07/07	Summer
M-023		Sgr	OC	NGC-6494	06/27	Summer
M-024		Sgr	OC	Small Sagittarius Star Cloud	07/23	Summer
M-025		Sgr	OC	IC-4725	07/06	Summer
M-026		Sct	OC	NGC-6694	07/10	Summer
M-027		Vul	PN	Dumbbell Nebula	07/28	Summer
M-028		Sgr	GC	NGC-6626	07/04	Summer
M-029		Cyg	OC	Cooling Tower Cluster	08/04	Summer
M-030		Cap	GC	Jellyfish Cluster	08/23	Summer
M-031		And	G	Andromeda Galaxy	10/08	Fall
M-032		And	G	NGC-221	10/08	Fall
M-033		Tri	G	Triangulum Galaxy	10/21	Fall
M-034		Per	OC	Spiral Cluster	11/07	Fall
M-035		Gem	OC	Shoe-Buckle Cluster	12/30	Winter
M-036		Aur	OC	Pinwheel Cluster	12/22	Winter
M-037		Aur	OC	Salt and Pepper Cluster	12/26	Winter

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
M-038		Aur	OC	Starfish Cluster	12/20	Winter
M-039		Cyg	OC	Pyramid Cluster	08/21	Summer
M-040		UMa	DS	Winnecke 4	04/04	Spring
M-041		CMa	OC	Little Beehive	01/08	Winter
M-042		Ori	EN, OC	Orion Nebula	12/21	Winter
M-043		Ori	EN	De Mairan's Nebula	12/21	Winter
M-044		Cnc	OC	Beehive Cluster	02/06	Winter
M-045		Tau	OC	Pleiades	11/24	Fall
M-046		Pup	OC	NGC-2437	01/22	Winter
M-047		Pup	OC	NGC-2422	01/21	Winter
M-048		Hya	OC	NGC-2548	01/31	Winter
M-049		Vir	G	NGC-4472	04/05	Spring
M-050		Mon	OC	Heart-shaped Cluster	01/13	Winter
M-051		CVn	G	Whirlpool Galaxy	04/21	Spring
M-052		Cas	OC	Scorpion Cluster	09/18	Fall
M-053		Com	GC	NGC-5024	04/16	Spring
M-054		Sgr	GC	NGC-6715	07/12	Summer
M-055		Sgr	GC	Specter Cluster	07/23	Summer
M-056		Lyr	GC	NGC-6779	07/18	Summer
M-057		Lyr	PN	Ring Nebula	07/12	Summer
M-058		Vir	G	NGC-4579	04/07	Spring
M-059		Vir	G	NGC-4621	04/09	Spring
M-060		Vir	G	NGC-4649	04/09	Spring
M-061		Vir	G	Swelling Spiral Galaxy	04/03	Spring
M-062		Oph	GC	Flickering Globular Cluster	06/13	Summer
M-063		CVn	G	Sunflower Galaxy	04/17	Spring
M-064		Com	G	Black Eye Galaxy	04/12	Spring
M-065		Leo	G	NGC-3623	03/18	Spring
M-066		Leo	G	NGC-3627	03/18	Spring
M-067		Cnc	OC	King Cobra Cluster	02/09	Winter
M-068		Hya	GC	NGC-4590	04/08	Spring
M-069		Sgr	GC	NGC-6637	07/06	Summer
M-070		Sgr	GC	NGC-6681	07/09	Summer
M-071		Sgr	GC	Angelfish Cluster	07/27	Summer
M-072		Aqr	GC	NGC-6981	08/11	Summer
M-073		Aqr	AS, OC	NGC-6994	08/13	Summer
M-074		Psc	G	Phantom Galaxy	10/22	Fall
M-075		Sgr	GC	NGC-6864	07/30	Summer
M-076		Per	PN	Little Dumbbell Nebula	10/23	Fall
M-077		Cet	G	Squid Galaxy	11/08	Fall
M-078		Ori	RN	NGC-2068	12/24	Winter
M-079		Lep	GC	NGC-1904	12/19	Winter
M-080		Sco	GC	NGC-6093	06/02	Summer
M-081		UMa	G	Bode's Galaxy	02/25	Winter
M-082		UMa	G	Cigar Galaxy	02/25	Winter

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
M-083		Hya	G	Southern Pinwheel Galaxy	04/22	Spring
M-084		Vir	G	NGC-4374	04/04	Spring
M-085		Com	G	NGC-4382	04/04	Spring
M-086		Vir	G	NGC-4406	04/05	Spring
M-087		Vir	G	Virgo A	04/06	Spring
M-088		Com	G	NGC-4501	04/01	Spring
M-089		Vir	G	NGC-4552	04/07	Spring
M-090		Vir	G	NGC-4569	04/07	Spring
M-091		Com	G	NGC-4548	04/07	Spring
M-092		Her	GC	NGC-6341	06/17	Summer
M-093		Pup	OC	Critter Cluster	01/23	Winter
M-094		CVn	G	Cat's Eye Galaxy	04/11	Spring
M-095		Leo	G	NGC-3351	03/10	Spring
M-096		Leo	G	NGC-3368	03/10	Spring
M-097		UMa	PN	Owl Nebula	03/17	Spring
M-098		Com	G	NGC-4192	04/01	Spring
M-099		Com	G	St. Catherine's Wheel	04/03	Spring
M-100		Com	G	Mirror Galaxy	04/04	Spring
M-101		UMa	G	Pinwheel Galaxy	04/29	Spring
M-102		Dra	G	Spindle Galaxy	05/15	Spring
M-103		Cas	OC	NGC-581	10/21	Fall
M-104		Vir	G	Sombrero Galaxy	04/08	Spring
M-105		Leo	G	NGC-3379	03/11	Spring
M-106		CVn	G	NGC-4258	04/03	Spring
M-107		Oph	GC	Crucifix Cluster	06/06	Summer
M-108		UMa	G	Surfboard Galaxy	03/17	Spring
M-109		UMa	G	Vacuum Cleaner Galaxy	03/28	Spring
M-110		And	G	NGC-205	10/08	Fall

Caldwell Catalog

The Caldwell Catalog was compiled by Patrick Moore and contains 109 deep sky objects not included in the Messier catalogue. It is considered a complement to the Messier catalog of 110 objects. "V" in the table below is for "Viewed" for your records.

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
C-001		Cep	OC	NGC-188	10/09	
C-002		Cep	PN	NGC-40	10/01	
C-003		Dra	G	NGC-4236	04/02	
C-004		Cep	EN	NGC-7023	08/13	
C-005		Cam	G	IC-341	11/24	
C-006		Dra	PN	Cat Eye Nebula, NGC-6543	06/28	
C-007		Cam	G	NGC-2403	01/21	
C-008		Cas	OC	NGC-559	10/20	
C-009		Cep	EN	Cave Nebula, SH2-155	09/11	
C-010		Cas	OC	NGC-663	10/24	
C-011		Cas	EN	Bubble Nebula, NGC-7635	09/17	
C-012		Cep	G	NGC-6946	08/06	
C-013		Cas	OC	Dragonfly Cluster, NGC-457	10/17	
C-014		Per	OC	Chi Persei, NGC-884, 869	11/02	
C-015		Cyg	PN	Blinking Planetary, NGC-6826	07/25	
C-016		Lac	OC	NGC-7243	09/01	
C-017		Cas	G	NGC-147	10/06	
C-018		Cas	G	NGC-185	10/07	
C-019		Cyg	EN	Cocoon Nebula, IC-5146	08/26	
C-020		Cyg	EN	Gulf of Mexico, NGC-7000	08/12	
C-021		CVn	G	NGC-4449	04/05	
C-022		And	PN	Blue Snowball, NGC-7662	09/19	
C-023		And	G	NGC-891	11/03	
C-024		Per	G	Perseus A, NGC-1275	11/17	
C-025		Lyn	GC	Intergalactic Wanderer, NGC-2419	01/22	
C-026		CVn	G	NGC-4244	04/02	
C-027		Cyg	EN	Crescent Nebula, NGC-6888	08/01	
C-028		And	OC	NGC-752	10/27	
C-029		CVn	G	NGC-5005	04/16	
C-030		Peg	G	NGC-7331	09/06	
C-031		Aur	EN	IC-405	12/17	
C-032		CVn	G	Herring Galaxy, NGC-4631	04/09	
C-033		Cyg	SNR	Cirrus Nebula, NGC-6995, 6992	08/12	
C-034		Cyg	SNR	Cirrus Nebula, NGC-6960	08/09	
C-035		Com	G	NGC-4884	04/13	
C-036		Com	G	NGC-4559	04/07	
C-037		Vul	OC	20 Vulpeculae Cluster, NGC-6885	08/01	
C-038		Com	G	NGC-4565	04/07	

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
C-039		Gem	PN	Eskimo Nebula, NGC-2392	01/19	
C-040		Leo	G	NGC-3626	03/19	
C-041		Tau	OC	Haydes	12/04	
C-042		Del	GC	NGC-7006	08/13	
C-043		Peg	G	NGC-7814	09/28	
C-044		Peg	G	NGC-7479	09/13	
C-045		Boo	G	NGC-5248	04/23	
C-046		Mon	EN	Hubble's Variable Nebula, NGC-2261	01/07	
C-047		Del	GC	NGC-6934	08/06	
C-048		Cnc	G	NGC-2775	02/14	
C-049		Mon	EN	Rosette Nebula, NGC-2239, 2237	01/05	
C-050		Mon	OC	Rosett Nebula Cluster, NGC-2244	01/05	
C-051		Cet	G	IC-1613	10/14	
C-052		Vir	G	NGC-4697	04/10	
C-053		Sex	G	Spindle Galaxy, NGC-3115	02/28	
C-054		Mon	OC	NGC-2506	01/27	
C-055		Aqr	PN	Saturn Nebula, NGC-7009	08/14	
C-056		Cet	PN	NGC-246	10/09	
C-057		Sgr	G	Barnard's Galaxy, NGC-6822	07/25	
C-058		CMa	OC	NGC-2360	01/16	
C-059		Hya	PN	CBS Eye, NGC-3242	03/05	
C-060		Crv	G	Antennae Galaxy, NGC-4038	03/29	
C-061		Crv	G	Antennae Galaxy, NGC-4039	03/29	
C-062		Cet	G	NGC-247	10/09	
C-063		Aqr	PN	Helix Nebula, NGC-7293	09/04	
C-064		CMa	OC	Mexican Jumping Star, NGC-2362	01/17	
C-065		Scl	G	Sculptor Galaxy, NGC-253	10/09	
C-066		Hya	GC	NGC-5694	05/08	
C-067		For	G	NGC-1097	11/09	
C-068		CrA	EN	NGC-6729	07/14	
C-069		Sco	PN	Bug Nebula, NGC-6302	06/16	
C-070		Scl	G	NGC-300	10/11	
C-071		Pup	OC	NGC-2477	01/25	
C-072		Scl	G	NGC-55	10/01	
C-073		Col	GC	NGC-1851	12/16	
C-074		Vel	PN	Eight-burst Planetary, NGC-3131	02/28	
C-075		Sco	OC	NGC-6124	06/04	
C-076		Sco	OC	Table of Scorpius, NGC-6231	06/11	
C-077		Cen	G	Centaurus A, NGC-5128	04/20	
C-078		CrA	GC	NGC-6541	06/30	
C-079		Vel	GC	NGC-3201	03/03	
C-080		Cen	GC	Omega Centauri, NGC-5139	04/20	
C-081		Ara	GC	NGC-6352	06/19	
C-082		Ara	OC	NGC-6193	06/08	
C-083		Cen	G	NGC-4945	04/14	

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
C-084		Cen	GC	NGC-5286	04/25	
C-085		Vel	OC	IC-2391	02/06	
C-086		Ara	GC	NGC-6397	06/23	
C-087		Hor	GC	NGC-1261	11/15	
C-088		Cir	OC	NGC-5823	05/15	
C-089		Nor	OC	NGC-6087	06/03	
C-090		Car	PN	NGC-2867	02/17	
C-091		Car	OC	Firefly Party Cluster, NGC-3532	03/15	
C-092		Car	EN	Eta Carinae Nebula, NGC-3372	03/10	
C-093		Pav	GC	Pavo Globular, NGC-6752	07/16	
C-094		Cru	OC	Jewel Box, NGC-4755	04/11	
C-095		TrA	OC	NGC-6025	05/30	
C-096		Car	OC	NGC-2516	01/27	
C-097		Cen	OC	NGC-03766	03/23	
C-098		Cru	OC	NGC-4609	04/09	
C-099		Cru	DN	Coalsack	04/11	
C-100		Cen	OC	IC-2944	03/23	
C-101		Pav	G	NGC-6744	07/16	
C-102		Car	OC	IC-2602	03/09	
C-103		Dor	EN	30 Doradus, NGC-2070	12/22	
C-104		Tuc	GC	NGC-362	10/13	
C-105		Mus	GC	NGC-4833	04/13	
C-106		Tuc	GC	47 Tucanae, NGC-104	10/04	
C-107		Aps	GC	NGC-6101	06/04	
C-108		Mus	GC	NGC-4372	04/04	
C-109		Cha	PN	NGC-3195	03/01	

Trumpler Catalog

The Trumpler Catalog of Open Clusters is a list of open clusters complied by Robert Julis Trumpler, who did extensive studies of open clusters and devised a system for classifying open clusters according to the number of stars observed within them, how concentrated these stars are in the center of the cluster and the range of there apparent brightness. This system is known as the Trumpler classification and is generally the morphology classification (M Class) utilized for describing open clusters. While the list provided here are certainly not representative of the best open clusters, it is an interesting list of open clusters cataloged by Trumpler.

ID	V	Const	M Class	Name/ Alt ID	Opposition	Season
Tr-01		Cas			2026/11/07	Fall
Tr-02		Per			2026/11/23	Fall
Tr-03		Cas			2026/12/02	Winter
Tr-04		Gem			2026/01/15	Winter
Tr-05		Mon			2026/01/23	Winter
Tr-06		CMa			2026/02/04	Winter
Tr-07		Pup			2026/02/04	Winter
Tr-08		Pup			2026/02/12	Winter
Tr-09		Pup			2026/02/12	Winter
Tr-10		Vel			2026/02/25	Winter
Tr-11		Car			2026/03/16	Spring
Tr-12		Car			2026/03/17	Spring
Tr-13		Car			2026/03/21	Spring
Tr-14		Car			2026/03/26	Spring
Tr-15		Car			2026/03/27	Spring
Tr-16		Car			2026/03/27	Spring
Tr-17		Car			2026/03/29	Spring
Tr-18		Car			2026/04/02	Spring
Tr-19		Car			2026/04/03	Spring
Tr-20		Cru			2026/04/25	Spring
Tr-21		Cen			2026/05/08	Spring
Tr-22		Cen			2026/05/23	Spring
Tr-23		Nor			2026/06/15	Summer
Tr-24		Sco			2026/06/29	Summer
Tr-25		Sco			2026/07/06	Summer
Tr-26		Oph			2026/07/07	Summer
Tr-27		Sco			2026/07/09	Summer
Tr-28		Sco			2026/07/09	Summer
Tr-29		Sco			2026/07/10	Summer
Tr-30		Sco			2026/07/14	Summer
Tr-31		Sgr			2026/07/15	Summer
Tr-32		Ser			2026/07/19	Summer
Tr-33		Sgr			2026/07/21	Summer

ID	V	Const	M Class	Name/ Alt ID	Opposition	Season
Tr-34		Sct			2026/07/25	Summer
Tr-35		Sct			2026/07/26	Summer
Tr-36		Cyg			2026/08/17	Summer
Tr-37		Cep			2026/09/08	Fall

SAC Best 110 NGC List

The SAC 110 Best of the NGC is a list compiled by the Saguaro Astronomy Club and contains many of the best NGC objects. "V" in the table below is for "Viewed" for your records.

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
001		And	Galaxy	NGC-891	11/03	Fall
002		And	P Neb	NGC-7662	09/19	Fall
003		Aql	P Neb	NGC-6781	07/18	Summer
004		Aqr	P Neb	NGC-7009	08/14	Summer
005		Aqr	P Neb	NGC-7293	09/05	Fall
006		Ari	Galaxy	NGC-772	10/28	Fall
007		Aur	Open	NGC-1907	12/20	Winter
008		Aur	Open	NGC-1931	12/20	Winter
009		Cam	P Neb	NGC-1501	11/29	Fall
010		Cam	Galaxy	NGC-2403	01/21	Winter
011		Cam	Galaxy	NGC-2655	02/10	Winter
012		Cas	Galaxy	NGC-185	10/07	Fall
013		Cas	Open	NGC-281	10/11	Fall
014		Cas	Open	NGC-457	10/17	Fall
015		Cas	Open	NGC-663	10/24	Fall
016		Cas	Open	NGC-7789	09/27	Fall
017		Cen	Galaxy	NGC-5128	04/20	Spring
018		Cen	Globular	NGC-5139	04/20	Spring
019		Cep	P Neb	NGC-40	10/01	Fall
020		Cep	Open	NGC-6939	08/06	Summer
021		Cep	Galaxy	NGC-6946	08/06	Summer
022		Cep	Open	NGC-7129	08/23	Summer
023		Cet	P Neb	NGC-246	10/09	Fall
024		Cet	Galaxy	NGC-936	11/04	Fall
025		CMa	E Neb	NGC-2359	01/17	Winter
026		Com	Galaxy	NGC-4274	04/03	Spring
027		Com	Galaxy	NGC-4414	04/05	Spring
028		Com	Galaxy	NGC-4494	04/06	Spring
029		Com	Galaxy	NGC-4559	04/07	Spring
030		Com	Galaxy	NGC-4565	04/07	Spring
031		Com	Galaxy	NGC-4725	04/11	Spring
032		Crv	P Neb	NGC-4361	04/04	Spring
033		CVn	Galaxy	NGC-4111	03/31	Spring
034		CVn	Galaxy	NGC-4214	04/02	Spring
035		CVn	Galaxy	NGC-4244	04/02	Spring
036		CVn	Galaxy	NGC-4449	04/05	Spring
037		CVn	Galaxy	NGC-4490	04/06	Spring
038		CVn	Galaxy	NGC-4631	04/09	Spring
039		CVn	Galaxy	NGC-4656	04/09	Spring

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
040		CVn	Galaxy	NGC-5005	04/16	Spring
041		CVn	Galaxy	NGC-5033	04/17	Spring
042		Cyg	Open	NGC-6819	07/24	Summer
043		Cyg	P Neb	NGC-6826	07/25	Summer
044		Cyg	E Neb	NGC-6960	08/09	Summer
045		Cyg	E Neb	NGC-6992	08/12	Summer
046		Cyg	E Neb	NGC-7000	08/12	Summer
047		Cyg	P Neb	NGC-7027	08/15	Summer
048		Dra	Galaxy	NGC-5907	05/18	Spring
049		Dra	Galaxy	NGC-6503	06/25	Summer
050		Dra	P Neb	NGC-6543	06/28	Summer
051		Eri	Galaxy	NGC-1232	11/15	Fall
052		Eri	P Neb	NGC-1535	12/01	Winter
053		Gem	Open	NGC-2158	12/30	Winter
054		Gem	P Neb	NGC-2392	01/19	Winter
055		Her	Galaxy	NGC-6207	06/09	Summer
056		Her	P Neb	NGC-6210	06/09	Summer
057		Hya	P Neb	NGC-3242	03/05	Spring
058		Lac	Open	NGC-7209	08/29	Summer
059		Lac	Open	NGC-7243	09/01	Fall
060		Leo	Galaxy	NGC-2903	02/19	Winter
061		Leo	Galaxy	NGC-3384	03/11	Spring
062		Leo	Galaxy	NGC-3521	03/15	Spring
063		Leo	Galaxy	NGC-3607	03/18	Spring
064		Leo	Galaxy	NGC-3628	03/19	Spring
065		LMi	Galaxy	NGC-3344	03/10	Spring
066		LMi	Galaxy	NGC-3432	03/12	Spring
067		Lyn	Galaxy	NGC-2683	02/09	Winter
068		Mon	Open	NGC-2244	01/05	Winter
069		Mon	E Neb	NGC-2261	01/07	Winter
070		Oph	P Neb	NGC-6369	06/20	Summer
071		Oph	P Neb	NGC-6572	07/01	Summer
072		Oph	Open	NGC-6633	07/05	Summer
073		Ori	E Neb	NGC-1788	12/14	Winter
074		Ori	E Neb	NGC-1973	12/21	Winter
075		Ori	P Neb	NGC-2022	12/23	Winter
076		Ori	E Neb	NGC-2024	12/23	Winter
077		Ori	Open	NGC-2194	12/31	Winter
078		Peg	Galaxy	NGC-7331	09/06	Fall
079		Per	Open	NGC-869	11/02	Fall
080		Per	Open	NGC-884	11/03	Fall
081		Per	Galaxy	NGC-1023	11/07	Fall
082		Per	E Neb	NGC-1491	11/28	Fall
083		Pup	P Neb	NGC-2438	01/22	Winter
084		Pup	P Neb	NGC-2440	01/22	Winter

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
085		Pup	Open	NGC-2539	01/30	Winter
086		Scl	Galaxy	NGC-253	10/09	Fall
087		Sct	Globular	NGC-6712	07/12	Summer
088		Sex	Galaxy	NGC-3115	02/28	Winter
089		Sgr	P Neb	NGC-6445	06/25	Summer
090		Sgr	Open	NGC-6520	06/29	Summer
091		Sgr	P Neb	NGC-6818	07/25	Summer
092		UMa	Galaxy	NGC-2841	02/17	Winter
093		UMa	Galaxy	NGC-3077	02/27	Winter
094		UMa	Galaxy	NGC-3079	02/27	Winter
095		UMa	Galaxy	NGC-3184	03/03	Spring
096		UMa	Galaxy	NGC-3675	03/20	Spring
097		UMa	Galaxy	NGC-3877	03/25	Spring
098		UMa	Galaxy	NGC-3941	03/27	Spring
099		UMa	Galaxy	NGC-4026	03/29	Spring
100		UMa	Galaxy	NGC-4088	03/30	Spring
101		UMa	Galaxy	NGC-4605	04/08	Spring
102		Vir	Galaxy	NGC-4216	04/02	Spring
103		Vir	Galaxy	NGC-4388	04/04	Spring
104		Vir	Galaxy	NGC-4438	04/05	Spring
105		Vir	Galaxy	NGC-4526	04/07	Spring
106		Vir	Galaxy	NGC-4535	04/07	Spring
107		Vir	Galaxy	NGC-4567	04/07	Spring
108		Vir	Galaxy	NGC-4568	04/07	Spring
109		Vir	Galaxy	NGC-4699	04/10	Spring
110		Vir	Galaxy	NGC-4762	04/11	Spring

Kemble's Fifty-To-The-Pole Program

Lucien J. Kemble (1922-1999) was an avid astronomer and member of the Royal Astronomical Society of Canada. He came up with a list of 50 interesting deep sky objects within 50° of the Celestial North Pole. Most are within reach of an 8-inch scope in a dark sky.

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
001		Cam	Galaxy	NGC 2146	01/01	Winter
002		Lyn	Galaxy	UGC 3574	01/10	Winter
003		Lyn	Galaxy	NGC 2320	01/13	Winter
004		Lyn	Galaxy	NGC 2322	01/13	Winter
005		Lyn	P Neb	Jones-Emberson 1	01/27	Winter
006		UMa	Galaxy	NGC 2602	02/05	Winter
007		UMa	Galaxy	NGC 2603	02/05	Winter
008		UMa	Galaxy	NGC 2606	02/05	Winter
009		Cam	Galaxy	NGC 2715	02/13	Winter
010		Dra	Galaxy	NGC 3183	03/04	Spring
011		UMi	Galaxy	NGC 3172	03/26	Spring
012		UMa	Galaxy	NGC 3972	03/28	Spring
013		UMa	Galaxy	NGC 4157	04/01	Spring
014		Dra	Galaxy+Quasar	Markarian 205	04/03	Spring
015		UMa	Galaxy	NGC 5308	04/25	Spring
016		UMa	Galaxy	NGC 5484	04/30	Spring
017		UMa	Galaxy	NGC 5485	04/30	Spring
018		UMa	Galaxy	NGC 5486	04/30	Spring
019		Boo	Galaxy	NGC 5875	05/16	Spring
020		UMi	Galaxy	NGC 5909	05/16	Spring
021		UMi	Galaxy	NGC 5912	05/17	Spring
022		UMi	Galaxy	NGC 6251	06/06	Summer
023		UMi	Galaxy	NGC 6252	06/06	Summer
024		Dra	Galaxy	Draco Dwarf	06/18	Summer
025		Dra	P Neb	NGC 6543	06/28	Summer
026		Dra	Galaxy	NGC 6643	07/03	Summer
027		Dra	Galaxy	NGC 6654	07/04	Summer
028		Dra	Asterism	Kemble 2	07/07	Summer
029		Cyg	P Neb	NGC 6826	07/25	Summer
030		Cep	Open	NGC 6939	08/06	Summer
031		Cep	Open	NGC 7023	08/13	Summer
032		Cep	Open	Cr471	08/30	Summer
033		Lac	Open	IC 1434	08/31	Summer
034		Cep	Open	Reiland 1	09/13	Fall
035		Cep	Open	NGC 7510	09/15	Fall
036		Cep	BrNeb	Ced 214	09/28	Fall
037		Cas	Asterism	Ling1	10/03	Fall
038		Cas	Open	King 14	10/06	Fall

ID	V	Const	Type	Name/ Alt ID	Opposition	Season
039		Cep	Open	NGC 188	10/09	Fall
040		Cas	Open	Tr 1	10/22	Fall
041		Cas	Neb	NGC 896	11/03	Fall
042		Per	Open	Cz8	11/05	Fall
043		Cas		IC 1851	11/10	Fall
044		Cam	Open	Stock 23	11/16	Fall
045		Cas	Asterism	Kemble 3	11/19	Fall
046		Cep	Globular	Pal 1	11/21	Fall
047		Cam	Galaxy	IC 342	11/24	Fall
048		Cam	Asterism	Kemble 1	11/27	Fall
049		Cam	Open	NGC 1502	11/29	Fall
050		Cam	Galaxy	NGC 1961	12/23	Winter

RASC: Dark Nebula

This is a list of dark nebulae compiled by Paul Gray for the Royal Astronomical Society of Canada.

Seq	V	ID	Const	Size	Opacity	Comments	Opposition	Season
001		B5	Per	60	5	1° NE of o Per	11/24	Fall
002		B211	Tau	12x110	3	narrow NW-SE lanes, faint bkgd starfield	12/02	Winter
003		B33	Ori	6x4	4	Horsehead Nebula; use βH filter	12/23	Winter
004		B34	Aur	20	4	2° W of M37; spider-like appearance	12/24	Winter
005		B35	Ori	20x10	5	near FU Ori and bright nebula Ced 59	12/24	Winter
006		B37	Mon	180	5	near NGC 2245, 2247; try binoculars	01/05	Winter
007		B40	Sco	15	3	in bright nebula IC 4592; 50' NE of ν Sco	06/01	Spring
008		B44	Oph	35x300	6	large dark rift; unaided-eye in superb sky	06/08	Spring
009		B59	Oph	60	6	3° SW of θ Oph; part of stem of Pipe Nebula	06/16	Spring
010		B64	Oph	20	6	30' W of M9; causes darkening of M9	06/17	Spring
011		B68	Oph	3	6	small; near B72; region rich in dark nebula	06/19	Spring
012		B70	Oph	4	4	small; near B72; region rich in dark nebula	06/19	Spring
013		B72	Oph	30	6	!! the Snake; "S" shape; 1.5° N of θ Oph	06/19	Spring
014		B78	Oph	180	6	!! Pipe bowl, "Prancing Horse" hindquarters	06/21	Spring
015		B84A	Sgr	16	5	1.5° N of M23; try for extensions to S	06/28	Spring
016		B85	Sgr	5	4	!! dark lanes inside Trifid Nebula (M20)	06/29	Spring
017		B86	Sgr	4	5	!! Ink Spot; nice pair with NGC 6520 5' E	06/29	Spring
018		B87	Sgr	12	4	Parrot's Head; 2° S of γ Sgr	06/29	Spring
019		B88	Sgr	2	4	on edge of M8; not Burnham's "Dark Comet"	06/29	Spring
020		Dark Comet	Sgr	2x1	4	Burnham's "Dark Comet"; use filter	06/29	Spring
021		B303	Sgr	1	5	inside IC 4685; use filter; challenging	07/01	Summer
022		B92	Sgr	12x6	6	!! on NW edge of Small Sgr STar Cloud, M24	07/02	Summer
023		B103	Sct	40	6	on NW side of Scutum star cloud	07/08	Summer
024		B104	Sct	16x1	5	20' N of β Set; a checkmark shape	07/10	Summer
025		B108	Sct	3	3	30' W of M11; rich region	07/11	Summer
026		B112	Sct	20	4	30' S of M11; also look for B114, B118	07/11	Summer
027		B133	Aql	10x3	6	on Scutum star cloud; very dark spot!	07/15	Summer
028		B142	Aql	80x50	6	!! Barnard's famous "E" cloud	07/23	Summer
029		B145	Cyg	6x35	4	triangular shape	07/29	Summer
030		L889	Cyg	100x20	4	within γ Cygni Nebula, IC 1318	08/04	Summer
031		L906	Cyg	3600	3	"Northern Coalsack"	08/07	Summer
032		B150	Dra	60x3	5	curved filament 1.6° S of η Cep	07/29	Summer
033		B353	Cyg	20x10	5	in N of North America Nebula; B352 in field	08/12	Summer
034		LG3	Cyg	720		!! "Funnel Cloud Nebula"; best after Coalsack	08/13	Summer
035		B361	Cyg	20	4	cluster IC 1369 to N; try for 1° tendril to W	08/16	Summer
036		B365	Cep	22x3	4	in IC 1396; indistinct "S" shape; use filter	08/22	Summer
037		B163	Cep	4	4	in IC 1396; use filter	08/24	Summer
038		B168	Cyg	100x20	5	large E-W lane; Cocoon Nebula at E end	08/26	Summer

RASC: Southern Hemisphere Splendors

This is a list of astronomical targets for the southern skies put together for the Royal Astronomical Society of Canada (RASC) by Alan Whitman uses a cut off of DEC of -35° to help determine what objects he will include in his list

Seq	V	ID	Const	Type	Name/ Alt ID	Opposition	Season
001		NGC-55	Scl	G	Caldwell 72	10/01	Fall
002		NGC-104	Tuc	GC	47 Tucanae, Caldwell 106	10/04	Fall
003		β Tuc	Tuc	MS	SAO-248201, HIP 2484	10/05	Fall
004		SMC	Tuc	G	Small Magellanic Cloud, NGC-292	10/11	Fall
005		NGC-362	Tuc	GC	Caldwell 104	10/13	Fall
006		ρ Eri	Eri	DS	SAO-130254, HIP 14168	11/13	Fall
007		NGC-1097	For	G	Caldwell 67	11/09	Fall
008		θ Eri	Eri	DS	SAO-216113, HIP 13847, Acamar	11/12	Fall
009		NGC-1313	Ret	G	PGC 12286	11/17	Fall
010		Fornax A	For	G	NGC-1316, PGC 12651	11/18	Fall
011		NGC-1365	For	G	PGC 13179	11/21	Fall
012		f Eri	Eri	DS	SAO-194551, HIP 17797	11/24	Fall
013		NGC-1566	Dor	G	PGC 14897, ESO 157-20	12/02	Winter
014		ι Pic	Pic	DS	SAO-233709, HIP 22531	12/10	Winter
015		NGC-1851	Col	GC	Caldwell 73	12/16	Winter
016		LMC	Dor	G	Large Magellanic Cloud, PGC 17223	12/18	Winter
017		NGC-2070	Dor	OC	Tarantula Nebula, Caldwell 103	12/22	Winter
018		γ Vol	Vol	DS	SAO-256373, HIP 34473, HR 2735 HD 55864, γ Vol, DUN 42, CPD -70 600	01/14	Winter
019		NGC-2451	Pup	OC	ESO 311-SC8	01/23	Winter
020		NGC-2477	Pup	OC	Caldwell 71, C-71	01/25	Winter
021		NGC-2516	Car	OC	Caldwell 96, C-96	01/27	Winter
022		γ Vel	Vel	MS	SAO-219501, SAO-219504	01/30	Winter
023		NGC-2547	Vel	OC	PGC 41789	01/30	Winter
024		IC-2391	Vel	OC	Caldwell 85, Omicron Velorum Cluster	02/06	Winter
025		NGC-2736	Vel	G	Herschel's Ray, Pencil Nebula	02/11	Winter
026		NGC-2808	Car	GC	ESO 91-SC1	02/14	Winter
027		NGC-3114	Car	OC		02/27	Winter
028		NGC-3132	Vel	PN	Eight-burst Nebula, Caldwell 74	02/28	Winter
029		NGC-3199	Car	EN	RCW 48	03/03	Spring
030		NGC-3201	Vel	GC	Caldwell 79	03/03	Spring
031		NGC-3293	Car	OC	Gem Cluster	03/08	Spring
032		NGC-3324	Car	OC		03/08	Spring

Seq	V	ID	Const	Type	Name/ Alt ID	Opposition	Season
033		IC-2602	Car	OC	Southern Pleiades, Theta Carinae Cluster	03/09	Spring
034		NGC-3372	Car	EN	Eta Carinae Nebula, Keyhole Nebula	03/10	Spring
035		NGC-3532	Car	OC	Firefly Party Cluster, Caldwell 91	03/15	Spring
036		NGC-3699	Cen	PN	Wray 16-90	03/21	Spring
037		NGC-3766	Cen	OC	Pearl Cluster, Caldwell 97	03/23	Spring
038		NGC-3918	Cen	PN	Blue Planetary	03/26	Spring
039		Dark Doodad	Mus	DN	CG21 DN	04/07	Spring
040		NGC-4372	Mus	GC	Caldwell 108	04/04	Spring
041		α Cru	Cru	MS	SAO-210990, HIP 94114, Alpha Coronae Australis, Acrux	04/05	Spring
042		DY Crucis	Cru	CS	DY Cru	04/10	Spring
043		Coalsack	Cru	DN	Coalsack, Caldwell 99	04/11	Spring
044		NGC-4755	Cru	OC	Jewel Box Cluster, Kappa Crucis Cluster, Caldwell 94	04/12	Spring
045		NGC-4833	Mus	GC	Caldwell 105	04/13	Spring
046		NGC-4945	Cen	G	Caldwell 83	04/15	Spring
047		NGC-5128	Cen	G	Centaurus A, Hamburger Galaxy, Caldwell 77	04/20	Spring
048		NGC-5139	Cen	GC	Omega Centauri, Caldwell 80	04/20	Spring
049		NGC-5189	Mus	PN	IC-4274	04/22	Spring
050		M-83	Hya	G	Southern Pinwheel Galaxy, NGC-5236	04/23	Spring
051		NGC-5286	Cen	GC	Caldwell 84	04/25	Spring
052		NGC-5460	Cen	OC		04/30	Spring
053		α Cen	Cen	MS	SAO-252838, HIP 71683, Bungula,Proxima,Rigil Kentaurus,Toliman	05/08	Spring
054		NGC-5822	Lup	OC		05/15	Spring
055		NGC-5927	Lup	GC	ESO 224-SC4	05/21	Spring
056		B-228	Lup	DN	Barnard 228	05/25	Spring
057		NGC-5986	Lup	GC	ESO 329-SC18	05/25	Spring
058		NGC-6025	TrA	OC	Caldwell 95	05/30	Spring
059		NGC-6067	Nor	OC	Caldwell 89	06/01	Summer
060		NGC-6087	Nor	OC		06/03	Summer
061		NGC-6124	Sco	OC	Caldwell 75	06/04	Summer
062		NGC-6231	Sco	OC	Caldwell 76, Table of Scorpius	06/12	Summer
063		NGC-6242	Sco	OC		06/12	Summer
064		NGC-6259	Sco	OC		06/13	Summer
065		NGC-6281	Sco	OC		06/14	Summer
066		NGC-6302	Sco	PN	Bug Nebula, Caldwell 69	06/16	Summer
067		IC-4651	Ara	OC		06/19	Summer
068		NGC-6388	Sco	GC	ESO 279-SC2	06/22	Summer

Seq	V	ID	Const	Type	Name/ Alt ID	Opposition	Season
069		NGC-6397	Ara	GC	Caldwell 86	06/23	Summer
070		NGC-6541	CrA	GC	Caldwell 78	06/30	Summer
071		NGC-6723	Sgr	GC	ESO 396-SC10	07/13	Summer
072		NGC-6726	CrA	EN	ESO 396-N14	07/14	Summer
072’		NGC-6727	CrA	EN	ESO 396-N14	07/14	Summer
073		NGC-6752	Pav	GC	Pavo Globular, Caldwell 93	07/16	Summer
074		NGC-7582	Gru	G	Grus Quartet	09/17	Summer

New General Catalogue (NGC)

The New General Catalogue of Nebulae and Clusters of Stars was compiled by John Dreyer in 1888 and contains 7,840 objects including galaxies, star clusters, and emission nebulae.

NGC 0000 – 2999

NGC 3000 – 4999

NGC 5000 - 7999

Index Catalogue (IC) Objects

The Index Catalogue is the first major update to the NGC and was published in two parts by Dreyer in 1895. This list serves as a supplement to the NGC and contains 5,386 objects.

Star List

Some carbon stars, binary (double) stars, and multiple star systems have been identified in this document and are listed below.

Other Items

Items provided in the list below are not associated with any of the previous lists we have identified.

Seasonal Highlights

Listed below are some highlights for each season. Items marked with * in the *Target* column are considered exceptional targets and should not be missed. Selection was based on ease of locating and/or viewing pleasure. Of course, this is a subjective list and what equipment you have will have great impact on your viewing experience. Each seasonal list is ordered according to what constellation is best positioned within the season from earliest to latest.

Spring (March – May)

Const	Target (Type)	Size / Sep	Comments

Summer (June – August)

Const	Target (Type)	Size / Sep	Comments

Fall (September – November)

Const	Target (Type)	Size / Sep	Comments

Winter (December – February)

Const	Target (Type)	Size / Sep	Comments

The Constellations

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Appendix

Utilization of Large Language Models (Claude AI)

Claude AI (AKA Claude) is a series of large language models developed by Anthropic and has been utilized to help automate and develop a number of aspects including some of the illustrations, tables and calculated values in Yoder's Constellation Guides.

While not all utilization of Claude AI will be identified in this document some of the more important ones are noted here with some basic information on development and limitations of the

- Approximate Separation Limit Table – Table listing aperture and difference in magnitude between stars and what the limit of separation between stars is possible.

Approximate Separation Limit Table

The table was developed to provide an approximation of the limit of separation between stars that is possible for telescopes with a given aperture.

Basis of the table

The table is generated from the equation

$$\rho(\Delta m, D) = (K/ D) \times 10^{(a \cdot \Delta m)}$$

Where:

- ρ = The output: the minimum resolvable separation between the two stars, in arcseconds (the value in each cell).
- D = Telescope aperture (objective diameter), in millimetres. This is the column variable.
- Δm = The magnitude difference between the primary and the companion (a dimensionless brightness-ratio measure). This is the row variable.
- K = The Dawes constant (units of arcsec·mm). Dividing it by D gives the classical Dawes' limit, i.e. the resolvable separation for an equal-brightness pair. This is the Δm = 0 anchor. This has been assigned a value of 116 in generation of this table.
- a = The magnitude-penalty exponent, fixed at 0.4 / 3 ≈ 0.133 (dimensionless). It sets how fast the required separation grows as the companion gets fainter. Its two pieces: the 0.4 is the Pogson coefficient (a flux ratio of $10^{(-0.4 \cdot \Delta m)}$ corresponds to a magnitude difference Δm), and the 3 comes from the Airy-pattern skirt falling off as θ^{-3}. This has been approximated a value of 0.13333 for generation of this table.
- 10 = The base of the penalty factor, following from the decimal (Pogson) definition of the magnitude scale; $10^{(a \cdot \Delta m)}$ is the multiplier applied to the Dawes limit.

Limitations

1. Idealized optics: The Airy-pattern basis assumes a perfect.
2. Atmosphere excluded: No seeing term is included.
3. Single wavelength: The ~550 nm basis is inherited from Dawes and is not scaled with wavelength.
4. Dawes' limit (K) is itself calibrated to one observer's contrast threshold. Visual acuity, experience.
5. Δm is the only companion parameter
6. Status of the penalty coefficient. As above, a = 0.4/3 is a physically motivated scaling, not a peer-reviewed or dataset-calibrated visual coefficient.
7. Approximation weakest where the table lives. The θ^{-3} envelope is an asymptotic far-field result; it is least accurate at separations comparable to the resolution limit itself — precisely the regime the table occupies. The penalty captures the correct trend but its quantitative accuracy is poorest exactly where it is applied.
8. Anchoring choice. Tying the Δm = 0 threshold to Dawes (rather than to the Rayleigh or Sparrow criterion) sets the absolute scale of every entry; a different anchor would rescale the whole table.
9. Displayed precision. The tenth-of-an-arcsecond formatting is presentational. It does not imply the model is accurate to 0.1″ — the underlying uncertainties (points 2, 4, 6) are far larger.

Constellation Object Summary Table

Utilization of Claude for automating data retrieval for a number of fields and estimating the minium aperture size (mApt) and maximum Bortle scale sky (mBortle) values. Summary of this below

- **Aliases** – Do a web-based search to retrieve alternate identifications for the listed object that may from different catalogs. Verification on each object is done by meeting one of two criteria:
    - Two identifiers match between sources
    - One Identifier matches between sources and RA & DEC values are within 5 arcminutes of each other for each source.
- Stats
    - mApt –
    - mBortle -

:

Log Book

We encourage you to create a personalized logbook to accompany this book. The following templates are designed for recording sketches, observations, and summaries of your stargazing experiences. Once you have printed the guide, you may choose to insert these pages throughout—either within each constellation section, at the beginning, or at the end of the guide—according to your preference. Decide which type of log you'd like to maintain (text, sketch, or both), print the desired number of log and summary pages, and add them to your printed copy. Page numbers have been intentionally omitted, allowing you to add them by hand as needed.

Astronomy Observation Log Summary

Page:

Target	Constellation	Page	Date	Comments

10

Target	Constellation	Page	Date	Comments

20

Target	Constellation	Page	Date	Comments

30

Target	Constellation	Page	Date	Comments

35

Astronomy Observation Log Summary

Page:

Target	Constellation	Page	Date	Comments

10

Target	Constellation	Page	Date	Comments

20

Target	Constellation	Page	Date	Comments

30

Target	Constellation	Page	Date	Comments

35

Observation Session - Quick Log

Location: _____ **Site** _____

Date: _____ **Conditions** _____

Constellation	Object	Type	Equipment	Located	Comments

Observation Session - Quick Log

Location: _____ **Site** _____

Date: _____ **Conditions** _____

Constellation	Object	Type	Equipment	Located	Comments

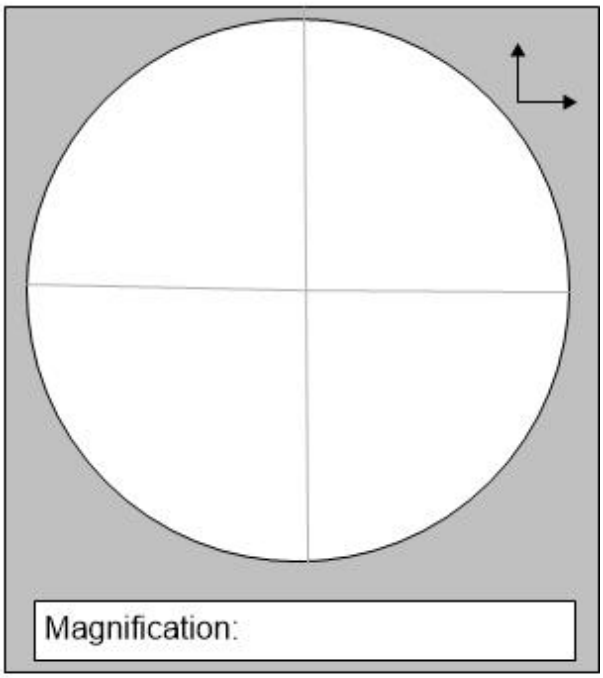
Astronomy Sketch Log

Page:

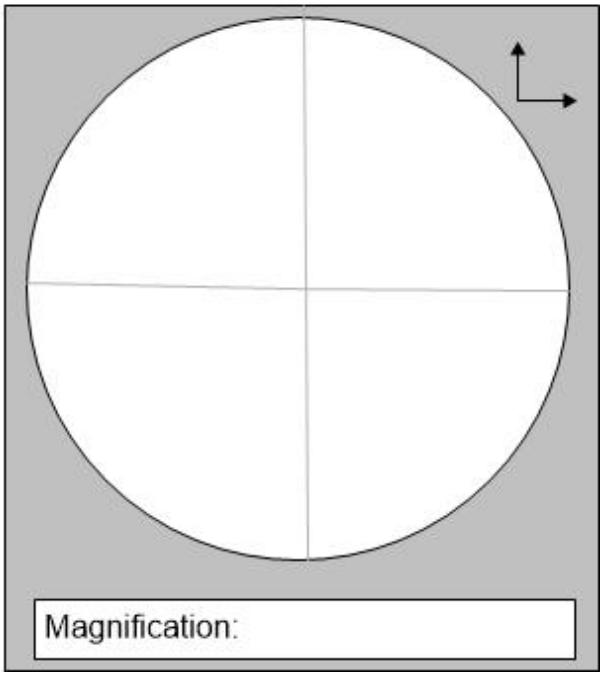
Site and Conditions
Date:
Site:
Observer:
Conditions:
Telescope:
Mount:

Session Notes

Target:	Time:
Eyepieces/Filters/etc:	
Observations:	
Comments:	



Target:	Time:
Eyepieces/Filters/etc:	
Observations:	
Comments:	



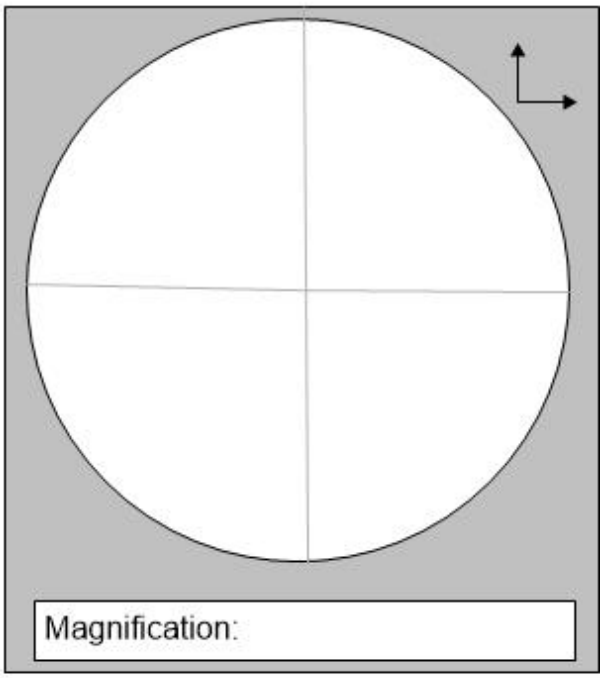
Astronomy Sketch Log

Page:

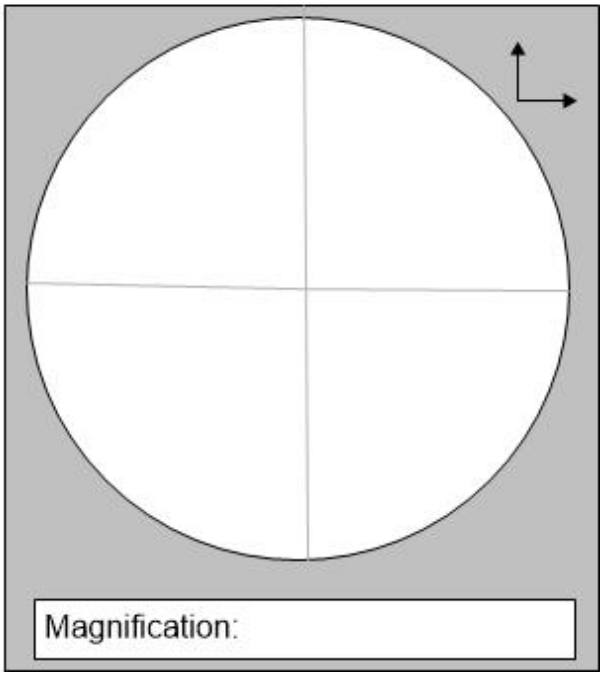
Site and Conditions
Date:
Site:
Observer:
Conditions:
Telescope:
Mount:

Session Notes

Target:	Time:
Eyepieces/Filters/etc:	
Observations:	
Comments:	



Target:	Time:
Eyepieces/Filters/etc:	
Observations:	
Comments:	



Astronomy Observation Log

Page:

Site and Conditions	Session Notes
Date:	
Site:	
Observer:	
Conditions:	
Telescope:	
Mount:	

Target:	Constellation:	Time:
Eyepieces/Filters/etc:		
Observations:		
Comments:		

Target:	Constellation:	Time:
Eyepieces/Filters/etc:		
Observations:		
Comments:		

Target:	Constellation:	Time:
Eyepieces/Filters/etc:		
Observations:		
Comments:		

Astronomy Observation Log

Page:

Site and Conditions	Session Notes
Date:	
Site:	
Observer:	
Conditions:	
Telescope:	
Mount:	

Target:	Constellation:	Time:
Eyepieces/Filters/etc:		
Observations:		
Comments:		

Target:	Constellation:	Time:
Eyepieces/Filters/etc:		
Observations:		
Comments:		

Target:	Constellation:	Time:
Eyepieces/Filters/etc:		
Observations:		
Comments:		

Change Log

These are some ongoing improvements I have been making to the constellation guides as I have learned what features I want to include or how to improve the usability of these guides. This can also serve as a check list for future review of older guides to make sure I implement these changes to some of the earlier developed guides.

Date	Feature	Description
2026-11	Revision 2.5 • Claud AI Worflow	• Utilization of Claude AI to automate most operations in building the constellation guide. Changes should not really be apparent in the final product.
2026-10	Revision 2.3 • Charts Orientation • Multiple Star Insert	• Charts Orientation – Update charts for targets to E-W orientation from W-E that it has been. the E-W orientation is more of a standard. • Multiple Star Insert – Addition of zoom-in for multiple star systems in the diagram showing multiple star systems. This helps show more detail on multiple stars while keeping the content of the star in the larger field of view.
2026-09	Revision 2.2 • Document Orientation • Constellation Map Update	• Document Orientation – Now complete document has been changed to Portrait; this will work better for publishing on Amazon if I decide to do so. • Constellation Map Update – I have reverted to using the In-The-Sky map since it lays out the constellation better relative to constellations next to it. I will continue to include my constellation map also where it identifies all objects in the guide.

2026-07	<u>REVISION 2.1</u>
	• Target Stats Update
	• New revision format
	• Claude AI
		• Target Stats Update
		  ○ Addition of Minimal Bortle sky required to identify an object (Assuming a 6” aperture telescope).
		  ○ Magnitude, Size, SB and MC are now being estimated with Claude AI based on multiple data sources.
		  ○ Minimal Bortle Sky – Calculate the minimal Bortle sky required to be able to distinguish to target object from the background sky.
		  ○ Minimal Aperture – Smallest aperture that will be able to split a multiple star system or see a deep sky object under ideal conditions.
		• New revision format will include layout revision along with the last update date for the document. So, Revision is specified as REV: 2.1 | Date.
		• Claude AI – I have started to utilize Claude AI to assist with gathering some information in the guides specifically for this revision Claude is providing some statistical information that my hope is will help ensure more accurate data by examining multiple sources and determining the most accurate information when possible. In this revision Claude is providing the following information:
		  ○ Object Aliases | Equipment | Magnitude | Size | Surface Brightness | Minimal Bortle (6” Scope) | Minimal Aperture |

2026-05		Basic review and minor corrections.

2026-03	• 3rd Party Apps
	• Targets Map Redo
	• Summary Pages Update
		Starting with the constellation **Coma Berenices** the following changes are being made to all constellation guides going forward.
		• Sky Safari Pro
		  ○ Observation Lists files will be provided for constellations that can be imported into Sky Safari (Plus/Pro)
		  ○ Objects in guide match Sky Safari names (for the most part)
		• AstroPlanner
		  ○ Exporting Constellations targets to AstroPlanner and uploading to Users Contributed Plans library
		• Targets Map Redo – Updating Target Maps to me more useful, new target icons and design

		• Telrad/Star Hopper Friendly - 4degree FOV has been replaced with a star-hop map displaying the target location specified by the Telrad bull-eye. Additionally, arrow have been added to help persons star-hop to the target. • Update Summary pages to provide more information and change basic layout • Constellation Object table update – addition of Gear column to identify what type of gear may be appropriate for viewing the identified target.
2026-03	List: RASC: Southern Hemisphere Splendors	Additional list to include in list of targets to include in targets for constellations
2026-02	List: RASC: 50 to the Pole Program	Additional list to include in list of targets to include in targets for constellations
2026-01	Morphological Classification	Addition of MC parameter to object summary, intended for Galaxies, Open Clusters, Globular Clusters, stars and perhaps planetary nebula (still to be determined what source could be used for this information)
2025-xx	List: SAC Best 110 NGC	Additional list to include in list of targets to include in targets for constellations
2025-xx	Trumpler Open Cluster Catalog	Additional list to include in list of targets to include in targets for constellations
2025-xx	List: Caldwell List	Additional list to include in list of targets to include in targets for constellations
2025-xx	Multiple Star Components	Identify component pairs for multiple star systems and provide details for each pair.
2025-xx	Observation Log	Addition of observation log for each constellation, make sure it starts on a odd number page since we want these to be printed on both sides, and removable from the book without impacting the guide. You may need to insert a “Blank” page to make this happen.
2025-xx	References Update	Additional references added

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Back Cover