



The ABCs of Stargazing



How would you describe to a friend the size of a sky object, its distance from a particular star, its brightness, or its location on the celestial dome?

The ABCs of stargazing allow you to do just that!



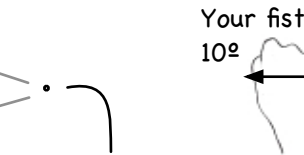
"A" is for angular size and distance

Be sure to remember these handy references when discussing size or distance in the sky:

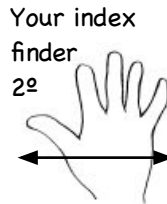
- The moon spans $1/2^\circ$. It would take 360 "full moons" to reach from horizon to horizon!
- The apparent width of the tip of your index finger on your extended arm is 2° .
- The width of the bowl of the Big Dipper is 5° and the bowl's length is 10° .
- Your clenched fist on your fully extended arm is 10° from side to side.
- Your outstretched hand on your extended arm is 20° from the tip of the pinky to the tip of the thumb.



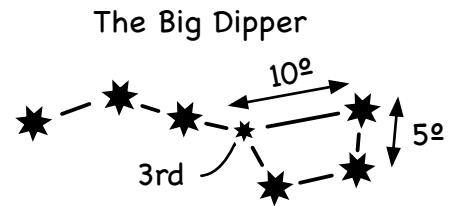
Width of the Full Moon $1/2^\circ$



Moon's apparent size relative to your clenched fist



Your hand 20°



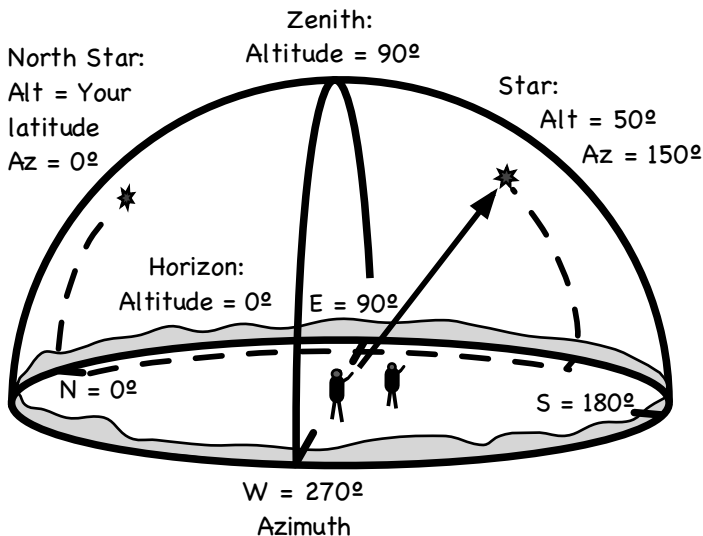
The Big Dipper
Six of the seven stars of the Big Dipper are of the 2nd magnitude.

"B" is for brightness

Skywatchers use the "magnitude" scale to describe an object's brightness. Don't be confused by the reverse nature of the scale: The brighter the object, the smaller the magnitude. Objects with negative magnitudes are very bright, indeed!

Polaris, the North Star, always has an azimuth of 0° and has an altitude above the northern horizon matching the latitude of the observer.

Mag.	Object
-26	Sun (never look at the sun!)
-12	Full moon
-4	Venus
-2.5	Jupiter at its brightest
-1.5	Sirius, the brightest star in the night
0	Arcturus, Vega, Capella, Saturn
+1	Pollux, Regulus, Altair
+2	Six stars of the Big Dipper, North Star
+6	The faintest star seen by unaided eyes



"C" is for coordinates

Stargazers often use the simple, but descriptive altitude-azimuth (alt-az) system to locate objects in the sky.

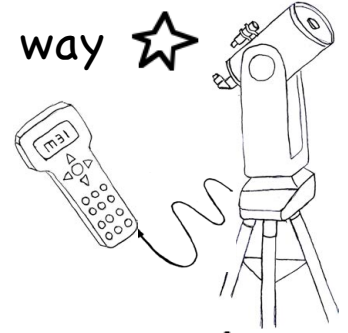
Azimuth coordinate:	Altitude coordinate:
North is 0°	Horizon is 0°
East is 90°	Zenith is 90°
South is 180°	
West is 270°	

How do you find celestial objects?

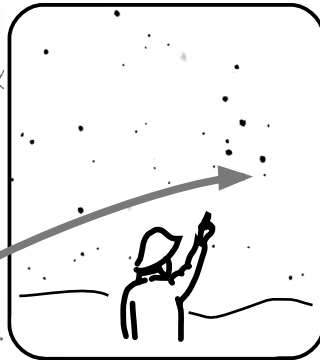
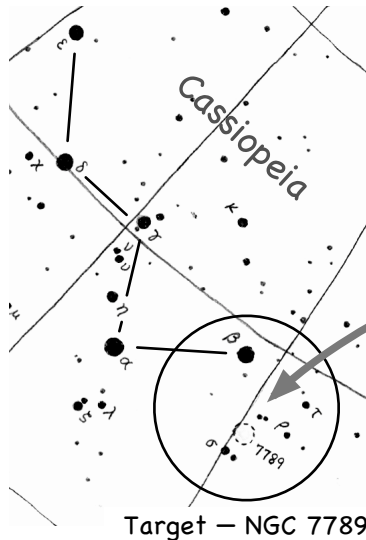
☆ Finding celestial targets the modern way ☆

Computerized "GoTo" telescopes ... the quick and easy method:

- 1 Level the telescope mount
- 2 Point the tube towards north
- 3 Indicate the date and time
- 4 Indicate observing location
- 5 Center on first guide star
- 6 Center on second guide star
- 7 Enter the target's designation
- 8 The scope automatically slews to it



☆ Finding celestial treasures the old fashioned way ☆



1 Learn the stars and constellations

- ★ There is no substitute for sitting under the stars with a map and red flashlight.
- ★ Use a star map that plots all stars visible to the unaided eye.
- ★ Start by finding well-known star patterns such as the Big Dipper, or the constellation of Orion or Cassiopeia.
- ★ Continue by identifying neighboring star patterns.

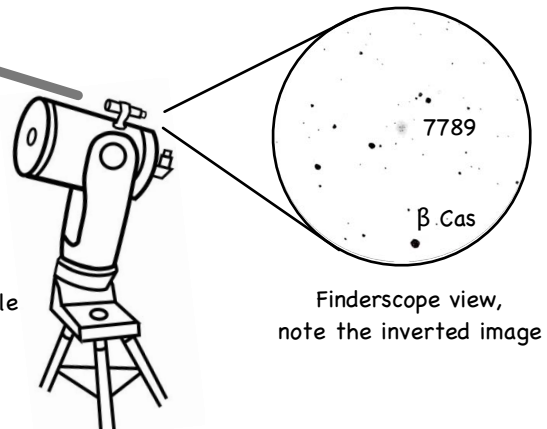
2 Finderscope: little scope, big view

Why a finderscope?

- ★ Gives a wide field of view, about 5°,
- ★ Must be aligned with the main telescope,
- ★ Only the bright planets, brighter nebulae and star clusters are visible

Simply...

- ★ Point the finder at a suitable guide star, or
- ★ Triangulate to the object by using nearby recognizable stars.



Finderscope view, note the inverted image

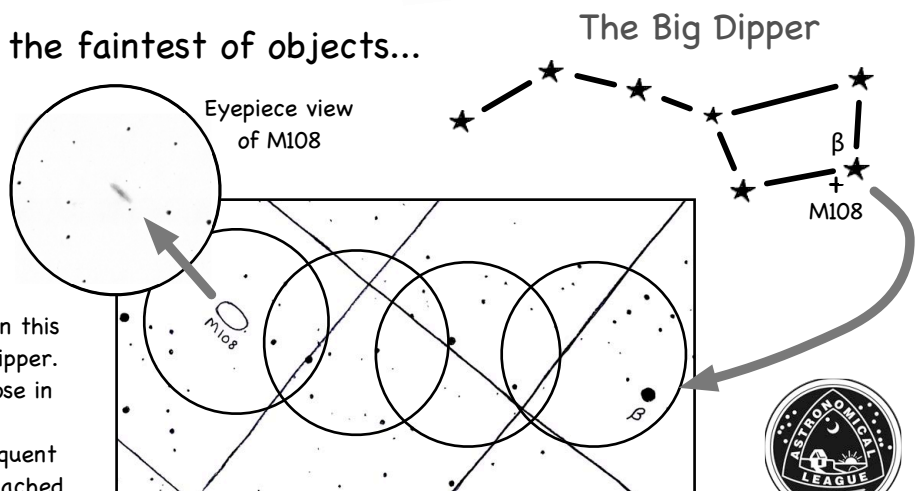
3 Star Hopping: finding the faintest of objects...

Before hopping begins:

- ★ Must have a detailed star map.
- ★ Must know the field of view of the eyepiece.

As an example, find galaxy M108:

- ★ Begin hopping at a reference star, in this case Beta (β) Ursa Majoris in the Big Dipper.
- ★ Match the stars on the map with those in the eyepiece.
- ★ Hope among the stars in each subsequent field of view until the correct field is reached.
- ★ Look closely to see the dim galaxy M108.



Star hopping to M108 from Beta Ursa Majoris



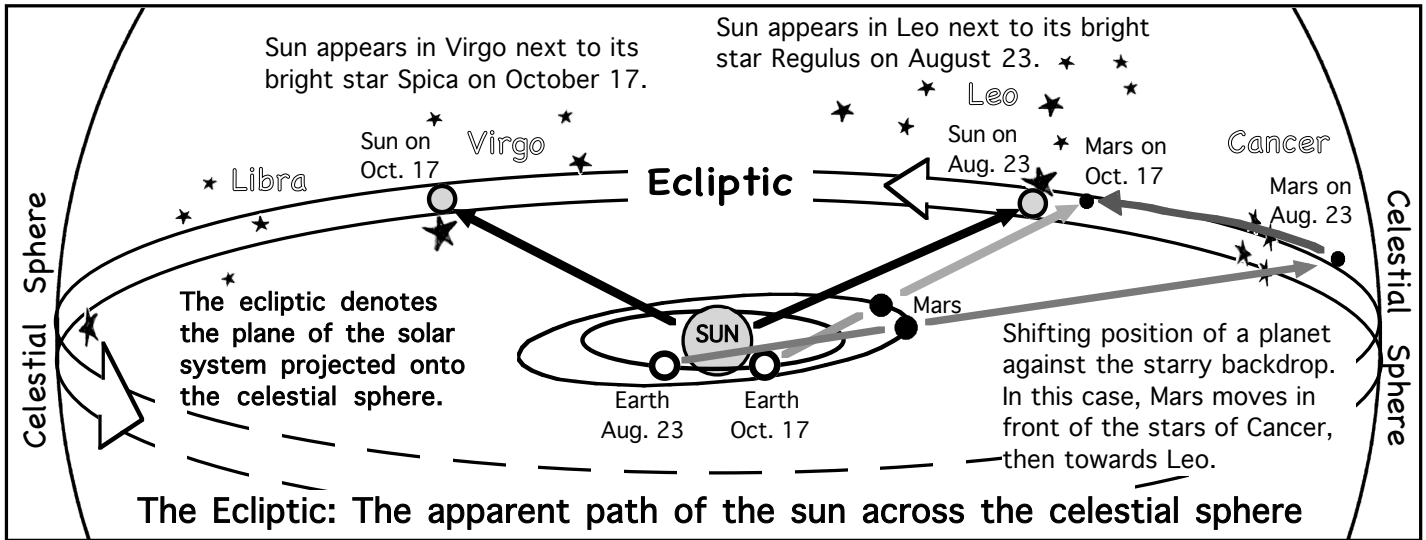
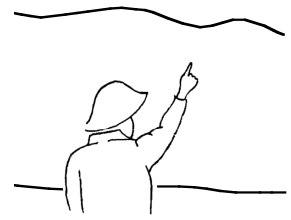


Is that a planet or a star?



Three tell tale visual characteristics of a planet:

1. A planet shines with a steady light, unless it is very close to the horizon. It doesn't "twinkle," while a star does.
2. A planet is always located near the ecliptic.
3. A planet slowly shifts its position nightly with respect to the background stars.



Mercury

- Either low above the western horizon in the evening, or low above the eastern horizon in the morning.
- A challenge to spot.

Venus

- Either above the western horizon in the evening, or rising above the eastern horizon in the morning.
- Dazzling white object.
- Very easy to see.

Mars

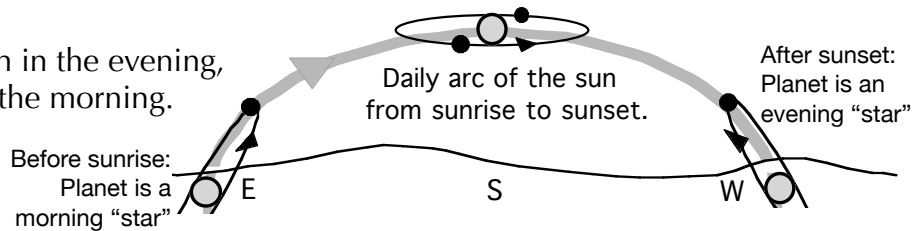
When it is close to Earth, Mars is a bright red-orange object in the east after sunset, high in the sky near midnight, and in the west before sunrise.

Jupiter

When it is not positioned near the sun, Jupiter is always seen as a very bright pale yellow object.

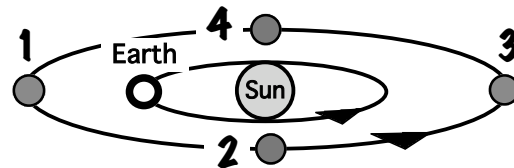
Saturn

When it does not appear close to the sun, Saturn is seen as a bright creamy starlike object.

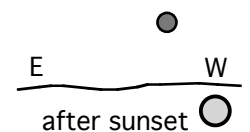
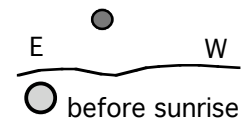
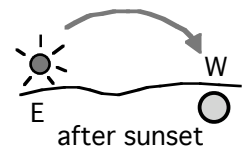


The Inner Planets: Mercury and Venus

The Outer Planets: Mars, Jupiter, and Saturn



- 1 When the planet is opposite the sun, it rises near sunset and is visible all night. It is closest to the Earth and shines at its brightest.
- 2 When the planet lies ahead of the Earth in their orbits, it is seen high in the east before sunrise. It is often said to be a "Morning Star" in the east.
- 3 When the planet moves on the far side of the sun, it appears in the day sky near the sun and can't be seen.
- 4 When the Earth lies ahead of the planet in their orbits, it is seen high in the west after sunset and sets around midnight. It is often said to be an "Evening Star" in the west.





The Astronomical League
www.astroleague.org/outreach

Our Moon

Apparent Diameter:
 30 arc minutes = 1800 arc seconds
 True Diameter: 2160 miles
 Average distance from Earth:
 240,000 miles

Langrenus: 82 miles in diameter,
 and about the same apparent size as Jupiter!

Section of the waxing crescent moon when it is four days past new.

The Need for Telescopes

Our solar system is very large and the planets are very far away. So far that, even though some of them are much larger than Earth, their angular sizes are quite small. Consequently, they always appear star-like to the unaided eye. A telescope is required to magnify their pinpoint appearances, making them visible as small disks for study. Magnifications of greater than 100 power are often needed.

Compare the relative apparent sizes of the moon and the bright planets with this circle which represents a typical low-power field of view. In many low-power eyepieces, the moon is about the same size as the field of view.

Mercury
 (greatest
 elongation)



Venus
 (greatest
 brilliancy)



Mars
 (closest)



Mars
 (farthest)



(Callisto

Jupiter

and its four large moons
 Callisto, Ganymede, Io, and Europa

Ganymede



Io Europa



Saturn
 and its rings and
 its large moon Titan



We all know how large the moon appears in our sky. While Venus, the planet that approaches closest to Earth, has a true diameter of over three times that of our moon, it is always at least 108 times farther away. As a result, its small angular size in the sky is comparable to the apparent sizes of the larger lunar craters. The other planets appear even smaller.

	Apparent Diameter (arc sec)	Actual Diameter (miles)	Distance at closest approach (miles)
Mercury (closest)	10	3025	57 million
Venus (closest)	60	7500	26 million
Earth	---	7900	---
Moon	1800	2160	220,000
Mars (closest)	25	4200	35 million
Jupiter	47	88,000	390 million
Saturn (planet)	19	75,000	794 million
Saturn (rings)	40	155,000	794 million

Selected objects visible on the First Quarter Moon



Crater Aristillus
Diameter: 34 miles

Crater Aristoteles
Diameter: 54 miles

Crater Eudoxus
Diameter: 42 miles

Caucasus Mountains

Sea of Serenity

Apennine Mountains

Sea of Crises

Sea of Tranquility

X ← **Apollo 11 Landing Site**

Crater Langrenus
Diameter: 82 miles

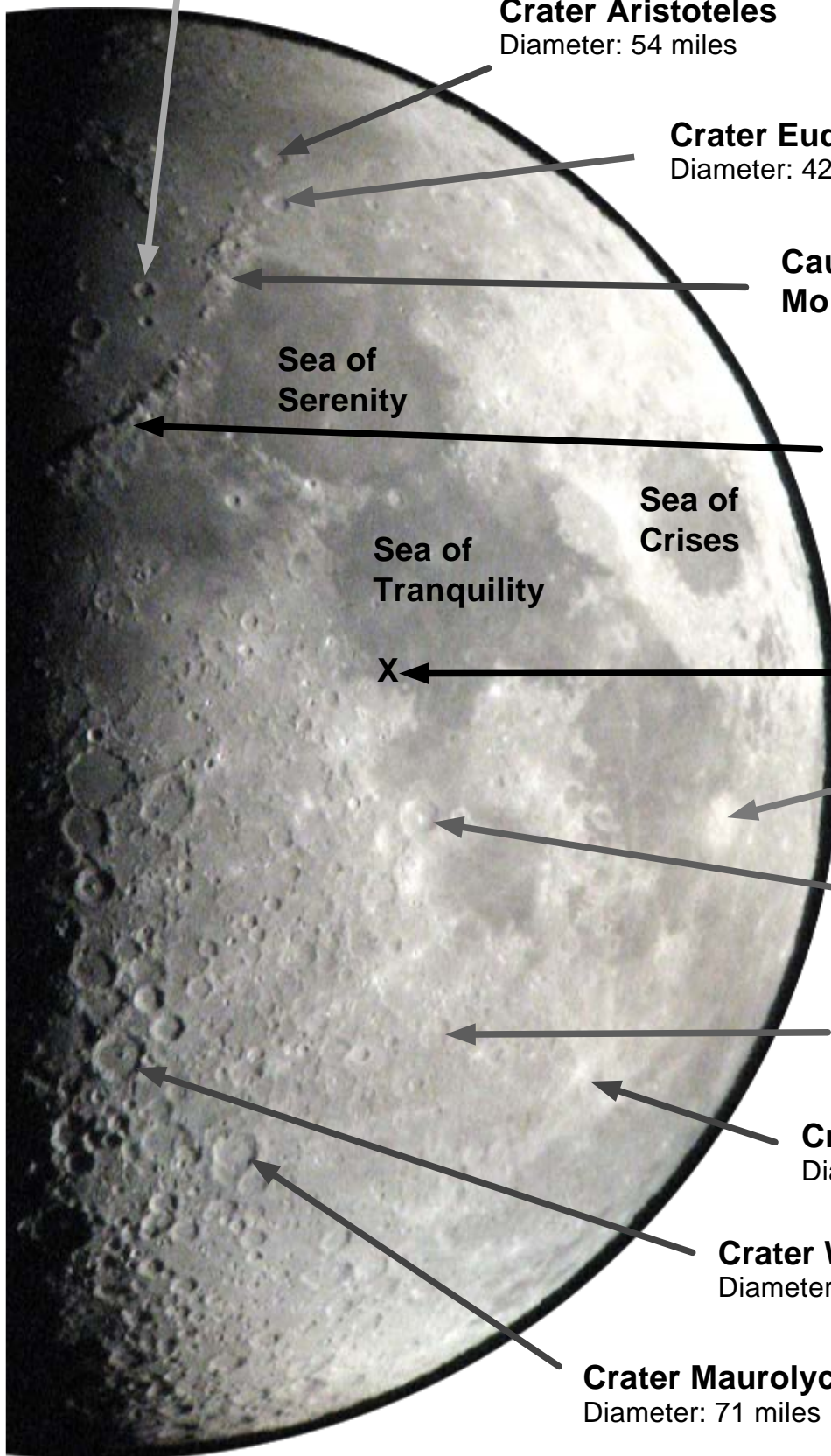
Crater Theophilus
Diameter: 62 miles

Crater Piccolomini
Diameter: 55 miles

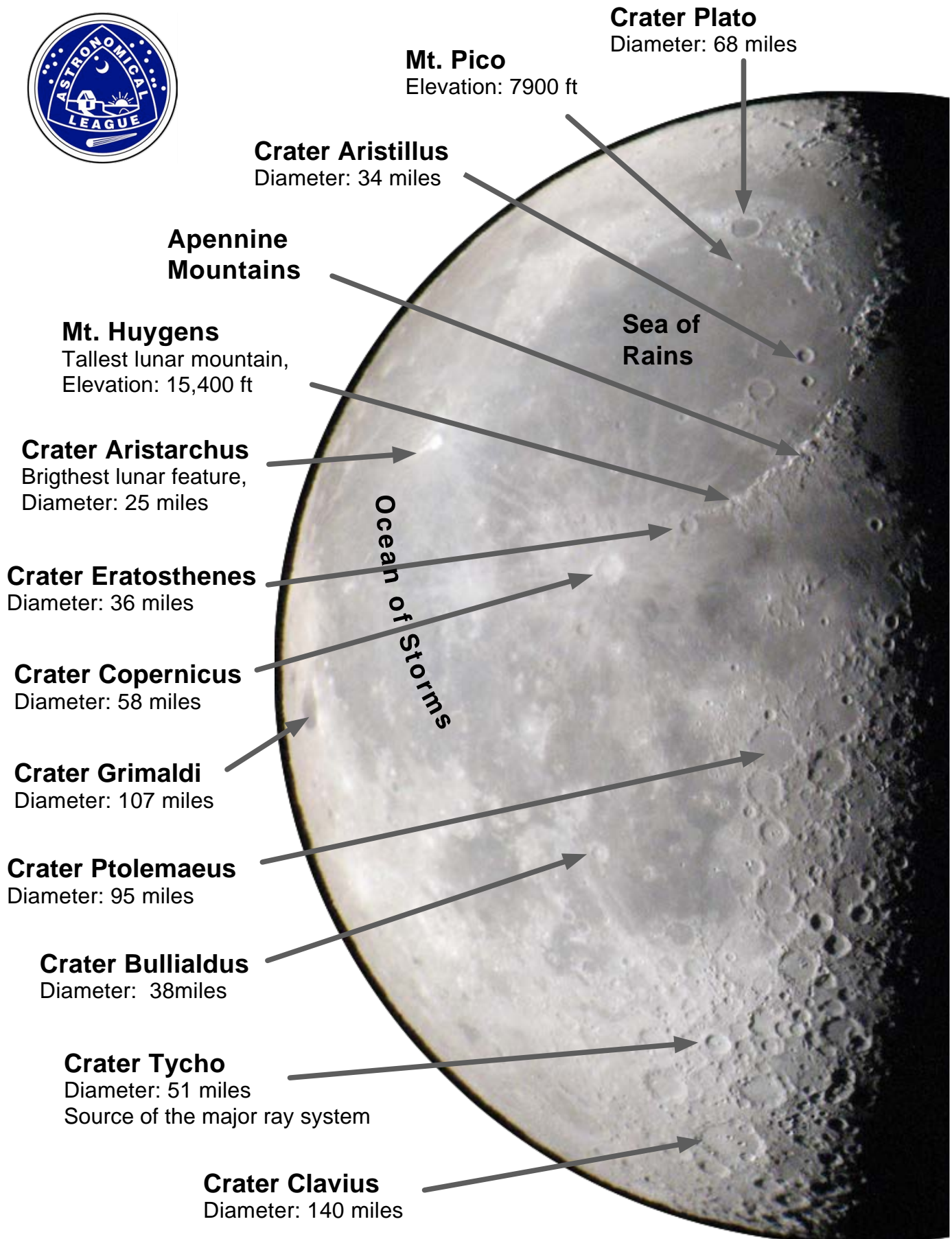
Crater Furnerius
Diameter: 78 miles

Crater Walther
Diameter: 84 miles

Crater Maurolycus
Diameter: 71 miles



Selected objects visible on the Third Quarter Moon



Crater Plato
Diameter: 68 miles

Mt. Pico
Elevation: 7900 ft

Crater Aristillus
Diameter: 34 miles

Apennine Mountains

Mt. Huygens
Tallest lunar mountain,
Elevation: 15,400 ft

Sea of Rains

Crater Aristarchus
Brigthest lunar feature,
Diameter: 25 miles

Ocean of Storms

Crater Eratosthenes
Diameter: 36 miles

Crater Copernicus
Diameter: 58 miles

Crater Grimaldi
Diameter: 107 miles

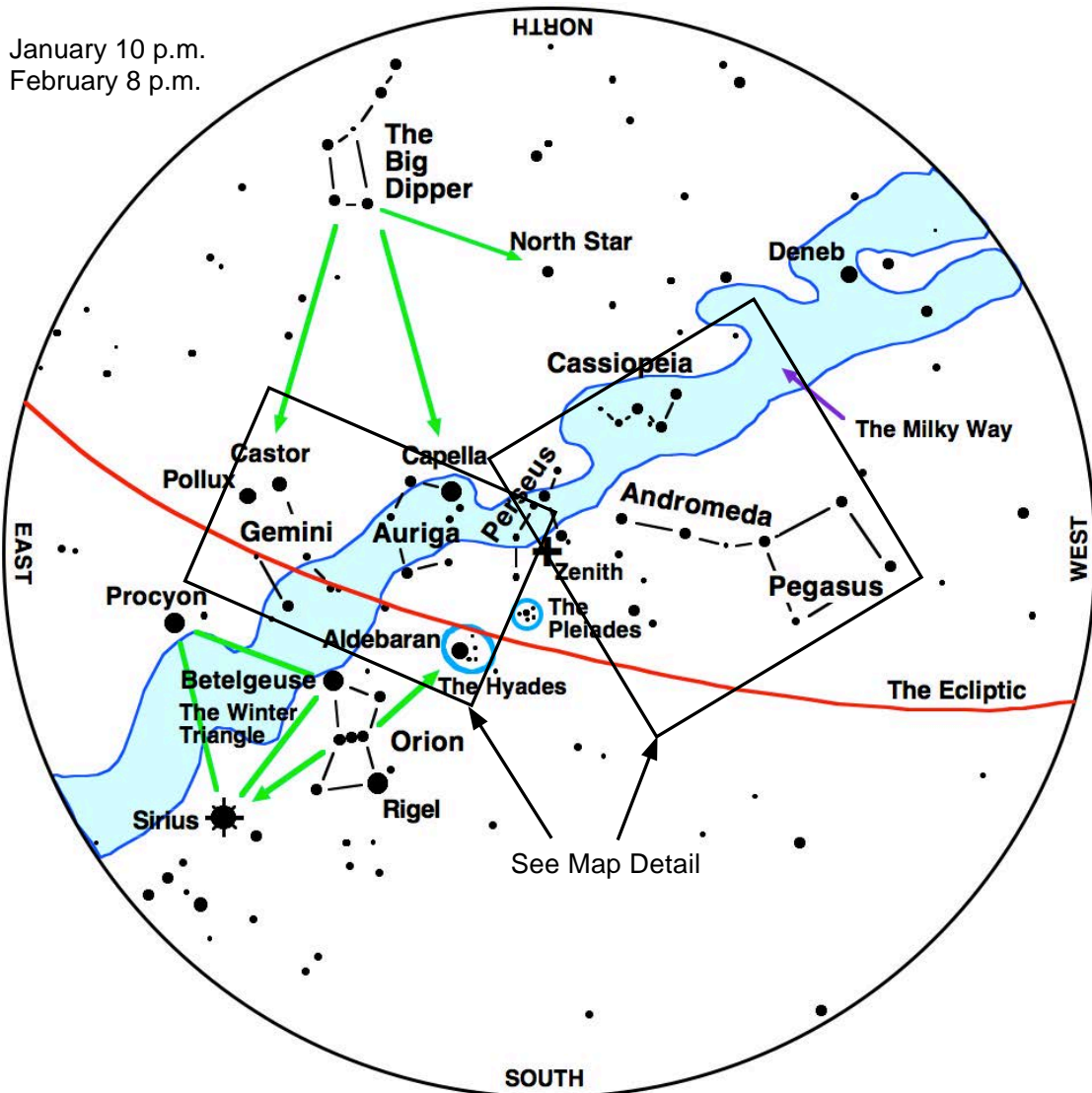
Crater Ptolemaeus
Diameter: 95 miles

Crater Bullialdus
Diameter: 38 miles

Crater Tycho
Diameter: 51 miles
Source of the major ray system

Crater Clavius
Diameter: 140 miles

All-Sky Map for January and February



Navigating the Night Sky

Learn the sky by first finding those stars or constellations that you already know, such as the Big Dipper or Orion. This time of year, the Big Dipper lies low in the northeast and Orion is high in the southeast. Judge the relative positions of new stars from the ones you know.

Use the Big Dipper as a guide to find:

The North Star
Capella
Castor

Use Orion as a guide to find:

Sirius, the brightest star in the night sky,
The Winter Triangle,
Aldebaran and the Hyades

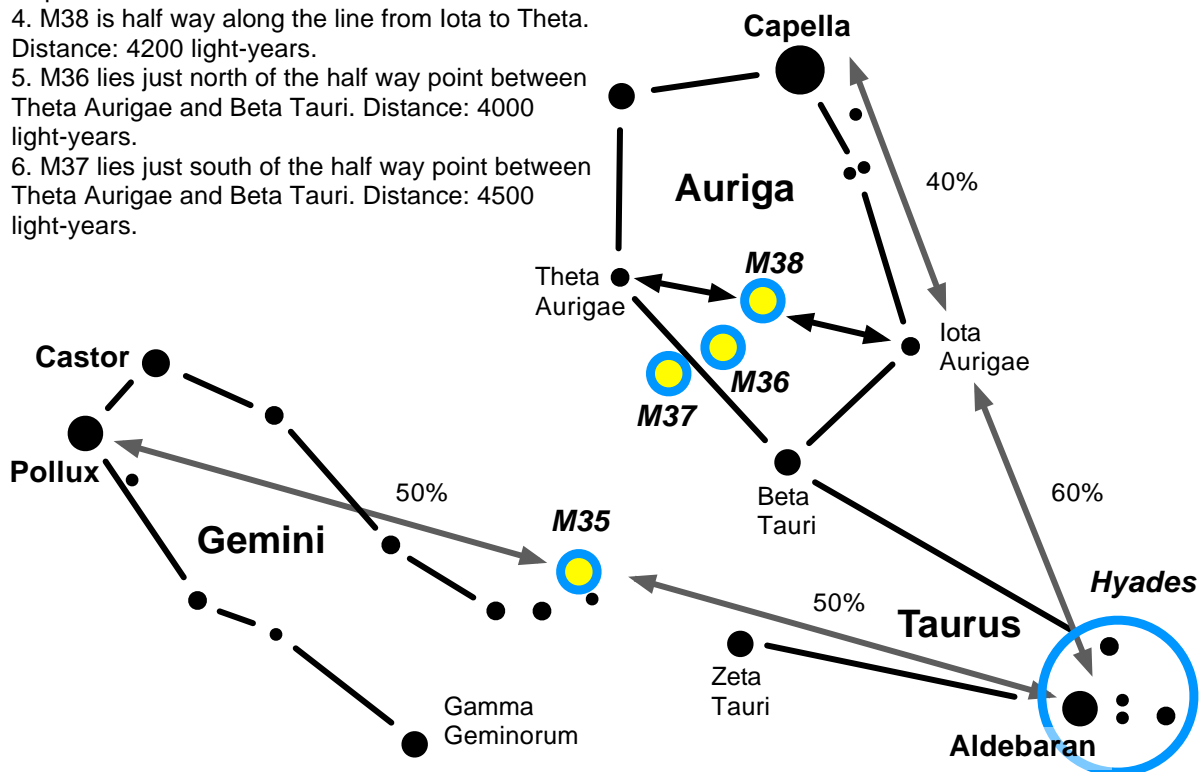
To use this map: Face south and hold the map above your head. The stars on the map should match those in the sky.

Selected Deep Sky Objects in the January through April early evening sky



To find star clusters M36, M37, and M38:

1. Locate the bright star Capella. It is nearly directly overhead. Locate reddish Aldebaran.
2. Locate the other four major stars of the pentagon of Auriga. The bottom one is really Beta Tauri.
3. Find Iota. It is 40% of the distance between Capella and Aldebaran.
4. M38 is half way along the line from Iota to Theta.
5. M36 lies just north of the half way point between Theta Aurigae and Beta Tauri. Distance: 4000 light-years.
6. M37 lies just south of the half way point between Theta Aurigae and Beta Tauri. Distance: 4500 light-years.



To find star cluster M35:

1. Find the bright stars Pollux and Aldebaran.
2. Draw a line between them.
3. M35 is located 1/2 way between them. Distance: 2800 light-years.
4. The telescope will also show another open cluster, NGC 2158, as a small blur in the same field. Distance: 11,000 light-years.

THE ASTRONOMICAL LEAGUE www.astroleague.org

Selected Deep Sky Objects in the January and February (and November and December) early evening sky



Look nearly overhead for Pegasus, Andromeda, Perseus, and Cassiopeia

To find the Double Cluster:

1. Look half way between Alpha Persei and the "W" of Cassiopeia.
 2. The Double Cluster appears as a fuzzy blur to the unaided eye.
- Distance: 7100 light-years

Alpha Persei,
Mirfak



Double Cluster

Cassiopeia

M103

ET Cluster

To find Cluster M103:

1. Scan the area to the left of the bottom left star of Cassiopeia's "W."
- Distance: 10,000 light-years

To find the ET Cluster:

1. Scan the area to the right of the bottom left star of Cassiopeia's "W."
 2. Some people think it resembles ET (from the movie) raising a lit finger.
- Distance: 8000 light-years

Beta Persei,
Algol

M34

40%

60%

Gamma
Andromedae

M31

Beta
Andromedae

Andromeda

To find Galaxy M31:

1. Draw an arrow through the three rightmost stars of the "W" of Cassiopeia.
 2. Follow it until it hits M31.
 3. This fuzzy galaxy will fill most of the field of view.
- Distance: 2.5 million light-years

To find Cluster M34:

1. Extend the handle of the dipper, known as the Great Big Dipper, formed by Pegasus, Andromeda, and Perseus.
 2. M34 is 40% between the last two stars of that dipper.
 3. Use our lowest magnification.
- Distance: 1400 light-years

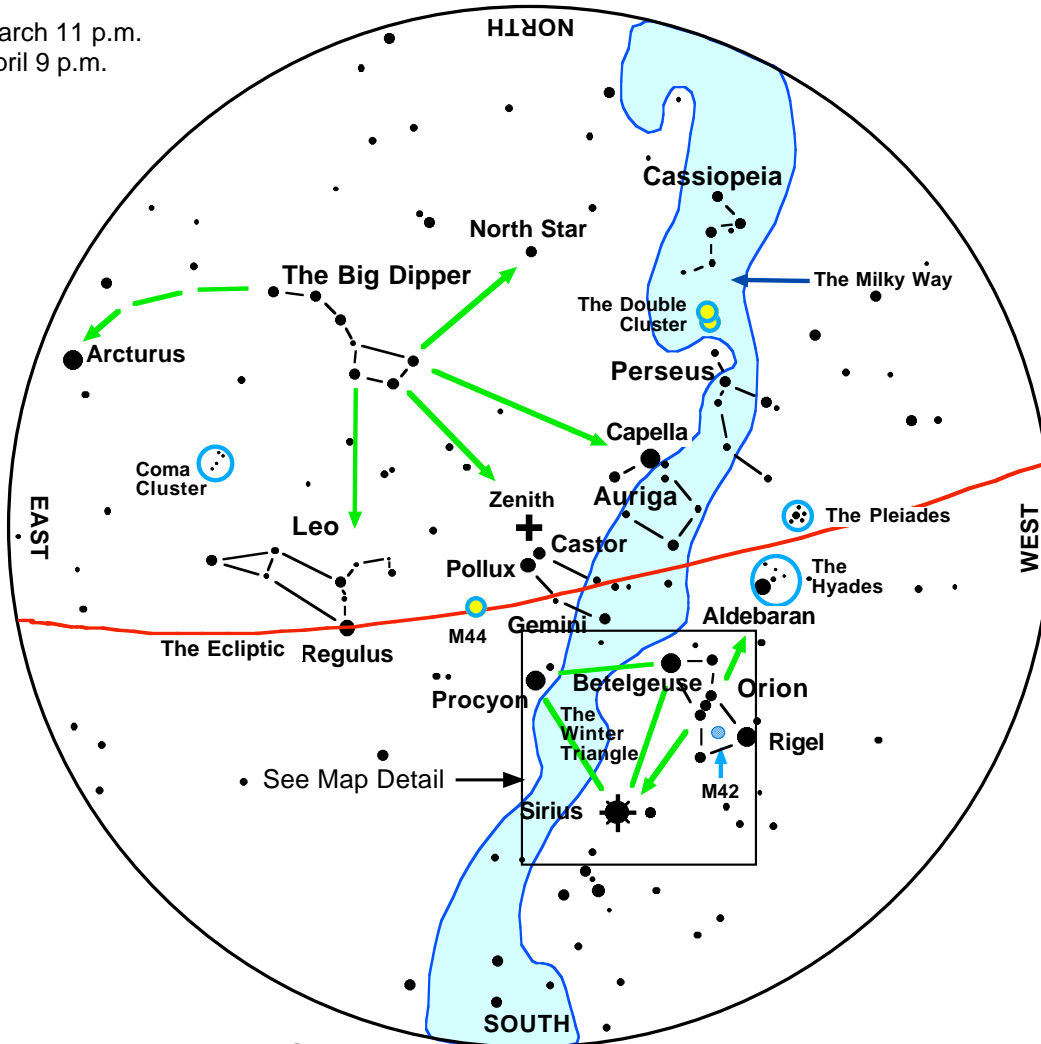
Gamma Andromeda, Double Star:

Use high magnification to reveal the two colorful components of Gamma Andromeda.

Square of
Pegasus

All-Sky Map for March and April

March 11 p.m.
April 9 p.m.



Navigating the Night Sky

Learn the sky by first finding those stars or constellations that you know, such as the Big Dipper or Orion. Judge the relative positions of the new stars from the ones you know. This time of year, the Big Dipper lies high in the northeast and Orion is high in the south or southwest.

Use the Big Dipper as a guide to find:

The North Star
Capella
Castor
Leo
Arcturus

Use Orion as a guide to find:

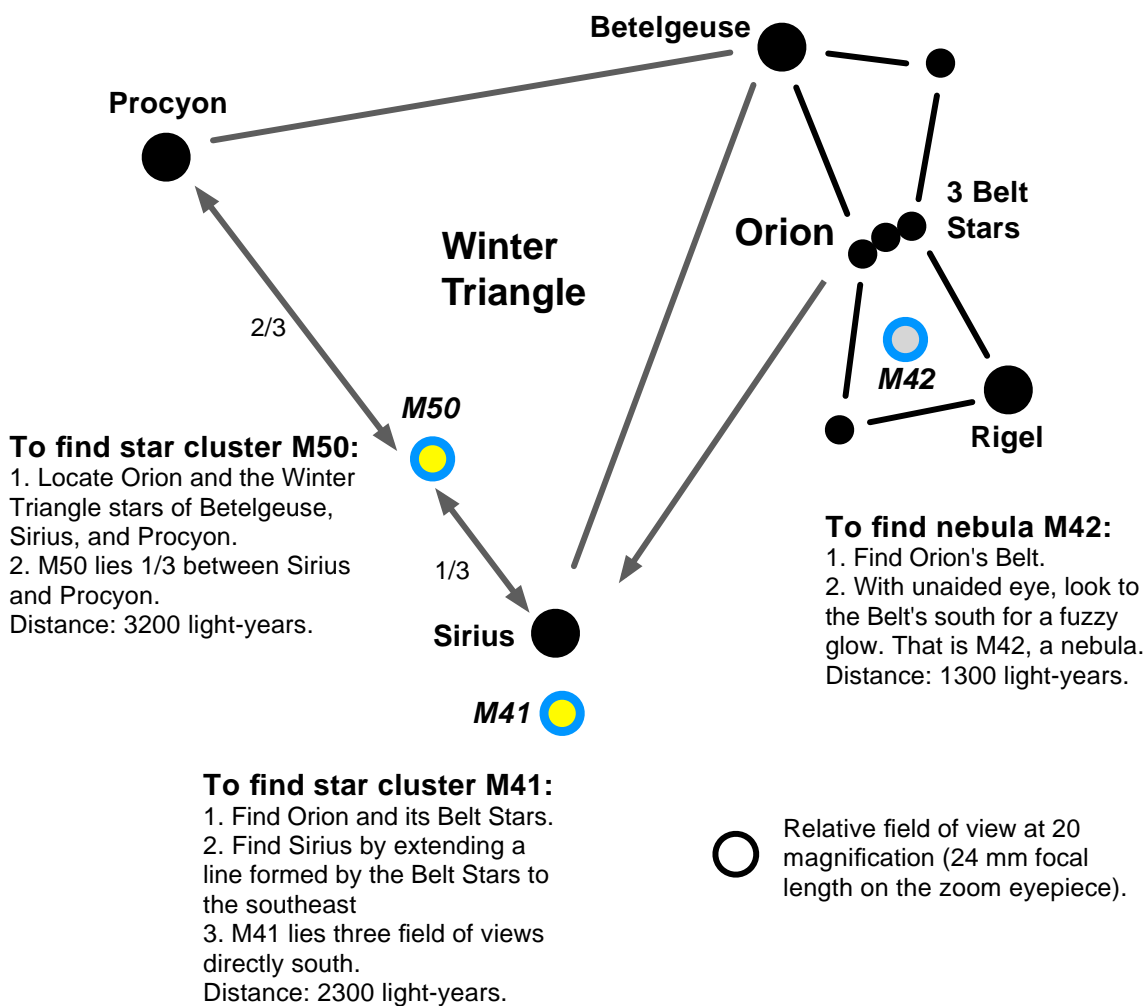
Sirius,
The Winter Triangle,
Aldebaran and the Hyades

View the large star cluster M44:

It lies near the center of a triangle formed by Pollux, Regulus, and Procyon. The cluster appears to the unaided eye as a smudge, but through a low-powered telescope, its many twinkling stellar lights can be easily seen. Distance: 580 light-years.

To use this map: Face south and hold the map above your head. The stars on the map should match those in the sky.

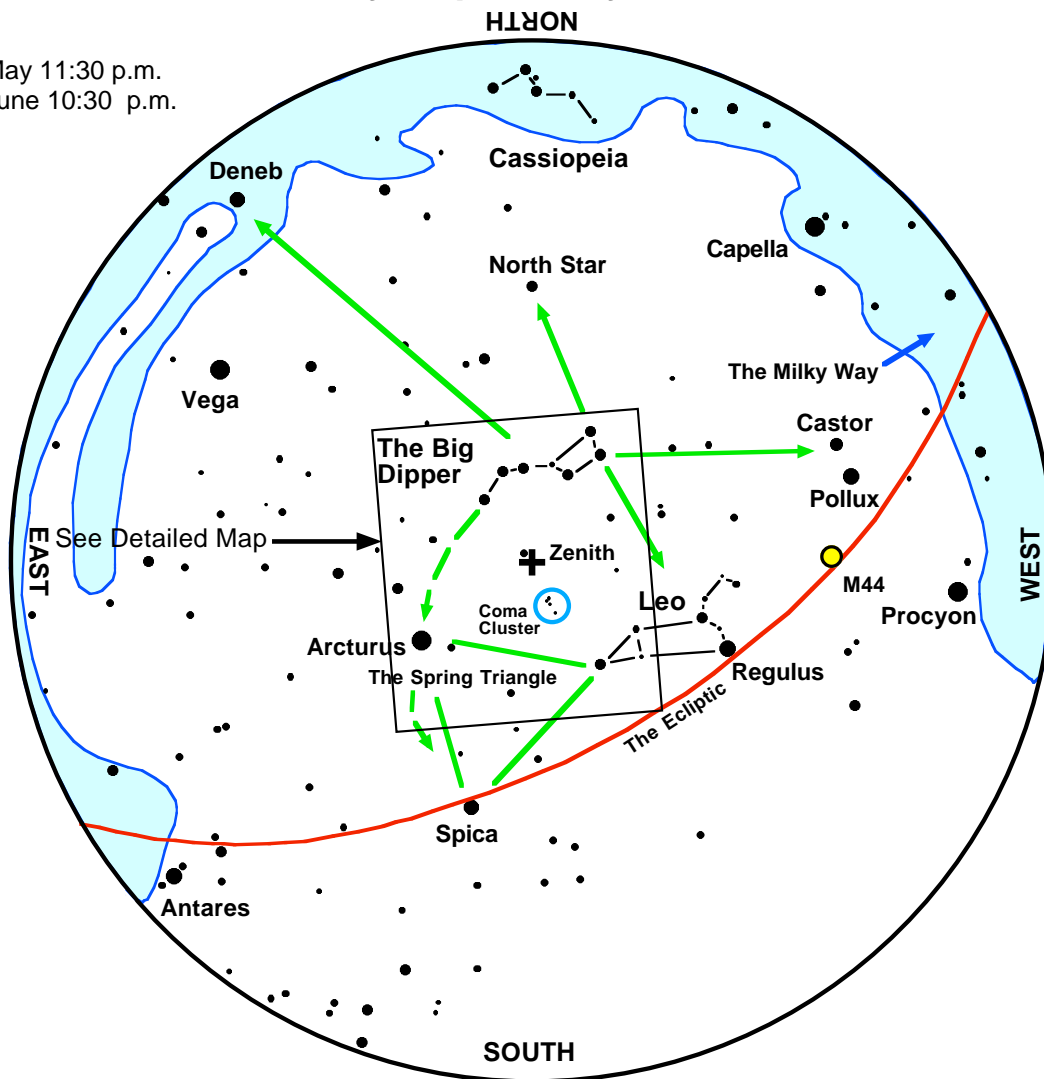
Selected Deep Sky Objects in the March and April early evening sky



THE ASTRONOMICAL LEAGUE www.astroleague.org

All-Sky Map for May and June

May 11:30 p.m.
June 10:30 p.m.



Navigating the Night Sky

Learn the sky by first finding those stars or constellations that you know, such as the Big Dipper. Judge the relative positions of the new stars from the ones you know. This time of year, the Big Dipper lies almost overhead.

Use the Big Dipper as a guide to find:

The North Star,
Deneb,
Arcturus then Spica,
Leo,
Castor

View the large star cluster M44:

Also called the Beehive, M44 lies near the center of a triangle formed by Pollux, Regulus, and Procyon. The cluster appears to the unaided eye as a smudge, but through a low-powered telescope, its many twinkling stellar lights can be easily seen.

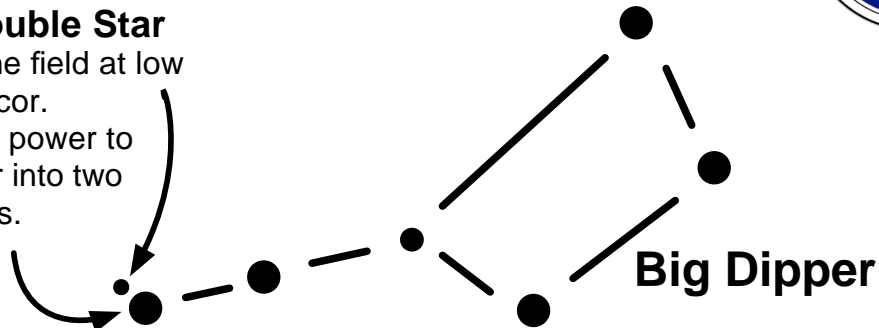
To use this map: Face south and hold the map above your head. The stars on the map should match those in the sky.

Selected Deep Sky Objects in the May and June early evening sky



Mizar, Double Star

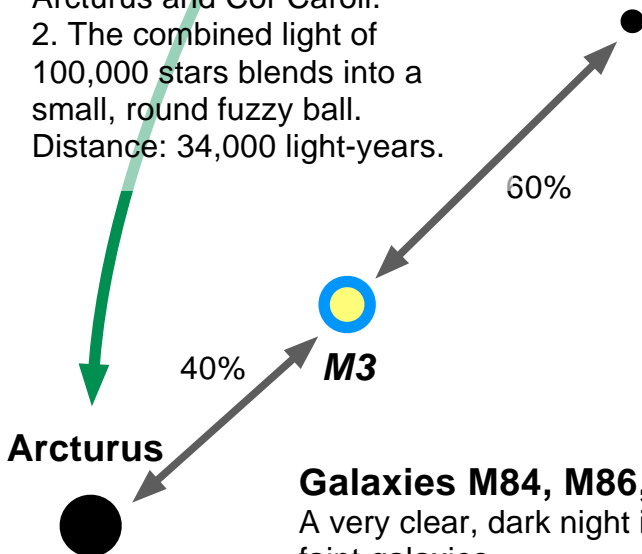
1. Also in the field at low power is Alcor.
2. Use high power to "split" Mizar into two components.



Big Dipper

M3, Globular Star Cluster

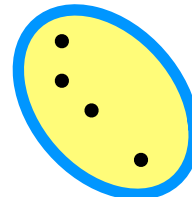
1. Located 40% between bright Arcturus and Cor Caroli.
 2. The combined light of 100,000 stars blends into a small, round fuzzy ball.
- Distance: 34,000 light-years.



Cor Caroli: Double Star

1. Moderately bright star located near the center of the arc of the Big Dipper's handle.
2. Two colorful stars barely separated, use 60x magnification.

Coma Berenices Cluster

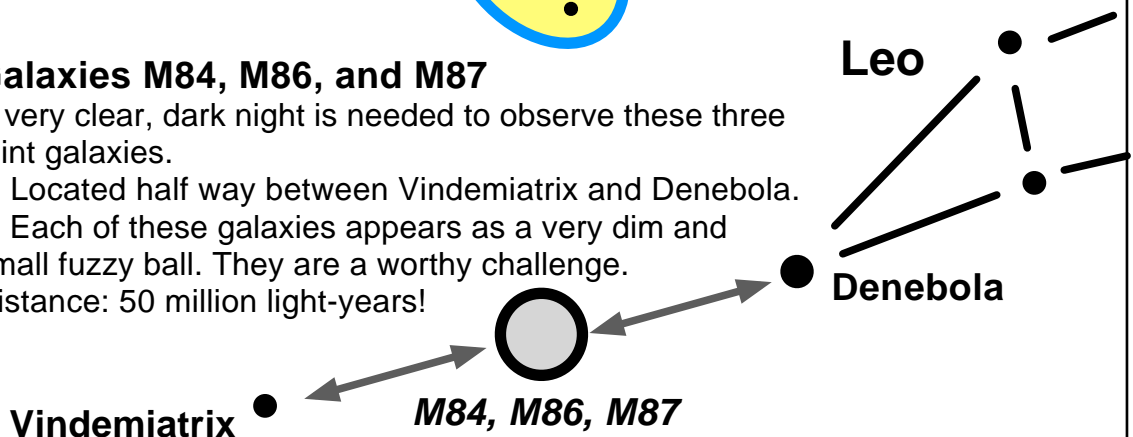


This is a large open cluster of approximately 50 stars. It is best seen with binoculars due to its large area.
Distance: 260 light-years.

Galaxies M84, M86, and M87

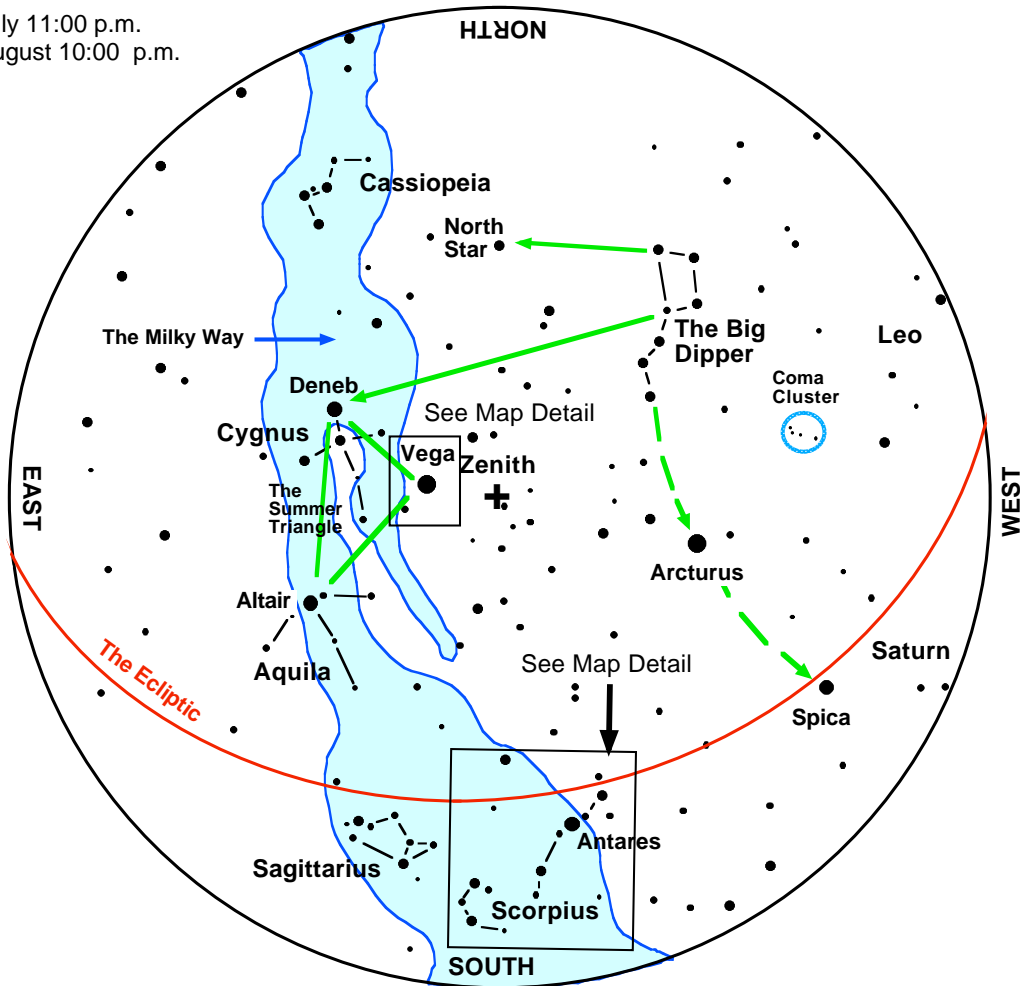
A very clear, dark night is needed to observe these three faint galaxies.

1. Located half way between Vindemiatrix and Denebola.
 2. Each of these galaxies appears as a very dim and small fuzzy ball. They are a worthy challenge.
- Distance: 50 million light-years!



All-Sky Map for July and August

July 11:00 p.m.
August 10:00 p.m.



Navigating the Night Sky

Learn the sky by first finding those stars or constellations that you know, such as the Big Dipper. Judge the relative positions of the new stars from the ones you know. This time of year, the Big Dipper lies high in the northwest.

Use the Big Dipper as a guide to find:

The North Star,
Deneb, and the other Summer Triangle stars of Vega and Altair,
Arcturus,
Spica

The Milky Way stretches from the northeast, almost overhead, then to the south. Scan with binoculars and telescope along its length for many fascinating star clusters and small ill-defined nebulae.

To use this map: Face south and hold the map above your head. The stars on the map should match those in the sky.

Selected Deep Sky Objects in the July and August early evening sky

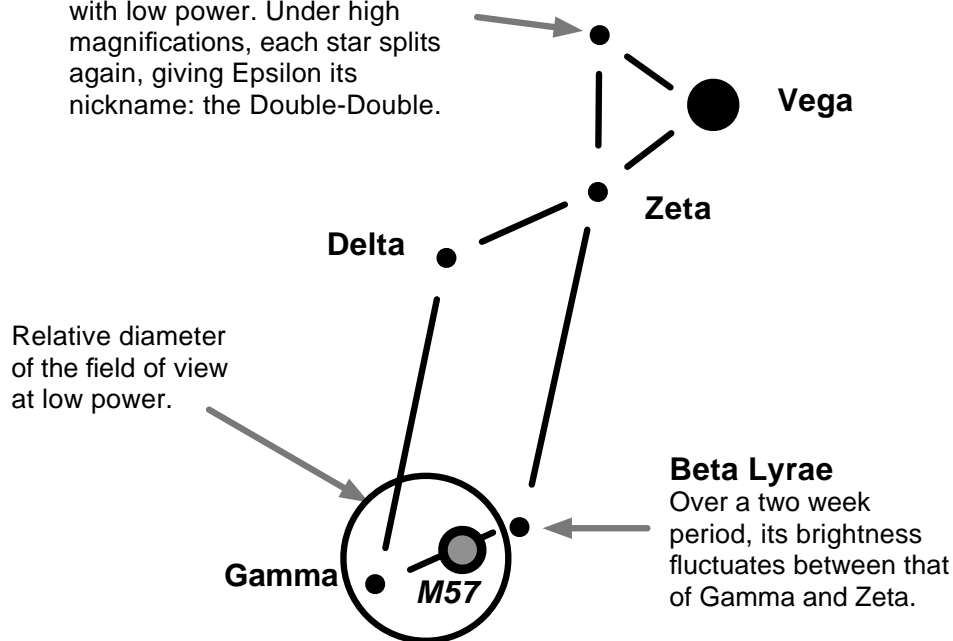


Lyra

Lyra is a small constellation situated almost overhead in summer evenings. It is dominated by its bright star, Vega, third brightest star visible from the mid latitudes of the United States. Vega is also the brightest member of the "Summer Triangle."

Epsilon Lyrae

A wide double star, easily split with low power. Under high magnifications, each star splits again, giving Epsilon its nickname: the Double-Double.



To find Planetary Nebula M57:

Although it is called a "planetary nebula," it has nothing to do with the planets.

1. Find the parallelogram of Lyra.
2. M57 lies between the two lower stars of the parallelogram, Beta and Gamma Lyrae.

3. It appears very small and dim, and slightly oblong.

Distance: 2000 light-years.

THE ASTRONOMICAL LEAGUE www.astroleague.org

Selected Deep Sky Objects in the July and August early evening sky



Enjoy the Constellation Scorpius

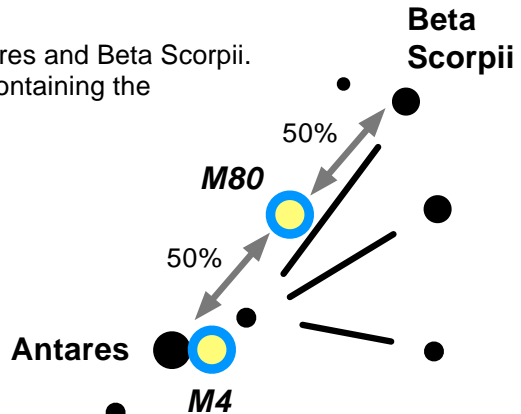
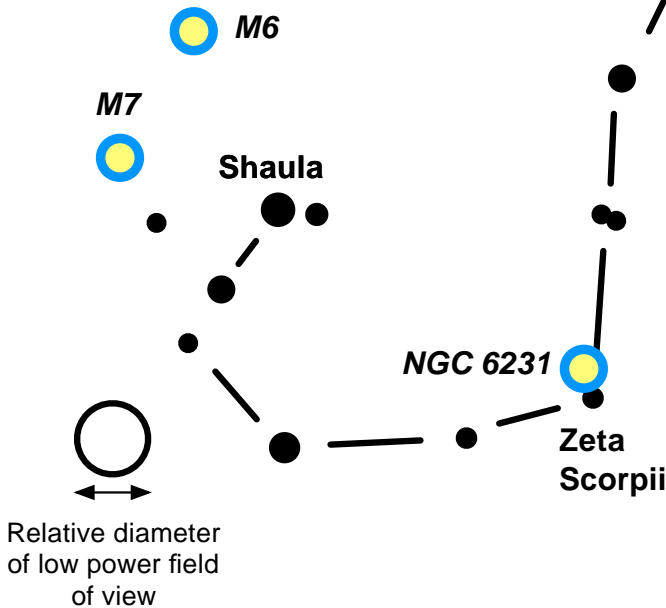
Look for its signature fish hook shape standing above the southern horizon after darkness falls in July and August.

Globular Cluster M80:

1. M80 is found half way between Antares and Beta Scorpii.
 2. It appears as a round, mottled ball containing the combined light of over 100,000 stars.
- Distance: 33,000 light-years.

Open Clusters M6 and M7:

M7 is visible to the unaided eye from a dark site. These two clusters are best seen at low power. Many stars fill the field. M6 Distance: 1600 light-years. M7 Distance: 800 light-years.



Globular Cluster M4:

1. Place Antares on the eastern edge of the field of the lowest power eyepiece setting (24 mm).
2. M4 is found near the center of the field of view. It appears as a round, grainy ball containing the combined light of over 100,000 stars. Distance: 7200 light-years.

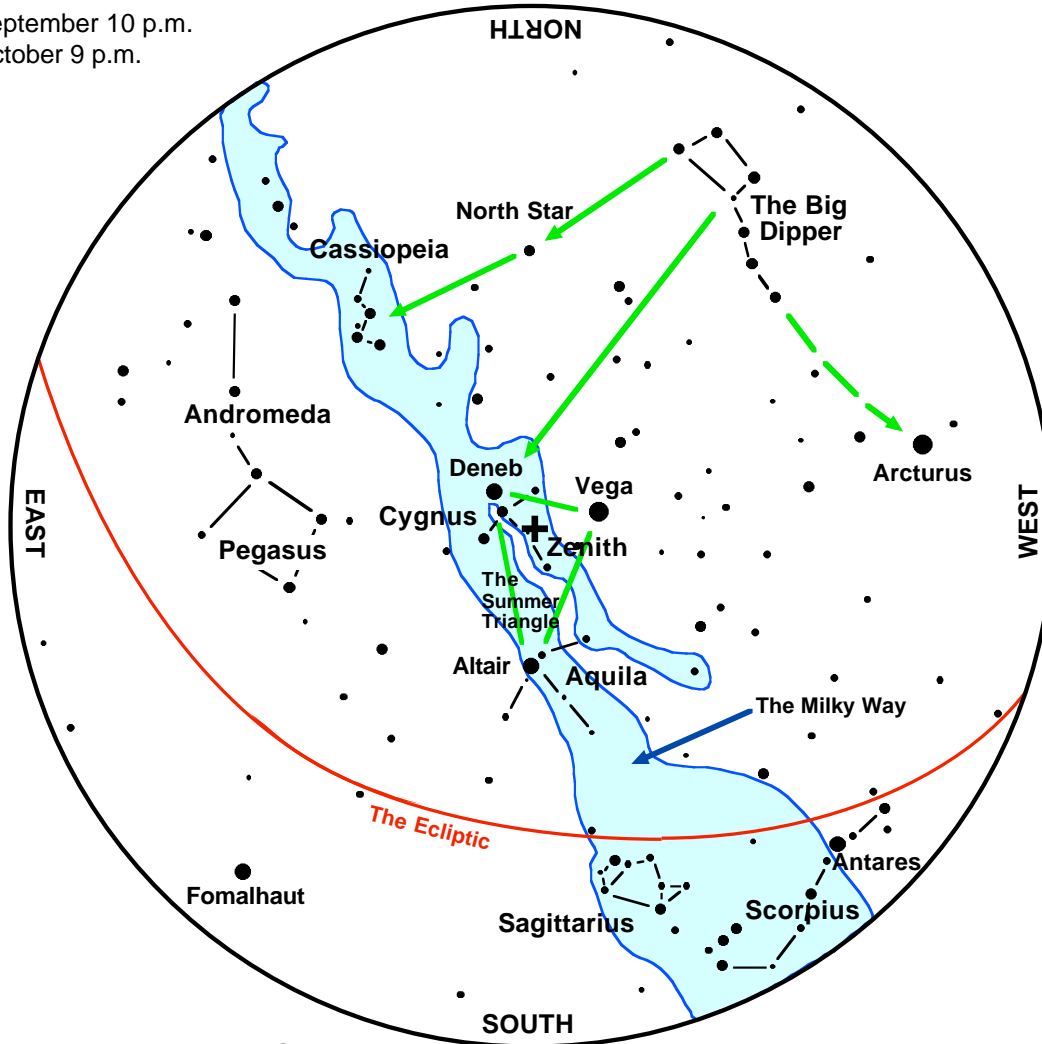
Open Cluster NGC 6231:

Point the telescope at Zeta and the cluster's many stars sweep out to the northeast. Distance: 6000 light-years. There is more than one cluster in the area. NGC 6231 has been called "The False Comet."

THE ASTRONOMICAL LEAGUE www.astroleague.org

All-Sky Map for September and October

September 10 p.m.
October 9 p.m.



Navigating the Night Sky

Learn the sky by first finding those stars or constellations that you know, such as the Big Dipper. Judge the relative positions of the new stars from the ones you know. This time of year, the Big Dipper lies high in the northwest.

Use the Big Dipper as a guide to find:

The North Star,
Deneb, and the other Summer Triangle stars of Vega and Altair,
Arcturus,
Cassiopeia

The Milky Way stretches from the northeast, overhead, then to the south. Scan, with binoculars and telescope along its length for many fascinating star clusters and small ill-defined nebulae.

To use this map: Face south and hold the map above your head. The stars on the map should match those in the sky.

Selected Deep Sky Objects in the September and October early evening sky



Enjoy the Constellation Sagittarius

Look for its signature teapot shape pouring above the southern horizon after darkness falls in September and October. Scan the area for many distant star clusters and nebulae.



Relative diameter of the field of view using low power.

Globular Clusters M22 and M28:

Both of these round glows are composed of the combined light of over 100,000 stars.

M22 Distance: 11,000 light-years.

M28 Distance: 18,000 light-years.

M16



Both M16 and M17 are star forming nebulae. M16 is nicknamed "The Eagle Nebula," and M17 "The Omega Nebula." Both nebulae are 6000 light-years distant.

M17



Mu Sagittarii: Possibly the farthest star the unaided eye can see. Distance: 10,000 light-years.

The Iced Teaspoon



M22



M28



M20

M8

Both M8 and M20 are star forming nebulae with imbedded star clusters. M8 is nicknamed "The Lagoon," M20 "The Trifid." M8 Distance: 4000 light-years. M20 Distance: 6000 light-years.

Both the star clusters M6 and M7 are large and bright. They nearly fill the field with many stars.

M6 Distance: 1600 light-years.

M7 Distance: 800 light-years.

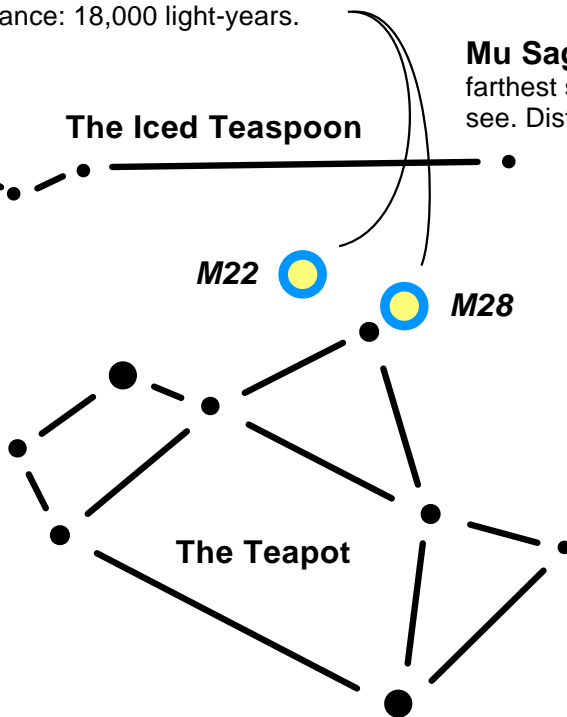
M6



M7



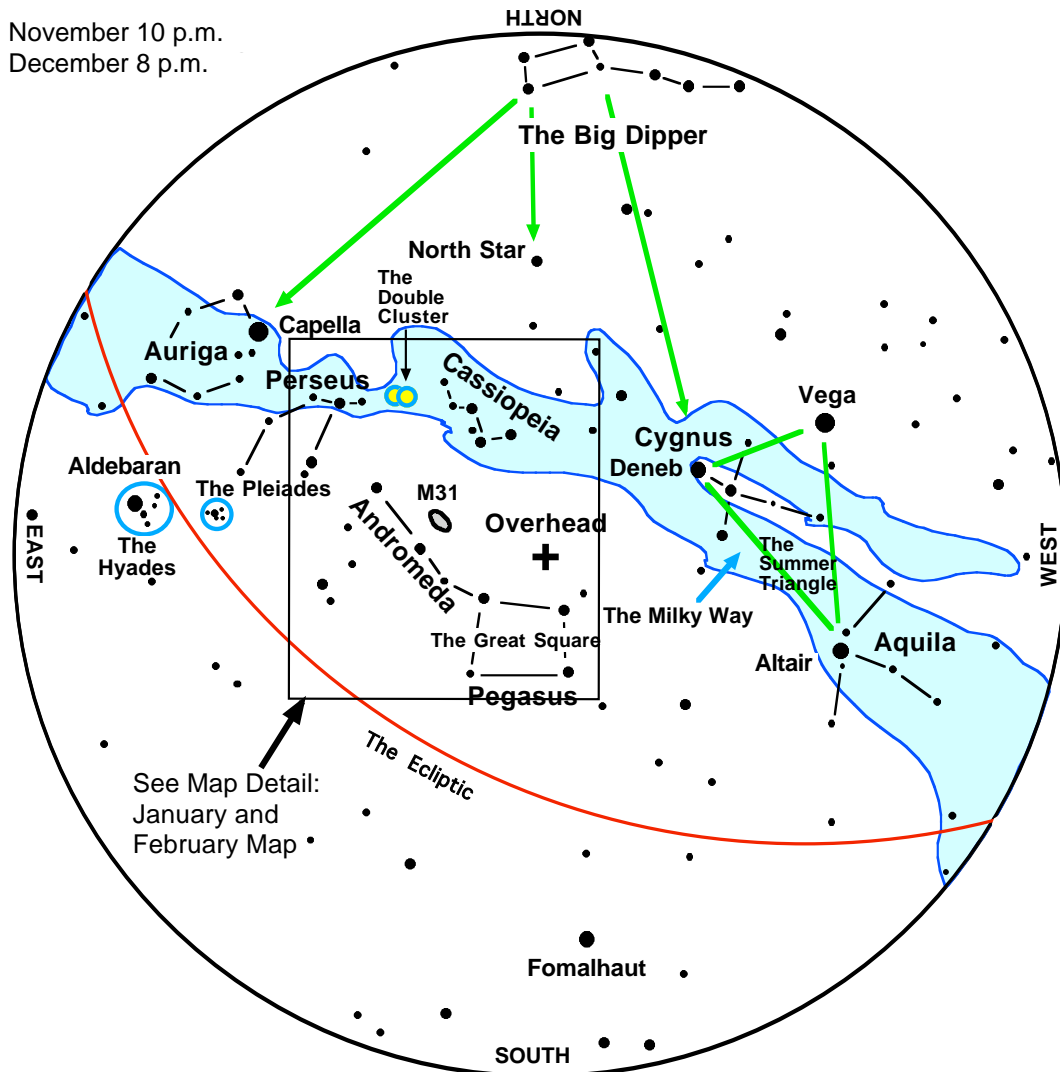
Shaula



THE ASTRONOMICAL LEAGUE www.astroleague.org

All-Sky Map for November and December

November 10 p.m.
December 8 p.m.



Navigating the Night Sky

Learn the sky by first finding those stars or constellations that you know, such as the Big Dipper. Judge the relative positions of the new stars from the ones you know. This time of year, the Big Dipper hugs the northern horizon. The "W" of Cassiopeia lies high overhead.

Use the Big Dipper as a guide to find:

The North Star,
Deneb, and the other Summer Triangle stars of Vega and Altair,
Capella

To use this map: Face south and hold the map above your head. The stars on the map should match those in the sky.