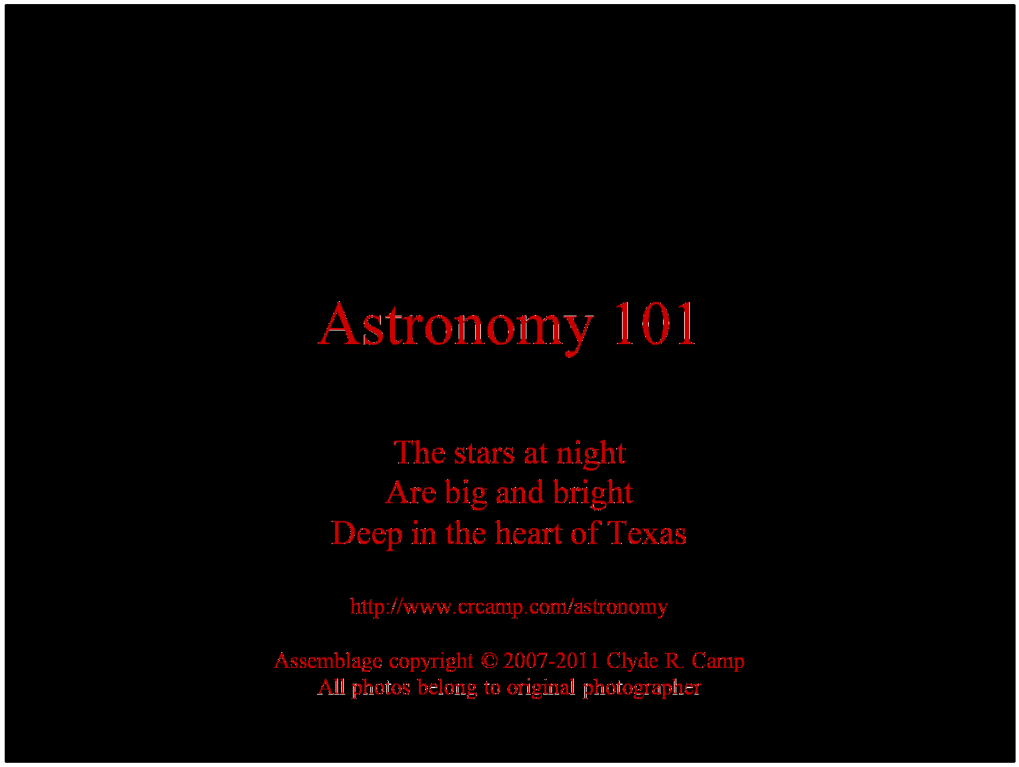


Astronomy 101
http://www.crcamp.com/astronomy101.pdf

Videos

Size of Universe http://www.youtube.com/watch?v=b0lxbzgwW7I

Comparative Star Sizes - http://www.youtube.com/watch?v=6X47B9x670E

Planetarium Programs

For the PC - Stellarium - http://www.stellarium.org/

Lots of others, Mac and PC, at http://astro.nineplanets.org/astrosoftware.html

Point & View Applications and Web Sites

For android – star3map or Google Sky Map

For iPhones – Starwalk or Starmap

Moon phase - http://aa.usno.navy.mil/imagery/moon

Local sidereal time - http://tycho.usno.navy.mil/sidereal.html

Sun/Moon rise/set times and lots of other astro info – http://www.usno.navy.mil/USNO/astronomical-applications

Constellation Photos - http://www.allthesky.de/

Hubble photographs - http://hubblesite.org

Messier Catalog - http://messier.seds.org/

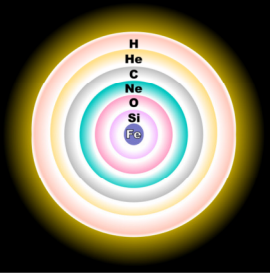

Agenda
• The Sun and other Stars
• Where is North?
• Night Sky
• Zodiac Constellations
• Other Constellations
• Other Deep Sky Objects
• Resources

Agenda

Solar Physics

A Star (including our sun) is a balancing act

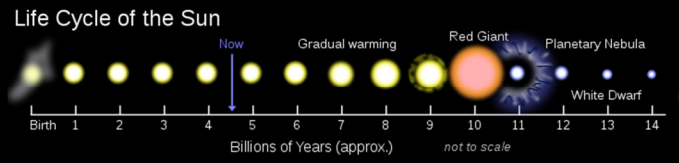
- It begins as a cloud of gas (mostly Helium) compressed by gravity
- Gravity continues to try to collapse it – increasing pressure & heat
- At some point fusion begins to push back out and a star is born
  - Hydrogen → Helium + Energy – good for billions of years
  - As a star burns up its hydrogen fuel, gravity starts to win
  - New energy, derived from converting Helium into oxygen, neon, carbon and other elements, keeps the star alive – good 100's of millions of years
  - At some point gravity starts converting things to iron – good for decades
    - Iron cannot undergo fusion to higher elements
    - When the iron core gets big enough the collapse starts
  - This is the end – gravity always wins



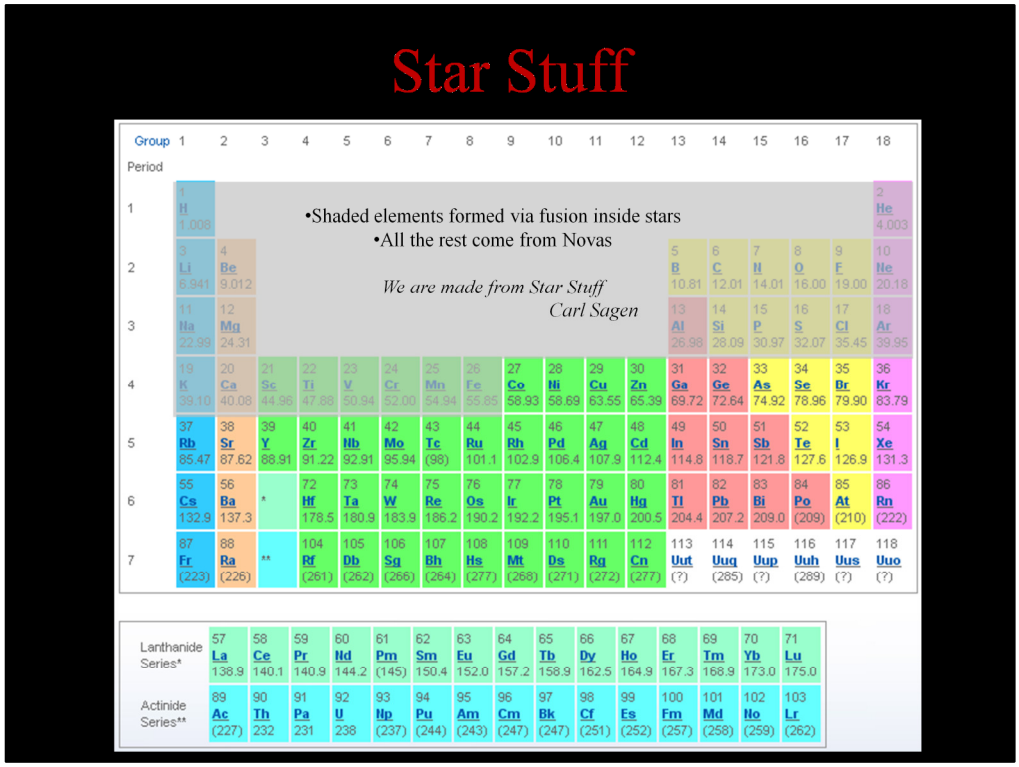
Solar Physics

The End – Kaboom!

- If big enough, at the end the star may Explode (Nova or Super-nova)
  - Inner core collapses *fast* (seconds – 40,000 mps – .25c)
  - Collapse converts Iron into Neutron core – 6000 times temp of Sun
  - Outer layers collapse slower and rebound off Neutron core
  - Collision energy blows off a shell of elements higher than iron on periodic table
  - Remnants join other remnants to (eventually) form another star
- All elements greater than iron were formed from exploding stars
  - Carl Sagan – "We are made from star stuff"
- But … our sun is not big enough to go Nova
  - Less than 1.38 Solar Masses → White Dwarf
  - 1.5 – 9 Solar Masses → Nova → Neutron Star
  - More than 10-25 Solar Masses → Super Nova → Black Hole



The end of a star


Star Stuff
Group 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Period
•Shaded elements formed via fusion inside stars
•All the rest come from Novas
We are made from Star Stuff
Carl Sagen
Lanthanide Series*
Actinide Series**

Star Stuff

Terminology

The difference between Astronomy and Astrology :

Astronomy is a science – Astrology is not

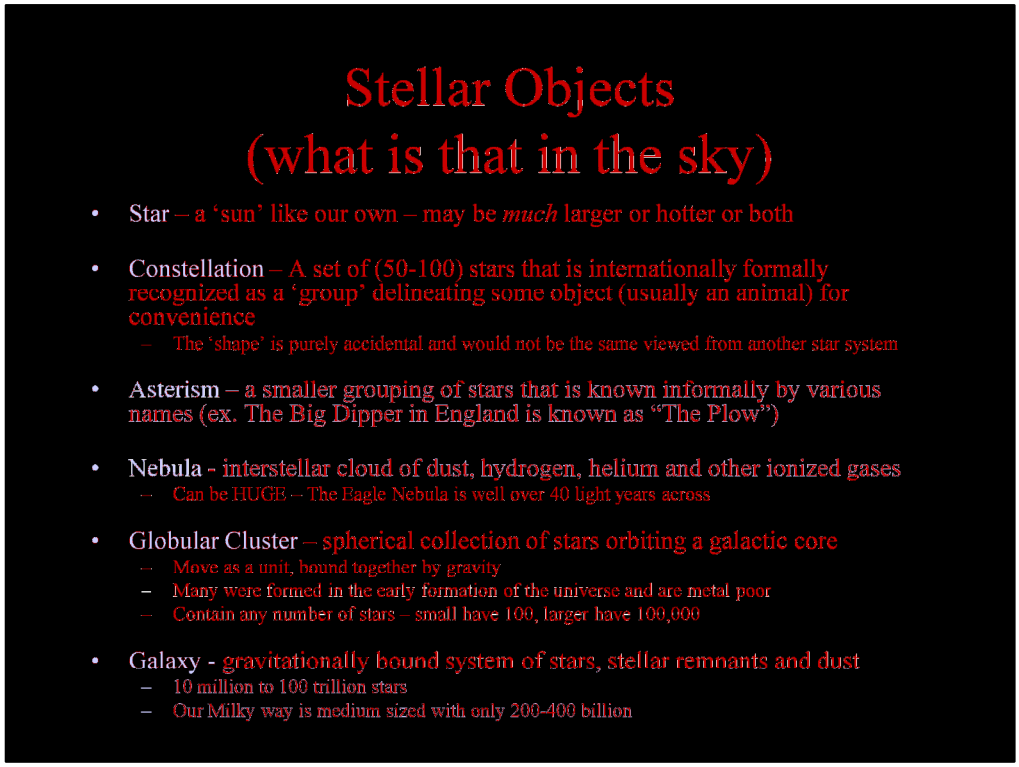
But … Astrology was the early version of Astronomy about 2000-2500 years ago when it was used to predict the seasons before there were calendars (or months or weeks or hours or minutes!). And Astronomy uses the same names of stars and constellations that the Astrologers used.

Like cartoons, Astrology can be fun to play with, but it shouldn't be taken too seriously

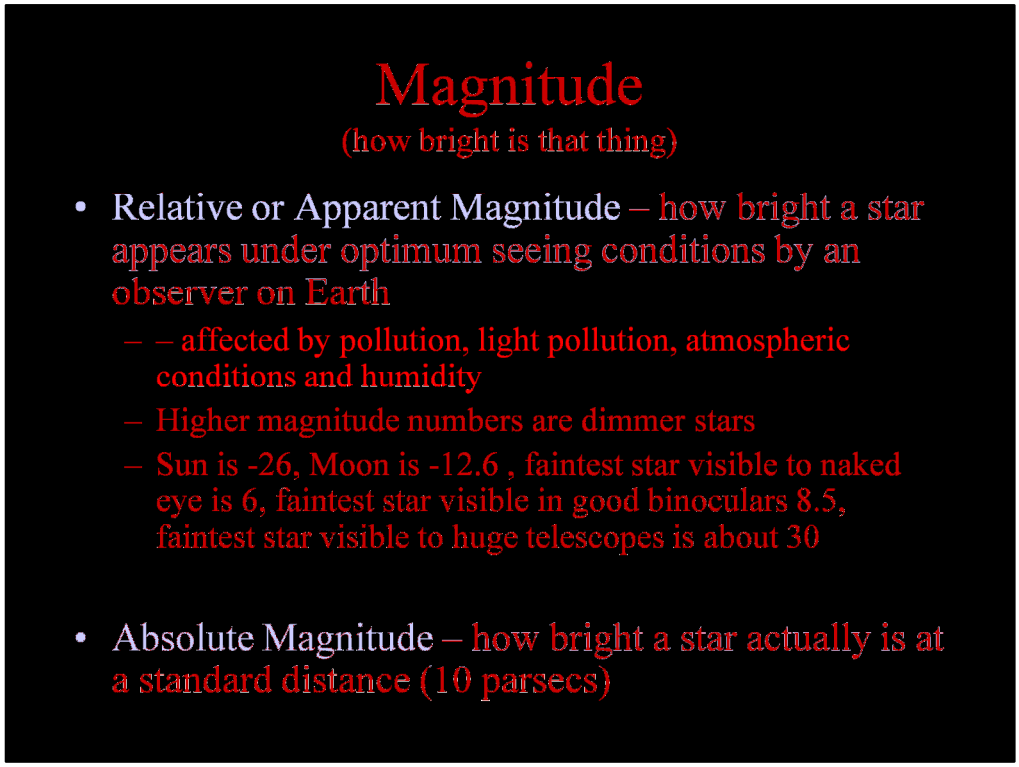
Astronomy is not like coin or stamp collecting where only a few can afford to have the best. Astronomy is the only hobby where every gets to see exactly the same thing as the professionals.

You don't need a fancy telescope to have fun. Most of the pictures you'll see today did *not* use a telescope. Although a telescope or binoculars help, you can see an awful lot with just your eyes if you know what you're looking for.

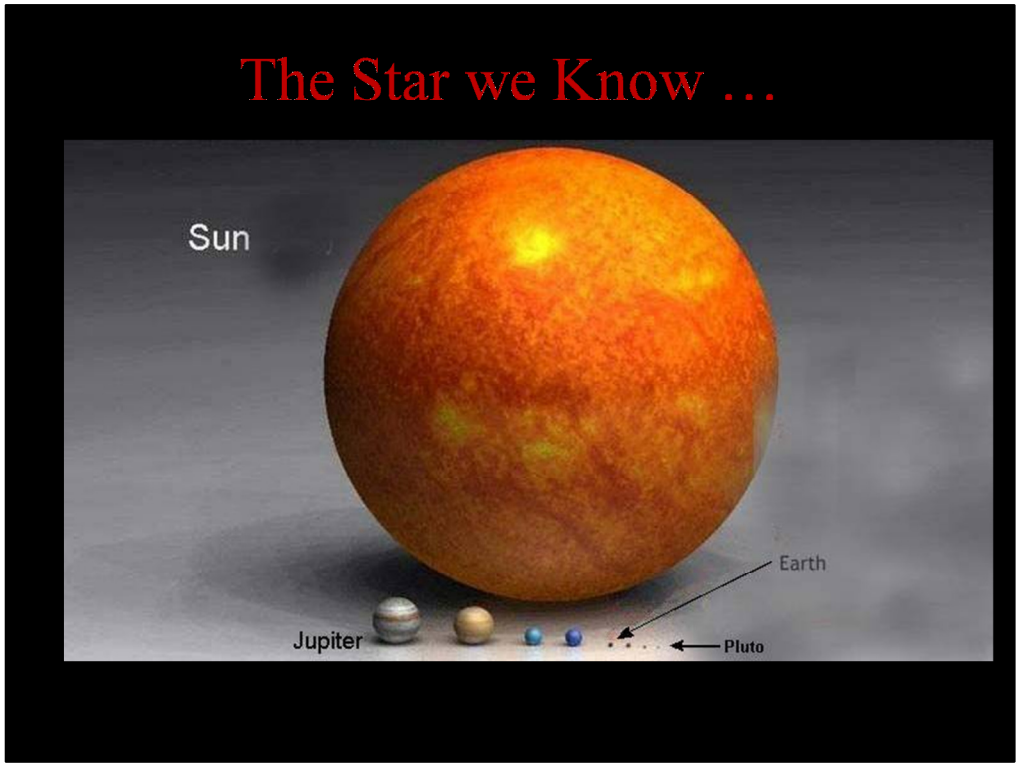
The stars you can see tonight are the same ones that professional astronomers are looking at. And they are the same ones that Aristotle and Noah and Mohammad and Jesus saw. Most of the names haven't even changed throughout recorded history (and some of them are pretty funny!)



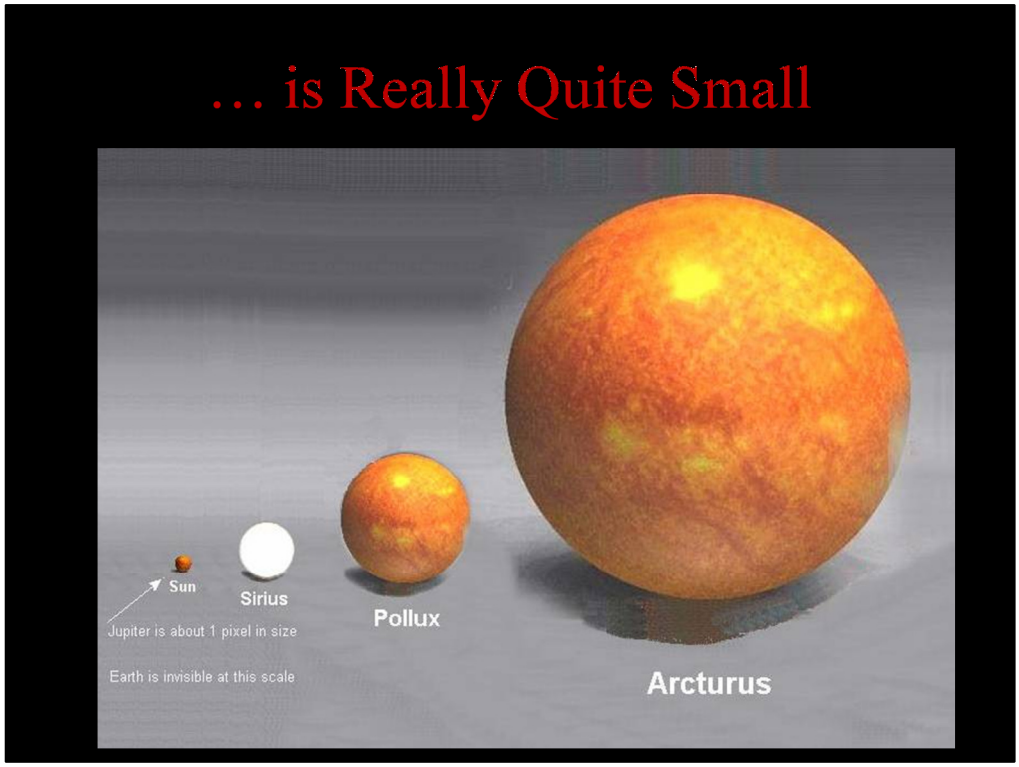
Stellar Objects



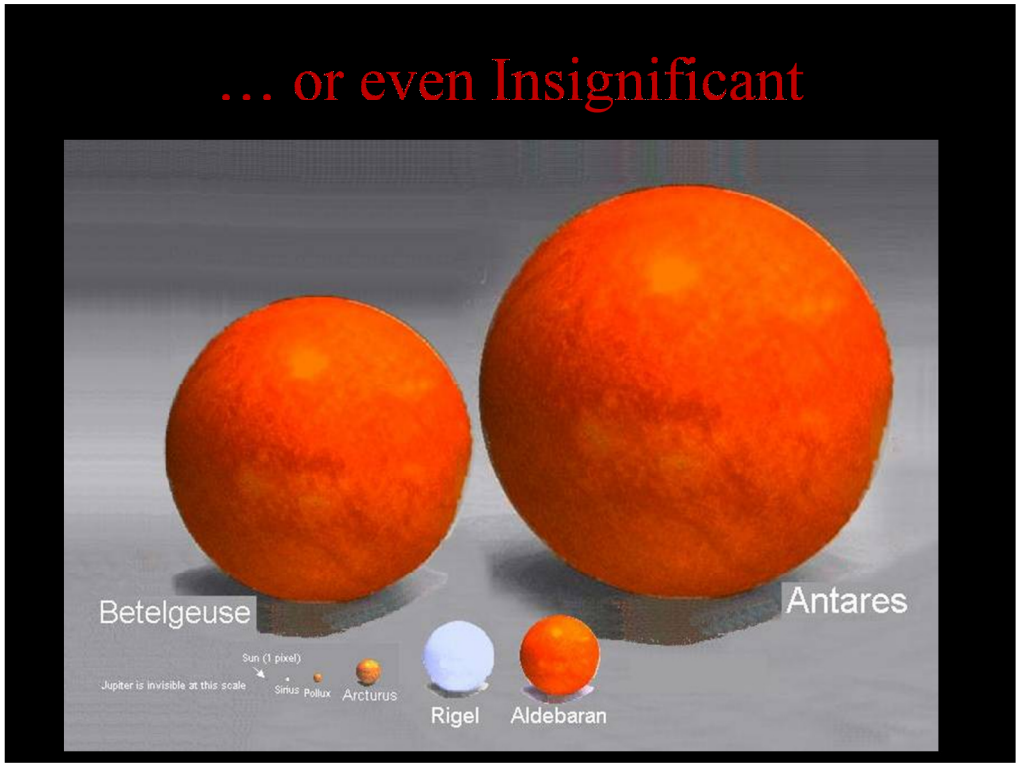
Magnitude Definitions



Relative Star Sizes



Relative Star Sizes



Relative Star Sizes

The 16 Brightest Stars

	Apparent Magnitude	Proper Name	Distance (LY)	Location (Constellation)
0	-26.74	(Sun)	0.000016	--
1	-1.46	Sirius (α CMa)	9	Canis Major
2	-0.72	Canopus (α Car)	310	Puppis
3	-0.04 var	Arcturus (α Boo)	37	Bootes
4	-0.01	Rigil Kent (α Cen A)	4	Centaurus
5	0.03	Vega (α Lyr)	25	Lyra
6	0.12	Rigel (β Ori)	770	Orion
7	0.34	Procyon (α CMi)	11	Canis Minor
8	0.42 var	Betelgeuse (α Ori)	640	Orion
9	0.5	Achernar (α Eri)	140	Eridanus
10	0.6	Hadar (β Cen)	530	Centaurus
11	0.71	Capella A (α1 Aur)	42	Auriga
12	0.77	Altair (α Aql)	17	Aquilla
13	0.85 var	Aldebaran (α Tau)	65	Taurus
14	0.96	Capella B (α2 Aur)	42	Auriga
15	1.04	Spica (α Vir)	260	Virgo
16	1.09 var	Antares (α Scorpio)	600	Scorpius

The larger the number, the fainter the star

Our sun is in a galaxy called the Milky Way. It is a spiral galaxy about 100 thousand light years in diameter with about 300-400 billion million stars. Because our solar system is way out on one edge instead of the center, we see the milky Way as a hazy band of light on a dark night.

Milky Way from Utah

Milky Way from Canada

Milky Way from South Texas

How many stars can you see?

(not as many as you think and only 15 brighter than magnitude 1)

	Absolutely perfect desert or mountain sky with no moon and no light polution			Rural area with low light polution	Suburban area - moderate/mild light polution	Urban area - severe light polution
Limiting Magnitude	6.5	6.3	6.0	5.0	4.0	3.0
Stars visible at any one point on earth at any one time (double this over the course of a year)	~4000	~3000	~2400	~750	~250	~80
Milky Way	Clearly visible - can leave a shadow		Often mistaken for a cloud	Barely visible	Nope	Nope
Orion Nebula	Actually looks like Small Nebula			Discernable as not a star	looks like faint star	Nope
Andromeda Galaxy 2.5 MLY - furthest distance a person can see	Clearly visible as faint oval		Visible as smudge	Need Binoculars	Need binoculars	Nope


•Big Bend area
•Great viewing,
low humidity & light pollution
•Stars down to Magnitude six
(the limit) can be seen
•This northern view shows
•Milky Way
•Dust Lanes
•Big Dipper
•Polaris
•In some ways dark skies make
things harder to find
Earth, Dallas, 143m
FOV 111°
10.5 FPS
2011-01-25 22:49:34

Find the Big Dipper – the Pointers and The North Star (Polaris)

Big Dipper is not a Constellation – it is an asterism

Wasn't the North star 10,000 years ago

Won't be 10,000 years from now

But it is at this moment in geologic time

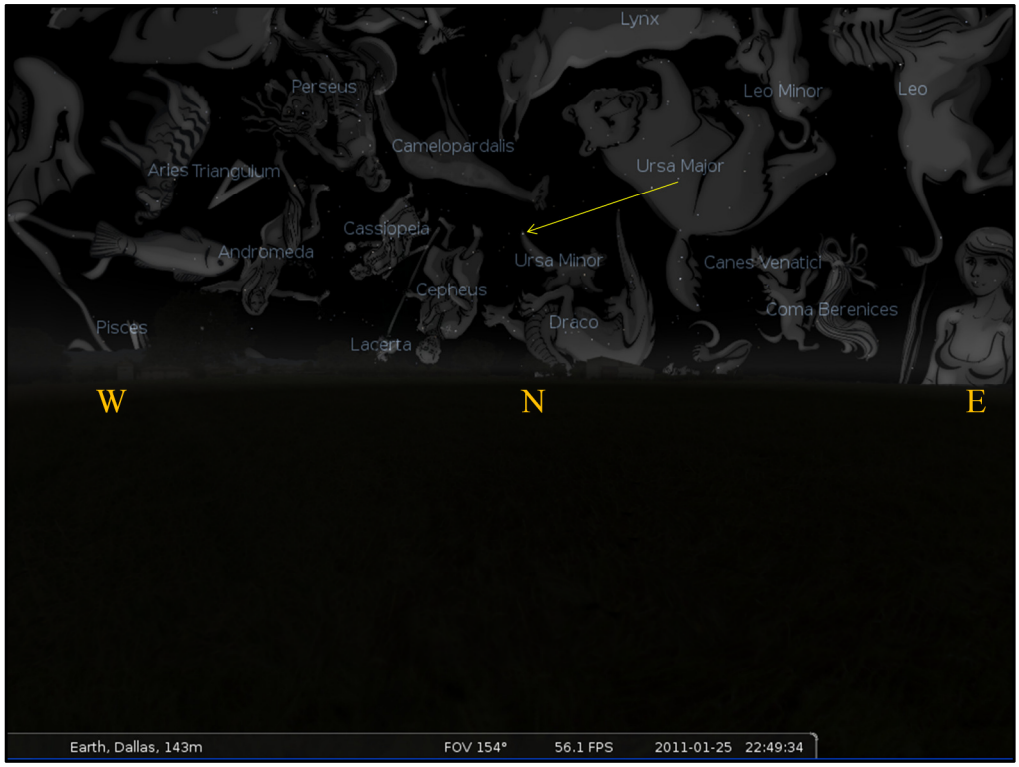
Due to precession that takes 26,000 years per cycle

in 14,000 AD, Vega in Lyra will be the polestar

3000 years ago it was Thuban (Alpha Draconis)

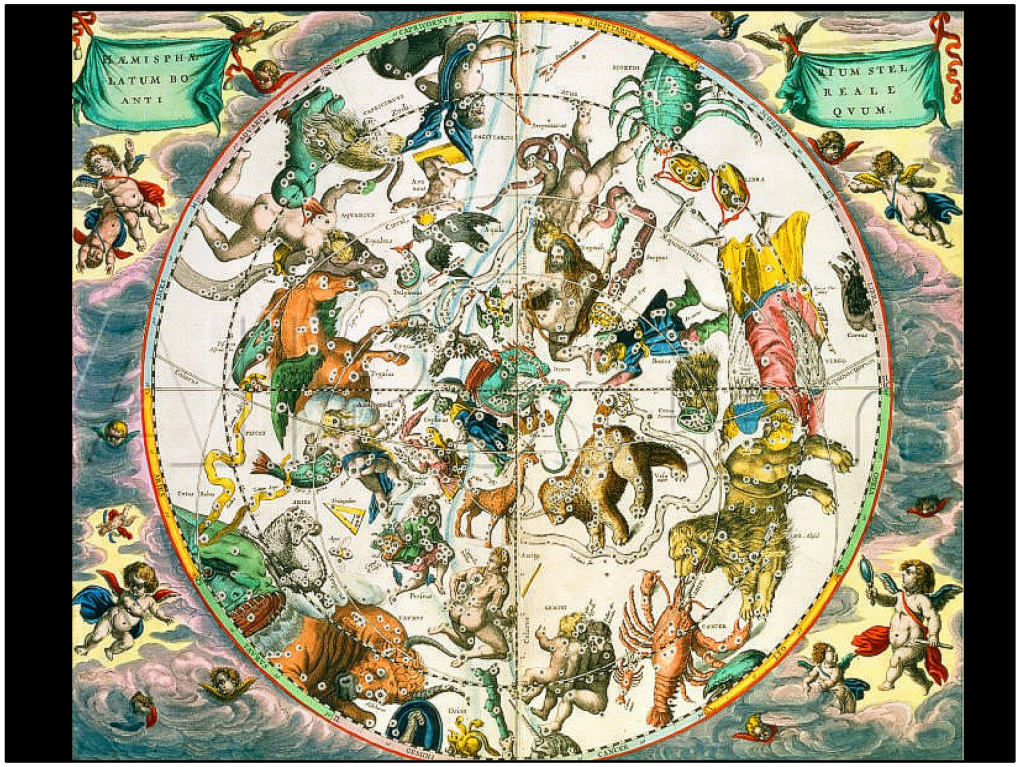
Two end stars in the dipper are moving one way – all others moving in opposite direction

in 100,000 years the bowl will be almost flat and the end handle star almost at 90 degrees to Mizar.

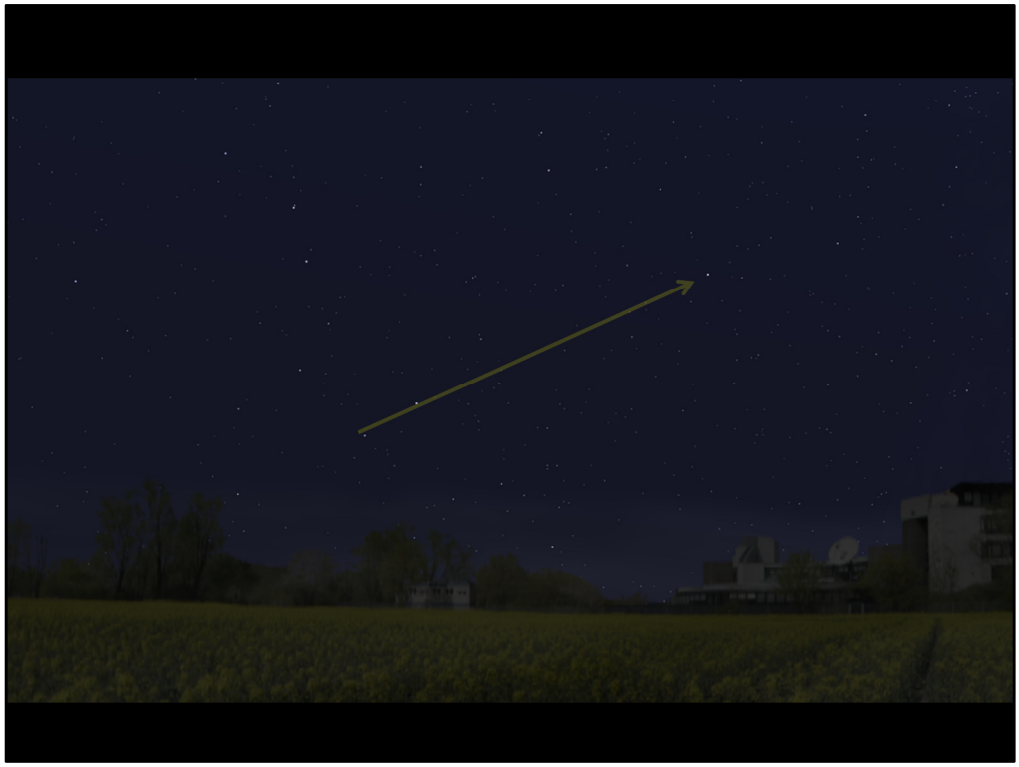


What's visible in January at 22:30

Artwork



Historic artwork print

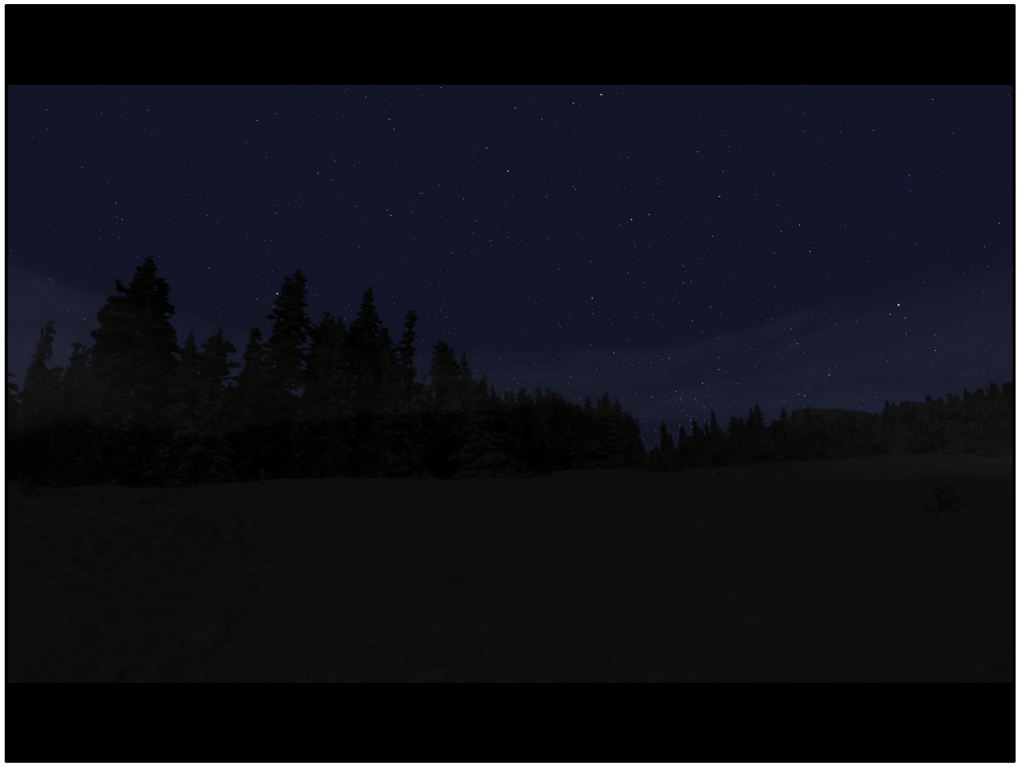


Find the dipper and the north star

Find the dipper and the north star

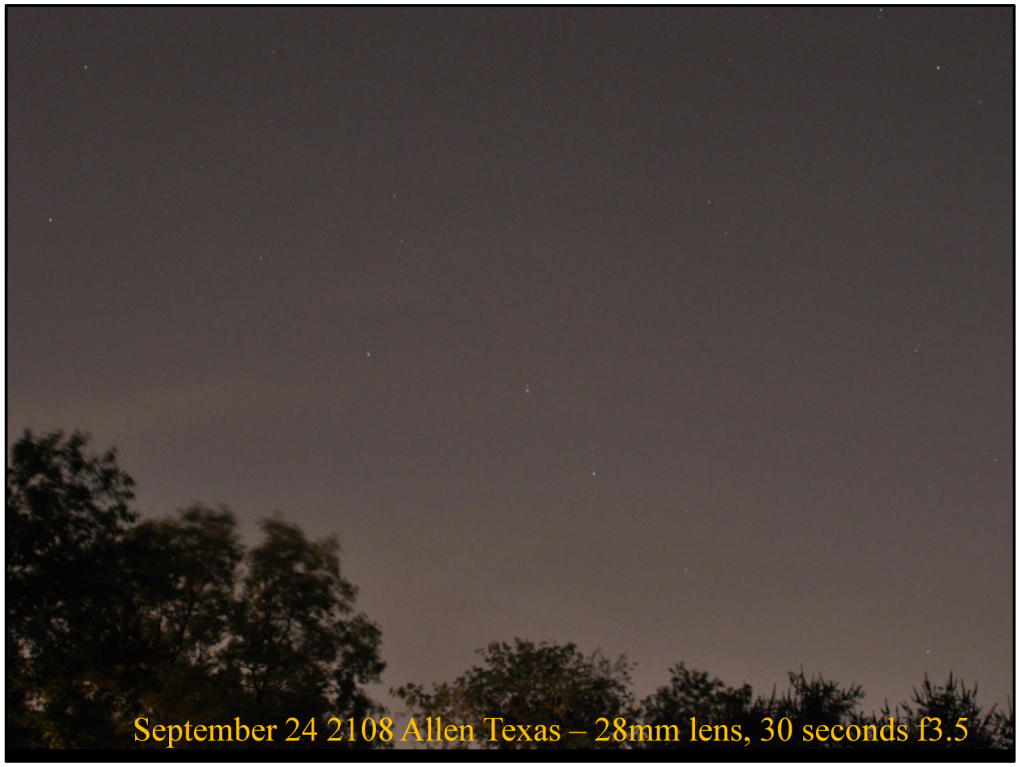
Find the dipper and the north star

Find the dipper and the north star



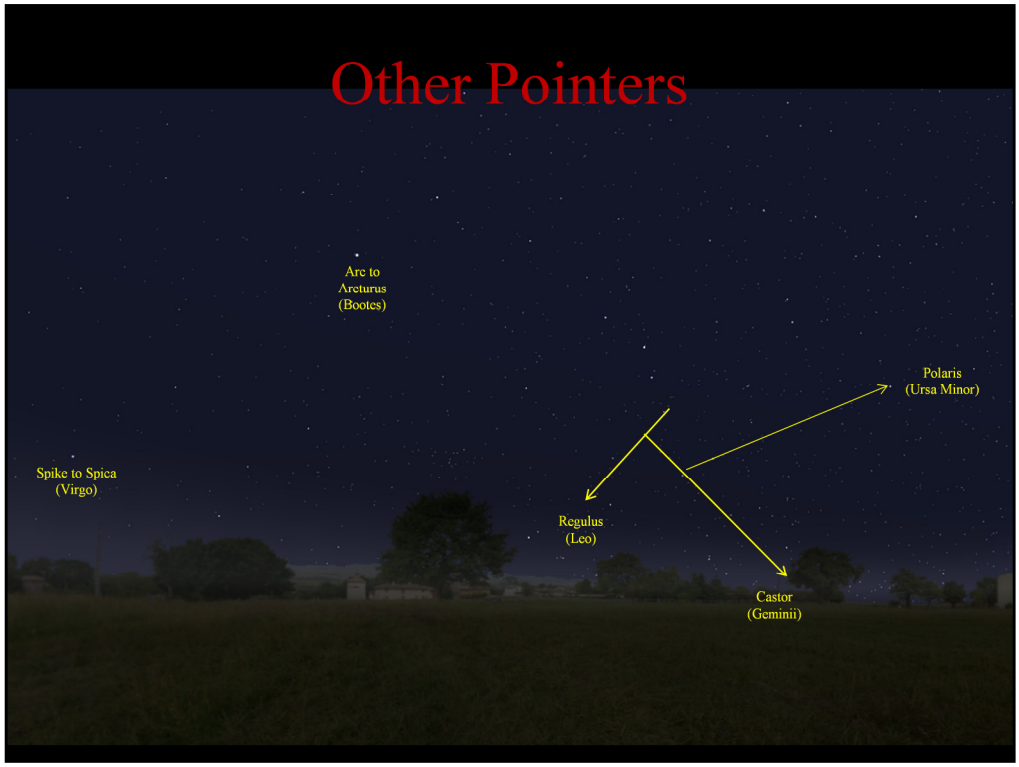
Find the dipper and the north star

Trick screen – dipper below landscape



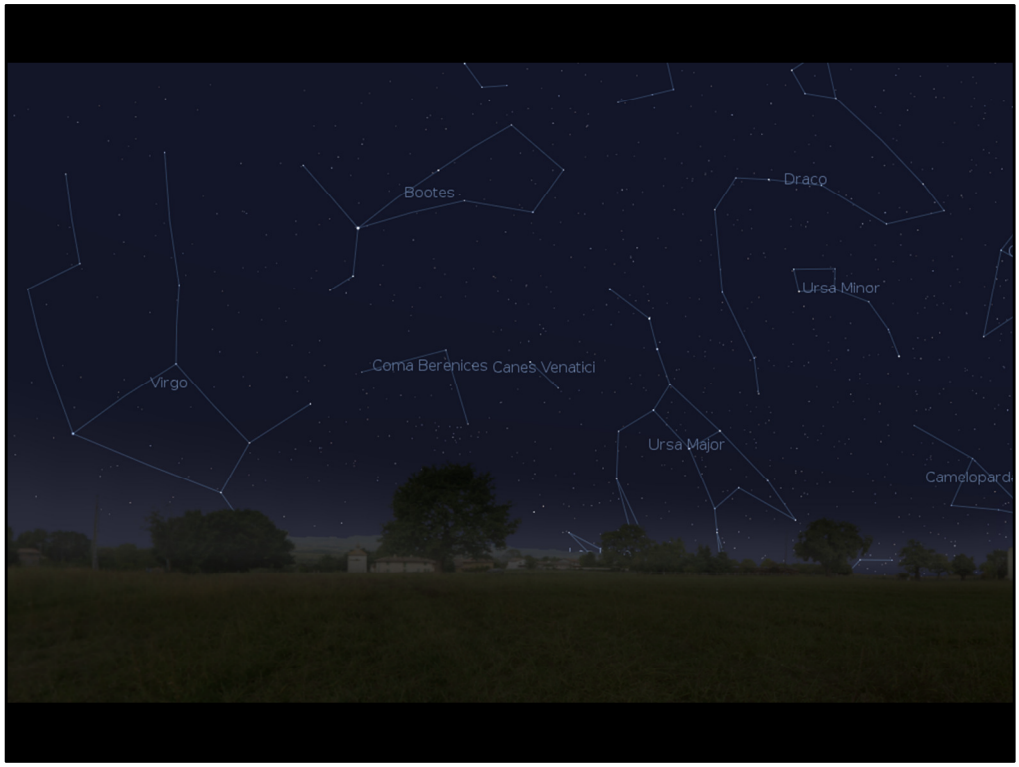
September 24 2108 Allen Texas – 28mm lens, 30 seconds f3.5

Same photo enlarged to show Mizar and star trails
caused by earth rotation in 30 seconds



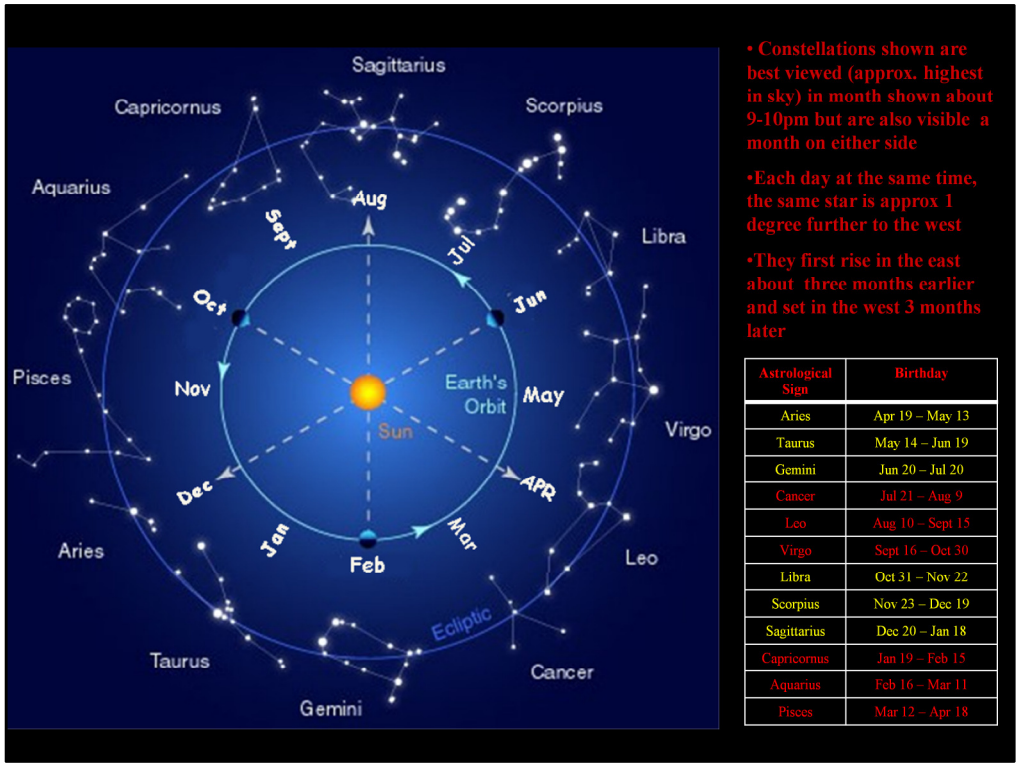
Other Pointers

Arc to Arcturus,
Spike to Spica
Back of bowl points to Regulus in Leo
Front of bowl points to Polaris in Ursa Minor
Bottom of bowl points to Castor in Geminii



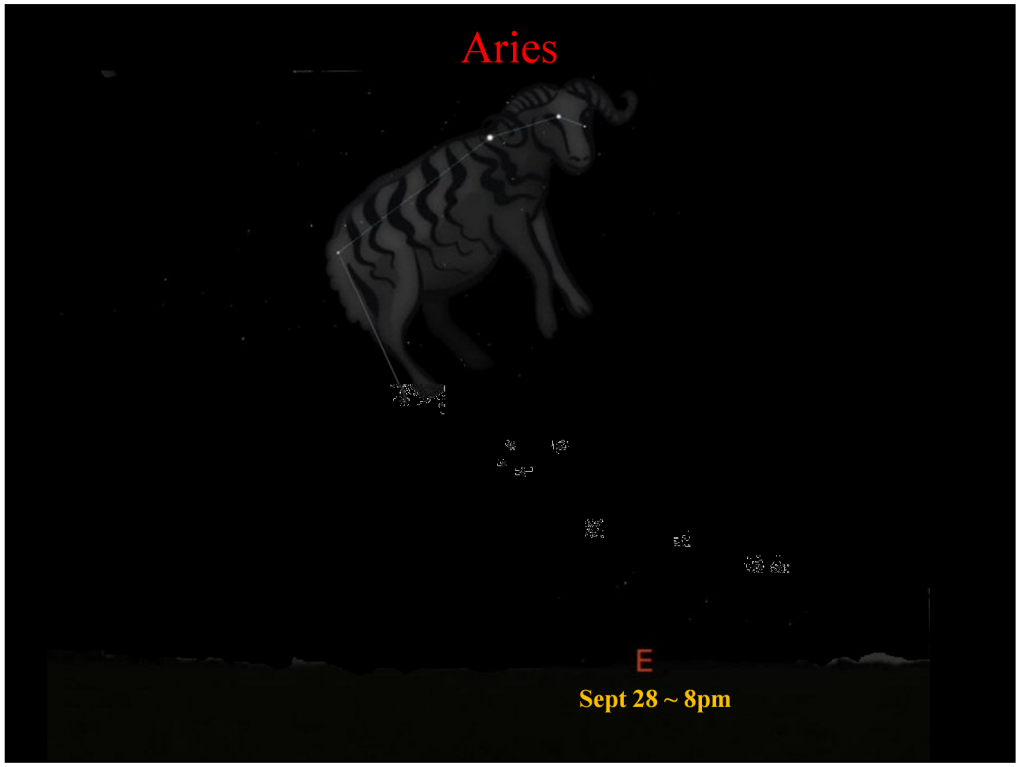
Constellation Lines

Constellation Artwork



Astrological Sign	Birthday
Aries	Apr 19 – May 13
Taurus	May 14 – Jun 19
Gemini	Jun 20 – Jul 20
Cancer	Jul 21 – Aug 9
Leo	Aug 10 – Sept 15
Virgo	Sept 16 – Oct 30
Libra	Oct 31 – Nov 22
Scorpius	Nov 23 – Dec 19
Sagittarius	Dec 20 – Jan 18
Capricornus	Jan 19 – Feb 15
Aquarius	Feb 16 – Mar 11
Pisces	Mar 12 – Apr 18

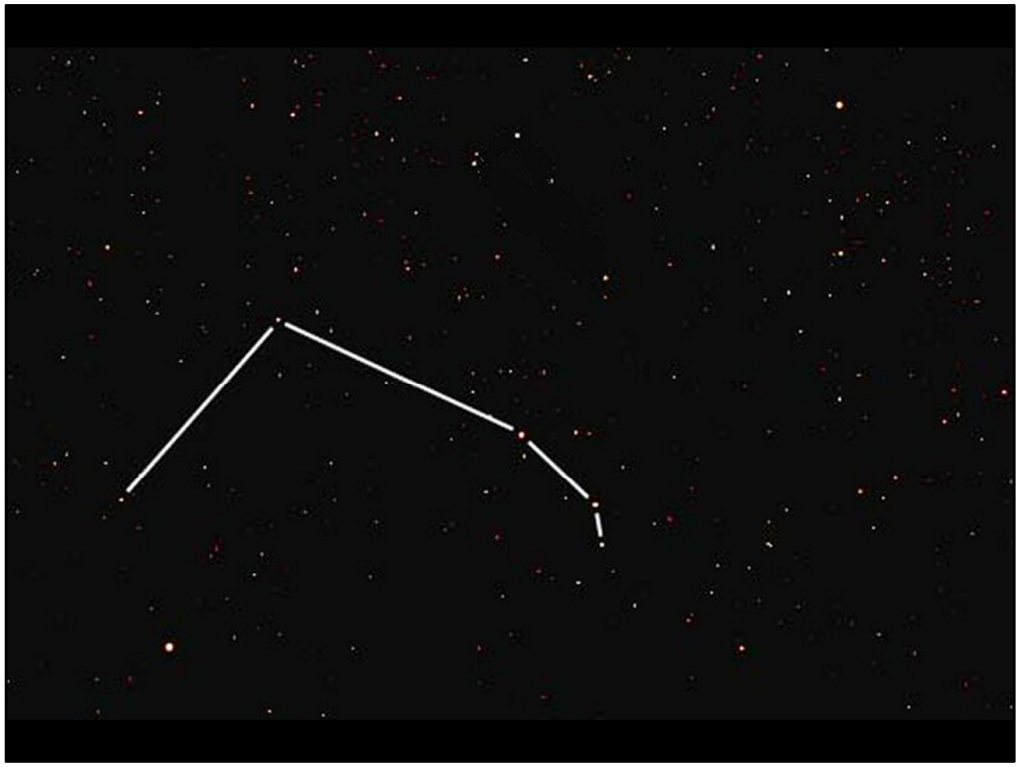
Astrological month orientations



Aries artwork

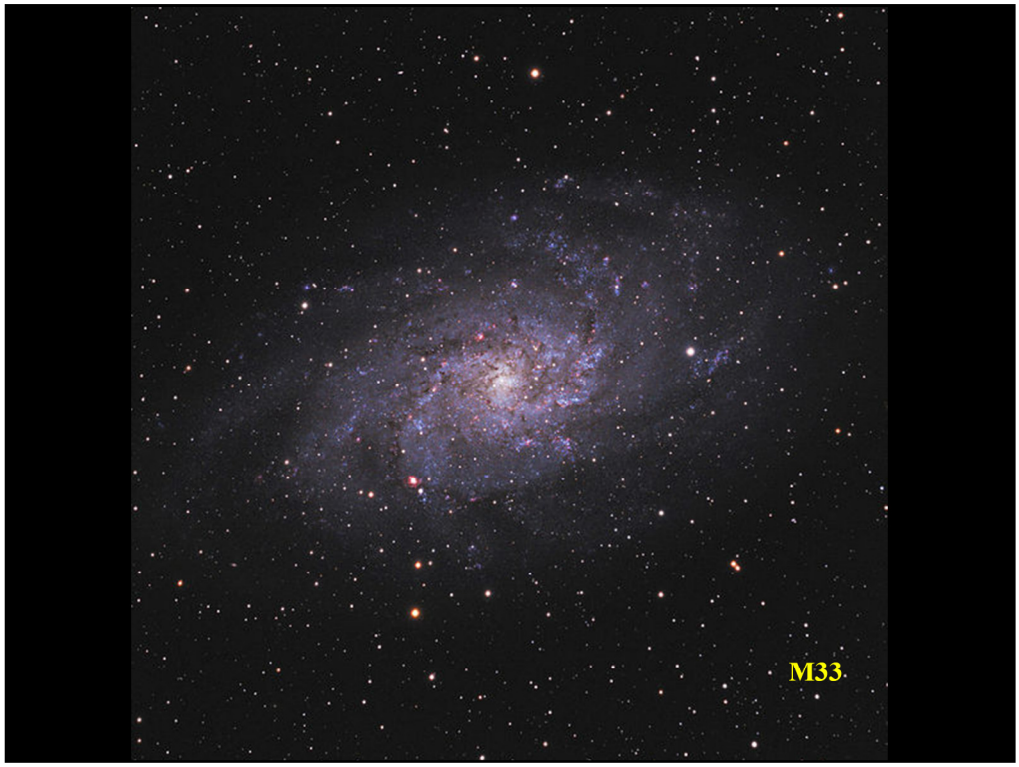
Hamal (Alpha) – ***The head of the Sheep***

Sheratan (Beta) – ***The Sign*** of Spring



Aries Lines

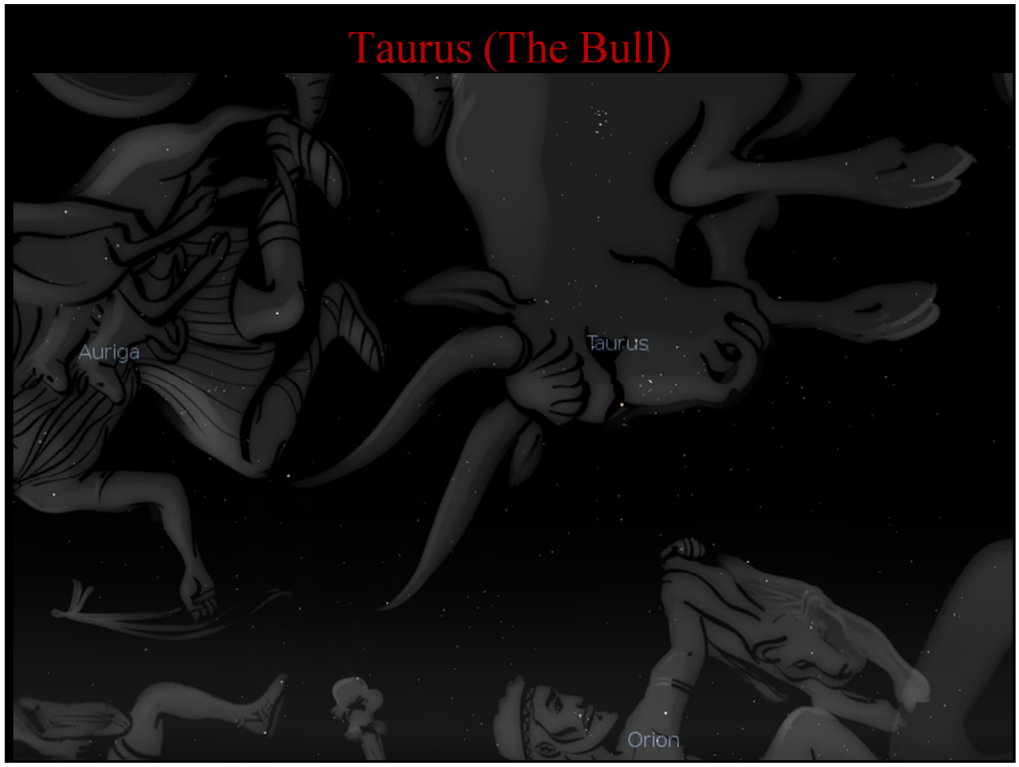

<-M33



M33 - Triangulum Galaxy

Distance 3000 (kly)
Apparent Brightness 5.7 (mag)
Apparent Dimension 73x45 (arc min)

Aries photo



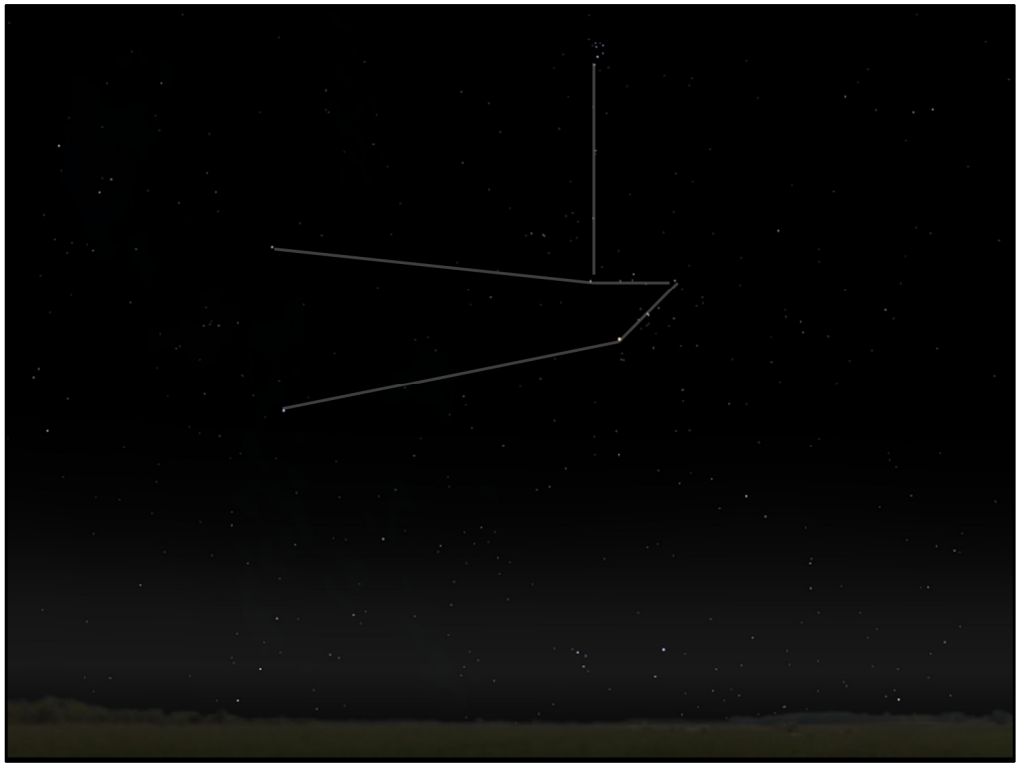
Taurus Artwork

Asterisms – Hyades , M45-Pleiades (7 sisters, only 6 show)
Both Hyades and Pleiades are true star clusters held together by gravity

Aldebaran (Bright one of the Follower) - 40 times larger than our sun – AKA The Eye of the Bull
– First of the four Royal Stars of Persia (others are Antares, Regulus, Fomalhaut)

El Nath (Al Nath) – upper horn - the Butting One

M1-Crab Nebula – remnants of 1054 nova recorded by Chinese is next to lower horn tip



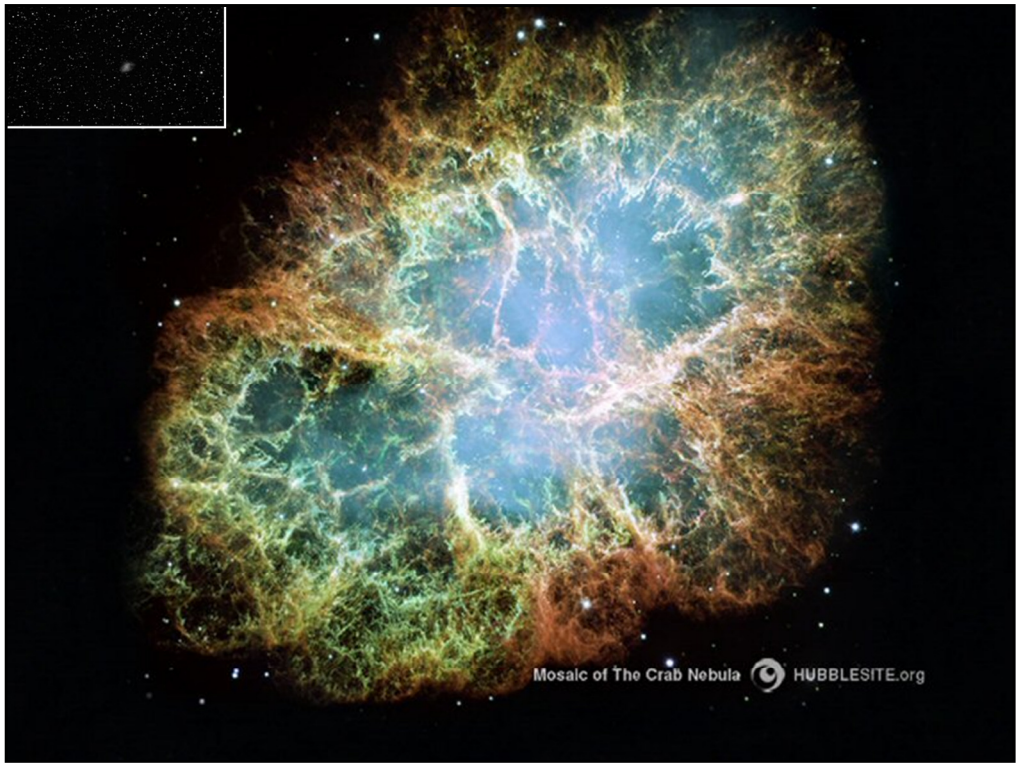
Dark Sky Long-term exposure photo

Note - Pleiades and Color of aldebaran – Bright one of the follower or Eye of the Bull

- two small nebulae in upper left

Crab Nebula next to bright white star in upper left

- Exploded in 1054 – recorded by chinese and arabic astronomers
- cast shadow in full daytime for two days then faded away
- visible to naked eye for two years, then faded away
- Remnant re-discovered in 1731 and again in 1758
- Designated M1 by Charles Messier as the first item of non-Interest in what is now known as the Messier Catalog
- illuminated by a pulsar: a neutron star as massive as the Sun but with only the size of a small town.
- The Crab Pulsar rotates about 30 times each second.
- Visible in a pair of binoculars (Magnitude 8) but great in Hubble photos



M1 – Crab Nebula in Taurus

Pleiades

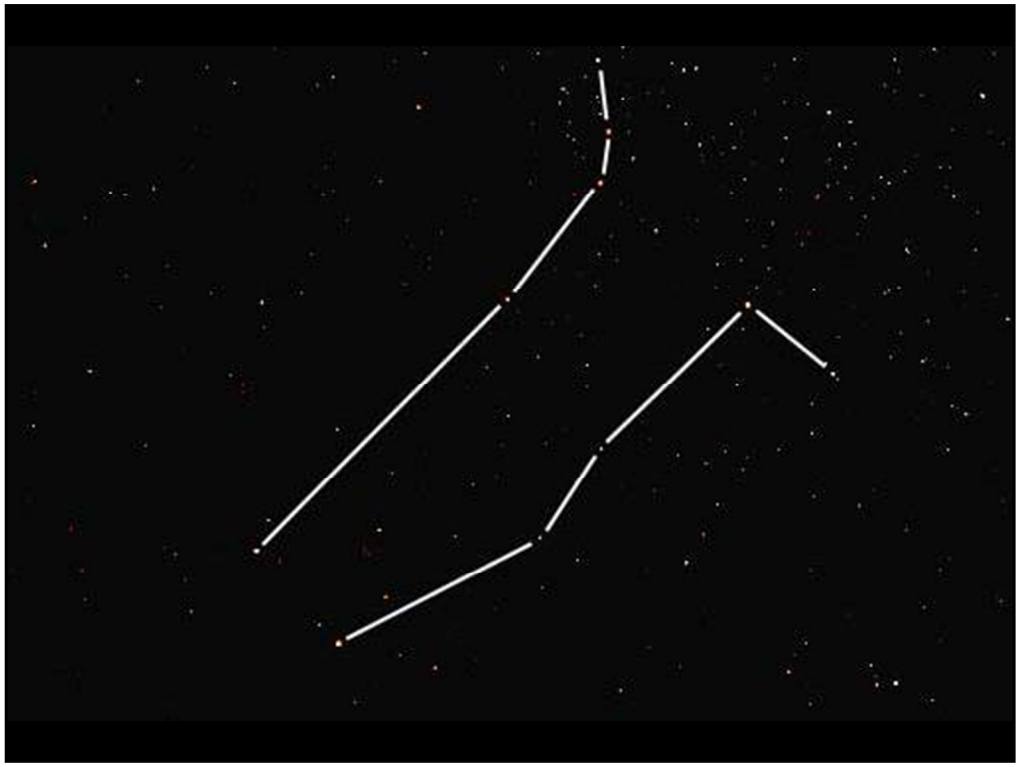
Where most constellations and star groups are an accident of perspective, the Pleiades are actually a local group traveling in the same direction. Stars are still forming

In Japanese the constellation is called Subaru and the Car's logo is a stylized depiction of the asterism.

Mentioned by Chaucer and by name in the bible (Job 9:9 and 38:31, and Amos 5:8)

Taurus Photo

Geminii Artwork



Castor (alpha) – ***The Horseman*** – (white- the upper star) the 23 Brightest Star in the sky

Pollux (beta) – ***The Boxer*** – (yellow – the lower star) the 17th brightest star in the sky

M35 – Large Open Cluster, Size: 28.0‘, Magnitude: 5.1

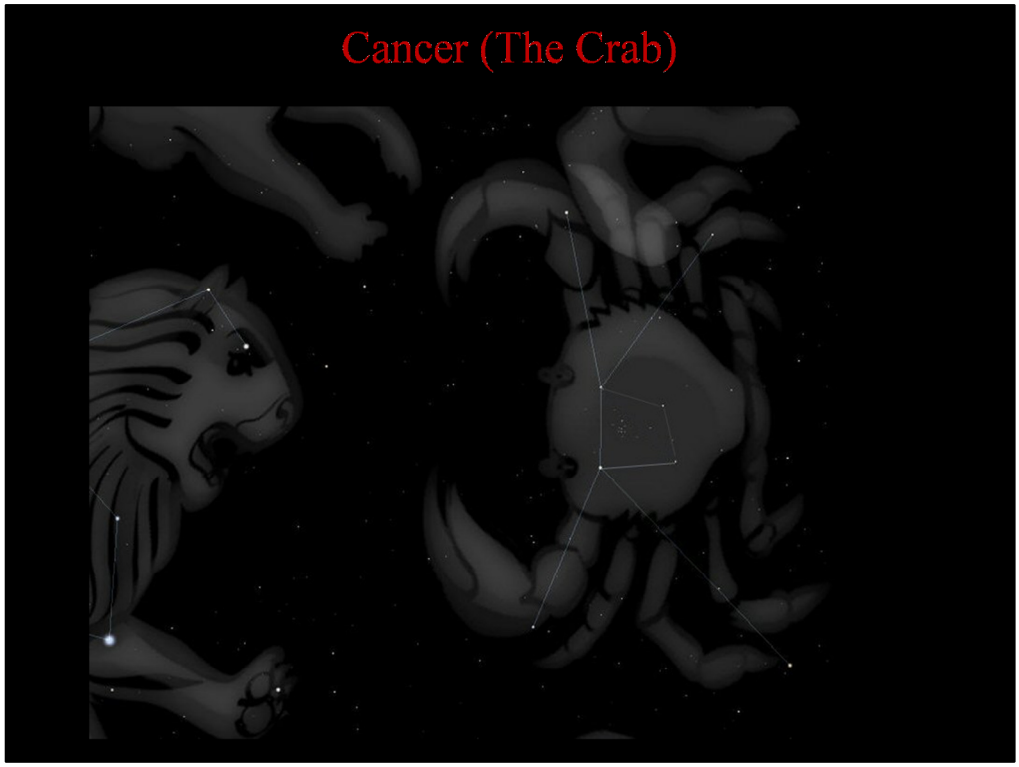
NGC 2174 – MonkeyHead Nebula - Emission, Reflection Nebulae, Size: 25'x 20‘

M35 – Large Open Cluster, Size: 28.0‘, Magnitude: 5.1

NGC 2174 – MonkeyHead Nebula - Emission, Reflection Nebulae, Size: 25'x 20‘

Geminii Photo

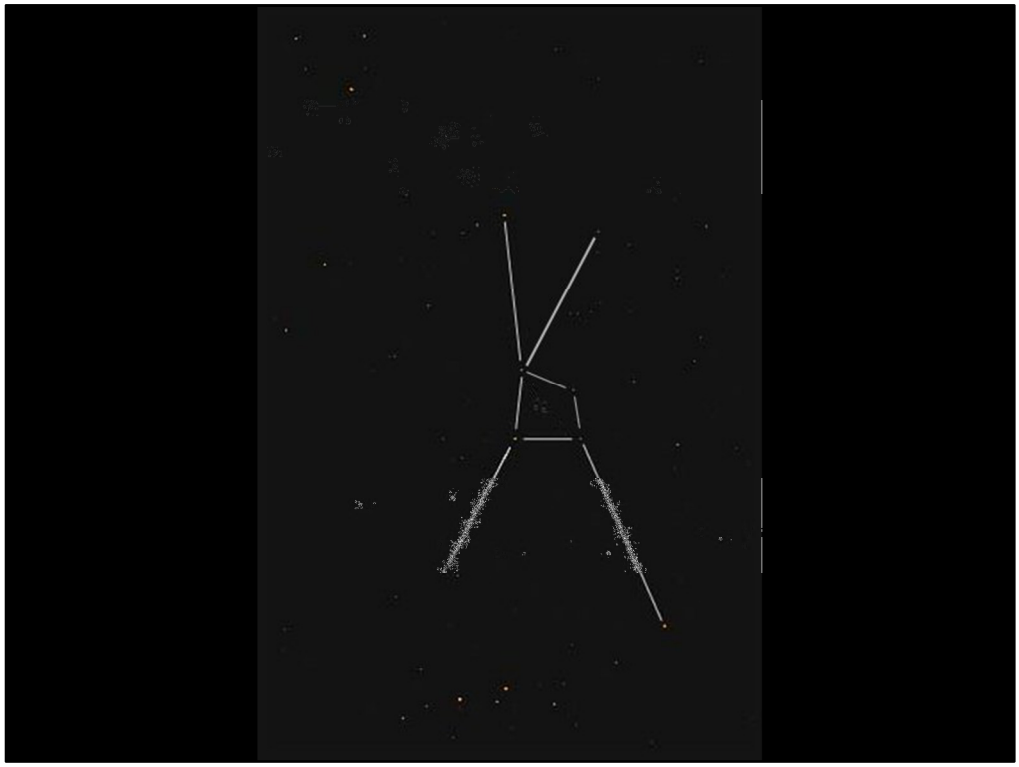
Bright ‘star’ is a planet –Jupiter

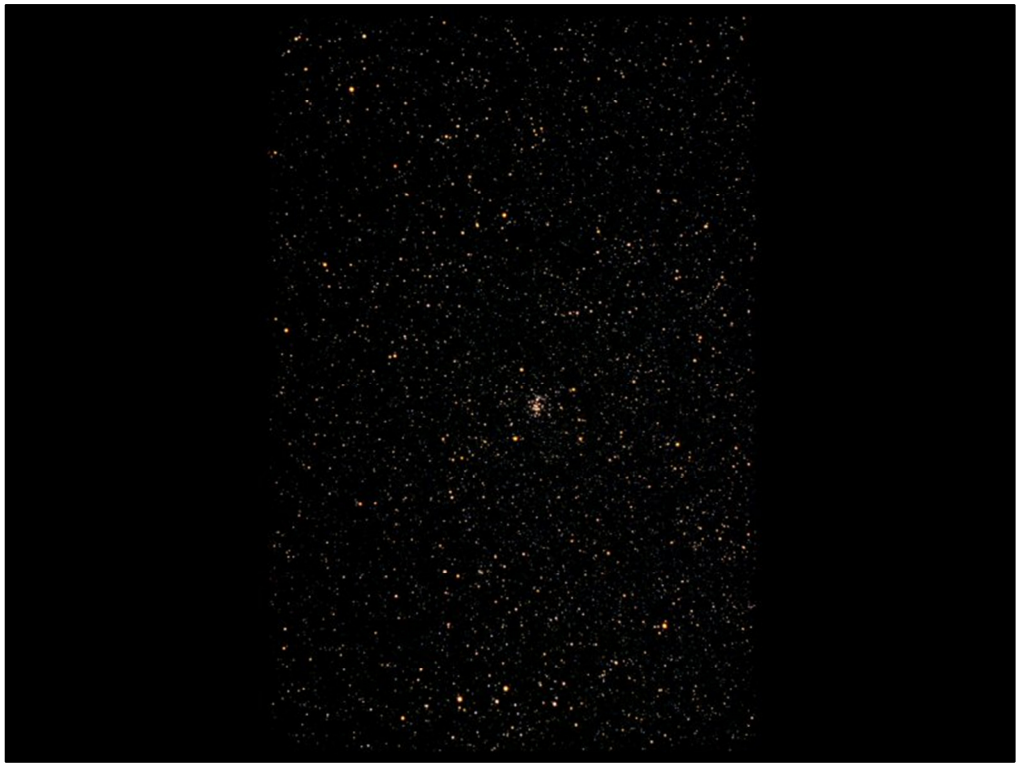


Cancer Artwork

Cancer difficult to see the Beehive (manger, jewelbox) Asterism is easy to find with a pair of binoculars or naked eye in dark sky – due west of Leo's nose.

Contains M44 – Praesepe (Latin for "manger") – a star cluster mentioned in literature from 260 BC





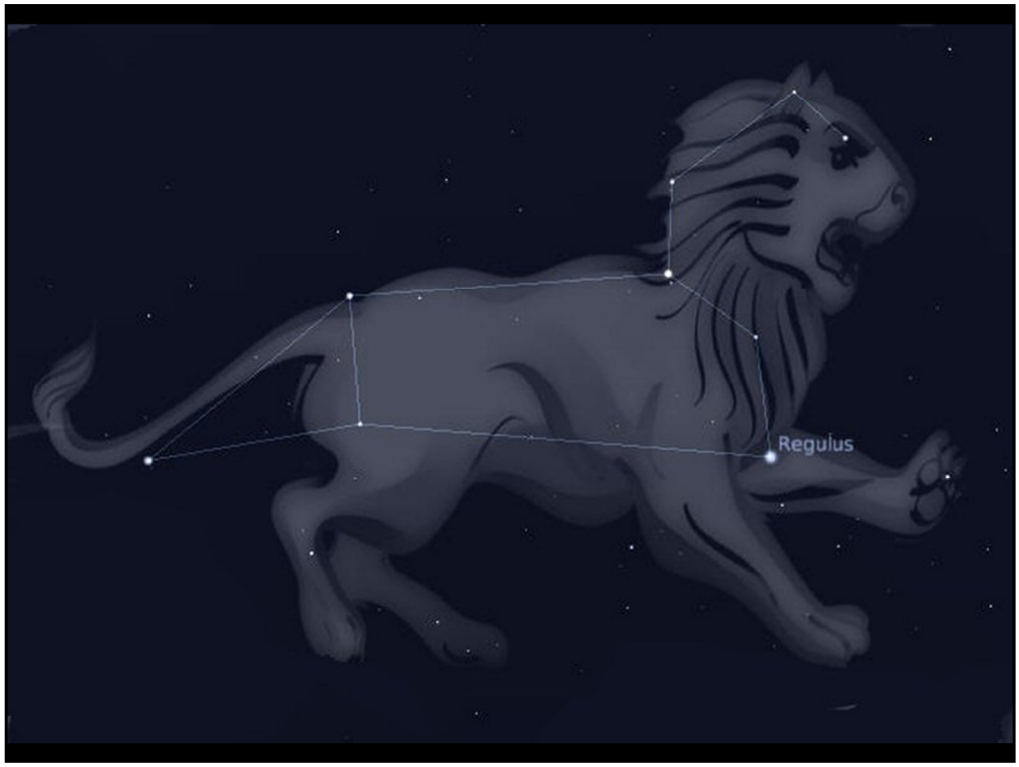
M44 Praesepe

The ***Beehive*** or ***Manger*** Asterism contains ***Praesepe*** – a star cluster mentioned in 260BC literature

M44 - ***Praesepe*** - is a globular cluster containing about 50 stars held together by gravity

Note star colors – they really are red, blue and yellow. Color directly corresponds to temperature.

Cancer Photo

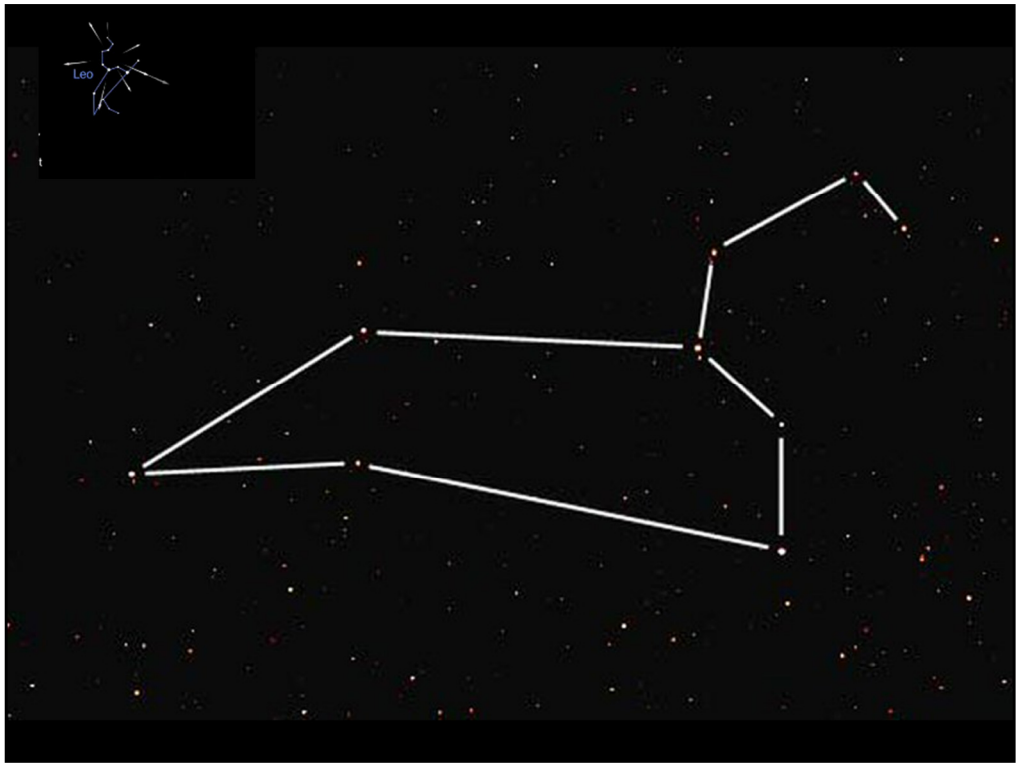


Leo Artwork

The Sickle Asterism – also known as ***The Yellow Dragon*** in ancient China

Regulus (Alpha) ***– The Little King*** or ***Lion's Heart*** – Second of the Royal four of Persia

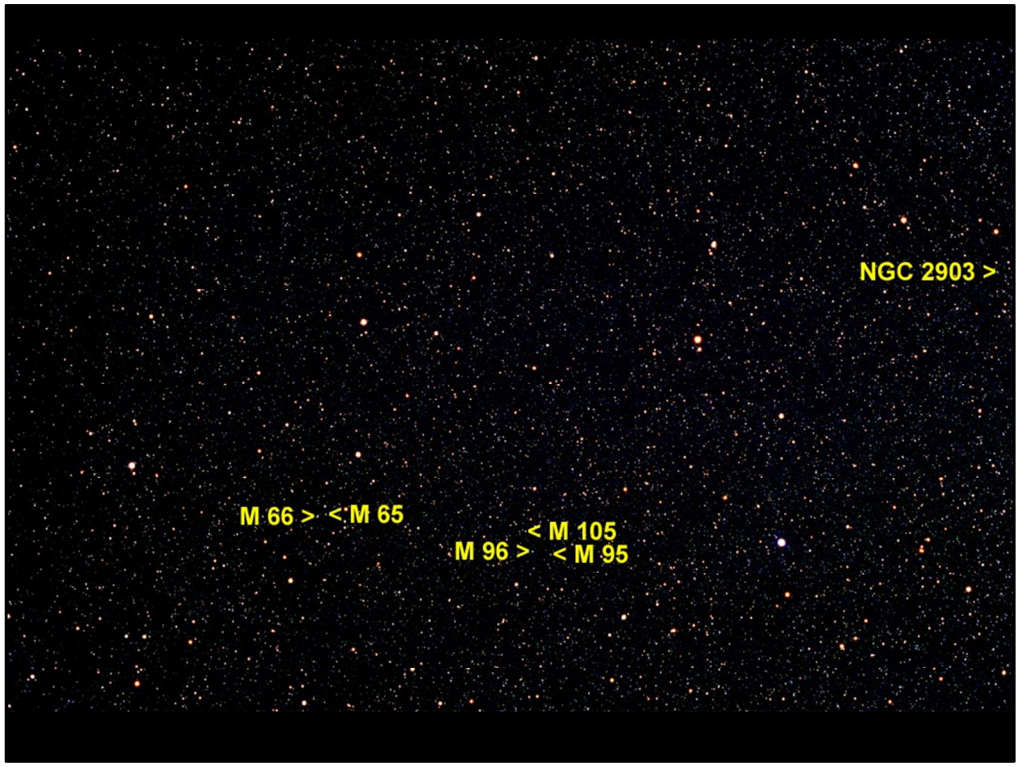
Denebola (Beta) – ***the Lion's Tail***

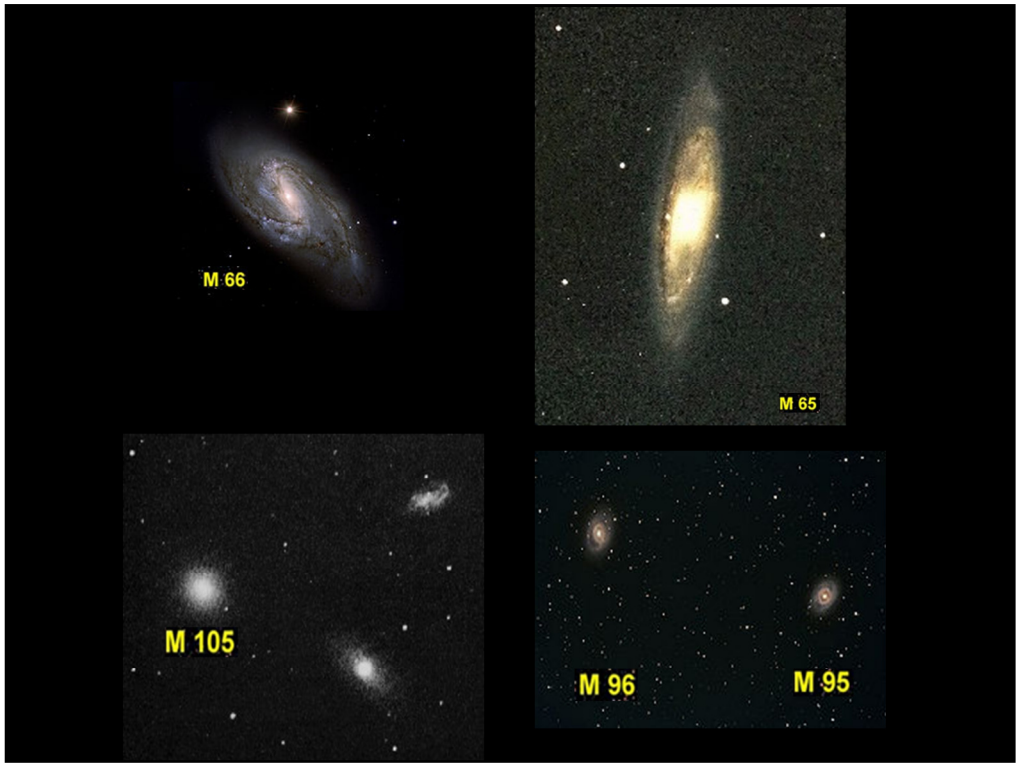


Leonid Meteor Shower in November

Regulus (Alpha) **– *The Little King*** or ***Lion's Heart*** – Second of the Royal four of Persia

Denebola (Beta) – ***the Lion's Tail***


NGC 2903 >
M 66 > < M 65
< M 105
M 96 > < M 95



M65 - Distance 35000 (kly), Visual Brightness 9.3 (mag), Apparent Dimension 8x1.5 (arc min)

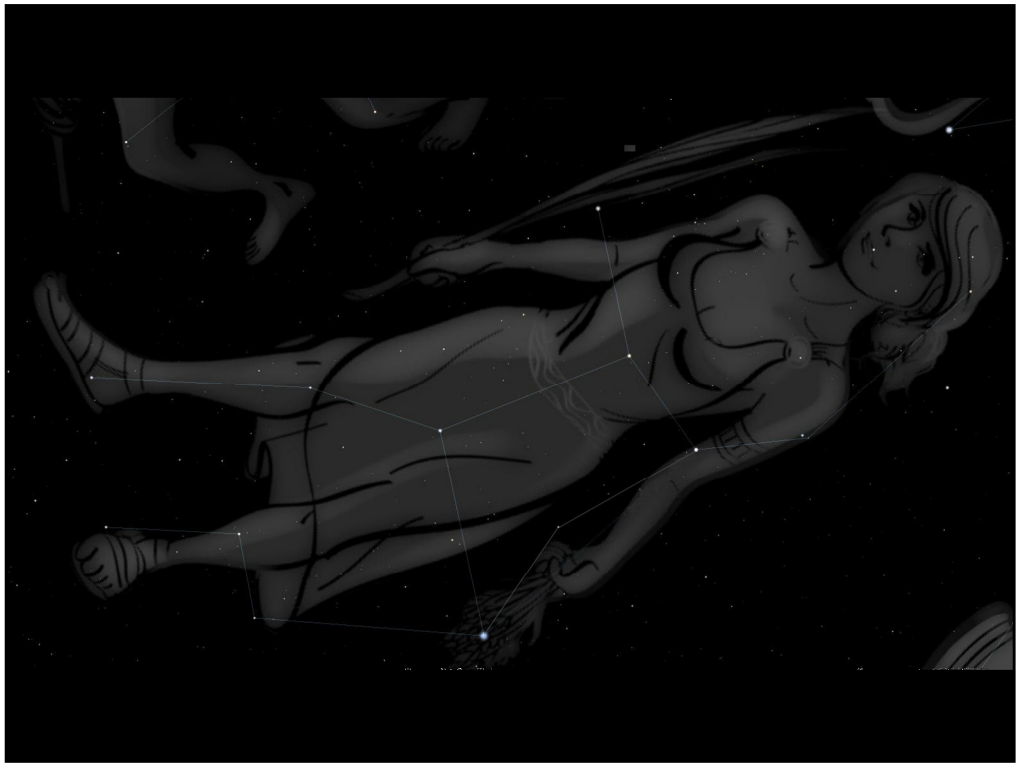
M66 - Distance 35000 (kly), Visual Brightness 8.9 (mag) , Apparent Dimension 8x2.5 (arc min)

M95 - Distance 38000 (kly), Visual Brightness 9.7 (mag) , Apparent Dimension 4.4x3.3 (arc min)

M96 - Distance 38000 (kly), Visual Brightness 9.2 (mag) , Apparent Dimension 6x4 (arc min)

M105 - Distance 38000 (kly), Visual Brightness 9.3 (mag), Apparent Dimension 2.0 (arc min)

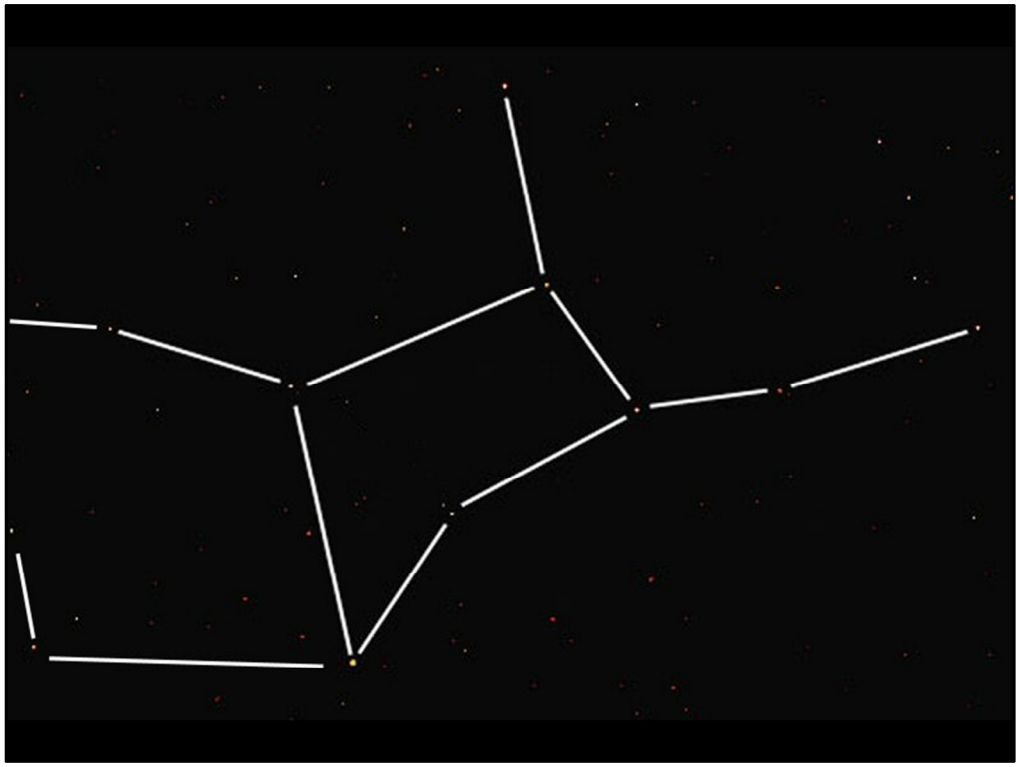
Leo Photo

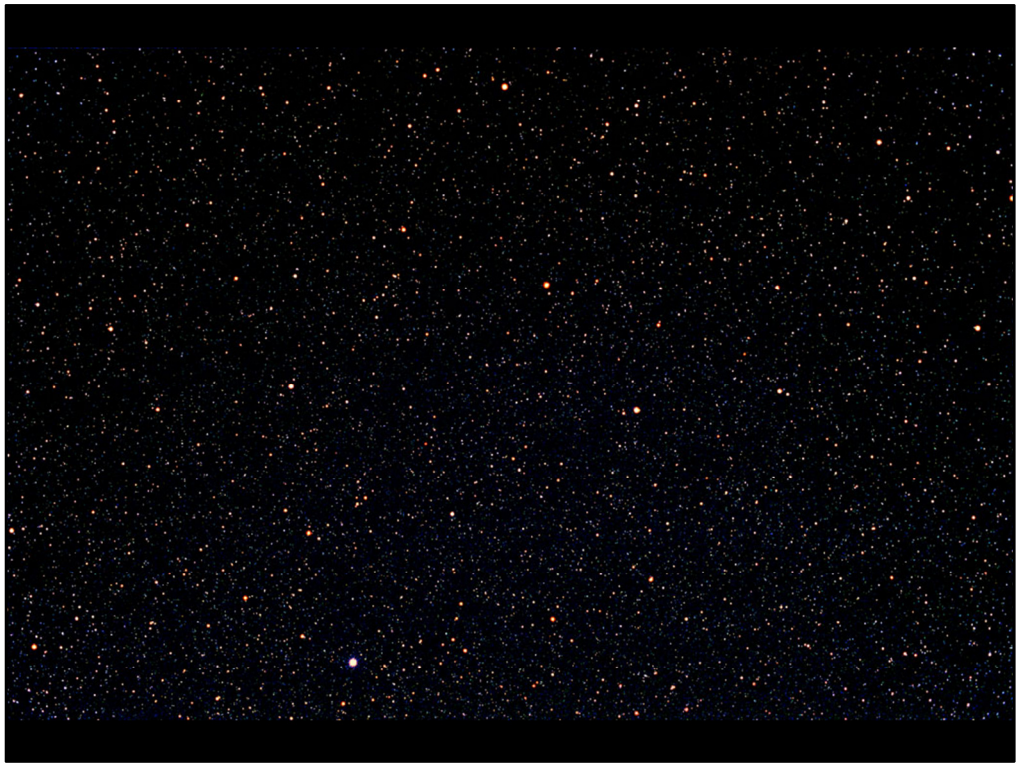


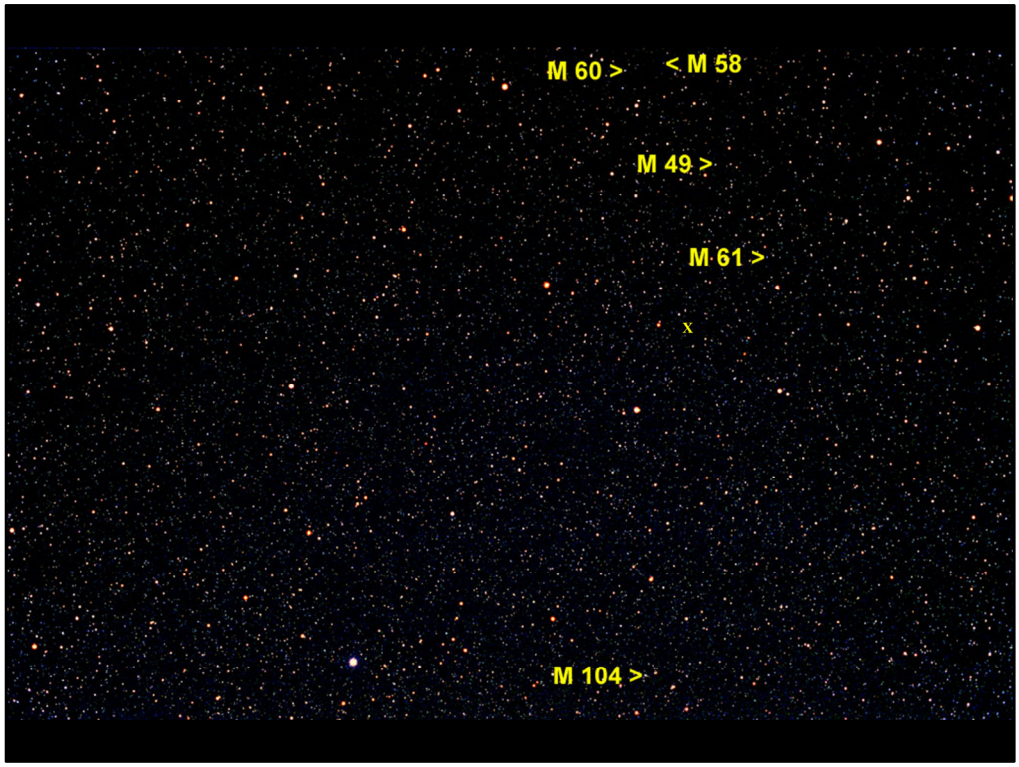
Virgo Artwork

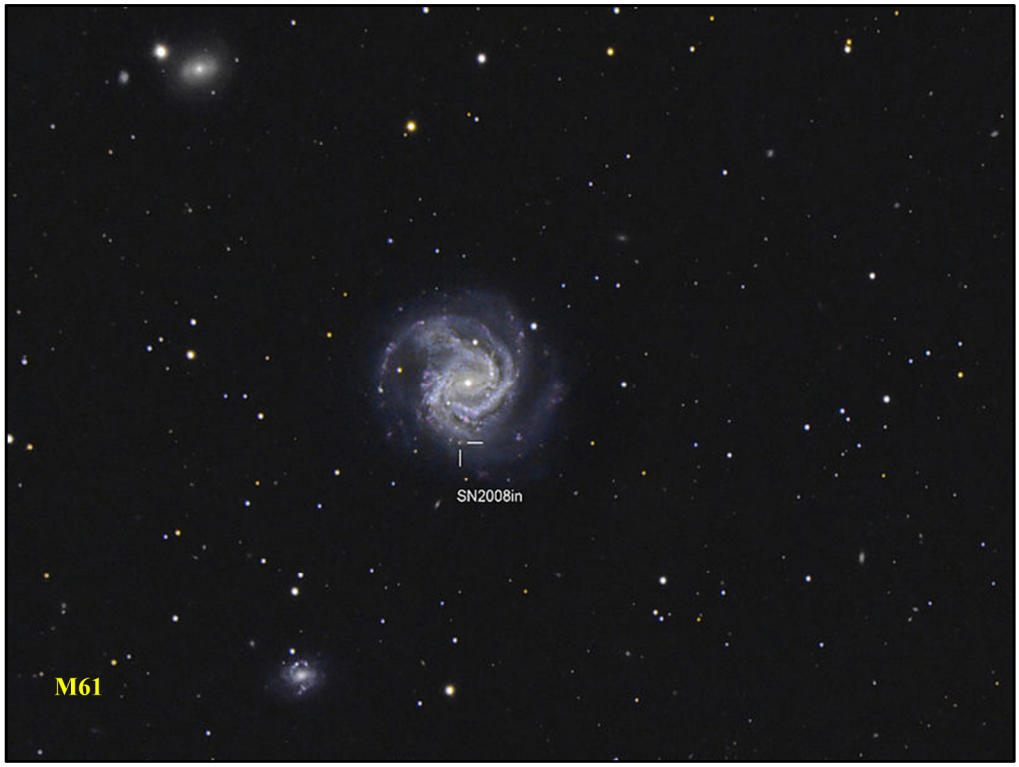
Spica (Alpha) – the Ear of wheat that Virgo holds in her left hand

16th Brightest star – about 10 times bigger than the sun



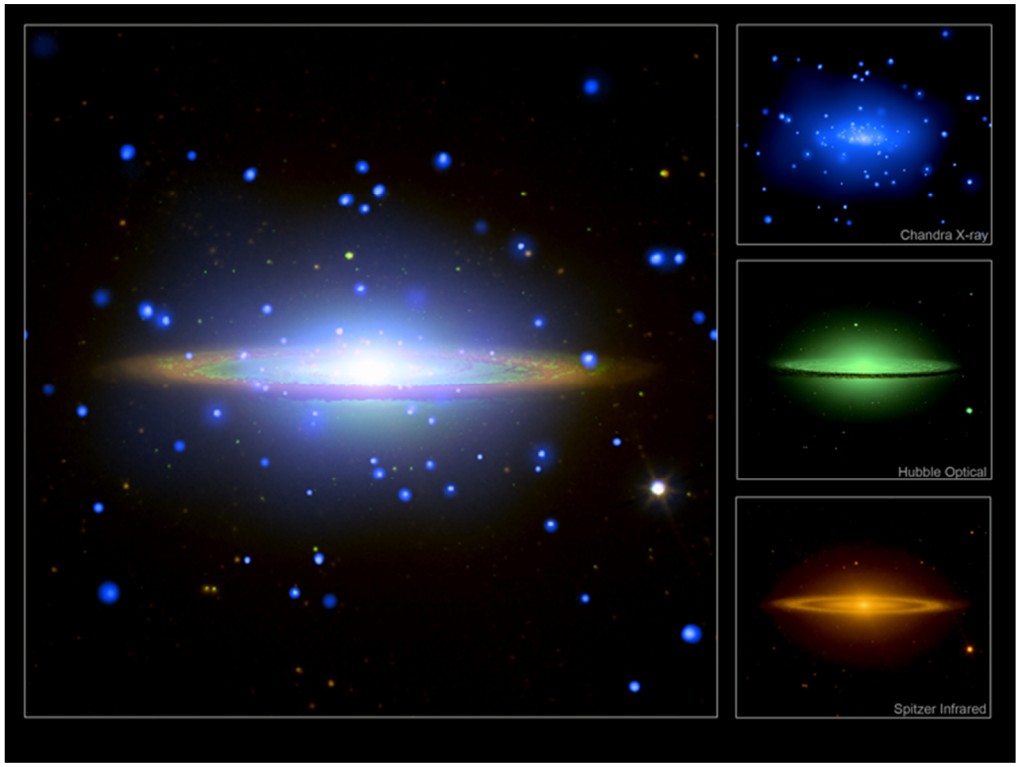



M 60 >
< M 58
M 49 >
M 61 >
x
M 104 >



M61 showing Nova from 2008

M104 – Sombrero galaxy – Dist. 50000 (kly), Visual Brightness 8.0 (mag), 9x4 (arc min)
http://www.youtube.com/watch?v=GBB2xQe8nMw visual tour

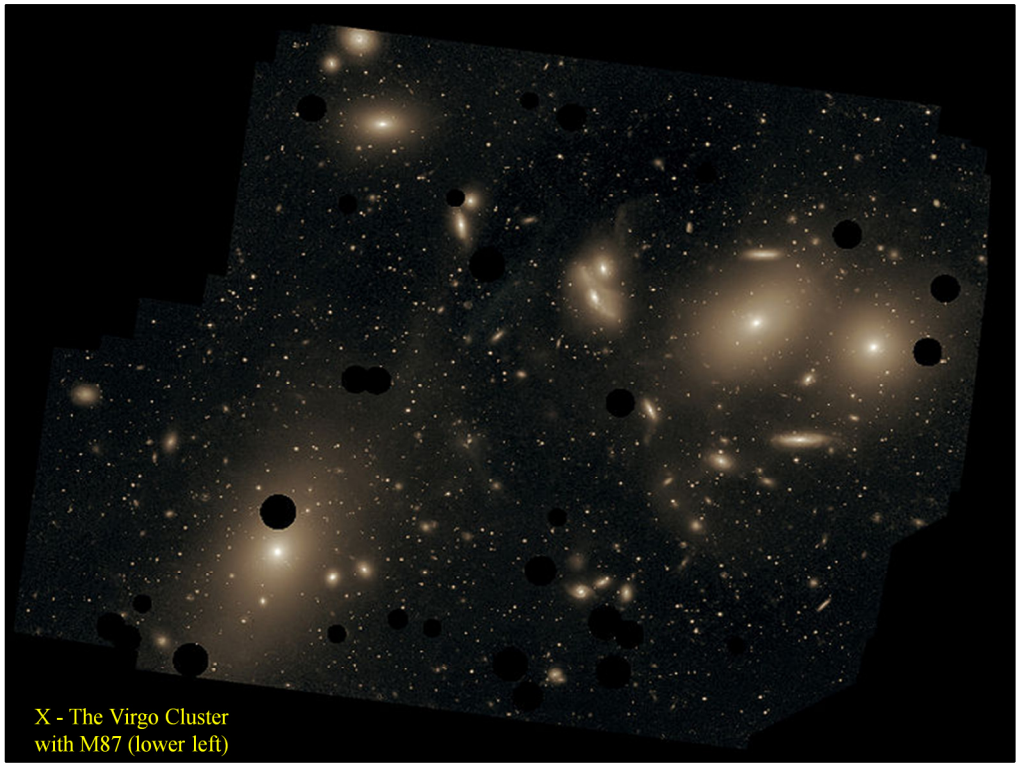


M 104 - Sombrero Galaxy under different wavelengths of light

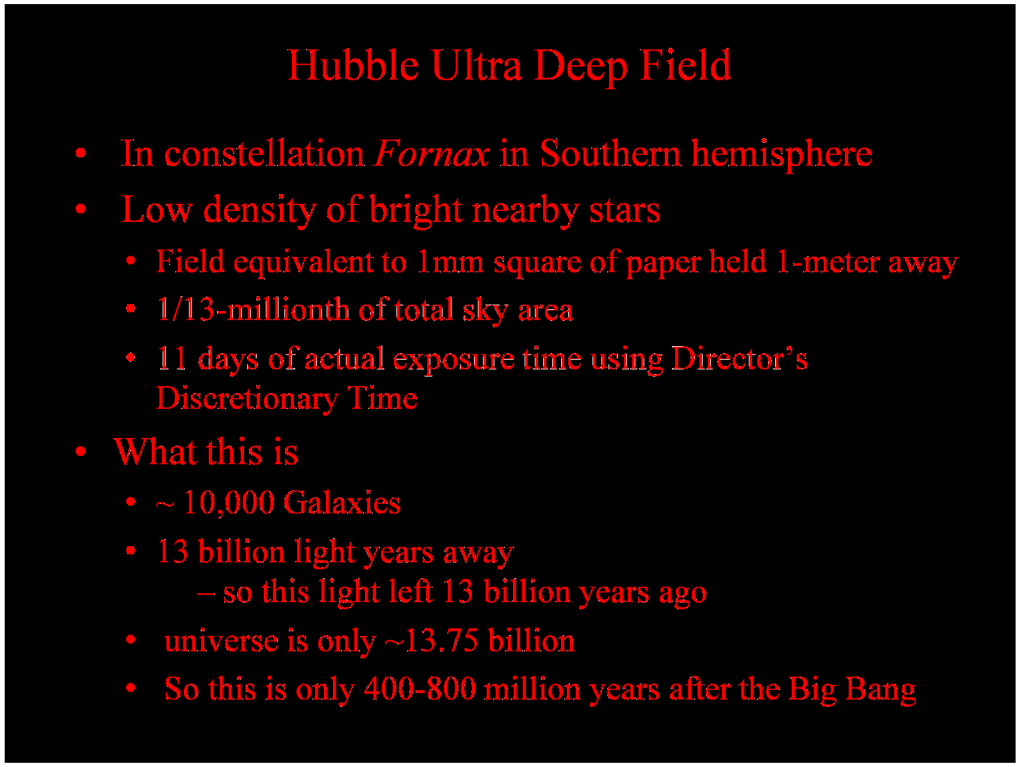
Blue – x-ray

Green – optical

Red – Infrared

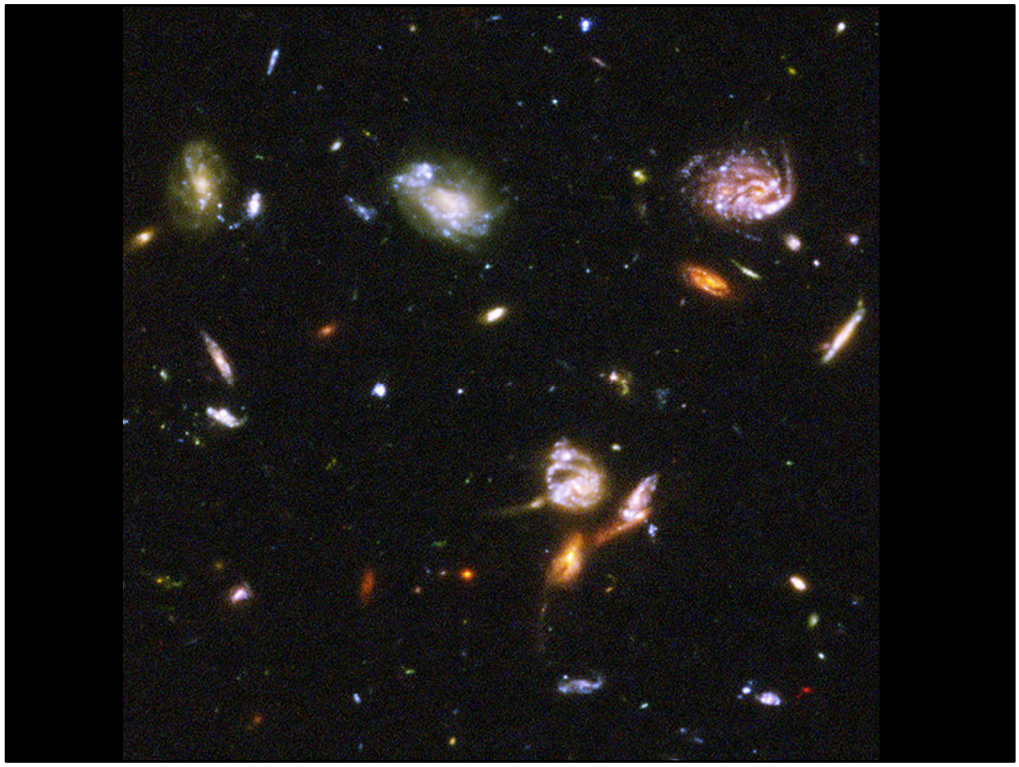


M87 in Virgo cluster



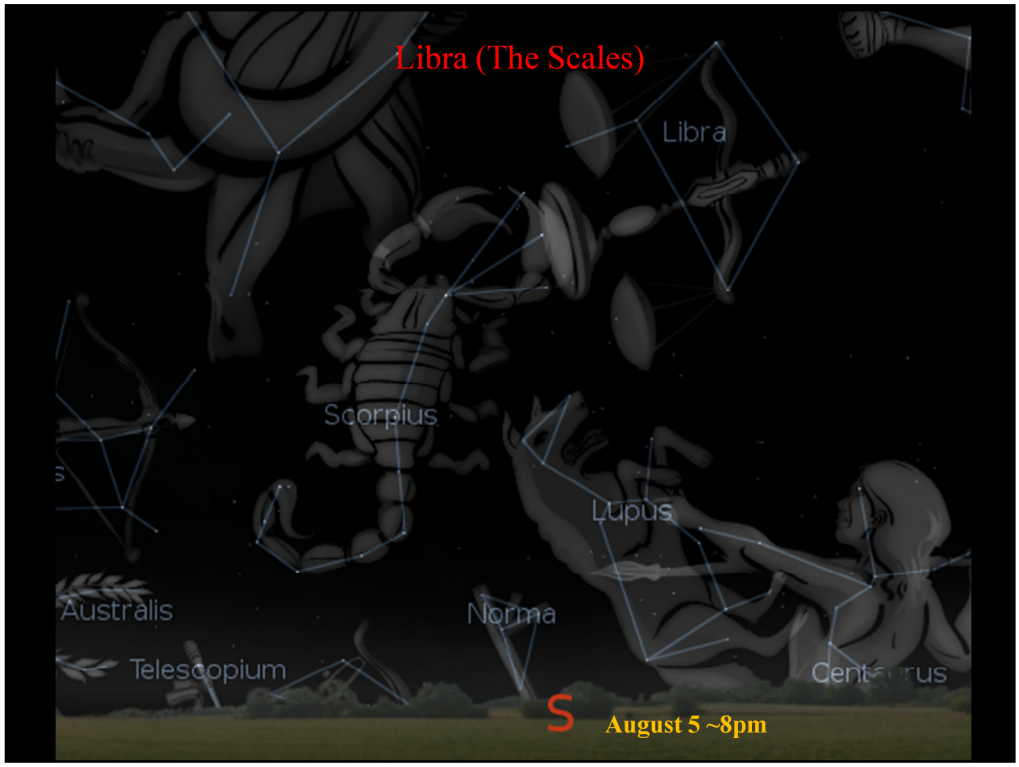
The **Hubble Ultra-Deep Field** (**HUDF**) is an image of a small region of space in the constellation Fornax, composited from Hubble Space Telescope data accumulated over a period from September 24, 2003, through to January 16, 2004. It is the deepest image of the universe ever taken,[1] looking back approximately 13 billion years (between 400 and 800 million years after the Big Bang), and it will be used to search for galaxies that existed at that time. The HUDF image was taken in a section of the sky with a low density of bright stars in the near-field, allowing much better viewing of dimmer, more distant objects. The image contains an estimated 10,000 galaxies. In August and September 2009, the Hubble's Deep Field was expanded using the infrared channel of the recently attached Wide Field Camera 3 (WFC3). When combined with existing HUDF data, astronomers were able to identify a new list of potentially very distant galaxies.[2]

Hubble Ultra Deep Field



Enlargement of portion of Hubble UDF

Virgo Photograph

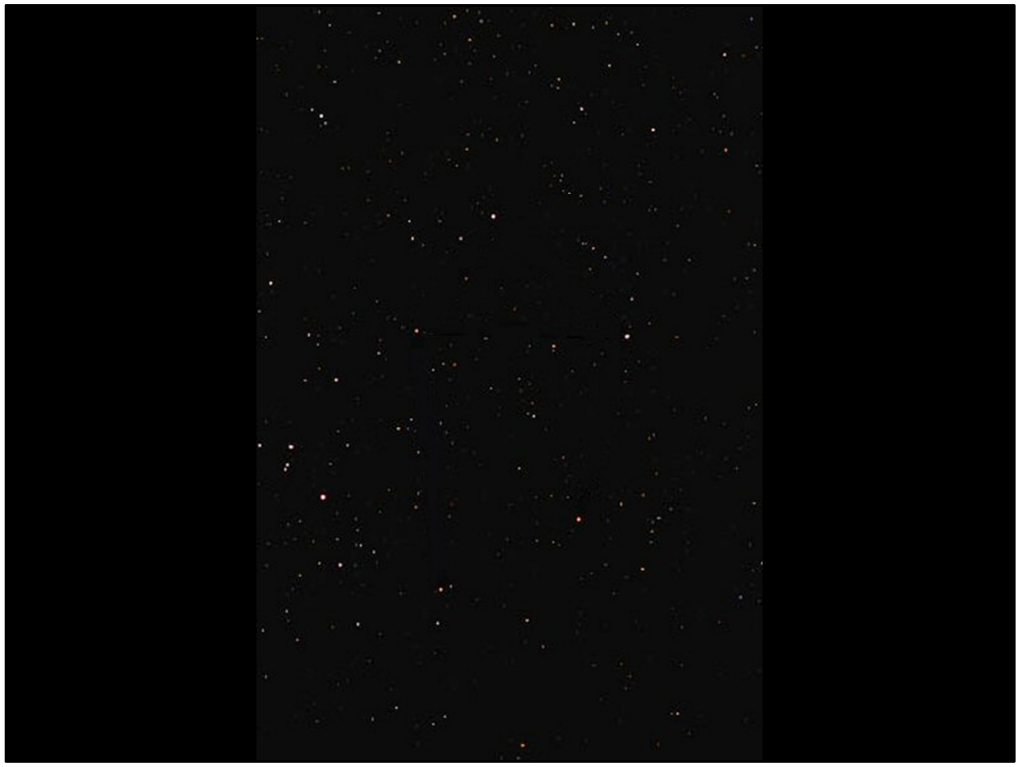


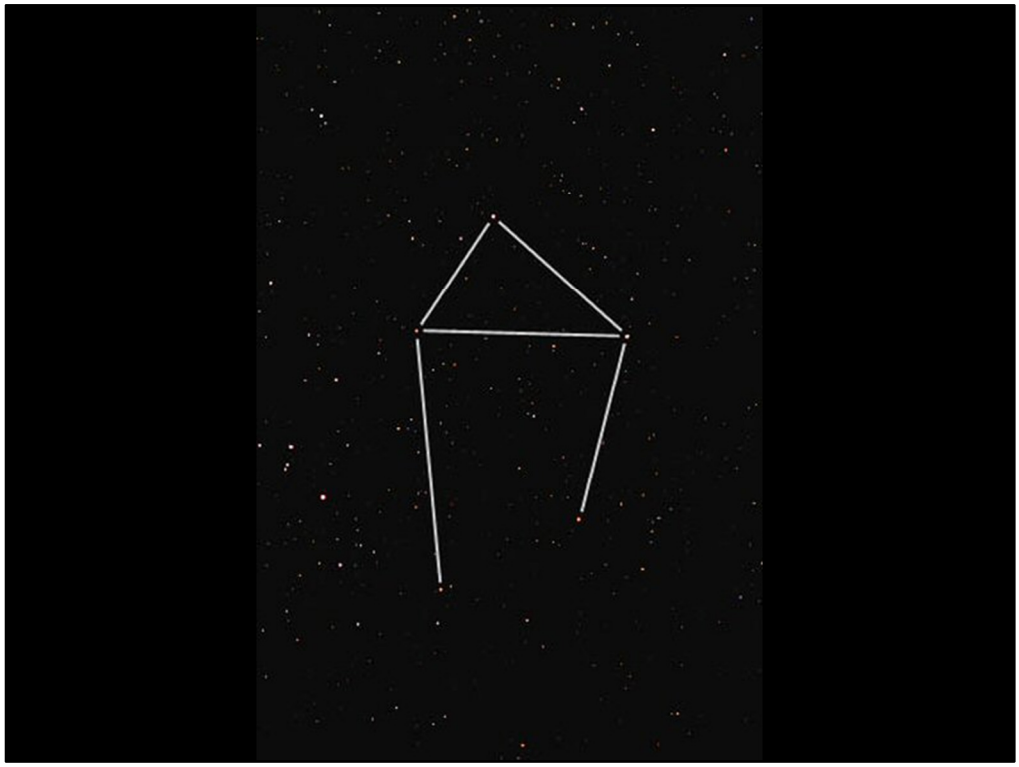
Libra Artwork

Only Zodiac sign that is not some sort of animal

Zuben el Genubi (alpha) – The Southern Claw (from Scorpius)

Zuben Eschamali (beta) – The Northern Claw (from Scorpius)

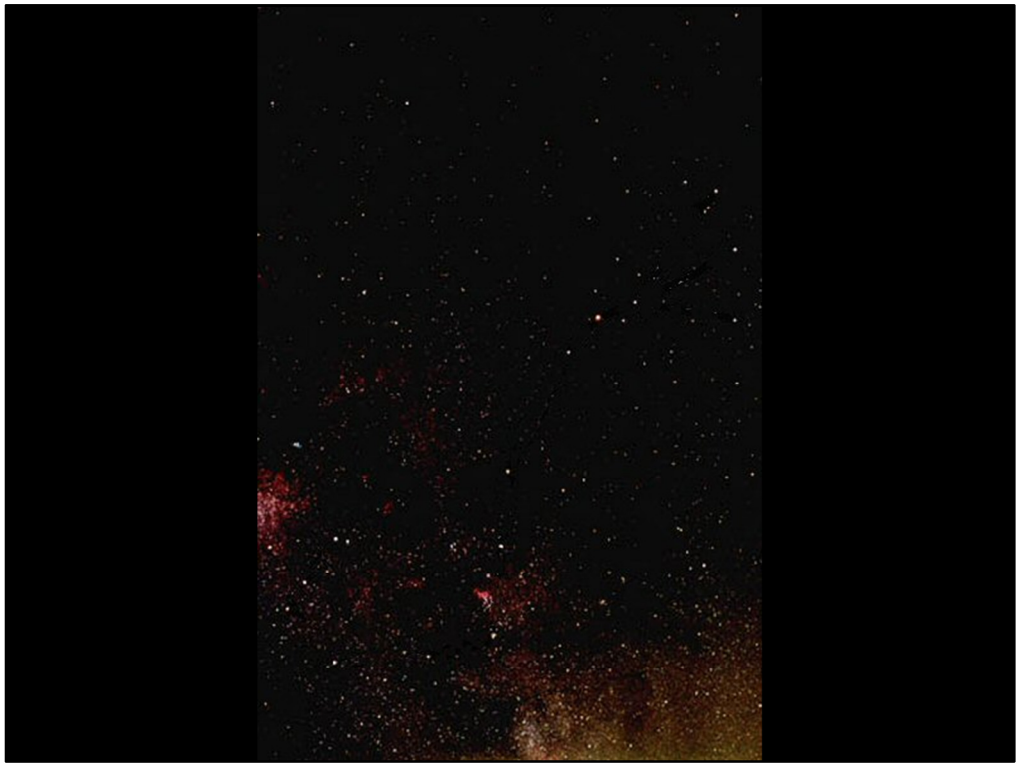


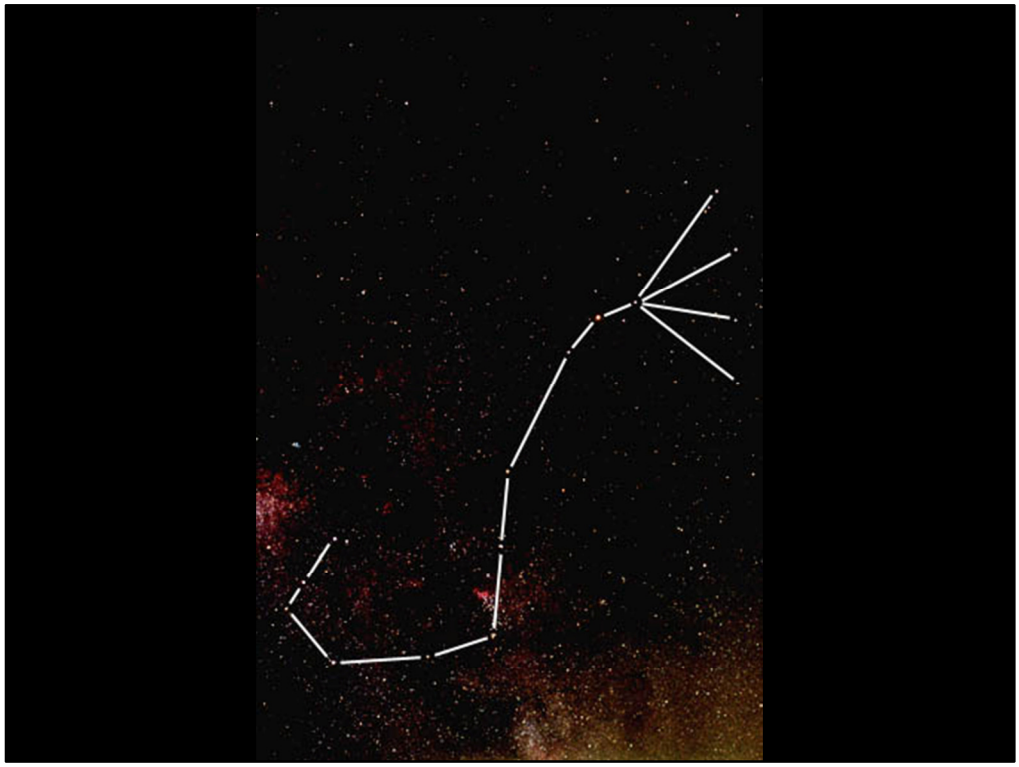


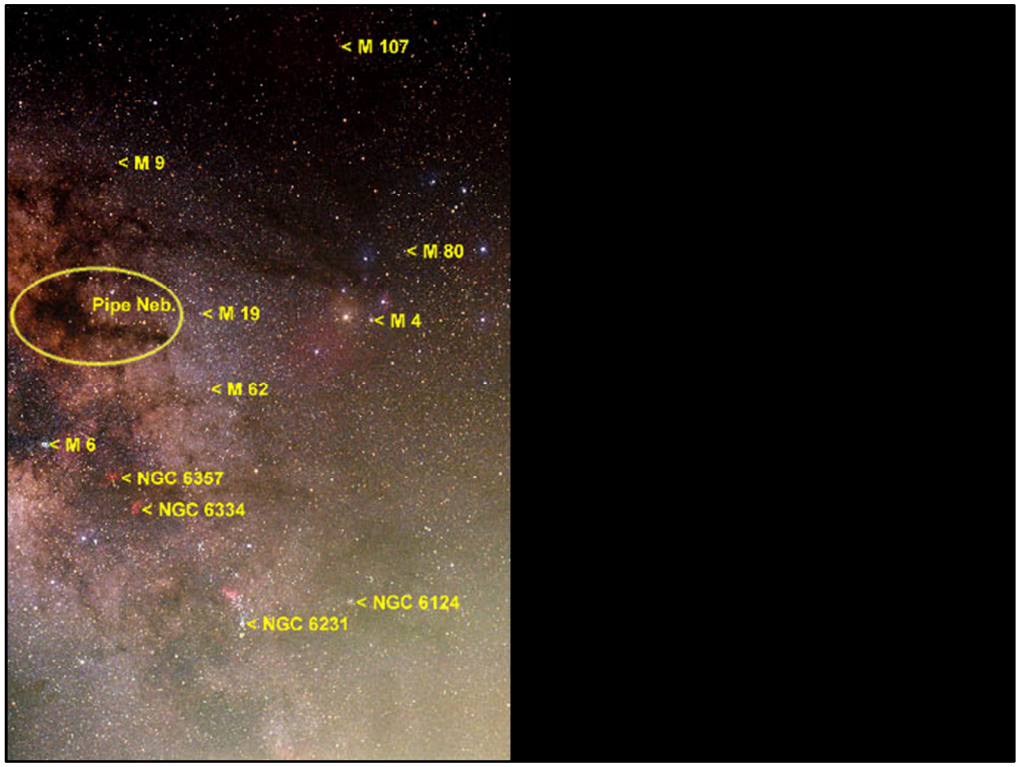
NGC 5897

Libra Photo

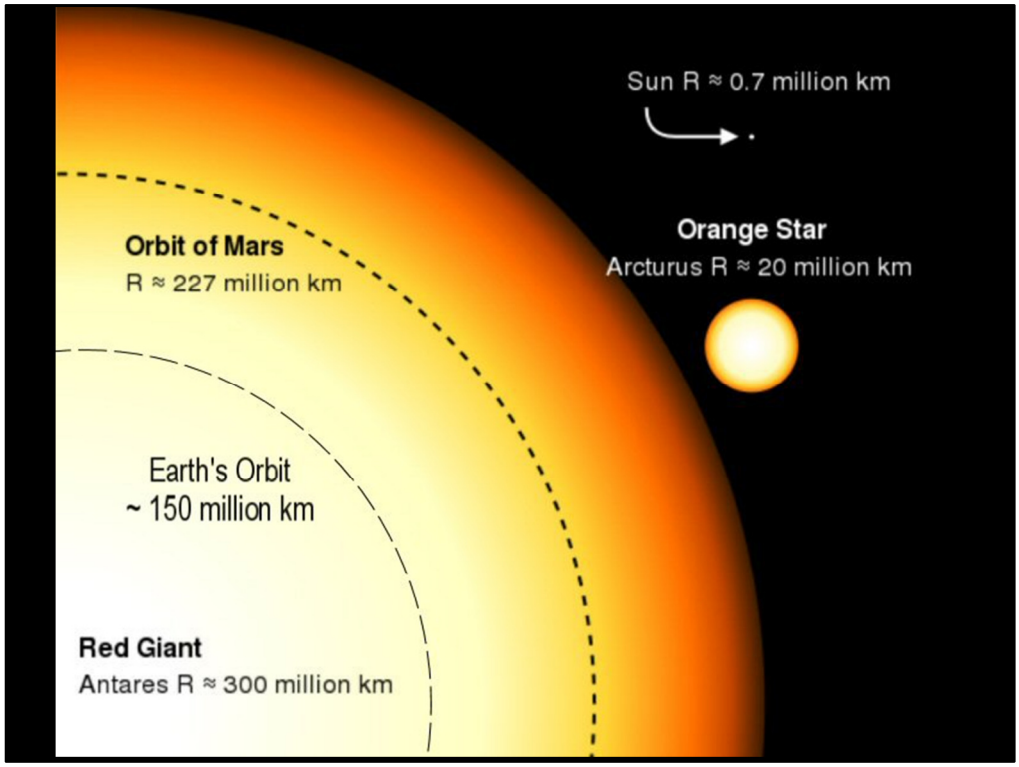
Scorpius (Scorpio) Artwork



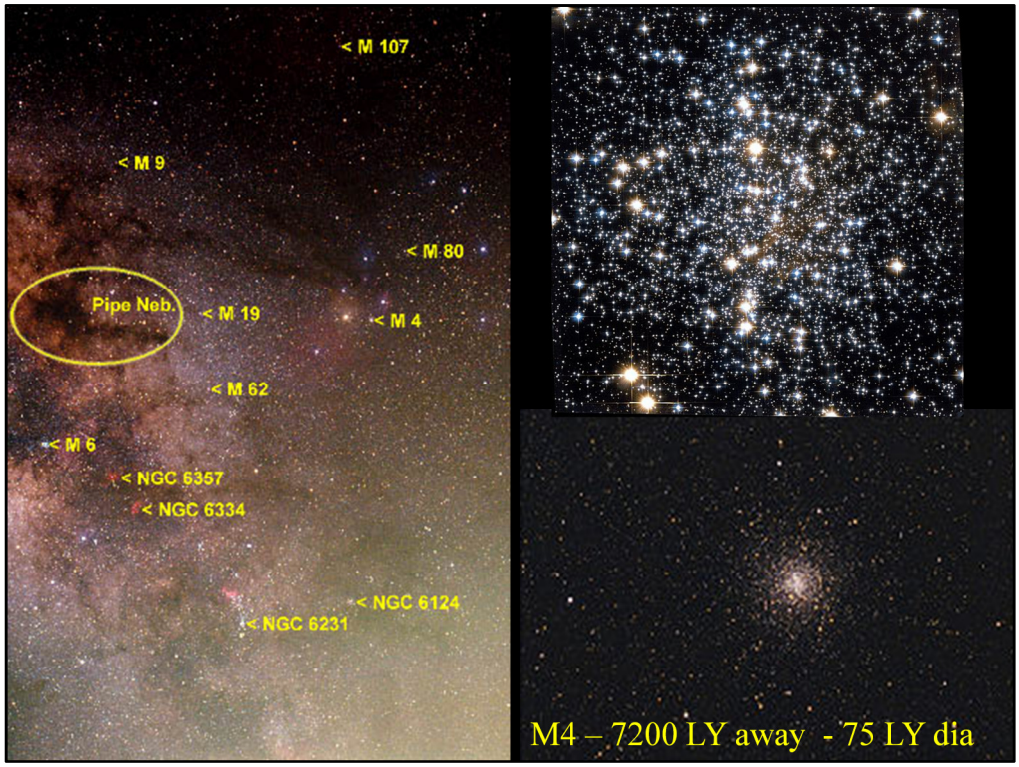




Deep Sky Objects

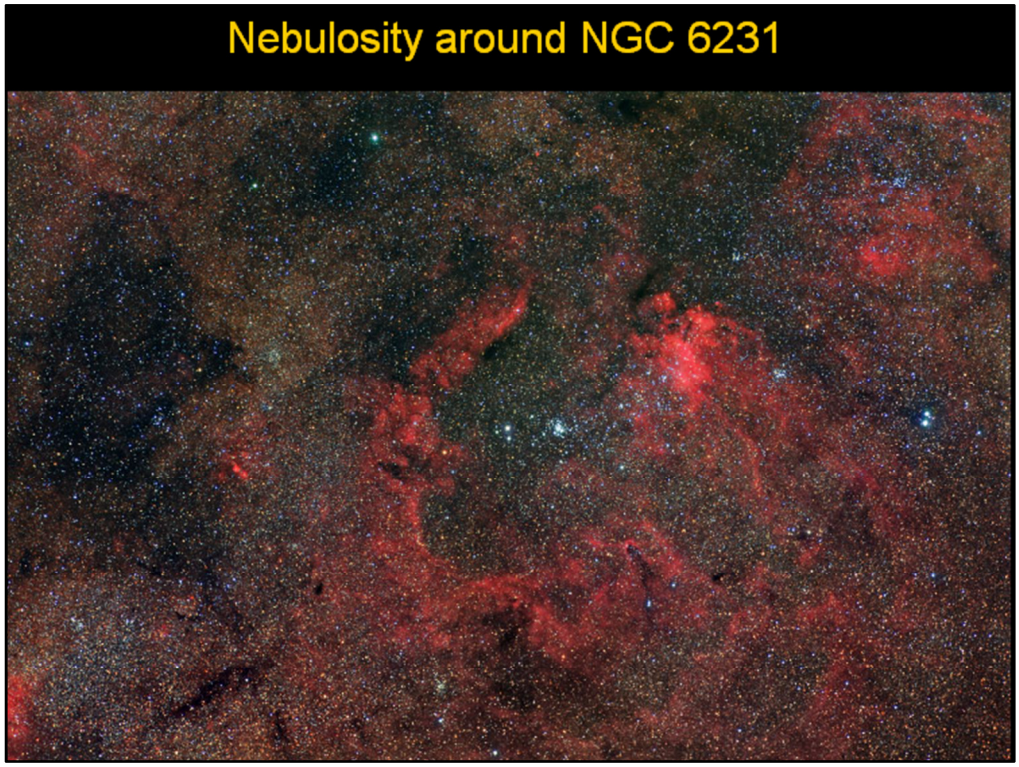

Sun R ≈ 0.7 million km
Orange Star
Arcturus R ≈ 20 million km
Orbit of Mars
R ≈ 227 million km
Earth's Orbit
~ 150 million km
Red Giant
Antares R ≈ 300 million km

Antares

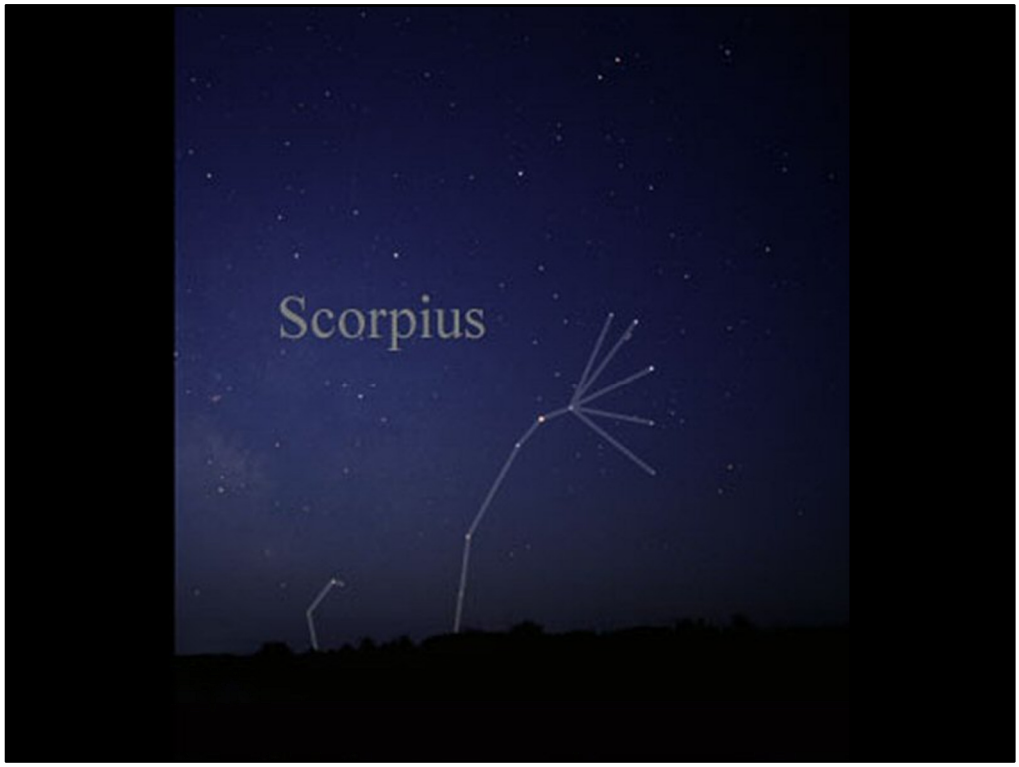

< M 107
< M 9
< M 80
Pipe Neb.
< M 19
< M 4
< M 62
< M 6
< NGC 6357
< NGC 6334
< NGC 6124
< NGC 6231
M4 – 7200 LY away - 75 LY dia

M4

NGC 6357

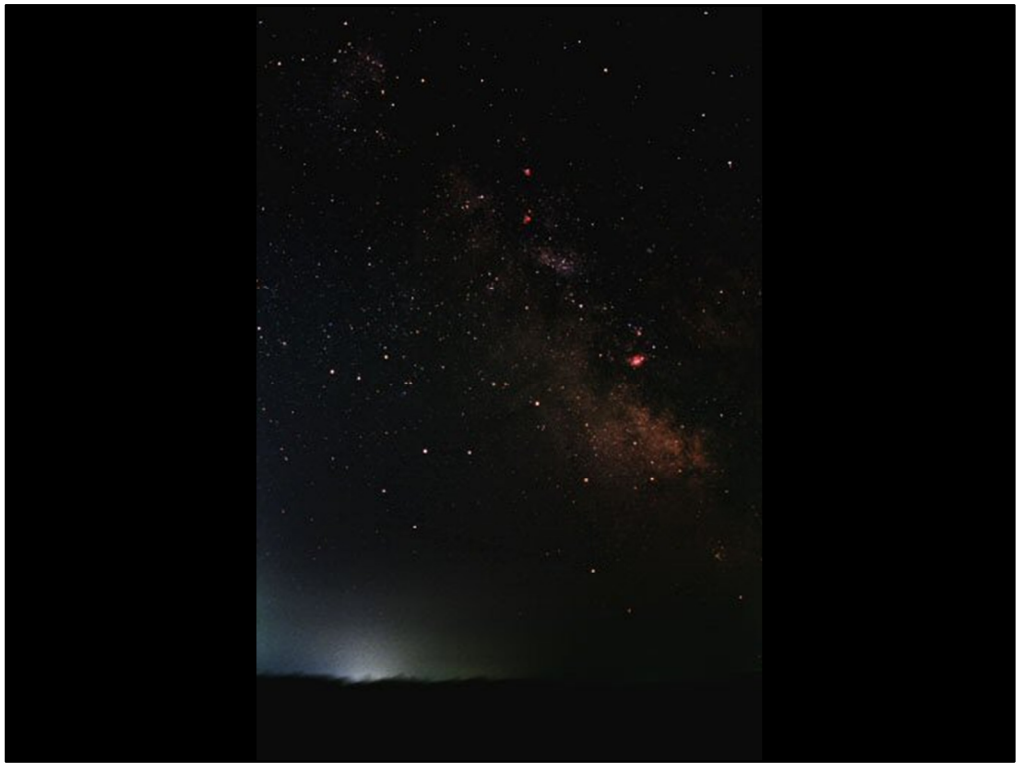


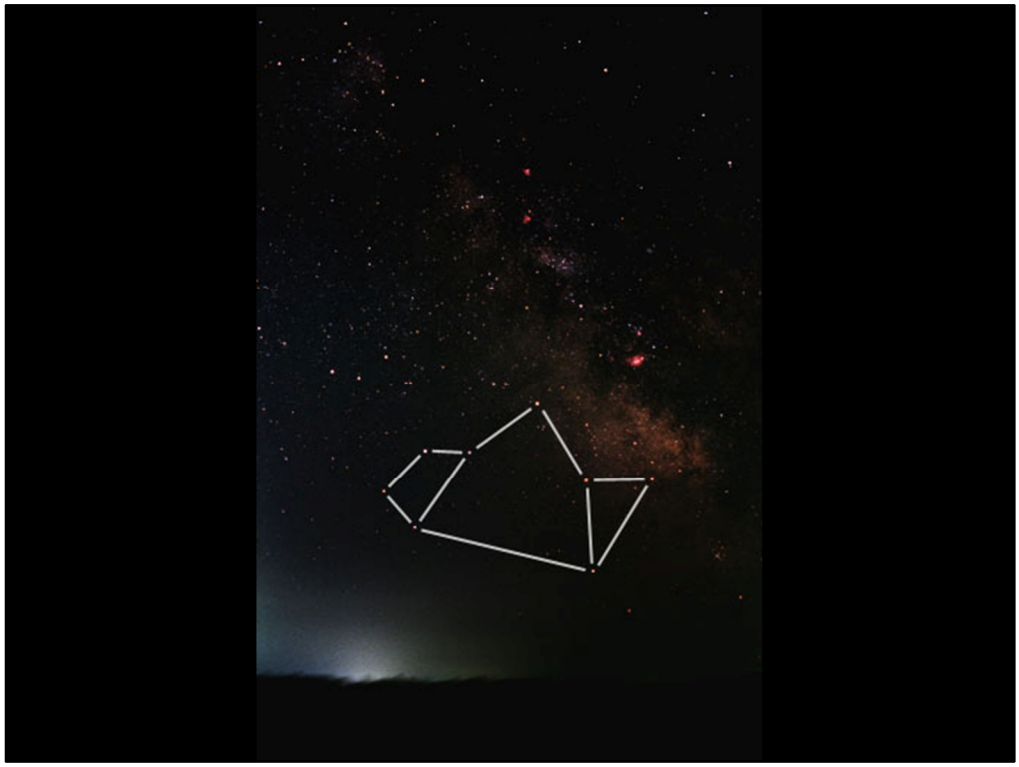
NGC 6231



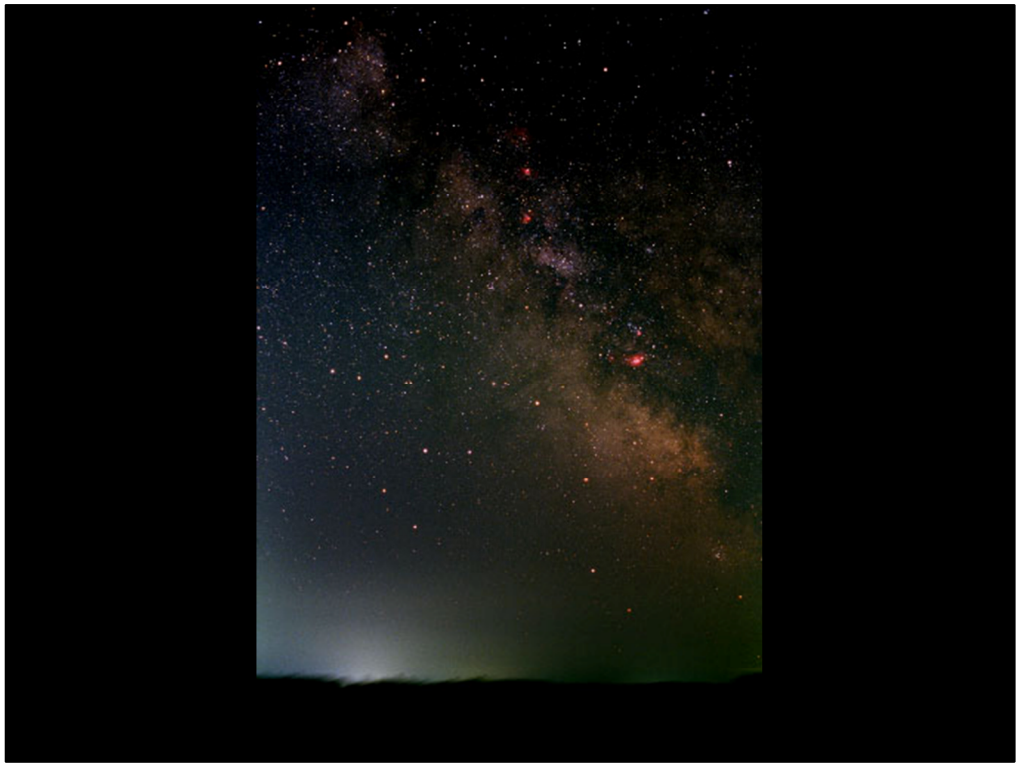
Scorpius Photo

Sagittarius Artwork

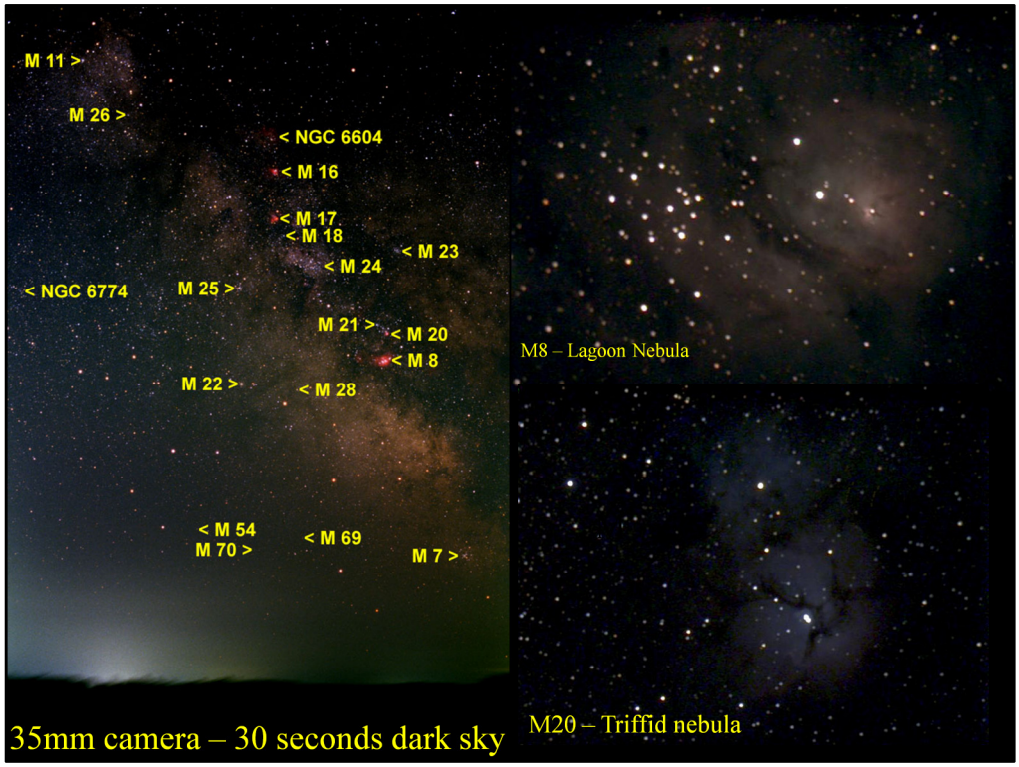




teapot



Darksky Nebulosity

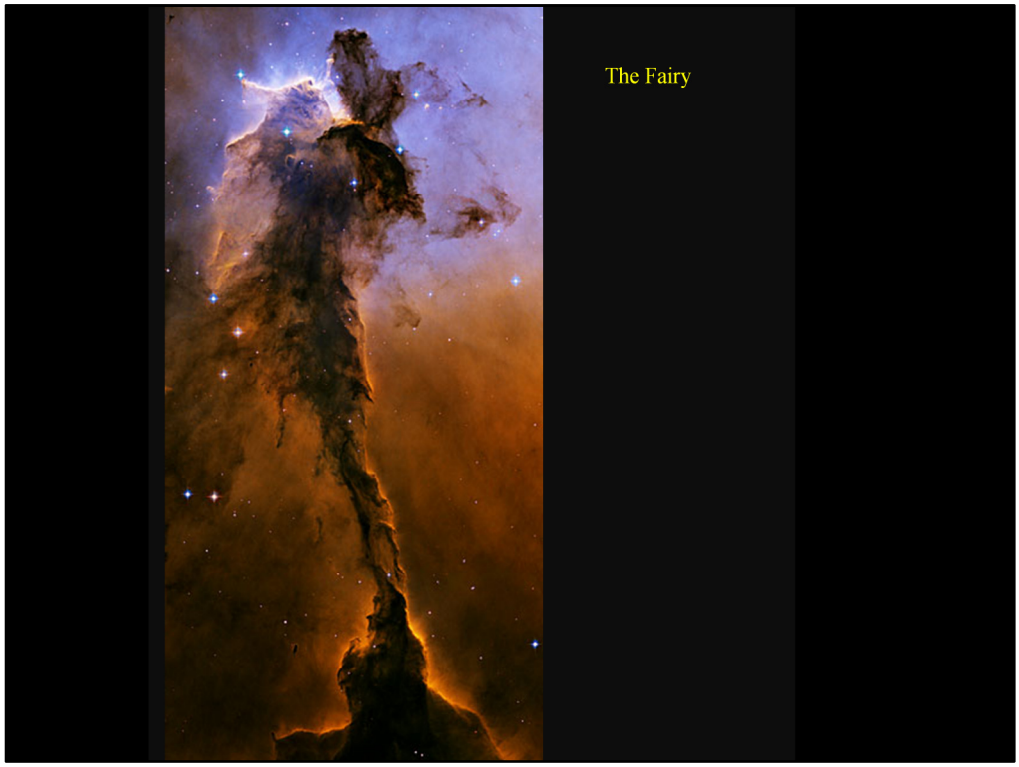


Deep Sky Objects – M8 & M20

M8 – Lagoon Nebula

M20 – Triffid Nebula

M16 Eagle Nebula

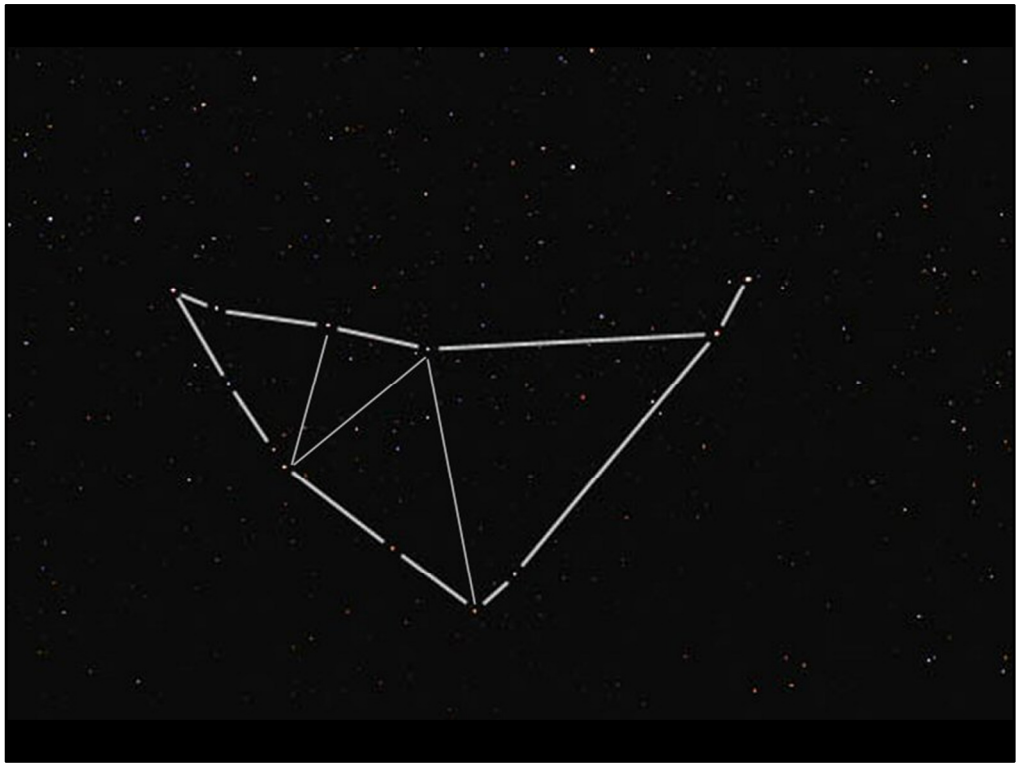


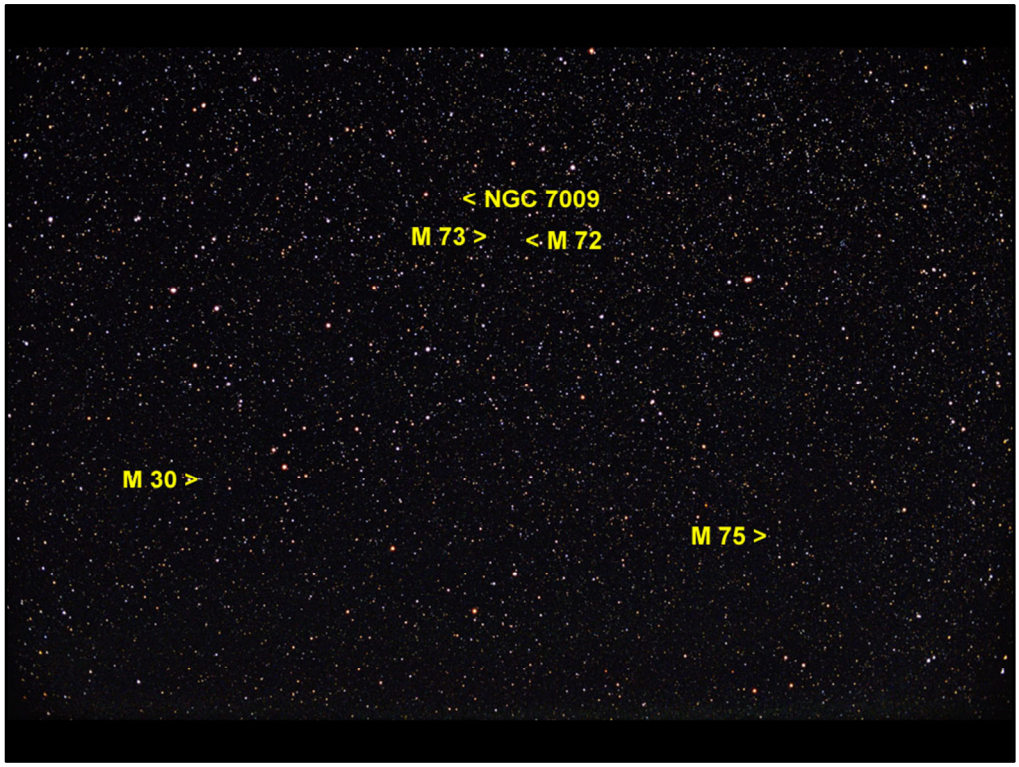
The Fairy

Pillars of Creation

Sagittarius Photo

Capricory (Capricornus) Artwork

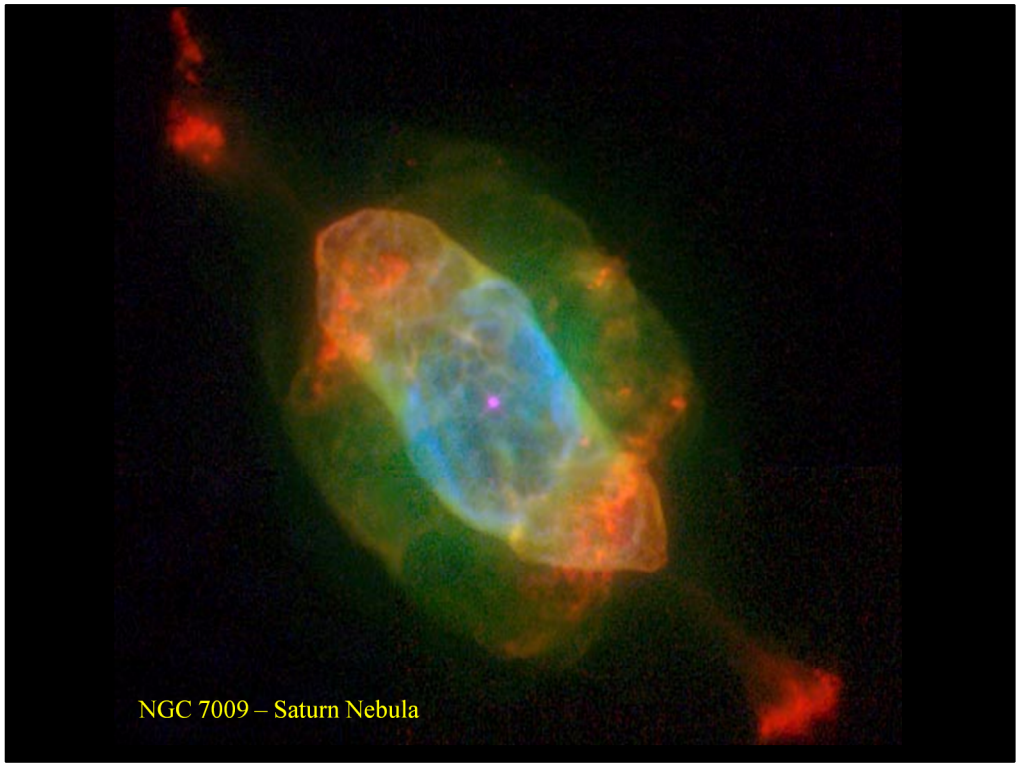




Deep Sky Objects

M75 – Actually in Sagittarius

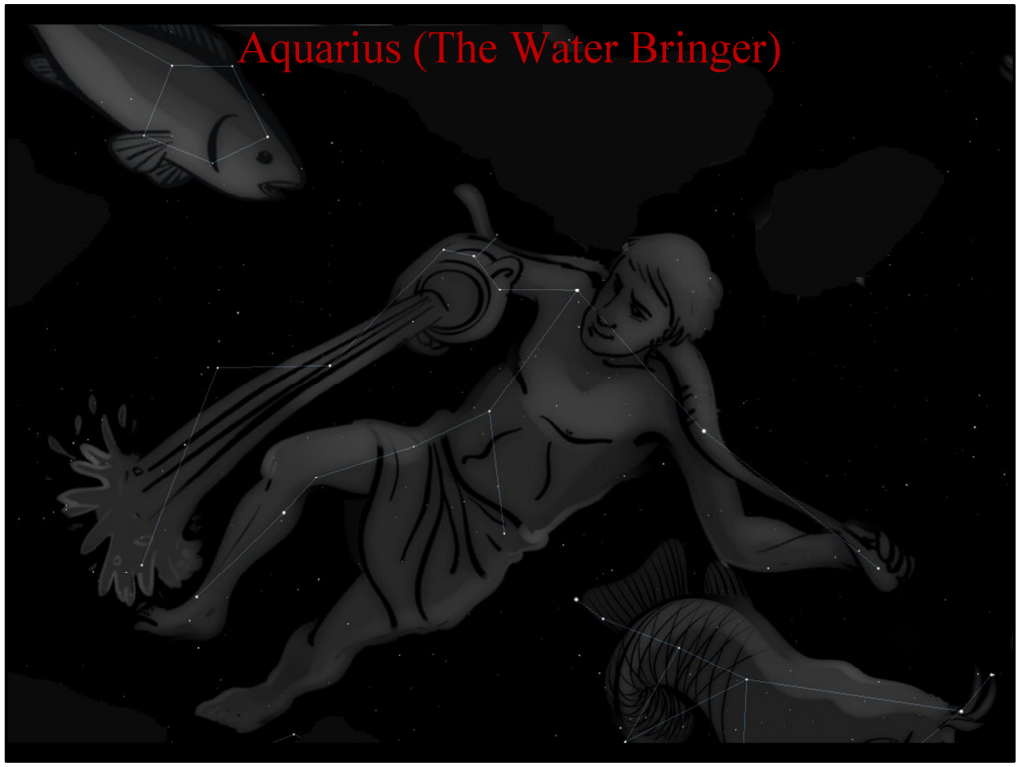
M30 -



NGC-7009 - Saturn Nebula (Actually in Aquarius as are Globular Clusters M72 and M73)

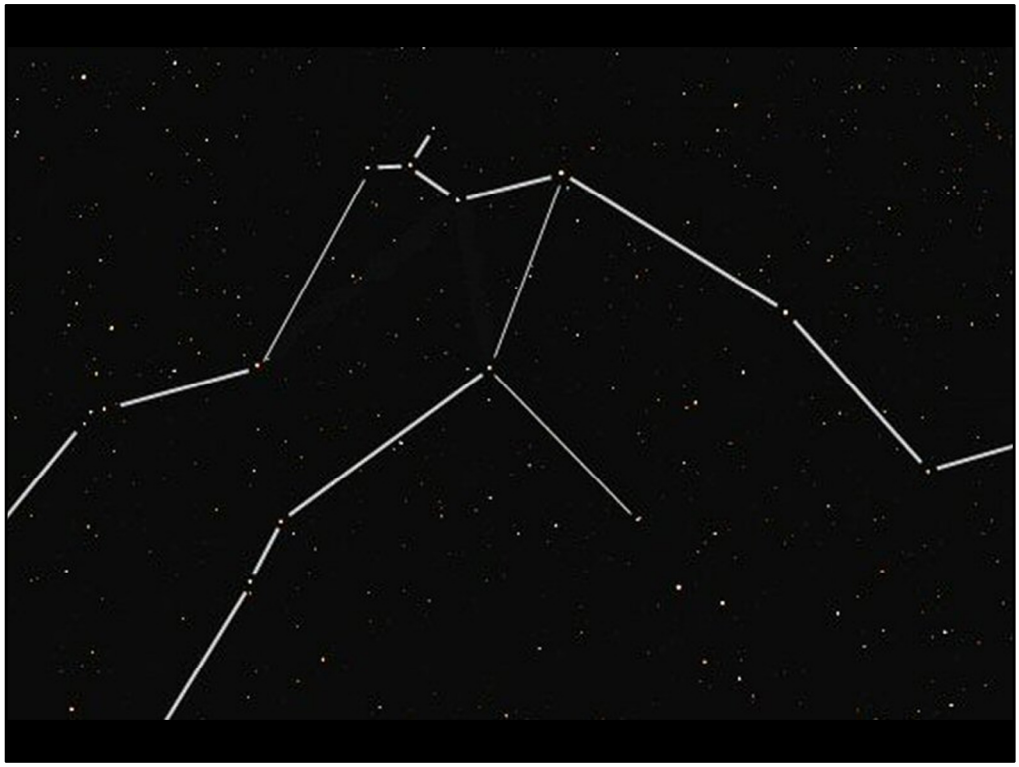
The layers of the Saturn Nebula give a complex picture of how this planetary nebula was created. The above picture, taken in April 1996, allows a better understanding of the mysterious process that transformed a low-mass star into a white dwarf star. A computer model indicates that the central star of NGC 7009 first expelled the green gas that now appears barrel shaped. This green gas now confines stellar winds flowing from the central star, creating a jet which forms the ansae that appear in red at the tips. Much remains unknown, including why the gas has not become turbulent.

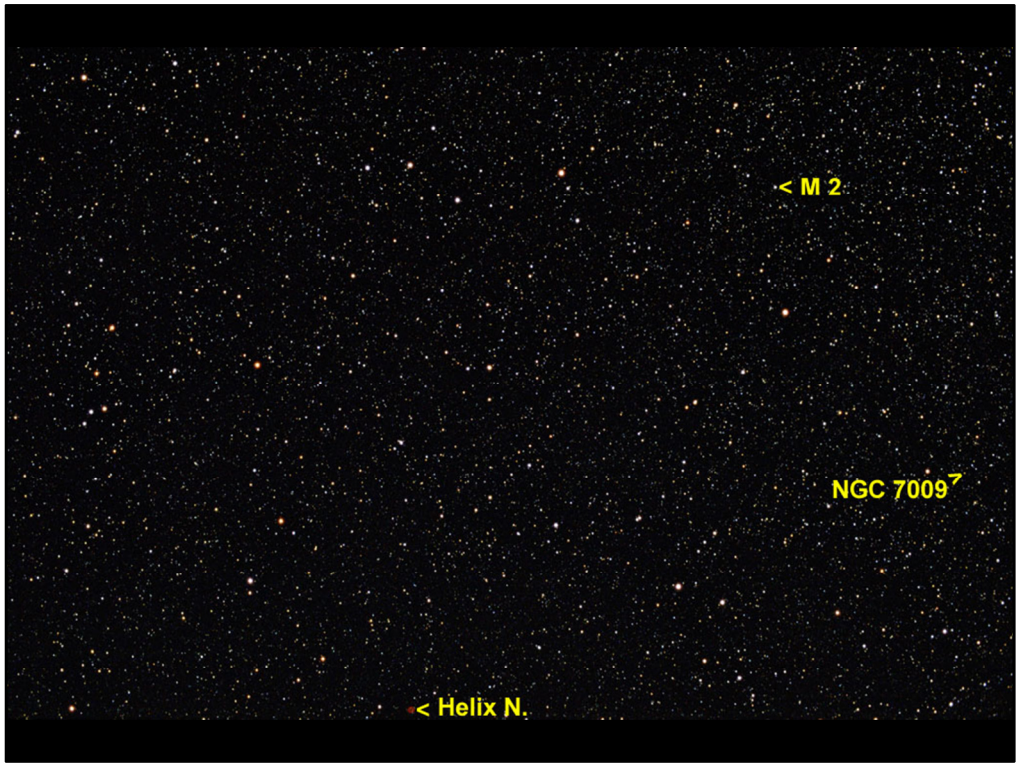
Capricorn Photo



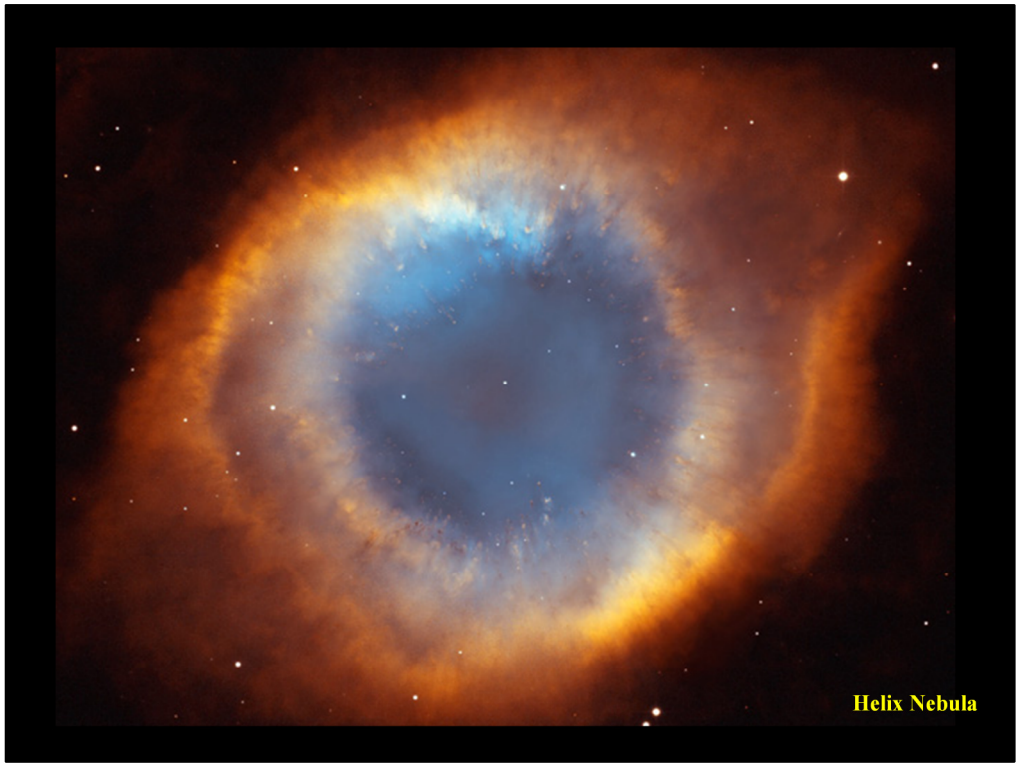
Aquarius Artwork

Water jar Asterism





Deep Space Objects



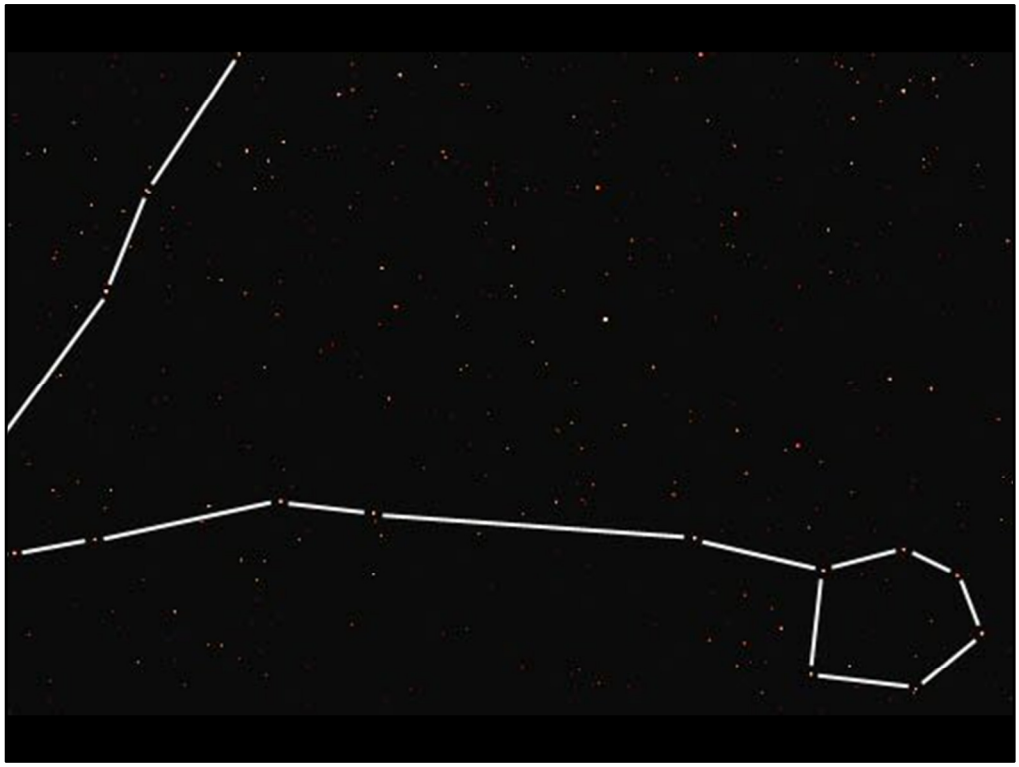
The Helix Nebula is the closest example of a planetary nebula created at the end of the life of a Sun-like star. The outer gasses of the star expelled into space appear from our vantage point as if we are looking down a helix. The remnant central stellar core, destined to become a white dwarf star, glows in light so energetic it causes the previously expelled gas to fluoresce. The Helix Nebula, given a technical designation of NGC 7293, lies about 650 light-years away towards the constellation of Aquarius and spans about 2.5 light-years.

Aquarius Photo

Pisces Artwork

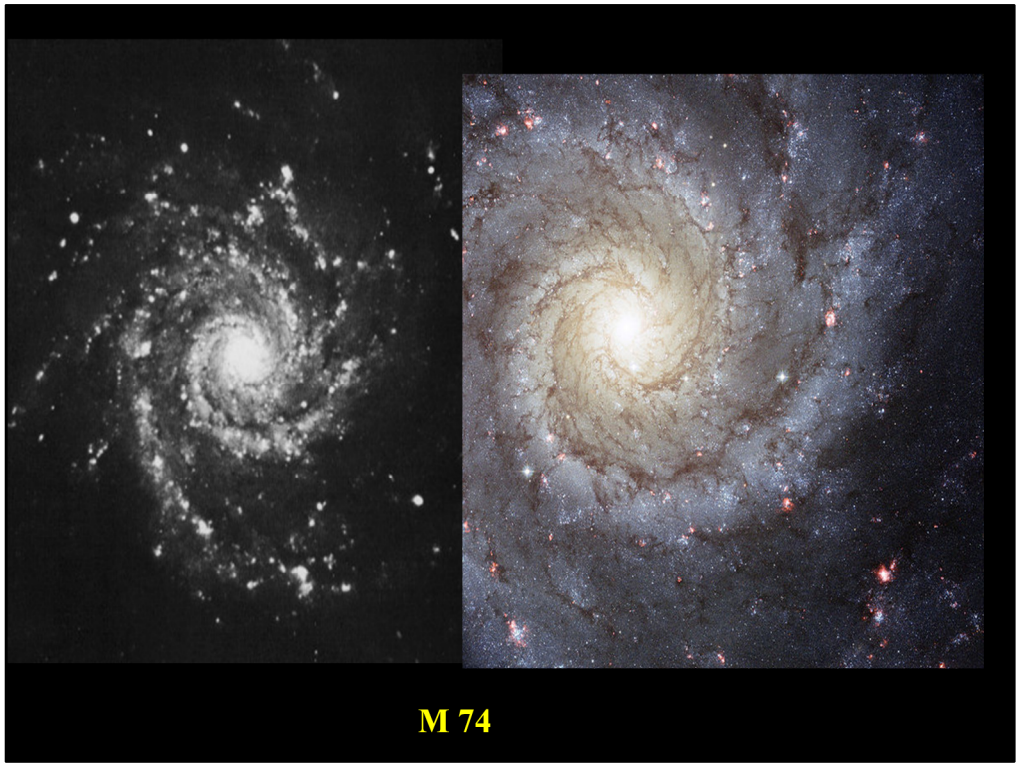
Another really big constellation spread out all over

***Circlet Asterism* –** is the easiest part to find and is the head of one of the fish



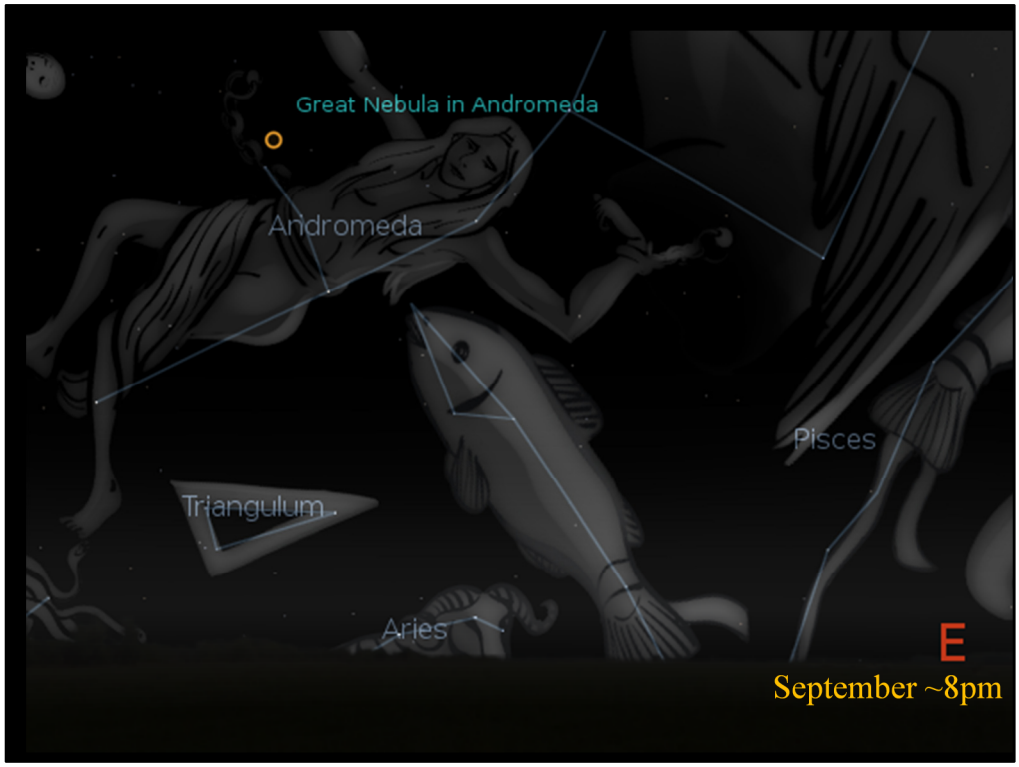
Pisces Circlet

Deep Sky Objects

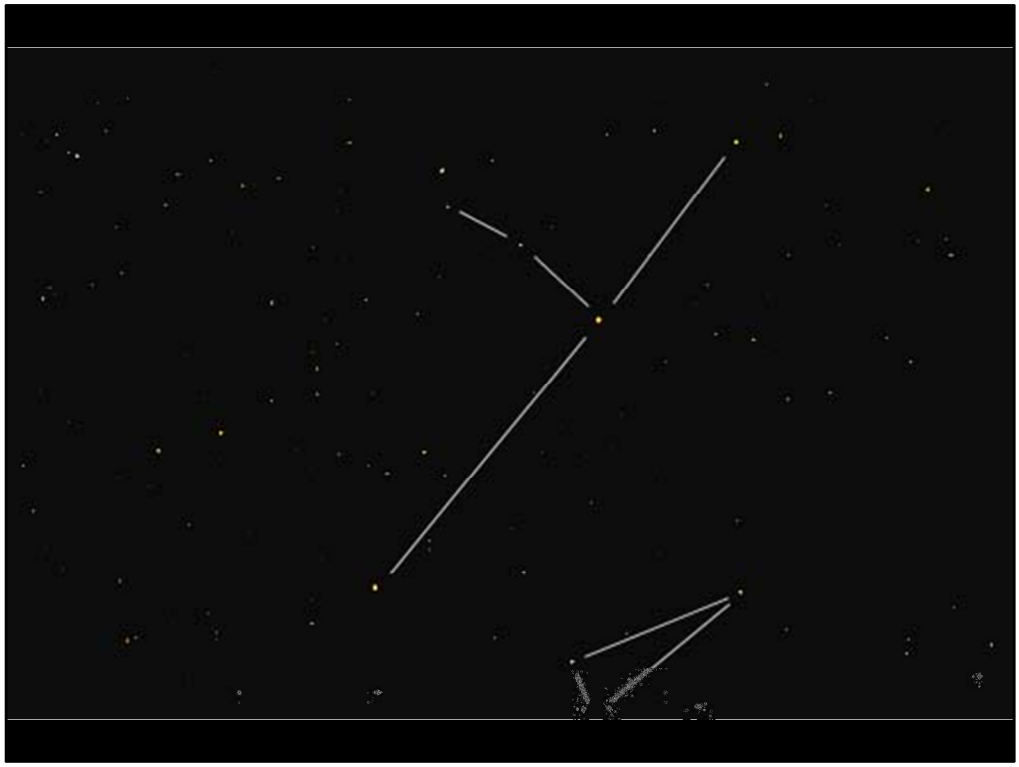


M74

Pisces Photo



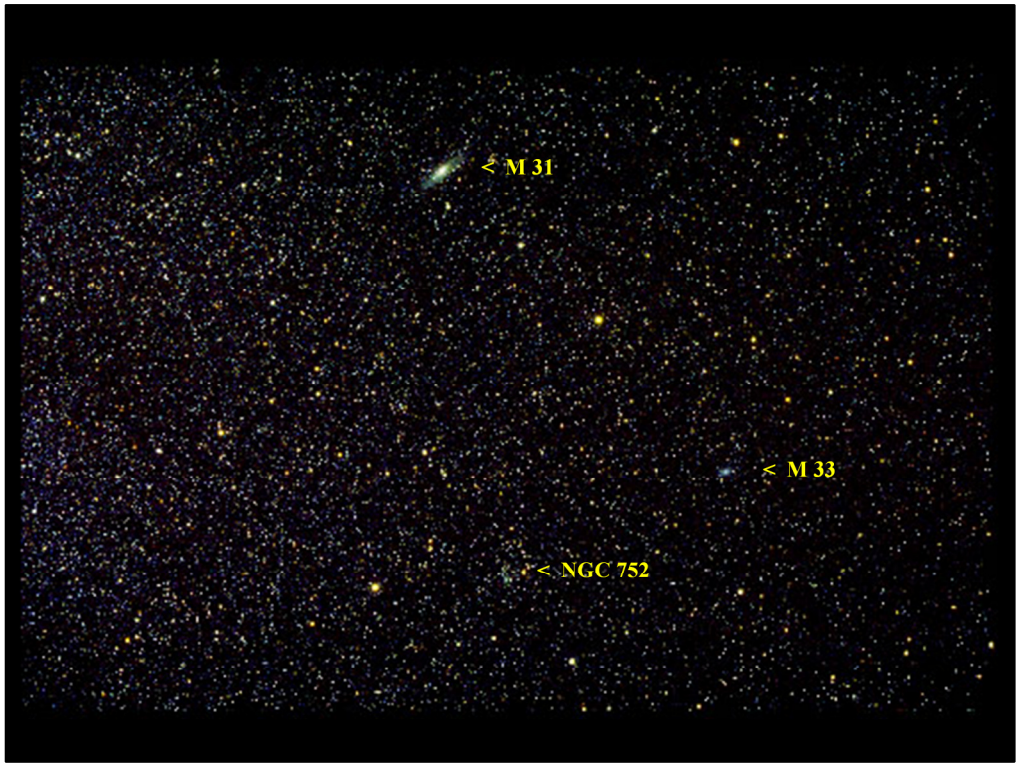
Andromeda Artwork



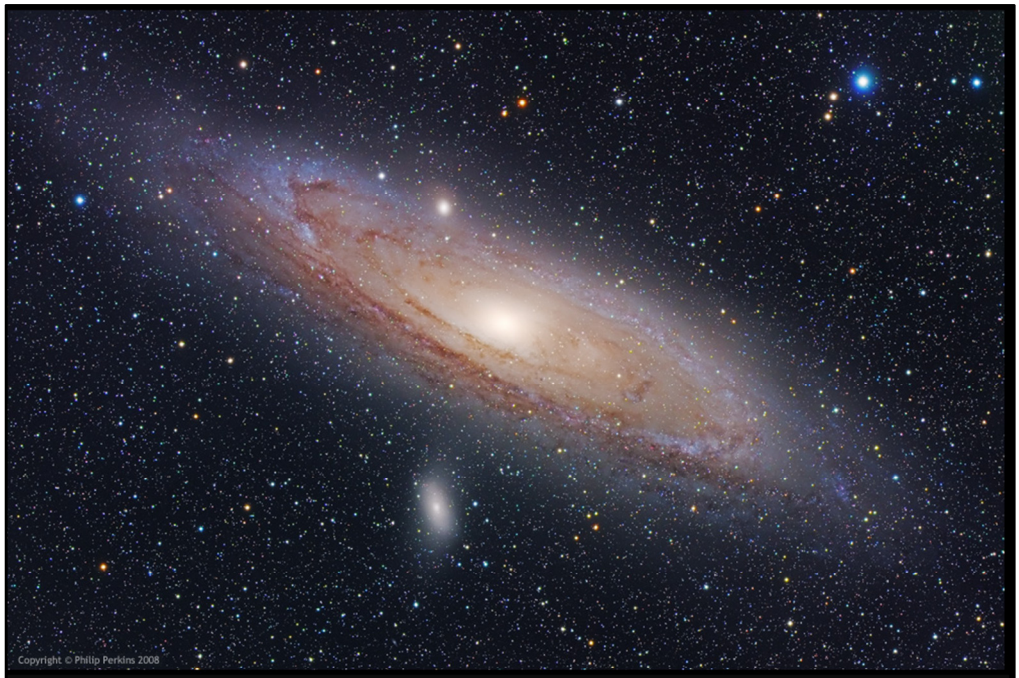
Known as the “The little cloud" to the Persian astronomer Abd-al-Rahman Al-Sufi, who described and depicted it in 964 AD

2.5 Million LY away and moving towards us at 300km per second – collision in about 3 billion years – effects in about 1 billion

225, 000 LY diameter - At least twice the number of stars than the milky way 1 trillion vs 400-600 billion



Deep Sky Objects



M31 (NGC 224, the famous Andromeda Galaxy) is the nearest large galaxy to our own Milky Way galaxy. It is so bright that it is easily seen by naked eye as a faint fuzzy patch of light in the northern part of Andromeda. It forms part of the Local Group of galaxies along with our Milky Way, its satellite galaxies, and M33. Of all members of the Local Group M31 is considered to have the closest external resemblance to the Milky Way, thus it is often referred to as a 'sibling galaxy'. Also seen in this photograph are M31's satellite galaxies M110 (below) and M32 (above) - in this respect it is also similar to the Milky Way, with M110 corresponding to the Large Magellanic Cloud and M32 corresponding to the Small Magellanic Cloud.

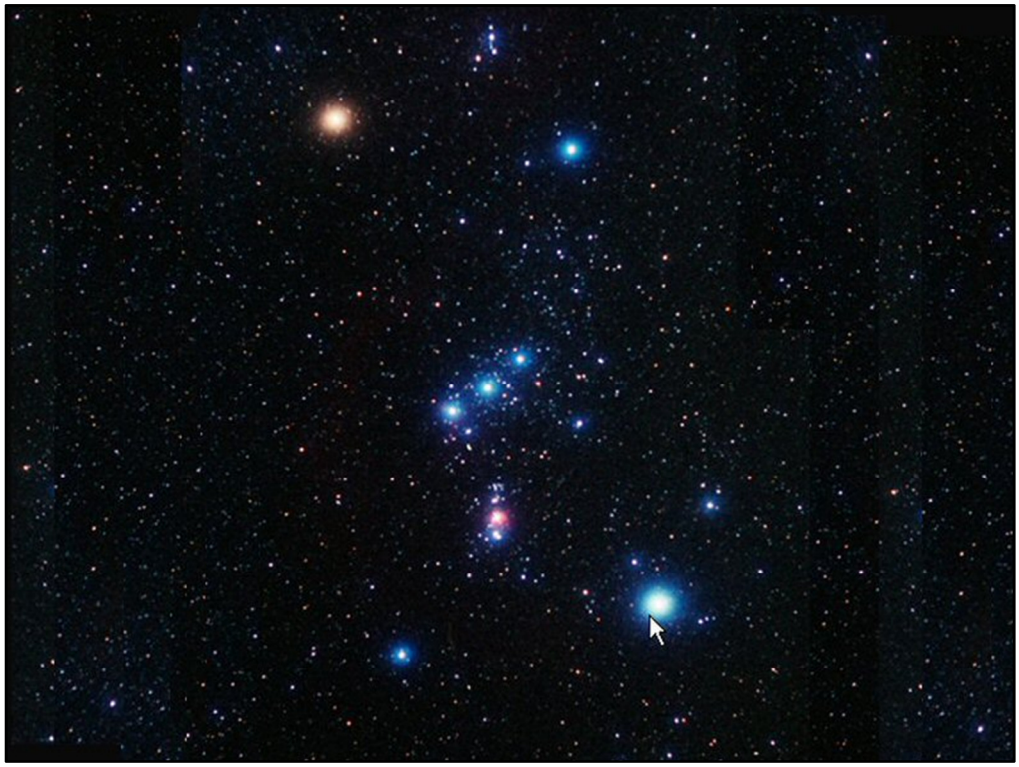
Known as the “The little cloud" to the Persian astronomer Abd-al-Rahman Al-Sufi, who described and depicted it in 964 AD

2.5 Million LY away and moving towards us at 300km per second – collision in about 3 billion years – effects in about 1 billion

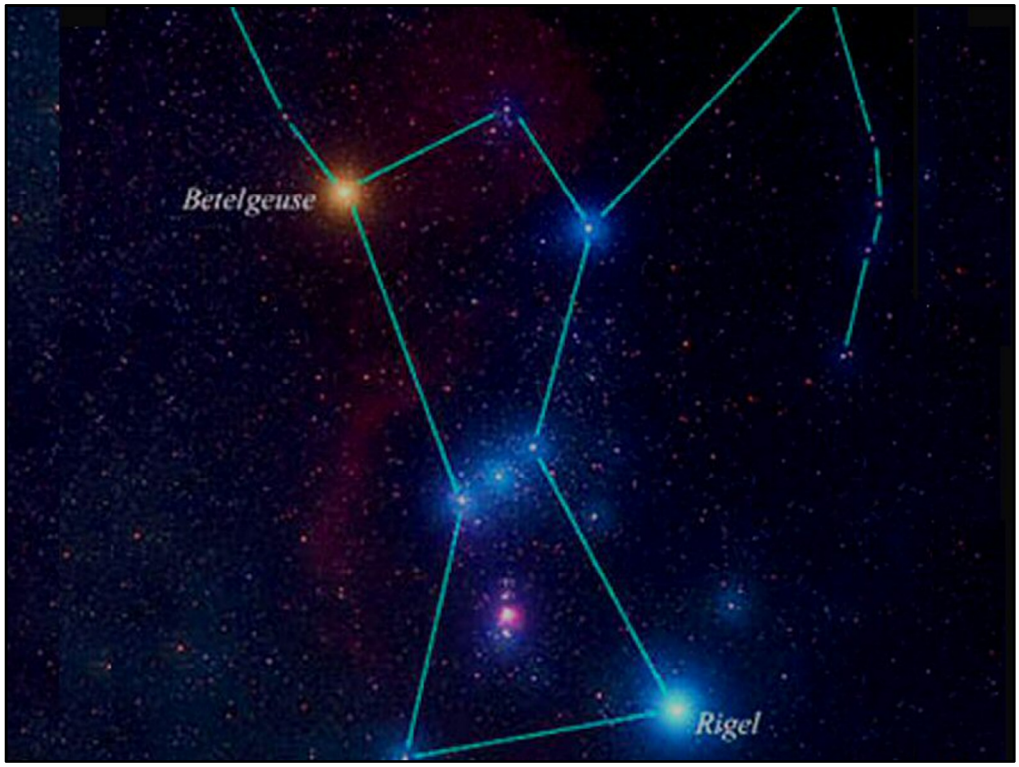
225, 000 LY diameter - At least twice the number of stars than the milky way 1 trillion vs 400-600 billion

Orion Artwork

Light Polluted photo



Dark sky photo



Betelgeuse & Rigel w/ Great Orion Nebula

Orion/Taurus/Aries group

Great Orion Nebula

Horsehead Nebula