Astronomy 101

The stars at night
Are big and bright
Deep in the heart of Texas

http://www.crcamp.com/astronomy

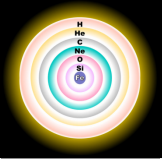
Agenda

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

Solar Physics

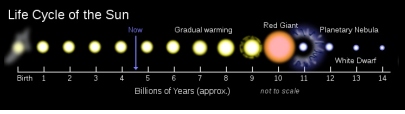
A Star (including our sun) is a balancing act

- 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

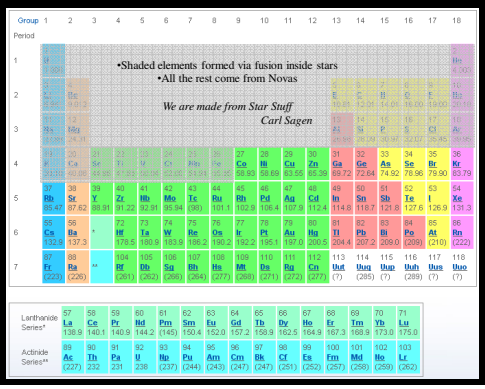


The End – Kaboom!

- 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



Star Stuff



Terminology

- Light Year – the *distance* light travels in one year - ~ 5.8 trillion miles
  - Our sun is about 8 light-minutes away
- Parsec - ~ 3.26 Light Years or 19 trillion miles
- Ecliptic – the apparent path of the sun through the celestial sphere over the course of a year. The moon and planet paths also lie roughly on the ecliptic
- Milky Way – Our Galaxy as seen edge on
- Zodiac – a band traditionally 9 degrees either side of ecliptic containing constellations that have had similar names/meanings since Sumerian times
- Celestial Sphere - is an imaginary sphere of arbitrarily large radius, concentric with the Earth and rotating upon the same axis.
- Solar Time – time measured by position of the sun. 24 hours in a solar day.
- Sidereal Time – time measured by the position of the stars. The sidereal day is *shorter* than the solar day by about 4 minutes due to the movement of the earth around the sun. 23 hours and 56 minutes in a sidereal day

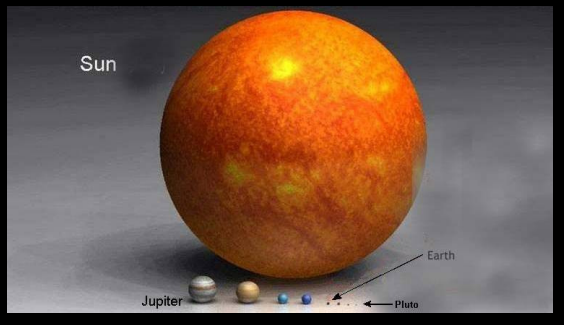
Stellar Objects
(what is that in the sky)

- Star – a 'sun' like our own – may be *much* larger or hotter or both
- Constellation – A set of (50-100) stars that is internationally formally recognized as a 'group' delineating some object (usually an animal) for convenience
  - The 'shape' is purely accidental and would not be the same viewed from another star system
- Asterism – a smaller grouping of stars that is known informally by various names (ex. The Big Dipper in England is known as "The Plow")
- Nebula - interstellar cloud of dust, hydrogen, helium and other ionized gases
  - Can be HUGE – The Eagle Nebula is well over 40 light years across
- Globular Cluster – spherical collection of stars orbiting a galactic core
  - Move as a unit, bound together by gravity
  - Many were formed in the early formation of the universe and are metal poor
  - Contain any number of stars – small have 100, larger have 100,000
- Galaxy - gravitationally bound system of stars, stellar remnants and dust
  - 10 million to 100 trillion stars
  - Our Milky way is medium sized with only 200-400 billion

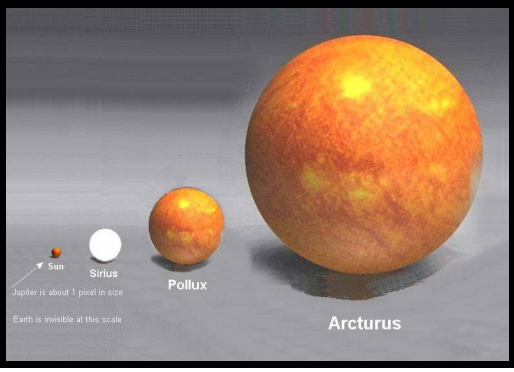
Magnitude
(how bright is that thing)

- Relative or Apparent Magnitude – how bright a star appears under optimum seeing conditions by an observer on Earth
  - – affected by pollution, light pollution, atmospheric conditions and humidity
  - Higher magnitude numbers are dimmer stars
  - Sun is -26, Moon is -12.6 , faintest star visible to naked eye is 6, faintest star visible in good binoculars 8.5, faintest star visible to huge telescopes is about 30
- Absolute Magnitude – how bright a star actually is at a standard distance (10 parsecs)

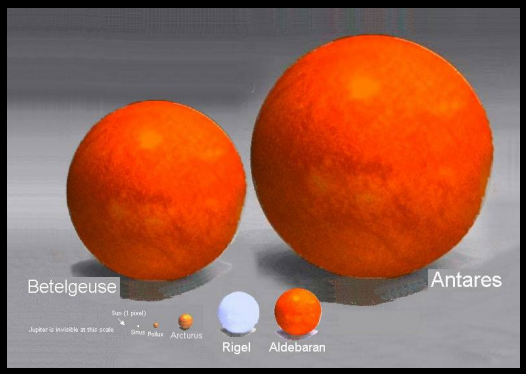
The Star we Know …



… is Really Quite Small



… or even Insignificant



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

And Where are We?

- In the Orion Arm of the Milky Way Galaxy
- 300-400 Billion Stars
- 90,000 light years in diameter & 10,000+ light years thick

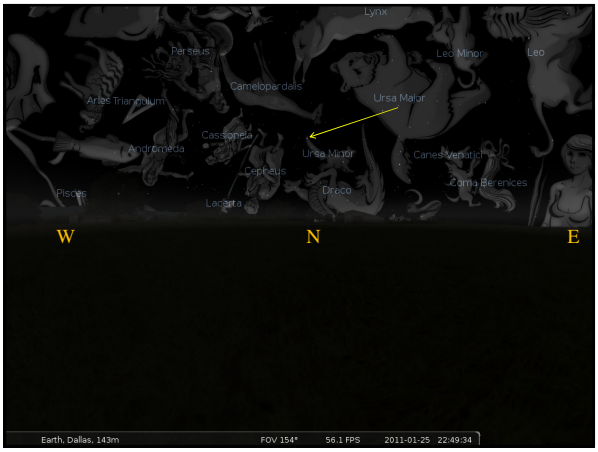
The Milky Way

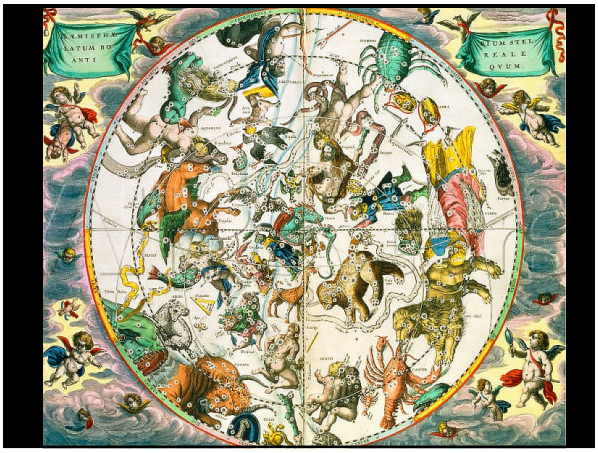
How many stars can you see?

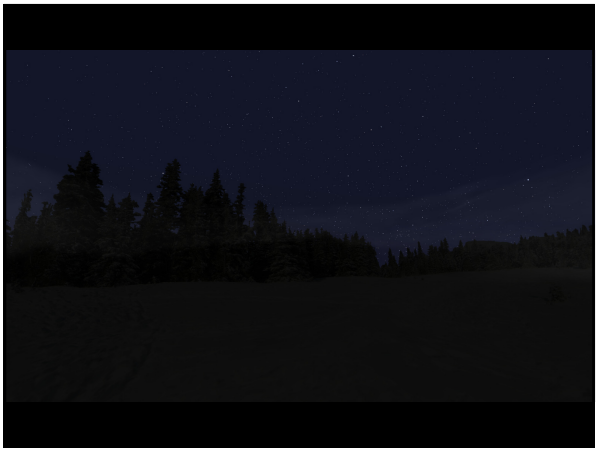
(not as many as you think and only 15 brighter than magnitude 1)

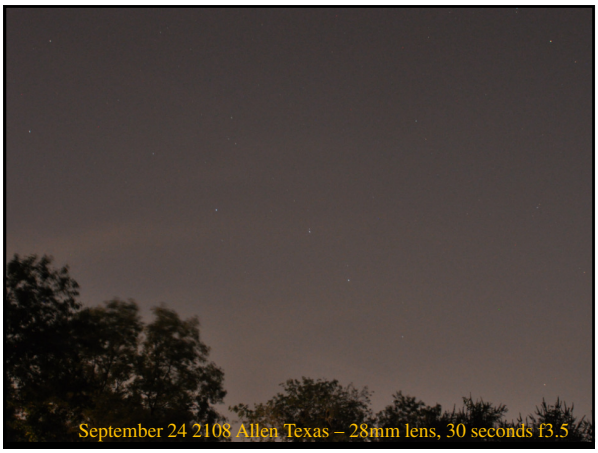
	Absolutely perfect desert or mountain sky with no moon and no light polution			Rural area with low light polution	Suburban area - moderate/mild light polution	Urban area - severe light polution
Limiting Magnitude	6.5	6.3	6.0	5.0	4.0	3.0
Stars visible at any one point on earth at any one time (double 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


• Dallas/Plano/Allen Area
•Dimmest stars about Magnitude 2 or 3
• High humidity & Light Pollution
Earth, Dallas, 143m
FOV 111°
102 FPS
2011-01-25 22:49:34

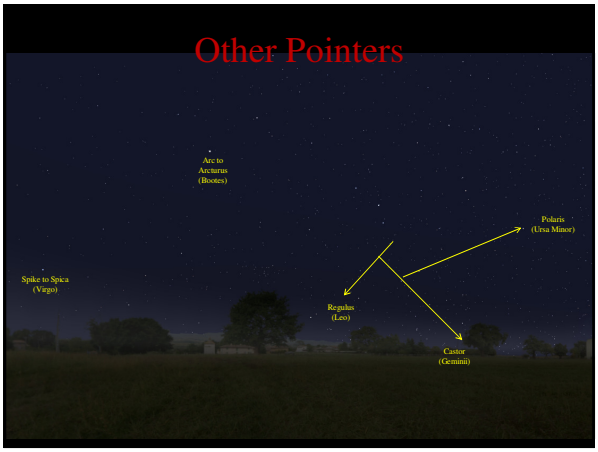

Lynx
Perseus
Leo Minor
Leo
Camelopardalis
Aries Triangulum
Ursa Major
Cassiopeia
Andromeda
Ursa Minor
Canes Venatici
Cepheus
Coma Berenices
Pisces
Draco
Lacerta
W
N
E
Earth, Dallas, 143m
FOV 154°
56.1 FPS
2011-01-25 22:49:34

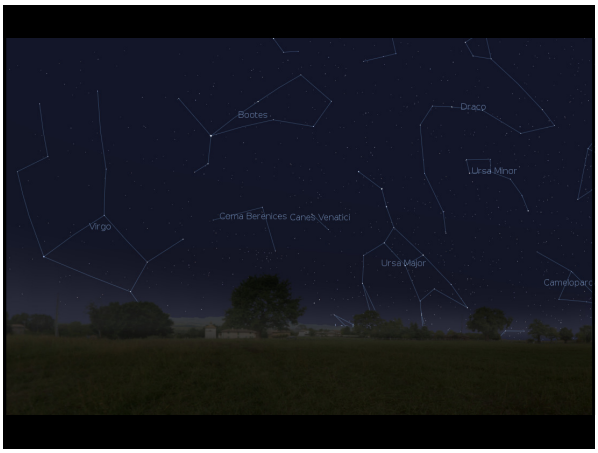


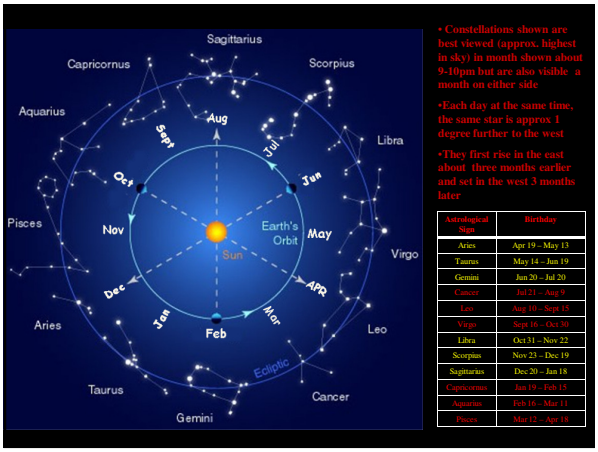




Other Pointers







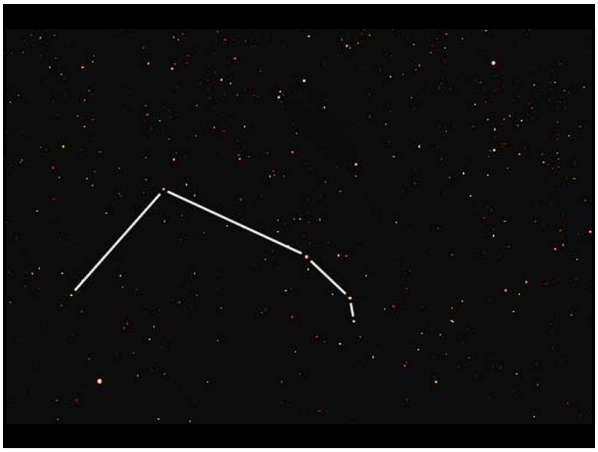
• Constellations shown are best viewed (approx. highest in sky) in month shown about 9-10pm but are also visible a month on either side

•Each day at the same time, the same star is approx 1 degree further to the west

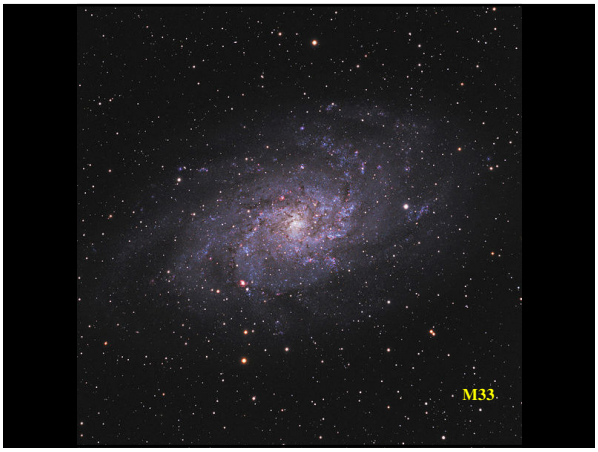
•They first rise in the east about three months earlier and set in the west 3 months later

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

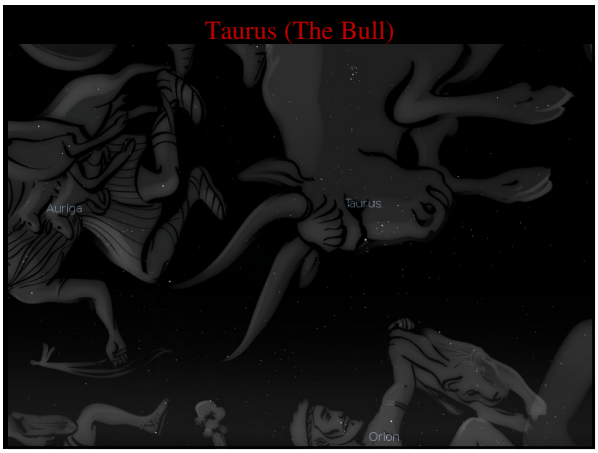

Aries
E
Sept 28 ~ 8pm

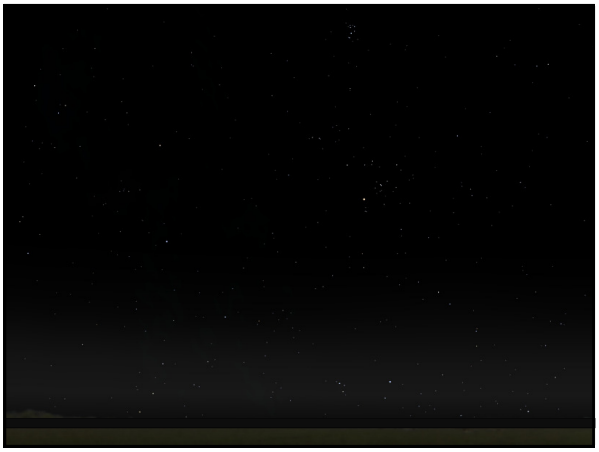


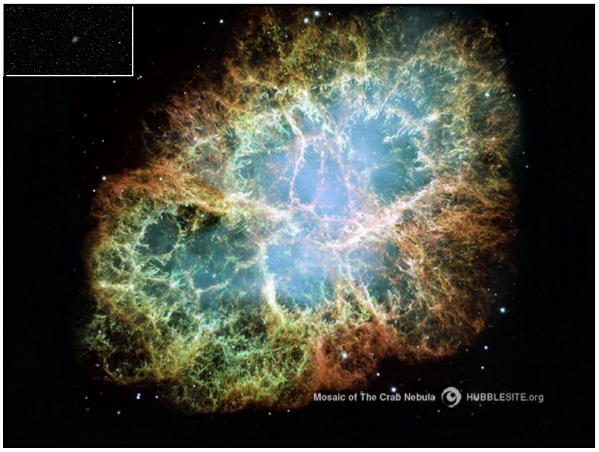

M33


M33

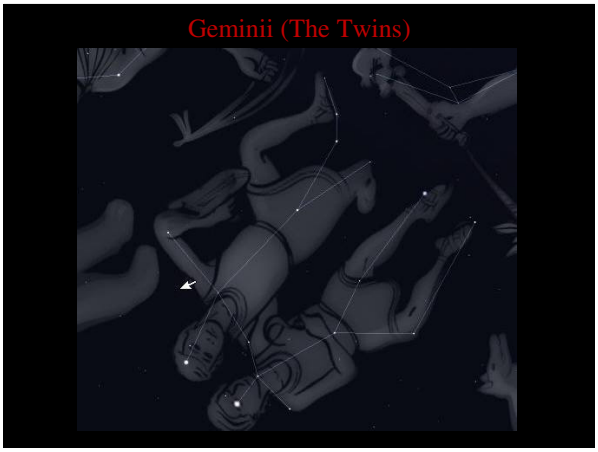

Aries

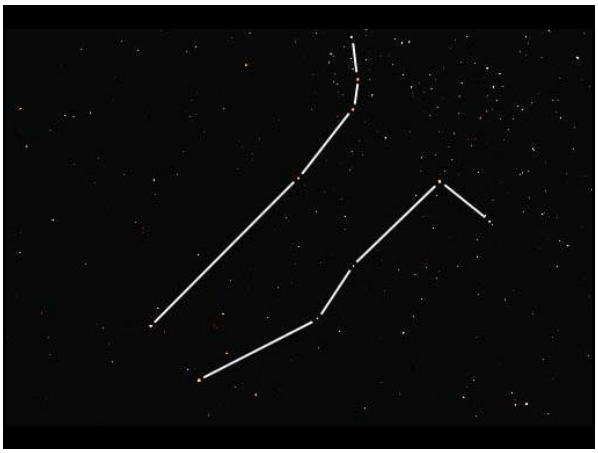

Taurus (The Bull)
Auriga
Taurus
Orion




Mosaic of The Crab Nebula
HUBBLESITE.org

Geminii (The Twins)

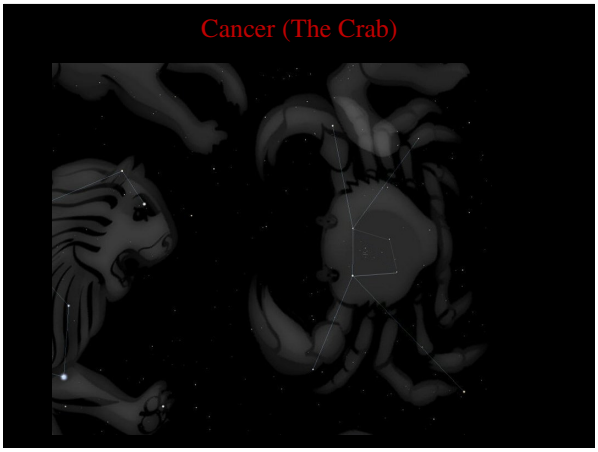


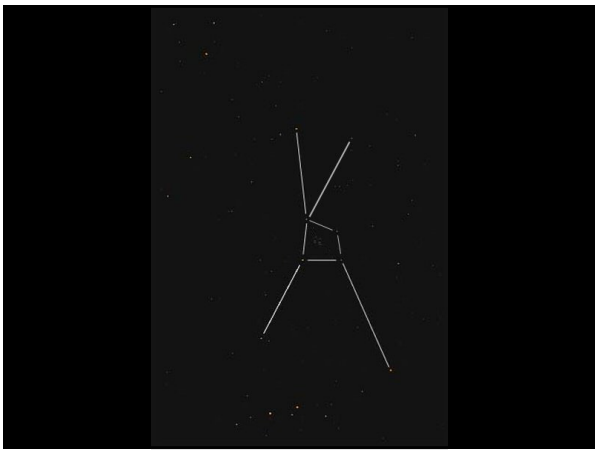


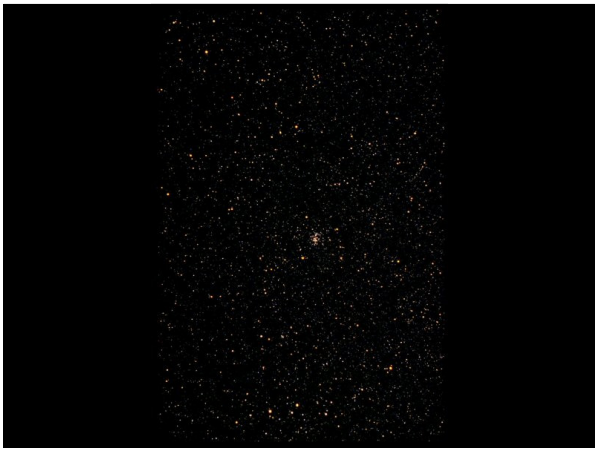

M35
NGC 2174

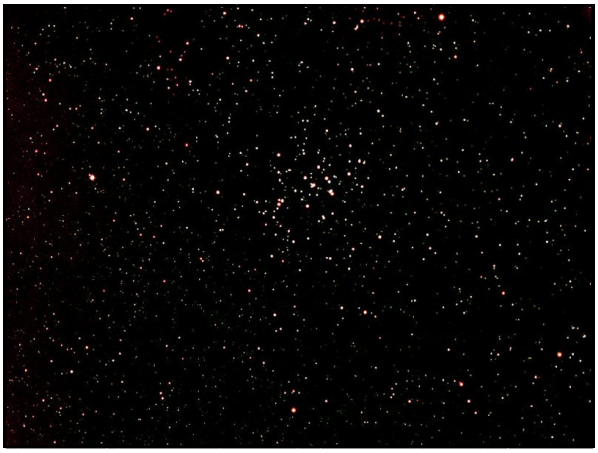

M35
NGC 2174


Gemini

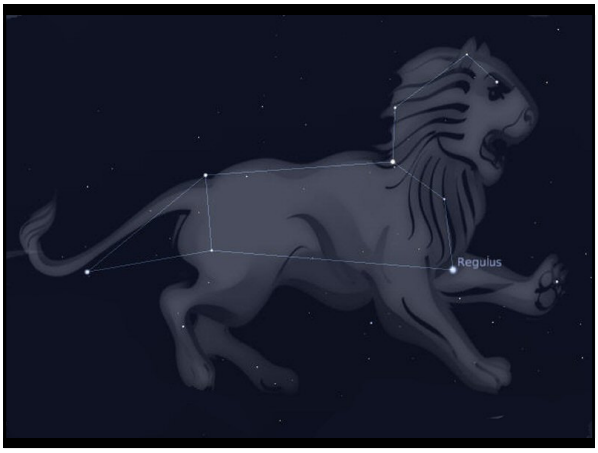

Cancer (The Crab)

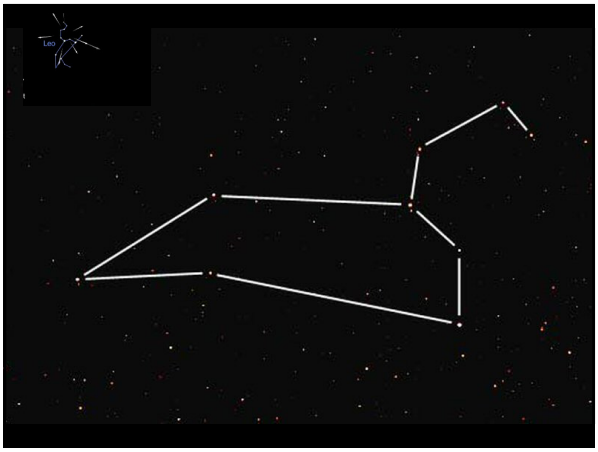


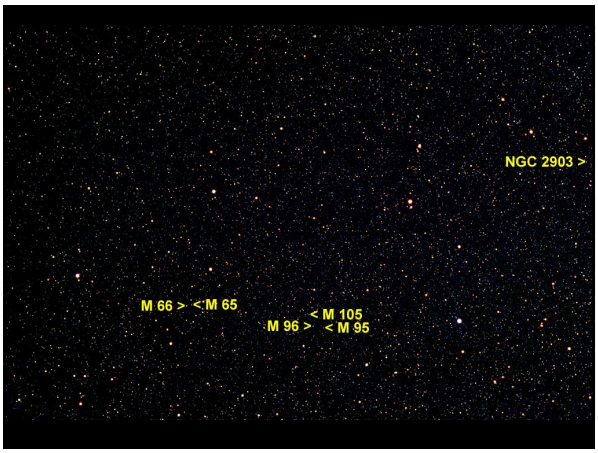


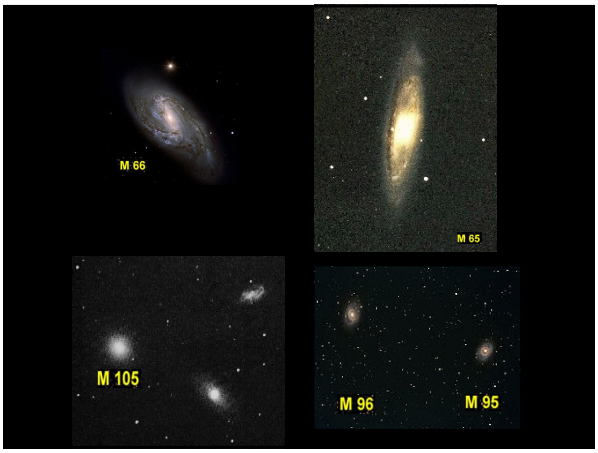



Cancer

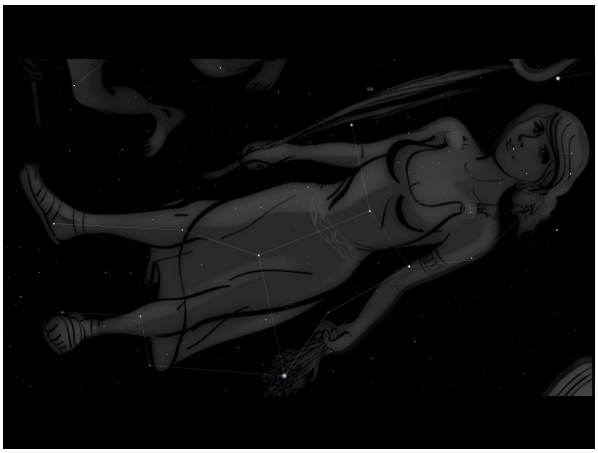

Regulus

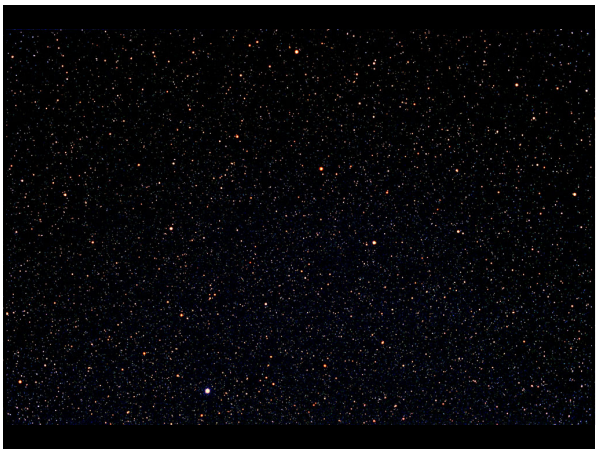

Leo

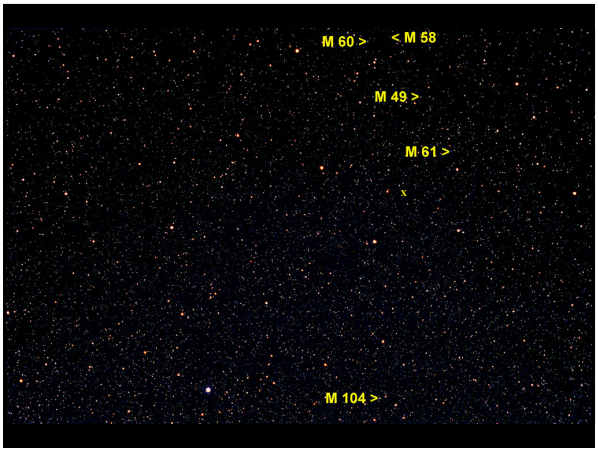

NGC 2903 >
M 66 > < M 65
< M 105
M 96 > < M 95


M 66
M 65
M 105
M 96
M 95

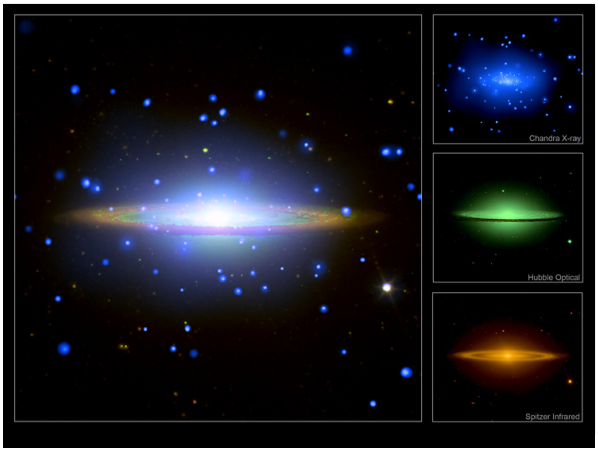

Leo

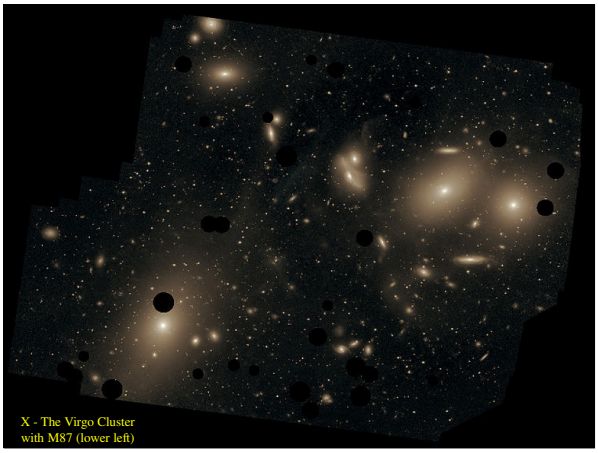





M 60 >
< M 58
M 49 >
M 61 >
M 104 >

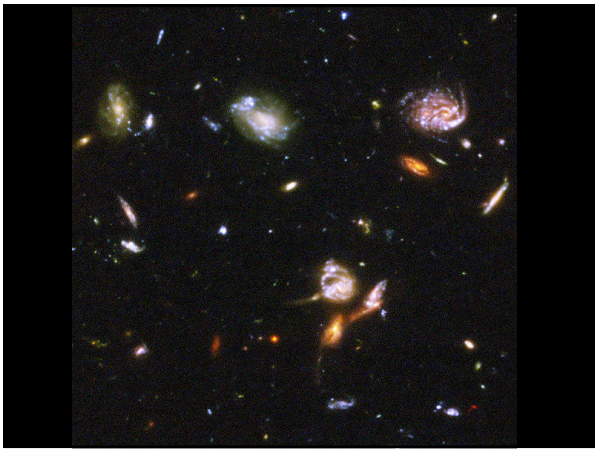

SN2008in
M61


Chandra X-ray
Hubble Optical
Spitzer Infrared

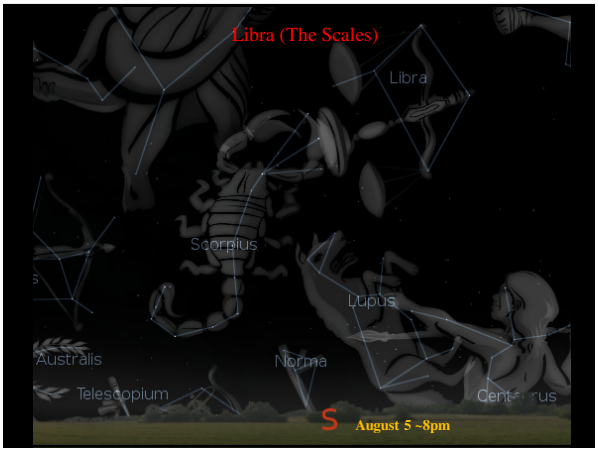

X - The Virgo Cluster
with M87 (lower left)

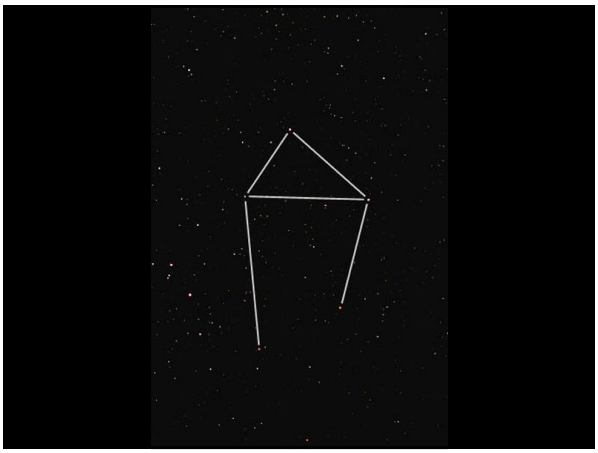
Hubble Ultra Deep Field

- In constellation *Fornax* in Southern hemisphere
- Low density of bright nearby stars
  - Field equivalent to 1mm square of paper held 1-meter away
  - 1/13-millionth of total sky area
  - 11 days of actual exposure time using Director's Discretionary Time
- What this is
  - ~ 10,000 Galaxies
  - 13 billion light years away
    – so this light left 13 billion years ago
  - universe is only ~13.75 billion
  - So this is only 400-800 million years after the Big Bang



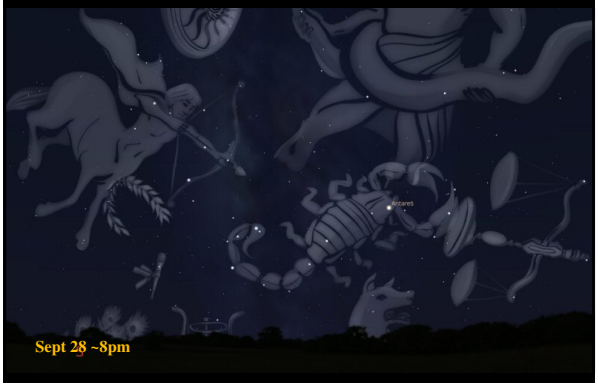

Virgo

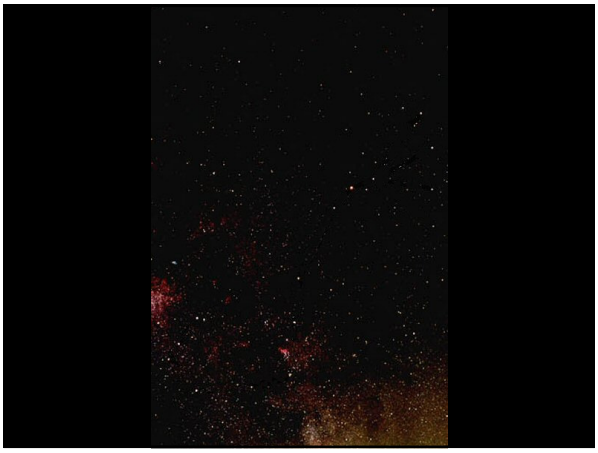

Libra (The Scales)
Libra
Scorpius
Lupus
Australis
Norma
Telescopium
S
August 5 ~8pm

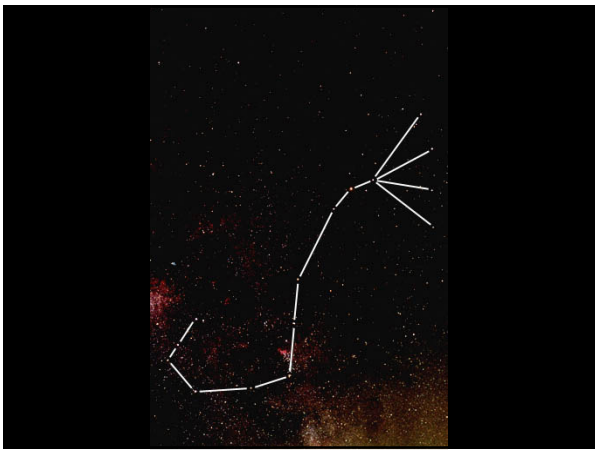


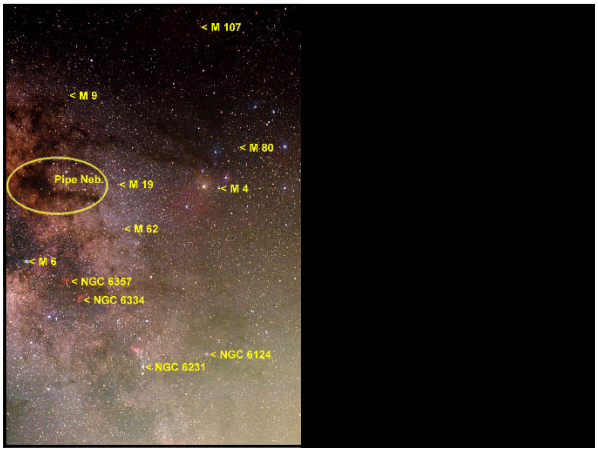

NGC 5897

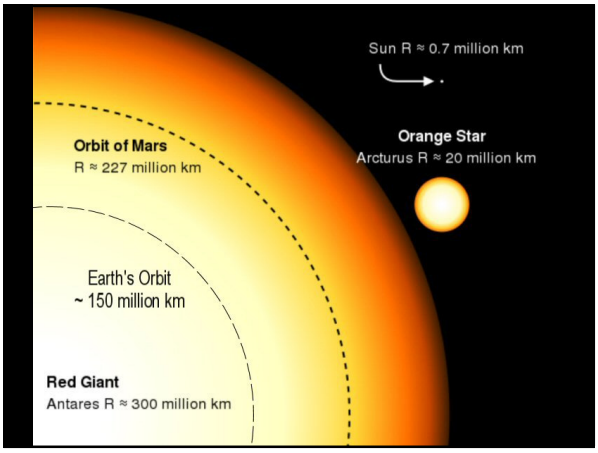
Scorpius/Scorpio (The Scorpion)

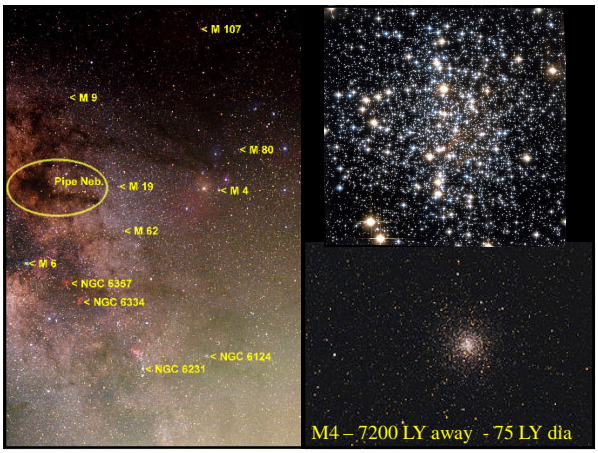




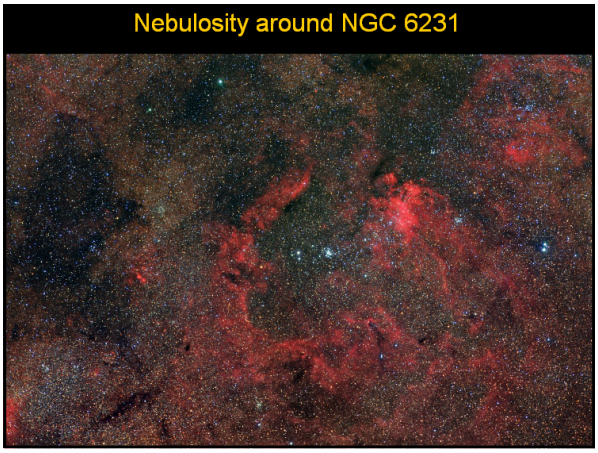


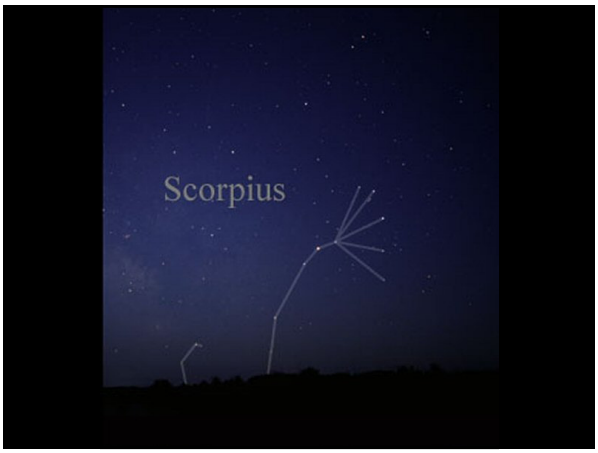

M 107
M 9
M 80
Pipe Neb.
M 19
M 4
M 62
M 6
NGC 6357
NGC 6334
NGC 6124
NGC 6231


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

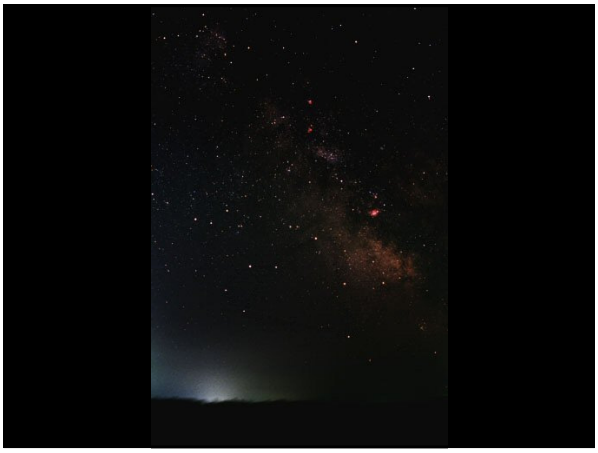

M 107
M 9
M 80
Pipe Neb.
M 19
M 4
M 62
M 6
NGC 6357
NGC 6334
NGC 6124
NGC 6231
M4 – 7200 LY away - 75 LY dia

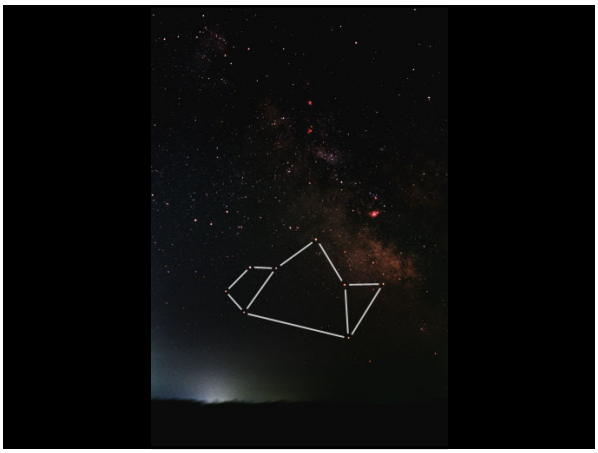

NGC 6357 – massive stars forming

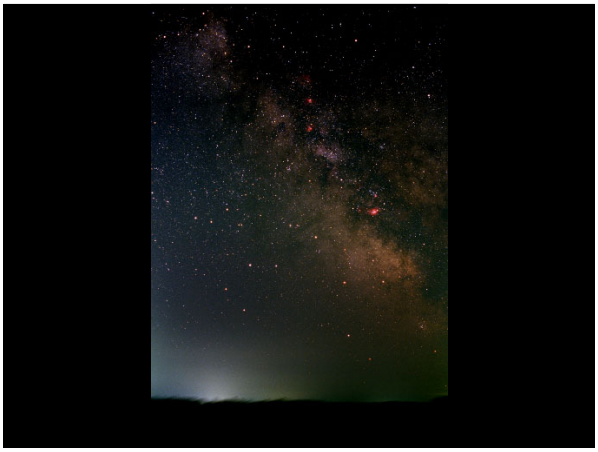

Nebulosity around NGC 6231

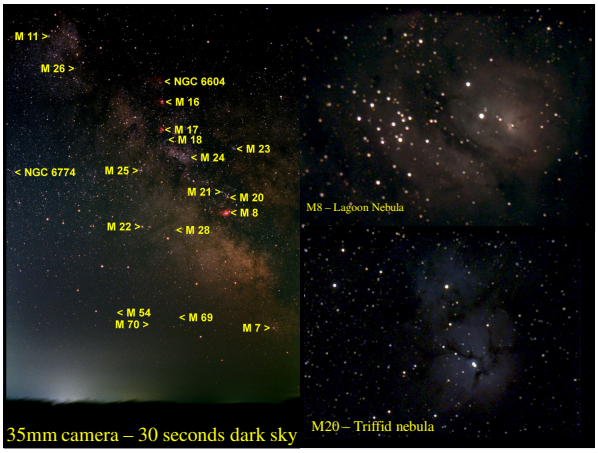

Scorpius


Sagittarius (The Archer)
S
Sept 21 ~8pm

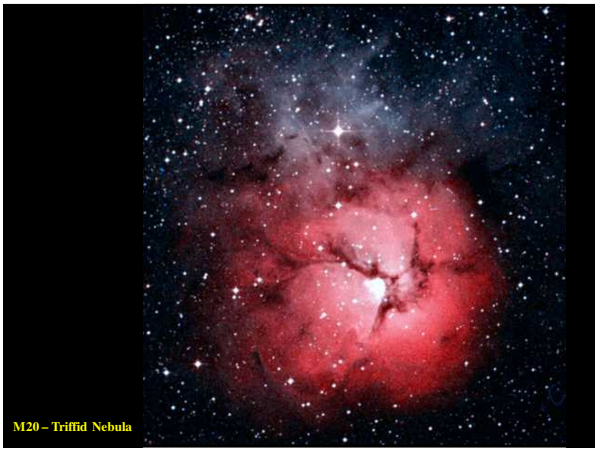







M 11 >
M 26 >
< NGC 6604
< M 16
< M 17
< M 18
< M 23
< M 24
< NGC 6774
M 25 >
M 21 >
< M 20
< M 8
M 22 >
< M 28
< M 54
M 70 >
< M 69
M 7 >
35mm camera – 30 seconds dark sky
M8 – Lagoon Nebula
M20 – Triffid nebula

M8 - Lagoon Nebula



M20 – Triffid Nebula

M16 – Eagle Nebula

Open Star cluster and Emission Nebula

Dist: 7000 ly

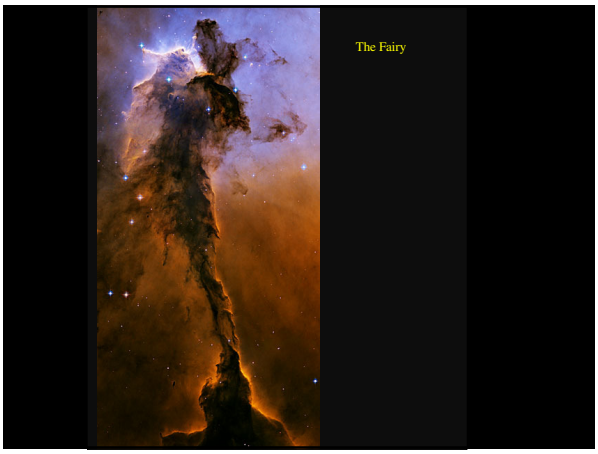
Size: 70x50 ly

Age: 5.5 million years

Two popular sub-features:

The Fairy and the Pillars of Creation

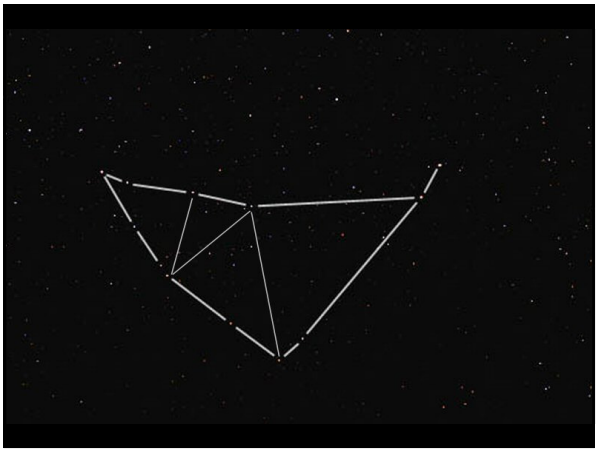
Active star formation in the Pillars


The Fairy


Pillars of Creation

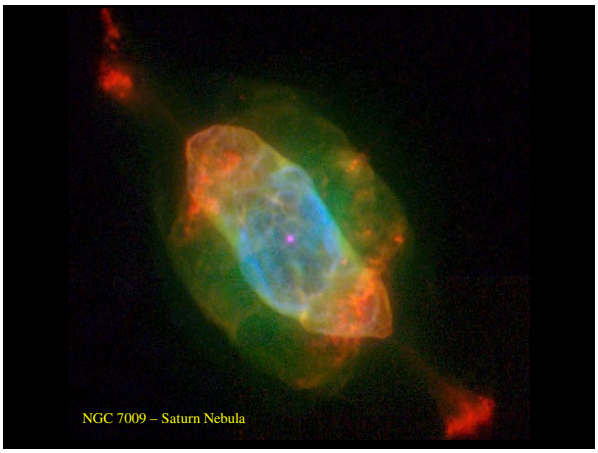

Sagittarius


Capricorn/Capricornus (The Sea Goat)

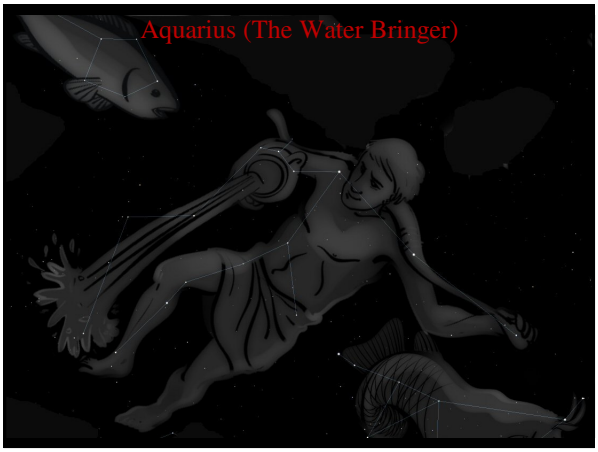


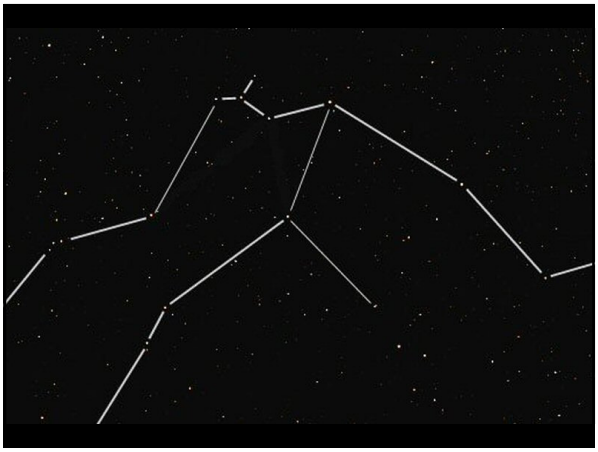

< NGC 7009
M 73 >
< M 72
M 30 >
M 75 >

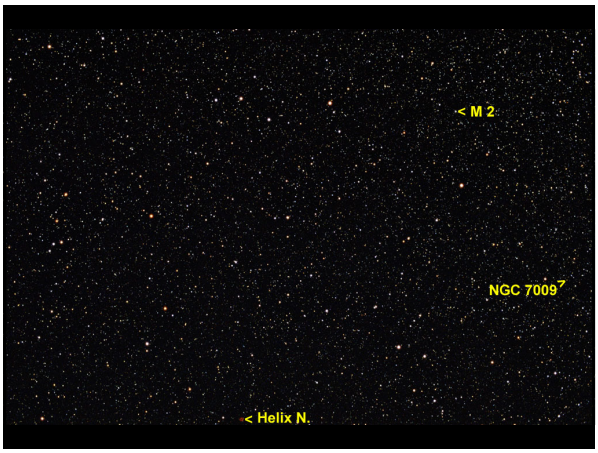

M30


NGC 7009 – Saturn Nebula


Capricornus


Aquarius (The Water Bringer)



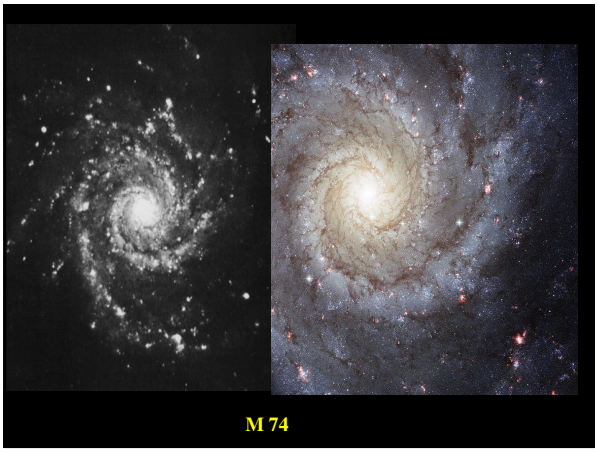

< M 2
NGC 7009
< Helix N.


Helix Nebula

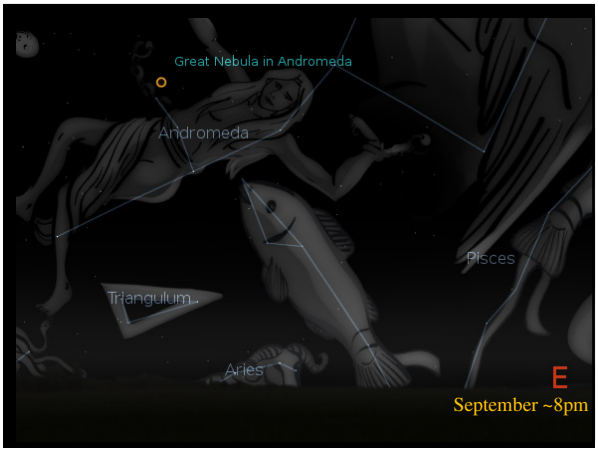

Aquarius

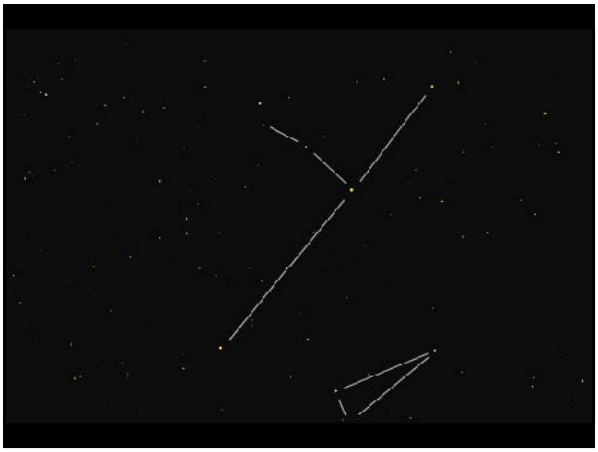

Pisces (The Fish)
Pegasus
Equuleu
Andromeda
Aquarius
Triangulum
Pisces
Aries
Piscis A
Sculptor
E
September ~8pm

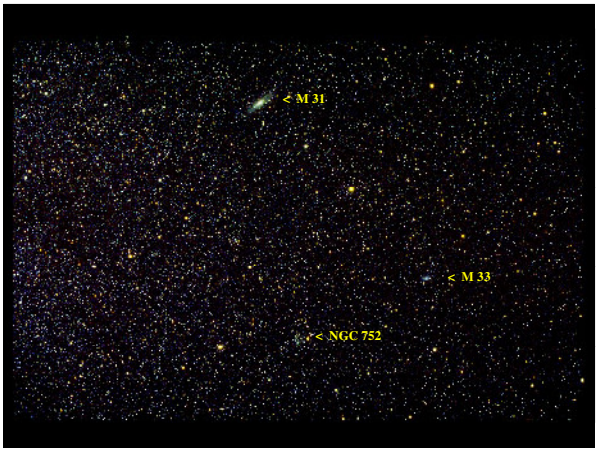

< M 74


M 74


Pisces

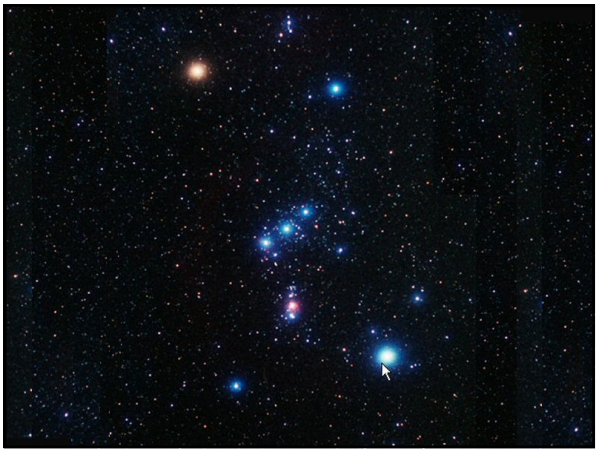

Great Nebula in Andromeda
Andromeda
Pisces
Triangulum
Aries
E
September ~8pm

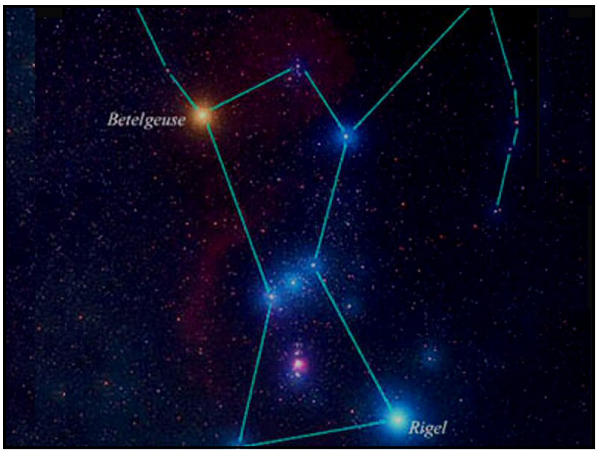




M31 – Andromeda Galaxy – 2.5 million ly away – the farthest the unaided human eye can see
At least twice as big as the Milky Way – a trillion stars vs our 300-600 billion
It's coming towards us at 300km per second - collision in about 3 billion years – watch out for it!


Triang
Jupiter
Taurus
Moon
Betelgeuse
Orion
Aries
Canis Minor
Procyon
Monoceros
Rigel
Sirius
Lepus
Canis Major
Cetus
Columba
Eridanus
Pyxis
Puppis
Caelum
Fornax
Canopus
S




Betelgeuse
Rigel

Horsehead Nebula in Orion