Stellafane Observing Olympics – 2021

"The Hidden Gems of Stellafane"

Observe – Any 15 Objects in Any Telescope – Receive a Pin

Sir William Herschel

The Greatest Telescope Builder of His Time.

The Greatest Visual Observer of All Time.

NAME		COORDINATES J2000	CONST.	TYPE	MAG.	SIZE	MISC.
❑ 39 Boötis	Σ1890	14 44 59.2 +27 04 27	Boo	B.S.	2.5/4.9	2.8" Sep	Binary
❑ NGC6304	ESO 454-2	17 14 32.5 -29 27 44	Oph	G.C.	8.22 (V)	8.0'	VTip 14.5
❑ NGC6401	ESO 520-11	17 38 36.9 -23 54 32	Oph	G.C.	7.4 (V)	4.8'	VTip 15.5
❑ NGC6503	UGC11012	17 49 28.1 +70 08 38	Dra	Gal	10.2(V)	7.1' x 2.4'	16.3 MLYrs
❑ NGC6517	MWSC 2780	18 01 50.6 -08 57 32	Oph	G.C.	10.3 (V)	4.0'	VTip 16.0
❑ NGC6824	UGC11470	19 43 40.8 +56 06 34	Cyg	Gal	13.0(B)	1.9' x 1.5'	160 MLYrs
❑ NGC6884	PK 82+7.1	20 10 23.8 +46 27 38	Cyg	P.N.	12.6 (P)	6.0"	C* 15.6
❑ NGC6894	PK 69-2.1	20 16 24.0 +30 33 51	Cyg	P.N.	14.4 (P)	60.0"	C* 18.1
❑ NGC6910	Cr 420	20 23 06.0 +40 47 00	Cyg	O.C.	7.4 (V)	7.0'	125 stars
❑ γ Delphini	Gamma Del	20 46 39.4 +16 07 28	Del	B.S.	4.5/5.5	9.6" Sep	104 LYrs
❑ NGC7008	PK 93+5.2	21 00 33.1 +54 32 32	Cyg	P.N.	13.3 (P)	86.0"	C* 13.2
❑ NGC7031	Cr 430	21 06 52.0 +50 51 00	Cyg	O.C.	9.1 (V)	15.0'	62 stars
❑ French 1	Toadstool	21 07 22.0 +16 18 00	Del	Ast.	--	13.0'	30 stars
❑ NGC7139	PK 104+7.1	21 46 08.6 +63 47 31	Cep	P.N.	13.3 (P)	77.0"	C* 18.7
❑ NGC7331	UGC12113	22 37 04.5 +34 25 00	Peg	Gal	9.4 (V)	14.5' x 3.7'	38.9 MLYrs
❑ NGC7510	Cr 454	23 11 04.1 +60 34 08	Cep	O.C.	7.9 (V)	4.0'	60 stars
❑ NGC7538	Sh 2-158	23 13 42.0 +61 31 09	Cep	E.N.	--	9.7' x 6.1'	9,100 LYrs
❑ NGC7640	UGC 12554	23 22 06.7 +40 50 43	And	Gal	11.9 (B)	11.6' x 1.9'	19.0 MLYrs
❑ NGC188	Cr 6	00 47 30.0 +85 14 30	Cep	O.C.	8.1	13.3'	120 stars
❑ NGC281	Pacman Neb	00 53 00.0 +56 38 00	Cas	E.N.	--	28.0' x 21.0'	9,200 LYrs
❑ NGC659	Cr 19	01 44 24.0 +60 40 12	Cas	O.C.	7.9 (V)	5.0'	40 stars
❑ NGC663	Cr 20	01 46 17.0 +61 13 06	Cas	O.C.	7.1 (V)	16.0'	80 stars
❑ γ Andromedae	Almach	02 03 53.9 +42 19 48	And	B.S.	2.2/5.5	9.8" Sep	Binary
❑ NGC891	UGC1831	02 22 33.4 +42 21 03	And	Gal	10.8 (B)	14.3' x 2.4'	27.3 MLYrs
❑ ι Cassiopeiae	iota Cas	02 29 04.0 +67 24 09	Cas	B.S.	4.6/6.9	2.5" Sep	Binary

Type:

B.N.-	**Bright Nebula**	**Gal -**	**Galaxy**
B.S. -	**Binary Star**	**O.C. -**	**Open Cluster**
E.N. -	**Emission Nebula**	**P.N.-**	**Planetary Nebula**
G.C. -	**Globular Cluster**		

Miscellaneous Designations:

B.S	**-Binary Stars: Separation Distance**
E.N.	**-Emission Nebula**
G.C.	**-Globular Cluster**
VTip	**-Magnitude of the Brightest stars in Globular Clusters**
Gal	**-Galaxy: Distance in Millions of Light Years**
O.C.	**-Open Clusters: No. of Stars**
P.N.	**-Planetary Nebulae**
C*	**-Central Star Magnitude of Planetary Nebula**
LYrs	**-Light Years**
MLYrs	**-Million Light Years**

All Distances are based upon a Hubble Constant: H_0 - 70 km. s^{-1}. Mpc^{-1}
Note: Distances are estimates only based upon various analysts and analytical methods.

Primary Sources:

"MegaStar5 The Universe at Your Command", Willmann-Bell
"STScI Digitized Sky Survey", POSS2 / UKSTU Red, 1994 (Photos)

Stellafane IS, ALWAYS HAS BEEN, AND ALWAYS WILL BE, a telescope building conference. The Observing Olympics Program is not intended to replace that well established and entrenched tradition. The goal of the observing program is to educate and provide some direction for observing unusual and seldom visited areas of this beautiful universe we all live in. The best, most satisfying discoveries will always be with instruments designed and crafted by the observer.

Clear - Steady - Skies

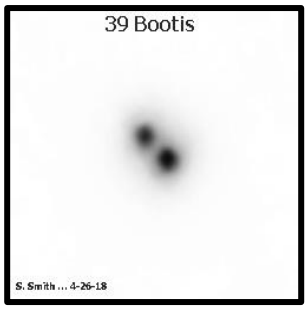
Larry Mitchell – Eileen Myers

***Stellafane Observing Olympics* - August 2021**

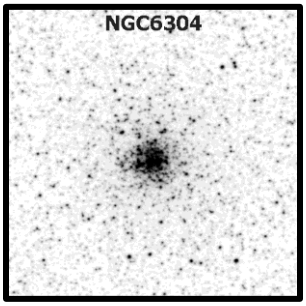
The Hidden Gems of Stellafane – The Stellafane Observing Olympics – 2021

Sir William Herschel
The Greatest Telescope Builder of His Time.
The Greatest Visual Observer of All Time.

Photo Modern Designation (Herschel Classification & Number - Herschel Description – Discovery Date)

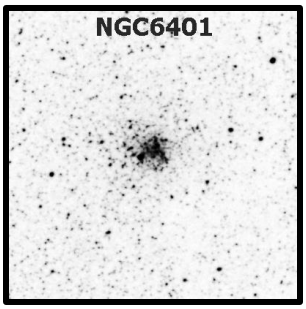


39 Boötis is a triple star system located approximately 224 light years from the Sun in the constellation of Boötis. It is visible to the naked eye as a faint, yellow-white star with a combined apparent magnitude of 5.68, and is moving towards the Earth through space at a rate of -19.3 miles per second. The two stars are separated by 2.9 arc-seconds, an easy split in most telescopes, and have an orbital period of 1,347.653 days, or 3.69 Earth years. This 3-star system is a source of X-ray emission with a luminosity of 41.4×10^{28} erg s^{-1}. The 6.36 magnitude primary star, component A, is itself a spectroscopic binary system as indicated by its double lined spectrum, which has an orbital period of 12.822 days. The two component A stars are separated by 2.021 mas (0.001"), which cannot be discerned in amateur telescopes. The combined stellar classification of the two stars is F8V, meaning it is an F-type main sequence star, and both components are slightly larger than the Sun with masses of 1.29 $M_\odot$ and 1.05 $M_\odot$. The second star, component B, is a single star with a magnitude of 6.72, and a mass of 1.25 $M_\odot$, with a stellar classification of F7V, so it is slightly hotter than the primary and is also a main sequence star.



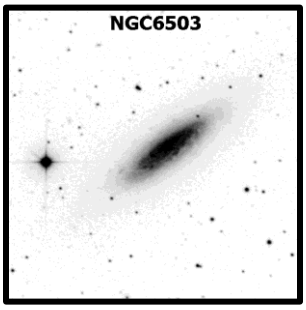
NGC 6304 (I 147 – Very bright, round gradually much brighter middle, 2 ½ arc-minute diameter - April 30, 1786)

NGC6304 is a globular cluster in Ophiuchus and was discovered by William Herschel in 1786, using his primary telescope, the 18.5-inch speculum mirrored f/13 telescope. The cluster is located 19,460 light years (± 260.8 LYrs) from the sun near the Milky Way's central galactic bulge, and only 7,200 light years from the galactic core. It is moderately compact with a non-core-collapse central region and a tidal diameter of 26.5 arc-minutes. NGC6304 is notable because it has a high metallicity, [Fe/H] = -0.59, which is unusual as most globular cluster are composed of metal poor stars. A total of 27 variable stars have been counted within NGC6304, eleven of which are RR Lyrae stars, which facilitates distance estimations and indicates an old stellar population. Additionally, three low mass X-ray binary stars (LMXBs) are present which aids in the study of neutron stars. The faint emission of transient accreting low-mass X-ray binaries, or qLMXBs, found in globular clusters, like NGC6304 are often used to measure the radii of neutron stars, and the low-mass X-ray binaries found in NGC6304 are all transient candidates.

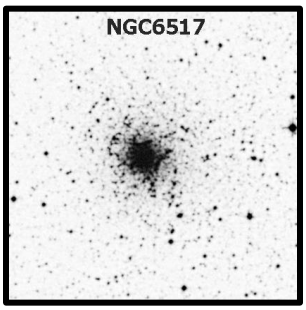


NGC6401 (I 44 – Considerably bright , pretty Large, a Nucleus - May 21, 1784)

NGC6401 is a globular cluster in Ophiuchus discovered by William Herschel in 1784, with his 18.5-inch telescope, but he mistakenly believed it to be a bright nebula. Later his son, John Herschel, was to make the same error because the speculum mirrored technology of the day, with only a 60% reflectivity, was insufficient to allow the individual stars to be resolved visually. NGC6401 has confused modern astronomers as well because in 1977 it was thought that a low-mass star in the cluster had been discovered venting its outer layers becoming a planetary nebula. However, a further study in 1990 concluded that the object is in fact a symbiotic star, which is a binary system composed of a giant star and a small hot star or white dwarf, with surrounding nebulosity. The dwarf's intense gravitation field is pulling material out of the larger cooler star, and symbiotic stars are often confused with planetary nebulae as they have similar appearances. NGC6401 is only 5.3° from the center of the galaxy and 20,701 ± 2,641 light years from the Sun. It has a metal-poor metallicity of [Fe/H] = -1.25 ± 0.06 and a total of 34 RR Lyrae star are present (23 – RRab and 11 RRc), many of which are located outside the main body of the cluster. Currently there are 158 known globular clusters associated with our Milky Way galaxy, with possibly ten or so yet to be discovered.

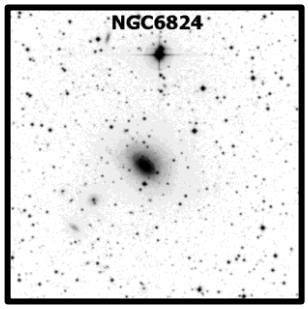


NGC6503, discovered by Georg Auwers (1838 – 1915) a German astronomer, is a dwarf spiral galaxy located 16.3 million light years away in the constellation of Draco. It has a diameter of only 30,000 light years, almost a third of the size of the Milky Way, and is a star forming ring galaxy. NGC6503 contains 224 distinct star forming regions, at various levels with plenty of colorful ionized gas and dark brown dust regions scattered throughout the spiral arms, which will give birth to many future stars and stellar associations. NGC6503 is a pure s-shaped spiral galaxy with well developed arms and a trace of a bar-like structure, seen in both H I velocity fields and near IR imaging. An inner ring of star forming material is found which spans the diameter of the bar. Usually galaxies are clumped together in small or large groupings of galaxies, but NGC6503 is different. It is located in an isolated place at the edge of an empty place in space called the Local Void. The Local Void is a huge stretch of space that is at least 150 million light-years across, and appears to be completely empty of stars or galaxies. Its odd location on the edge of this never-never-land area led Stephen James O'Meara to dub it the "Lost-In-Space galaxy" in his excellent 2007 book, "Hidden Treasures".



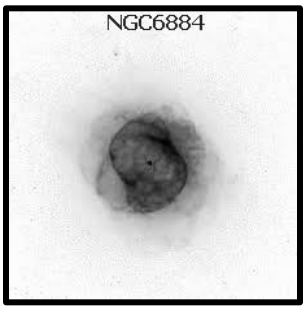
NGC6517 (II 199 – Pretty bright, Pretty Large, Round, gradually brighter middle, resolvable, mottled - June 16, 1784)

NGC6517 is a globular cluster in Ophiuchus and was discovered by William Herschel on June 16, 1784. It is in the first Herschel 400 observing program. Its apparent diameter is 4.1 arc-minutes, giving an actual diameter of about 42 light-years, and it has a low metallicity of [Fe/H] = -1.58 ± 0.05. The cluster is located about 35,000 light-years distant, and is only 9,800 light-years from the galaxy's core, making it a galactic bulge member. This is interesting, as its low metallicity indicates it is a halo object, which has migrated into the bulge area of the galaxy. Only a handful of globular clusters have similar characteristics, and its galactic central location means the area is highly reddened by dust. NGC6517 is listed as a class IV globular cluster, which is fairly condensed. A class I cluster is the most condensed, while class XII's are the least condensed objects, with black space often seen between stars. For comparison, M13 is a class V globular cluster, slightly less condensed than NGC6517. The relatively far distance of 35,000 light years for NGC6517 and its dense structure make resolving the cluster into individual stars difficult.



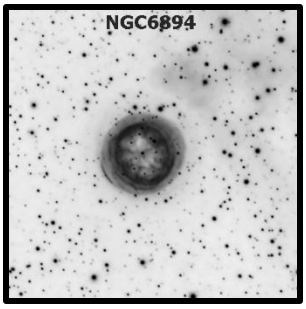
NGC6824 (II 878 - pretty Bright, irregular figure, brighter Middle, contains 2 stars – Sept. 16, 1792)

This is a galaxy in northern Cygnus, which is not a place most would consider galaxies to be located, being located in the "zone of avoidance". NGC6824 was discovered by William Herschel on September 16, 1792. Redshift estimates place it about 150 million light-years away, while Tully-Fisher estimates of its spiral structure run from 120 to 180 million light-years. The Tully-Fisher relation states that more massive galaxies rotate faster and therefore can be used as a yardstick to measure distances to galaxies, because if we know more accurately their true size, then we can better calculate their true distance. NGC6824 is tilted 59 degrees and is dominated by visible matter, with an extended pseudo-bulge, and a normal mass to light ratio, meaning it is not dark matter dominated. It is about 125,000 light years in diameter, a bit larger than the Milky Way. In 2017 supernova SN 2017glx was discovered in NGC6824 on September 4th, notable for its prominent iron lines.



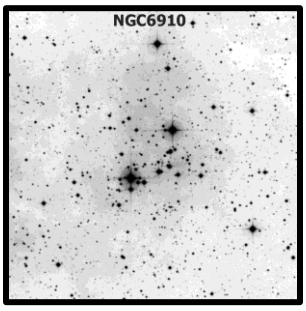
NGC6884 was discovered by the English astronomer Ralph Copeland (1837 – 1905), and is a small planetary nebula of only 7.5 arc-seconds diameter. It is located in northern Cygnus 5.5 degrees due west of Deneb, and is around 6,000 light years away, resulting in a diameter calculated to be two-tenths of a light year across. The central star has a blue magnitude of 16.1, a hot temperature of around 87,000 Kelvin, and it is still heating up. Since it is located within the Milky Way galaxy, it suffers from intervening interstellar dust dimming of about 1.5 magnitudes. The nebula is expanding at a rate of 23 miles per second and will eventually dissipate leaving behind only the central star, which will then be a lower-mass white dwarf star. Earth bound telescopes show a small bright slightly elongated disk of nearly equal brightness throughout. The Hubble Space Telescope (Photo) however reveals an inner nebula which is a twisted ring set within a larger complex outer halo. This outer halo represents the original 'slow-wind' ejection of material from the star when it was on either the red giant branch or the asymptotic giant branch stage in its stellar evolution. Since the nebula is elongated, the

central star probably has a companion or companions, in the form of another star, a brown dwarf, or planets. In a telescope this visually will be small in apparent size.



NGC6894 (IV 13 – pretty Faint, exactly Round, of equal light, the edges pretty well defined, 1 arc-minute diameter - July 17, 1782)

NGC6894 is 60 arc-seconds in diameter, located in Cygnus the Swan, and is a typical planetary nebula with a very diffuse outer shell representing the initial stellar ejection of material, and a more convoluted high energy inner structure. Its central star is a faint 18.1 magnitude rendering it not visible in most amateur telescopes. The filaments or stripes located inside the ring structure have been ionized by the central star. These stripes are parallel to the Milky Way galactic plane and their structure is thought to be manufactured by the galactic magnetic field stripping material from the halo leaving the stripes visible and vulnerable. Deep images of NGC6894 indicate it is interacting with the local interstellar medium and its slight elongation in a northwest-southeast trajectory is an indication of its direction of travel as it interacts with latent galactic gas clouds in its pathway. This provides astronomers a beneficial laboratory with which to analyze the Milky Way galaxy at the planetary nebula's approximate distance of 4,000 light years.

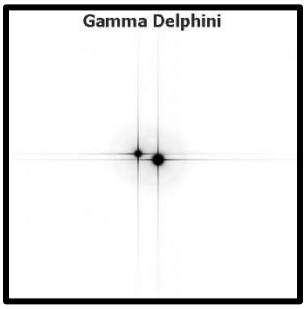


NGC6910 (VIII 56 – A star cluster of coarse scattered stars of various sizes. Extended like a forming cluster - Oct. 17, 1786)

NGC6910 is an open cluster in the constellation Cygnus, discovered by William Herschel on October 17, 1786. The cluster was also observed by his son John Herschel on September 18, 1828, and is located half a degree east-north east of Gamma Cygni, also known as Sadr, a foreground star lying at a distance estimated from 1,500 to 3,710 light years. NGC6910 is considered a poor open cluster with a Trumpler classification of I 2 p, but it contains some very hot and massive stars. In Robert Trumpler's world this means NGC6910 is "Detached with a strong central stellar concentration, a moderate range of brightness, and is composed of less than 50 stars". NGC6910 is the core cluster of the much larger Cygnus OB9 Stellar Association, located within the Orion arm of the Milky Way. Cygnus OB9's dimensions in the sky are 2.5 degrees by 1.5 degrees, which corresponds to an actual diameter of 175 × 105 light years, and it contains many very hot type O and B supergiant stars.

NGC6910 may be physically related with the large nebula IC1318, located to the immediate east of NGC6910, and which is also known as the Gamma Cygni Nebula Complex, as it lies at a similar distance, behind the galactic Great Rift. Because it lies behind a number of molecular clouds, the light from NGC6910 is dimmed by more than one magnitude. The core radius of the cluster is 0.8 parsec (2.6 light years), while the tidal radius is 4.2 parsecs (13.7 light years). This tidal radius represents the average outer limit of NGC6910, beyond which a star is unlikely to remain gravitationally bound to the cluster core. In contrast to Trumpler's classification, 125 stars, are considered to be probable members of the cluster, and are located within the central part of the cluster, while a total of 280 probable members are located within the angular diameter of the cluster. The brightest member of NGC6910 is a blue supergiant star with a spectral type B2 and an apparent magnitude of 7.0, and is located at the southeast edge of the cluster. It is also known as HD 194279 or V2118 Cygni and is a variable star with a P Cygni profile. P Cygni stars are massive Hypergiant stars which are short lived, with masses typically 50 times solar, and are variable in nature, possibly due to a companion.

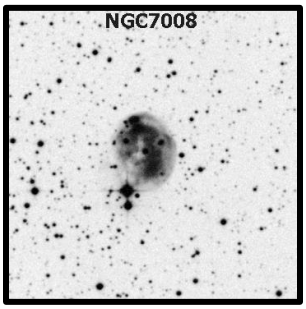
A mag 8.1 star lies at the northwest edge of the cluster, and a mag 8.5 type O6 giant star (HD 229196 = V2245 Cygni) lies a bit southwest from the line connecting the two brightest stars. Other members of the cluster include two 10.3 mag stars, one being a massive spectral type O9.5 star and the other a B0.5 main sequence star. A total of four beta Cephei variables, also known as Beta Canis Majoris stars, are located in the cluster, a rather high number, which has been attributed to the perceived higher metallicity of the cluster, based upon its young age of only 13 million years. Beta Cephei variables are main sequence stars with masses between 7 and 20 solar masses which exhibit small (0.1 – 0.3 mag.) rapid variations in brightness.



Gamma (Y) Delphini is a binary star system approximately 104 light-years away, located in Delphinus. The star marks the point star of the asterism "Job's Coffin". It is one of the best known double stars in the sky, consisting of a fifth magnitude yellow-white dwarf, γ^1 Delphini, and a fourth magnitude orange subgiant, γ^2 Delphini. They revolve with a period of 3,200 years at an average distance of 330 Astronomical Units (AU), but they have a highly eccentric orbit, taking them as close as 40 AU and as far apart as 600 AU. From each star the other member would appear as bright as 100 of our full moons. When seen individually star colors are subtle, but with stars seen together the eye sees colors notably enhanced. The brighter member of Gamma Delphini, γ^2 Delphini, is a pale-yellow orange color, while the fainter member γ^1 Delphini is really white in color, but it has been described as yellow, green or blue in color.

γ^1 Delphini is a yellow-white dwarf star of spectral type F7V with an apparent visual magnitude of 5.14. Gamma^1 has a temperature of 6,060 Kelvin, a luminosity of 7.5 times solar, and a mass 1.5 times solar. Gamma^1 is still fusing hydrogen in its core, but in about 2 billion years it will begin becoming a giant star like its companion.

The brighter component γ^2 Delphini is an orange subgiant star of spectral type K1 IV and an apparent magnitude of 4.27. It is the cooler of the two stars at 4,700 Kelvin, but with a luminosity 26 times solar and a diameter 15 times solar. Its mass is slightly higher at 1.7 times that of the sun and it has recently stopped fusing hydrogen in the core and is now expanding and slowly brightening, becoming a helium-fusing giant star. In 1999, the presence of a planetary companion was inferred around Gamma^2 Delphini, and the planet was calculated to yield a minimum mass of 0.7 Jupiter masses, an orbital period of 1.44 years and a separation of nearly 1.5 astronomical units (almost the orbital separation of Mars from the Sun). The planetary candidate has not been confirmed.

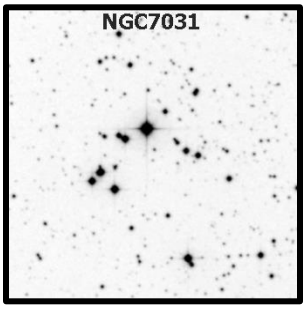


NGC7008 (I-192, center Bright, irregular Faint, 3' large, 2 arcminutes 1/2 area brighter, Nebulosity – Oct. 14, 1787)

NGC7008, also known as the **Fetus Nebula** is a planetary nebula with a diameter of approximately 1 light-year and is located at a distance of 2,800 light years from the Earth in northern Cygnus. It was discovered by William Herschel in 1787, in Slough, England near Windsor Castle, and is included in the Astronomical League's Herschel 400 observing program. Some of NGC7008's dynamic structure comes from dual layers of radically different dust, which originated from two different central sources. This could be the result of a binary star taking its last twin breath, with the older star first, and then the younger member expelling material. One theory says that the Hydrogen-poor layers in these stars have been exposed shortly after the planetary nebula formation at the tip of asymptotic giant branch stage or AGB, forming what is termed the slow wind. As the central star increases in energy, the energy output becomes stronger resulting in a second structure formed by what has been termed the "fast wind" as it snowplows into the previously formed slow wind.

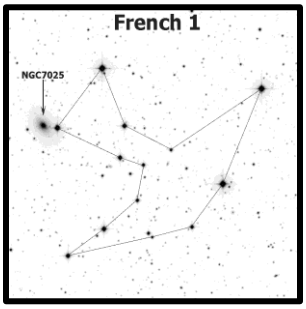
Another theory states that within NGC7008, the observed deviation from symmetry is expected, but the main energy signature is on the outskirts of the nebula, due to an interaction with the ISM (interstellar medium). It is therefore not clear if the nebula is formed due to the companion star, or is solely due to an interaction with the ISM. Perhaps both influence the morphology and shape of the nebula. NGC7008 has the presence of FLIERS or ANSAE and a well resolved central region. The destruction of brown dwarfs and massive planets inside the envelopes of asymptotic giant branch stars can lead to the formations of jets and ansae in elliptical planetary nebulae, and thick disks with jets on their two sides are the plausible outcome of this process. This is likely to occur at late stages of the AGB, as the jets push their way out of the envelopes in the course of a number of years. This Roche lobe overflow continues for several hundred years and destroys the secondaries (planets, etc.).

Planetary Nebulae are found in three general shapes, spherical, bipolar, and elliptical or elongated. It has been theorized that spherical planetary nebula have slow rotating single central stars, while bipolar nebula are the product of a binary system consisting of two members interacting. Elliptical planetary nebula are the product of multiple systems which can consists of stars, brown dwarfs or planets as secondary members to the primary star. Secondary members to a hot central star can spin-up the star resulting in the elongated bipolar or elliptical shapes.

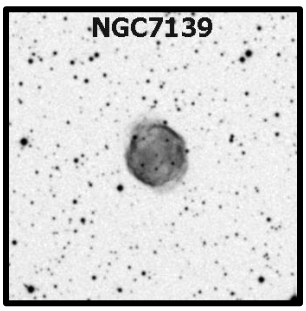


NGC7031 (VIII-74 – A cluster of coarse scattered stars with one Large star, not rich, 6are-minutes in diameter – Sept. 21, 1788)

NGC7031 is located in Cygnus and near the outer edge of the Sun's spiral arm, the Orion arm, at about 91 light years (28 pc) above the galactic plane. Its distance has been estimated to be from 2,380 to 3,586 light years from the Earth, and it has an age calculated from 224 to 480 million years. Its size is 49.1 arc-minutes and its apparent visual magnitude is 9.1, and 62 stars are considered to be cluster members. The largest star at the point of the inverted "V" asterism is a large red star with a bright Vmagnitude of 9.73, but it is not an actual cluster member, and is a foreground star. The eastern most apparent cluster star has a Vmagnitude of 11.78, while the star just to its west (photo) has a Vmagnitude of 11.54, and both of these stars are true members of the cluster. The brightest member in the close binary star has a V mag. of 11.79 while its close companion is a fainter 13.45, and both of these stars are also cluster members. NGC7031 contains at least one blue straggler star, which is an older star that appears to be a young star as a result of its merging with another stellar member. NGC7031 and the cluster NGC7086, located 3.8 degrees to the northeast, have been proposed as forming a binary open cluster system. NGC7086 has a much younger estimated age of 178 million years, so it seems based upon the age difference that the two clusters most likely were not formed together from the same molecular cloud, and therefore do not form a true binary cluster.



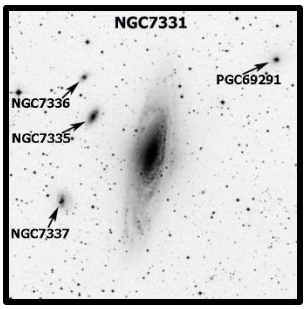
French 1 - This clustering of stars is officially listed as an asterism, and is also known as the "Toadstool" due to its distinctive shape. It is 13 arc-minutes in size, and was discovered by Susan French in 1997. The Toadstool asterism is more obvious visually to the eye than in photos. The bright star HD201117 at V mag. 8.93 is part of the cap and the star, GSC1649:2401 at mag. 9.7 is part of the stem, next to the 13.5 magnitude galaxy, NGC7025. The faintest members of the cluster are around 12th magnitude, making this object easily observable in most telescope apertures. Bruno Alessi, an advanced amateur astronomer from São Paulo, independently discovered this group and points out that the proper motions of the brightest stars are somewhat similar, so it is possible this object may be a physically gravity bound open cluster association of stars, instead of an asterism of unrelated objects. However, the proper motions of the main "toadstool" stars, are just too random with each other to be considered an open cluster or the remnant of an old open cluster, so therefore, this truly is an asterism of unrelated, non-gravitationally bound objects – A nice Illusion However. A wide field low power eyepiece gives the best views of this large asterism.



NGC7139 (III 696 – very Faint, Small, Round, little brighter Middle, resolvable or mottled, 1 arc-minute diameter – Nov. 5, 1787)

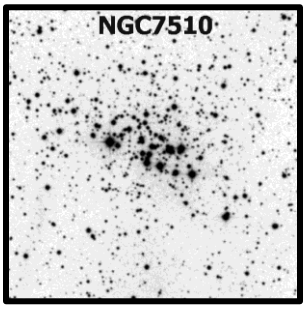
NGC7139 is a mostly round planetary nebula, approximately 70 arc-seconds in diameter. It is located in Cepheus, and was discovered on November 5, 1787 by William Herschel. It is located about 4,000 light years away, but the distances to such nebula are very uncertain, with distances estimated from 2,900 to 7,800 light years. The central star is very hot with a temperature of 125,000 Kelvin, but it has been estimated to be as low as 90,000 Kelvin. The luminosity of the star is about 49 times solar, and its mass is approximately 0.8 M☉. The mass of the nebula ranges from 0.169 M☉ at a distance of 4,900 light years, to a nebular mass of 0.548 M☉ if the distance is 7,800 light years. The age of the nebula is 8,910 years. Visually NGC7139 has a red ring of N II, singly ionized nitrogen (neutral nitrogen is N I) surrounding a blue center. In most cases it is N II (6584Å) that gives the red color in planetary nebulae. Close to the star the ultraviolet radiation causes the doubly ionized oxygen, O III (4959Å, 5007Å), to glow with its characteristic blue color which fades as it reaches the outer parts of the nebula, as there is no longer enough energy to cause oxygen to be doubly ionized. Nor is there enough to singly ionize Nitrogen without help. The stars initial ejection of material resulted in a "slow wind" which created a bubble, but as more of the material was lost the ejections became more energetic becoming a "fast-wind" which has now run into the edge of the slow-wind bubble. Gases pile up creating a shock front, and energy from this shock, plus the energy that reaches it from the central star, are enough to cause the nitrogen to singly ionize with its characteristic red color. But it is not sufficient energy to

doubly ionize oxygen, so we don't see the blue color farther out which would normally overwhelm N II emissions. Therefore, the red N II emission defines the shock front where it meets the interstellar medium. It is possible we are looking at this star right down its pole-on orientation, and the ring is the edge of a disk or cylinder of material the star initially threw off, sometimes referred to as a Torus.



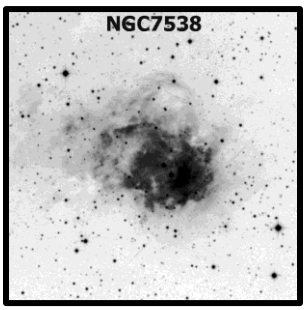
NGC7331 (I 53 – Very Bright, considerably large, much Extended, much brighter middle, mottled – Sept. 5, 1784)

NGC7331 is also known as **Caldwell 30** and was discovered by William Herschel in 1784 who considered it a "bright nebula". The galaxy is similar in size and structure to the Milky Way, and is sometimes referred to as "the Milky Way's twin". It is a spiral type galaxy about 40 million light-years (12 Mpc) away in Pegasus and is a LINER type active galaxy. The bulge of the galaxy rotates retrograde to its disk and has a boxy shape which is indicative of a bar-like structure, which is seen end-on. If it is a bar seen end-on, this bar has to be thicker than the disk, and the fact that the inner component is retrograde indicates it was formed from infalling material in either stellar or gaseous form, or both. In both visible light and infrared photos of NGC7331, the core of the galaxy appears to be slightly off-center, with one side of the disk appearing to extend further away from the core than the opposite side. NGC7331 is the brightest member of the NGC7331 Group of galaxies. The other members of the group are the spirals NGC7335 (Bmag. 14.4), NGC7336 (Bmag. 15.0), NGC7337 (Bmag. 15.2) and the elliptical galaxy NGC7340 (Bmag. 14.9). These galaxies lie at distances of 332, 365, 348 and 294 million light years, respectively, so they cannot really be affiliated with NGC7331. Visually through a telescope NGC7331 is spectacular.



NGC7510 (VII 44 – A Small Cluster of very Small stars, considerably cometary in shape and pretty rich – Nov. 3, 1787)

NGC7510 (aka **Collinder 454**) is an open cluster located around 11,400 light years away in Cepheus, near the border with Cassiopeia. Distance values have ranged from 7,200 to 16,430 light years, but if 11,400 light years is adopted, then the light from the cluster has undergone extinction from interstellar gas and dust equal to E(B – V) = 0.90 ± 0.02 magnitude in the UBV photometric system. The cluster's age is approximately 10 million years and its brightest member is a normal giant star with a stellar classification of B1.5 III, meaning it is massive and hot. This cluster forms part of the Perseus Spiral Arm and has a Trumpler class rating of II 2 m, meaning it is detached with a strong central concentration, a moderate range of brightness and is medium rich with 50 to 100 stars. The whole area is faintly filled with ionized hydrogen, especially to the east, where there is a segment of Sh2-157, the Lobster Claw Nebula. Many other nebulae are part of this huge cloud, with the Bubble Nebula probably the most famous of these. NGC7510 is a nice visual open cluster easily seen in almost any telescope, and visually it resembles a broadhead arrow point with three razor edges. This is lost in the photo image however. The brightest star is located on the eastern side and has a V-magnitude of 9.67, but it is unclear if it is an actual member of the cluster.

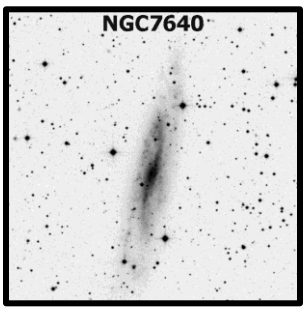


NGC7538 (II 706 – pretty Bright Middle, 2 pretty bright stars involved in Nebulosity, 2 arc-minutes large, 1 ½ arc-minute area bright – Nov. 3, 1787)

NGC7538 is located near the more famous Bubble Nebula in Cepheus. It is located about 9,130 light-years from Earth and is home to the biggest protostar yet discovered , which is about 300 times the size of the Solar System. NGC7538 is probably part of the Cassiopeia OB2 complex, a region of active star formation including several luminous near- and far-infrared (IR) sources. NGC7538 is often overlooked by amateur astronomers, but professionals looking to study stellar formation find it an exciting target, as it is the host to ongoing star formation, which is not completely understood. Stars in NGC7538 are mainly low-mass pre-main-sequence stars. Because of the dusty nature of this region, studies targeting the nebula are frequently conducted in longer wavelengths, ranging from the infrared to the radio. Previous studies have put the age of the forming stars at approximately 1-4 million years.

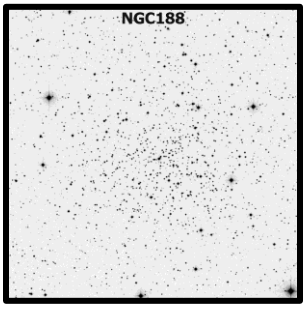
Within the nebula complex several individual sub-groups of star formations have occurred, and among some of the more interesting individual forming stars are 'NGC7538S', and 'MM 1'. The protostar NGC7538S is embedded in a collapsing core of approximately 85 – 115 solar masses and hosts a rotating accretion disc, as well as large outflows of material. Although the star has not finished forming, the conditions are right for it to form into a high mass B-type star. It is undergoing accretion at an unusually high rate of 1/1,000th of a solar mass per year. MM 1 is a massive star already estimated to have accumulated 20-30 solar masses and is well on the way to forming a massive O class star. Radial velocity measurements of molecules in the

protostar's vicinity indicate it's still undergoing large amounts of accretion, mostly from its equatorial plane, and this massive proto-star is creating powerful jets. Near MM 1 an additional eight cores are forming into young stars and these cores are interesting because they exist in regions where the density and temperature were not expected to be sufficiently high to induce star formation. This suggests that their formation was not due to a self-induced collapse, but rather, triggered by shock waves or magnetic fields, and there are indications that numerous shock waves exist from magnetic fields in the region. Additionally, four of these cores have masses similar to that of MM 1 which may allow them to form into a grouping of high mass stars similar to the famous Trapezium stars in Orion. These stars near MM 1 all exist in a narrowly confined region of about 1 light year, which is also similar to the separation of the Trapezium stars. Many of these newly discovered cores have large outflows and maser emissions.



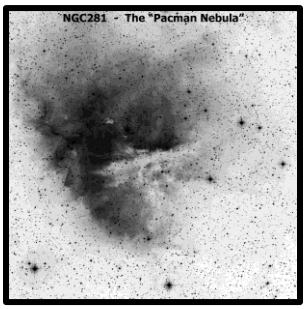
NGC7640 (II 600 – pretty Bright, much Elongated, north preceding, south following, but near - meridian, little brighter Middle, resolvable or mottled, 5 arc-minutes long, 1 ½ arc-minutes brighter region, also observed 1784 – Oct. 17, 1786)

NGC7640 was discovered by William Herschel on October 17, 1786 and is a nearly edge-on barred spiral galaxy located in Andromeda, with an inclination of at least 77°, and located at distances ranging from 19 to 38.8 million light years from Earth. If the galaxy is only 19 million light years away, then its diameter is 59,240 light years, or about half that of the Milky Way galaxy. The spiral arms fan out from the ends of an elongated bar which cuts through the center of the galaxy. It is not immediately obvious this is a spiral galaxy from some photographs because of its edge on appearance, but high-resolution photographs show a very tight S-shaped spiral structure, with arms extending well beyond the main body. Some very prominent H II regions are found in the outer spiral arms, and prominent dust lanes are present on the inner side of the arms. From our viewpoint these dark lanes appear in front of and behind the central region of the galaxy. There is evidence that this galaxy has experienced an interaction with another galaxy in the (astronomically) recent past.



NGC 188 (No. H34 – Cluster, very Large, Round, 150-200 stars of 10 to 18 magnitude - 1825)

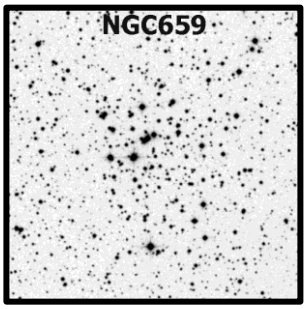
NGC188 (also known as **Caldwell no. 1**) was discovered by John Herschel on November 3, 1831, and is an open cluster in Cepheus, located about 5,610 light year from the Sun. NGC188 is only 4.75 degrees away from the North Celestial Pole which puts it above the Milky Way's disk and further from the center of the galaxy than the Sun. NGC188 is the northernmost open cluster in the sky and is circumpolar from all Northern Hemisphere locations, but can never be seen from south of 5 degrees south. Unlike most open clusters that drift apart after a few hundred million years because of internal and external gravitational interactions within our Milky Way galaxy, NGC188s age is estimated to be from 5.78 to 6.8 billion years. This makes NGC188 one of the most ancient open clusters known, possibly because of its location far above the plane of the galaxy, and away from interferences. However, NGC188 is metal rich with an [Fe/H] = +0.125, possibly due to its stellar dense gravitational field. NGC188 consists of about 120 stars, with the hottest main sequence star being of spectral type F2. This is interesting as open clusters typically contain stars initially formed roughly at the same time. The presence of an F2 type star with an estimated total lifetime of only about 3 billion years, located in a cluster approximately 6 billion years of age, indicates at least as second generation of star formation must have occurred in NGC188. The ten brightest stars in the cluster are yellow giants of spectral types G8 to K4 and luminosity class III, meaning they are normal giant stars. Their apparent visual magnitudes are 12 to 14, which corresponds to absolute magnitudes of 0 to +2, and overall, stars in NGC188 range in visual magnitudes from 12.5 to 20.547.



NGC281, **IC11, Sh2-184** or the **"Pacman Nebula"** is a bright emission nebula discovered by Edward Emerson Barnard in August of 1883, who described it as "a large faint nebula, very diffuse." NGC281 is part of an H II region in Cassiopeia which is part of the Milky Way's Perseus Spiral Arm and is a site of future star formation. This 20 × 30 arc-minute sized nebulosity is also associated with the open cluster IC1590, several Bok globules and the multiple star, B 1 or β 1, which collectively forms Sharpless 2-184, which spans over a larger area of 40 arc-minutes. The multiple star B 1 was discovered by S. W. Burnham, and its brightest component is the massive highly luminous O6 spectral class star, HD 5005 or HIP 4121. The complex consists of the 8th-magnitude primary, with four companions at distances between 1.4 and 15.7 arc-seconds. There has been no appreciable change in this quintuple system since the first measurements were made in 1875. Radio parallaxes of water masers at 22 GHz made during 2014 determined a distance to NGC281 of 9,200 light years (2.82 ± 0.20 kpc) from Earth, and it was found to be conveniently located almost 1,000 light years above the plane of the Galaxy. Therefore, NGC281 is nearby and relatively unobscured, and this allows unfettered views of poorly understood high mass stars which are normally found far away and obscured by gas and dust.

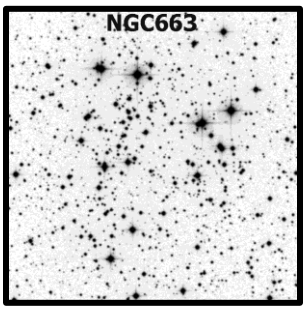
NGC281 is also known as the Pacman Nebula for its resemblance to the video game character. The "mouth" of the Pacman appears dark because of obscurations by gas and dust. Visually the Pacman nebula responds well to nebular filters.

Bok globules, discovered by the Dutch-American astronomer Bart Bok (1906-1983) in the 1940s, are isolated and relatively small dark nebulae, containing very cold dense cosmic dust and gas from which star formation take place. They are found within H II regions, and typically have a mass of 2 to 50 solar masses, which is contained within a region of about a light year across. They contain molecular hydrogen (H_2), carbon oxides and helium, and around 1% (by mass) silicate dust. Bok globules most commonly result in the formation of double- or multiple-star systems.



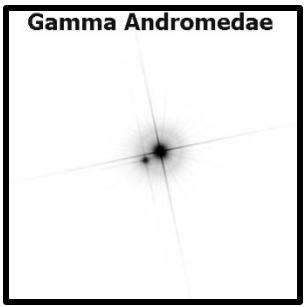
NGC659 (VIII 65 – A Star Cluster of small faint stars, not very rich, discovered by Caroline Herschel 1783 – Nov. 3, 1787)

NGC659, also known as the "**Yin-Yang" Cluster**, is a small open cluster in Cassiopeia, and was discovered by Caroline Herschel in 1783. It has an apparent visual magnitude of 7.9, an angular diameter of 6 arc-minutes, and is estimated to lie at the distance of 7,000 light years. It is about 15 light years in diameter, and only about 20 million years old, considered to be very young for an open cluster. NGC659's listed mass has been estimated from 100,000 to I million solar masses, but this is thought to be a gross overestimate. NGC659 is composed of many faint members, the brightest of which are 10.5 in apparent visual magnitude, which make it a fairly easy visual target for mid-sized telescopes. Delicate, curved star streamers in an East-West trajectory have earned it its "Yin-Yang Cluster" nickname. A total of 7 variable stars have been found in NGC659 with three of them Be type stars, and the others pulsating variables. Be stars are B spectral type stars thought to be rapid rotators, but they are not supergiant stars and are mostly found on the main sequence. They typically have prominent hydrogen emission lines with long term variabilities and amplitudes of a few tenths of a magnitude. The open clusters NGC659, NGC663, NGC654 and M103 all have similar ages and distances and are assumed to form the stellar association Cassiopeia OB8, which lies in the outer Perseus spiral arm of the Milky Way galaxy.



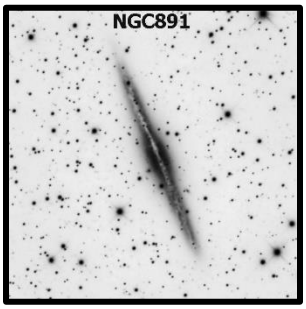
NGC663 (VI 31 – A beautiful Cluster of pretty Large stars, near 15 arc-minutes diameter, considerably rich – Nov. 3, 1787)

NGC663 is also known as **Caldwell 10**, a young open cluster of about 400 stars in Cassiopeia, and spans about a quarter of a degree across the sky. It has reportedly been detected with the unaided eye, and the brightest members of the cluster can be viewed with binoculars. The listed visual magnitude is 7.1, but several observers have reported brighter estimates. After adjusting for reddening due to interstellar dust, the cluster is estimated to be about 6,850 light years away (2,100 pc) with an estimated age of only 20–25 million years. This means that stars of spectral class B2 or higher (higher mass stars), are reaching the end of their main sequence lifespan, and there should be no massive O-type stars present at all. NGC663 is located in front of a molecular cloud, although the two are not physically associated, and this cloud has the effect of blocking background stars from the visual image of the cluster. NGC663 is of interest because of the high number of Be type stars, with a total of about 24 discovered. These are spectral class B stars that show prominent emission lines of hydrogen in their spectrum. Most of the Be stars in the cluster lie between spectral class B0 and B3. There are at least five blue stragglers in the cluster, which are stars that formed by the merger of two other stars, and are therefore old stars masquerading as young stars. Two of the cluster's star systems are likely eclipsing binaries with periods of 0.6 and 1.03 Earth days, and NGC 663 also has two red supergiant stars, both located on its periphery. NGC663 is assumed to form part of the stellar association Cassiopeia OB8, that is located in the Perseus arm of the Milky Way, along with the open clusters M103, NGC 654, NGC 659, and some supergiant stars scattered between them, with all of them having similar ages and distances.

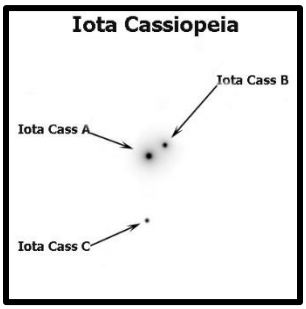


Gamma Andromedae (γ Andromedae or Almach) is the third-brightest star in Andromeda, the constellation, and is comparable in brightness to Polaris. Johan Tobias Mayer discovered that ϒ Andromedae was a double star in 1778 and this multiple star system is 358 light-years from the Earth. Through even a modest telescope, Gamma Andromedae appears as one of the finest double stars in all the heavens. The name "Almach" originally applied only to the brightest member, Υ^1 Andromedae or ϒ Andromedae A, a bright golden-yellow star, of spectral type K3, but Almach has traditionally

become the name for the entire system. The fainter member is Υ^2 Andromedae or Υ Andromedae B, and it is an indigo-blue star, of spectral type B9, and is a hot main-sequence star. Υ^2 Andromedae itself is actually a triple star system, and large amateur telescopes on a good night can split the blue secondary into two of its components. The magnitude of the two Υ^2 Andromedae components are +5.1 and +6.3, but they are separated by only 0.3 arc-seconds, and were discovered by Wilhelm Struve in 1842. The brighter +5.1 star is also a spectroscopic double star which makes the secondary Υ^2 Andromedae component a three-star system. The two visual stars are separated by about 10 arc-seconds and the striking contrast of colors results in a beautiful visual double star, which in actuality is a quadruple star system. Any small telescope will easily split Almach into the two major components.



NGC891 (V 19 – considerably Bright, much Elongated, above 15 arc-minutes in length, 3 arc-minutes area is brighter, a black division 3 or 4 arc-minutes in length in the Middle – Oct. 6, 1784)
NGC891 is also known as **Caldwell 23** or the "**Silver Sliver Galaxy**" and is an edge-on spiral type galaxy located 27.3 million light-years away in the constellation of Andromeda. NGC891 was discovered by William Herschel on October 6, 1784, although his sister Caroline is also given credit for the discovery. The central region of the galaxy is rich in H II regions, and NGC891 is a member of the NGC1023 group of galaxies in the Local Supercluster. The object is visible in small to moderate size telescopes as a faint elongated smear of light with a dust lane visible in apertures of 10-inches or more. NGC891 looks as the Milky Way would look like when viewed edge-on and both galaxies are considered very similar in terms of luminosity and size. NGC891 is 100,000 light years in diameter and is seen exactly edge-on, and its molecular hydrogen has proven the likely presence of a central bar. Recent high-resolution images of its dusty disk show unusual filamentary patterns extending 65,000 light years vertically from the disk. Scientists presume that supernova explosions caused this interstellar dust to be thrown out of the galactic disk toward the halo, but it may also be possible that the light pressure from surrounding stars causes this phenomenon. The surrounding area of NGC891 is populated by multiple low-surface brightness substructures, like giant streams that loop around the parent galaxy up to distances of approximately 163,000 light years (50 kpc). These filaments of dust and gas escape the plane of the galaxy into the halo. In HST images they can be clearly seen against the bright background of the galaxy halo, expanding into space from the disk of the galaxy. The bulge and the disk are surrounded by a flat and thick cocoon-like stellar structure, which have vertical and radial distances of up to 48,900 light years (15 kpc) and 130,400 light years (40 kpc), respectively, and are interpreted as the remnant of a satellite galaxy disrupted and in the process of being absorbed by NGC891.
Supernova SN 1986J was discovered on August 21, 1986 at an apparent visual magnitude of 14.0.
In a telescope, visually NGC891 is a magnificent object.



Iota Cassiopeiae is a multiple star system in Cassiopeia and has a combined apparent magnitude of 4.53, making it visible to the naked eye. Based on its parallax, it is located about 133 light-years (41 parsecs) from Earth. Iota Cassiopeiae is a quintuple star system, consisting of a total of five stars. The brightest star system, iota Cassiopeiae A, contains a white-colored A-type main-sequence star with a mean apparent V-magnitude of +4.61, and component A is a tight binary star system composed of two stars. These are designated Aa and Ab, although sometimes confusingly they may also be labeled as A and Aa, respectively. The primary star is classified as an Alpha^2 Canum Venaticorum-type variable star, and the brightness of this two star system varies from magnitude +4.45 to +4.53 with a period of 1.74 Earth days, because of its magnetic field. The fainter of the A-companion stars is a G-type star with a mass of only 0.69 solar masses. The orbital period of the two stars is about 50 Earth years.

The second major component, iota Cassiopeiae B, is a yellow-white F-type main sequence single dwarf star with an apparent V-magnitude of +6.87. The semimajor axis of its orbit is 2.88 arc-seconds, and it has an orbital period of 620 Earth years around the two stars comprising iota Cassiopeiae A. The third major component, iota Cassiopeiae C, is another binary star system like iota Cassiopeiae A. It comprises two stars, a K-type star and a M-type star, with a combined apparent V-magnitude of +9.05, and it orbits at an angular distance of 7 arc-seconds from the A-B primary.

William Herschel:

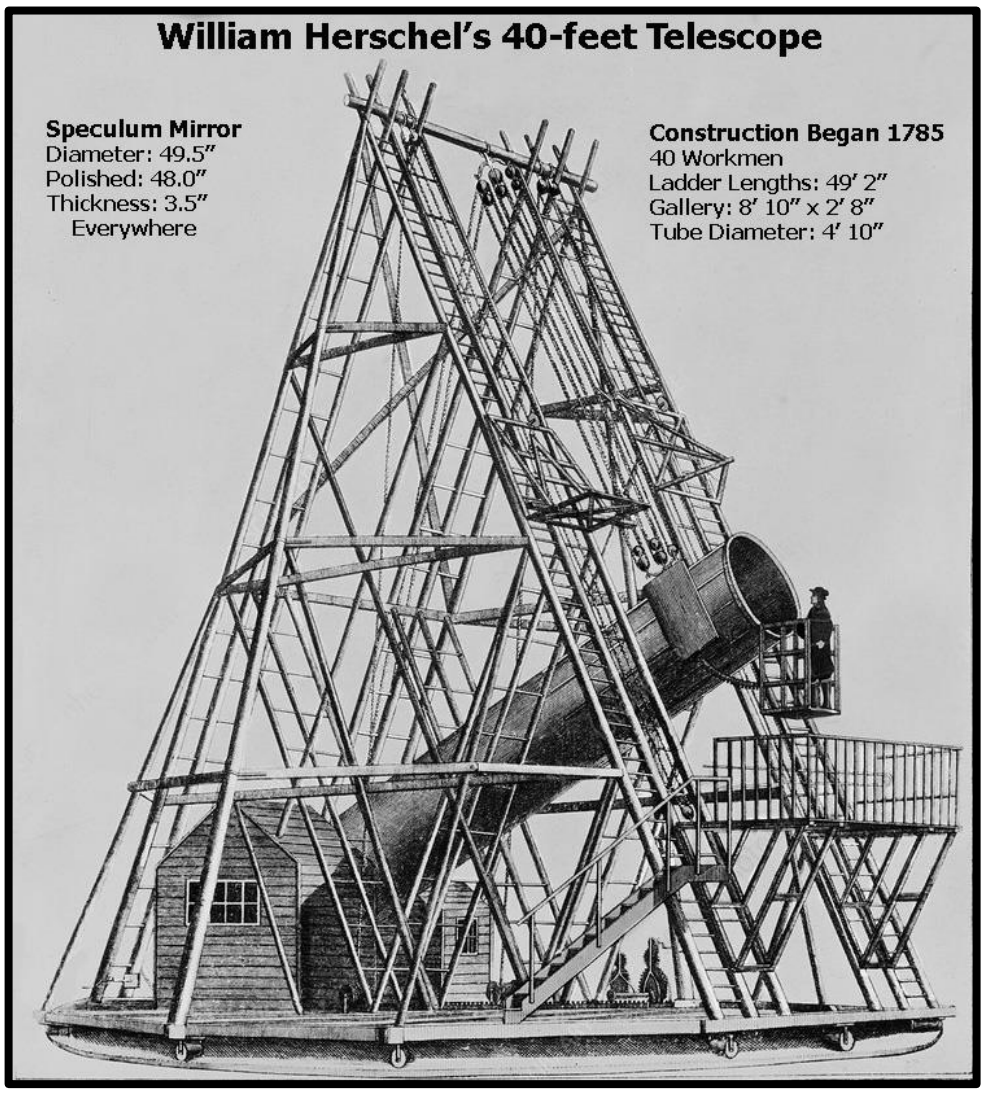
The telescope William Herschel used for his "*Catalogue of new Nebulae and Clusters of Stars*", in his own words was a "Newtonian reflector of 20-feet focal length, and 18 7/10 inches aperture. The sweeping power has been 157 and the field of

view 15’ 4”. The eyeglass is mounted on the side of the octagonal tube. Positional accuracy was true to within 1 1/2 or 2 minutes of polar distance and 4 to 6 seconds of time in right ascension.”

In Herschel’s day any object which could not be resolved into stars was call a “Nebulae”- This includes the objects we call galaxies. William Herschel’s Classification System – The numbers represent the order of discovery. (And the system used Above).

Classification I	**Bright Nebulae**
Classification II	**Faint Nebulae**
Classification III	**Very Faint Nebulae**
Classification IV	**Planetary Nebulae**
Classification V	**Very Large Nebulae**
Classification VI	**Very Compressed and Rich Clusters of Stars**
Classification VII	**Pretty Much Compressed Clusters of Large or Small Stars**
Classification VIIII	**Coarsely Scattered Clusters of Stars**

In 1864 Sir John Herschel published the General Catalogue (GC) of Nebulae which was almost entirely compiled by his father, William Herschel, and his own observations, accounting for 4,629 objects out of the total 5,079 objects listed in the GC. Due to positional errors and new additions, the need for an updated catalog was undertaken by Dr. John Lewis Emil Dreyer in 1876 at Lord Rosse’s Birr Castle observatory in Ireland. Lord Rosse, Lewis Swift and many others contributed observations, in addition to the Herschel’s and in 1886 Dreyer submitted a second supplementary catalogue to the Council of the Royal Astronomical Society which was arranged exactly like the first catalogue, and it was called the New General Catalogue or the NGC. This was published in 1888, and contained a total of 7,840 objects, and is the NGC listing we still use today. Dreyer also published two supplemental catalogues in 1895 and 1908 which included a further 5,386 astronomical objects, and he called these the “*Index Catalogues*”.



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