Stellafane Observing Olympics – 2019

"The Hidden Gems of Stellafane"

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

Observing Pin

Object	Coord (J2000)	Const.	Type	Mag.	Size	S&T Atlas
❑NGC5350	13 53 21.5 +40 21 49	CVn	Gal	11.3 (V)	3.3' x 2.4'	42
NGC5353	13 53 26.7 +40 16 58			10.9 (V)	3.3' x 1.8'	42
NGC5354	13 53 26.7 +40 18 09			11.3 (V)	2.8' x 2.2'	42
NGC5355	13 53 45.6 +40 20 19			14.0 (B)	1.2' x 0.7'	42
❑NGC5981	15 37 53.3 +59 23 29	Dra	Gal	14.2 (B)	3.2' x 0.6'	51
NGC5982	15 38 39.9 +59 21 21			12.0 (B)	2.5' x 1.8'	51
NGC5985	15 39 37.1 +59 19 55			14.2 (V)	5.5' x 2.9'	51
❑NGC6217	16 32 38.7 +78 11 56	UMi	Gal	13.9 (V)	3.0' x 2.4'	51
❑NGC6207	16 43 04.0 +36 49 56	Her	Gal	11.7 (V)	3.3' x 1.7'	52
IC4617	16 42 08.1 +36 40 59		Gal	15.6 (G)	1.2' x 0.4'	52
❑Mu Draconis	17 05 20.1 +54 28 12	Dra	B.S.	5.7/5.7	Stellar	52
❑□α Hercules	17 14 38.9 +14 23 25	Her	B.S	3.4 / 5.3	Stellar	54
❑NGC6440	17 48 52.6 -20 21 34	Sgr	G.C.	10.1 (V)	4.4'	67
NGC6445	17 49 14.9 -20 00 36	Sgr	P.N.	13.2(P)	44.0" x 30.0"	67
❑Haro 1-36	17 49 48.2 -37 01 28	Sco	S.T.	12.0 (P)	10.0"	69
❑NGC6520	18 03 24.9 -27 52 56	Sgr	O.C.	7.6 (V)	6.0'	67
Barnard 86	18 02 58.6 -27 52 00		D.N.	--	5.0' x 5.0'	67
❑NGC6522	18 03 35.0 -30 02 02	Sgr	G.C.	9.5 (V)	9.4'	67
NGC6528	18 04 49.6 -30 03 21	Sgr	G.C.	10.7 (V)	5.0'	67
❑Barnard 92	18 15 27.9 -18 13 19	Sgr	D.N	--	14.0' x 9.0'	67
❑NGC6590	18 17 02.0 -19 51 47	Sgr	R.N	--	5.6' x 3.3'	69
NGC6589	18 16 52.0 -19 46 43		R.N.	--	4.0' x 3.1'	69
IC1283/IC1284	18 17 32.0 -19 41 00		E.N.	--	19.2' x 14.2'	69
❑Σ2470 / Σ2474	19 08 45.1 +34 45 37	Lyr	B.S.	7.0 / 8.4	Stellar	63
❑NGC6760	19 11 12.1 +01 01 50	Aql	G.C.	9.8 (V)	9.6'	65
❑NGC6791 Berkeley 46	19 20 53.7 +37 46 09	Lyr	O.C.	9.5 (V)	10.0'	63
❑NGC6804	19 31 35.2 +09 13 31	Aql	P.N.	13.4 (V)	35.0"	64
❑Berkeley 86	20 20 24.0 +38 42 00	Cyg	O.C.	11.8 V	7.0'	62
❑Egg Nebula PK 80-6.1	21 02 18.7 +36 41 40	Cyg	PP.N.	13.5	1.0' x 0.5'	62
❑NGC7027	21 07 01.8 +42 14 07	Cyg	P.N.	10.9 (V)	60.0"	62
❑NGC7048	21 14 15.3 +46 17 15	Cyg	P.N.	12.1 (V)	61.0"	62
❑S Cephei	21 35 12.8 +78 37 28	Cep	C.S	7.4 – 12.9	Stellar	71
❑NGC7129	21 42 00.0 +66 05 00	Cep	R.N..	11.5 (V)	8.0' x 8.0'	71
❑Mu Cephei - H. Garnet Star	21 43 30.5 +58 46 48	Cep	C.S	3.4 – 5.1	Stellar	71
❑NGC7789 - Blue Stragglers	23 57 26.6 +56 43 14	Cas	O.C.	6.7 (V)	15.0' x 15.0'	03
❑NGC404	01 09 27.3 +35 43 08	And	Gal	11.7 (V)	3.4' x 3.4'	03

***Atlas - "Sky & Telescope's Pocket Sky Atlas", Roger W. Sinnott**

B.N.- Bright Nebula
B.S. - Binary Star
C.S. - Carbon Star
D.N.- Dark Nebula
E.N. - Emission Nebula
Gal - Galaxy
G.C. - Globular Cluster
O.C. - Open Cluster
R.N. - Reflection Nebula
P.N.- Planetary Nebula
Sym - Symbiotic Star

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)

Clear - Steady - Skies

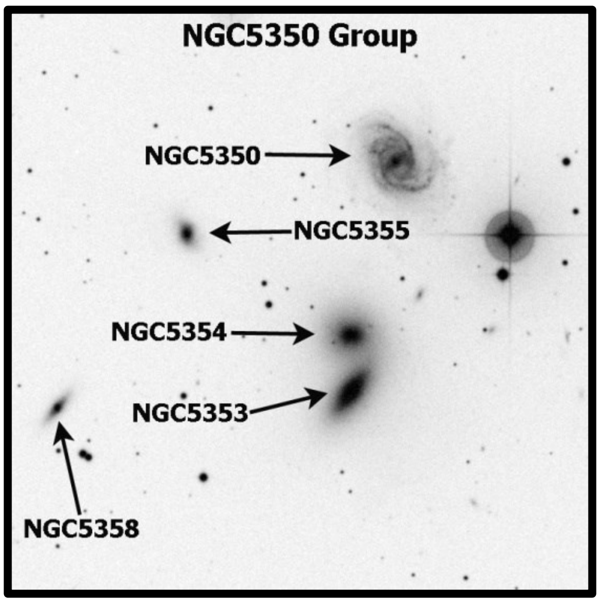
Larry Mitchell – Eileen Myers

***Stellafane*: August 2019**

Stellafane Observing Olympics – 2019
"The Hidden Gems of Stellafane"
Technical Information

Observing Pin

Visual objects in a telescope are always more interesting when the observer knows something about the object being viewed.



NGC5350   Galaxy
Other: Hickson 68C, UGC8810, CGCG 219-17
J2000: 13 53 21.5 +40 21 49   Canes Venatici
Mag.: 11.3 V   Size: 3.3′ x 2.4′   Class.: SB(r) b
Distance (H_0-70km s^{-1} Mpc^{-1}): 107.5 MLYrs

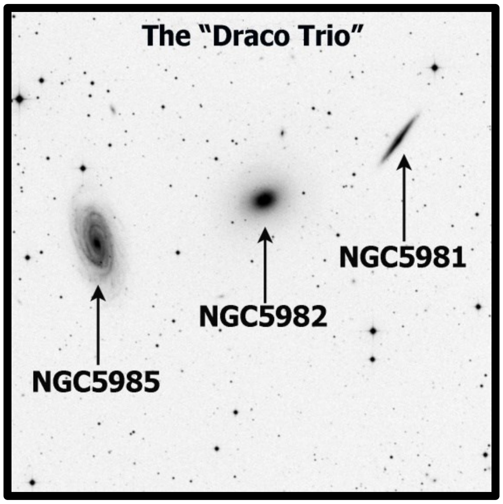
NGC5353   Galaxy
Other: Hickson 68A, UGC8813, CGCG 219-18
Mag.: 10.9 V   Size: 3.3′ x 1.8′   Class.: S0 sp
Distance (H_0-70km s^{-1} Mpc^{-1}): 98.1 MLYrs

NGC5354   Galaxy
Other: Hickson 68B, UGC8814, CGCG 219-19
Mag.: 11.3 V   Size: 2.8′ x 2.2′   Class.: S0 sp
Distance (H_0-70km s^{-1} Mpc^{-1}): 114.5 MLYrs

NGC5355   Galaxy
Other: Hickson 68D, UGC8819, CGCG 219-19
Mag.: 14.0 B   Size: 1.2′ x 0.7′   Class.: S0 ?
Distance (H_0-70km s^{-1} Mpc^{-1}): 112.4 MLYrs

Four of the five galaxies which make-up Hickson 68 were discovered by William Herschel in 1788 using his 17.7 inch speculum reflector. There are 137 other nearby galaxies within 1.23 degrees of NGC5353-NGC5355, and 53 of these have an average similar distance of 113 million light years. Since these are located at the same relative distance as Hickson 68, there could actually be approximately 58 members that are associated with the Hickson 68 group. The luminosity of all 137 galaxies (candidates) within the same diameter is 200 billion times Solar, and the mass to light ratio, MΘ/LΘ is 105, meaning there is a considerable amount of dark matter present. Galaxies are strongly clustered around NGC5353/NGC5354 and the Hickson 68 group is really only a substructure within a larger bound galaxy group. All of these galaxies are located within a filament of material that connects the Coma Galaxy Cluster (Abell 1656) to the Virgo Galaxy Cluster.

Hickson 68 contains three large galaxies, all of which are radio sources. The core of the group is dominated by the S0 galaxies, NGC5353 and NGC5354, while the periphery is composed mostly of spiral galaxies, which are the most luminous. The two elliptical galaxies, NGC5353 = H68A & NGC5354 = H68B, are overlapping from our perspective and are interacting, as they are physically separated by only 29,000 light years (9 kpc). NGC5354 has a weakly active nucleus and is classified as a Low Ionization Nuclear Emission Region or LINER. The large distorted spiral galaxy, NGC5350, is an infrared source, and is classified as a Seyfert galaxy meaning it has an active nucleus.



NGC5981 Galaxy

Other: UGC9948, CGCG 297-23, MCG+10-22-27
J2000: 15 37 53.3 +59 23 29 Draco
Mag.: 14.2 B Size: 3.1′ x 0.6′ Class.: Sab c
Distance (H_0-70km s^{-1} Mpc^{-1}): 112.4 MLYrs

NGC5982 Galaxy

Other: UGC9961, CGCG 294-24, MCG+10-22-29
Mag.: 12.0 B Size: 2.5′ x 1.8′ Class.: E3
Distance (H_0-70km s^{-1} Mpc^{-1}): 123 ± 34 MLYrs

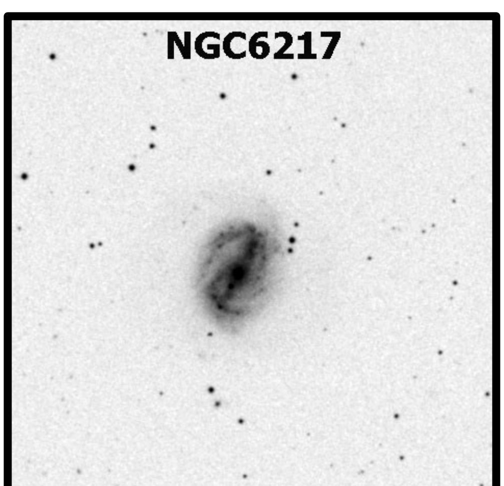
NGC5985 Galaxy

Other: UGC9969, CGCG 297-25, MCG+10-22-30
Mag.: 14.22 V Size: 2.5′ x 2.9′ Class.: SAB(r)b
Distance (H_0-70km s^{-1} Mpc^{-1}): 115.0 MLYrs

Together these three galaxies form the "Draco Trio" or the "Draco Group", but there is no evidence that they gravitationally form a bound group of galaxies. These galaxies all lie slightly over 100 million light years away and take up about half the width of the Moon in the sky. There are many background galaxies in the area.

NGC5982 is an elliptical galaxy located 123 million light years away and was discovered by William Herschel on May 25, 1788. Its diameter is approximately the same as the Milky Way's at 100,000 light years. The central region is very unusual in that the major axis of the nuclear region is nearly perpendicular to the rotational direction of the galaxy. NGC5982 has a large number of rotating shells (26) in its envelope, with the most distant one being 150 arc-seconds along the major axis and best seen in mid-infrared light. The innermost shell is only 8 arc-seconds from the nucleus. These shells and the decoupled nucleus are the product of an accretion-merger of the elliptical galaxy with a much smaller object. The galaxy has both red and blue globular clusters which are over 5 billion years of age, which possibly dates the accretion event. The luminosity of NGC5982 is dominated by light emitted by old stars, and in the center is a supermassive black hole with an estimated mass of 830 million Solar masses. The nucleus exhibits a low level of activity and has been classified as a Low Ionization Nuclear Emission Region or LINER type of galaxy.

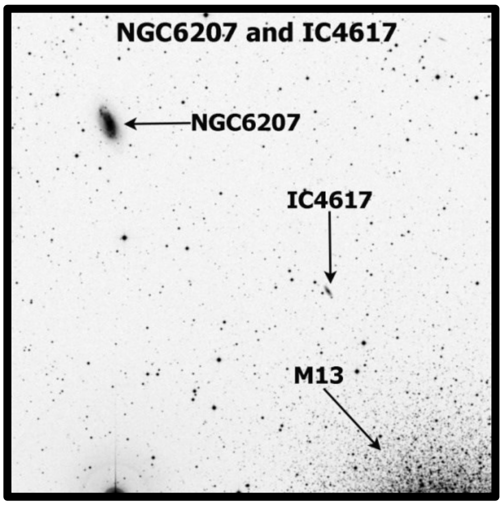
NGC5981 is a spiral galaxy in an edge-on configuration and is located 6.3 arc-minutes to the west-northwest of NGC5982. Its stellar disk appears to be suddenly cut off, or foreshortened. This anomaly is seen in both optical and near infrared images, with the truncation radius being larger in the V-band than in the NIR by about 10 arc-seconds or 10,000 light years. This could be evidence of a bar seen in an edge-on configuration. NGC5985, a face on spiral galaxy is 7.7 arcminutes to the east southeast of NGC5982. NGC5985 has tightly wound spiral arms full of dust and H II regions with a very bright nuclear region which qualifies it as a Seyfert type active galaxy. It has confusingly been classified both as a LINER galaxy, which is the least type of active galaxy, and also as a Seyfert 1 galaxy, which is the most energetic of the active galactic nuclei (AGN) galaxies.



NGC6217 Galaxy

Other: UGC10470, CGCG 355-14, Arp 185, Kaz 73
J2000: 16 32 38.7 +78 11 56 Ursa Minor
Magnitude: 13.9 V
Size: 3.0′ x 2.4′
Classification: (R)SB(rs)bc
Distance (H_0-70km s^{-1} Mpc^{-1}): 63.7 - 67 MLYrs

NGC6217 is a barred spiral galaxy located about 2.5° east-northeast of the star Zeta Ursae Minoris. It is inclined 33° to the line of sight along a position angle of 162°. Its classification indicates it has a false outer ring-like structure which is formed by the spiral arms, the (R) designation. It has a well-defined bar structure running across the face of the galaxy (SB) and a partial inner ring (rs). The spiral arms are moderately wound (bc),with one unusual feature. A third arm originates from the central region of the galaxy. The nuclear region is round with no indication of a disturbance and the bar is prominent and spans an angular diameter of 48 arc-seconds across the face of the galaxy at a position angle of 35.97°. The inner ring of the galaxy is about 43.5 arc-seconds across and a prominent star forming region is located about 10 arc-seconds southeast of the nucleus at the end of the bar (See Photo). NGC6217 is undergoing a large amount of star formation, compared to other galaxies, and has been classified as a starburst galaxy. Ionized H II knots of activity are prominently displayed at the ends of the bar and in the spiral arms. NGC6217's spectrum is dominated by the stellar photo-ionization of hot young stars, less than 10 million years of age. The core of the galaxy contains a low luminosity active galactic nucleus which really is a large H II region, a feature routinely seen in active galaxies, giving it a Seyfert 2 level of activity .



NGC6207 Galaxy

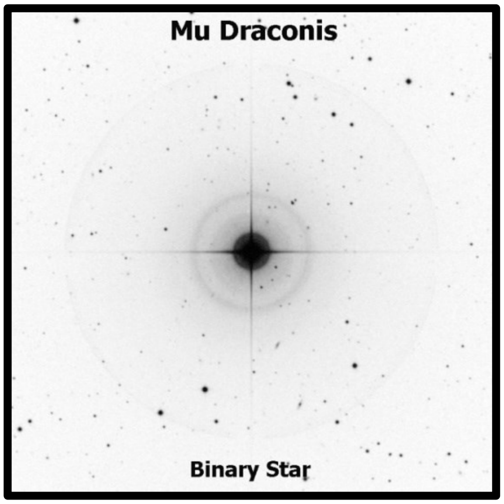
Other: UGC10521, CGCG 197-7, Kara 766, LEDA 58827
J2000: 16 43 04.0 +36 49 56 Hercules
Magnitude: 11.65 V
Size: 3.3′ x 1.7′
Classification: SA(s)c
Distance (H_0-70km s^{-1} Mpc^{-1}): 30 - 39.7 MLYrs

IC4617 Galaxy

Other: LEDA 2085077, 2MASX J16420807+3641025
J2000: 16 42 08.1 +36 40 59 Hercules
Magnitude: 15.6
Size: 1.2′ x 0.4′
Classification: Sbc
Distance (H_0-70km s^{-1} Mpc^{-1}): 490 - 550 MLYrs

NGC6207 was discovered by William Herschel on May 16, 1787 and is relatively nearby for galaxies at 40 million light years distance. A 13.5 magnitude star is located very near the nucleus of the galaxy, but it is not the actual nucleus being a foreground object. The galaxy appears to be evenly lit throughout and no nucleus is seen. NGC6207 has some H II emission present, and a hint of spiral arms are detected in infrared light. A prominent H II knot is located at the north-eastern edge of the halo. Whether or not the galaxy has nearby companions is a controversial subject as some say it is isolated, while other analysts believe there are potentially 5 dwarf galaxies nearby. Its distance is also controversial with most estimates between 30 and 40 million light years although one estimate, based upon non redshift analysis, yields a distance of 62 million light years. In 2004 supernova 2004A was found in NGC6207 located approximately 22" west and 17" north of the center, and initially observed at 15.7 V-magnitude. There are 3 proven quasars in the field and another 5 likely quasars nearby. .

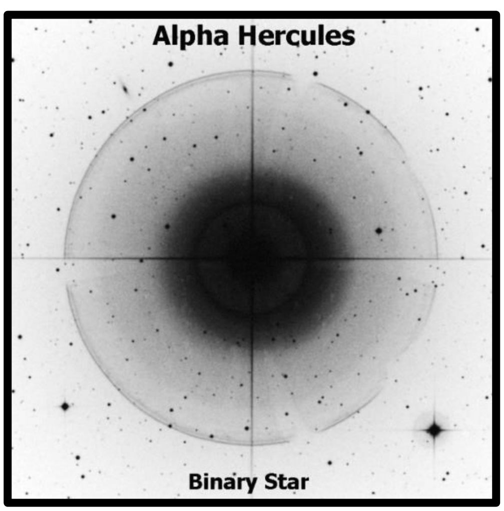
IC4617 is a small background galaxy located only 15′ north of the globular cluster M13, and was discovered by E.E. Barnard. The object appears as a slightly tilted spiral galaxy with well-defined arms and prominent dust lanes, and the core is considerably brighter. There is a hint of a bar-like structure. IC4617 is a Seyfert 2 type galaxy, which explains the bright central region, and therefore it is an active galaxy, with intense emission originating either from profuse stellar formations or from a massive central black hole, or a combination of both. The faint outer spiral structure appears to be slightly warped, but the reasons for this are unclear as IC4617 may or not be isolated. IC4617 has a radial velocity of nearly 11,000 kilometers per second, which puts it nearly 550 million light years from the Earth, and well beyond the 22,000 light years distance to the bright globular cluster, M13 at Vmag. 5.78. The estimated diameter of the galaxy is 107,000 light years which puts it about the size of the Milky Way. It is possible that IC4617 is part of the Abell 2197/ Abell 2199 galaxy superclusters, which are nearby and lie at approximately the same distance. In spite of its listed 15.5 magnitude, the galaxy has a high surface brightness and is visible in medium to small aperture telescopes - Depending upon the sky conditions and the observer.



Mu Draconis   Binary Star

Other: μ Draconis, Alrakis
J2000: 17 05 20.12403 +54 28 12.0994   Draco
Magnitude: Combined 4.92 V
Classification: Binary Star
Distance (H_0-70km s^{-1} Mpc^{-1}): 89 $\pm$ 1 LYrs

Mu Draconis is a double star and possible a triple star system located near the head of Draco, the tip of the Dragon's tongue. The stars together reach 4.9th magnitude because of the combined light of its two similar sixth magnitude stars. Mu-Dra-A and Mu-Dra-B are both spectral type F7 hydrogen fusing dwarf stars with respective close magnitudes of 5.66 and 5.69 and diameters of 3 and 2.6 times Solar. They are both white stars and are separated by only 2 arc-seconds. Both stars have similar temperatures of 6,200 K and have luminosities 3.3 times that of the Sun. The main difference between the two stars are the rotational spin rates. "A" spins with an equatorial velocity of 8.1 miles per second for a rotation period under 6 days, while the "B" member spins at a faster 14.3 miles per second with a period of 3.3 days. The stars are not in tidal synchrony as their orbit averages a large 109 Astronomical Units (AU) with a period of 672 years. Their orbit has a high eccentricity which brings them as close as 62 AU, as it did in 1949, and as far apart as 156AUs. However the large orbit does generate magnetic activity and X-rays from the outer thin coronae of both stars, which have temperatures of about 3 million Kelvin. The primary star is Mu-Dra-A which is also named Alrakis or Errakis, named by Arabian stargazers meaning "the trotting camel" ("the dancing one"). The American author, Frank Herbert, used Alrakis as his inspiration for his named planet "Arrakis" in his popular "Dune" series of books. Mu-Dra-B itself is a close spectroscopic binary star with Mu-Dra-Bb having a mass only 0.29 times Solar. A third star, called Mu-Dra-C is a 14th magnitude star which is located 13.2 arc-seconds away from the inner pair. It is unclear if this is a true gravitationally bound member of the system or a background star. It is a class M4 dwarf with a mass of only 0.29 Solar masses, and if it is a bound member then it has an orbital size of at least 360 AU and a period greater than 4,000 years. At this distance from the primaries however it would be gravitationally unstable and would probably suffer a chaotic ejection.



Alpha Herculis   Binary Star

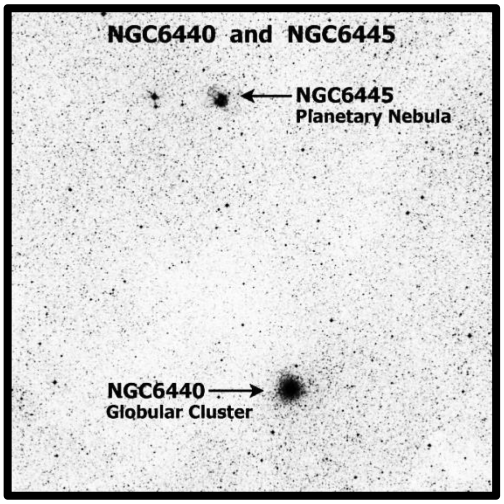
Other: 64 Herculis, Rasalgethi or Ras Algethi, BD+14 3207
J2000: 17 14 38.853 +14 23 25.0   Hercules
Magnitude: Combined 3.08 V
Classification: Binary Star
Distance (H_0-70km s^{-1} Mpc^{-1}): 360 LYrs

Alpha Herculis is a multiple star system which appears as a single point of light to the naked eye. It has the second closest asymptotic giant branch (AGB) star to the Sun and consists of a triple stellar system of spectral type G5 III, A9 IV-V and M5 Ib-II components. The average temperature of the system is 3,280 K with a combined mass of 2.175 to 3.250 times Solar, and the age of the system is between 0.41 and 1.25 billion years.

The primary member is designated α^1 Her, and is called "Rasalgethi or HD 156014, with a visual V-magnitude of 3.350 $\pm$ 0.003. It is a spectral type M5 Ib-II semi-regularly pulsating massive bright giant star with an effective temperature of around 3,275 K. It has a companion star, α^1 Herculis Ab, in a 10 year orbit. The A component, α^1 Her Aa, is the AGB star, a luminous red giant and it has both hydrogen and helium shells around a degenerate carbon-oxygen core. It is the star that is the second nearest AGB star to the Sun. The angular diameter of the star itself has been measured at 0.034 arcseconds, and at its estimated distance of 359 light years this corresponds to a radius of about 170 million miles, which is roughly 1.87 AU. If Rasalgethi were at the center of our Solar System, its radius would extend past the orbit of Mars at 1.5 AU. The red giant is estimated to have started its life with about 2.175-3.250 Solar masses.

The secondary star, α^2 Her or HD 156015, has a Vmag. of 5.39 and is a spectroscopic double star consisting of a G5 III yellow giant, designated α^2 Her A and an A9 IV-V yellow white dwarf star designated α^2 Her B, which is either in the core hydrogen-burning phase or has just entered the sub-giant phase. It is the least evolved star in the system and has a mass between 1.6 and 2.3 times Solar. The α^2 Her A star has a temperature of about 4,900 K while the α^2 Her B star is hotter at 7,350 K. The two stars have an orbital period of only 51.578 days.

The primary α^1 Her, and the secondary star α^2 Her, are separated by 4.7 arc-seconds and have an orbital period of approximately 3,600 years. The Alpha Herculis system is enshrouded in an envelope of dust which is larger than the combined orbits of the stars, and has an average temperature of 518 K. During 1990 α^1 Her experienced a major outburst in which a millionth Solar mass of material was ejected at a speed of approximately 46.6 miles per second (75 km s^{-1}).



NGC6440 Globular Cluster

Other: GC1 77, C 1746-203, MXB 1746-20
J2000: 17 48 52.6 -20 21 34 Sagittarius
Magnitude: 10.10 V, 16.7 V(tip), 18.7 V(HB)
Size: 4.4′
Classification: SSC-V
Distance (H_0-70km s^{-1} Mpc^{-1}): 27,700 LYrs

NGC6445 Planetary Nebula

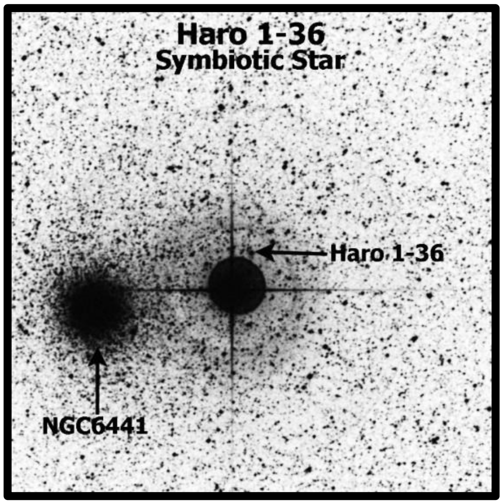
Other: Little Gem Nebula, ESO 589-9, PK 8+03.1
J2000: 17 49 14.9 -20 00 36
Magnitude: 13.2 P
Size: 44.0″ x 30.0″
Classification: 3b + 3 (Oval shaped - Unevenly bright with brighter edges)
Distance (H_0-70km s^{-1} Mpc^{-1}): 3,300 LYrs

NGC6440 is a massive globular cluster containing 572,000 solar masses of material. It was discovered by William Herschel on May 28, 1786, and has a Shapley-Sawyer Concentration Class of V, meaning it is a fairly concentrated cluster, with 1 being the most concentrated and 12 the least. It is located about 258,000 light years from Earth. The cluster is unusual in that it has two horizontal branches, which is a peculiar feature found only in two other bulge stellar systems, namely Terzan 5 and NGC6569. The Color Magnitude Diagram shows a steep Red Giant Branch (RGB) with RGB stars having an average temperature of around 4,500 K. The cluster is located in Sagittarius and therefor suffers from differential reddening, which averages E(B-V)= 1.15. Typical of clusters located within the Galactic bulge, NGC6440 has a high metallicity [Fe/H] = -0.28 $\pm$ 0.14 to -0.50 $\pm$ 0.03 dex, with the latter figure the most recent. NGC6440 has one of the highest oxygen abundances among Galactic globular clusters. Analysis of heavy elements indicates there was a strong and early contamination by type II supernovae. This high abundance enrichment found in NGC6440 could indicate it formed in an area which had a more extended pre-enrichment due to supernovae when compared to the bulk of other field stars.

NGC6440 has energetic activity with a new weak X-ray transient enhancement noted from 2015 to 2017 and coming from the direction of NGC6440. The X-ray burst indicates the compact object in this system is a neutron star. Two accreting millisecond X-ray pulsars were also noted in NGC 6440 which exhibited X-ray outbursts with similar X-ray fluxes. This latest outburst adds to the 24 X-ray sources already present in the cluster.

The planetary nebula NGC6445 appears to be a neighbor of NGC6440 in the sky, but in reality is a much closer object at only 3,300 light years distance. It is a bipolar shaped object with a central ring or torus and bi-polar lobes which are open on the ends. The central region is irregularly shaped with a size ∼40″ x 50″ and ionized forbidden oxygen [O III] dominates. Weaker ionized nitrogen, [N II] emission is found in more extended regions and traces the bi-polar lobes. The lobes are oriented in an east-west direction and span about 1.8 arc-minutes. At the given distance of 3,300 light years this equates to an absolute diameter of 4 light years across the nebula. Filaments are seen both in the lobes and extending from the central region perpendicular to the direction of the lobes (north and south). The north-south emission is mainly in molecular hydrogen or H_2 while the east-west lobes are traced by [N II]. The H_2 emission extends farther away from the center than the lobes. The north-south H_2 emitting filaments which extend ∼1.4′– 1.6′

respectively from the center of NGC 6445, might be the outer boundaries of an edge-on-viewed torus, which was ejected in the asymptotic giant branch (AGB) phase. It is now being disrupted by interaction with the fast stellar wind that was developed later. The south region of the torus seems to be much more disrupted than its northern counterpart.



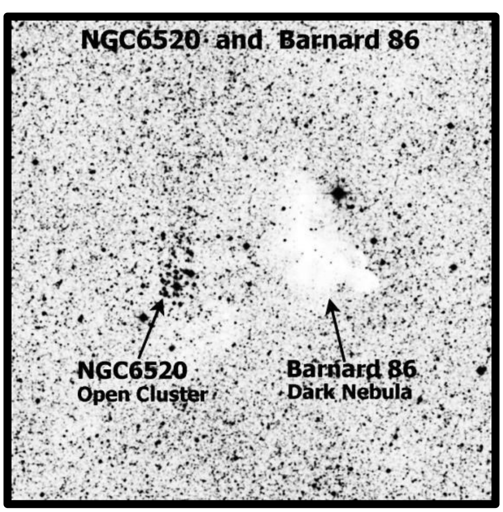
Haro 1-36 Symbiotic Star

Other: ESO 393-31, Henize 2-289, Sanduleak 2-249
J2000: 17 49 48.2 -37 01 28 Scorpius
Magnitude: 12.0 P (Central star 16.8)
Size: 10″
Classification: Symbiotic
Distance (H_0-70km s^{-1} Mpc^{-1}): 14,670 LYrs

Haro 1–36 is a symbiotic star (SySt) and these are binary systems composed of a compact hot star, and a cool giant star. Symbiotics exhibit similar spectral characteristics to planetary nebulae and are often mis-identified. Symbiotic stars represent a brief phase near the onset of the super-wind which ultimately leads to the formation of a planetary nebula. Here a cool, normally a red giant a Mira type star, transfers mass to a much hotter and more luminous compact companion, which is usually a white dwarf, but in some cases it can be a neutron star. The giant star is the origin of the ejection episodes of dust and different emitting gases, resulting in the subsequent nebula, forming a halo around the star closely resembling a planetary nebula halo. Symbiotic stars emit radiation across nearly the entire electromagnetic spectrum, and in near infrared (NIR) colors they have been classified into specific types. Sometimes they erupt in an event called a "symbiotic nova."

Guillermo Haro's discovery (Haro, G. 1952, Boletin de los Observatorios Tonantzintla y Tacubaya) in 1952 initially catalogued Haro 1-36 as a planetary nebula despite its extremely high emission-line spectrum and infrared excess. It was even thought to be a hard X-ray source, but in 1981 it was classified as a binary D-type (Dusty) symbiotic star, which it is still considered to be today. The distance to Haro 1-36 is 14,670 light years (4.5 kpc) and the angular separation between the two stars is ∼0.5 arcseconds, although they have never been resolved. This could mean the actual binary separation has been over estimated. Symbiotic stars have both the hot and the cool stars losing mass through their strong stellar winds, which collide inside and outside the system, resulting in a complicated nebula of gas and dust. These winds create two major shocks with one being the head-on shock, or the front established between the two stars. The other shock is the reverse shock which propagates outward and is the expanding shock we see visually as the halo.

VISUAL: This is a stunning object when using a nebula filter. Without a filter often nothing is seen, but when the filter is in place the difference is stunning, and Haro 1-36 literally jumps out of the background - Bright and easily seen.



NGC6520 Open Cluster

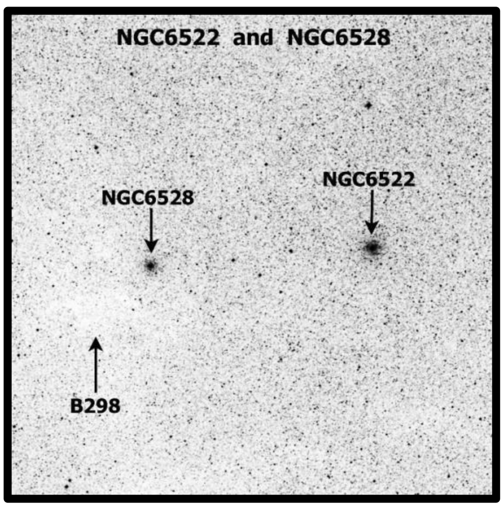
Other: Cr 361, Melotte 187
J2000: 18 03 24.9 -27 52 56 Sagittarius
Magnitude: 7.6 V
Size: 6.0′ x 6.0′
Classification: *Trumpler 1 2 r n
Distance (H_0-70km s^{-1} Mpc^{-1}): 6,500 LYrs

Barnard 86 Dark Nebula

Other: B86, Ldb 93
J2000: 18 02 58.6 -27 52 00
Size: 5.0′ x 5.0′
Classification: Dark Nebula
Distance (H_0-70km s^{-1} Mpc^{-1}): 6,500 LYrs

The Open cluster NGC6520 and the nearby Dark Nebula, Barnard 86, provide one of the most stunningly beautiful views found anywhere in the universe. The pair are superimposed over millions of stars that are located in the central core of the Milky Way Galaxy, yet the star cluster stands out well from the background, and the Dark Nebula's inky blackness is enhanced by this background glow. The cluster contains many bright blue-colored hot stars, an indication of youth. NGC6520 has recently been found to be a much younger object than previously thought, at only 60 million years of age. The earliest stellar objects in the cluster are type B4 V stars which indicate a mass of 6 times Solar. Since we know the average lifetime of this type of stellar object (B4 V), which is 60 million years, we can deduce a Main sequence maximum age of 60 million years, for the cluster. Any more massive stars than this would have even shorter life-times and therefore have disappeared. The most recent distance analysis derived a distance of 6,500 light years. This places the cluster and nebula on the outer edge of the Scutum-Centaurus spiral arm. The brightest star near the center of the cluster is a G8 I extremely massive star with a V magnitude of 8.9. It is an actual cluster member and not a foreground star.

Barnard 86 appears in the sky immediately to the west of the cluster. Barnard 86 is a small dark nebula and was discovered by Edward Emerson Barnard who described it as a "drop of ink on the luminous sky". He was surprised this prominent object had not been previously discovered. B86 is a non-illuminated and non-ionized cloud, but it is not a "Bok globule", which are much smaller denser star forming regions. The center of the nebula is only 6 arcminutes from the center of the star cluster and the two objects do not appear to be completely detached from one another. All of the studies indicate the two objects are located at relatively the same distance from us, however, they have very different radial velocities, and different proper motions, so B86 could not be the birthing cloud for NGC6520, as has been commonly accepted. Even though they may be near each other now, they certainly were not neighbors when they formed. They truly are "two ships passing in the night."



NGC6522 Globular Cluster

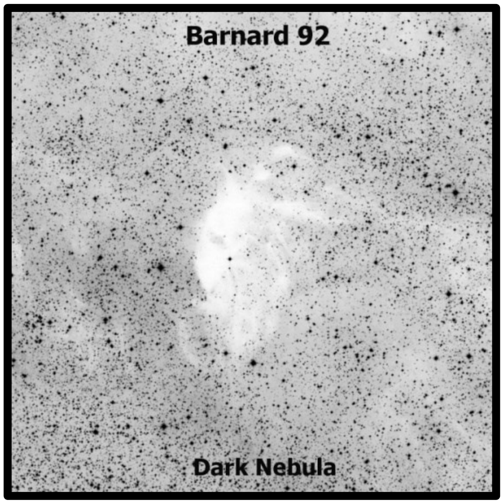
Other: GC1 82, C 1800-300, C1 VDBH 256
J2000: 18 03 35.0 - 30 02 02 Sagittarius
Magnitude: 9.48 V, V(tip) 14.1
Size: 9.4′
Classification: SSC VI
Distance (H_0-70km s^{-1} Mpc^{-1}): 25,000 LYrs

NGC6528 Globular Cluster

Other: GC1 84, C 1801-300, ESO 456-48
J2000: 18 04 49.6 -30 03 21 Sagittarius
Magnitude: 10.65 V, V(tip) 15.5
Size: 5.0′
Classification: SSC V
Distance (H_0-70km s^{-1} Mpc^{-1}): 25,750 LYrs

NGC6522 was discovered by William Herschel on June 24, 1784, and is located only 16 arc-minutes to the west of NGC6528. Both clusters lie roughly at the same distance. It is centered in a region of the sky known as Baade's Window. This is an area of the sky with a relatively low amount of interstellar dust along the line of sight from the Earth. This permits an observational window into the normally obscured Galactic center of the Milky Way and was named for Walter Baade who first recognized its importance. NGC6522 has a Shapley-Sawyer Concentration Classification of VI meaning it is about halfway between the most and the least concentrated globular clusters. It is possible that NGC6522 is the oldest star cluster in the Milky Way with an age estimated to be in excess of 12 billion years. It has a moderate metallicity of [Fe/H] = -1.0 $\pm$ 0.2, unusual for such an old object, but a blue horizontal branch, as expected from an old cluster. Its horizontal branch and abundance ratios are very similar to those of the globular clusters HP-1 and NGC6558, which also are very old, yet moderately metal rich. These clusters indicate the bulge of the galaxy is old, but it went through an early prompt chemical enrichment due to the large number of supernovae as the universe's first stars destructed. These first stars were fast-rotating "spinstars", as determined by the chemical signature they have left behind. Their fast spins may have made them especially prone to dying in spectacular explosions called gamma-ray bursts. Today's telescopes are not yet powerful enough to directly observe the universe's first stars, called generation III stars, which formed and died just a few hundred million years after the big bang. Little is known about them, except that they were probably much more massive than the sun or maybe any star existing today. Their explosive deaths left behind enriched material that was incorporated into stars that formed later, some of which are still around today.

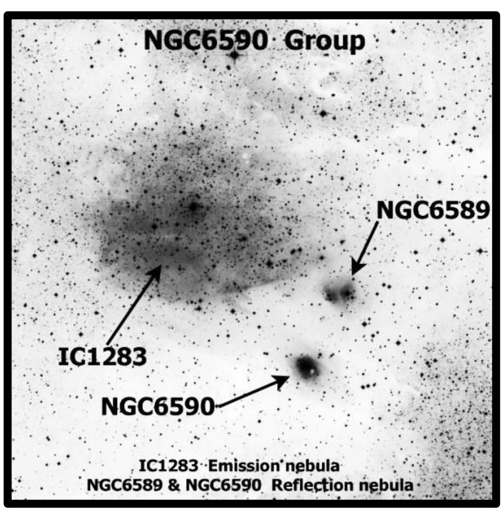
NGC6528 has a Shapley-Sawyer Concentration Classification of V, meaning it is slightly more concentrated than its neighbor to the west. Like NGC6522, it was discovered in 1784 by Willian Herschel and its brightest stars are 15.5 magnitude, as found at the most luminous end-point of the red giant branch. It is one of the most metal-rich bulge globular clusters with [Fe/H] = -0.11 to -0.14 and is only moderately reddened at E(B-V) = 0.54 as it also is located inside Baade's Window. NGC6528 is slightly younger than its neighbor to the west with an age of 11.0 $\pm$ 2 billion years. Of the cluster stars which have been analyzed the average effective temperature is around 4,400 K. The chemical analysis of NGC6528 suggests an origin and evolution similar to that of typical old Galactic bulge field stars enriched by the generation III supernovae mentioned above.



Barnard 92 Dark Nebula

Other: B92, LDN 323
J2000: 18 15 27.9 -18 13 19 Sagittarius
Magnitude: --
Size: 15.0′ x 9.0′
Classification: Dark Nebula
Distance (H_0-70km s^{-1} Mpc^{-1}): 10,000 LYrs

Edward Emerson Barnard referred to Barnard 92 as a "black spot" and it was one of the first dark nebulae known, as it was discovered by Edward Emerson Barnard in 1913. He said, "This black spot known to me in my early days of comet seeking is very sharply defined on its east edge, but less definite on the west. There is a twelfth magnitude star near the middle with several other small stars." Barnard 92 is located on the northern edge of the Great Sagittarius Star Cloud, M24, and is the more conspicuous of two dark nebulae located there, with the other nebula being B93 located just to the northeast of B92. B92 has an opaque core with transparent dark nebulosity attached and it stands out nicely from the Small Sagittarius Star Cloud, M24, part of which it obscures. The nebula is composed of dense obscuring dust that is not illuminated by nearby massive stars and obscures light from more distant stars behind it. It is estimated to be 10,000 light years from the Earth. These dark nebulae are sometimes confused as Bok globules, the place where star formation occurs. Bok globules are small dense isolated clouds that are far less massive than the large dark molecular cloud complexes such as Barnard 92 and those found in Ophiuchus and Taurus. These dark nebulae are also star forming regions but on a much larger scale. The extinction is caused by dust grains located within the complex.



NGC6589 Reflection Nebula

Other: VDB 118, LBN 46
J2000: 18 16 52.0 -19 46 43 Sagittarius
Size: 4.0′ x 3.1′
Distance (H_0-70km s^{-1} Mpc^{-1}): --

NGC6590 - IC4700 Reflection Nebula

Other: LBN 43
Size: 5.6′ x 3.3′
Distance (H_0-70km s^{-1} Mpc^{-1}): --

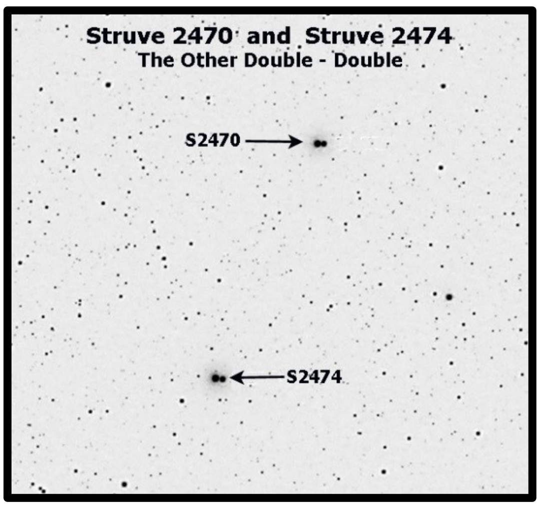
IC1283 Emission + Reflection Nebula

Other: IC1283, IC1284, Sh 2-37
Size: 19.2′ x 14.2′
Distance (H_0-70km s^{-1} Mpc^{-1}): --

The original discovery was apparently made by John Herschel on July 14, 1830, but it was later listed as NGC6595. Both NGC6590 and the nearby NGC6589 were then independently discovered by Barnard's friend and rival comet-seeker,

Lewis Swift on July 12, 1885, who is probably better known today as the co-discoverer of the periodic comet Swift-Tuttle. He described both objects similarly in that a double star was seen in the center of an extremely faint pretty large nebula. IC4700, however, was an independent discovery by E.E. Barnard in August 1905 who was unaware of the prior discovery of NGC6590. Around the turn of the century sharing of information was difficult so multiple discoveries of the same object were unfortunately common. Barnard's "discovery" is listed separately in the Index Catalog, as IC4700. The description is "stars from the 9th mag. downward, 4 stars are in dense nebula." Barnard apparently did not see the nebulosity, NGC6589, which is located just 5.0 arcminutes to the north-west.

NGC6590, the brightest object in the complex, consists of a pair of 11th magnitude stars which are surrounded by a bright reflection nebula, which is part of a grouping of objects some of which are controversial. Superimposed on top of NGC6590 is a small round and distinct dark cloud located on the south-west side of the reflection nebula (See Photo). This is a small patch of dark nebulous material that is not reflective and not ionized. Just to the northwest of NGC6590 is another fainter reflection nebula, NGC6589, which also surrounds a double star. To the northeast of NGC6590 on some atlases, is the much larger object NGC6595 which is supposed to be an open cluster, but there seems to be nothing there. This is considered a mistake, or a mis-classification of one of the nearby reflection nebulae, and is now considered a non-existent object. To the northeast of both reflection nebulae and superimposed over where NGC6595 is supposed to be, is a much larger patch of nebulosity, IC1283/IC1284, which is an H II region, but also contains some un-ionized reflection nebulosity.

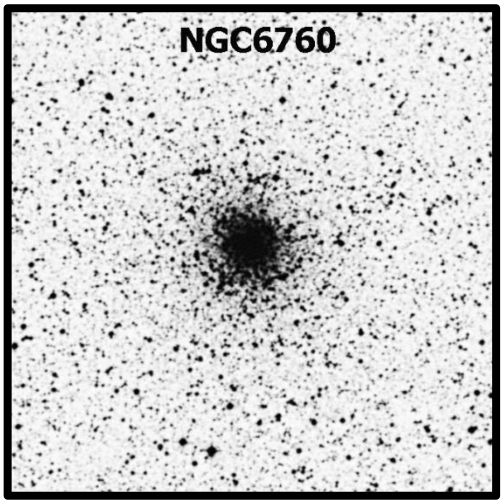


Σ2470 and Σ2474 Binary Star

Other: B92. The Other "Double Double" in Lyrae
J2000: 19 08 45.1 +34 45 37 Lyra
Magnitude: 7.03 / 8.4
Classification: Optical Double (Chance Alignment)
Distance (H_0-70km s^{-1} Mpc^{-1}): 40.8 LYrs and 170 LYrs

This system of stars has gained a bit of fame as the "other double-double" in Lyra, and it is located just to the southeast of the more famous "Double-Double", Epsilon Lyrae. The main stars are separated by 10.5 arc-minutes or three time the split of the Epsilon Lyrae pair. Additionally the space between the tight pairs is about 2.4 arc-seconds for Epsilon Lyrae, but for Σ2470/Σ2474, the space between the tight pairs averages 14.7 arc seconds.

Σ 2470 is the northern most member and consists of "A" at 7.0 mag. and a "B" member at 7.9 mag. which are separated by 13.9". It is located at a distance of 40.8 light years and the stars are massive main sequence stars of spectral type B3V. Σ2474, the southern member, consists of two 6.8 and 7.9 magnitude stars separated by 15.9 arc-seconds, and located 170 light years away. These stars are also main sequence stars but are less massive with spectral types G1V and K1V. Σ2474's primary consists of two stars, not visible in telescopes, Lying one-tenth of an arc second apart, with the secondary star, Ab, at magnitude 8.96 and position angle 258 degrees. These wide doubles therefore are separated by about 130 light years so they are not related and represent a chance alignment in the night sky.

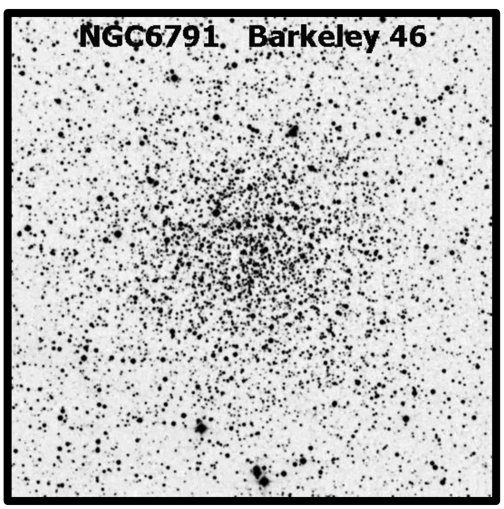


NGC6760 Globular Cluster

Other: GC1 109, C 1908+009, MWSC 3064
J2000: 169 11 12.1 +01 01 50
Magnitude: 9.8 (V), 15.6 (Vtip)
Size: 9.6′
Classification: SSC IX
Distance (H_0-70km s^{-1} Mpc^{-1}): 24,125 LYrs

NGC6760 is located toward the inner galaxy and one of its distinguishing features is its rich metallicity. The cluster has a Shapley-Sawyer Concentration classification of IX meaning it is a fairly loosely concentrated cluster. In 1993 a binary pulsar, PSR J1911+0102A was discovered in NGC6760. The pulsar is a member of a binary system with a short orbital period of 3.618 milli-seconds (mas) or thousandths of a second, and is one of the most compact binary pulsar systems known. The companion mass was the lowest known at the time at 0.02 Solar masses, with the pulsars mass estimated at 1.4 times solar and it is probably a neutron star. No eclipses have been observed in the binary system despite its short orbital time. This pulsar was one of the very low mass binary pulsars (VLMBPs) known in globular clusters. In 2004 a second millisecond pulsar, PSR J1911+0101B was discovered in NGC6760. It is an isolated single object with a rotational period of 5.384 milli-seconds. Both of these pulsars are located within 1.3 core radii of the center of the cluster, and the newly discovered pulsar is probably situated on the far side of the cluster.

Binary pulsars and milli-second pulsars are related to low-mass X-ray binary systems and are the fastest spinning stars in the universe. A milli-second pulsar is one with a period of less than 25 milli-seconds. Many have both a milli-second period and a binary companion so there is a close connection between the two pulsar types. Milli-second pulsars are believed to acquire their short periods by accreting mass from a binary companion which then transfers angular momentum to the primary speeding its rotation upwards. The cores of globular clusters, like NGC6760 are ideal environments for the formation of such systems. Currently there are about 130 milli-second pulsars known in globular clusters, with Terzan 5 holding the most at 38. Terzan 5 also contains the fastest rotating pulsar which spins at 716 times per second.



NGC6791 Open Cluster - Galaxy Core ?

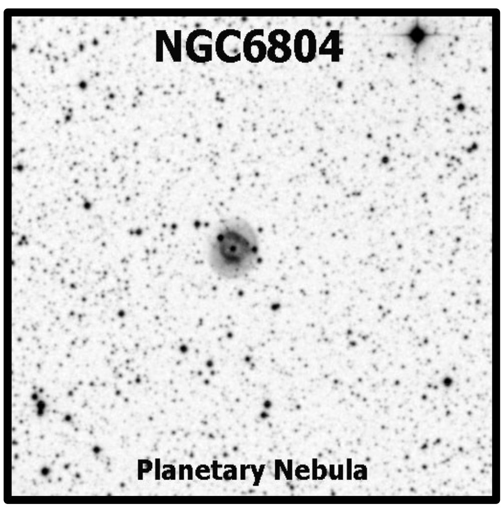
Other: Berkeley 46
J2000: 19 20 53.7 +37 46 09 Lyra
Magnitude: 9.5 V
Size: 10.0′ x 10.0′
Classification: *Trumpler 1 2 r
Distance (H_0-70km s^{-1} Mpc^{-1}): 13,000 - 16,000 LYrs

NGC6791 or Berkeley 46 is located at 13,000 – 16,000 light years distance and is one of the most populated star clusters in the heavens, with a mass of approximately 5,000 solar masses. NGC6791 is also one of the most studied objects, as it has several unusual features which point out that we still have a way to go before we really understand the scientific nature behind the evolution of stars and open clusters. It is officially listed as an open star cluster in Lyra, however it may in fact be a low mass globular cluster, or a transitional object between the two, or even possibly the remnant core of a dwarf galaxy.

NGC6791 was discovered by Friedrich August Theodor Winnecke in 1853. In general, open clusters contain stars that were born out of the same nebulous cloud, at roughly the same time, and most clusters totally dissipate within a few hundred million years due to various internal and external gravitational effects. NGC6791 is considered by many to be the oldest open cluster in the galaxy with estimates ranging from 8.0 to over 12.0 BILLION years, an almost unbelievable statistic for an open cluster. However, in spite of its advanced age, NGC6791 is super metal-rich with [Fe/H] = ∼+0.3 to +0.4, as determined from its evolved stars. The metallicity of NGC6791 is actually more than twice that of the Sun ([Fe/H]

= 0.012). NGC6791 therefore ranks as both one of the oldest open clusters, and also is one of the most metal-rich objects in our galaxy, seemingly an odd, even impossible combination. Other old open clusters include M67 and NGC188 which have ages of 4 and 7 billion years, and they are also considered to have high metallicities, but their [Fe/H] is only solar in nature. This apparent anomaly is explained due to the compact nature of NGC6791, the stellar cluster members, and the intense gravitational field which results. Massive type O and B stars which end their relatively short lives as supernovae, and less dense stars, all expel their newly formed metals into the interstellar medium, but the intense gravitational field of all these stars holds these metals in place, thereby enriching the nearby interstellar medium. This results in newly formed stars being composed of an unusually higher metallic content than would normally be found in most environments. The extremely dense mass of NGC6791 has resulted in the very unusual high metallicity found. This metal richness is contrary to the typical theory where older celestial objects normally carry fewer metals, as metals have simply not yet had enough time to form. 10 billion years ago there had not been time for an abundance of metals to form since stars had only been in existence for a relatively short time period.

To further add to the confusion, the cluster also contains three generations of stars. This is almost unheard of for open clusters, which form out of the same interstellar cloud and at roughly the same time. This is an indication that possibly NGC6791 is the remnant core of an accreted galaxy, which is certainly capable of multi-generations of stars. One further complication present is the population of white dwarf stars with unusual surface abundances. This could be due to the small initial masses of many of the stars which never reach the Helium Flash burning phase of stellar evolution. NGC67891's unique combination of old age, high mass, stellar content and metallicity characteristics place NGC6791 between the physical properties of galaxies and globular clusters and open clusters, and therefore NGC6791 keeps astronomers up at night.

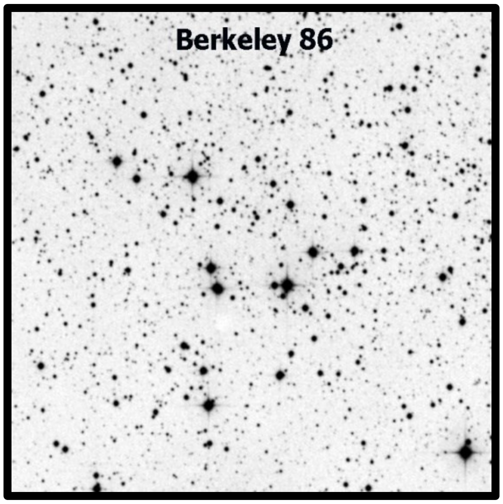


NGC6804 Planetary Nebula

Other: "Snowball Nebula", PK 4.5-4.1, PNG 45.7-4.5
J2000: 19 31 35.2 +09 13 31 Aquilla
Magnitude: 13.4 V
Size: 35.0"
Classification: 4 + 2 (Annular and Oval shaped)
Distance (H_0-70km s^{-1} Mpc^{-1}): 4,200 to 4,900 LYrs

NGC 6804 was discovered by William Herschel on August 25, 1791, but it was not confirmed as a planetary nebula until 1917 by Francis Pease. It's distance has been calculated from 4,200 to 4,900 light years, a typical estimation spread for planetary nebulae, and it is 62" x 49" in angular size which equates to about 1.3 light years in diameter. It is easily located in telescopes and lies only 5 degrees west of Altair. The central star, HD183932, has a temperature of 85,000 K and it is surrounded by a dusty disk of material. In general planetary nebulae have a mean expansion rate of 26 miles per second, so it takes only 15,000 years for the halo of NGC5704 to reach a diameter of 1.3 light years. This holds for all stellar masses, but visibility times become shorter for lower metallicity objects.

NGC6804 is one of the planetary nebula whose shape departs from any standard planetary nebulae kind of symmetry. This possibly is due to the interactions of a triple stellar system. For about one in six planetary nebulae the morphology is too "messy" to be accounted for by models of two star interactions, resulting in bi-polar shapes. Some statistics suggests that approximately 13% to 21% of all planetary nebulae are shaped by an interacting triple stellar progenitor. A third star might influence the mass-loss process which departs from any kind of symmetry in the halos, accounting for the irregular shapes seen in many planetary nebulae, like NGC6804. However in some evolutionary scenarios not all three stars survive the completion process.

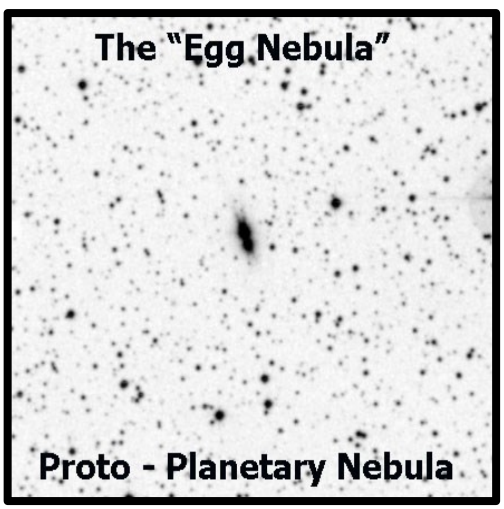


Berkeley 86 Open Cluster

Other: Be 86, OCISM 35, OCL 167.8, C2018+385
J2000: 20 20 24.0 +38 42 00 Cygnus
Magnitude: 11.82 V
Size: 7.0′ x 7.0′
Classification: *Trumpler IV 2 m n
Distance (H_0-70km s^{-1} Mpc^{-1}): 2,900 LYrs

Berkeley 86 lies within the Orion arm in the Cygni OB1 Stellar Association, a region rich in massive OB-Type stars and Young Open clusters, similar to Berkeley 86. Berkeley 86 is considered to be one of the three nuclei of the OB-1 Association and in addition to Be 86, other members of the OB-1 association include Be 87, NGC6913, IC4996, the Wolf Rayet stars WR 139, 141 and 142, and also the Luminous Hypergiant star P Cygni. It is difficult to determine the true distance to the Cyg OB1 Association as it is strung out along our line of sight as we are looking straight down the Cygnus spiral arm when looking in this direction in the sky. Distance estimates range from 5,000 light years (1,500 pc) to 6,000 light years (1,800 pc) and the rich groupings of stars make it difficult to discriminate between cluster members and unrelated stars without a good distance resolution and proper motion determinations. Berkeley 86 is located near the edge of a foreground obscuring cloud at a distance of 2,900 light years (900 pc) which is centered to the east and southeast of the cluster. This results in a variable reddening across the cluster with a range of 0.8 < E(B_V) < 1.2.

Berkeley 86 is a young open cluster at only 5 to 6 million years of age, as determined by its turn-off from the main sequence. There appears to be little current star formation going on with most of the stars having evolved onto the main sequence. A few very bright stars with masses larger than 10 Solar masses have already evolved slightly off of the main sequence. There are, however a number of pre-main sequence stars that have been found, with 27 having an infrared excess. Three of these are thought to be Herbig Ae/Be stars, so some star formation on a limited basis is still occurring.

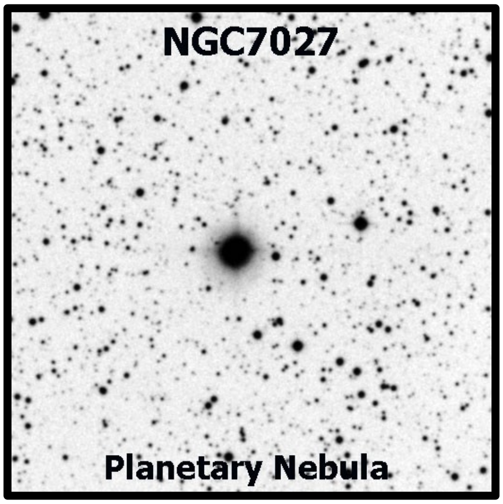


The "Egg Nebula" Proto-Planetary Nebula

Other: PK 80-6.1, CRL 2688
J2000: 21 02 18.7 +36 41 40 Cygnus
Magnitude: 13.5
Size: 1.0′ x 0.5′
Classification: Proto-Planetary nebula (PPN)
Distance (H_0-70km s^{-1} Mpc^{-1}): 1,370 - 3,000 LYrs

The Cygnus "Egg" Nebula is a bipolar proto-planetary nebula, located approximately 1,370 light years from the Earth, although a distance of 3,000 light years has also been proposed, which at present is the more accepted distance. A proto-planetary nebula (Or Pre-planetary nebula) represents the stellar evolutionary stage immediately after the asymptotic giant branch (AGB) phase, but before the star becomes sufficiently hot enough to ionize the expanding halo in the planetary nebula phase. It is a short lived stage and emits strongly in infrared light and is mostly a reflection nebula.

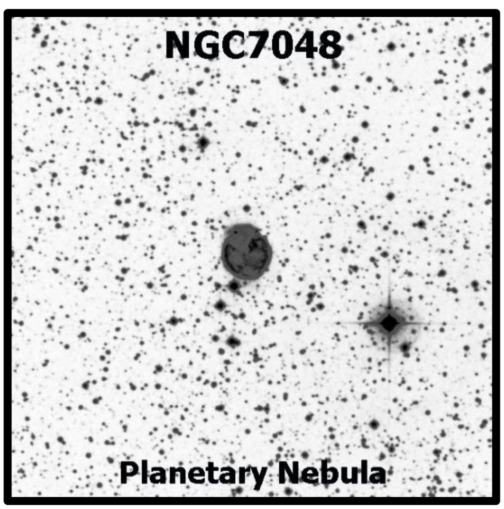
Originally, the Egg Nebula was classified by Fritz Zwicky as a pair of galaxies. In 1975, it was properly identified after being analyzed at 11 µm wavelength with a sounding rocket by the Air Force Geophysical Laboratory. The central star was probably once a Mira type variable star, but it is now a mid-temperature class F5 super-giant star that is illuminating out-flowing columns of dusty gas. Since this is a bipolar nebula the central star most likely is a binary star with one member currently a post asymptotic giant branch star or post AGB. The evolution from the asymptotic giant branch (AGB) to the planetary nebula stage is rapid and therefore relatively few objects of this stage are known, only 326 as of 2007. The Egg Nebula, is one of the best known objects in this post AGB transition stage, along with AFGL 617 in Caelum, in the southern sky. The Egg Nebula is known for its signature bipolar lobes, its jets, and nearly circular concentric arcs. There are about a dozen sources with such arcs, but the Egg Nebula is known to possess the largest number of them, at over 20. These arcs are thought to be mass loss intervals due to stellar pulsations spaced from 50 to 400 years apart, that took place during the early AGB phase of the star's evolution.



NGC7027 Planetary Nebula

Other: "Gummy Bear Nebula", PK 84-3.1, ONG 84.9-3.4
J2000: 21 07 01.8 +42 14 07 Cygnus
Magnitude: 10.9 V
Size: 60.0"
Classification: 3a (Oval Shaped - Unevenly Bright)
Distance (H_0-70km s^{-1} Mpc^{-1}): ~3,260 LYrs

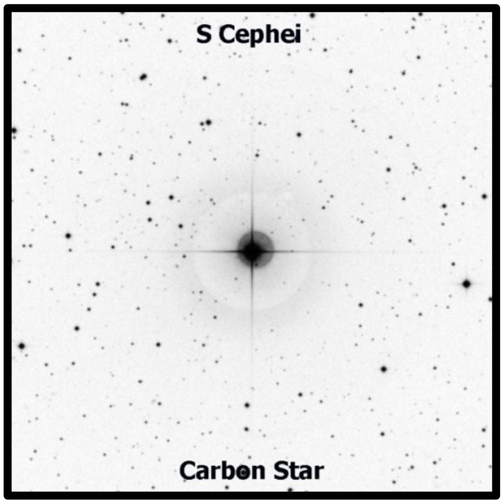
NGC7027 was discovered in 1878 by Edouard Stephan using the 31 inch refractor at Marseille Observatory. Until recently, astronomers were unsure how to classify NGC7027 and it was thought to be a proto-planetary nebula with a cool central star that could not yet ionize the nebula. This was because of the massive amounts of dust present which completely hid the central star. Now we know NGC7027 is a full planetary nebula with one of the hottest central stars known, and it is very young with an age of only approximately 600 years. However, age estimates of 1,200 years (still young) have also been derived. The distance to NGC7027 is only approximately known at 3,260 light years (1 kpc). NGC7027 has a relatively high mass for a planetary nebula at about 0.7 Solar masses, and it is excited by an extremely hot white dwarf star of over 200,000 K, with an estimated luminosity of 7,700 $L_\odot$. At this temperature, the vast majority of the energy is in the ultraviolet. It is thought the progenitor was a rather massive star in excess of 3 solar masses. Collimated directional outflows have been detected, but no stellar fast wind from the central star in NGC7027 has yet been seen, which is very unusual for a central star with the hot temperature measured. The gas and dust patterns are not spherical, but rather elongated and disturbed looking, which is thought to be the product of these highly collimated ejections from the central star. Three collimated outflows have been identified and are located at position angles of -53°, 4°, and -28°, with the -53° outflow the most recent, at less than 1,500 years of age, while expanding outward at 34.2 miles per second (55 km s^{-1}). NGC7027 is one of the most highly energized planetary nebula in the Milky Way.



NGC7048 Planetary Nebula

Other: Hubble 9, PK 88-1.1, PNG 88.7-1.6, PN VV 262
J2000: 21 14 15.3 +46 17 15 Cygnus
Magnitude: 12.1 V
Size: 61.0"
Class.: 3b (Oval shaped, evenly lit, no concentration)
Distance (H_0-70km s^{-1} Mpc^{-1}): 5,260 - 6,200 LYrs

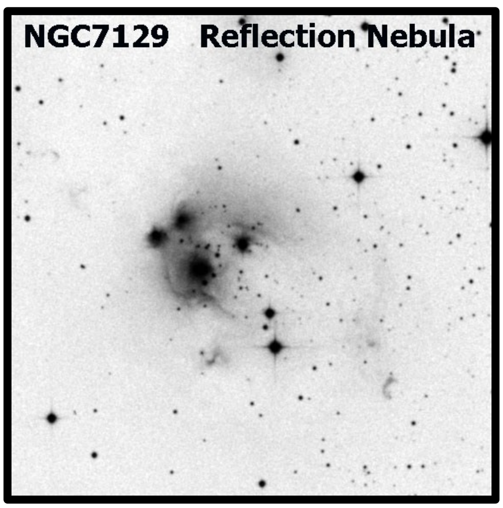
NGC7048 was discovered by Edouard Stephan on October 19, 1878 using a 31.5 inch reflector, and it has received very little interest from the professional community. The nebula is slightly elliptical shaped and has a relatively low surface brightness, indicating it is a highly evolved nebula. It is slightly brighter along the west and east sides and has a bright apparent magnitude of 12.1. A bright star, TYC 3589-4652-1 at 10.5 magnitude is located just to the southwest of the outer nebula and interferes with visual observations. Color photographs show a hot blue [O III] ionized inner region and a cooler red Hα and [N II] outer region. The central star has a V magnitude of 19.12 and a luminosity calculated for hydrogen of only 176 times Solar. NGC7048 exhibits irregularities in the ionization structure and material densities as seen across the face of the disk. These features are indicative of a planetary nebula which may contain a triple star in the center, although this is not yet proven. Planetary nebulae with triple central stars often result in what is termed a "Messy" planetary nebulae, one with an elongated and/or irregular shape. The third object may not be a star at all, but could be a brown dwarf or a massive planet. The irregularities seen in NGC7048 also could result from instabilities in the process of launching the jets, so at present the reason for the abnormalities noted within NGC7048 remain unclear.



S Cephei   Carbon-Variable Star

Other: S Cep., HIP106583, HD206363, BD+77 827
J2000: 21 35 12.8 +78 37 28.2   Cygnus
Magnitude: 7.49 - 12.9
Classification: Carbon-Variable Star
Distance (H_0-70km s^{-1} Mpc^{-1}): 125 LYrs

S Cephie has a spectral type of C6II which means the star is a carbon rich Mira type star, red in color, and nearing the end of its evolutionary life. Its (B-V) Color Index is 2.7 pointing out its temperature is relatively cool for a star. It is bright at an apparent or visual magnitude of 7.49 but its light varies and can be a faint as 12.9 magnitude. Its distance from Earth has been calculated as 125.87 light years (406.50 pc). S Cephei is a highly evolved pulsating Mira type variable meaning its physical size changes over time with a pulsating period of 486.84 days. The light curve is unstable and sometimes a hump or a double maximum occurs. It has the large amplitude pulsations which are typical of Mira type stars, but there is more irregularity present in the light curve than usual. The shape and amplitude of each cycle varies from one to the next. For many Mira type stars often the minimum seems to be more stable than the maximum. In 1999 a second cycle of 1,500 days was found, using amateur observations. S Cephie is surrounded by a shell of material extending out about a third of a light year. This shell is commonly seen around advanced stars and is evidence of a past mass loss of material in the form of a dusty infrared shell.



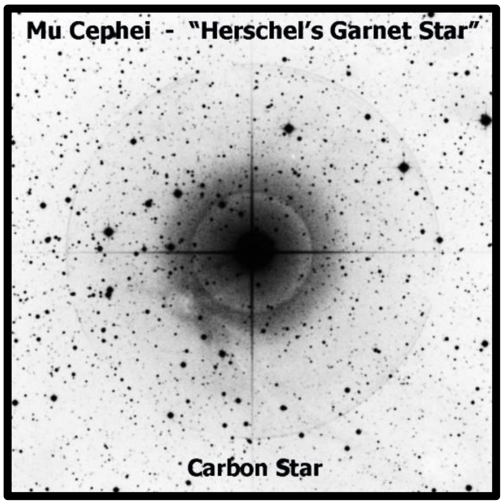
NGC7129 Star Cluster - Reflection Nebula

Other: Cr 441, OCL 240, LBN 497
J2000: 21 42 00.0 +66 05 00   Cepheus
Magnitude: 11.5 V
Size: 8.0′
Classification (Cluster): *Trumpler IV 2 p n
Distance (H_0-70km s^{-1} Mpc^{-1}): 3,300 - 3,750 LYrs

There is a lot of confusion regarding this object. Simbad and MegaStar list NGC7129 as a star cluster, while the professional literature generally refers to this area as a reflection nebula with young embedded stars. Probably both labels are correct and will be recognized here. Some analysts list NGC7133 as the nebula, but Simbad says this is "Not an object (error, artefact)".

The bright reflection nebula NGC7129 is illuminated by the early-type members of a young stellar cluster just emerging from the molecular cloud complex which is composed of the dark nebulae Lynds 1181. The cluster, often labelled as NGC7129, is dominated by a tight grouping of massive B-type stars which includes BD+65°1638 (B3), BD +65°1637 (B3e), SVS 13 (B5e), and the Herbig Be star LkHα 234 (B8e). A compact stellar cluster of low-mass stars also formed concurrently with the B-type stars and are concentrated within a central diameter of ~4.6 light years. An elongated cavity 3.26 light years (one parsec) in diameter has been carved out of L1181, the dark nebula, by the stellar winds and the ultraviolet flux emanating from the central grouping of the massive B-stars. Star forming activity is present throughout the region in the form of two dozen Herbig-Haro (HH) objects, Herbig Ae/Be stars (YSOs 2-8 MΘ), two large molecular outflows, numerous nebulous filaments, cometary nebulae and embedded infrared sources. In the area about 130 pre-main sequence candidates have been identified in an area ~10 arc-minutes in diameter or 10,750 light years in size. The area also includes about 80 Hα emission sources, many of which are T Tauri stars located within the embedded cluster, and have a median age of only 1.8 million years. The temperature, chemistry and the complex molecules found in the hot core region of the NGC7129 complex are all very similar to conditions found within the Orion Nebula, M42.

NGC 7129 is probably associated with the large Cepheus Bubble, an expanding shell 400 light years in diameter. The distance to NGC 7129 is 3,750 light years and its age is about 3 million years. T Tauri type stars (TTSs) are pre-main sequence (PMS) stars with a relatively low mass, less than 2 times Solar. T Tauri stars are still contracting towards the main sequence and convert their own gravitational potential energy to light. Unlike main sequence stars, the temperature in the core of T Tauri stars is not sufficient to start nuclear fusion. These stars show strong irregular photometric variability and emission line spectra. T Tauri stars are separated into two sub-classes, with Classic T Tauri stars surrounded by a circumstellar disk, while Weak-line T Tauri stars have no disk. Both classes have photometric variabilities with different amplitudes. Classic T Tauri stars variability is associated with accretion from the disk and the existence of hot spots on the stellar surface. Weak line variabilities arise from cool spots, or flare like events on the stars surfaces. In some pre-main sequence (PMS) stars, large amplitude drops in brightness (reaching up to 3 mag in the V - band) are observed. The stars with such photometric behavior are known as UXors (the name comes from their prototype UX Orionis). The observed drops in the star's brightness can last for several days and in some cases a few weeks. These drops are probably caused by obscuration of the young star from circumstellar clouds of dust in the line of sight to the star. All of these stellar types are displayed in the NGC7129 complex.

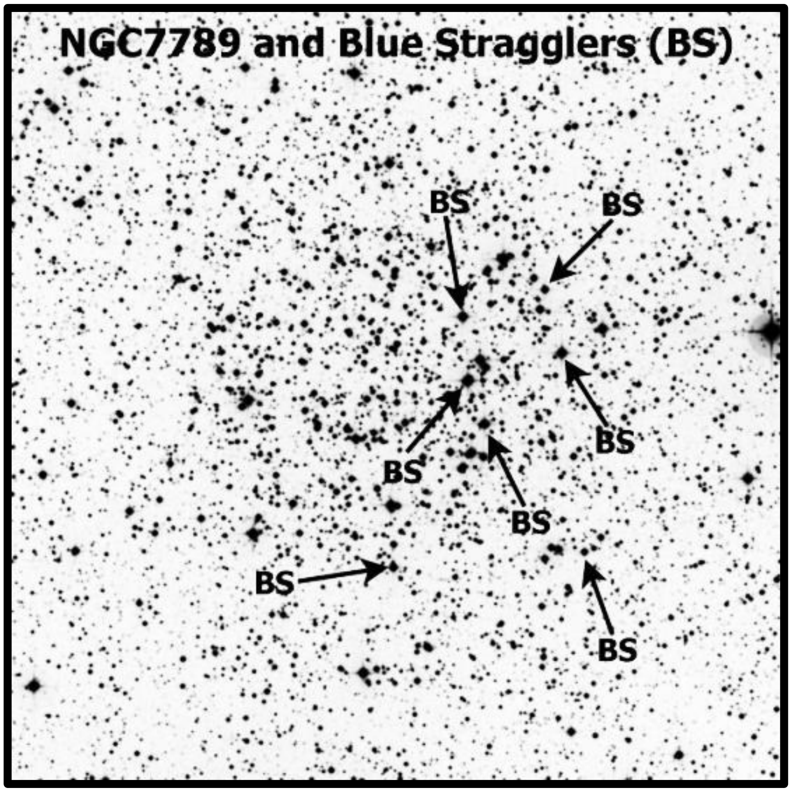


Mu Cephei Carbon Star

Other: Herschel's Garnet Star, μ Cep, Erakis
J2000: 21 42 30.5 +58 46 48 Cepheus
Magnitude: 3.4 - 5.1
Size: 18.672 mas
Classification: Carbon Star
Distance (H_0-70km s^{-1} Mpc^{-1}): 1,270 - 2,840 LYrs

Mu Cephei is a red supergiant or even a Hypergiant, a huge star, with a radius 1,260 - 1,420 times larger than the Sun and is one of the largest stars known. In our Solar System if it was placed where the Sun is its outer surface would be between the orbits of Jupiter and Saturn. Large aperture telescopes with high magnification and good sky conditions can actually see the disk of the star (Its angular diameter is 18.672 mas). It is 1,270 to 2,840 light years away and is visually 283,000 brighter than the Sun. William Herschel was the first to notice its "very fine deep garnet color". John Russell Hind in 1848 discovered the star was variable and Its apparent brightness varies erratically between magnitude 3.4 and 5.1. A lot of different periods have been reported, but they are all near 860 days and 4,400 days.

Mu Cephei is a runaway star which is moving at a rapid velocity of 50.0 miles per second. Its effective temperature has been various calculated at around 3,750 K, and its initial mass was around 25 Solar masses. Mu Cephei is surrounded by a shell of dusty material extending out to a distance four times the star's radius, with a temperature of 2,055 ± 25 K. This shell also contains molecular gases such as CO, H_2O, and Si, and this shell is expanding at 6 miles per second (10 km s^{-1}), indicating an age for the shell of 2,000 to 3,000 years. The star is losing mass at the rate of one ten millionth of a Solar mass per year, and its days are numbered. It is presently fusing helium into carbon and cannot shed enough material to prevent an explosive end in an event called a supernova. For a star as massive as Mu Cephei the remnant left behind will not be a white dwarf, or a neutron star, but a massive black hole. Mu Cephei is located at the edge of the IC1396 nebula. Since 1943, the spectrum of this star has served as the M2 Ia standard by which other similar stars are classified.



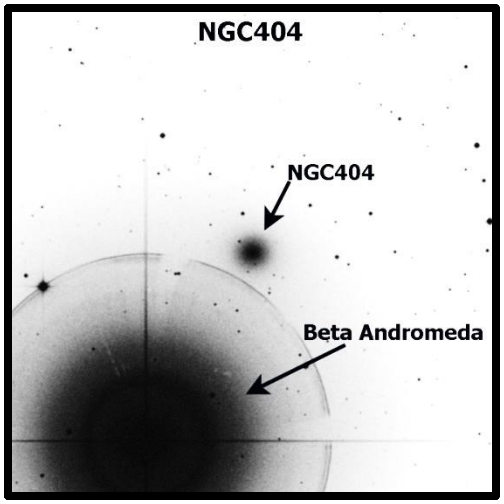
NGC7789 - Blue Stragglers

Other: "Caroline's Rose", Cr 460
J2000: 23 57 26.6 +56 43 14 Cassiopeia
Magnitude: 6.7 V
Size: 15.0′
Classification: *Trumpler II 2 r
Distance (H_0-70km s^{-1} Mpc^{-1}): 5,870 LYrs

NGC7789 is a beautiful open cluster in Cassiopeia that was discovered by Caroline Herschel in 1783. Her brother William Herschel included it in his catalog as H VI 30. This cluster is also known as "The White Rose" Cluster or "Caroline's Rose" because when seen visually, the loops of stars and dark lanes look like the swirling pattern of rose petals as seen from above.

NGC7789 is one of the most studied and analyzed objects in the heavens. It is an Intermediate aged open cluster that has been intensely studied for stellar and open cluster evolution. There are many reasons for this interest, some of which are, it is nearby and populous, has a well-defined color magnitude diagram (CMD), an extended Red Branch, a prominent "red clump" of core Helium burning stars, many blue stragglers and it has a well-defined main sequence. Its age has been estimated to be 1.1 to 1.85 billion years, with the older age the more recent. Proper motion studies within the cluster have identified 679 stellar objects out to B ≈ 15.5 mag. as having similar trajectories and therefore are probable cluster members. The Milky Way Star Cluster Catalog lists nearly 1,500 objects as cluster members. As of 2015, 73 stars have been found to be variable with most of them being eclipsing binaries, rather than more evolved pulsating stars. Most of these stars are W UMa type variables with periods shorter than a day. W Ums variable stars are interacting binary stars where both members are so close they are practically in contact with each other and will eventually merge into a single rapidly rotating object.

NGC7789 has probably been studied more for the 30 or so blue straggler (BS) stars it contains, than just about any other cluster. Blue stragglers are main sequence stars in an open or globular cluster that appear younger and are more luminous and bluer (hotter) than the stars at the main sequence turnoff. On a typical Color magnitude Diagram they appear above and to the left of the main sequence turnoff - Where no cluster stars should be. The conventional stars in an open cluster are positioned along the main sequence according to their initial mass and they all reach the turnoff point at roughly the same age and mass. These BS stars however typically contain two to three times the mass of these "conventional" stars and even more confusingly they are situated above the turnoff point of the cluster on Color Magnitude Diagrams. These stars were first discovered by Alan Sandage in 1953, and astronomers are still to this day trying to understand how these seemingly impossible stars exist. Initially it was thought they were late forming stars and in effect were "*straggling*" behind the rest of the cluster evolution. The best theories now are related to interactions or mergers between two or more stars in a binary system within the confines of the star cluster. This results in "born again stars" with chemical content, mass and temperatures equivalent to what is seen in blue straggler stars. The blue stragglers in NGC7789 are bright and visually are easily seen



NGC404 Galaxy

Other: "Mirach's Ghost", UGC718, CGCG 520-20
J2000: 01 09 27.3 +35 43 08 Andromeda
Magnitude: 11.7 V
Size: 3.4′ x 3.4′
Classification: SA(s)0
Distance (H_0-70km s^{-1} Mpc^{-1}): 10.0 MLYrs

NGC 404 is a galaxy located only 10 million light years away. It was discovered by William Herschel in 1784 and NGC404 lies just beyond the Local Group of galaxies and does not appear gravitationally bound to it. In the sky It is located within 7 arc-minutes of the second magnitude star Mirach, making it a difficult target to observe or photograph and granting it the nickname "Mirach's Ghost". NGC404 is a very isolated dwarf lenticular galaxy that is slightly smaller than the Small Magellanic Cloud, but it is slightly brighter. Unlike many other early-type lenticular galaxies it is very rich in neutral hydrogen, most of which is concentrated in a pair of large concentric rings. Low level star formation is occurring both in the central and in its outermost regions. Both the outer gas disk and its star formation are assumed to have been triggered by one or several mergers with smaller galaxies roughly 1 billion years ago. It is thought that NGC404 is a former spiral galaxy that was transformed into a lenticular galaxy by one of these accretion events. The core of the galaxy contains a Low Ionization Nuclear Emission-line Region or LINER, which is characterized by spectral line emissions from weakly ionized atoms. This is the weakest form of active galactic nuclei or AGNs and is the product of an active nuclear star cluster or a black hole of several tens of thousands of Solar masses. Two methods of measuring distances to nearby galaxies have yielded 9.9 and 10.0 million light years. Recently in 2018 a possible satellite galaxy designated Donatiello I was identified as a possible companion to NGC404. Donatiello I is a dwarf spheroidal galaxy with very little activity or star formation. Its distance has not been confirmed so it may or may not be a true satellite of NGC404.

*Trumpler Classification (Open Clusters):

Degree of Concentration:

- I. Detached cluster - strong central concentrtion
- II. Detached cluster - little central concentrtion
- III. Detached cluster - no noticeable central concentrtion
- IV. Not well detached from surrounding star field

Brightness Range:

1. Most stars same apparent brightness
2. Moderate range in brightness
3. Composed of bright and faint stars

Number of stars in cluster:

- p. Poor - less than 50 stars
- m. Medium rich - 20 to 100 stars
- r. Rich - more than 100 stars

Shapley-Sawyer Concentration Class (SSC) for Globular Clusters:

Scale ranges from one to twelve according to concentration.

SSC I = Most concentrated (M75)
SSC XII = Least concentrated (Palomar 12)

Named for Harlow Shapley and Helen Sawyer Hogg who catagorized GCs from 1927 to 1929.

Larry Mitchell - Eileen Myers Stellafane - 2019