2022

Stellafane Observing Olympics – 2022

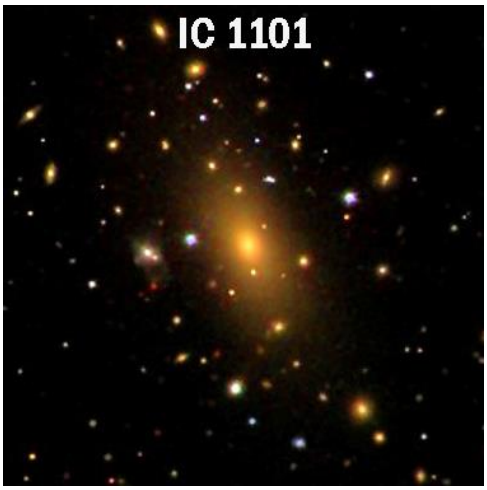
"The Hidden Gems of Stellafane"

Observe Any 15 Objects in Any Telescope – Receive a Pin

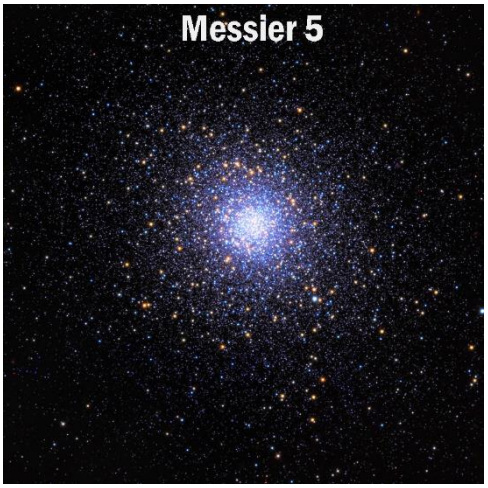
NAME	ALTERNATE	COORDINATES J2000	CONST.	TYPE	MAG.	SIZE	MISC.
☐ IC1101	UGC9752	15 10 56.1 +05 44 41	Vir	Gal.	14.7	1.1' x 0.6'	E/S0
☐ Messier 5	NGC5904	15 18 33.2 +02 04 52	Ser	G.C.	5.7	23.0'	V(tip) 12.2
☐ Delta Ser	Σ1934	15 34 48.0 +10 32 15	Ser	Binary	5.2	Stellar	4.0" Sep
☐ IC4567	UGC9940	15 37 13.5 +43 17 52	Boo	Gal.	13.5	1.4' x 0.9'	Scd ?
☐ NGC6231	OCL 997.0	16 54 08.5 -41 49 36	Sco	O.C.	2.6	14.0'	1207 members
☐ Messier 10	NGC6254	16 57 09.1 -04 06 01	Oph	G.C.	6.6	20.0'	V(tip) 12.0
☐ Messier 92	NGC6341	17 17 07.3 +43 08 11	Her	G.C.	6.5	14.0'	V(tip) 12.1
☐ 95 Her	STF 2264	18 01 30.4 +21 35 44	Her	Binary	5.2	Stellar	6.3" Sep
☐ NGC6633	Theia 924	18 27 31.2 +06 34 12	Oph	O.C.	4.6	27.0'	145 members
☐ Messier 11	NGC6705	18 51 05.0 -06 16 12	Sct	O.C.	5.8	13.0'	682 members
☐ NGC6709	Collinder 392	18 51 18.0 +10 19 16	Aql	O.C.	6.7	13.3'	305 members
☐ Messier 54	NGC6715	18 55 03.3 -30 28 48	Sgr	G.C.	7.7	12.0'	V(tip) 15.2
☐ Messier 56	NGC6779	19 16 35.6 +30 11 01	Lyr	G.C.	8.4	8.8'	V(tip) 13.2
☐ Coat hanger	Collinder 399	19 25 24.0 +20 11 00	Vul	Asterism	3.6	60.0'	42 members
☐ Messier 55	NGC6809	19 39 59.7 -30 57 53	Sgr	G.C.	6.3	19.3'	V(tip) 11.2
☐ NGC6819	Collinder 403	19 41 18.0 +40 11 12	Cyg	O.C.	7.3	5.0'	929 members
☐ Messier 71	NGC3838	19 53 46.5 +18 46 45	Sge	G.C.	8.4	7.2'	V(tip) 12.1
☐ IC1311	Collinder 414	20 10 47.4 +41 10 30	Cyg	O.C.	13.1	9.0'	392 members
☐ Omicron 1		20 13 37.9 +46 44 29	Cyg	Asterism	8.7	Stellar	5.5' Sep
☐ Messier 39	NGC7092	21 31 48.0 +48 26 00	Cyg	O.C.	4.6	31.0'	100 members
☐ NGC7332	LEDA 69342	22 37 24.5 +23 47 54	Peg	Galaxy	12.0 B	4.0' x 1.1'	SO pec sp
☐ NGC7814	UGC 8	00 03 14.9 +16 08 43	Peg	Galaxy	11.6 B	6.3' x 2.2'	SA(s)ab: sp
☐ NGC185	UGC396	00 38 57.7 +48 20 14	Cas	Galaxy	10.1	11.9' x 10.1'	E3 pec
☐ Vetešník 42	Inside M31	00 41 01.1 +41 13 47	And	G.C.	14.26 V	--	2.5 MLYrs Dist.
☐ NGC752	Melotte 12	01 57 41.0 +37 46 06	And	O.C.	53.7	49.3' x 49.3'	258 members

LARRY MITCHELL - EILEEN MYERS

Stellafane Observing Olympics – 2022
"The Hidden Gems of Stellafane"

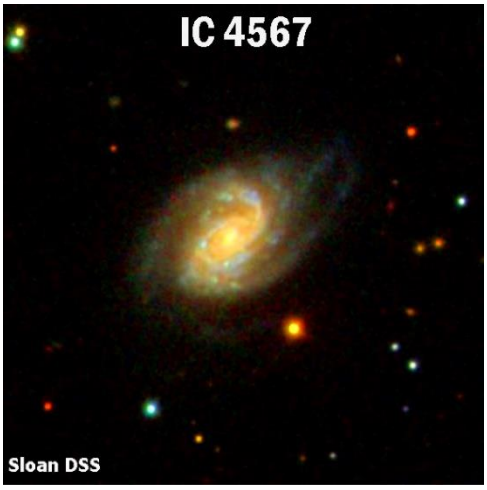


IC1101 was discovered on a Saturday night, June 19th 1790 by Sir William Herschel. It is located in the Virgo constellation, but its distance of 1.04 billion light years places well behind the Virgo Galaxy Cluster. IC1101 is a supergiant elliptical galaxy located at the center of the rich Abell 2029 galaxy cluster, and is its brightest member. IC1101 is often referred to as the largest galaxy known, with a halo which spans a whopping 2.0 to 6.0 million light years and contains about 100 trillion stars. This means that IC1101 is 55 times the Milky Way's size and about 2,000 times more massive. If the diameter of IC1101 is 6 million light years and our galaxy were replaced with IC1101, it would swallow the Milky Way, Magellanic Clouds, M31, M33 and all the space in between. There is debate regarding the classification of IC1101, and whether it is an elliptical galaxy or a lenticular galaxy. IC1101 shows almost no rotation within 42,000 light years of the center, but beyond this region a rotation rate has been tentatively measured at ~31 - 95 miles s^{-1}. Hubble Space Telescope images indicate a flattened core region which indicates a lenticular classification, but its true status is unclear. Like most large galaxies, IC1101 is populated by a number of older, lower density metal-poor stars, some of which are seven billion years older than the Sun. This make the galaxy appear golden yellow in color images.

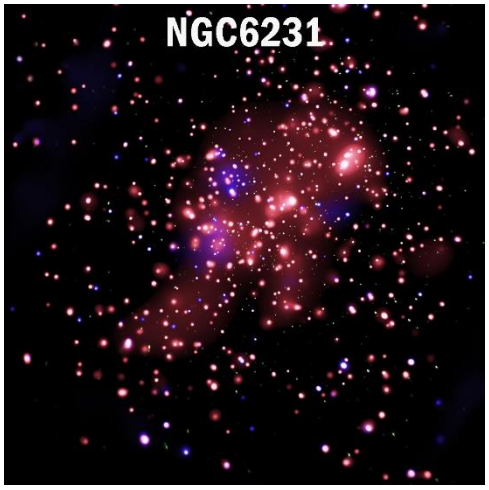


Messier 5 – This bright (Vmag. 5.6) globuar cluster was discovered in 1702 by Gottfried Kirch and independently "discovered" by Charles Messier in 1764. Under favorable conditions M5 is just visible to the naked eye as a faint star-like object, located 22 arc-minutes north-west of the double star 5 Serpentis. M5 is 24,500 light years away and contains a mass of 857,000 solar masses, which is located within a sphere 160 light years in diameter. its estimated age is 10.62 billion years which results in a low metallicity, [Fe/H] = -1.12 dex. The brightest stars at the V-tip have an apparent magnitude of 10.6 making the cluster easily resolvable in small telescopes. There are 105 known variable stars within M5 and 97 of these are RR Lyrae type stars. Because these are ancient stars which frequent globular clusters, they are sometimes referred to as "*Cluster Variables*". The brightest variable stars in M5 vary from magnitude 10.6 to 12.1 in a period of just under 26.5 days. Some visual observers report a curved wing of stars stretching from the northeast to the south of the central region. Steve O'Meara says this is the finest visual globular cluster in the northern sky for small telescopes.

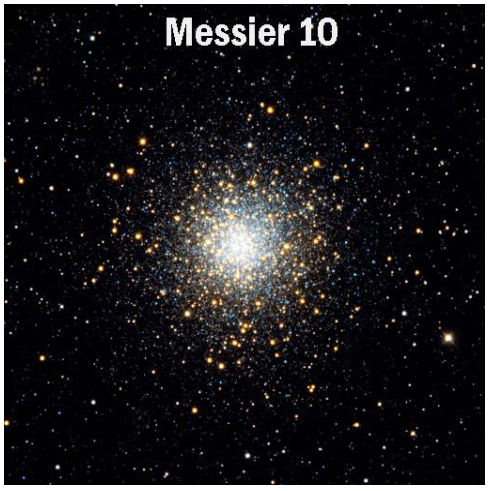
Delta (δ) Serpens is a binary star system which is bright enough to be visible to the naked eye, as the combined light from the two stars has an apparent magnitude of 3.80. The system is located approximately 230 light years from the Sun and is moving in our direction with a radial velocity of 26 miles per second. This movement will place the stars only 115 light years away in 1.2 million years from now. The primary, or component A is a yellow-white spectral F-type sub giant with an apparent magnitude of +4.25, and is classified as a Delta Scuti type variable star. Its magnitude varies by only 0.04 mag. with a period of only 3.74 hours. Its companion, or component B is also an F-type subgiant which is slightly fainter with a magnitude of +5.2. The A and B stars are separated by 4 arc-seconds in the sky, creating a visual test of the observer, optics and sky conditions. The stars complete one orbit around their center of mass once every 3,200 years, so little or no movement has been observed.



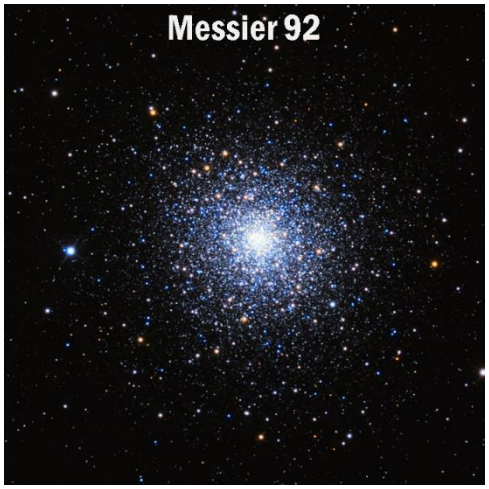
IC4567 was discovered on August 20, 1890 by Edward E. Barnard and is an emission line ***"Grand Design***" starburst galaxy. It is rich in H II star forming regions, but it does not appear to be disturbed despite the nearby galaxies IC4562, IC4564, and IC4566, which have similar redshifts. The majority of starburst galaxies are in the midst of a merger or close encounter with another galaxy which frequently show irregularities and tidal tails. A starburst galaxy has an exceptionally high rate of star formation. The star formation rate in the Milky Way is about 3 M☉/year while a starburst galaxy may experience star formation rates 33 times greater. A starburst galaxy must have a large supply of gas and dust available to form stars, but these galaxies consume their gas reservoirs so rapidly they can only maintain this phase for a short time-period, much shorter than the age of the galaxy. Massive stars emit most of their energy at short ultraviolet wavelengths, but very little of this light actually reaches Earth as surrounding dust grains absorb the UV light and reemit it in the infrared.



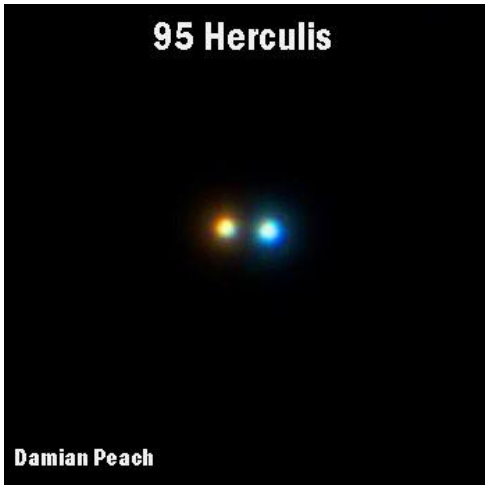
NGC6231 or Caldwell 76 is an open cluster located half a degree north of the double star Zeta Scorpii. NGC6231 and Zeta (HR6262/HR6271) are both part of a large stellar concentration known as the ***Scorpius OB1 Association***, which contains seven individual physical groups. The cluster and the association both lie on the near side of the neighboring Sagittarius Arm, which is located just inside the Orion Spur where we are located. NGC6231 is 4,540 - 5,600 light years away, is approaching the Solar System at 13.7 miles per second, and is bright with a V-magnitude of 2.6. Its apparent diameter on the sky is 15.0 arc-minutes and its estimated age is a young 2 to 7 million years, as indicated by the cluster still located within its natal star forming cloud. NGC6231 has a core radius of 3.9 light years with a central density of ~200 stars pc^{-3} and a total of 1,207 member stars. A small subcluster of stars is superimposed on the main cluster. NGC6231 contains a substantial O-type binary population, while B-type stars are less frequently found in binary systems than their more massive O-type counterparts. Three massive Wolf Rayet stars are found within NGC6231.



Messier 10 or NGC6254 is a globular cluster located in Ophiuchus. It was discovered by Charles Messier on May 29, 1764, a Tuesday night, who described it as a "nebula without stars". William Herschel using his larger telescope of 18.75-inches aperture resolved M10 into stars. The tidal diameter is 38.6 arc-minutes which is about the apparent diameter of the Moon, but visually it appears only half this size, as its bright core dominates and is 35 light years across. The overall spacial diameter of M10 is 83 light years and it is approximately 14,300 light years away from Earth. It is one of the closest clusters to the Galactic center at only 16,300 light years, completing an orbit around the Galaxy in about 140 million years. Messier 10 has an age of 11.39 billion years and is moderately metal poor at [Fe/H] = -1.45 dex, which is only 3.5% the abundance of the Sun. M10 has an enrichment of elements generated through the s-process in massive stars and Type II supernovae, but it shows little evidence of enrichment by Type 1a supernovae. Binary stars on average are more massive than normal stars, so they tend to migrate toward the center of clusters. The fraction of binary stars in the core region of M10 is about 14% and this proportion decreases with increasing radius to a population of only 1.5% in the outlying regions of the cluster. The density of stars in the core region is about 3.8 solar masses per cubic parsec, and contains a concentration of interaction-formed blue straggler stars, most of which formed 2–5 billion years ago. Four variable stars have been found so far in Messier 10.

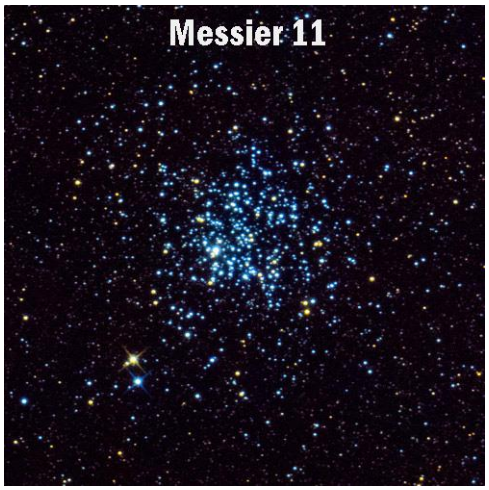


Messier 92 or NGC6341 was discovered by Johan Elert Bode in 1777 and inadvertently rediscovered by Charles Messier in 1781. The cluster is located in Hercules and is visible to the naked eye under very good conditions with an apparent Vmag. of 6.4, but it is often overlooked by amateurs due to its close angular proximity to the bright Messier 13. M92 is one of the galaxy's oldest globular clusters with estimates of 11.0 billion years to as old as 14.2 billion years. This yields a very low metallicity of [Fe/H] = -2.20 which is only 0.5% of the solar elemental abundance. Its distance is 26,700 light years from the Sun and it has a tidal diameter of 30 arc-minutes, which contains approximately 200,000 solar masses of material. M92 is only slightly flattened as its minor axis is about 89% ± 3% of the major. The core radius is only about 2 arc-seconds, but there is no evidence of any core collapse having taken place. M92 is an ***Oosterhoff type II*** globular cluster, meaning it belongs to the group of metal-poor clusters with longer period RR Lyrae variable stars. The 1997 Catalogue of Variable Stars in Globular Clusters listed 28 candidate variable stars in the cluster, although only 20 have been confirmed. As of 2001, there were 17 known RR Lyrae variables in Messier 92, plus 10 X-ray sources, of which half are candidate cataclysmic variable stars. An eclipsing binary millisecond pulsar has been discovered in M92 with an orbital period of 0.20 days, which orbits a low-mass companion with a median mass of ~0.18 $M_\odot$. Visually M92 is riddled with dark lanes.

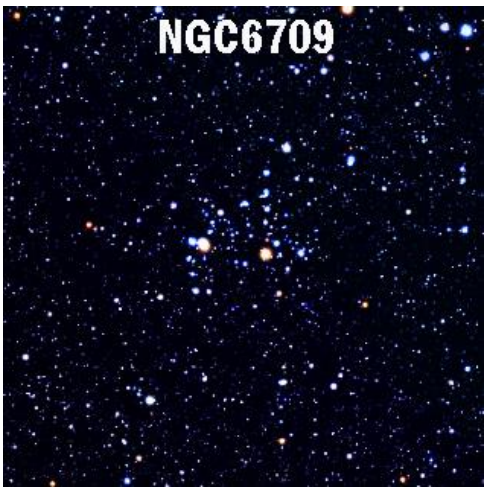


95 Herculis is a glorious double star which consists of a pair of fifth magnitude (4.96 for 95 Herculis A, 5.18 for 95 Her B) giant stars separated by 6.3 arc-seconds (900 AUs) that combine into a single fourth magnitude (4.31) star at a distance of 470 light years from the Sun. Both are evolving stars that have given up core hydrogen fusion, but they are at different stages of life, rendering them in slightly different colors. 95 Her A is a white class A (A5) giant, with a temperature of 8,000K and it shines with a total luminosity 167 times that of the Sun. It is by far the fastest rotator spinning at its equator with a speed of at least 145 miles per second, while 95 Her B spins at a minimum of only 3.5 miles, giving them highly contrasting rotation periods of 1.5 and 170 days. 95 Her B is a class G (G8) yellow-white giant and appears fainter to the eye, but when its infrared radiation is accounted for, due to its cooler 4,900K temperature, it actually is more luminous at 194 times solar. It is also the larger star at 19.4 solar diameters as opposed to 6.8 for 95 Her A. 95 Her B is the more advanced star by about half a billion years. It would take 11,000 years to make a full orbit around each other.

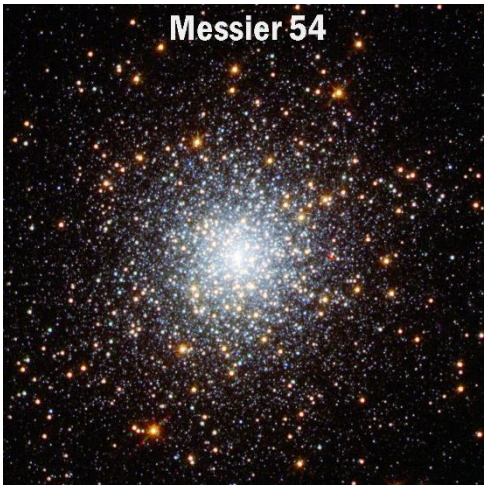
NGC6633 or Collinder 380 or Melotte 201 is also known as the 'Tweedledum Cluster' when paired with the nearby IC 4756 as 'Tweedledee'. It is also known as the 'Captain Hook Cluster**'** due to its hook shape. It was discovered in 1745-46 by Philippe Loys de Chéseaux, and independently rediscovered by Caroline Herschel in 1783 and included in her brother William's catalog as H VIII72. NGC6633 is a large bright open cluster Ophiuchus, and with a Vmag. of 4.6, it is bright enough to be seen with the naked eye. It is nearly as large as the full moon, due to its nearby distance of only 1,000 – 1,255 light years. NGC6633 is approximately 660 million years of age and contains 38 known bright stars and a total of 145 members, which are located in an incredibly rich star field. The brightest star shines at a Vmagnitude of 7.6. One star, HD170054 has been identified as a blue straggler of classification B6IVp. Another star, BD+06 3755, is a cool late spectral A-type, zero-age main sequence star with a mass of about 1.7 $M_\odot$. It is considered a **chemically peculiar (CP)** star as it contains a rare combination of enhanced chromium, strontium, and europium. Such stars are very important for the study of the early formation and evolution of the local stellar magnetic field. More than a century ago a subclass of A-type stars with peculiar lines and line strengths became known as "Ap stars". Later on, the spectral range was widened and the class become known as chemically peculiar (CP) stars of the upper main sequence.



Messier 11 or NGC6705 is called the "Wild Duck Cluster" due to the roughly V-shaped arrangement of its brightest stars. M11 was discovered by the German astronomer Gottfried Kirch in 1681 and is located just to the east of the Scutum Star Cloud midpoint. It is located 6,200 light-years from Earth and has an apparent Vmagnitude rated from 5.8 to 6.3. Of the 26 open clusters included in the Messier catalog, M11 is the most distant that can be seen with the naked eye. It is one of the most densely populated open clusters known, containing over 2,900 stars, with a total estimated mass ranging from 3,700 MʘO to 11,000 MʘO. M11 is near the limit between the most massive OCs and least massive GCs. The cluster contains 870 members of at least a Vmagnitude of 16.5, while the brightest cluster member has a visual magnitude of 8.0. The overall cluster diameter is 22.8 arc-minutes or 190 light years. Its age is 316 million years, resulting in M11 being metal-rich, with an iron abundance of [Fe/H] = 0.17 ± 0.04. Despite its youth, M11 shows an enhancement of Alpha process elements, which were formed within massive stars. Possibly this is due to an enhancement of its birth molecular cloud by a nearby Type II supernova explosion. At least nine variable star members have been identified with a high probability, plus 29 lower probability members. The former include two eclipsing binary star systems. The cluster is located 22,000 light years from the galactic center and close to the galactic plane, and has not wondered far from its birthplace



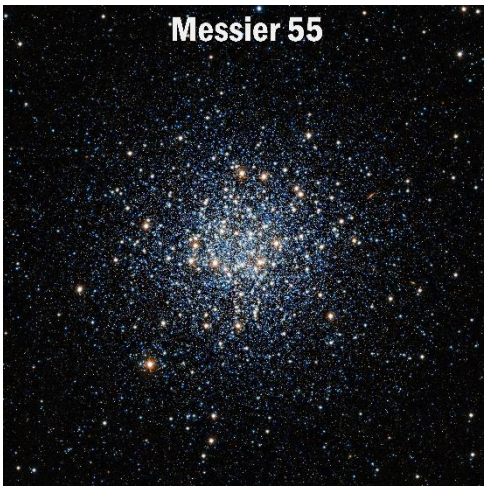
NGC6709 is an open cluster of stars located in the equatorial constellation of Aquila and some 5° to the southwest of the star Zeta Aquilae. It is located toward the center of the galaxy at a distance of 3,880 light-years, with an age of 141 - 400 million years. If the younger age is correct, then NGC6709 is about the same age as the Pleiades. The core radius of NGC 6709 is 2.2 light years and the overall tidal radius 26.4 light years. The cluster contains two Be stars and one of them is a shell star, and there is only one candidate red giant star within the cluster. NGC6709 is located in a rich star field which contaminates proper motion studies. Three stars are brighter than Vmags. of 9.5 while the main sequence is well populated between Vmagnitudes of 10.5 and 12.0. A gap exists between Vmags. 12.0 and 12.7, where only one star is present, and there is again a gap between Vmags. 13.0 and 13.5. Above 14th mag. the main sequence becomes continuous. A Color Magnitude Diagram gap in the main sequence is considered real and represents a band, which contains no or very few stars. NGC6709 has a Trumpler class of IV 2 m, meaning it is not well detached from the surrounding star field, has a moderate range of brightness, and contains 50 to 100 stars. Today we know NGC6709 contains about 305 members.



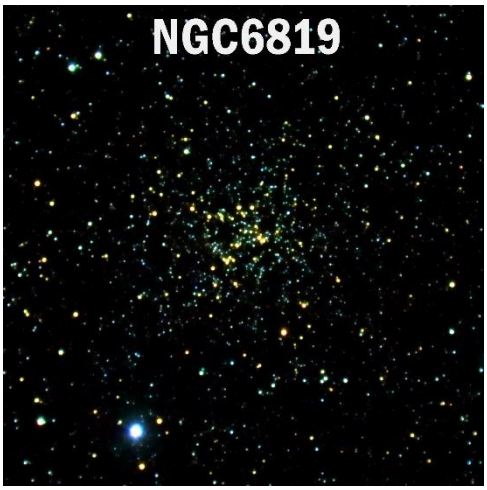
Messier 54 or NGC6715 is a controversial object as originally it was thought to belong to the Milky Way Galaxy at a distance from Earth of about 50,000 light-years. However, it was discovered in 1994 that M54 most likely belongs to the Sagittarius Dwarf Elliptical Galaxy (SagDEG) as it is located in the center of SagDEG and therefore may be the core of the dwarf galaxy. Its chemical composition also differs from field Sagittarius stars. However, a contrasting idea proposes that M54 is a real globular cluster that fell to the center of this galaxy due to decay of its orbit caused by dynamical friction. The strong gravitational pull of our large galaxy is currently engulfing SagDEG which will eventually merge with the Milky Way to create a larger galaxy. Recently Minniti et al., 2021 discovered 8 new globular clusters within SagDEG, and all are ~7 billion years of age, along with Ter 7, Ter 8, Arp 2, Pal 12 and Whiting 1. All are more metal rich than M54, with an estimated age of 12 billion years, which may indicate its Milky Way origin. Modern estimates now place M54 at a distance of 87,000 light-years, which translates into a large true diameter of 300 light-years. Messier 54 is one of the denser of the globular clusters with a Shapley-Sawyer Concentration Class of III (where I is the densest and XII the least dense). It shines with the luminosity of roughly 850,000 times that of the Sun and in July 2009, a team of astronomers reported they had found evidence of an intermediate-mass black hole of approximately 9,400 solar masses in the core of M54.

Messier 56 or NGC6779 is a globular cluster in Lyra and was discovered by Charles Messier in 1779. M56 is approximately 32,900 light-years away from Earth and is roughly 84 light-years across, containing 230,000 solar masses (M☉). It is located 31–32 light years from the Galactic Center and 4,900 LYrs above the galactic plane. M56 has an estimated age of ~10 billion years, which is younger than typical Milky Way halo objects. However, its metallicity, the abundance of elements other than hydrogen and helium, has a low value of [Fe/H] = –2.00 dex which is 1⁄100 of the abundance in the Sun. The brightest stars in the cluster are 13th magnitude, and M56 contains about a dozen known variable stars. In 2000, a diffuse X-ray emission was identified coming from the vicinity of the cluster which is most likely interstellar medium heated by the passage of the cluster through the galactic halo. The relative velocity of the cluster is about 177 km s^{-1}, which is sufficient to heat the medium in its wake to a temperature of 940,000 K. M56 is following a retrograde orbit through the Milky Way which suggest that it may have been acquired during the merger of a dwarf galaxy of approximately 50 billion M☉. The remains of this event is known as the **"Gaia Sausage"** which is an elongated structure of halo stars and X-ray emission, discovered in 2018. M56 is thought to be one of ten globular clusters which merged with this dwarf galaxy, as all are strung out like beads on a chain, and all have highly eccentric orbits. M56 therefore has an extragalactic origin.

The "Coat Hanger", Brocchi's Cluster or Collinder 399 is generally considered to be an asterism, or a pattern of stars which is only a chance alignment of physically unrelated stars, and therefore not a true open star cluster. However, Hall and VanLandingham (1970) determined there are 6 actual members, moving together, which constitute a gravitationally bound cluster (Marked in Photo). It is located in Vulpecula and centered around 4 and 5 Vulpeculae. The bright stars of the structure look like its namesake, making it easy to spot in a dark sky. The coat hanger was first mentioned by William F. Meyer (1903, 1905) in his proper motion study, and E.E. Barnard (1927) described it as "a fine group of five bright stars equally distant in a straight line east and west. With two others to the south they make a remarkable figure". There is a good spread of at least 42 stars in the area which vary in brightness from Vmag. 6.43 to 14.16 and spectral types ranging from type B3 to K8. Cr 399 lies in front of a molecular cloud which obscures many stars in the area, except for stars brighter than Vmag. = 8. The coat hanger has a Trumpler Classification of III 3 m, meaning it is "detached with no noticeable concentration, is composed of bright and faint stars and is medium rich with 50 to 100 stars".

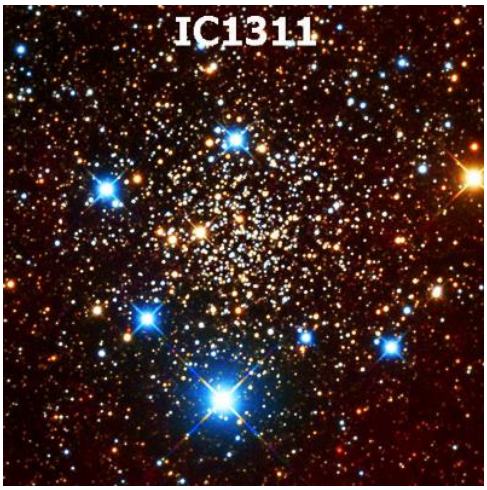


Messier 55 or NGC6809 is a globular cluster in southern Sagittarius. It was discovered by Nicolas Louis de Lacaille in 1752 while observing from South Africa. Starting in 1754, Charles Messier made several attempts to find this object from Paris but its low declination meant from there it rises very little above the horizon, hampering observation, so it was 1778 before he observed and catalogued it. The cluster is 17,600 light-years away from Earth and contains about 269,000 solar masses (M☉). Its actual diameter is 96 light years and it has a Shapley-Sawyer Concentration Class of XI meaning it is a very loosely structured globular cluster. M55 is an old cluster with an estimated age of 12.3 billion years, which results in its low metallicity of [Fe/H] = -1.94. This is a characteristic of most Milky Way globular clusters, as it contains few elements other than hydrogen and helium when compared to the Sun. Metallicity is normally listed as the base 10 logarithm of the proportion of the Sun, expressed as a ratio of iron to hydrogen. This means the cluster has only 1.1% of the proportion of the Sun's iron when compared to hydrogen and helium (If the metallicity were −2 then there would be 100 times less iron than is contained in the Sun). About 55 variable stars have been found in the central part of M55.

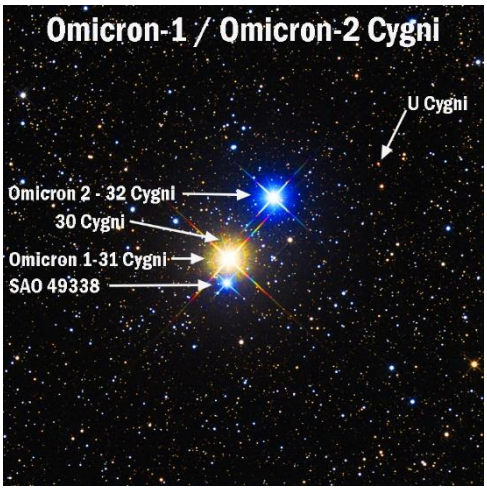


NGC6819 is an open cluster located on the boundary of Cygnus and Lyra. The cluster was discovered by Caroline Herschel on 12 May 1784. NGC6819 contains 194 known cluster members with the more luminous members of 10 to 12th magnitude, resulting in a bright overall Vmagnitude of 7.3. The age of NGC6819 is estimated to be 2.1 to 2.5 billion years, which gives it an intermediate-aged classification. Its distance is calculated to be 7,050 – 7,200 light years from Earth resulting in an apparent dimension of 5 arc-minutes. The Kepler telescope found 7 candidate eclipsing binary stars located within the tidal radius of NGC6819, which is about 40 arc-minutes. The Gaia spacecraft found that only one target, (KIC 4937217) is an actual member of NGC6819, with the other binaries only in the nearby field. A contact binary is a close binary system whose components are so close they share a common envelope. These systems are important for studying strong interactions between stars, mass transfers, and stellar mergers. The evolution of a binary star is more complex than the evolution of a single star.

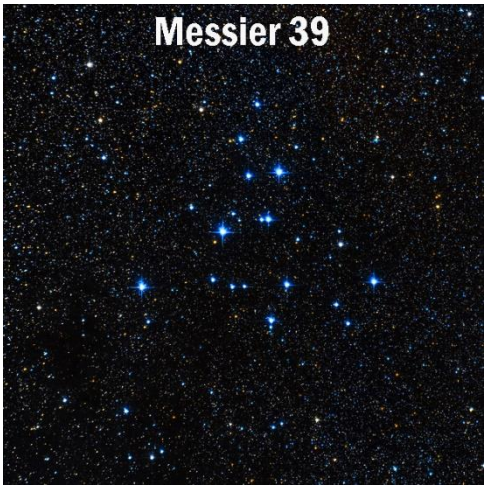
Messier 71 or NGC6838 has been a controversial object since its discovery in 1746 by the Swiss astronomer Jean-Philippe Loys de Chéseaux. Charles Messier added it to his catalog of non-comet-like objects in 1780. M71 is located roughly 13,000 light-years from Earth, spans 27 light-years, and has an apparent magnitude of 6.1. It has a mass of about 53,000 $M_\odot$ and a luminosity of around 19,000 $L_\odot$. Over the centuries M71 has been classified as both an abnormally dense open star cluster and as an unusually loose globular cluster. Those favoring an open cluster status point out that M71 does not have a high concentration of stars at its center, and its relatively high metallicity ([Fe/H] = -0.78 dex), suggests its stars are younger than most globular clusters. Additionally M71 lacks the RR Lyrae "cluster" variable stars that are common in most globulars. However, modern photometric photometry beginning in the 1970s detected a short "***horizontal branch***" in the H-R diagram, which is a characteristic of globular clusters. The shortness of the branch explains the lack of RR Lyrae variables and is due to the clusters relatively young age of only 9–10 billion years. Therefore M71 was reclassified by some as a young, loosely concentrated globular cluster — one of the smallest of its kind. Today – 2022- M71 is still mostly designated (by Simbad and others) as an "open galactic cluster, while others consider M71 to be a very loosely concentrated globular cluster, much like M68 in Hydra….The controversy continues.



IC1311 is a middle aged open cluster at 1.585 billion years, with distance estimates ranging from 15,650 to 19,000 light years. IC1311 is located 1,150 light years above the galactic plane at the transition region between the thin disk and the intermediate disk population. The cluster has an actual diameter of 207 light years and a radial velocity of -63.5/second, meaning it is approaching the Sun. The total cluster membership is 392 stars and most of the denser binary and giant stars are located in the inner region of the cluster, the bottom of the gravitational well. The metallicity [Fe/H]= —0.3 of this 1.5 billion year old cluster is actually lower than that of the older Sun (4.5 GYrs) which is [Fe/H] = +0.0196. This has led to confusion, as to where IC1311 formed, what it is, and where it came from. The clusters location on the age-metallicity diagram suggests a formation environment more similar to that found in the Large Magellanic Cloud (LMC), rather than in the Galactic disk. IC1311 is one of 8 leading candidates for the impact of a high-velocity cloud merging from an extragalactic origin creating low metallicity stars. Another possibility postulates it could be a low [Fe/H] globular cluster impacting the Galactic disk and IC1311 does have the appearance of a loosely bound globular cluster. Either of these scenarios would produce a cluster with a lower metallicity. IC1311 also orbits differently from normal open clusters, as it is located three times the scale-height of the Galactic thin disk with half the eccentricity of most open clusters. This would all seemingly indicate an infall or extragalactic origin for IC1311. These factors all point to a most unusual formation for the open/globular(?) cluster IC1311.

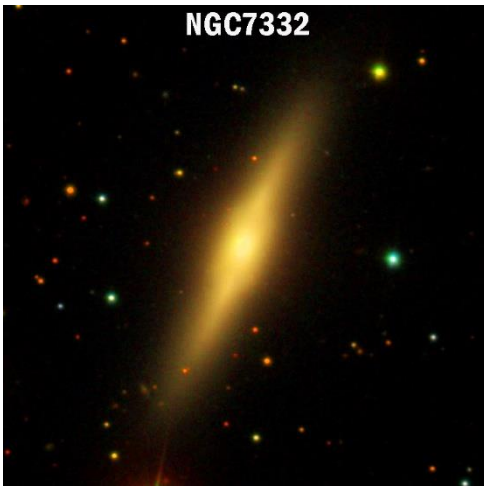


Omicron 1 Cygni or 31 Cygni (HD 192223) is only one of two stars in Cygnus with the "Omicron" designation (Omicron 2 is 32 Cygni). Omicron 1 is the lower orange star showing the color of a K-class giant star. Just barely above this star (not seen) is 30 Cygni, a class A5 dwarf star, and Omicron 2 is the bluish colored star to the upper right. There is just a line of sight coincidence and no physical relationship exists between any of these stars, yet Omicron 1 and Omicron 2 are the same kind of star, a remarkable coincidence. Both are large cool supergiant stars which eclipse a hot blue class B dwarf in orbit around the large member. Omi-1 consists of a large K2 bright giant star with a diameter 200 times that of the Sun, and a hot B3 dwarf shining in ultraviolet light. Collectively they are known as Omi-1 A and B. The K2 - A star has a Vmag. of 4.3 and mass of 4-6 MʘO and the B star 4.9, and mass 6-7 MʘO. They orbit each other in 3,784.3 days or 10.36 years, which is 3.3 times longer than the Omicron-2 pair. The Omi-1 pair are separated by 11 AU, and a drop of about a tenth of a mag. occurs when the K giant eclipses the B member. The K star has a luminosity *L* = 1,800ʘO and a temperature of 3,900K, at an estimated distance of 600 light years. The B stars luminosity is also around 1,800 times solar.



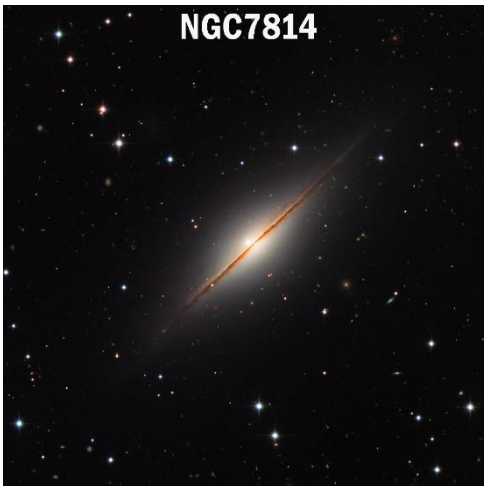
Messier 39 or NGC7092 is a sparce and relatively nearby open cluster in Cygnus, located 2 degrees south of Pi Cygni. It was initially discovered by Guillaume Le Gentil in 1749, then Charles Messier added it to his catalogue in 1764. M39 has a total integrated magnitude of 4.6, meaning it is a naked eye visual object which spans an angular diameter of 29 arc- minutes, which is about the size of the full Moon. M39 is centered 950 to 1,010 light-years away and has an estimated mass of 232 M⊙, all enclosed within a linear tidal radius of 28 light years. Only 100 stars are thought to be actual members and of the 15 brightest stars, six form binary systems and one more is suspected. Additionally, at least five are chemically peculiar stars and ten are suspected short-period variable stars. Photometric analysis of 19 main sequence stars showed a Vmagnitude range in brightness of 6.74 to 11.28. Overall M39 is triangular in shape and a nice double star is located near the center. Peculiar stars are hot main-sequence stars with unusual surface compositions which have been caused by processes that happened after the star formed, such as diffusion or magnetic effects in the outer layers of the stars. These processes cause some elements, particularly He, N and O, to "settle" out in the atmosphere into the layers below, while other elements such as Mn, Sr, Y and Zr are "levitated" out of the interior to the surface, resulting in the observed spectral peculiarities.

NGC7139 is a planetary nebula located in Cepheus which was discovered on November 5, 1787, a Monday night, by astronomer William Herschel. Stated distances to planetary nebulae are always suspect and distance estimates for NGC7139 range from 2,870 to 7,825 light years. The age of the nebula is 5,925 to 8,910 years and the mass of the central star is approximately 0.8 MʘO. The nebula is round in overall shape with hints of a biconal structure with a major axis of approximately 70 arc-seconds. NGC7139 has strong emission structures in [O III] 5007 Å and He II 4686 Å which indicate this is a high excitation nebula. Faint emission in [O III] is seen all along the axis at 30° to the north which is probable evidence the nebula is not ionization bounded in all directions, and low density, higher temperature material is expanding into the interstellar medium. Around the edge of NGC7139 [O I] emission is found at an ionization shock front where the nebula is expanding at 24 miles per second. This indicates in this region the nebula is ionization bounded. This ionization shock front in planetary nebulae is the result of a fast wind from the central star at velocities up to 1,250 miles per second and a mass loss rate of $\sim 10^{-7}$ to 10^{-8} MʘO yr^{-1}, which drives a shock-front into the slow wind of the former red giant star.

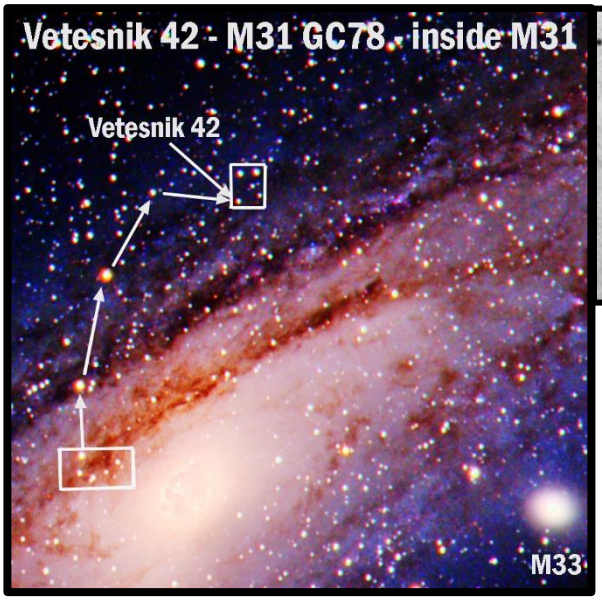


NGC7332 was discovered on September 19, 1784 by William Herschel and is an edge-on peculiar lenticular or S0 type galaxy. It is located 67 -75 million light-years away in Pegasus and is an unusually blue object for an S0 type galaxy. It has a boxy-peanut-shaped bulge, associated with a stellar bar. Soon after they form, bars buckle and settle with an increased thickness, appearing boxy-shaped when seen end-on (along the bar major axis) and peanut-shaped when seen side-on (along the bar minor axis). NGC7339 is 5 arc-minutes away from NGC7332 and together they form a dynamically isolated binary system orbiting each other with NGC7332 the brighter object. Spectral analysis of the central regions reveals a luminosity age of about 6 billion years. NGC7332 is best known for its peculiar gas structure, namely the presence of two kinematically decoupled ionized gas components. The more massive is a bright counter-rotating ionized structure plus a faint corotating gas component moving with the stars. The counter-rotating gas has a mass of about 150,000 MΘ and likely originated from an accretion event, NGC7339, or a nearby 6mMΘ cloud. Extended counter-rotating ionized gas is common in S0 type galaxies. 175 – 190 globular clusters have been found in NGC7332 which mark major star formation-merger episodes in galaxies.

NGC185 or Caldwell 18 is a dwarf spheroidal galaxy discovered by William Herschel on November 30, 1787. It is located in Cassiopeia and is 2.02 - 2.475 million light-years from Earth, depending upon the analysts. NGC185 is a member of the Local Group, and is located in front of (along with NGC147) the Andromeda Galaxy (M31) and involved with its halo. Unlike most dwarf elliptical galaxies it contains young stellar clusters, gas and dust, and star formation has occurred at a low rate until the recent past. NGC185 had already formed about 70% of its stars prior to 12.5 billion years ago, with the remaining population forming between 8 to 10 billion years ago. It has been fairly quiet since then but in the last approximately 100 million years, stars have formed, but only near the center of the galaxy in the central 500 x 300 light year region. NGC185 has an active galactic nucleus (AGN) and is usually classified as a type 2 Seyfert (Sy) galaxy. It is possibly the closest Seyfert galaxy to Earth, and is the only known Seyfert in the Local Group, although its status as a Seyfert is sometimes questioned. NGC185 is host to 8 known planetary nebulae and 151 RR Lyrae stars which prove star formation occurred over 10 billion years ago. NGC185 shows no evidence of any distortion, indicating that NGC185 and NGC147 may have separate formation paths and are just now two 'passing objects in the night' that are not gravitationally bound.



NGC7814 or UGC 8 or Caldwell 43 is a spiral galaxy 39 million light-years away in Pegasus. The galaxy is sometimes referred to as "the little sombrero", a miniature version of Messier 104. A complicating factor for investigating edge-on galaxies is extinction from dust in the disk. Apart from S0 galaxies whose disks may be transparent, the disk of most edge-on galaxies are opaque in the inner regions in optical light. It is therefore difficult to know how much extinction is present in front of the bulge. NGC7814 is a system with a large bulge and a disk that is very near edge-on (90°). Color variations are found as a function of radius in the bulge which is evidence that dust and metallicity gradients in bulges are common. The thickness of the disk in NGC7814 varies from 7 to 10 arc-seconds, with an average of 9 arc-seconds. This corresponds to a thickness of 1,565 light years if NGC7814 is 39 million light years distant. In comparison, the Milky Way disk has a scale height of only 652 light years so the disk of NGC7814 is thicker by a factor greater than 2. The dust lane itself however is thinner than the disk in NGC7814, and varies from 3.1 to 4.6 arc-seconds in thickness, which is more than a factor of 2 times smaller than the thickness of the disk. This is understood if the dust-lane is only associated with the young stars which have a much smaller vertical scale height, which also occurs in our galaxy. A total of ~200 globular clusters have been found in NGC7814, which is comparable to those of the Milky Way and Messier 31.



M31 GC-78 or Vetešnik 42 (Inside M31), is named for Dr. M. Vetešnik, a Czechoslovakian astronomer who in 1962 published a list of globular clusters affiliated with Messier 31. M31 GC-78 is bright at a Vmag. = 14.24 and visually is the second brightest GC located within Messier 31, after M31 GC-1. The core diameter of M31 GC-78 is 5.6 light years, with a total diameter of 21.2 light years, which is very large and one of the largest globular clusters in Messier 31. This is a compact globular cluster as it takes high magnification well and remains tightly concentrated in structure at magnifications >500X. M31-GC78 would therefore have a low Shapley-Sawyer classification number. In color, size and spacial distribution the Messier 31 globular clusters are similar to those found in the Milky Way Galaxy. However, Messier 31 has a much richer population of globular clusters than the Milky Way. As of 2009, M31 contained 416 old globular clusters with colors consistent with those of the Milky Way. Additionally 156 young blue clusters have been identified, plus another 373 clusters marked as "candidates". The Messier 31 halo is more metal enriched than its Milky Way counterpart, and the rotation rates of its globular clusters are strong, which indicates past major galactic merger events which possibly spun up the entre galaxy along with its globular cluster population.

NGC752 or Caldwell 28 is an open cluster in Andromeda, which was discovered by Caroline Herschel in 1783 and cataloged by her brother William Herschel in 1786. This large stellar cluster lies 1,430 light-years away from Earth, and may approach naked eye visibility under good observing conditions. NGC752 has about 60 members which are no brighter than 9th magnitude and 24 potential dwarf members have been identified with Vmagnitudes 15.0 to 16.5. The total present mass of NGC752 is 297 MʘO but it is estimated the cluster has lost 95.2% to 98.5% of its initial mass. Ascertaining actual stellar membership into the cluster has proven difficult. There is significant overlap between the catalogs, but Agüeros et al (2018) report a total of 258 probable cluster members. Daniel et al (1994) reports 255 stars of which 109 are probable members, 48 are possible members and 98 are probable non-members. NGC752 is the nearest open cluster older than 1 billion years with calculated ages of 1.34 - 1.45 billion years. Therefore all of the present members are relatively low mass stars which average M = 1.82 MʘO, and are in the main sequence or the red giant evolutionary phase. The average main sequence turn-off age is slightly higher than the average age at 1.52 billion years, and the overall metallicity is a rich [Fe/H] = 0.05 dex. A blue straggler star is also present, along with some spectroscopic binaries and variable stars. Tidal tails have been discovered extend outward from NGC752 to approximately 115 light years on either side of the dense central region and follow the clusters orbit.

Good Luck!

LARRY MITCHELL - EILEEN MEYERS
Stellafane Observing Olympics, 2022