Chapter 3

Star Clusters

Having looked at stars as individual objects, let's now turn our attention to groups of stars, or *star clusters*.

There is such a plethora of star clusters available for observation that they provide a rich and diverse selection of observing targets whether one is using the naked eye, binoculars or telescopes. Some clusters may have only a few members (these are the *open clusters*), while others may contain several thousand stars – or, in some cases, even a million – as is the case for many so-called *globular clusters*. Many display a jewel-box array of colors, while others may contain only steely blue stars or brilliant white ones. Some types of clusters contain only very young stars, perhaps only a few million years old, whereas other kinds will contain stars that are very old, perhaps several billion years old.

The clusters selected here are only a representative few of the hundreds that are available to the amateur astronomer.

As usual, a few words on origin, evolution and structure are appropriate before the objects are described.

Open Star Clusters

A casual glance at the night sky may lead you into believing that stars are solitary, isolated objects, but in fact no star is born in isolation. The process of star birth takes place in immense interstellar clouds of dust and gas that, depending upon the cloud's size, can give rise to anything from a few dozen to many thousands of new, and young, stars. Over time, however, this stellar nursery of young stars will gradually disperse. Theory predicts that massive stars have much shorter life spans than

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smaller, less massive ones, such that the more massive stars do not live long enough to escape their birthplace, whereas a smaller star, say, of solar mass in size, will in most cases easily migrate from its stellar birthplace.

It's worth noting, in relation to stars of mass about equal to that of the Sun, that where there may be several thousand of these objects, the combined gravitational attraction of so many stars may slow down the dispersion of the group. It really depends on the star-density and mass of the particular cluster. So we can infer that the most dense or closely packed clusters, containing solar mass-sized stars, will be the ones that contain the oldest population of stars, while the most scattered clusters will have the youngest stellar population.

Open clusters, or *galactic clusters*, as they are also called, are collections of young stars, containing anything from maybe a dozen members to thousands. A few of them, for example, Messier 11 in Scutum, contains an impressive number of stars, equaling that of globular clusters, while others seem little more than a faint grouping set against the background star field.

Such is the variety of open clusters that they come in all shapes and sizes. Several are over a degree in size, and their full impact can only be appreciated by using binoculars, as a telescope has too narrow a field of view. An example of such a large cluster is Messier 44 in Cancer. Then there are tiny clusters, seemingly nothing more than compact multiple stars, as is the case with IC 4996 in Cygnus. In some cases all the members of the cluster are equally bright, such as Caldwell 71 in Puppis, but there are others that consist of only a few bright members accompanied by several fainter companions, as is the case of Messier 29 in Cygnus. The stars that make up an open cluster are called *Population I* stars, which are metal-rich and usually to be found in or near the spiral arms of the galaxy.

The size of a cluster can vary from a few dozen light-years across, as in the case of NGC 255 in Cassiopeia, to about 70 light-years across, as in either component of Caldwell 14, the Perseus Double Cluster.

The reason for the varied and disparate appearances of open clusters is the circumstances of their births. It is the interstellar cloud that determines both the number and type of stars that are born within it. Factors such as the size, density, turbulence, temperature, and magnetic field all play a role as the deciding parameters in star birth. In the case of *giant molecular clouds* (GMCs) the conditions can give rise to both O- and B-type giant stars along with solar-type dwarf stars, whereas in *small molecular clouds* (SMCs) many solar-type stars will be formed, with very few, if any at all, of the luminous 0- and B-type stars. An example of an SMC is the Taurus Dark Cloud, which lies just beyond the Pleiades.

An interesting aspect of open clusters is their distribution in the night sky. You may be forgiven in thinking that they are randomly distributed across the sky, but sky surveys show that although well over a thousand clusters have been discovered, only a few are observed to be at distances greater than 25° above or below the galactic equator. Some parts of the sky are very rich in clusters – Cassiopeia, and Puppis, for example – and this is due to the absence of dust lying along these lines of sight, allowing us to see across the spiral plane of our galaxy. Many of the clusters mentioned actually lie in different spiral arms, and so as you observe them

you are actually looking at different parts of the spiral structure of our galaxy. An amazing thought!

It was mentioned earlier that stars are not born in isolation. However, this does not mean that they are all born simultaneously. The more massive a star the faster it contracts and becomes stable, with the result that some clusters have a few bright young O- and B- main sequence stars, while at the same time contain low-mass members that may still be in the process of gravitational contraction, for example the star cluster at the center of the Lagoon Nebula. In a few cases, the star production can be at a very early stage, with only a few stars visible, the majority of protostars, as they are called, still in the process of contraction and hidden within the interstellar cloud.

A perfect example of such a process is the open cluster within Messier 42, the Orion Nebula. The stars within the cluster called the Trapezium are the brightest, youngest and most massive stars in what will eventually become a large cluster containing many A-, F- and G-type stars. However, the majority are blanketed by dust and gas clouds and are only detectable by their infrared radiation.

As time passes, the dust and gas surrounding a new cluster will be blown away by the radiation from the O-type stars, resulting in the cluster becoming visible in its entirety, such as in the case of the young cluster Caldwell 76 in Scorpius.

Once a cluster has formed it will remain more or less unchanged for at least a few million years, but over time changes within the cluster occur, with two processes responsible. The evolution of open clusters depends on both the initial stellar content of the group and the ever-pervasive pull of gravity. If a cluster contains O-, B- and A-type stars, then these stars will eventually become supernovae, leaving the cluster with slower evolving, less massive and less luminous members of type G, K and M stars. A famous example of such a cluster is Caldwell 94, the Jewel Box in Crux, which is a highlight of the southern sky, although, alas, unobservable to northern hemisphere observers. However, these too will become supernovae, with the result that the most luminous members of a cluster will, one by one, disappear over time. This doesn't necessarily mean the demise of a cluster, especially those that have many tens or hundreds of members. But some, which consist of only a few bright stars, will seem to meld into the background star field.

However, even those clusters that have survived the demise of their brighter members will eventually begin to feel the effect of a force that pervades everywhere – the galaxy's gravitational field. As time passes the cluster will be affected by the influence of other clusters and the interstellar medium itself, as well as the tidal force of the galaxy. The cumulative effect of all these encounters will result in some of the less massive members of the cluster acquiring enough velocity to escape from it. Thus, given enough time, a cluster will fade and disperse. (Take heart, as this isn't likely to happen in the near future so that you would notice. The Hyades star cluster, even after having lost most of its O- and B-type stars, is still with us, after 600 million years!).

For the amateur, observing open clusters is a very rewarding experience, as they offer a variety of views from naked eye to telescopic. Happily, many of them are best viewed by binoculars, especially the larger clusters that are of an appreciable

angular size. Furthermore, nearly all have double or triple stars within the cluster, and so regardless of magnification there is always something of interest to be seen.

From the preceding chapter you will know that color in observed stars is best seen when contrasted with a companion or companions. Thus an open cluster presents a perfect opportunity for observing star colors. Many clusters, such as the ever and rightly popular Pleiades, are all a lovely steely blue color. On the other hand, Caldwell 10 in Cassiopeia has contrasting bluish stars along with a nice orange star. Other clusters have a solitary yellowish or ruddy orange star along with fainter white ones, such as Messier 6 in Scorpius. An often striking characteristic of open clusters is the apparent chains of stars that seemingly arc across apparently empty voids, as in Messier 41 in Canis Major.

Another word for a very small, loose group of stars is an *asterism*. In some cases there may only be five to six stars within the group.

Because open clusters display such a wealth of characteristics, different parameters are assigned to a cluster that describe its shape and content. For instance, a designation called the *Trumpler type* is often used. It is a three-part designation that describes the cluster's degree of concentration, that is, from a packed cluster to one that is evenly distributed, the range in brightness of the stars within the cluster, and finally the richness of the cluster, from poor (less than 50 stars) to rich (more than 100). The full classification is:

Trumpler classification for star clusters	
Concentration	
I	Detached – strong concentration of stars towards the center
II	Detached – weak concentration of stars towards the center
III	Detached – no concentration of stars towards the center
IV	Poor detachment from background star field
Range of Brightness	
1	Small range
2	Moderate range
3	Large range
Richness of Cluster	
p	Poor (with less than 50 stars)
m	Moderate (with 50–100 stars)
r	Rich (with more than 100 stars)
n	Cluster within nebulosity

Actually, in truth, this designation is of limited use, as some clusters that appear very rich when seen in good binoculars are disappointing when viewed using a telescope. Additionally, the use of high magnification and large aperture will often make a poor cluster appear very rich. However, for completeness, we are using the designation as a rough guide as to what you can expect to see under perfect conditions with perfect optics, and so on.

Two further points need to be mentioned that can often cause problems: the magnitude and size of the cluster. The quoted apparent magnitude of a cluster may be the result of only a few bright stars, but it can also be the result of a large number of faint stars. Therefore, do not be surprised if a low magnitude cluster appears faint in the eyepiece. Also, the diameter of a cluster is often misleading, as in most cases it has been calculated from photographic plates, which, as experienced amateurs will know, bear little resemblance to what is seen at the eyepiece.

Although magnitudes and diameters may be quoted in the text, do treat them with a certain amount of caution.

You may notice that a few star clusters seem to be missing from the lists. There is a reason for this. In this new edition, a new chapter has been included, "Naked-Eye Deep-Sky Objects." This new chapter will deal with, among other things, star clusters that can (hopefully) be seen with the naked eye. So for instance, the Pleiades will be mentioned in the new chapter, and not this one. But telescope users should take heart, as the descriptions of the naked-eye objects will also include binocular and telescopic information as and when appropriate.

In the descriptions given below, the first line lists the name, the position and the approximate midnight transit time, the second line the visual magnitude (this is the combined magnitude of all stars in cluster), object size in arcminutes (⊕), the approximate number of stars in the cluster (bear in mind that the number of stars seen will depend on magnification and aperture and will increase when large apertures are used; thus the number quoted is an estimate using modest aperture), the Trumpler designation and the level of difficulty (based on the magnitude, size and ease of finding the cluster).

Once again you will notice that the listings present data in two forms. If a cluster is at its best time to observe, i.e., the month during which it transits, then a full description will be given. Lots of other clusters may also be visible, but they may not be at their best position to be observed. In that instance, a brief reference to the month at which the cluster will transit is given and thus be at an acceptable position to be observed.

January

–	NGC 2301	$06^h\ 51.8^m$	+00° 28′	January 3
6.0 m	⊕ 12′	70	I 3 m	Easy

Superb! A very striking cluster. In binoculars, a north-south chain of eighth- and ninth-magnitude stars is revealed, marked at its midway point by a faint haze of unresolvable stars. With large aperture, there is a colorful trio of red, gold and blue stars at the cluster's center.

Collinder 121	–	$06^h\ 54.2^m$	−24° 38′	January 3
2.6 m	⊕ 50′	20	III 3 p	Easy

A very large cluster, but one that is difficult to locate because of the plethora of stars in the background. At the northern border of the cluster is *O* Canis Majoris. Best seen with large binoculars or low-power telescopes.

Herschel 34	NGC 2353	$07^h\ 14.6^m$	−10° 18′	January 9
7.1 m	⊕ 20′	30	II 2 p	Easy

A cluster of stars best seen in a telescope. It includes many orange sixth-magnitude stars.

Caldwell 58	NGC 2360	$07^h\ 17.8^m$	−15° 37′	January 9
7.2 m	⊕ 12′	80	II 2 m	Easy

A beautiful open cluster, irregularly shaped and very rich. There are many faint stars, however, so the cluster needs moderate-aperture telescopes for these to be resolved, although it will appear as a faint blur in binoculars. This is believed to be an old cluster with an estimated age of around 1.3 billion years.

Caldwell 64	NGC 2362	$07^h\ 18.8^m$	−24° 57′	January 10
4.1 m	⊕ 8′	60	I 3 p n	Easy

A very nice cluster, tightly packed and easily seen. With small binoculars the glare from t CMa tends to overwhelm the majority of stars, although it is itself is a nice star, with two bluish companion stars (recent research indicates that the star is a quadruple system). But the cluster becomes truly impressive with telescopic apertures; the bigger the aperture, the more stunning the vista. It is believed to be very young – only a couple of million years old – and thus has the distinction of being the youngest cluster in our galaxy. Contains O- and B-type giant stars.

Messier 48	NGC 2548	$08^h\ 13.8^m$	−05° 48′	January 24
5.8 m	⊕ 55′	80	I 3 r	Easy

Located in a rather empty part of the constellation Hydra, this is believed to be the missing Messier object. It is a nice cluster in both binoculars and small telescopes. In the former, about a dozen stars are seen, with a pleasing triangular asterism at its center, while the latter will show a rather nice but large group of about 50 stars. Many amateurs often find the cluster difficult to locate for the reason mentioned above, but also for the fact that within a few degrees of M48 is another nameless, but brighter, cluster of stars that is often mistakenly identified as M48. Some observers claim that this nameless group of stars is in fact the correct missing Messier object, and not the one that now bears the name.

Caldwell 54	NGC 2506	$08^h\ 00.2^m$	−10° 47′	January 20
7.6 m	⊕ 7′	100	I 2 r	Medium

A nice, rich and concentrated cluster best seen with a telescope, but one that is often overlooked owing to its faintness even though it is just visible in binoculars. Includes many 11th- and 12th-magnitude stars. It is a very old cluster, around 2 billion years, and contains several blue stragglers. These are old stars that nevertheless have the spectrum signatures of young stars. This paradox was solved when research indicated that the younger-looking stars were the result of a merger of two older stars.

Herschel 21	NGC 2266	$06^h\ 43.2^m$	+26° 58′	January 1
9.5 m	⊕ 6′	50	II 2 m	Difficult

A pleasant cluster though difficult to locate, consisting of over 50 stars tightly compressed.

See also:

Cluster	Designation[1]	Month
Herschel 33	II 2 m	December
Collinder 464	II 2 m	December
Collinder 69	II 3 p n	December
Collinder 73	III 2 p n	December
Collinder 38	I 3 p n	December
Caldwell 50	–	December
Collinder 112	IV 3 p	December
Herschel 59	III 1 p	December
Collinder 81	II 3 r	December
Herschel 61	III 2 p	December
Herschel 68	II 1 p	December
Herschel 13	III 3 m	December
Messier 67	II 2 m	February

February

Messier 67	NGC 2682	$08^h\ 50.4^m$	+11° 49′	February 2
6.9 m	⊕ 30′	200	II 2 m	Difficult

Often overlooked owing to its proximity to M44, it is nevertheless very pleasing. However, the stars it is composed of are faint ones, so in binoculars it will be unresolved and seen as a faint misty glow. At a distance of 2,500 light-years, it is believed to be very old, possibly 9 billion years, and thus has had time to move from the galactic plane, the usual abode of open clusters, to a distance of about 1,600 light-years off the plane.

[1]This is the Trumpler designation discussed earlier in the chapter.

See also:

Cluster	Designation	Month
NGC 2301	I 3 m	January
Collinder 121	III 3 p	January
Messier 50 (see Chapter 7)	II 3 m	January
Herschel 34	II 2 p	January
Caldwell 58	II 2 m	January
Caldwell 64	I 3 p n	January
Messier 48	I 3 r	January
Caldwell 54	I 2 r	January
Herschel 21	II 2 m	January
Upgren 1	IV 2 p	March

March

Upgren 1	–	$12^h\ 35.0^m$	+36° 18′	March 31
6.6 m	⊕ 10′	10	IV 2 p	Easy

Almost unknown to amateurs, this is a fairly inconspicuous cluster of about ten stars. Binoculars show about seven of these. Although it has been shown to be a cluster, it appears to many observers as nothing more than an asterism.

See also:

Cluster	Designation	Month
Messier 67	II 2 m	February

April

See:

Cluster	Designation	Month
Upgren 1	I 3 r	March
Caldwell 75	I 3 r	May

May

Caldwell 75	NGC 6124	$16^h\ 25.6^m$	–40° 40′	May 28
5.8 m	⊕ 29′	75	I 3 r	Easy

A very nice, rich cluster, suitable for large binoculars and small telescopes. There is a chain of stars at its southern edge, and a tightly grouped collection of five bright stars at its center. It also contains several nice star chains and a few red-tinted stars. It is relatively close, at a distance of around 1,500 light-years.

See also:

Cluster	Designation	Month
Caldwell 76	I 3 p	June
Trumpler 24	IV 2 p n	June
IC 4665	III 2 m	June
Messier 23	II 2 r	June
Messier 21	I 3 r	June
Messier 16	II 3 m n	June
Messier 18	II 3 p n	June
Herschel 72	III 2 m	June
Collinder 309	I 2 r	June
Trumpler 26	II 1 m	June
Trumpler 26	II 1 m	June
Herschel 7	I 2 r n	June

June

Caldwell 76	NGC 6231	$16^h\ 54.0^m$	–41° 48′	June 5
2.6 m	⊕ 14′	100	I 3 p	Easy

A superb cluster located in an awe-inspiring region of the sky. Brighter by 2.5 magnitudes than its northern cousins, the Double Cluster in Perseus. This cluster is full of spectacular stars – very hot and luminous O-type and B0-type giants and supergiants, a couple of Wolf-Rayet stars, and ξ^{-1} Scorpii, which is a B1.5 Ia extreme supergiant star with a luminosity nearly 280,000 times that of the Sun! The cluster is thought to be a member of the stellar association Sco OB1, with an estimated age of 3 million years. A wonderful object in binoculars and telescopes, the cluster contains many blue, orange and yellow stars. It lies between μ^{1+2} Scorpii and ξ^{-1} Scorpii, an area rich in spectacular views. A good cluster to test the technique of averted vision, where many more stars will jump into view. Observe and enjoy.

Trumpler 24	Harvard 12	$16^h\ 57.0^m$	–40° 40′	June 5
8.6 m	⊕ 60′	100	IV 2 p n	Easy

A loose and scattered cluster, set against the backdrop of the Milky Way. It is, along with nearby Collinder 316, the core of the Scorpius OB1 stellar association.[2]

Messier 23	NGC 6494	$17^h\ 56.8^m$	–19° 01′	June 20
5.5 m	⊕ 27′	100	II 2 r	Easy

Often overlooked because it lies in an area studded with celestial showpieces, this is a wonderful cluster that is equally impressive seen in telescopes or binoculars, but the latter will only show a few of the brighter stars shining against a misty glow of fainter stars. Full of double stars and star chains.

Messier 21	NGC 6531	$18^h\ 04.6^m$	–22° 30′	June 22
5.9 m	⊕ 14′	60	I 3 r	Easy

An outstanding cluster for small telescopes and binoculars. A compact, symmetrical cluster of bright stars with a nice double system of ninth and tenth magnitude located at its center. Very close to the Triffid Nebula. In the cluster is the grouping called Webb's Cross, which consists of several stars of sixth and seventh magnitude arranged in a cross. Several amateurs report that some stars within the cluster show definite tints of blue, red and yellow. Can you see them?

A fine large cluster easily seen with binoculars. About 7,000 light-years away,

Messier 16	NGC 6611	$18^h\ 18.8^m$	–13° 47′	June 26
6.0 m	⊕ 22′	50	II 3 m n	Easy

Located in the Sagittarius-Carina spiral arm of the galaxy, its hot O-type stars provide the energy for the Eagle Nebula, within which the cluster is embedded. A very young cluster of only 800,000 years, with a few at 50,000 years old.

Messier 18	NGC 6613	$18^h\ 19.9^m$	–17° 08′	June 26
6.9 m	⊕ 10′	30	II 3 p n	Easy

A small and unremarkable Messier object, and perhaps the most often ignored, this little cluster, containing many ninth-magnitude stars**,** is still worth observing. Best seen with binoculars or low-power telescopes. A double star is located within the cluster.

[2]Stellar associations are discussed in the naked-eye deep-sky chapter.

Herschel 72	NGC 6633	$18^h\ 27.7^m$	+06° 34′	June 28
4.6 m	⊕ 27′	25	III 2 m	Easy

Bordering on naked-eye visibility, although reports are hard to come by, this bright, large but loose cluster is perfect for binoculars and small telescopes. The stars are a lovely bluish-white set against the faint glow of the unresolved members. At the northern periphery of the cluster is a small but nice triple-star system.

Herschel 7	NGC 6520	$18^h\ 03.4^m$	–27° 54′	June 22
7.5 m	⊕ 7′	30	I 2 r n	Difficult

This cluster, although fairly bright, is situated within the Great Sagittarius Star Cloud, and thus makes positive identification difficult. It contains about three dozen faint stars and locating it is a good test of an observer's skill.

See also:

Cluster	Designation	Month
Caldwell 75	I 3 r	May
Stock 1	III 2 m	July
Collinder 413	II 2 p n	July
Caldwell 37	III 2 p	July
Messier 29	I 2 m n	July
Herschel 8	III 2 r	July
Messier 26	I 2 m	July
Messier 11	I 2 r	July
Collinder 392	III 2 m	July
NGC 6755	II 2 r	July
Collinder 402	IV 3 p	July
Collinder 403	I 1 r	July
Harvard 20	IV 2 p	July
NGC 6791	I 2 r	July
NGC 6939	I 1 m	July

July

Stock 1	–	$19^h\ 35.8^m$	+25° 13′	July 16
5.3 m	⊕ 60′	40	III 2 m	Easy

An enormous cluster best seen in binoculars, although it is difficult to estimate where the cluster ends and the background stars begin.

Collinder 413	NGC 6871	$20^h\ 05.9^m$	+35° 47′	July 23
5.2 m	⊕ 20′	30	II 2 p n	Easy

A nice cluster that is easily seen in small telescopes. It appears as a enhancement of the background Milky Way. Binoculars will show several stars of seventh to ninth magnitude surrounded by fainter members.

Caldwell 37	NGC 6885	$20^h\ 12.0^m$	+26° 29′	July 25
5.9 m	⊕ 7′	25	III 2 p	Easy

An irregular cluster containing many 9th- to 13th-magnitude stars. One of a number of objects that apparently remain unknown to many amateur astronomers. Visible in binoculars as a hazy blur, it is located next to (within?) the cluster NGC 6882 and thus is not easily delineated. An old cluster with an estimated age of around 1 billion years, with recent measurements by Hipparchos placing it at a distance of 1,140 light-years.

Messier 29	NGC 6913	$20^h\ 23.9^m$	+38° 32′	July 28
6.6 m	⊕ 7′	80	I 2 m n	Easy

A very small cluster and one of only two Messier objects in Cygnus. It contains only about a dozen stars visible with small instruments, and even then benefits from a low magnification. However, studies show that it contains many more bright B0-type giant stars, which are obscured by dust. Without this, the cluster would be a very spectacular object.

Herschel 8	NGC 6940	$20^h\ 34.6^m$	+28° 18′	July 30
6.3 m	⊕ 32′	75	III 2 r	Easy

A beautiful cluster, which although visible in binoculars, is best appreciated with a telescope. It contains the semi-variable star FG Vulpeculae near its center that has a nice reddish-orange tint.

Messier 26	NGC 6694	$18^h\ 45.2^m$	–09° 24′	July 3
8.0 m	⊕ 14′	30	I 2 m	Medium

This is a small but rich cluster containing 11th- and 12th-magnitude stars, set against a haze of unresolved stars. This makes it unsuitable for binoculars, as it will be only a hazy small patch of light, and so apertures of 10 cm and more will be needed to appreciate it in any detail.

Messier 11	NGC 6705	$18^h\ 51.1^m$	–06° 16′	July 4
5.8 m	⊕ 13′	200	I 2 r	Medium

Also known as the Wild Duck Cluster, this is a gem of an object. Although it is visible with binoculars as a small, tightly compact group, reminiscent of a globular cluster, they do not do it justice. With telescopes, however, its full majesty becomes apparent. Containing many hundreds of stars, it is a very impressive cluster. It takes

high magnification well, where many more of its 700 members become visible. At the top of the cluster is a glorious pale yellow tinted star. The well-known British amateur astronomer Michael Hurrell called this "one of the most impressive and beautiful celestial objects in the entire sky."

Collinder 392	NGC 6709	$18^h\ 51.5^m$	+10° 21′	July 4
6.7 m	⊕ 13′	45	III 2 m	Medium

A difficult object to locate for binoculars, as it will be unresolvable. Nevertheless this presents a good challenge for you to hone your observing skill. For small telescopes it presents a nice, rich cluster.

_	NGC 6755	$19^h\ 07.8^m$	+04° 14′	July 8
7.5 m	⊕ 15′	100	II 2 r	Medium

An easily found cluster in small telescopes, standing out from the background star field.

Collinder 402	NGC 6811	$19^h\ 36.9^m$	+46° 23′	July 16
6.8 m	⊕ 21′	65	IV 3 p	Medium

One of many clusters in Cygnus, this is a coarse open cluster of many tenth magnitude and fainter stars. The cluster has caught the attention of many amateurs, as it has been described as looking like a "smoke ring." The stars resemble the ring, while the interior is very dark. Apparently, the feature is easier to see with a small telescope than with a large one.

Collinder 403	NGC 6819	$19^h\ 41.3^m$	+40° 11′	July 17
7.3 m	⊕ 10′	100	I 1 r	Medium

A rich cluster located within, and contrasting with, the Milky Way. Contains many 11th-magnitude stars and thus is an observing challenge. The cluster is very old at over 3 billion years.

Harvard 20	–	$19^h\ 53.1^m$	+18° 20′	July 20
7.7 m	⊕ 10′	20	IV 2 p	Medium

A somewhat difficult binocular object, as the stars are of 12th and 13th magnitude and spread out without any noticeable concentration. The two nineth-magnitude members are easily spotted, however.

–	NGC 6791	$19^h\ 20.7^m$	+37° 51′	July 12
9.5 m	⊕ 15′	250	I 2 r	Difficult

A rich cluster of faint stars. It contains many faint 11th-magnitude stars and so poses an observing challenge.

–	NGC 6939	$20^h\ 31.4^m$	+60° 38′	July 30
7.8 m	⊕ 7.0′	50	I 1 m	Difficult©

A moderately bright and small cluster, unresolvable in binoculars. A challenge as the brightest member is only of 11.9 magnitude. In telescopes of aperture 10 cm, it will appear as a small hazy spot with just a few very faint stars resolved.

See also:

Cluster	Designation	Month
Caldwell 76	I 3 p	June
Trumpler 24	IV 2 p n	June
IC 4665	III 2 m	June
Messier 23	II 2 r	June
Messier 21	I 3 r	June
Messier 16	II 3 m n	June
Messier 18	II 3 p n	June
Herschel 72	III 2 m	June
Collinder 309	I 2 r	June
Trumpler 26	II 1 m	June
Trumpler 26	II 1 m	June
Herschel 7	I 2 r n	June
Messier 73	IV 1 p	August
Messier 39	III 2 m	August
Caldwell 16	IV 2 p	August
IC 1396	II m n	August
Collinder 445	II 1 p	August

August

Messier 73	NGC 6994	$20^h\ 59.0^m$	–12° 38′	August 6
8.9 m	⊕ 2.8′	4	IV 1 p	Easy

Something of an enigma. It shouldn't really be classified as an open cluster, as it consists of only four stars! Perhaps originally cataloged when Messier was having a bad day. Still nice, though. A small grouping of stars like this is often called an asterism. There is considerable debate as to whether the stars are related to each other, or are the result of a chance alignment. One line of research suggests M73 is a "Possible Open Cluster Remnant (POCR)," whereas later work suggests otherwise.

Messier 39	NGC 7092	$21^h\ 32.2^m$	+48° 26′	August 14
4.6 m	⊕ 31′	30	III 2 m	Easy©

A nice cluster in binoculars, it lies at a distance of 840 light-years. About two dozen stars are visible, ranging from seventh to ninth magnitude. What makes this cluster so distinctive is the lovely color of the stars – steely blue – and the fact that it is nearly perfectly symmetrical, having a triangular shape. There is also a nice double star at the center of the cluster.

Caldwell 16	NGC 7243	$22^h\ 15.3^m$	+49° 53′	August 25
6.4 m	⊕ 21′	40	IV 2 p	Easy©

Set against the backdrop of the Milky Way, this large, irregular cluster nevertheless stands out quite well. Several of the stars are visible in binoculars, but the remainder blur in the background star field. A nice object in an otherwise empty part of the sky – if you overlook the fact that it is located within the Milky Way!

–	IC 1396	$21^h\ 39.1^m$	+57° 30′	August 16
3.7 m	⊕ 50′	40	II m n	Medium

Although a telescope of at least 20 cm is needed to really appreciate this cluster, it is nevertheless worth searching out. It lies south of Herschel's Garnet Star and is rich but compressed. What makes this so special, however, is that it is cocooned within a very large and bright nebula.

Collinder 445	IC 1434	$22^h\ 10.5^m$	+52° 50′	August 24
9.0 m	⊕ 7′	70	II 1 p	Difficult©

Located within the Milky Way, this is a large but irregular cluster of over 70 stars of tenth magnitude and fainter. Try using a high magnification of, say, 150–200×, and also use averted vision. These two factors will almost certainly improve this cluster's observability.

See also:

Cluster	Designation	Month
Stock 1	III 2 m	July
Collinder 413	II 2 p n	July
Caldwell 37	III 2 p	July
Messier 29	I 2 m n	July
Herschel 8	III 2 r	July
Messier 26	I 2 m	July
Messier 11	I 2 r	July
Collinder 392	III 2 m	July.
NGC 6755	II 2 r	July
Collinder 402	IV 3 p	July
Collinder 403	I 1 r	July
Harvard 20	IV 2 p	July
NGC 6791	I 2 r	July

(continued)

Cluster	Designation	Month
NGC 6939	I 1 m	July
Messier 52	I 2 r	September
Blanco 1	III 2 m	September
Herschel 78	IV 2 p	September
Herschel 69	IV 1 p	September
King 14	III 2 p	September
King 12	I 2 p	September
Herschel 35	II 2 p	September

September

Messier 52	NGC 7654	$23^h\ 24.2^m$	+61° 35′	September 11
6.9 m	⊕ 12′	100	I 2 r	Easy©

A small, rich and fairly bright cluster. One of the densest north of the celestial equator. Several stars are visible in binoculars, but telescopic apertures are needed to fully appreciate this cluster. It is one of the few clusters that show a distinct color. Many observers report a faint blue tint to the group, and this along with a fine topaz-colored (blue) star and several nice yellow and blue stars make it a very nice object to observe. Apparently, it has a star density of the order of 50 stars per cubic parsec!

Blanco 1	–	$00^h\ 04.3^m$	–29° 56′	September 22
4.5 m	⊕ 90′	30	III 2 m	Easy

Located close to the south galactic pole, this is an ill-defined and very large cluster. Easily visible in binoculars.

Herschel 78	NGC 129	$00^h\ 29.9^m$	+60° 14′	September 28
6.5 m	⊕ 21′	30	IV 2 p	Easy©

A bright, open cluster. Irregularly scattered and uncompressed, making it difficult to distinguish from the background. Up to a dozen stars can be seen with binoculars, but many more are visible under telescopic aperture. Under good observing conditions and using averted vision, the unresolved background stars of the cluster can be seen as a faint glow.

Herschel 69	NGC 7686	$23^h\ 30.2^m$	+49° 08′	September 13
5.6 m	⊕ 14′	20	IV 1 p	Medium©

A sparse and widely dispersed cluster containing many 10th- and 11th-magnitude stars. Best seen with large-aperture telescopes.

King 14	–	$00^h\ 31.9^m$	+63° 10′	September 28
8.5 m	⊕ 7′	20	III 2 p	Medium ©

Often overlooked, this cluster is a faint but rich object. With a 10-cm aperture telescope, several stars can be resolved set against a faint glow.

King 12	–	$23^h\ 53.0^m$	+61° 58′	September 19
9.0 m	⊕ 2′	15	I 2 p	Difficult

A very faint cluster containing many 10th-, 11th- and 12th-magnitude stars. A challenge to deep-sky observers.

Herschel 35	NGC 136	$00^h\ 31.5^m$	+61° 32′	September 28
– m	⊕ 1.2′	20	II 2 p	Difficult

A very small cluster looking like a tiny sprinkling of diamond dust. Although it can be observed with a 15-cm telescope, it needs a very large aperture of at least 20 cm to be fully resolvable.

See also:

Cluster	Designation	Month
Messier 73	IV 1 p	August
Messier 39	III 2 m	August
Caldwell 16	IV 2 p	August
IC 1396	II m n	August
Collinder 445	II 1 p	August
Caldwell 13	I 3 r	October
Collinder 33	III 1 m	October
Stock 2	III 1 m	October
Caldwell 14 (see Chapter 7)	I 3 r	October
Herschel 64	III 2 p	October
Messier 103	III 2 p	October
Trumpler 1	I 3 p	October
Herschel 49	I 3 p	October

October

Caldwell 13	NGC 457	$01^h\ 19.1^m$	+58° 20	October 11
6.4 m	⊕ 13′	80	I 3 r	Easy ©

This is a wonderful cluster and can be considered one of the finest in Cassiopeia. Easily seen in binoculars as two southward-arcing chains of stars, surrounded by many fainter components. The gorgeous blue and yellow double φ Cass and a lovely

red star, HD 7902, lie within the cluster. Located at a distance of about 8,000 light-years, this young cluster is located within the Perseus spiral arm of our galaxy.

Collinder 33	NGC 752	$01^h\ 57.8^m$	+37° 41′	October 20
5.7 m	⊕ 45′	77	III 1 m	Easy

Best seen in binoculars, or even at low powers in a telescope, this is a large, loosely structured group of stars containing many chains and double stars. Lies about 5° south-southwest of γ Andromedae. Often underrated by observing guides, it is worth seeking out. It is a cluster of intermediate age.

Stock 2		$02^h\ 15.0^m$	+59° 16′	October 25
4.4 m	⊕ 60′	50	III 1 m	Easy©

Another often passed-over cluster! Wonderful in binoculars and small telescopes it lies 2° north of its more famous cousin, the Double Cluster. At nearly a degree across it contains over 50, 8th magnitude and fainter stars. Well worth seeking out.

Herschel 64	NGC 381	$01^h\ 08.3^m$	+61° 35′	October 8
9.3 m	⊕ 6′	50	III 2 p	Medium©

A faint cluster, but rich and compressed. Can be resolved with an aperture of 10 cm, but with medium aperture, of say, 20–25 cm, over 60 stars of 12th and 13th magnitude become visible.

Messier 103	NGC 581	$01^h\ 33.2^m$	+60° 42′	October 14
7.4 m	⊕ 6′	25	III 2 p	Difficult©

A nice, rich cluster of stars, which is resolvable in small binoculars. Using progressively larger apertures, more and more of the cluster will be revealed (as with most clusters). It has a distinct fan shape, and the star at the top of the fan is Struve 131, a double star with colors reported as pale yellow and blue. Close by is also a rather nice, pale, red-tinted star. The cluster is the last object in Messier's original catalog.

Trumpler 1	Collinder 15	$01^h\ 35.7^m$	+61° 17′	October 15
8.1 m	⊕ 4.5′	20	I 3 p	Difficult©

Even with a telescope of 12 cm aperture, this small and tightly compressed cluster will be a challenge.

Herschel 49	NGC 637	$01^h\ 42.9^m$	+64° 00′	October 17
8.2 m	⊕ 3.5′	20	I 3 p	Difficult©

A faint and very condensed cluster. About ten stars can be seen with a telescope of at least 10 cm aperture, but many more will remain unresolved.

See also:

Cluster	Designation	Month
Messier 52	I 2 r	September
Blanco 1	III 2 m	September
Herschel 78	IV 2 p	September
Herschel 69	IV 1 p	September
King 14	III 2 p	September
King 12	I 2 p	September
Herschel 35	II 2 p	September
Messier 34 (see Chapter 7)	II 3 m	November
Stock 23	III 3 p n	November

November

Stock 23	–	$03^h\ 16.3^m$	+60° 02′	November 9
5.6 m	⊕ 18′	25	III 3 p n	Easy©

A little known cluster on the border of Camelopardalis-Cassiopeia. Binoculars reveal several stars, best viewed in medium-aperture telescopes. It is bright and large but spread out.

See also:

Cluster	Designation	Month
Caldwell 13	I 3 r	October
Collinder 33	III 1 m	October
Stock 2	III 1 m	October
Caldwell 14 (see Chapter 7)	I 3 r	October
Herschel 64	III 2 p	October
Messier 103	III 2 p	October
Trumpler 1	I 3 p	October
Herschel 49	I 3 p	October
Herschel 33	II 2 m	December
Collinder 464	II 2 m	December
Collinder 69	II 3 p n	December
Collinder 73	III 2 p n	December
Collinder 38	I 3 p n	December
Herschel 59	III 1 p	December
Collinder 81	II 3 r	December
Herschel 68	II 1 p	December
Herschel 61	III 2 p	December
Herschel 13	III 3 m	December

December

Herschel 33	NGC 1857	$05^h\ 20.2^m$	+39° 21′	December 11
7.0 m	⊕ 6′	35	II 2 m	Easy

A very rich cluster containing several small chains of stars with starless voids located within and around it. The brightest member of the cluster is a nice orange-tinted star, but its glare can overpower the many fainter stars. Some observers try to occult the bright star so that it is obscured, thus allowing the fainter stars to be observed.

Collinder 464		$05^h\ 22.0^m$	+73° 00′	December 11
4.2 m	⊕ 120′	50	II 2 m	Easy©

A large, very rich, irregular open cluster, with the distinction that it is best seen in binoculars, as viewing it in a telescope will dissipate the cluster. Contains many fifth-, sixth- and seventh-magnitude stars.

Collinder 69	–	$05^h\ 35.1^m$	+09° 56′	December 14
2.8 m	⊕ 65′	20	II 3 p n	Easy

Perfect for binoculars. This cluster surrounds the third-magnitude stars l Orionis, and includes φ^{-1} and φ^{-2} Orionis, both fourth magnitude. Encircling the cluster is the very faint emission nebula, Sharpless 2–264, only visible using averted vision and an OIII filter with extremely dark skies.

Collinder 73	NGC 1981	$05^h\ 35.2^m$	–04° 26′	December 14
4.6 m	⊕ 25′	20	III 2 p n	Easy

A nice, bright, coarse cluster, lying about 1° north of M42. Around eight or nine stars can be seen in binoculars, while the remaining stars are a hazy background glow. In moderate telescopes, the most striking feature is two parallel rows of stars.

Collinder 38	NGC 2169	$06^h\ 08.4^m$	+13° 57′	December 23
5.9 m	⊕ 6′	30	I 3 p n	Easy

This is a small but bright cluster. Some observers find it hard to believe that this scattering of stars has been classified as a cluster. Easily visible in binoculars, the stars appear to range in magnitude from about 8–10. Also, binoculars will show the four brightest members to be surrounded by faint nebulosity – sometimes!

Herschel 59	NGC 1664	$04^h\ 51.1^m$	+43° 42′	December 3
7.6 m	⊕ 13′	25	III 1 p	Medium

A nice bright cluster, but loosely structured and best seen with an aperture of 20 cm. Appears as an enrichment of the background Milky Way star field. There is a seventh-magnitude star within the cluster, but it is not a true member, and the glare from the star can sometimes make observation of the cluster difficult. Increasing the aperture will progressively show more stars.

Collinder 81	NGC 2158	$06^h\ 07.5^m$	+24° 06′	December 23
8.6 m	⊕ 5′	70	II 3 r	Medium

Lying at a distance of 160,000 light-years, this is one of the most distant clusters visible using small telescopes, and lies at the edge of the galaxy. It needs a 20 cm telescope to be resolved, and even then only a few stars will be visible against a background glow. It is a very tight, compact grouping of stars, and something of an astronomical problem. Some astronomers class it as an intermediate object lying between an open cluster and a globular cluster, and it is believed to be about 800 million years old, making it very old as open clusters go.

Herschel 68	NGC 2126	$06^h\ 03.0^m$	+49° 54′	December 22
10.2 m	⊕ 6′	40	II 1 p	Difficult©

Has been described as diamond dust on black velvet. A very faint but nice cluster, although it can prove a challenge to find.

Herschel 61	NGC 1778	0	$5^h\ 08.1^m$	+37° 03′	December 8
7.7 m	⊕ 6′		30	III 2 p	Difficult

Although a fairly bright cluster, it is so sparse and spread out that it will require some careful observation to be located.

Herschel 13	NGC 2204	$06^h\ 15.7^m$	−18° 39′	December 25
8.6 m	⊕ 13′	80	III 3 m	Difficult

A difficult cluster to locate and observe, composed of many faint stars but with a nice orange star at its northern limit.

See also:

Cluster	Designation	Month
Messier 34	II 3 m	November
Stock 23	III 3 p n	November
NGC 2301	I 3 m	January
Collinder 121	III 3 p	January
Messier 50 (see Chapter 7)	II 3 m	January
Herschel 34	II 2 p	January
Caldwell 58	II 2 m	January
Caldwell 64	I 3 p n	January
Messier 48	I 3 r	January
Caldwell 54	I 2 r	January
Herschel 21	II 2 m	January

Globular Clusters

Having covered one type of star cluster – the open or galactic cluster – we now turn our attention to a very different type.

Recall that open clusters are groups of stars that are usually young, have an appreciable angular size and may have a few hundred components. Globular clusters, as they are known, are clusters that are very old, are compact and may contain up to a half a million stars, in some cases even more.[3]

The stars that make up a globular cluster are called Population II stars. These are metal-poor stars and are usually to be found in a spherical distribution around the galactic center at a radius of about 200 light-years. Furthermore, the number of globular clusters increases significantly the closer one gets to the galactic center. This means constellations that are located in a direction towards the galactic bulge have a high concentration of globular clusters within them, such as Sagittarius and Scorpius. Thus, the spring and summer are by far the most favorable times for viewing these elusive objects.

The origin and evolution of a globular cluster is very different from that of an open or galactic cluster. All the stars in a globular cluster are old, with the result that any star earlier than class G- or F-type will have left the main sequence and either be moving toward the red giant stage of its life, or, for the O- and B- type stars will have long ago evolved to the supernova phase and beyond, leaving behind a neutron star or even perhaps a black hole! In fact, new star formation[4] no longer takes place within any globular clusters in our galaxy, and these clusters are

[3]The very largest, for example, Omega Centuari, are now believed to be the dense cores of satellite galaxies that have been consumed by the Milky Way – galactic cannibalization, as it is called!

[4]The possibility that new stars can be formed from merging old stars does not count!

believed to be the oldest structures formed in our galaxy.[5] It may well be that the youngest of the globular clusters is still far older than the oldest open cluster. The origin of the globular clusters is a topic of fierce debate, and research with the current models predict that the globular clusters may have been formed within the proto-galaxy clouds that went to make up our galaxy.

There are about 150–158[6] globular clusters in our galaxy ranging in size from 60 to 150 light-years in diameter. They all lie at vast distances from the Sun, are about 60,000 light-years from the galactic plane, and are located in what is termed the halo of the galaxy. The nearest globular clusters, for example, Caldwell 86 in Ara, lies at a distance of over 6,000 light-years, and thus the clusters are difficult objects for small telescopes. That is not to say they can't be seen; rather, it means that any structure within the cluster will be difficult to observe with small aperture telescopes. Even the brightest and biggest globular will need apertures of at least 15 cm for individual stars to be resolved. However, if large aperture telescopes are used, then these objects are truly magnificent. Some globular clusters have dense concentrations towards their center while others may appear as compact open clusters. In some cases, it is difficult to say where the globular cluster peters out and the background stars begin.

As in the case of open clusters, there exists a classification system, the Shapley-Sawyer concentration class, where Class I globular clusters are the most star-dense, while Class XII is the least star-dense. The ability of an amateur to resolve the stars in a globular actually depends on how condensed the cluster actually is, and so the scheme will be used in the descriptions, but it is only really useful for those amateurs who have large aperture instruments. Nevertheless, the observation of these clusters that are among the oldest objects visible can provide you with breathtaking, seemingly three-dimensional aspects, and at the same time, increase and develop your observing skills.

The details listed are of the same order as in open clusters, with the omission of star numbers, and the replacement of Trumpler type with the Shapley-Sawyer concentration class.

January

Caldwell 25	NGC 2419	$07^h\ 38.1^m$	+38° 53′	January 15
9,06 m	⊕ 4.1′		II	Difficult

Also known as the Intergalactic Wanderer. A difficult object to resolve with any detail; even large telescopes of aperture 40 cm will be unable to resolve any stellar detail.

[5]There now exists the interesting scenario that there are in fact two types, or populations, of globular clusters. Named after their discoverer, the Dutch astronomer Pieter Oosterhoff, Type II clusters differ from Type I in that they are actually captured clusters from satellite galaxies and could be older than Type I clusters.

[6]Depending on which research paper you read!

It has been reported as observed with an 10 cm telescope under perfect conditions, but will appear as just a faint, hazy dot. It lies at the vast distance of 300,000 light-years, further even than the Magellanic Clouds, because it has a space velocity in excess of the velocity needed to escape from the gravitational pull of our galaxy. One of the five most luminous clusters in the Milky Way, it has been suggested that it is in fact of extragalactic origin and maybe the remains of a small galaxy, captured and subsequently disrupted by the Milky Way.

See also:

Cluster	Designation	Month
Messier 79	V	December

February

See:

Cluster	Designation	Month
Caldwell 25	II	January
NGC 4147	VI	March

March

–	NGC 4147	$12^h\ 10.1^m$	+18° 33′	March 25
10.2 m	⊕ 4′		VI	Difficult

This is a faint cluster, hazy in appearance with a star-like core. A challenge for telescopic observers. Several variable stars are also located within the cluster.

See also:

Cluster	Designation	Month
Messier 68	X	April
Caldwell 80	VIII	April
Messier 53	V	April
Herschel 9	XII	April
Herschel 7	XI	April

April

Messier 68	NGC 4590	$12^h\ 39.5^m$	−26° 45′	April 1
7.8 m	⊕ 12′		X	Easy

Appearing only as a small, hazy patch in binoculars, this is a nice cluster in telescopes, with an uneven core and faint halo. Under low magnification, some faint structure or mottling can be glimpsed which under medium to high magnification resolves itself as a myriad assembly of stars. A definite challenge to naked-eye observers, where perfect seeing will be needed. Use averted vision and make sure that your eyes are well and truly dark-adapted.

Caldwell 80	NGC 5139	$13^h\ 26.8^m$	−47° 29′	April 13
3.5 m	⊕ 36′		VIII	Easy

Also known as Omega Centauri. A fabulous cluster and one of the showpieces of the night sky. Visible to the naked eye as a clearly seen, hazy patch of light. A stunning sight in binoculars, and a jaw-dropping spectacle in telescopes.[7] Words do not do it justice, so we won't even attempt to describe it but will leave it up to you to search out this wonderful object. It contains over a million stars, and some sources put it at having nearly ten million. It is about 15,800 light-years away. Recent research has suggested that the cluster is in fact the central core of a dwarf galaxy that was disrupted by the Milky Way.

Messier 53	NGC 5024	$13^h\ 12.9^m$	+18° 10′	April 9
7.6 m	⊕ 12′		V	Medium

An often ignored globular cluster, which is a shame as it is a nice object. Contains about 100,000 stars, none of which are resolved in binoculars, through which it will appear as a faint hazy patch with a brighter center, located in a star field. Telescopes show a nice symmetrical glow with a concentrated core. Some observers report a colored hue to the cluster – what do you see? It stands up nicely to magnification and indeed is a lovely sight in telescopes of aperture 10 cm and greater. It lies at a distance of around 60,000 light-years away from the center of the Milky Way.

Herschel 9	NGC 5466	$14^h\ 05.5^m$	+28° 32′	April 23
9.0 m	⊕ 11′		XII	Medium

[7] Alas, this wonderful globular cluster is not visible from the UK, or northern parts of the United States, but it is still included here as it is truly an amazing object to observe, and should you have the chance to see it, then do so.

A challenge for binoculars, and even when located will appear as a faint hazy and small glow. In telescopes the cluster has a resolvable core.

Herschel 7	NGC 5053	$13^h\ 16.4^m$	+17° 42′	April 10
10.9 m	⊕ 10′		XI	Difficult

A very faint and loose cluster containing only 3,500 stars, it lies very close to Messier 53, and both can be glimpsed using a low power. This is one of those clusters that is very impressive when seen through a large-aperture telescope. Its position in space is also unique, in that it lies about 50,000 light-years above the galactic plane.

See also:

Cluster	Designation	Month
NGC 4147	VI	March
Messier 80	II	May
Messier 4	IX	May
Messier 107	X	May
Caldwell 66	VII	May
Herschel 19	XI	May

May

Messier 80	NGC 6093	$16^h\ 17.0^m$	−22° 59′	May 26
7.9 m	⊕ 10.0′		II	Easy

Readily detectable in binoculars as a tiny, glowing hazy patch set in a stunning star field, it has a distinctly noticeable brighter core. Telescopes will be needed to resolve its 14th-magnitude stellar core. One of the few globular clusters to have been the origin of a nova, T Scorpii, when it flared to prominence in 1860, then disappeared back into obscurity within 3 months.

Messier 4	NGC 6121	$16^h\ 23.6^m$	−26° 32′	May 28
5.8 m	⊕ 26.3′		IX	Easy

A superb object, presenting a spectacle in all optical instruments, but it does lie very close to the star Antares, so that the glare of the latter may prove a problem in the detection with small aperture telescopes. High-power binoculars will even resolve several stars. Telescopes of all apertures show detail and structure within the cluster, and the use of high magnification will prove beneficial; but what is more noticeable is the bright lane of stars that runs through the cluster's center. Thought to be the closest globular to Earth at 7,200 light-years (although NGC 6397 in Ara

may be closer), and about 12.2 billion years old. Research has discovered many white dwarf stars in the cluster, believed to be among the oldest known, and one in particular is a binary star with a pulsar companion, PSR B1620-26, and a planet orbiting it with a mass of 2.5 times that of Jupiter.

Messier 107	NGC 6171	$16^h\ 32.5^m$	−13° 03′	May 30
8.85 m	⊕ 13′		X	Medium

Often missed by amateurs owing to its faintness, it is nevertheless a pleasant cluster with a mottled disc and brighter core. Not visible with the naked eye, it nevertheless presents a pleasing aspect when medium to high magnification is used. What makes this inconspicuous globular important, however, is that it is one of the very few that seem to be affected by the presence of interstellar dust. Deep imaging has revealed several obscured areas within the cluster, possibly due to dust grains lying between us. This isn't such a surprise, as the globular is located over the hub of the galaxy in Scorpius.

Caldwell 66	NGC 5694	$14^h\ 39.6^m$	−26° 32′	May 1
10.9 m	⊕ 3.6′		VII	Difficult

A faint cluster that has a bright core but an unresolved halo in telescopes of less than 30 cm. An unremarkable object, which you will probably not visit more than once! It is a difficult cluster to locate, especially from the UK. Precise setting circles on your telescope (or of course even a computerized system) will help significantly in finding it. It is actually located on the far side of our galaxy, at around 110,000 light-years from the Solar System. Research suggests that the cluster may have attained a velocity that will allow it to escape from the gravitational pull of the galaxy.

Herschel 19	NGC 5897	$15^h\ 17.4^m$	−21° 01′	May 11
8.6 m	⊕ 12.5′		XI	Difficult

A very difficult cluster to locate in binoculars owing to its low surface brightness. Even with a telescope, it is not an easy object to observe.

See also:

Cluster	Designation	Month
Messier 68	X	April
Caldwell 80	VIII	April
Messier 53	V	April
Herschel 9	XII	April
Herschel 7	XI	April
Messier 12	IX	June
Messier 62	IV	June
Messier 19	VIII	June

(continued)

Cluster	Designation	Month
Messier 9	VII	June
Messier 92 (see Chapter 7)	IV	June
Messier 14	VIII	June
Herschel 147	VI	June
Herschel 49	VI	June
Herschel 12	XI	June
Messier 28	IV	June
Messier 69	V	June
Herschel 50	IV	June
Herschel 200	V	June

June

Messier 12	NGC 6218	$16^h\ 47.2^m$	–01° 57′	June 3
7.68 m	⊕ 16.0′		IX	Easy

A small cluster that will be a challenge to naked-eye observers. In telescopes of aperture 20 cm and more, this cluster is very impressive, with many stars being resolved against the fainter background of unresolved members. It also contains many faint-colored stars that show up well with telescopes of aperture 10 cm and greater. It is nearly the twin of Messier 10, which is within 3° southeast. A recent study has shown that it has a small number of low mass stars, and it has been suggested that many stars may have been stripped from it by the gravitational influence of the Milky Way.

Messier 62	NGC 6266	$17^h\ 01.2^m$	–30° 07′	June 6
6.5 m	⊕ 14′		IV	Easy

A very nice cluster, visible in binoculars as a small hazy patch of light set in a wonderful star field. Owing to its irregular shape, it bears a cometary appearance, which is apparent even in small telescopes. Has a very interesting structure where concentric rings of stars have been reported by several observers, along with a colored sheen to its center, described as both pale red and yellow!

Messier 19	NGC 6273	$17^h\ 02.6^m$	–26° 16′	June 7
6.8 m	⊕ 17′		VIII	Easy

A splendid albeit faint cluster when viewed through a telescope, it nevertheless can be glimpsed with binoculars, where its egg shape is very apparent. Although a challenge to resolve, it is nevertheless a colorful object, reported as having both faint orange and faint blue stars, while the overall color of the cluster is a creamy

white. Some amateurs also claim that a few faint dark patches mottle the cluster; perhaps this is interstellar dust between us and it.

Messier 9	NGC 6333	$17^h\ 19.2^m$	−18° 31′	June 11
7.7 m	⊕ 12.0′		VII	Easy

Visible in binoculars, this is a small cluster with a bright core. The cluster is one of the nearest to the center of our galaxy and is in a region conspicuous for its dark nebulae, including Barnard 64; it may be that the entire region is swathed in interstellar dust, which gives rise to the cluster's dim appearance. It lies about 26,000 light-years away.

Messier 14	NGC 6402	$17^h\ 37.6^m$	−03° 15′	June 16
7.6 m	⊕ 11.7′		VIII	Medium

Located in an empty part of the sky, this is brighter and larger than is usual for a globular. Though visible only in binoculars as a small patch of light, and not resolved even in a small telescope (<15 cm), it is nevertheless worth searching for. It shows a delicate structure with a lot of detail, much of which will be obscured if seen from an urban location. It has a pale yellow tint, and some observers report seeing a definite stellar core, which has a striking orange color. But this feature is seen only with telescopes of aperture 15 cm and greater and using a high magnification.

Herschel 147	NGC 6304	$17^h\ 14.5^m$	−29° 28′	June 18
8.4 m	⊕ 6.9′		VI	Medium

This is a small but bright cluster with only a few resolvable stars near its edge. Nevertheless it will be a challenge to locate with binoculars.

Herschel 49[8]	NGC 6522	$18^h\ 03.6^m$	−30° 02′	June 22
8.6 m	⊕ 5.6′		VI	Medium

With telescopes of aperture 20 cm this cluster will appear with a bright core but an unresolved halo. A difficult object to locate with binoculars.

Herschel 12	NGC 6553	$18^h\ 09.3^m$	−25° 54′	June 24
8.1 m	⊕ 8.1′		XI	Medium

Not easily visible in binoculars (although it would prove an observational challenge to locate), this is a fairly evenly bright cluster, with no perceptible increase towards the core.

[8]Located within the constellation Sagittarius are a plethora of globular clusters; only the brightest are discussed here.

Messier 28	NGC 6626	$18^h\ 24.5^m$	−24° 52′	June 27
6.8 m	⊕ 11.2′		IV	Medium

Only seen as a small patch of faint light in binoculars, this is an impressive cluster in telescopes. With an aperture of 15 cm it shows a bright core with a few resolvable stars at the halo's rim. With a larger aperture the cluster becomes increasingly resolvable and presents a spectacular sight. It lies at a distance of about 22,000 light-years. Well worth seeking out for large-aperture telescope owners, as it is a lost gem.

Messier 69	NGC 6637	$18^h\ 31.4^m$	−32° 21′	June 29
7.6 m	⊕ 7.1′		V	Medium

Visible as just a hazy spot in binoculars, this appears with a nearly star-like core in telescopes. Large aperture will be needed to resolve any detail and will show the myriad dark patches located within the cluster.

Herschel 50	NGC 6229	$16^h\ 47.0^m$	+47° 32′	June 3
9.4 m	⊕ 4.5′		IV	Difficult

A difficult object to locate, and even with 20 cm telescopes will appear unresolved. Large-aperture telescopes, however, will show structure and detail within the cluster.

Herschel 200	NGC 6528	$18^h\ 04.8^m$	−30° 03′	June 22
9.5 m	⊕ 3.7′		V	Difficult

Even in large telescope of aperture 35 cm this cluster is unresolved. It will just appear as a faint glow with a slightly brighter center. A good challenge for large-aperture telescopes.

See also:

Cluster	Designation	Month
Messier 80	II	May
Messier 4	IX	May
Messier 107	X	May
Caldwell 66	VII	May
Herschel 19	XI	May
Messier 55 (see Chapter 7)	XI	July
Messier 70	V	July
Messier 54	III	July
NGC 6760	IX	July
Messier 56	X	July
Messier 71	X	July
Messier 75	I	July
Caldwell 47	VIII	July

July

Messier 70	NGC 6681	$18^h\ 42.2^m$	–32° 18′	July 2
8.0 m	⊕ 7.8′		V	Medium

A faint binocular object that is a twin of M69. Best viewed with a large aperture, as with a small telescope, it is often mistaken for a galaxy. It lies at a distance of 35,000 light-years.

Messier 54	NGC 6715	$18^h\ 55.1^m$	–30° 29′	July 5
7.6 m	⊕ 9.1′		III	Medium

With telescopic apertures smaller than 35 cm the cluster remains unresolved and will show only a larger view similar to that seen in binoculars – a faint hazy patch of light. It has a colorful aspect – a pale blue outer region and pale yellow inner core. Recent research has found that the cluster was originally related to the Sagittarius dwarf galaxy, but that the gravitational attraction of our galaxy has pulled the globular from its parent. Among the globular clusters in the Messier catalog it is one of the densest as well as being the most distant.

–	NGC 6760	$19^h\ 11.2^m$	+01° 02′	July 9
9.1 m	⊕ 6.5′		IX	Medium

A faint, symmetrical cluster with a just perceptible brighter core. High-power binoculars should be able to locate this cluster, and even with a small telescope it should present no problems. But a knowledge of the use of setting circles would be useful, as would a computer-controlled telescope.

Messier 56	NGC 6779	$19^h\ 16.6^m$	+30° 11′	July 11
8.3 m	⊕ 7′		X	Medium

It is situated in a rich star field and in small instruments will appear as a hazy patch with a brighter core. It has often been likened to a comet in its appearance. Resolution of the cluster will need at least a 20 cm aperture telescope, and increasing magnification will show further detail.

Messier 71	NGC 6838	$19^h\ 53.8^m$	+18° 47′	July 20
8.2 m	⊕ 7.2′		X	Medium

A rich and compressed cluster that only shows a very faint glow in binoculars. Located in a glittering star field. Up until recently there was some debate as to whether this was a globular or open cluster. The consensus now is that it is a very young globular cluster, only 13,000 light-years away. What makes this globular so nice is that the central stars can be resolved all the way to the core, which is rare among globular clusters.

Messier 75	NGC 6864	20^h 06.1^m	–21° 55′	July 23
8.5 m	⊕ 6′		I	Medium

A difficult object to locate with binoculars as it is so small and faint. Even then it will only appear as a hazy spot (like so many others). Will show a bright core and a few resolved stars in the halo with 25 cm aperture telescopes. One of the most distant globulars in Messier's catalog, at 60,000 light-years.

Caldwell 47	NGC 6934	20^h 34.2^m	+07° 24′	July 30
8.9 m	⊕ 5.9′		VIII	Medium

A difficult object for binoculars, appearing as a tiny patch of light. Just resolvable, with 10 cm aperture telescopes, as a small, bright, round cluster, with a brighter and condensed center. Some observers report that the use of averted vision aids in seeing some faint structure within the cluster. It has many blue straggler stars and was one of the first objects to be imaged by the Gemini North Telescope, which resolved its core.

See also:

Cluster	Designation	Month
Messier 12	IX	June
Messier 62	IV	June
Messier 19	VIII	June
Messier 9	VII	June
Messier 92 (see Chapter 7)	IV	June
Messier 14	VIII	June
Herschel 147	VI	June
Herschel 49	VI	June
Herschel 12	XI	June
Messier 28	IV	June
Messier 69	V	June
Herschel 50	IV	June
Herschel 200	V	June
Messier 15 (see Chapter 7)	IV	August
Messier 2 (see Chapter 7)	II	August
Messier 30	V	August
Messier 72	IX	August
Caldwell 42	I	August
Palomar 12	XII	August

August

Messier 30	NGC 7099	$21^h\ 40.4^m$	−23° 11′	August 16
7.2 m	⊕ 12′		V	Easy

In binoculars this will appear simply as a tiny, round, hazy patch of light, and even telescopes of aperture 20–25 cm will show just a bright, asymmetrical core with an unresolved halo. At its periphery are several looping arcs of stars.

Messier 72	NGC 6981	$20^h\ 53.5^m$	−12° 32′	August 4
9.3 m	⊕ 6.6′		IX	Medium

At a distance of about 53,000 light-years, this is faintest globular cluster catalogued by Messier. In binoculars it will appear as just a tiny, hazy point of light, but in telescopes of aperture 20 cm and larger its true nature becomes apparent. The use of averted vision may help you to see any detail within the cluster.

Caldwell 42	NGC 7006	$21^h\ 01.5^m$	+16° 11′	August 6
10.6 m	⊕ 2.8′		I	Medium

Another very distant cluster, at 185,000 light-years from the Solar System. In telescopes it appears as a small unresolved disc, not unlike a planetary nebula. However, even with large binoculars little will be seen unless averted vision is used. A very old cluster located far out in the galactic halo.

Palomar 12	–	$21^h\ 46.5^m$	−21° 14′	August 18
11.7 m		⊕ 3′	XII	Difficult

A challenge for amateurs who possess telescopes of aperture 20–25 cm. It will appear as a faint, small patch of nebulosity. Perfect seeing conditions will be needed.

See also:

Cluster	Designation	Month
Messier 55 (see Chapter 7)	XI	July
Messier 70	V	July
Messier 54	III	July
NGC 6760	IX	July
Messier 56	X	July
Messier 71	X	July
Messier 75	I	July
Caldwell 47	VIII	July

September

See:

Cluster	Designation	Month
Messier 15 (see Chapter 7)	IV	August
Messier 2 (see Chapter 7)	II	August
Messier 30	V	August
Messier 72	IX	August
Caldwell 42	I	August
Palomar 12	XII	August

October

Only a few objects are visible in October, and these are not very well placed. Refer to the August list for details.

November

See:

Cluster	Designation	Month
Messier 79	V	December

December

Messier 79	NGC 1904	$05^h\ 24.5^m$	−24° 33′	December 12
8.0 m	⊕ 9.6′		V	Medium

A fine cluster, best appreciated with a telescope because binoculars cannot resolve it. Small telescopes of, say, 10 cm aperture can resolve the core, but it will be a challenge because you will need a high magnification, dark skies and averted vision. A perfect test for you and your telescope optics. Telescopes of aperture 40 cm and more will resolve the core with no difficulty. Located at a distance of 41,000 light-years, it is the sole globular cluster for northern hemisphere observers in the winter. Like Messier 54, it is believed that Messier 79 is in fact a member of the Canis Major dwarf galaxy, currently undergoing a close encounter with the Milky Way – one that it is unlikely to survive!

See also:

Cluster	Designation	Month
Caldwell 25	II	January