NEW

Astronomy

The Complete Manual

The essential guide to viewing the night sky

Welcome to Astronomy

The Complete Manual

You don't need letters after your surname, an encyclopaedic knowledge of the skies or even a telescope to get into stargazing. That's the beauty of astronomy: armed with nothing more than your eyes and a basic grasp of where to look in the night sky, you can embark on one of the most rewarding hobbies in the world. Planets, stars, constellations, nebulas, meteor showers and many other celestial objects can be spotted using only the naked eye. And for those *with* telescopes, the universe – with its myriad colours and awe-inspiring sights – is your personal gallery of a trillion cosmic wonders. Our easy-to-follow guides will furnish you with all the bare essentials, taking you on a journey from stargazing hobbyist to becoming a fully equipped astronomy enthusiast. With practical guidance, seasonal sky charts and pointers on how to spot some of the sky's most accessible sights, this new edition will be your companion as you unravel the beauty of the night sky.

Astronomy
The Complete Manual

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Cover images courtesy of Thinkstock

Printed by
William Gibbons, 26 Planetary Road, Willenhall,
West Midlands, WV13 3XT

Distributed in the UK, Eire & the Rest of the World by
Marketforce, 5 Churchill Place, Canary Wharf, London, E14 5HU.
☎ 0203 787 9060 www.marketforce.co.uk

Distributed in Australia by
Gordon & Gotch Australia Pty Ltd, 26 Rodborough Road,
Frenchs Forest, NSW, 2086 Australia
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Future plc is a public company quoted on the London Stock Exchange (symbol: FUTR).
www.futureplc.com

Chief executive Zillah Byng-Thorne
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Part of the All About Space bookazine series

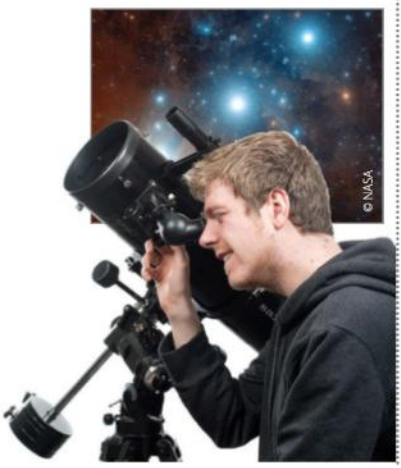
Contents

What you can find inside the bookazine

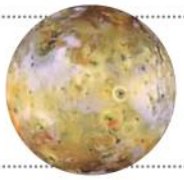
Astronomy essentials

Getting started

Seasonal guides



What to observe



Astronomy essentials

Did you know you can see a galaxy 2½ million light-years away with your unaided eyes? Craters on the Moon with simply a pair of binoculars? Countless wonders await you on any clear night. Learn the essentials to help you take the first step toward a lifetime of cosmic exploration and enjoyment.

Includes…

- Essential equipment
- Selecting the right telescope
- Choosing an eyepiece
- Setting up your mount


HERE
FEBRUARY
MARCH
APRIL

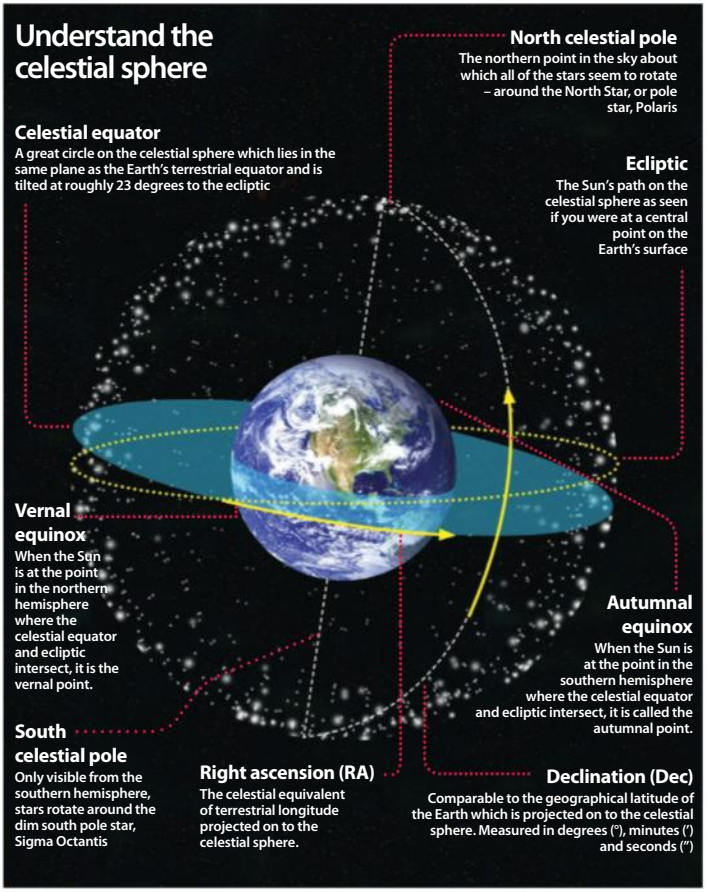
Introduction to astronomy

Ever wanted to explore the night sky but don't know where to start? Our beginners' guide is here to help

There's a treasure trove of astronomical objects brimming from near enough every degree of the 20,000 square degrees that make up the night sky above your head at any one time. Standing under a vast number of twinkling stars, galaxies and planets, in the vast blackness on their orbit around Earth, we are almost looking out of a great dome-shaped window as our planet orbits around the Sun. This is known as the celestial sphere.

As the seasons change, so does the night sky and as you gain a familiarity with the stars and planets you will notice new constellations and astronomical objects from winter through to autumn.

Stepping outdoors into a clear night you might not realise it, but your eyes are a wonderful device when it comes to taking in what nature has to offer.



Earth ©NASA

Measuring the skies

1 degree
Extend your arm and hold out your little finger, you can measure the distance and apparent size of an object to 1°.

5 degrees
Stretch out your arm and hold up three fingers to measure a distance between objects and apparent size equal to 5°.

10 degrees
If you can stretch out your arm and fit your fist between Jupiter and the Moon, they are 10° apart.

20 degrees
Hold your arm in front of you and spread your fingers, the distance is approximately 20°.

Four naked eye sights

Discover four space objects you can see without any equipment at all

There are plenty of objects to see and identify in the night sky with the naked eye. Go outside on a clear night and you'll probably already be able to name some of the more famous constellations, but you might not be aware there is so much more waiting to be observed with your eyes alone. It's not just stars, though. Planets, comets and galaxies are all visible to an observer without any fancy equipment. Sometimes seeing and identifying an object with just your eyes can be a more rewarding experience than using a telescope to find it. Below we've highlighted four great sights you can see while out and about on a dark and clear night. For things like the Milky Way, you'll need to be in an area of low light pollution, and then the night sky is there for you to behold.

Ursa Major

Constellation: Ursa Major **Right ascension:** 10.67h
Declination: +55.38°

Also known as the Great Bear, the Big Dipper or the Plough, it can be seen from most of the northern hemisphere. The middle star is actually a famous double star comprising Mizar and Alcor. Found in the northern night sky, and the outside of the Big Dipper's bowl also points towards Polaris, the North Star, with the helpful 'pointer stars' Merak and Dubhe.

The Quadrantid meteor shower

Constellation: Boötes **Right ascension:** 15h 28m
Declination: +50°

Start the new year with the Quadrantids as they shoot from their radiant in the constellation of Boötes during 1 to 5 January. Up to 40 meteors per hour can be seen at the shower's peak on 3 through to 4 January. Best viewing is in the darker hours after midnight, in a dark spot away from light pollution.

The Orion Nebula (M42)

Constellation: Orion **Right ascension:** 05h 35m 17.3s **Declination:** -05° 23′ 28″

The Orion Nebula is situated at a distance of around 1,340 light years away. To find the nebula, locate Orion's Belt. From the left star of Orion's Belt (Alnitak), move south in the direction in which Orion's sword points, hanging from his belt, with the nebula visible clearly at the sword's tip.

Centre of the Milky Way Galaxy

Constellation: Towards Sagittarius **Right ascension:** 17h 25m 40.04s **Declination:** -29° 00′ 28.1″°

Our galaxy weaves through the night sky as a powdery band of light from billions of stars. Few have seen the splendid view of the Milky Way because of light pollution. However, from a dark spot, the form of such a huge abundance of stars becomes immediately apparent.

Choosing the right telescope

Get the best start in amateur astronomy by buying the right telescope for your needs

Choosing the right telescope can be a tricky prospect, but the most important thing to be aware of when buying any telescope is its optical quality.

A Newtonian reflector on a simple undriven altazimuth mount (known as a 'Dobsonian') offers the best value in terms of aperture. Dobsonians collect lots of light and deliver knockout views.

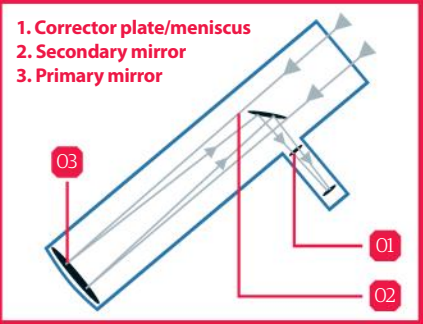
Newtonians (and refractors) become much more costly with an equatorial or computerised mount. Computerised mounts come in several forms – Dobsonian (push-to or go-to), single tine-mounted (tracking or go-to) and German equatorial (go-to). A computerised push-to Dobsonian costs about twice as much as a manual one, while a high-end Newtonian on a driven German equatorial mount may cost ten times more.

For ease of use a short focal length refractor of up to four inches in diameter or catadioptric up to five inches on a computerised mount may fit the bill. Both will show many deep-sky objects as well as revealing detail on the Moon and planets. Achromatic refractors of short focal length display a degree of false colour around the edges of bright objects. The best views, however, are to be had through apochromatic refractors, which are about four times more costly than an equivalent-sized achromat.

Reflectors and refractors

Reflectors

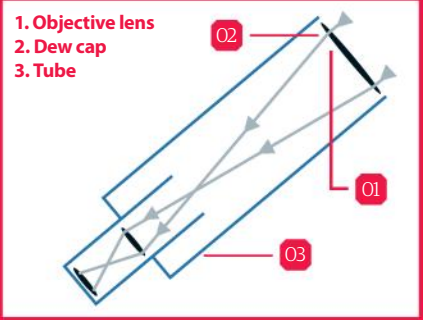
Reflectors use mirrors to gather and focus light. The primary mirror is parabolic in order to focus incoming light rays, while the secondary mirror reflects light into the eyepiece. Generally cheaper than refractors but they are sensitive and can be easily knocked out of alignment.



Refractors

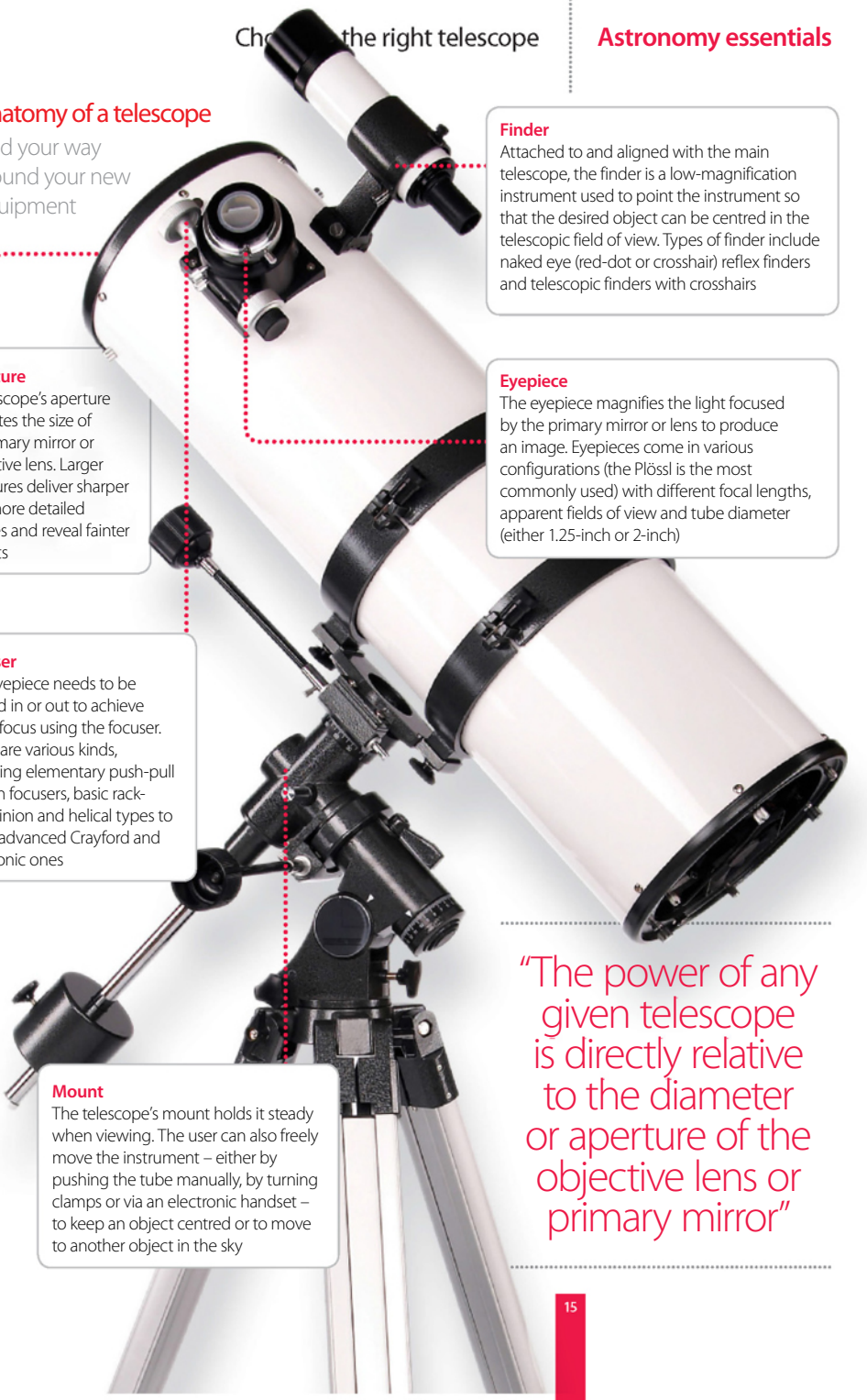
Refractors bend, or refract, light as it enters through the front, with an objective lens gathering and focusing the light.

They are more resilient, keeping their alignment even when knocked. However, refractors are usually longer than reflectors in order to minimise the occasional visual impairment induced by refraction.



Anatomy of a telescope

Find your way around your new equipment



Finder
Attached to and aligned with the main telescope, the finder is a low-magnification instrument used to point the instrument so that the desired object can be centred in the telescopic field of view. Types of finder include naked eye (red-dot or crosshair) reflex finders and telescopic finders with crosshairs

Aperture
A telescope's aperture indicates the size of its primary mirror or objective lens. Larger apertures deliver sharper and more detailed images and reveal fainter objects

Eyepiece
The eyepiece magnifies the light focused by the primary mirror or lens to produce an image. Eyepieces come in various configurations (the Plössl is the most commonly used) with different focal lengths, apparent fields of view and tube diameter (either 1.25-inch or 2-inch)

Focuser
The eyepiece needs to be moved in or out to achieve sharp focus using the focuser. There are various kinds, including elementary push-pull friction focusers, basic rack-and-pinion and helical types to more advanced Crayford and electronic ones

Mount
The telescope's mount holds it steady when viewing. The user can also freely move the instrument – either by pushing the tube manually, by turning clamps or via an electronic handset – to keep an object centred or to move to another object in the sky

"The power of any given telescope is directly relative to the diameter or aperture of the objective lens or primary mirror"

Refractor telescopes

Refractors offer fantastic views of the night sky

This instrument was turned on the sky, most famously by Galileo Galilei who observed Jupiter and its moons, the lunar surface and the Sun.

Nowadays, the lenses have become bigger and developments in optics introduced doublet or even triplet lenses. These compound lenses help to reduce 'chromatic aberration'. A single lens doesn't focus all the colours of the spectrum at the same point, but this can be corrected considerably, by using two lenses of different shape and type of glass put close together. This type of telescope lens is called an 'achromatic lens', or just an achromat. These are found in just about every type of refracting telescope made today. The effect of chromatic aberration is to make bright objects appear to have a coloured halo around them.

Because refractors are particularly good at giving highly magnified and high contrast images, they are ideal for observing the Moon and planets. Remember cheap refractors have poor quality lenses, so don't be tempted to buy one of these.

Make sure that all the lenses are 'fully multi-coated' in the technical specification. This helps to make sure that all the light is passed through the lens system and reduces flares and other unwanted artefacts. Also ensure the focuser is smooth and that it is supplied with a diagonal mirror which makes viewing more comfortable. If eyepieces are supplied, check they are of decent quality. If you are hoping to see stars and nebulas as well as planets, then go for an instrument of a moderate focal ratio. Finally, avoid purchasing a telescope which is too big, making it unwieldy. You'll see more with a telescope that you can handle. Remember, quality nearly always costs a little more, so be prepared for the price tag!

Anatomy of a refractor telescope

Lens
The refractor lens is the 'eye' of the telescope. It gathers the light from objects and directs it down the tube to the eyepiece at the other end

Dew shield
As the name suggests, this part of the telescope tube extends beyond the lens to prevent dew forming on it. Ideally this should protrude 10-15cm (4-6in) in front of the lens

Diagonal
Making viewing more easier as it turns the light coming through the telescope through 90°. Made from a prism or a flat mirror, mirrors absorb less light than prisms, important as starlight is faint

■ Many telescopes feature go-to mounts that guide you to many sights

Focuser
This is the mechanism which smoothly moves the drawtube in and out to obtain a good focus of the image. Each eyepiece will have a slightly different point of focus and it's important that the focuser is smooth and does not cause the drawtube to wobble as it moves

■ **Refractors offer great views of the Moon and planets**

Eyepiece
The eyepiece is the lens which magnifies the image and puts the focused image where your eye can see it. Telescopes are often sold with two or three eyepieces which are usually interchangeable with other telescopes

"Remember, quality nearly always costs a little more"

Reflector telescopes

The reflector telescope is an amazing instrument. But how they work?

The great 17th Century scientist Sir Isaac Newton is credited with the invention of the reflector telescope, although there were others who came up with a similar idea for such a device at around the same time.

In 1668, Newton produced a small telescope which used a spherical mirror made of polished metal that bounced the light reflected from it up the tube to a much smaller flat mirror at an angle of 45 degrees. This in turn reflected light through a small hole made in the side of the tube where it could be focused and viewed through an eyepiece lens. This type of telescope soon became known as the Newtonian reflector and it is still very much in use today, although its size and method of construction has taken a great leap from Newton's first production. However, the problem with making metal mirrors, made from a material called 'speculum', an alloy of copper and tin which can be highly polished, meant that they did not become popular for nearly another 100 years when the technology was improved such that the mirrors could now be made of glass.

It was quickly realised that reflecting telescopes had many benefits including less optical problems, known as aberrations, than refractors at the time. And, probably the greatest advantage of all, the fact that mirrors could be easily made much larger than lenses. As construction methods and technology improved, mirrors and therefore telescopes, became larger. This in turn meant that fainter objects could be discerned and detail, known as resolution, could be greater. Because it is cheaper to manufacture mirrors of a given size than lenses of the same size, reflectors also have an advantage on a cost/performance scale. Due to this and some of its inherent optical advantages, Newtonian reflectors are popular for astronomers wanting to study deep sky objects which are, by their nature, faint. Newtonian reflectors don't hold all the aces, though. Due to the secondary mirror effectively blocking some of the light entering the tube, contrast in images can be affected, although this is usually minimal. It can be enough, though, to make a difference to planetary and lunar studies where contrast and detail can be critical.

The 'compound' telescopes now come in many guises, but the Newtonian reflector is still ubiquitous, being used as an effective and less expensive solution by both amateurs and professionals the world over.

Anatomy of a reflector telescope

Secondary mirror
Tilted at an angle of 45°, this small, flat mirror has an elliptical shape which looks circular when viewed through the open focuser tube

Focuser
The focuser consists of a tube which can be adjusted towards and away from the telescope tube to give a sharp focus in the eyepiece of the objects being viewed

Spider
The spider is the device which holds the secondary mirror centrally over the primary. The vanes have to be thin so as not to block light coming down the tube

Reflectors have come a long way since Newton's time

Primary mirror
The primary mirror in a Newtonian reflector should be of good quality and preferably parabolic in shape, as this will give cleaner, crisper images. The diameter governs how much you will see

Tube
The cylindrical tube which makes up the body of the telescope holds the mirrors, the 'spider' and the focusing mount. Its size is governed by the diameter of the primary mirror

A versatile option

Newtonian reflectors are versatile so can be used for viewing the Moon, planets and deep sky objects. However, they do take more maintenance than other refractors. This can seem daunting at first, providing the user is careful and methodical it is usually straightforward and with practice, quite quick. Because the telescope tube is open to the sky, mirrors can become tarnished and dirty; they can be cleaned, or every few years re-coated. This is cheap and is like having a brand-new telescope once the mirrors are reinstalled. Therefore the first-time purchaser needs to consider carefully if this is the right kind of telescope for them.

Dobsonian telescopes

There is a lot of misunderstanding about Dobsonian telescopes; what they are and what they can do. This should help clear it up…

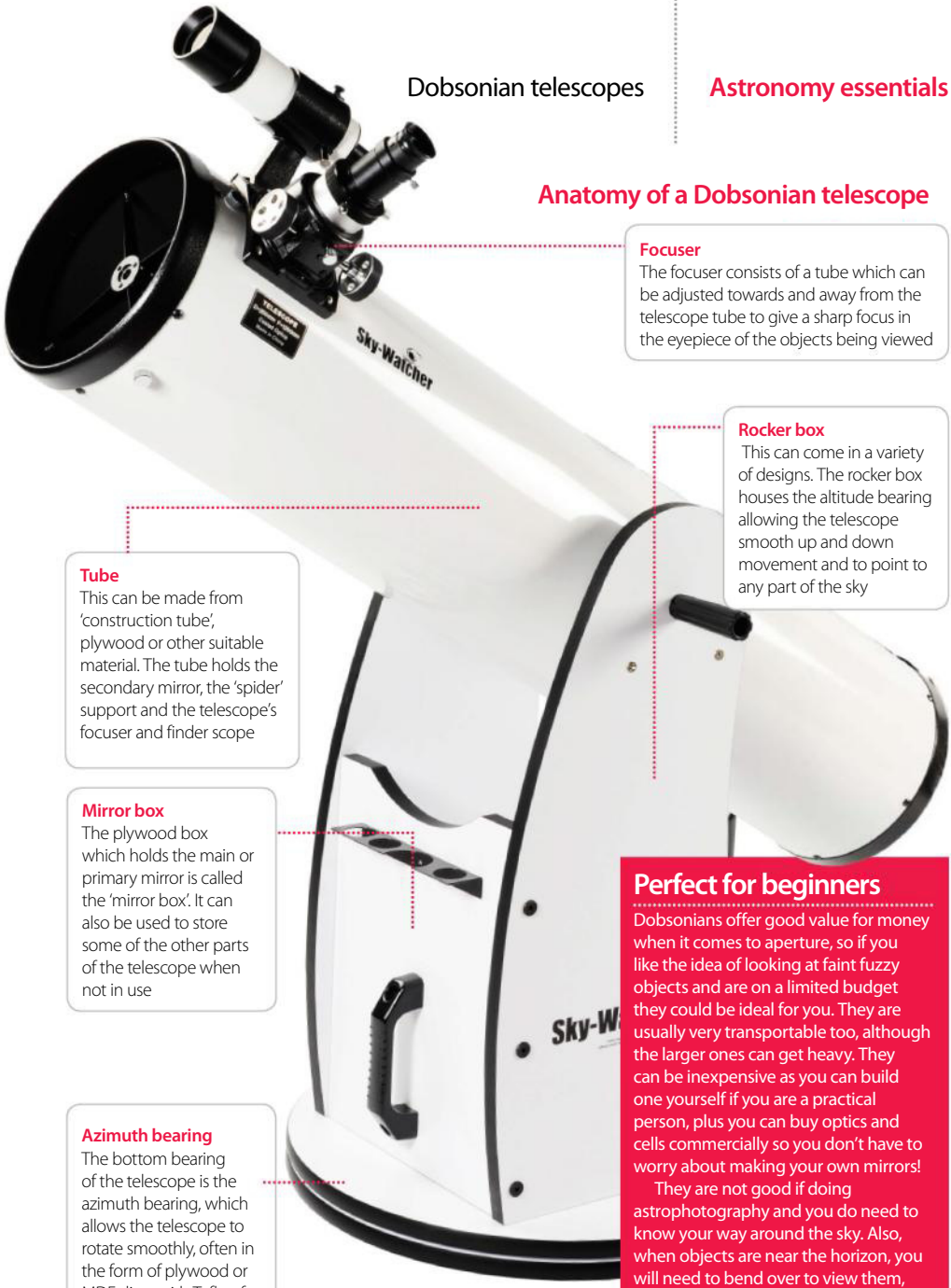
The Dobsonian telescope is a Newtonian reflecting telescope on an altazimuth mount. It is the mount that distinguishes it from any other type of Newtonian reflector and this was popularised in the Sixties by avid amateur astronomer John Dobson.

It is their simplicity of design and cheap parts that made these telescopes so popular. There were many differing variations on the theme, some being very sophisticated and rather getting away from the humble and inexpensive materials and design. The popularity was quickly appreciated by commercial telescope manufacturers and so you can find Dobsonians as mass-produced products of varying size and quality, as well as in kit form.

Dobsonians are often known as 'light buckets' as they are an inexpensive way of owning a relatively large aperture telescope - most of the money you spend is put into the optics rather than the mount. One of the advantages of the It is possible to have a 16-inch aperture telescope that fits into the back of a small family car. You can travel to a dark sky site and take advantage of it with a large telescope. They are not suitable for some forms of observing.

Dobsonian telescopes still make a great introductory telescope for observers on a budget.

Anatomy of a Dobsonian telescope



Focuser
The focuser consists of a tube which can be adjusted towards and away from the telescope tube to give a sharp focus in the eyepiece of the objects being viewed

Rocker box
This can come in a variety of designs. The rocker box houses the altitude bearing allowing the telescope smooth up and down movement and to point to any part of the sky

Tube
This can be made from 'construction tube', plywood or other suitable material. The tube holds the secondary mirror, the 'spider' support and the telescope's focuser and finder scope

Mirror box
The plywood box which holds the main or primary mirror is called the 'mirror box'. It can also be used to store some of the other parts of the telescope when not in use

Azimuth bearing
The bottom bearing of the telescope is the azimuth bearing, which allows the telescope to rotate smoothly, often in the form of plywood or MDF discs with Teflon for friction-free movement

Perfect for beginners

Dobsonians offer good value for money when it comes to aperture, so if you like the idea of looking at faint fuzzy objects and are on a limited budget they could be ideal for you. They are usually very transportable too, although the larger ones can get heavy. They can be inexpensive as you can build one yourself if you are a practical person, plus you can buy optics and cells commercially so you don't have to worry about making your own mirrors!

They are not good if doing astrophotography and you do need to know your way around the sky. Also, when objects are near the horizon, you will need to bend over to view them, not so good if you have a bad back.

Cassegrain telescopes

One of the most popular telescopes for the more serious amateur astronomer

The Schmidt-Cassegrain telescope is a hybrid which is the merging of two designs of telescope by a German optician (Schmidt) and a French optician (Cassegrain).

Designed in 1930 by Bernhard Schmidt to produce a wide, flat field of view. A photographic film was placed at the focal plane of a spherical mirror as this design of telescope was never meant for visual use. Because the mirror is spherical, it distorts the image and so the light entering the telescope has to be altered in such a way as to counteract this distortion introduced by the spherical mirror.

The hybridised Schmidt-Cassegrain telescope was invented in 1940 by James Gilbert Baker and combines the spherical optics and corrector plate of the Schmidt camera with the Cassegrain's central hole in the primary mirror and the field-flattening effects of the secondary mirror to produce a visual and photographic-capable system that is compact and relatively inexpensive to produce. This has proved popular with amateur astronomers as it offers a telescope with a moderately long focal length which is good for lunar, planetary and much deep-sky viewing and imaging, all in a compact 'package'.

The American optical company Meade quickly realised this telescope design's potential and so it set up the manufacture of a rival scope to Celestron, but with similar features. This proved beneficial for the would-be purchaser as the competition prompted both companies to innovate new ideas. This included computerised 'GoTo' systems and various optical and mechanical additions to both the telescope and the mount. Various-sized apertures were produced by both companies, eight-inch up to 16-inch aperture for the Meade products.

Because of the various aperture sizes, the good quality optics and the plethora of accessories for these telescopes as well as the easy adaptability of the scopes for both visual and imaging use, the Schmidt-Cassegrain has become a byword in amateur astronomical circles for versatility and affordability.

Anatomy of a Schmidt-Cassegrain telescope

Secondary mirror
This mirror reflects the light from the primary mirror back down the tube to the focuser. Because of this the telescope is effectively 'concertinaed' up, producing a relatively short, compact tube

Visual back
The hole at the back of the telescope is threaded to accept a variety of accessories including the eyepiece. Cameras can also be added using adaptors made for the purpose

Spherical primary mirror
Unlike a Newtonian telescope, the Schmidt-Cassegrain primary mirror is made to a spherical curve. The aberration this produces can be easily corrected to give a good image

Focus knob
In most commercially made Schmidt-Cassegrain telescopes the focuser knob turns a screw which moves the primary mirror up and down the tube to obtain good focus

Schmidt-Cassegrain telescopes often come with built-in computerised 'GoTo' systems

A great advanced option

These are the choice of both beginner and tend to be made in larger apertures and usually come with sophisticated computerised 'GoTo' systems allowing the observer to find and easily track thousands of different objects in the night sky. Versatile, they provide a long focal length telescope in a compact tube. They do have fairly large secondary mirrors, which increases the obstruction for the light in the aperture of the telescope. This can reduce contrast in the final image. All in all, they make a good all-round telescope for beginners.

Which is the right mount for me?

Whether you're a novice or experienced astronomer, the correct mount makes all the difference

With a wide variety on the market, combined with the different types and brands of telescopes available you can cut out the guesswork by considering the budget you have and the types of objects that you're planning to observe.

If you are looking for a quick and easy-to-use mount, then some form of alt-azimuth would probably suit you best. However, if time is an issue for you, avoid the more sophisticated instruments with computer drive systems, as these can take longer to set up.

Alt-azimuth mounts are mostly suited to simple shots of the Moon. To get the very best shots you'll need an equatorial mount, which follows the rotation of the sky. While these mounts tend to be larger, heavier and require more effort to set up in comparison with an alt-azimuth mount, they can be used for long-exposure astrophotography and even visual observing. With an equatorial mount you only need to guide the telescope around the one polar axis, rather than in altitude and azimuth directions.

Alt-azimuth fork mount

Where the telescope pivots is the altitude axis and the azimuth axis is provided by the rotating base. These instruments are usually provided with either electronic drives to both axes or computer systems, enabling the telescope to be set up to point at and track objects in the night sky.

Dobsonian mount

The whole point of this version of mount is to provide astonomers with a cheap, stable platform for larger telescopes and to have very smooth motion in both axes. This is achieved by using frictionless Teflon bearings so that a user can nudge the telescope without the object flying off out of the field of view. This is a very popular mount due to it being inexpensive and a good DIY project for many amateurs.

German equatorial mount

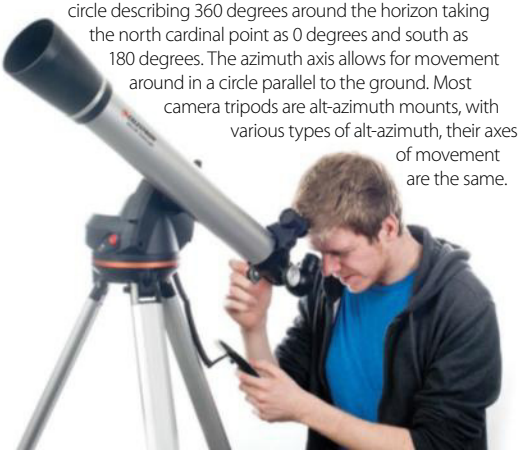
Looking a little like the letter T, the upright of the letter is the polar axis and is tilted to become parallel to the Earth's axis. It's only necessary to track the telescope, which is positioned at the end of one of the arms of the T, around this polar axis, to follow the path of the stars as they rise in the east and set in the west. Perfect for tracking a specific object in the sky.

Fork equatorial mount

The fork equatorial mount performs a similar function to the German equatorial mount, it enables the telescope to be driven around the polar axis. The polar axis is formed by the fork itself. The tilt of the axis is created by an equatorial wedge, usually added to an alt-azimuth fork mount as an accessory. Enabling long-exposure photography and imaging.

Alt-azimuth mount

It has two axes of movement, the first is in altitude the second is in azimuth, which enables the observer to move the telescope from side to side. This altitude is a circle describing 360 degrees around the horizon taking the north cardinal point as 0 degrees and south as 180 degrees. The azimuth axis allows for movement around in a circle parallel to the ground. Most camera tripods are alt-azimuth mounts, with various types of alt-azimuth, their axes of movement are the same.



Single-arm alt-azimuth mounts

This mount suits smaller refractor and catadioptric telescopes as the tube is attached to one arm as opposed to being slung between the two. It's a type of mount favoured by the manufacturer Celestron for its smaller range of instruments. These motorised mounts are often supplied with a GoTo computer tracking system, making them versatile and appealing as a family telescope.

Choosing an eyepiece

You can't look through a telescope without an eyepiece

Kellner

An achromat lens, which is designed to correct any false colours caused by refraction or bending of light in the eyepiece. Relatively inexpensive, Kellners are often included with starter telescope kits. Varying in quality, they are still useful.

Orthoscopic

This design gives a near distortion-free image. It uses four elements of glass, three of which are cemented together. They make very good lenses for observing planets, partly due to their clarity and relatively narrow field of view.

Plössl

The design uses two sets of identical lenses and is sometimes known as a symmetrical eyepiece. It gives a reasonably large, flat field of view. Varying in quality; but chances are that you'll keep the best ones, even if change your telescope.

Wide-Angle

This wide-angle telescope eyepiece was a big hit, due to its outstanding quality and the impressive vistas it offered. It's an excellent eyepiece for low power, deep sky viewing. As you might expect, they are normally quite expensive.

Long Eye Relief

Providing 'long eye relief', you can use these comfortably without having to take off your glasses. They have quite a wide field of view and the higher power eyepieces are good for lunar and planetary viewing; a great benefit if you need to use your glasses.

Nagler-style

With a superb 82° apparent field of view, this range is beloved of serious deep-sky observers. These have a price you would expect of the very best. As optical technology moves on, there are even wider-field eyepieces coming onto the market.

Telescopes are also available in a binocular variety, as is the case with this Vixen BT81S-A

Selecting the right binoculars

Binoculars come in all shapes and sizes, so which ones are best for astronomy?

Binoculars are essentially two refractor telescopes bolted together. To make the tubes shorter, prisms are used internally to fold up the light path. There are two types of prisms which are used in binoculars; roof prisms, which mean that the binoculars tend to have straight, short tubes, and porro-prisms, used mostly in what are called field glasses. It's normally the latter type which are best for astronomy, often because they are used in instruments with larger objective lenses.

Binoculars are described by using two numbers, this is a type of shorthand. It's this number for the objective lens diameter that's the most important, as this governs the amount of light entering your binoculars, in other words how faint and well resolved the objects you'll look at will be. Any binoculars with an objective lens diameter of less than 40mm will not show objects particularly well; much larger and they will be heavy and difficult to hand hold. Likewise, too high a magnification will also make them difficult to hand hold and the image too faint. For example, 16x50s will also magnify your handshake 16x! Ideally, we recommend that you should use binoculars rated at 7x50 or 10x50 as these will be the easiest to hand hold and give you enough aperture to show you hundreds of objects in the night sky.

Binoculars explained

Right eye focus adjuster
This eyepiece has a mechanism to obtain sharp focus in the right eye. Use the centre wheel focuser to get a sharp image in the left eye first

Centre wheel focuser
This moves both eyepieces in and out of the body of the binocular to give a sharply focused image. It should rotate smoothly and slowly for best effect

Eyepieces
These are the lenses which you look through. They govern the magnification of the binocular and need to be comfortable and give a sharp image

Objective lenses
The front lenses which gathers the light. Ideally around 50mm in diameter, these should be properly coated to allow maximum transmission of light through the glass

■ A good quality pair of binoculars can last a lifetime, so keep those lenses capped and scratch-free when you're not using them

Benefits of binoculars

Compact binoculars are often too small to be useful for observing the night sky. Binoculars using porro-prisms usually have larger objective lenses. Using 7x50 or 10x50 binoculars will normally give you the best results as these don't magnify your hand shake too much and give you a reasonably wide field of view, important when you are trying to find objects in the sky. One of the many benefits of using binoculars is the upright image, and because the lenses are so much bigger than your eyes you will see thousands of objects that you can't without them.

Spotting scope astronomy

These compact scopes offer a cheap alternative to telescopes for basic astronomy

Astronomers like to use spotting scopes for quick and easy astronomy sessions. These compact scopes will get a surprisingly good views of bright objects like the Moon, nearby planets and open clusters.

For night-sky observations, a power of at least 60x is a must, however you have to be mindful of your spotting scope's aperture. This is the diameter of your device's objective lens – the bigger it is, the more light your instrument will be able to collect and the more enriched your observing experience will be.

Most spotting scopes generally accept a variety of digital cameras that can be affixed using special adapters. Low brightness means that the shutter speed for your camera has to be quite slow and, as such, you must ensure that movement and vibrations are kept to a minimum to obtain a clear picture.

Due to the fact that they are portable, have an ability to capture clear images and that they are often cheaper than a standard telescope, the spotting scope has become an increasingly common presence on the astronomy scene.

Eyepieces
The more-advanced spotting scopes come with a zoom eyepiece that can often be removed and, combined with the scope's focal length, will provide your magnification

Top tips for choosing a spotting scope

01: The larger the objective lens, the better. If you are on a budget, then you are best off buying a higher-quality telescope with a smaller objective lens.

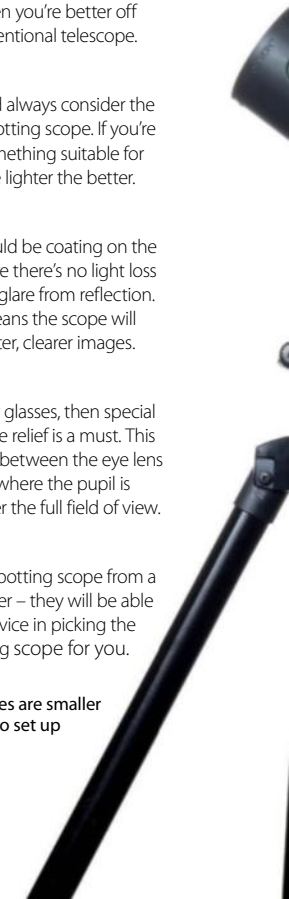
02: Think about what you'll use your spotting scope for. If you are looking to observe deep-sky objects and won't use the spotting scope past astronomy, then you're better off buying a conventional telescope.

03: You should always consider the weight of a spotting scope. If you're looking for something suitable for travel, then the lighter the better.

04: There should be coating on the lenses to ensure there's no light loss and to reduce glare from reflection. This usually means the scope will produce brighter, clearer images.

05: If you wear glasses, then special attention to eye relief is a must. This is the distance between the eye lens and the point where the pupil is positioned over the full field of view.

06: Buy your spotting scope from a reputable dealer – they will be able to offer you advice in picking the correct spotting scope for you.



■ Spotting scopes are smaller and so far easier to set up than telescopes

The astronomer's spotting scope

Gathering light
A spotting scope has a large, multi-coated, objective lens, so it can gather much more light. This makes the device especially useful in low-light conditions

Water resistance
Telescopes aren't massively water-resistant because they're used under clear skies. However, spotting scopes are often used in the rain by nature-watchers, which means they must be highly fog- and water-resistant

Bright targets
To get the brightest objects in the night sky, such as the Moon, planets and open clusters, you will need a magnification of at least 60x

Angled or straight?
Straight spotting scopes are much easier for beginners to use for terrestrial viewing. An angled scope (with an eyepiece positioned at 45 or 90 degrees) is much better for astronomy, as these can be mounted and then easily pointed skywards

Digiscoping
It's possible to photograph the night sky by attaching a digital camera, though getting a decent image takes much trial and error

Tripod
The beauty of a spotting scope is that it can be used with or without a tripod. However, if you're using your scope for astronomical purposes, it's strongly recommend mounting the scope on a sturdy tripod

Short cool-down
Many astronomers complain about the cool-down time of their telescopes. Since spotting scopes are so compact and lightweight, they have a short cool-down time, making them ready to use almost immediately

Olivon T650 spotting scope

Aperture: 65mm
Magnification: 16-48x zoom eyepiece (removable)
From: www.opticalhardware.co.uk
Cost: £240

Getting started

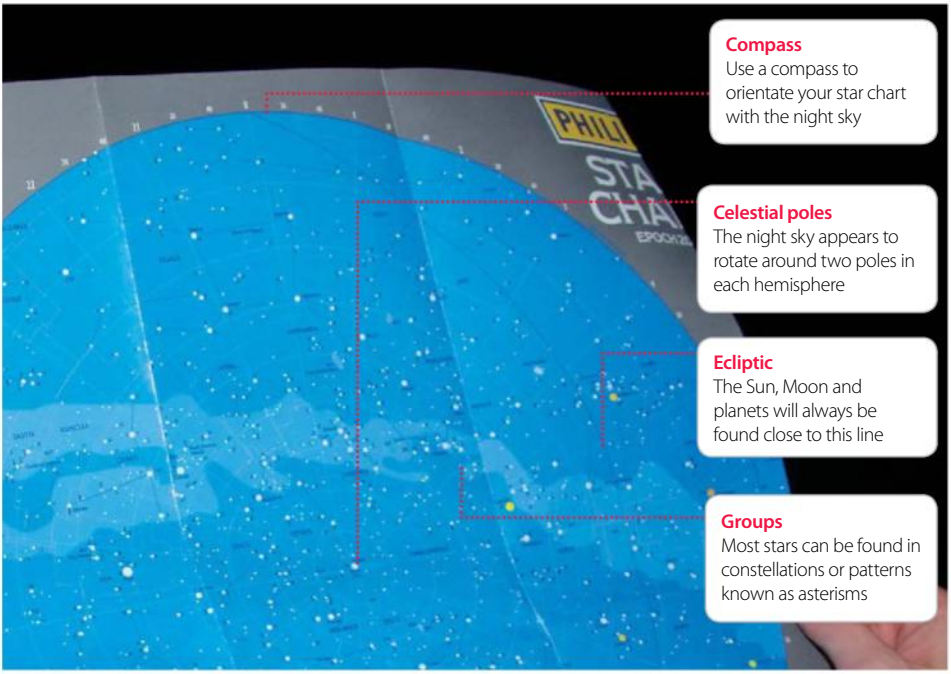
Astronomy can be a fascinating pastime, whether you have a substantial telescope, or are a beginner observing with the naked eye. Discover the excitement of spotting planets, star clusters, and nebulae with your own eyes.

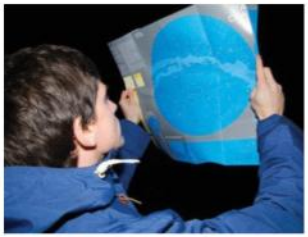
Includes…

- Using sky charts
- How to minimise light pollution
- Reporting a discovery
- The best astronomy apps

Using a sky chart

How to find your way around a map of the stars





01: Find your way
In the northern hemisphere hold the chart above your head pointing south, vice versa for the southern hemisphere. Orientate the chart with the compass points and use a red light to view it.

02: Track the sky
You'll be familiar with constellations after a few nights. To find planets, learn where the ecliptic line is. All the planets, and the Moon, sit close to this line, so you'll be able to find them here.

03: Star hopping
Once you've mastered the basics, you can use the star hopping technique to find more objects in the sky. Find a bright star and then use it as a reference to locate dimmer deep sky objects nearby.

Navigate the night sky

Use celestial co-ordinates to find your way around the night sky

Modern astronomy has made it much easier and has opened it up to a wider audience which is a great way to get more people involved in a fantastic hobby.

Astronomy revolves around the celestial co-ordinate system, devised millennia ago when our understanding of the universe was much less than it is now. This sphere appears to rotate daily, and so objects change their position. Depending on your location on Earth, you will be standing on a different declination line, sort of like latitude. At Earth's equator you are at 0° declination, while at the North Pole you are at a declination of +90° (vice versa for the South Pole).

Declination is broken down into arcminutes (there are 60 in one degree, denoted as 60') and arcseconds (60 in one arcminute, written as 60"). Polaris, for example, was found at a declination of +89° 19'8".

Right ascension is measured in hours from 0 to 24, with one hour corresponding to 15 degrees of the circle that is the spherical night sky. It is broken down in units of time, rather than arcs or degrees, and written as hours, minutes and seconds. So, for example, you may see an object written as having a right ascension of 18h 36m 56.3s.

The right ascension and declination are the same for any observer anywhere on Earth, as they use Earth's north and south celestial poles as orientation. By using both, you will be able to find the location of most celestial objects.

What is a planisphere?

A star chart that can be rotated to show the positions of stars at any time and date of the year. The whole sky is not always available for viewing, you can rotate the viewable 'window' of a planisphere to a particular time and date to show you what you can currently see in the night sky. They are a useful tool for astronomers who want to identify objects quickly and easily.

A planisphere will give you the right ascension and declination for objects in the night sky

To perform astronomy without computerised equipment you'll need to use the celestial coordinate system

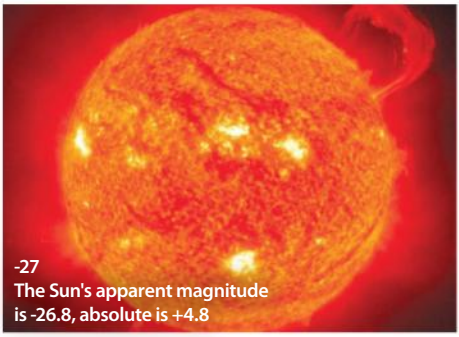
Measuring magnitudes

Celestial objects have varying levels of brightness – just how is it measured, and what does it mean for you?

The Moon is the brightest object in the night sky, with Venus the second brightest. This brightness, doesn't go far enough for serious study, which is where the magnitude scale comes in. Allowing for a more accurate reading of brightness, the apparent magnitude of a star measures the brightness of an object in the visible spectrum as if there was no atmosphere.

The scale is not straightforward, though. Not only does a lower number indicate a higher brightness, five points on the scale is equivalent to a difference of 100 times the brightness. The Sun, for example, is measured at about -27 magnitudes, while the Moon is -13 when it's full. Venus, the brightest planet in the night sky, is -4.9 at its most visible. Zero on the scale is usually described as Vega, and most of the brightest stars are around this number, with Sirius rated at -1.4 as the brightest star in the sky.

All of which is very interesting, but how do the magnitudes relate to you? Well, they can be used as a guide to figure out what kind of equipment you'll need to view them while star gazing. With the naked eye, you can make out around 8,500 stars, with good eyes able to pick up stars with as little as +6 magnitude. Between the range of +6 and +8, you'll need to use binoculars to properly make out Neptune, some nebula and brighter deep sky objects. Going even further, amateur telescopes will be able to pick up objects with a minimum brightness of about +11, allowing for better clarity of other deep sky objects, but just not strong enough to pick up Pluto.



-27
The Sun's apparent magnitude is -26.8, absolute is +4.8

-13
This magnitude is for when the Moon is full

-4.9
Venus is at its brightest during its crescent phase

"The apparent magnitude of a star measures the brightness of an object in the visible spectrum as if there was no atmosphere"

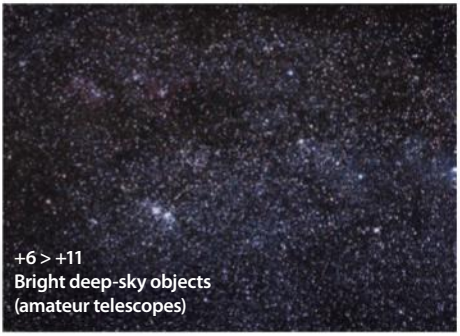
-2.9
Jupiter at its brightest and closest to the Earth

+1 > +6
Altair and 8,500 other naked-eye stars

-1.4
Sirius, the brightest star in the night sky visible from Earth

+6 > +8
Dark nebula and other bright deep-sky objects (binoculars)

0 > +1
Canopus and the 14 brightest stars in the sky



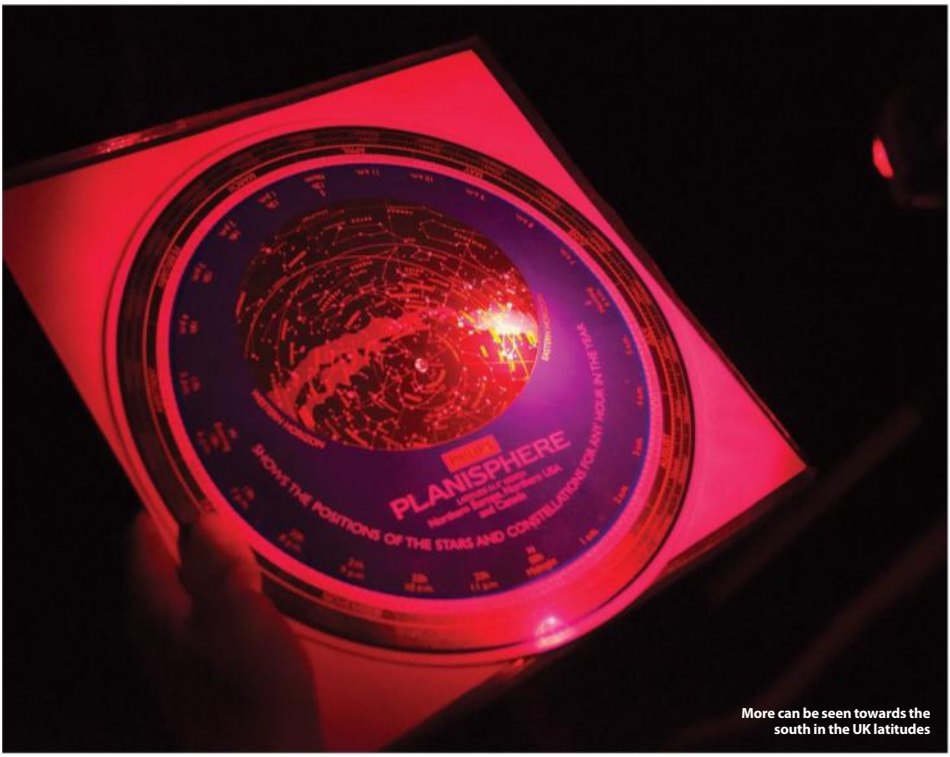
+6 > +11
Bright deep-sky objects (amateur telescopes)

First night: what to do

Top tips for your first foray into the field

On stepping from a well-lit room to your spot under the stars, you might notice that you can't see much at first. The stars that you do see are the brightest and so your eyes do not need to adjust very much to collect light from them. The faintest, on the other hand, stay hidden until your pupils adapt to night vision. To get the best views possible, you need to take care where you place your telescope. A stable surface is essential, so that rules out bumpy lawns. Concrete provides a stable surface but it also retains heat that has built up during the day and, as a result, this warmth is emitted at night – this creates air currents that can cause shimmering images through your telescope. Remember if kept indoors before use, your telescope also needs a good half an hour to cool down to the ambient temperature outdoors.

Pick a spot with a good southern view. The 23-degree tilt of the Earth means that more can be seen towards the south than the north from UK latitudes. It is always a good to have an idea of what you

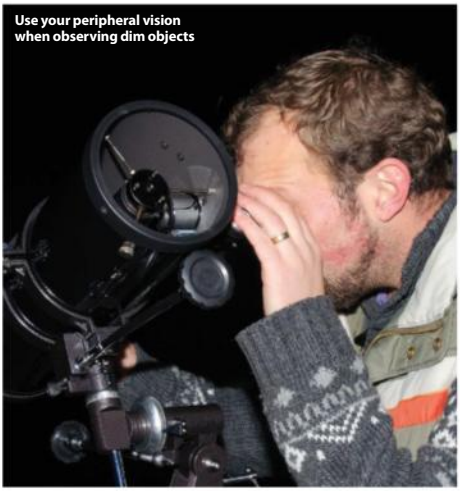


More can be seen towards the south in the UK latitudes

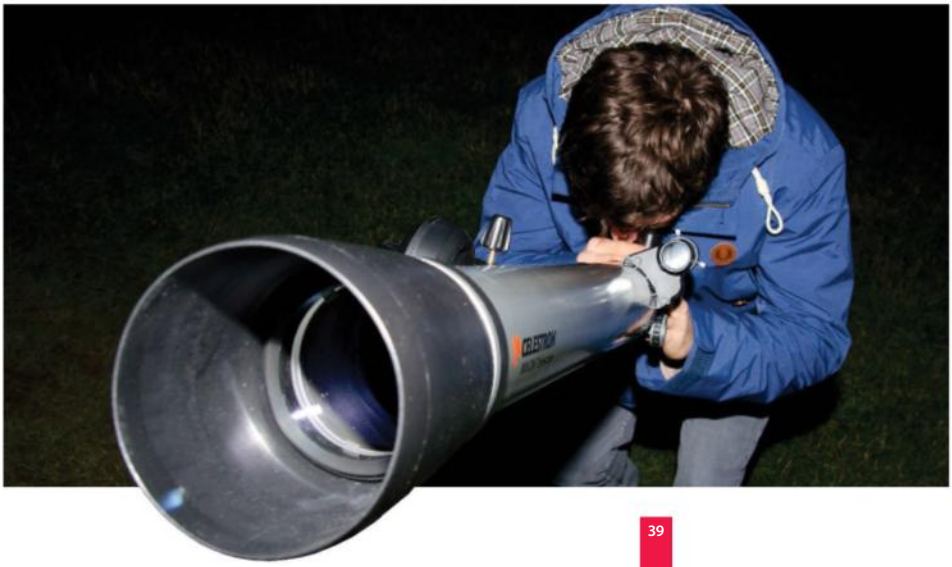
want to view before you go outside – doing this will help direct your evening's observing.

Don't expect too much from your first night. Forget notions of seeing things like what the Hubble Space Telescope sees through your telescope – there's a reason why deep sky objects like galaxies and nebulas are called faint fuzzies.

However, there are things you can do in order to make these faint objects seem much more visible. A clever tactic is to use something which is called averted vision. In your eye, there are two different types of receptor: the cone cells, which are concentrated mostly in the middle of your eye and give you colour vision, and rod cells, which are on the periphery of your eye and are more light sensitive than cones, providing you with night vision. When looking at a faint object through the telescope's eyepiece, if you just simply look off to one side of the object through the eyepiece while keeping the object on the periphery of your vision, it will appear brighter because the rod cells around the outside of your eye are more sensitive to the dim light of the object.


Use your peripheral vision when observing dim objects

Experiment with the magnification and you will find that different magnifications work better on different objects. Try out different filters: an Oxygen III filter is often called a 'nebula filter' as it blocks out all the light except for that wavelength of light emitted by oxygen atoms. It can also double up as a light pollution filter, blocking light you may encounter in an observing session!



10 tips to minimise light pollution

If you do live in or near a town or city you know the effects of stray light dimming down and ruining your view of the stars. Here are some tips to help...

01: Get into shadow

If street lights shine into your garden, getting into the shadow of a brick wall, tree or side of a building can help. This can block your view, so you may need to hunt around for the best spot.

02: Wait for the right conditions

High humidity or prolonged dry spells when dust can be thrown up into the atmosphere makes stargazing difficult. Check weather reports and also wait for stable wind conditions.

03: Get out of town

Pack up your equipment and drive a few miles out of your town or city to find darker skies. You will be amazed at the difference this makes, and you'll find that it's definitely worth the extra effort.

04: Shade your optics

If you can't shield yourself from stray light, then you can at least shield the equipment you are using. Dew shields or flexible 'wings' will help reduce stray light entering your eye from the side.

05: Cover your head

Covering your head with a dark cloth is surprisingly effective in getting your eyes 'dark adapted'. In turn, this will help you to see those faint stars and other objects through your telescope.

06: Be nice to your neighbour

If your neighbour's security lights are troublesome, then simply be polite and ask them to turn them off while you observe. You could also bring them over to show them what you are looking at.

Find a dark sky site

You don't have to travel to the Australian outback to see the stars in all their glory. Very often there are fantastic, light-pollution free sites just hours drive outside of town. In the UK, the website **www.darkskydiscovery.org.uk** will allow you to finds sites near you.

07: Use coloured filters

Coloured filters only allow through the wavelengths of light of the specific colour of the filter. This means that they block out the other colours, such as the orange/pink glow of street lights.

08: Stay out late

After midnight the amount of stray light around seems to be less. This is due to people going to bed and turning lights off. Also some local authorities will turn street lighting down or off completely.

09: Use specialist filters

City Light Suppression (CLS) filters or Anti Light Pollution filters (ALP), are narrow band filters that 'tune out' the wavelengths of light emitted by low-pressure sodium street lights.

10: Take up imaging

This is the most expensive option, unless you already own a DSLR camera. Because of the sensitivity of these cameras they can 'see' more than the human eye in light-polluted conditions.

20 amazing amateur discoveries

Be inspired by some of the fantastic discoveries made by amateurs over time

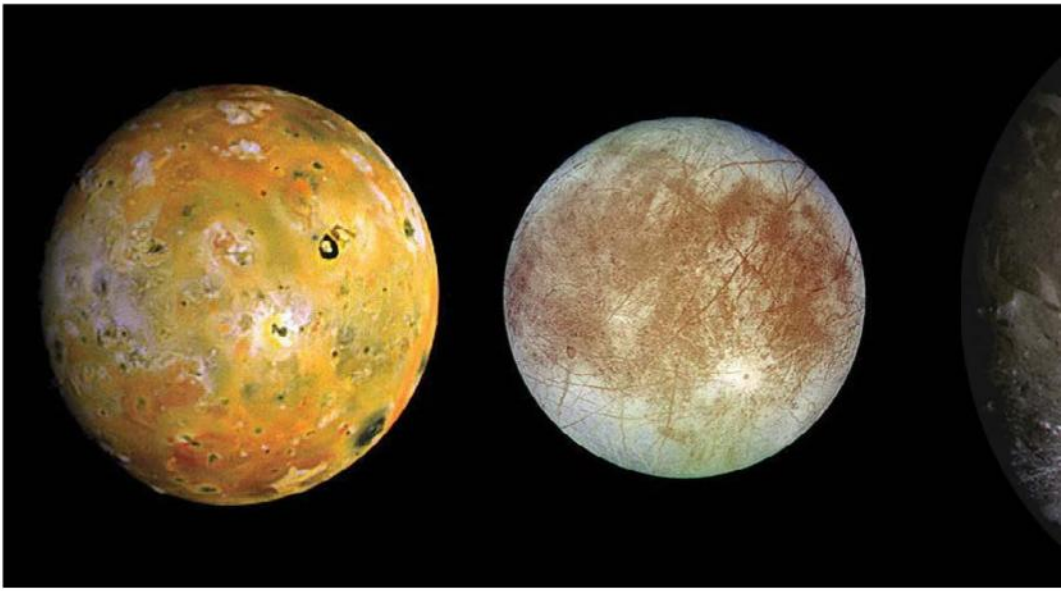
Agencies like NASA are actually very enthusiastic about pro-am collaborations. As an amateur, you can actually be involved in hunting for meteors, comets and even exoplanets.

This is because amateurs can fill in the gaps left by automated observatories and professionals who concentrate on limited areas of study. Often the amateur can just get lucky and spot something.. As an example, it took British amateur George Alcock six years looking for a comet, and then five days later he found another one. With modest equipment you have a greater chance of becoming an amateur space pioneer than ever before. And if you need proof, check out these examples.

Jovian moons Io, Europa, Ganymede and Callisto

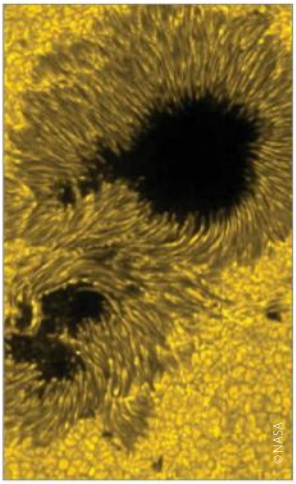
Discoverer: Galileo Galilei **Discovered:** January 1610

Using a telescope with a 20x magnification, Galileo noticed what looked like four stars near Jupiter. For two months, he continued observing these objects and determined that they were satellites orbiting Jupiter. This discovery undermined the Ptolemaic belief that the Earth is at the centre of the universe and showed the effectiveness of telescopic observations.



The planet Uranus

Discoverer: William Hershel
Discovered: March 1781
Using his equipment, he searched for double stars. Then he spotted a planet orbiting beyond Saturn.

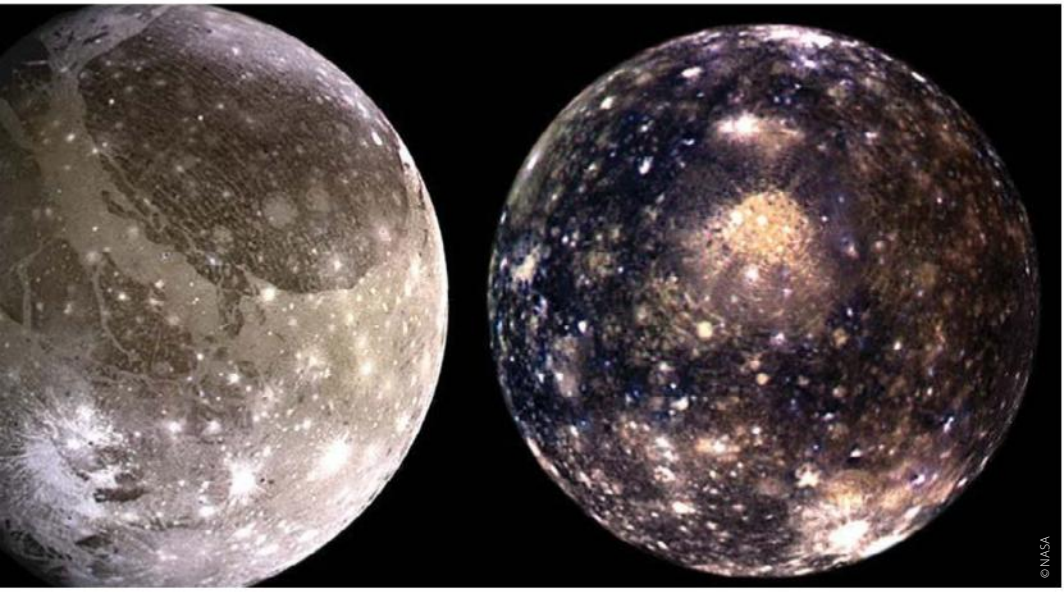


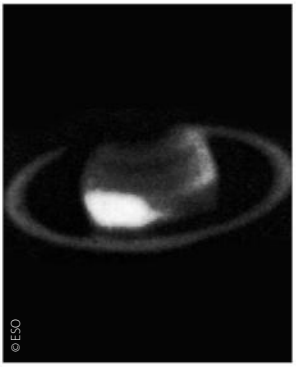
Sun spot cycle

Discoverer: Heinrich Schwabe
Discovered: 1843
German amateur, Heinrich Schwabe, noticed a ten year cycle of sun spot activity, which was revised to 11 years.

Nova Cygni 1920

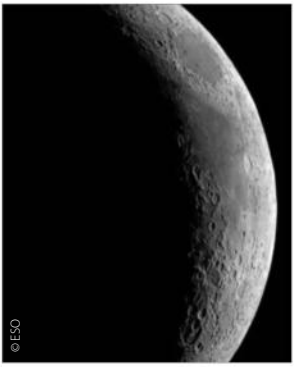
Discoverer: Will Denning
Discovered: 20 August 1920
Denning spotted a bright new star in the Cygnus constellation. This was named Nova Cygni 1920 (V476 Cygni).





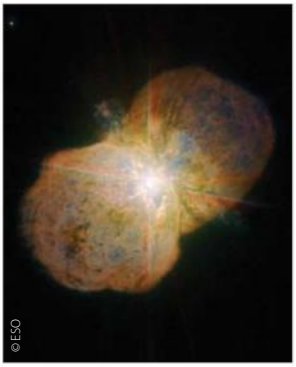
Saturn's white spot

Discoverer: Will Hay
Discovered: 3 August 1933 at 2 2:35 GMT
He spotted a large bright area in the Equatorial region of Saturn. The huge storm was visible for several months.



Lunar surface details

Discoverer: Patrick Moore
Discovered: 1945 onwards
His detailed maps were used by the Russians to check images captured by Lunar 3 in 1959, and by NASA for the Moon landing preparations.

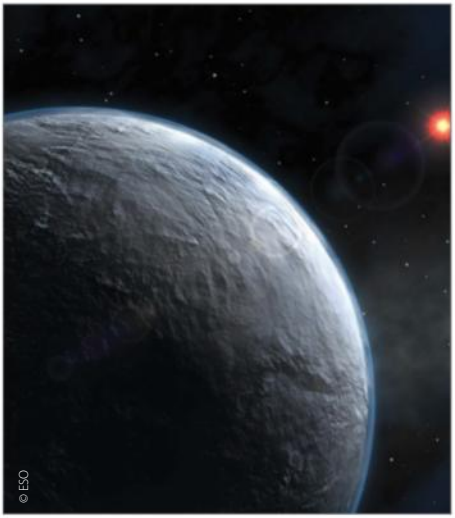


Multiple variable stars

Discoverer: Michiel Daniel Overbeek
Discovered: 1951 onwards
Viewing 250,000 variable stars, his data was used to schedule observing time for the Hubble Space Telescope.

Multiple supernovas

Discoverer: Owen Robert Evans
Discovered: 1955 onwards
The proud discoverer of one comet and 40 supernovas. He also succeeded in memorising the position of a staggering 1,500 galaxies, making it easy for him to scrutinise them.

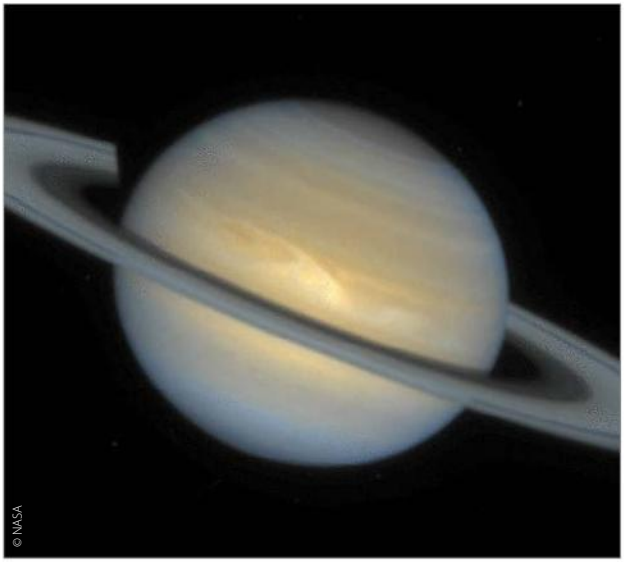


OGLE-2005-BLG-071

Discoverer: Grant Christie, Jennie McCormick
Discovered: April 2005
With data supplied by these two New Zealand amateur astronomers, a new exoplanet was confirmed. It was determined to be 3x the size of Jupiter.

Comet C/1959 Q1 (Alcock)

Discoverer: George Eric Deacon Alcock **Discovered:** 27 August 1959
Concentrating on comets and novas, he memorised the position of thousands of stars to enable him to spot any new arrivals. Over 24 years, he discovered five comets. In addition, he spotted four novas, the last being nova V838 Her, in 1991.



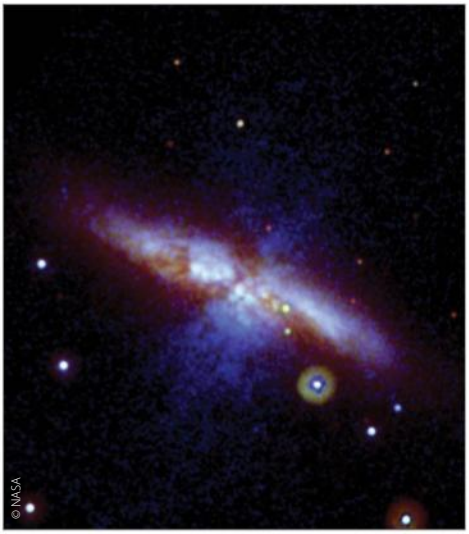
Saturn storm

Discoverer: Erick Bondoux, Jean-Luc Dauvergne, Jim Phillips, Don Parker
Discovered: 25 January 2006
The two French men working together, and the two US amateurs working independently, spotted a white patch on the surface of Saturn. NASA used this to confirm the presence of a storm detected by its Cassini space probe.

"Agencies like NASA are actually very enthusiastic about pro-am collaborations"

Comet C/1995 O1 (Hale-Bopp)

Discoverer: Thomas Hale, Alan J. Bopp
Discovered: 23 July 1995
Two amateur astronomers in the USA spotted one of the brightest comets to appear in the 20th Century. Alan Hale saw the comet whilst at home. On the same evening Thomas Bopp saw it through a friend's telescope.



Supernova SN2014J

Discoverer: UCL students
Discovered: 21 January 2014
Found when Steve Fossey was showing four undergraduate students how to use a small telescope. The supernova is located in Messier 82, also known as 'the Cigar Galaxy'.

Kn 61 planetary nebula

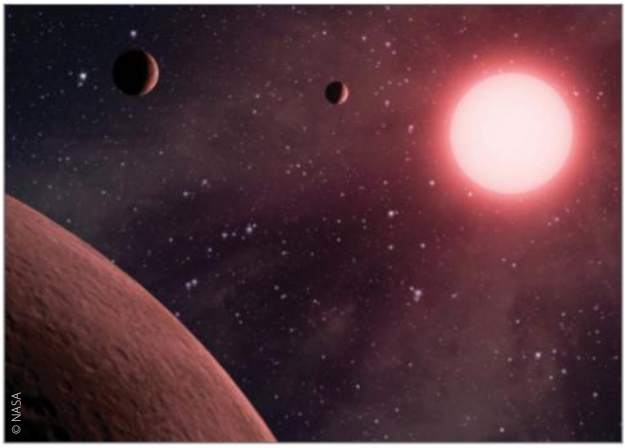
Discoverer: Matthias Kronberger
Discovered: January 2011
Kronberger spotted this intriguing raspberry shaped nebula in the Cygnus constellation. It consists of an ionised shell of gas surrounding a blue coloured central star.

Jupiter asteroid collision

Discoverer: Anthony Wesley
Discovered: 19 July 2009
Using his 14.5 inch Newtonian telescope, he captured images of a spot moving over Jupiter. This turned out to be an asteroid colliding with the planet, now nicknamed the Wesley Impact.

NGC 4449 galaxy star streams

Discoverer: Robert Jay Gabany
Discovered: April 2010
After working with the Max Planck Institute for Astronomy, he contributed to the mapping and analysis of a stellar stream in the halo of the nearby dwarf NGC 4449 starburst galaxy.



Exoplanets

Discoverer: Roy Jackson
Discovered: 2012 ongoing
As part of the Planet Hunters project, these volunteers sifted through data supplied by the NASA Kepler Space Telescope, to discover the existence of 42 potential exoplanets. Fifteen were identified as being in the habitable zone of its parent star, indicating they could support life forms. For this research, web browsers are used instead of telescopes to find exoplanets that had been missed or overlooked by the professionals. One volunteer was 71-year-old Roy Jackson, a retired police officer in Gateshead.

Comet C/2012 S1 (ISON)

Discoverer: Vitali Nevski, Artyom Novichonok
Discovered: 21 September 2012
ISON was a comet to keep an eye on when discovered. It could potentially be the 'comet of the century'.

Asteroids

Discoverer: NASA volunteers
Discovered: April 2012
NASA's Target Asteroids! project is encouraging volunteers to measure the position, brightness and spectrum of the carbonaceous asteroid (101955) Bennu.

Comet Lovejoy (C/2011 W3)

Discoverer: Terry Lovejoy
Discovered: 27 November 2011
Terry Lovejoy has discovered three comets. His rarest discovery so far was of C/2011 W3, which is a Kreutz Sungrazing comet.

Reporting a discovery

Our universe is a vast treasure trove of new objects to be found. But what do you do if you think you've made a discovery? We take you through the steps to successfully report it

Astronomy is one of the few sciences that allows everyone and anyone to stake claim on a discovery. New asteroids, comets, novae and supernovae are all well within reach of amateur astronomers to discover.

In 1993, Carolyn and Gene Shoemaker and David Levy scanned the starry skies to find a comet orbiting Jupiter. The speeding chunk of ice, named Shoemaker-Levy 9, smashed into the heavyweight gas giant.

The Shoemakers and Levy who found comets, had to approach the Central Bureau for Astronomical Telegrams (CBAT) with their discovery as did Boles with his reports on the supernovae he found. The CBAT is also the organisation to report observations of novae and outbursts from unusual variable stars.

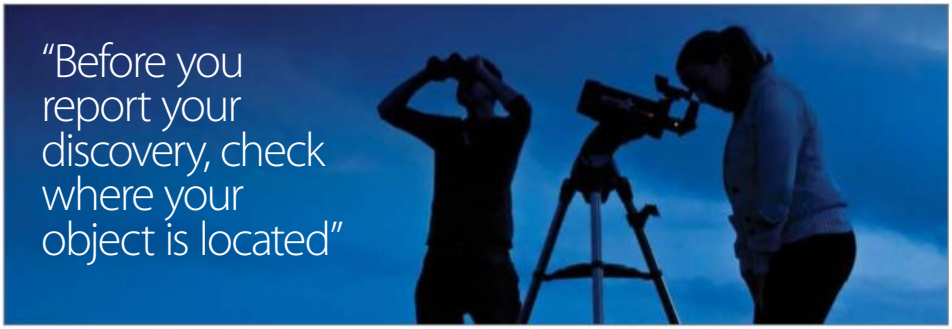
However, those who have located asteroids or planets will find that they must report to the Minor Planet Centre, while any new variable stars should be made known to the American Association of Variable Star Observers or reported to the variable star section of the British Astronomical Association.

Last but not least, any fireballs and meteorites that are discovered will need to be flagged up to the Fireball Data Center of the International Meteor Organisation.

Think you've found a new planet?

Planets around other stars are too faint to be seen with back garden telescopes – specialised professional telescopes and cameras in exotic locations such as Hawaii, the Canary Islands, or even space, are required. However, these telescopes produce so much data that scientists need the public's help to search through it all.

Many enthusiastic amateurs use the citizen science project – Planet - Hunters – which forms part of the Zooniverse project and some have successfully found an exoplanet around another star by studying data yielded from this project on their computer. Could you be the next?



01: What type of object have you found?

After you have checked that your finding is real, and you have confirmed your observation on a second night and have multiple photographic exposures, you're now ready to look into what type of object you've found. How does it move? If there's definite or small movement, of if it's placed in a galaxy it could be a comet or minor planet. If there doesn't seem to be any movement, then you might well have found a supernova or nova.

02: How bright is it?

Your next task is to look at how bright your object is as this, combined with the object's movement, can give you some clues as to what your target could be. If the brightness changes, but you're sure it's not a nova or supernova, you might have detected a variable star. You may have spotted the outburst of an unusual variable star, a cataclysmic variable or even one of the more familiar types of variable star.

03: Consult a list or database of known objects

Before you can think about reporting your discovery, you need to check where your potentially new found object is located. As soon as you have noted the Right Ascension (RA) and Declination (Dec), you can then make use of a sky atlas such as WIKISKY or the Digitized Sky Survey to check and make sure your object hasn't already been catalogued.

04: What do I need to include in my report?

If you can't find your object on any of the catalogues, then you are now ready to make an exciting step – reporting your discovery. Make sure that you have noted an accurate position and time, written a description of you object including its magnitude, your full name and contact details, information on your observing location and the instrument you used to detect it as well as information on the sources you used to check that the object is new.

05: Where do I report my discovery to?

Depending on what you've found, there are several organisations to report to. For comets, supernovae, and outbursts of unusual variable stars, contact the Central Bureau for Astronomical Telegrams (CBAT), for minor planets and asteroids you should report to the Minor Planet Centre and either the American Association of Variable Star Observers should be contacted for the more routine or new variable stars.

Best astronomy apps around

Essential space-based mobile apps to inform you on the go

01: SkySafari Pro

Cost: £27.99 ($39.99)/ £22.99 ($36.99)

Available for: iOS/Android

One of the most professional astronomy apps out there. It gets the majority of its data from the Hubble Guide Star catalog as well as comets and asteroids. Use the app as a 'GoTo' device to control a full-sized telescope. It's the size of data on offer that sets SkySafari Pro apart from the rest.

02: NASA App

Cost: Free

Available for: iOS/Android

For all things NASA-related this app is the way to go. It contains a multitude of information on all current missions plus other features. Watch NASA TV live when there's a show or press conference on air. The app can be bland in places, but there's plenty of nifty features, such as the International Space Station locator.

03: ISS Spotter

Cost: Free

Available for: iOS

Never miss another ISS flyby again. This app tracks the spacecraft and lets you know when you're due another flyby by setting off an alarm. Easy to use, and does exactly what it says on the tin. While some planetarium apps offer a tracker for the Earth-orbiting habitat, the ISS Spotter won't take up much space.

04: Star Walk

Cost: £1.99 ($2.99)/£1.79 ($2.99)
Available for: iOS/Android

Pinch and swipe to locate a multitude of constellations in the night sky. Star Walk uses augmented reality, so simply point your phone at the sky and you'll be able to locate objects with the app's help. There's a ton of information on offer and is a great companion for amateur astronomers on the go.

05: Redshift

Cost: £7.49 ($10.99)
Available for: iOS

A definitive guide to the stars, constellations and galaxies and search functionality is impressive, allowing users to find objects by their name or browse through different categories quickly and easily. Browse through the universe, and if you need an app to help with amateur astronomy then you'll want Redshift.

06: Mobile Observatory – Astronomy

Cost: £3.95 ($4.99)
Available for: Android

The app also points out key events that are coming up, such as solar eclipses or meteor showers. Like Star Walk, this app also boasts incredible augmented reality features, allowing you to point your device at the sky and locate constellations, stars, planets and more.

Operate a telescope remotely

Controlling a large telescope – as far out as Australia or Hawaii – from the comfort of your very own home has never been easier

Due to modern technology, it is now possible for amateurs to get involved simply through the touch of a computer keypad. Anyone with an Internet connection can now escape cloudy skies to some of the clearest in the world.

Not only can you skip through the skies of New Mexico and Spain to Australia and elsewhere, you will also be using equipment that would otherwise be out of financial reach to many.

While you don't actually get the chance to look through the eyepiece as you would if you were at home or at a society meeting, controlling an observatory in another country or even another hemisphere is completely mind-boggling in its own right. With a few simple clicks of a mouse, and very affordable rates per hour of observing time, you could be using a telescope under a pitch-black foreign sky, observing and imaging deep-sky objects that you might never have seen before, in addition to distant comets and asteroids. Now the universe really does lie at your fingertips like never before.

Global Rent-A-Scope

www.global-rent-a-scope.com

Hailed as the best facility for the advanced amateur astronomer, the Global Rent-A-Scope (GRAS) operates a network of some ten telescopes in three locations across both the Northern and Southern Hemispheres.

So many telescopes means observers are given a huge choice in camera and focal length configurations including a CCD that is aimed at near-infrared observations.

Time using the telescopes can be bought in packages ranging from a starter trial at $19 up to a larger sum of $289 per month supplying you with 11 hours observing time as well as the added bonus of being able to schedule your telescope time. Free time is also offered to new users, allowing you to try out the system.

The ultimate remote telescope – Hubble is operated by several space agencies

Faulkes Telescope Project

www.faulkes-telescope.com

The Faulkes Telescope Project provides free access to its two-metre robotic telescopes situated in Hawaii and Australia. It provides training for anyone wanting to get the most out of amateur astronomy, either online or workshops across the UK as well as selected events in Europe.

Slooh

www.events.slooh.com

Slooh offers membership to use its telescopes at a free level. You have the option to be guided through live imaging sessions by an astronomer. Simple to use, there are observing programs for the young astronomer – without parents having to worry about large bills!

LightBuckets

www.lightbuckets.com

Free to join, but you need to purchase telescope time to use the five telescopes situated in France. A simple setup that leads the user through choosing an observatory, a target as well as setting up an imaging run and retrieving data. You also have the option of having complete observatory control as well as command of your imaging run.

Bradford Robotic Telescope

www.telescope.org

Often used by schools and colleges, boasting over 75,000 registered users. Free to use, meaning that telescope-time is heavily over-subscribed.

Completely automated, the system features multiple power backup and can cater for any teething troubles that it may encounter. The telescope is high above cloud level and allows users to monitor local conditions.

Seasonal guides

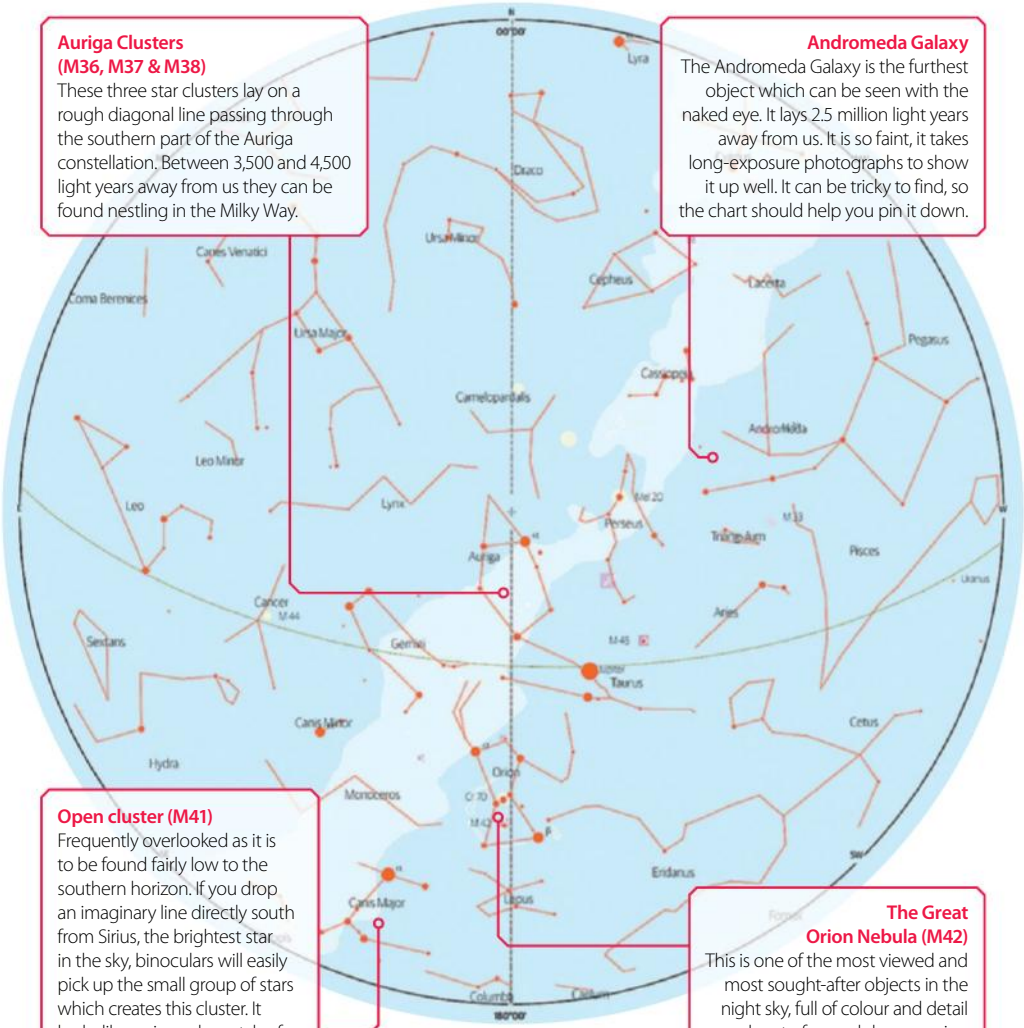
One of the first steps is to make sure you are familiar with the night sky, and how it changes through the night season by season. Follow our month-by-month star charts and track what there is to see, and where you can see it.

Includes...

- Monthly guides
- Detailed star charts
- Uncover deep sky delights
- Get to know your constellations

December-January

Here are a few of the amazing sights you'll be able to see after dark…



Auriga Clusters (M36, M37 & M38)
These three star clusters lay on a rough diagonal line passing through the southern part of the Auriga constellation. Between 3,500 and 4,500 light years away from us they can be found nestling in the Milky Way.

Andromeda Galaxy
The Andromeda Galaxy is the furthest object which can be seen with the naked eye. It lays 2.5 million light years away from us. It is so faint, it takes long-exposure photographs to show it up well. It can be tricky to find, so the chart should help you pin it down.

Open cluster (M41)
Frequently overlooked as it is to be found fairly low to the southern horizon. If you drop an imaginary line directly south from Sirius, the brightest star in the sky, binoculars will easily pick up the small group of stars which creates this cluster. It looks like an irregular patch of light, but a telescope will show it to be full of stars.

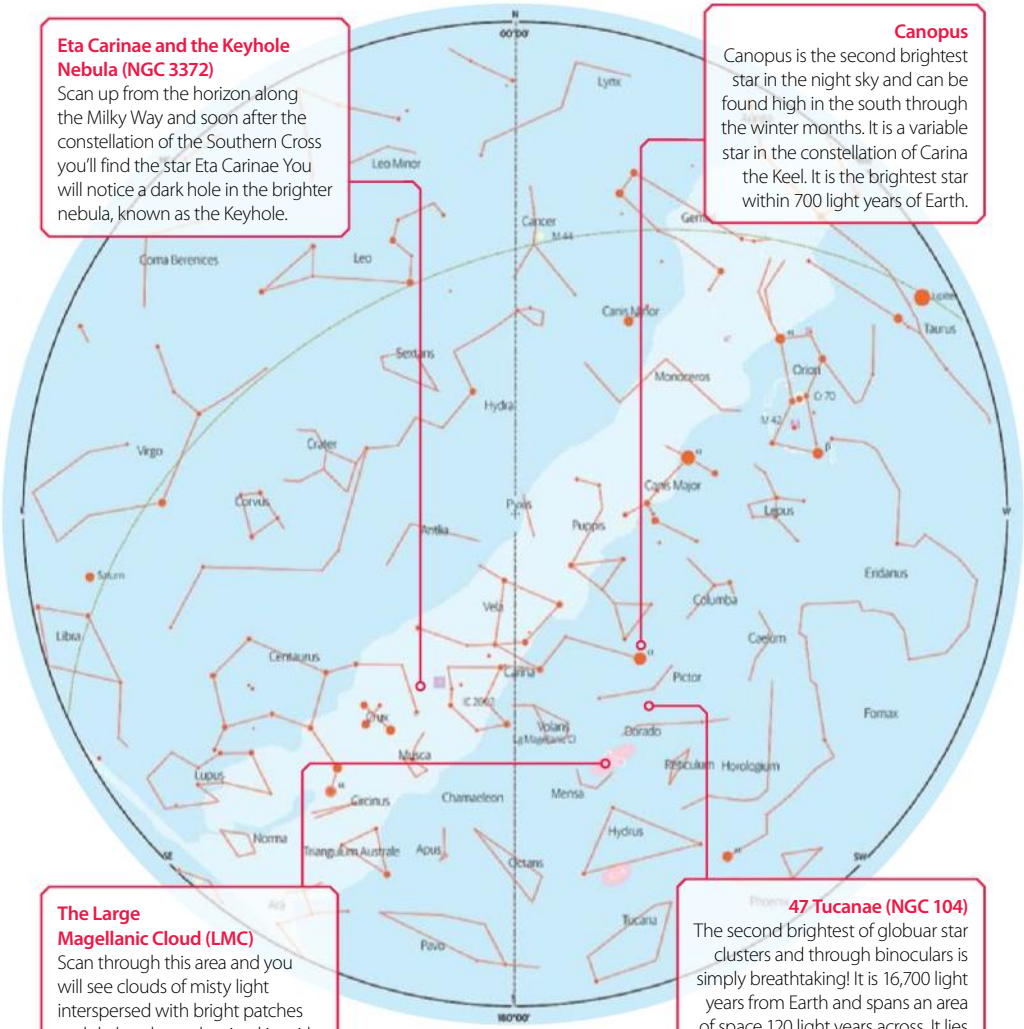
The Great Orion Nebula (M42)
This is one of the most viewed and most sought-after objects in the night sky, full of colour and detail and part of a much larger region of nebulosity that surrounds almost the entire constellation.

LARGE MAGELLANIC CLOUD

ETA CARINAE

Eta Carinae and the Keyhole Nebula (NGC 3372)
Scan up from the horizon along the Milky Way and soon after the constellation of the Southern Cross you'll find the star Eta Carinae You will notice a dark hole in the brighter nebula, known as the Keyhole.

Canopus
Canopus is the second brightest star in the night sky and can be found high in the south through the winter months. It is a variable star in the constellation of Carina the Keel. It is the brightest star within 700 light years of Earth.



The Large Magellanic Cloud (LMC)
Scan through this area and you will see clouds of misty light interspersed with bright patches and darker channels mixed in with stunning star clusters. It is a satellite galaxy of our own Milky Way.

47 Tucanae (NGC 104)
The second brightest of globuar star clusters and through binoculars is simply breathtaking! It is 16,700 light years from Earth and spans an area of space 120 light years across. It lies not far from the Small Magellanic Cloud, a smaller sibling of the LMC.

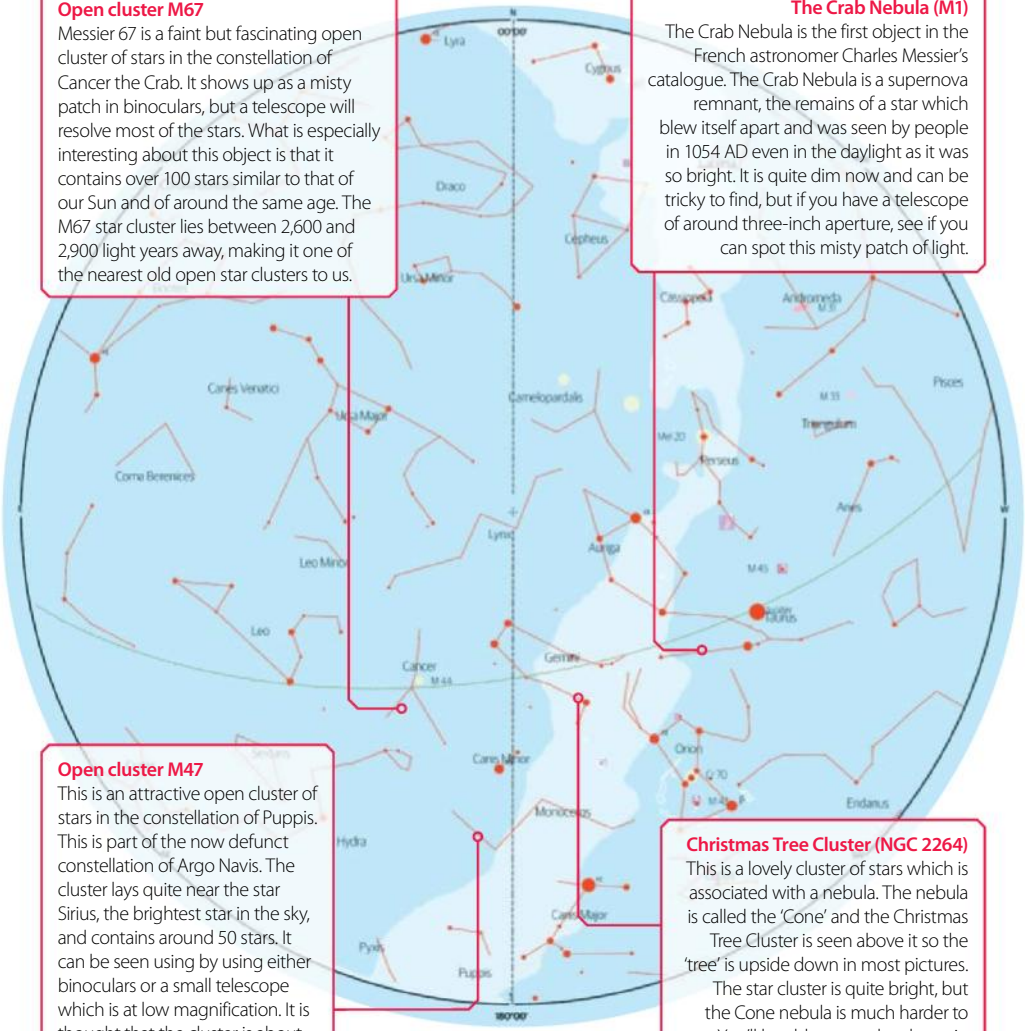
SOUTHERN HEMISPHERE

January-February

Start your new year viewing with this selection of fantastic night sky sights

Open cluster M67
Messier 67 is a faint but fascinating open cluster of stars in the constellation of Cancer the Crab. It shows up as a misty patch in binoculars, but a telescope will resolve most of the stars. What is especially interesting about this object is that it contains over 100 stars similar to that of our Sun and of around the same age. The M67 star cluster lies between 2,600 and 2,900 light years away, making it one of the nearest old open star clusters to us.

The Crab Nebula (M1)
The Crab Nebula is the first object in the French astronomer Charles Messier's catalogue. The Crab Nebula is a supernova remnant, the remains of a star which blew itself apart and was seen by people in 1054 AD even in the daylight as it was so bright. It is quite dim now and can be tricky to find, but if you have a telescope of around three-inch aperture, see if you can spot this misty patch of light.



NORTHERN HEMISPHERE

Open cluster M47
This is an attractive open cluster of stars in the constellation of Puppis. This is part of the now defunct constellation of Argo Navis. The cluster lays quite near the star Sirius, the brightest star in the sky, and contains around 50 stars. It can be seen using by using either binoculars or a small telescope which is at low magnification. It is thought that the cluster is about 78 million years old and is around 1,600 light years distance.

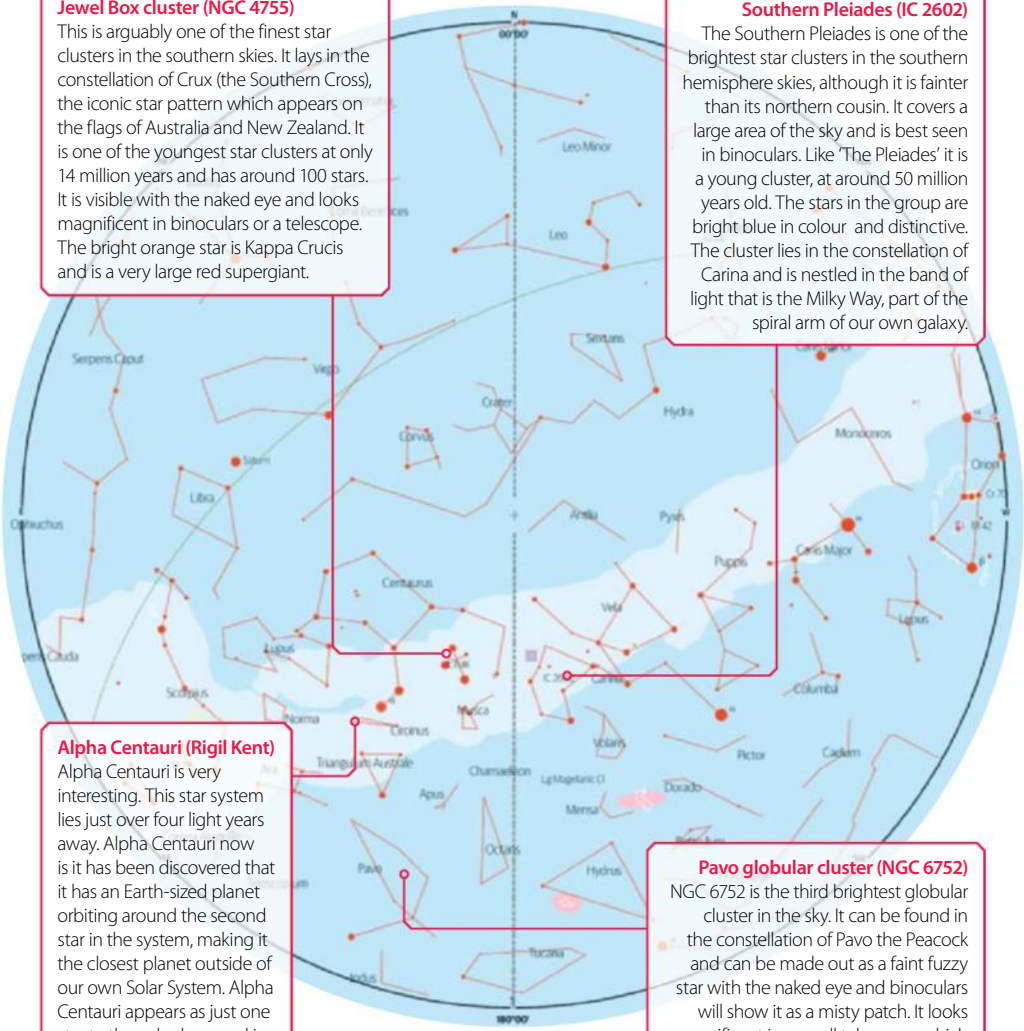
Christmas Tree Cluster (NGC 2264)
This is a lovely cluster of stars which is associated with a nebula. The nebula is called the 'Cone' and the Christmas Tree Cluster is seen above it so the 'tree' is upside down in most pictures. The star cluster is quite bright, but the Cone nebula is much harder to see. You'll be able to see the cluster in binoculars and it looks great in small telescopes at low power.

JEWEL BOX CLUSTER

PAVO GLOBULAR CLUSTER

Jewel Box cluster (NGC 4755)
This is arguably one of the finest star clusters in the southern skies. It lays in the constellation of Crux (the Southern Cross), the iconic star pattern which appears on the flags of Australia and New Zealand. It is one of the youngest star clusters at only 14 million years and has around 100 stars. It is visible with the naked eye and looks magnificent in binoculars or a telescope. The bright orange star is Kappa Crucis and is a very large red supergiant.

Southern Pleiades (IC 2602)
The Southern Pleiades is one of the brightest star clusters in the southern hemisphere skies, although it is fainter than its northern cousin. It covers a large area of the sky and is best seen in binoculars. Like 'The Pleiades' it is a young cluster, at around 50 million years old. The stars in the group are bright blue in colour and distinctive. The cluster lies in the constellation of Carina and is nestled in the band of light that is the Milky Way, part of the spiral arm of our own galaxy.



Alpha Centauri (Rigil Kent)
Alpha Centauri is very interesting. This star system lies just over four light years away. Alpha Centauri now is it has been discovered that it has an Earth-sized planet orbiting around the second star in the system, making it the closest planet outside of our own Solar System. Alpha Centauri appears as just one star to the naked eye and is among the brightest stars in the entire sky.

Pavo globular cluster (NGC 6752)
NGC 6752 is the third brightest globular cluster in the sky. It can be found in the constellation of Pavo the Peacock and can be made out as a faint fuzzy star with the naked eye and binoculars will show it as a misty patch. It looks magnificent in a small telescope, which will resolve many of the outer stars in the cluster. It lays 13,000 light years away.

SOUTHERN HEMISPHERE

February-March

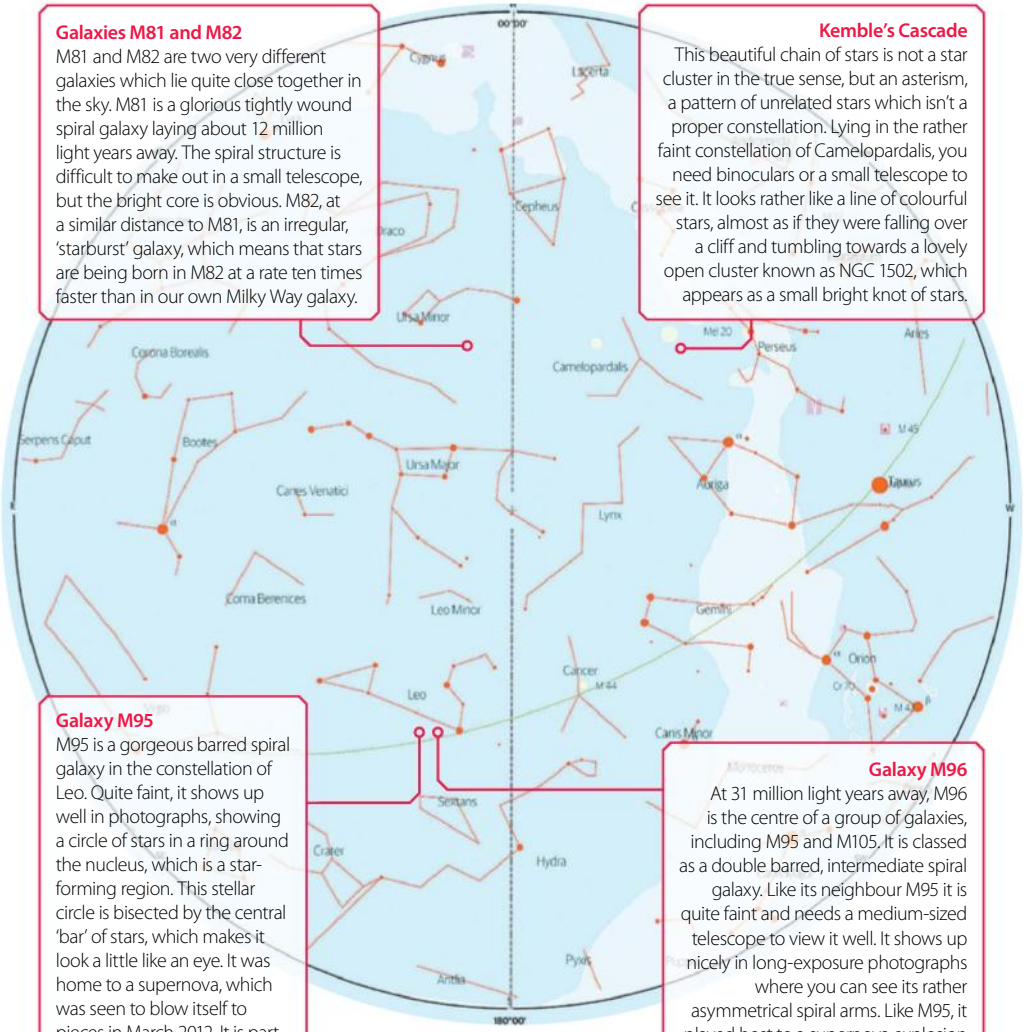
At the first hints of spring, take a look at the views you can enjoy in the crisp night air…

Galaxies M81 and M82

M81 and M82 are two very different galaxies which lie quite close together in the sky. M81 is a glorious tightly wound spiral galaxy laying about 12 million light years away. The spiral structure is difficult to make out in a small telescope, but the bright core is obvious. M82, at a similar distance to M81, is an irregular, 'starburst' galaxy, which means that stars are being born in M82 at a rate ten times faster than in our own Milky Way galaxy.

Kemble's Cascade

This beautiful chain of stars is not a star cluster in the true sense, but an asterism, a pattern of unrelated stars which isn't a proper constellation. Lying in the rather faint constellation of Camelopardalis, you need binoculars or a small telescope to see it. It looks rather like a line of colourful stars, almost as if they were falling over a cliff and tumbling towards a lovely open cluster known as NGC 1502, which appears as a small bright knot of stars.



NORTHERN HEMISPHERE

Galaxy M95

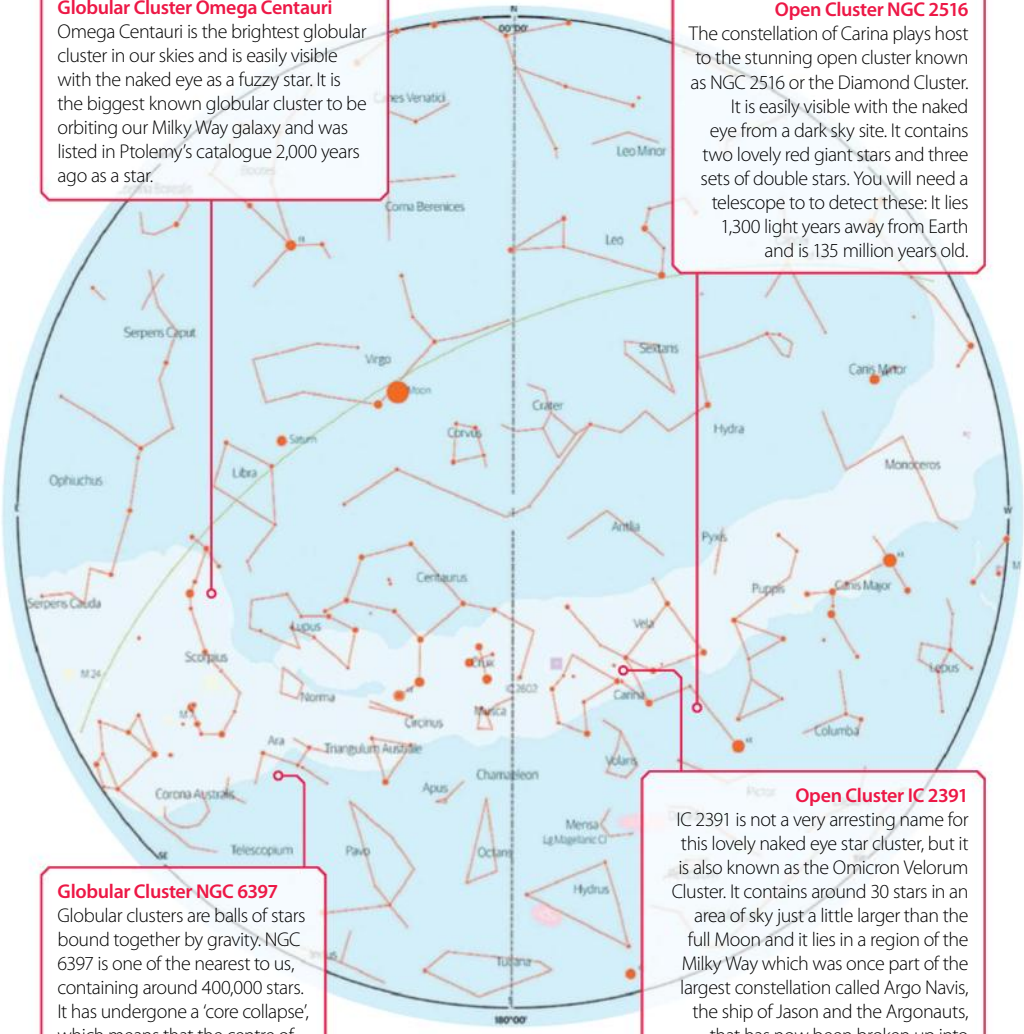
M95 is a gorgeous barred spiral galaxy in the constellation of Leo. Quite faint, it shows up well in photographs, showing a circle of stars in a ring around the nucleus, which is a star-forming region. This stellar circle is bisected by the central 'bar' of stars, which makes it look a little like an eye. It was home to a supernova, which was seen to blow itself to pieces in March 2012. It is part of a group of galaxies, centred on the brighter galaxy M96.

Galaxy M96

At 31 million light years away, M96 is the centre of a group of galaxies, including M95 and M105. It is classed as a double barred, intermediate spiral galaxy. Like its neighbour M95 it is quite faint and needs a medium-sized telescope to view it well. It shows up nicely in long-exposure photographs where you can see its rather asymmetrical spiral arms. Like M95, it played host to a supernova explosion in 1998. This galaxy is thought to contain a supermassive black hole.

Globular Cluster Omega Centauri
Omega Centauri is the brightest globular cluster in our skies and is easily visible with the naked eye as a fuzzy star. It is the biggest known globular cluster to be orbiting our Milky Way galaxy and was listed in Ptolemy's catalogue 2,000 years ago as a star.

Open Cluster NGC 2516
The constellation of Carina plays host to the stunning open cluster known as NGC 2516 or the Diamond Cluster. It is easily visible with the naked eye from a dark sky site. It contains two lovely red giant stars and three sets of double stars. You will need a telescope to to detect these: It lies 1,300 light years away from Earth and is 135 million years old.



Globular Cluster NGC 6397
Globular clusters are balls of stars bound together by gravity. NGC 6397 is one of the nearest to us, containing around 400,000 stars. It has undergone a 'core collapse', which means that the centre of the cluster has contracted to a dense agglomeration.

Open Cluster IC 2391
IC 2391 is not a very arresting name for this lovely naked eye star cluster, but it is also known as the Omicron Velorum Cluster. It contains around 30 stars in an area of sky just a little larger than the full Moon and it lies in a region of the Milky Way which was once part of the largest constellation called Argo Navis, the ship of Jason and the Argonauts, that has now been broken up into more manageable parts. The cluster lies around 500 light years from Earth.

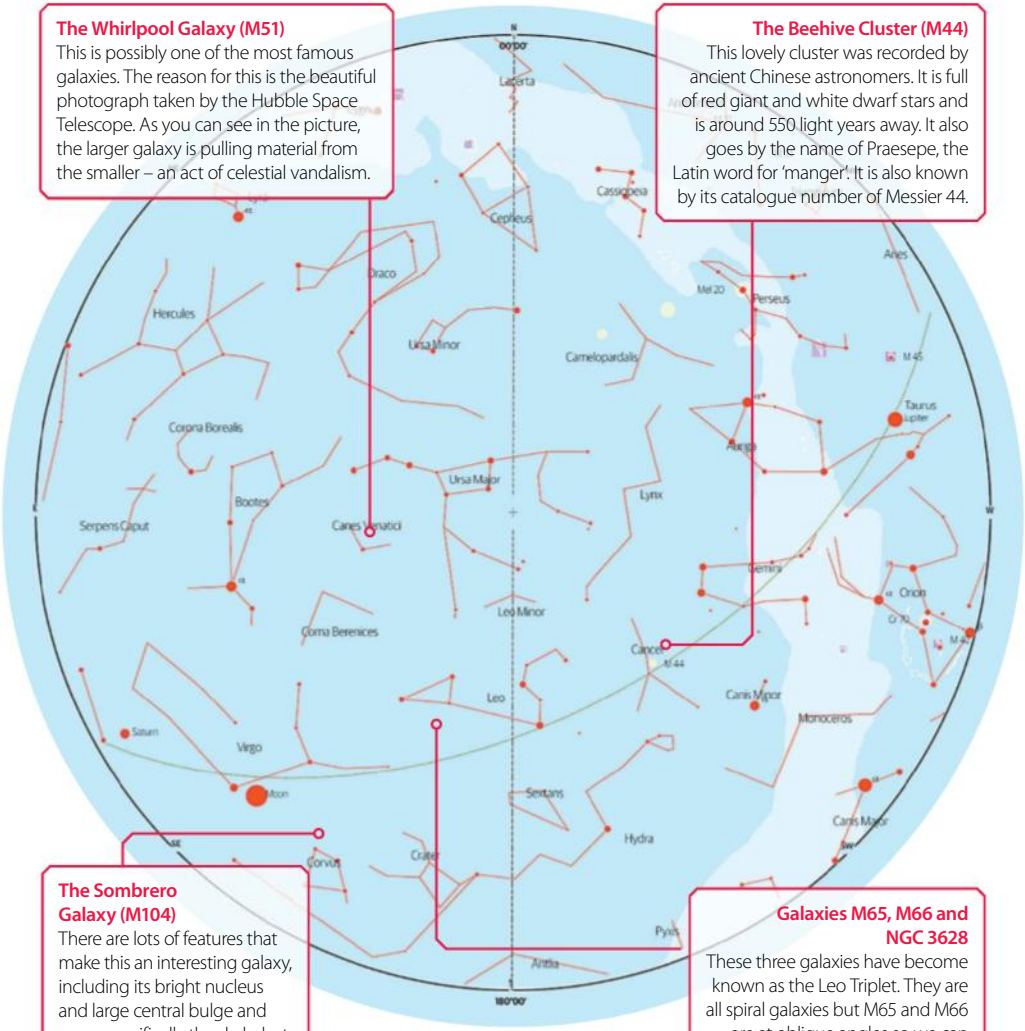
SOUTHERN HEMISPHERE

March-April

See what this season of rebirth means for what the skies have to offer…

The Whirlpool Galaxy (M51)
This is possibly one of the most famous galaxies. The reason for this is the beautiful photograph taken by the Hubble Space Telescope. As you can see in the picture, the larger galaxy is pulling material from the smaller – an act of celestial vandalism.

The Beehive Cluster (M44)
This lovely cluster was recorded by ancient Chinese astronomers. It is full of red giant and white dwarf stars and is around 550 light years away. It also goes by the name of Praesepe, the Latin word for 'manger'. It is also known by its catalogue number of Messier 44.



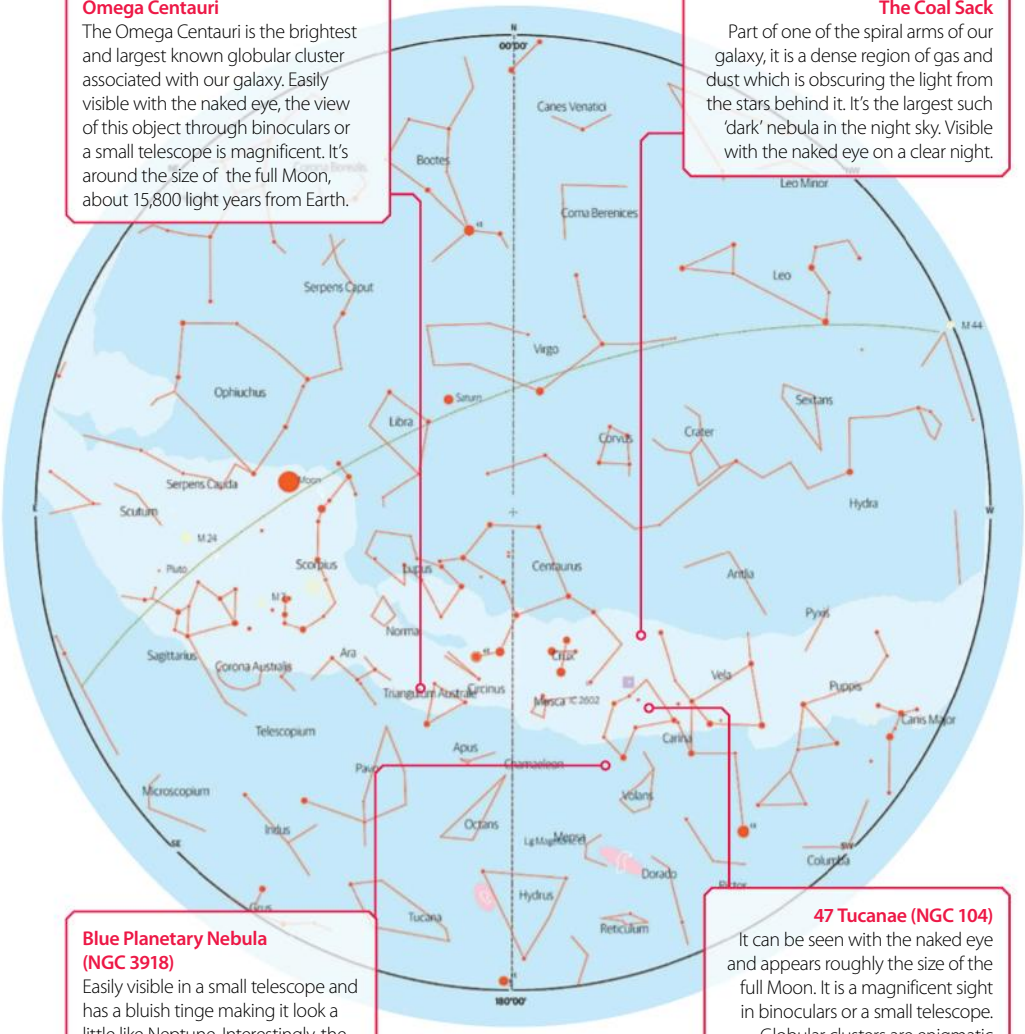
NORTHERN HEMISPHERE

The Sombrero Galaxy (M104)
There are lots of features that make this an interesting galaxy, including its bright nucleus and large central bulge and more specifically the dark dust lane running around the edge of this beautiful object.

Galaxies M65, M66 and NGC 3628
These three galaxies have become known as the Leo Triplet. They are all spiral galaxies but M65 and M66 are at oblique angles so we can see the spiral structure, whereas NGC 3628 is edge on to us.

Omega Centauri
The Omega Centauri is the brightest and largest known globular cluster associated with our galaxy. Easily visible with the naked eye, the view of this object through binoculars or a small telescope is magnificent. It's around the size of the full Moon, about 15,800 light years from Earth.

The Coal Sack
Part of one of the spiral arms of our galaxy, it is a dense region of gas and dust which is obscuring the light from the stars behind it. It's the largest such 'dark' nebula in the night sky. Visible with the naked eye on a clear night.



Blue Planetary Nebula (NGC 3918)
Easily visible in a small telescope and has a bluish tinge making it look a little like Neptune. Interestingly, the faint central star at the heart of the nebula is invisible to visual observers.

SOUTHERN HEMISPHERE

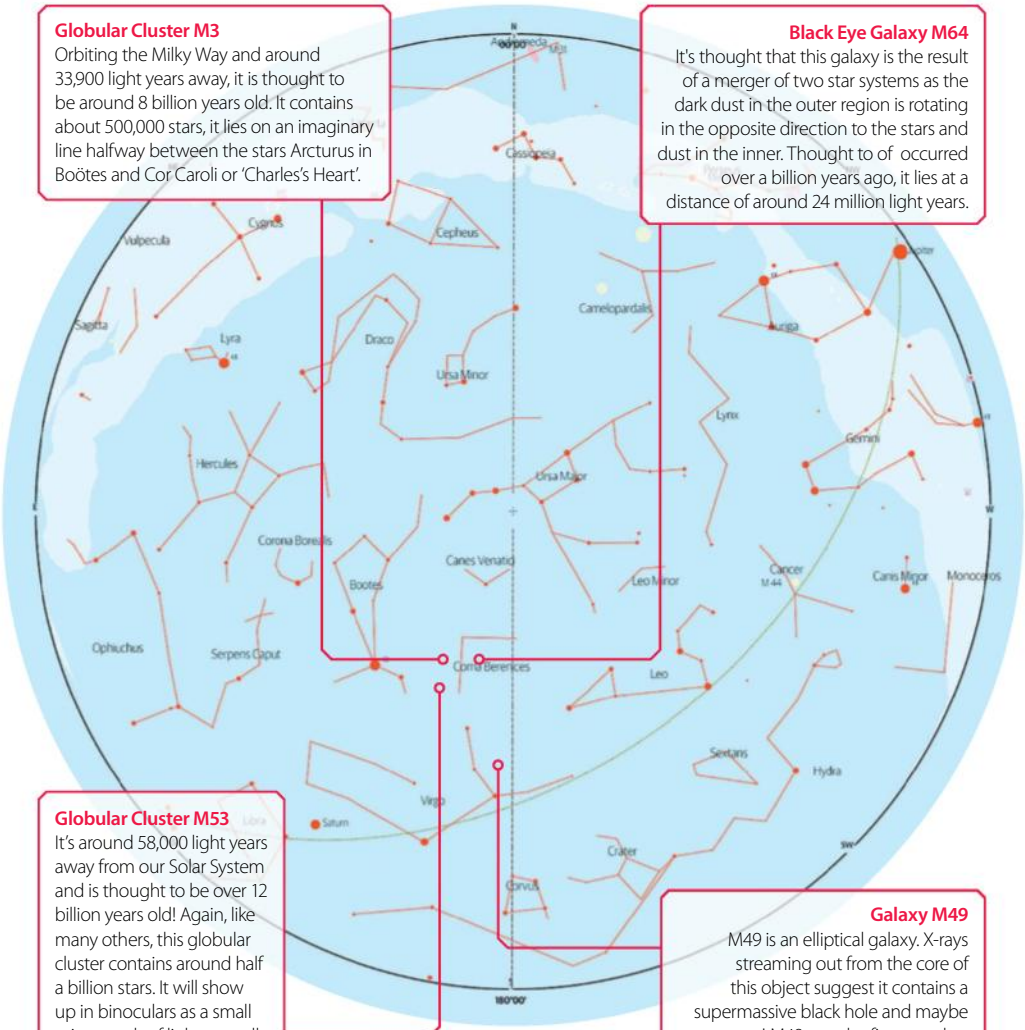
47 Tucanae (NGC 104)
It can be seen with the naked eye and appears roughly the size of the full Moon. It is a magnificent sight in binoculars or a small telescope. Globular clusters are enigmatic objects, as they contain some of the oldest stars in the known universe.

April-May

The constellations of spring are now on show with a myriad of deep-sky delights

Globular Cluster M3
Orbiting the Milky Way and around 33,900 light years away, it is thought to be around 8 billion years old. It contains about 500,000 stars, it lies on an imaginary line halfway between the stars Arcturus in Boötes and Cor Caroli or 'Charles's Heart'.

Black Eye Galaxy M64
It's thought that this galaxy is the result of a merger of two star systems as the dark dust in the outer region is rotating in the opposite direction to the stars and dust in the inner. Thought to of occurred over a billion years ago, it lies at a distance of around 24 million light years.



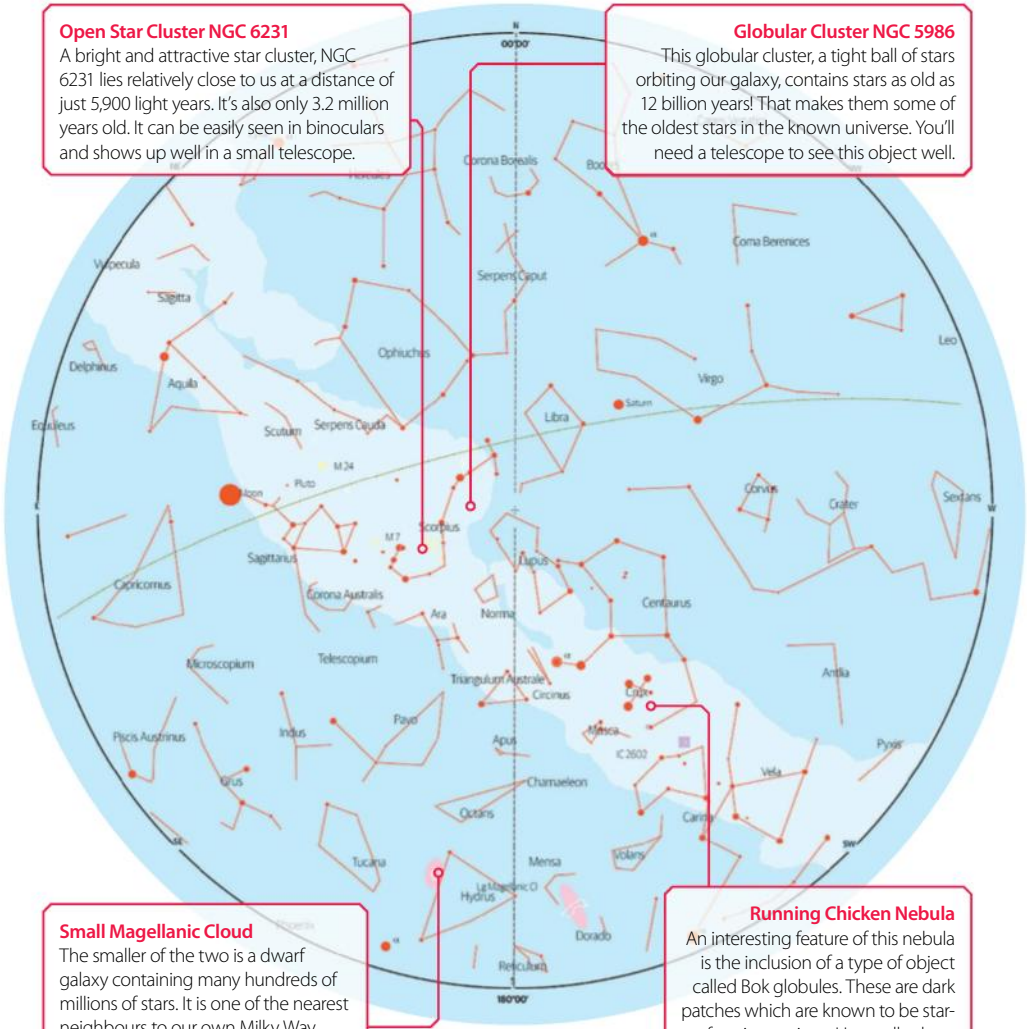
Globular Cluster M53
It's around 58,000 light years away from our Solar System and is thought to be over 12 billion years old! Again, like many others, this globular cluster contains around half a billion stars. It will show up in binoculars as a small misty patch of light; a small telescope will reveal its true nature though.

Galaxy M49
M49 is an elliptical galaxy. X-rays streaming out from the core of this object suggest it contains a supermassive black hole and maybe even two! M49 was the first member of the 'Virgo Cluster' of galaxies discovered in 1771.

NORTHERN HEMISPHERE

Open Star Cluster NGC 6231
A bright and attractive star cluster, NGC 6231 lies relatively close to us at a distance of just 5,900 light years. It's also only 3.2 million years old. It can be easily seen in binoculars and shows up well in a small telescope.

Globular Cluster NGC 5986
This globular cluster, a tight ball of stars orbiting our galaxy, contains stars as old as 12 billion years! That makes them some of the oldest stars in the known universe. You'll need a telescope to see this object well.



Small Magellanic Cloud
The smaller of the two is a dwarf galaxy containing many hundreds of millions of stars. It is one of the nearest neighbours to our own Milky Way Galaxy, it is one of the most distant objects to be seen with the naked eye.

SOUTHERN HEMISPHERE

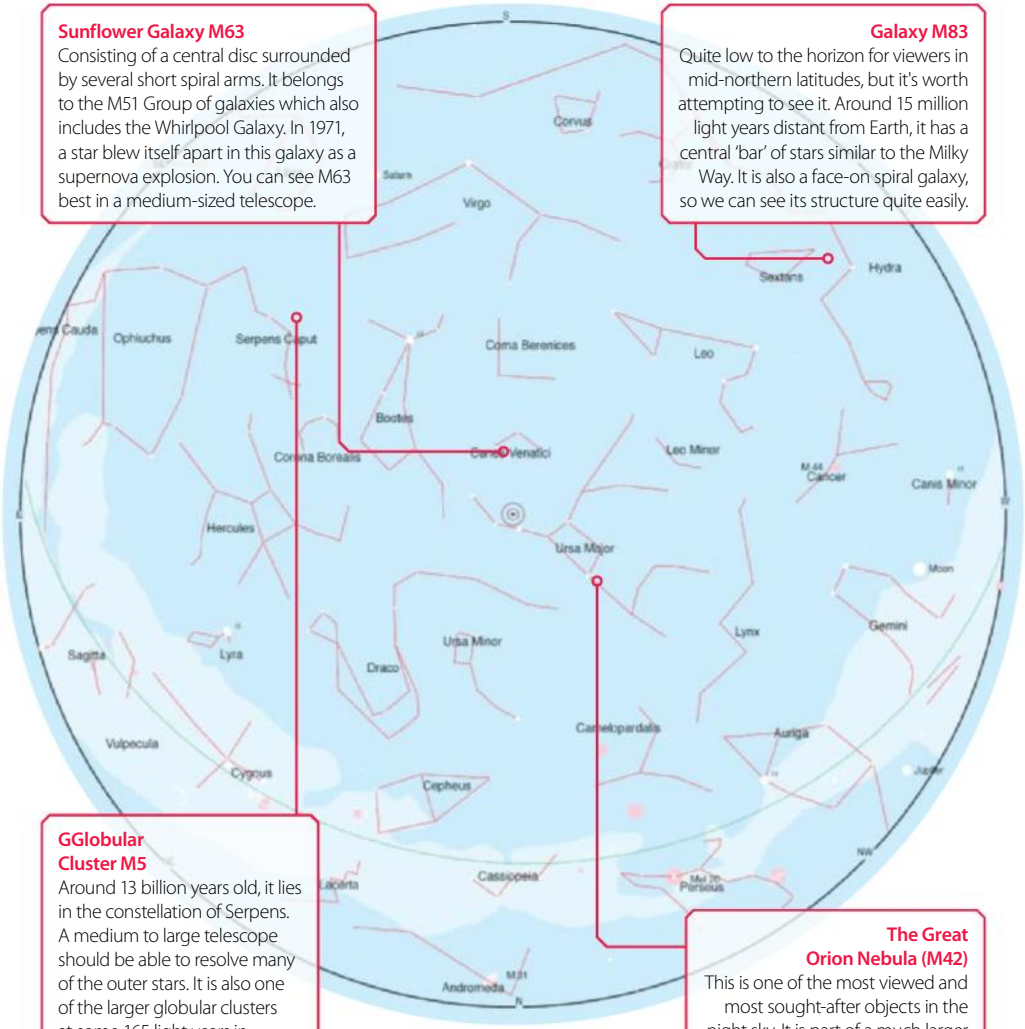
Running Chicken Nebula
An interesting feature of this nebula is the inclusion of a type of object called Bok globules. These are dark patches which are known to be star-forming regions. Unusually, there has been no such star formation detected within this nebula.

May-June

The constellations of late spring bring us a range of wonders to enjoy on balmy evenings

Sunflower Galaxy M63
Consisting of a central disc surrounded by several short spiral arms. It belongs to the M51 Group of galaxies which also includes the Whirlpool Galaxy. In 1971, a star blew itself apart in this galaxy as a supernova explosion. You can see M63 best in a medium-sized telescope.

Galaxy M83
Quite low to the horizon for viewers in mid-northern latitudes, but it's worth attempting to see it. Around 15 million light years distant from Earth, it has a central 'bar' of stars similar to the Milky Way. It is also a face-on spiral galaxy, so we can see its structure quite easily.



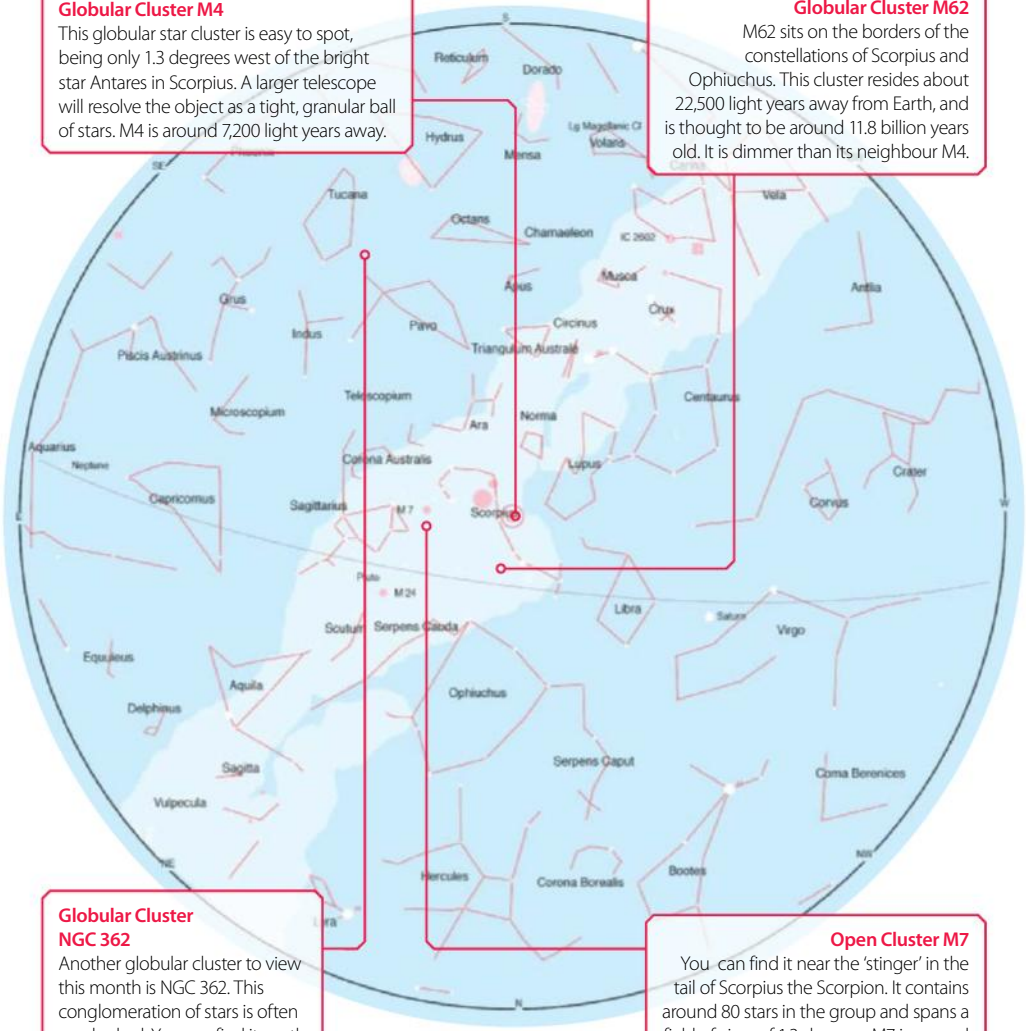
GGlobular Cluster M5
Around 13 billion years old, it lies in the constellation of Serpens. A medium to large telescope should be able to resolve many of the outer stars. It is also one of the larger globular clusters at some 165 light years in diameter. It is 24,500 light years away from Earth.

The Great Orion Nebula (M42)
This is one of the most viewed and most sought-after objects in the night sky. It is part of a much larger region of nebulosity that surrounds almost the entire constellation.

NORTHERN HEMISPHERE

Globular Cluster M4
This globular star cluster is easy to spot, being only 1.3 degrees west of the bright star Antares in Scorpius. A larger telescope will resolve the object as a tight, granular ball of stars. M4 is around 7,200 light years away.

Globular Cluster M62
M62 sits on the borders of the constellations of Scorpius and Ophiuchus. This cluster resides about 22,500 light years away from Earth, and is thought to be around 11.8 billion years old. It is dimmer than its neighbour M4.



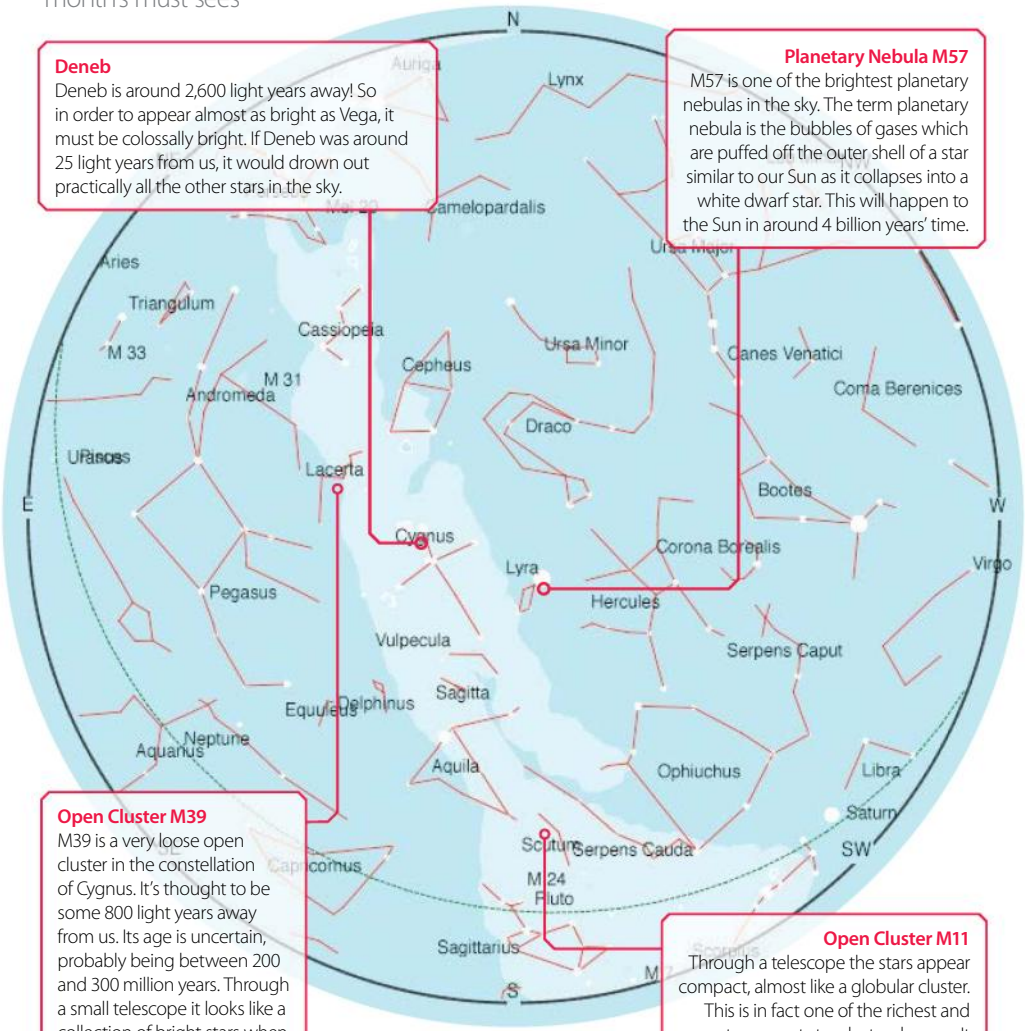
Globular Cluster NGC 362
Another globular cluster to view this month is NGC 362. This conglomeration of stars is often overlooked. You can find it south of 47 Tuc, it sits on the border of the Small Magellanic Cloud.

Open Cluster M7
You can find it near the 'stinger' in the tail of Scorpius the Scorpion. It contains around 80 stars in the group and spans a field of view of 1.3 degrees. M7 is around 980 light years away. It is thought to be about 200 million years old.

SOUTHERN HEMISPHERE

July

The height of summer offers some fantastic night-sky sights. Here are some of the month's must-sees



Deneb
Deneb is around 2,600 light years away! So in order to appear almost as bright as Vega, it must be colossally bright. If Deneb was around 25 light years from us, it would drown out practically all the other stars in the sky.

Planetary Nebula M57
M57 is one of the brightest planetary nebulas in the sky. The term planetary nebula is the bubbles of gases which are puffed off the outer shell of a star similar to our Sun as it collapses into a white dwarf star. This will happen to the Sun in around 4 billion years' time.

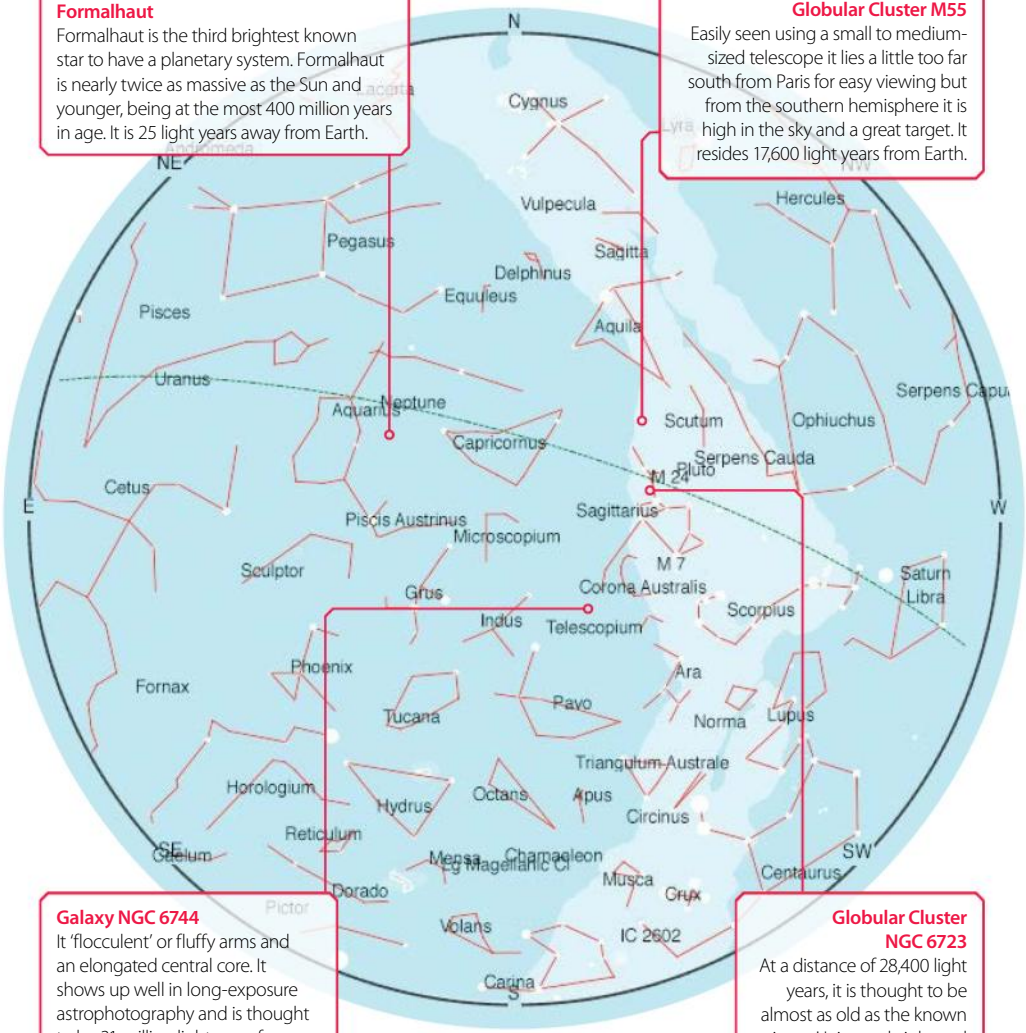
Open Cluster M39
M39 is a very loose open cluster in the constellation of Cygnus. It's thought to be some 800 light years away from us. Its age is uncertain, probably being between 200 and 300 million years. Through a small telescope it looks like a collection of bright stars when observed in the field of view of a low-power eyepiece.

Open Cluster M11
Through a telescope the stars appear compact, almost like a globular cluster. This is in fact one of the richest and most compact star clusters known. It contains approximately 2,900 stars and is thought to be 220 million years old.

NORTHERN HEMISPHERE

Formalhaut
Formalhaut is the third brightest known star to have a planetary system. Formalhaut is nearly twice as massive as the Sun and younger, being at the most 400 million years in age. It is 25 light years away from Earth.

Globular Cluster M55
Easily seen using a small to medium-sized telescope it lies a little too far south from Paris for easy viewing but from the southern hemisphere it is high in the sky and a great target. It resides 17,600 light years from Earth.



Galaxy NGC 6744
It 'flocculent' or fluffy arms and an elongated central core. It shows up well in long-exposure astrophotography and is thought to be 31 million light years from us. Difficult to spot in small telescopes, due to its low surface brightness.

Globular Cluster NGC 6723
At a distance of 28,400 light years, it is thought to be almost as old as the known universe! It is very bright and looks bes through a small to medium-sized telescope.

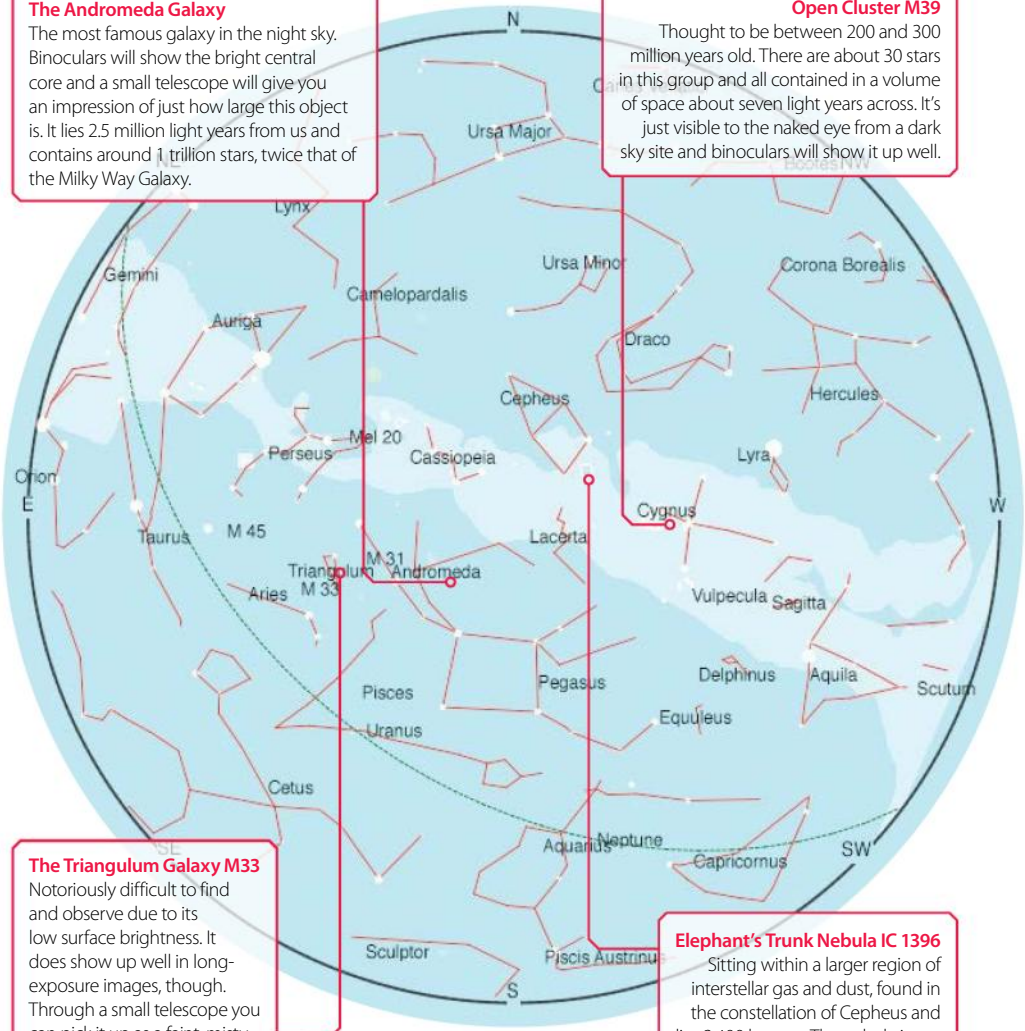
SOUTHERN HEMISPHERE

August-September

Late summer/autumn night skies are full of riches and wonders…

The Andromeda Galaxy
The most famous galaxy in the night sky. Binoculars will show the bright central core and a small telescope will give you an impression of just how large this object is. It lies 2.5 million light years from us and contains around 1 trillion stars, twice that of the Milky Way Galaxy.

Open Cluster M39
Thought to be between 200 and 300 million years old. There are about 30 stars in this group and all contained in a volume of space about seven light years across. It's just visible to the naked eye from a dark sky site and binoculars will show it up well.



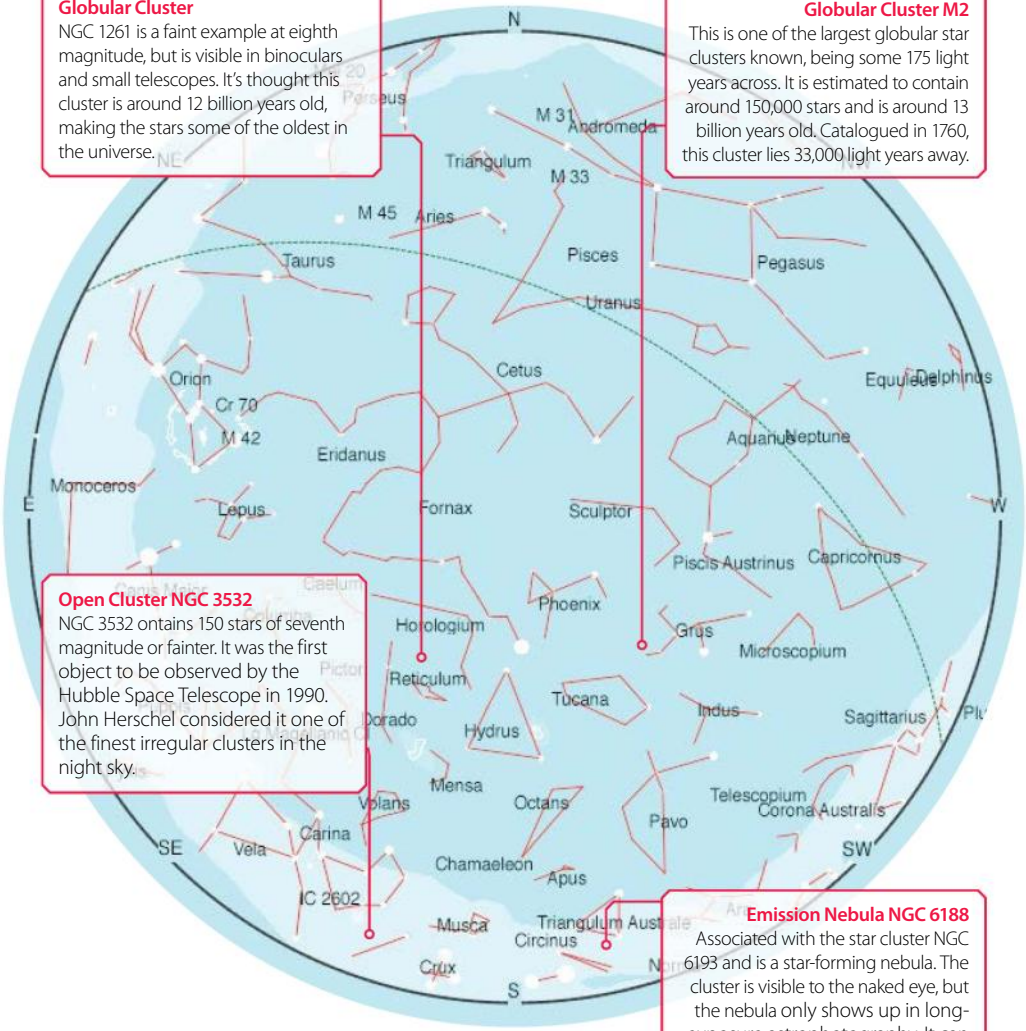
The Triangulum Galaxy M33
Notoriously difficult to find and observe due to its low surface brightness. It does show up well in long-exposure images, though. Through a small telescope you can pick it up as a faint, misty patch of light. It lies about three million light years away.

Elephant's Trunk Nebula IC 1396
Sitting within a larger region of interstellar gas and dust, found in the constellation of Cepheus and lies 2,400 ly away. The nebula is not visible to the naked eye, but shows up well in long-exposure images.

NORTHERN HEMISPHERE

Globular Cluster
NGC 1261 is a faint example at eighth magnitude, but is visible in binoculars and small telescopes. It's thought this cluster is around 12 billion years old, making the stars some of the oldest in the universe.

Globular Cluster M2
This is one of the largest globular star clusters known, being some 175 light years across. It is estimated to contain around 150,000 stars and is around 13 billion years old. Catalogued in 1760, this cluster lies 33,000 light years away.



Open Cluster NGC 3532
NGC 3532 ontains 150 stars of seventh magnitude or fainter. It was the first object to be observed by the Hubble Space Telescope in 1990. John Herschel considered it one of the finest irregular clusters in the night sky.

Emission Nebula NGC 6188
Associated with the star cluster NGC 6193 and is a star-forming nebula. The cluster is visible to the naked eye, but the nebula only shows up in long-exposure astrophotography. It can be found 4,000 light years away from Earth.

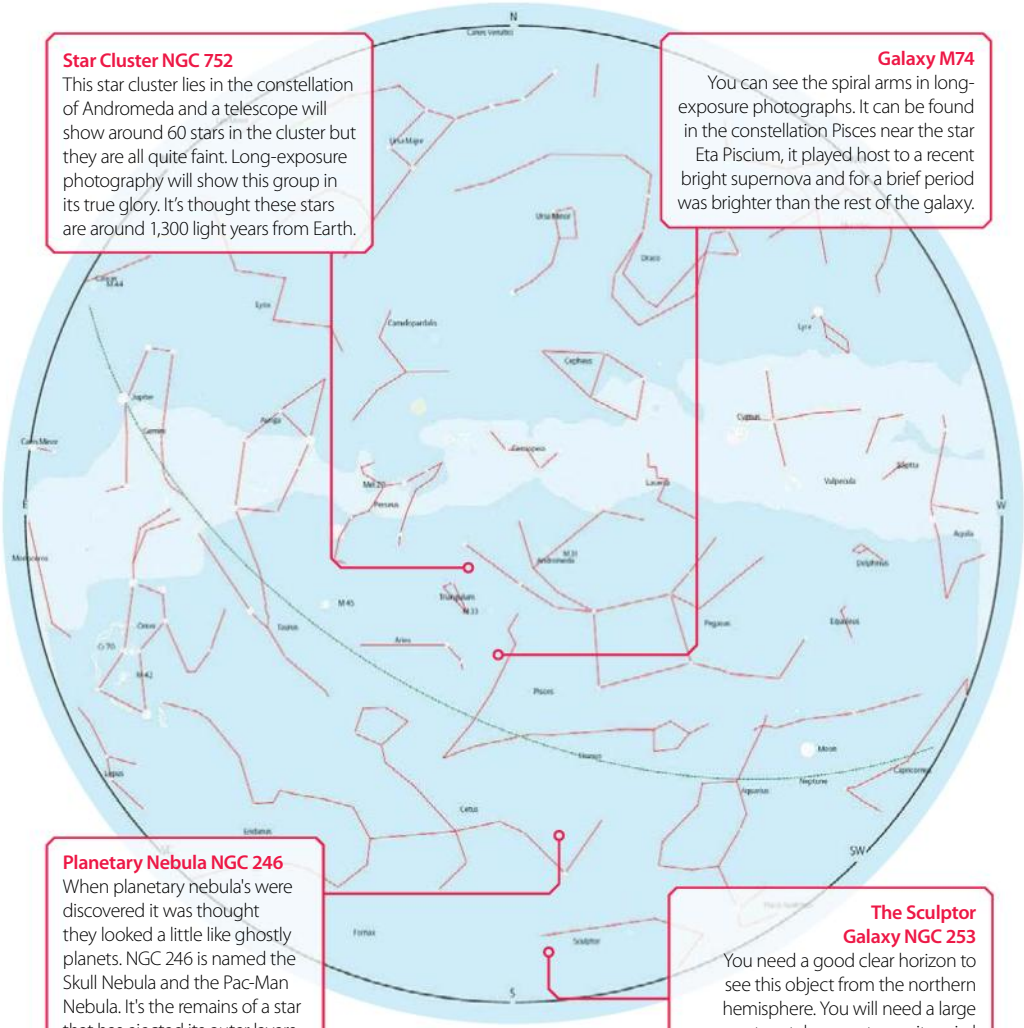
SOUTHERN HEMISPHERE

September-October

The skies are darker for longer, so there's more time to view those deep-sky objects…

Star Cluster NGC 752
This star cluster lies in the constellation of Andromeda and a telescope will show around 60 stars in the cluster but they are all quite faint. Long-exposure photography will show this group in its true glory. It's thought these stars are around 1,300 light years from Earth.

Galaxy M74
You can see the spiral arms in long-exposure photographs. It can be found in the constellation Pisces near the star Eta Piscium, it played host to a recent bright supernova and for a brief period was brighter than the rest of the galaxy.



NORTHERN HEMISPHERE

Planetary Nebula NGC 246
When planetary nebula's were discovered it was thought they looked a little like ghostly planets. NGC 246 is named the Skull Nebula and the Pac-Man Nebula. It's the remains of a star that has ejected its outer layers of gas, forming a bubble around it and is expanding into space.

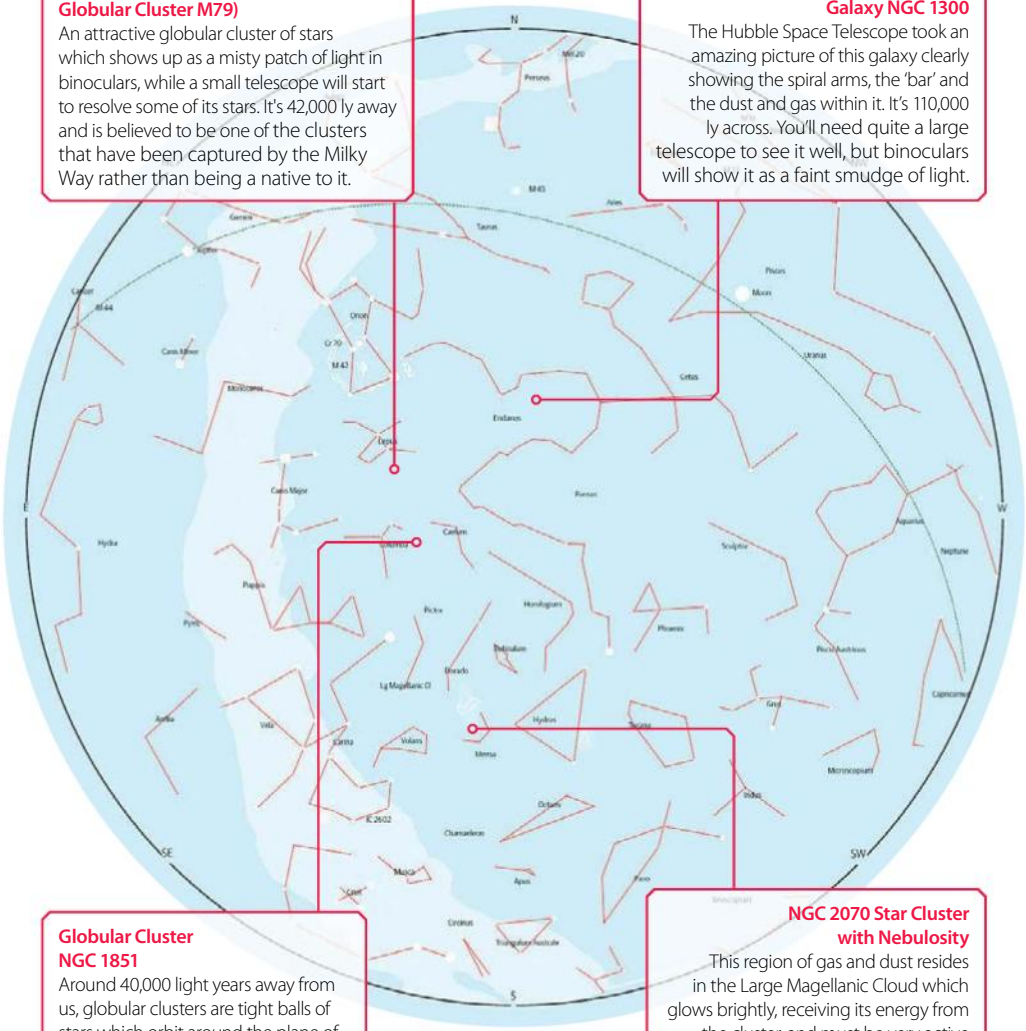
The Sculptor Galaxy NGC 253
You need a good clear horizon to see this object from the northern hemisphere. You will need a large aperture telescope to see its spiral structure, but it shows up well in long-exposure photographs.

GALAXY NGC 1300

NGC 2070 STAR CLUSTER WITH NEBULOSITY

Globular Cluster M79)
An attractive globular cluster of stars which shows up as a misty patch of light in binoculars, while a small telescope will start to resolve some of its stars. It's 42,000 ly away and is believed to be one of the clusters that have been captured by the Milky Way rather than being a native to it.

Galaxy NGC 1300
The Hubble Space Telescope took an amazing picture of this galaxy clearly showing the spiral arms, the 'bar' and the dust and gas within it. It's 110,000 ly across. You'll need quite a large telescope to see it well, but binoculars will show it as a faint smudge of light.



Globular Cluster NGC 1851
Around 40,000 light years away from us, globular clusters are tight balls of stars which orbit around the plane of our galaxy, the Milky Way. Found in the constellation of Columba.

NGC 2070 Star Cluster with Nebulosity
This region of gas and dust resides in the Large Magellanic Cloud which glows brightly, receiving its energy from the cluster, and must be very active because it is easily visible despite lying around 160,000 light years away from us.

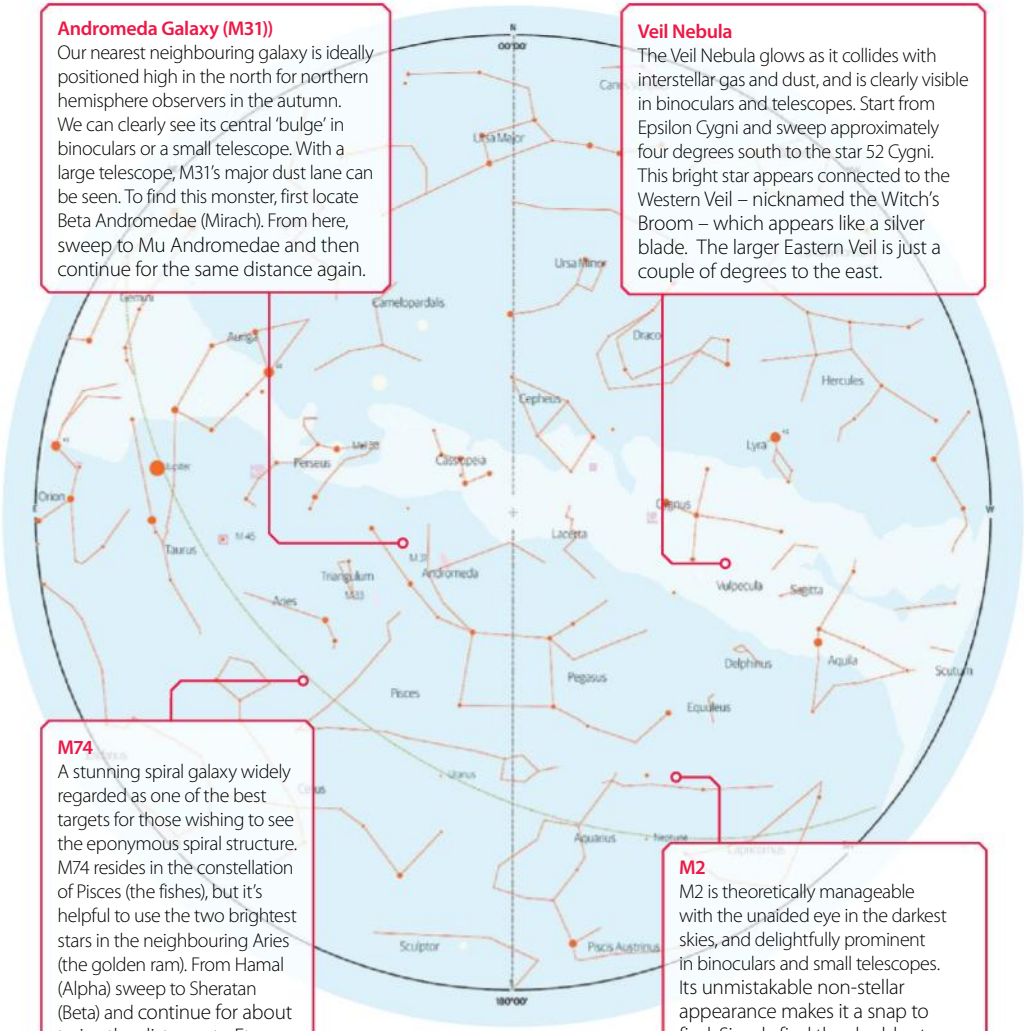
SOUTHERN HEMISPHERE

October-November

Here are eight of the best for you to discover for yourself

Andromeda Galaxy (M31))
Our nearest neighbouring galaxy is ideally positioned high in the north for northern hemisphere observers in the autumn. We can clearly see its central 'bulge' in binoculars or a small telescope. With a large telescope, M31's major dust lane can be seen. To find this monster, first locate Beta Andromedae (Mirach). From here, sweep to Mu Andromedae and then continue for the same distance again.

Veil Nebula
The Veil Nebula glows as it collides with interstellar gas and dust, and is clearly visible in binoculars and telescopes. Start from Epsilon Cygni and sweep approximately four degrees south to the star 52 Cygni. This bright star appears connected to the Western Veil – nicknamed the Witch's Broom – which appears like a silver blade. The larger Eastern Veil is just a couple of degrees to the east.



M74
A stunning spiral galaxy widely regarded as one of the best targets for those wishing to see the eponymous spiral structure. M74 resides in the constellation of Pisces (the fishes), but it's helpful to use the two brightest stars in the neighbouring Aries (the golden ram). From Hamal (Alpha) sweep to Sheratan (Beta) and continue for about twice the distance to Eta Piscium. M74 lies about one degree south of this line.

M2
M2 is theoretically manageable with the unaided eye in the darkest skies, and delightfully prominent in binoculars and small telescopes. Its unmistakable non-stellar appearance makes it a snap to find. Simply find the double star Beta Aquarii and from here sweep about five degrees northward.

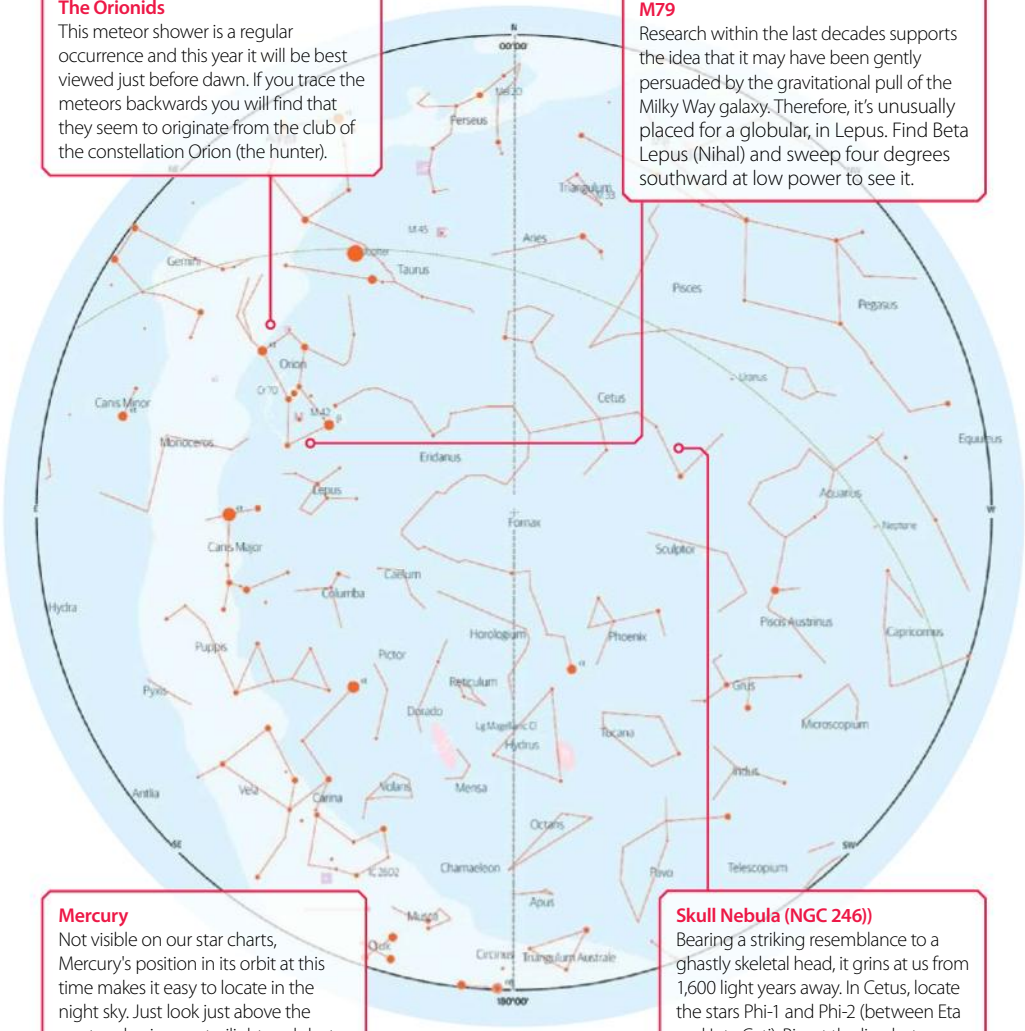
NORTHERN HEMISPHERE


VEIL NEBULA


M74

The Orionids
This meteor shower is a regular occurrence and this year it will be best viewed just before dawn. If you trace the meteors backwards you will find that they seem to originate from the club of the constellation Orion (the hunter).

M79
Research within the last decades supports the idea that it may have been gently persuaded by the gravitational pull of the Milky Way galaxy. Therefore, it's unusually placed for a globular, in Lepus. Find Beta Lepus (Nihal) and sweep four degrees southward at low power to see it.



Mercury
Not visible on our star charts, Mercury's position in its orbit at this time makes it easy to locate in the night sky. Just look just above the western horizon as twilight ends but bear in mind that to the unaided eye that Mercury looks just like a star.

SOUTHERN HEMISPHERE

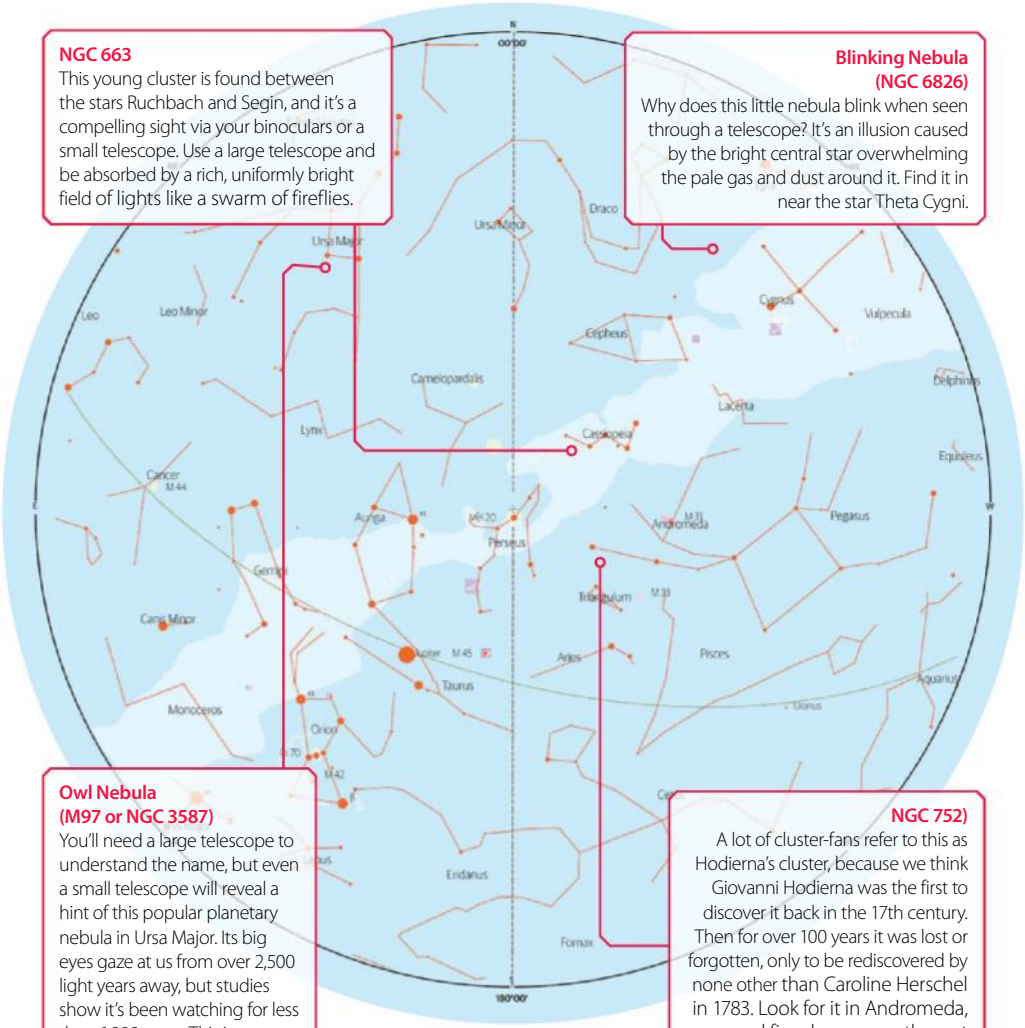
Skull Nebula (NGC 246))
Bearing a striking resemblance to a ghastly skeletal head, it grins at us from 1,600 light years away. In Cetus, locate the stars Phi-1 and Phi-2 (between Eta and Iota Ceti). Bisect the line between them, and from the centre sweep directly south about one degree.

November-December

Whether you're using the naked eye, binoculars or a telescope, there's plenty to see. Here are some of the season's highlights...

NGC 663
This young cluster is found between the stars Ruchbach and Segin, and it's a compelling sight via your binoculars or a small telescope. Use a large telescope and be absorbed by a rich, uniformly bright field of lights like a swarm of fireflies.

Blinking Nebula (NGC 6826)
Why does this little nebula blink when seen through a telescope? It's an illusion caused by the bright central star overwhelming the pale gas and dust around it. Find it in near the star Theta Cygni.



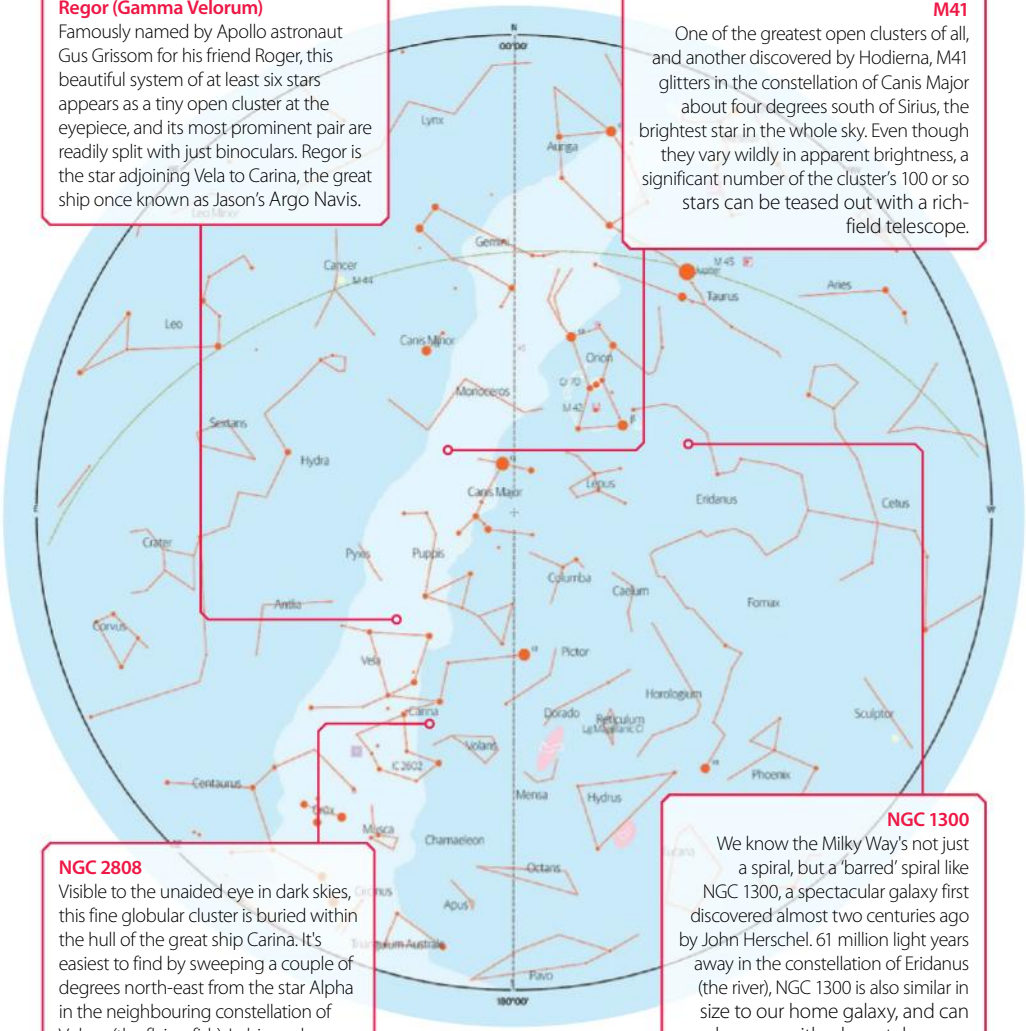
NORTHERN HEMISPHERE

Owl Nebula (M97 or NGC 3587)
You'll need a large telescope to understand the name, but even a small telescope will reveal a hint of this popular planetary nebula in Ursa Major. Its big eyes gaze at us from over 2,500 light years away, but studies show it's been watching for less than 6,000 years. This is a young nebula. It sits within a couple of degrees from Merak.

NGC 752)
A lot of cluster-fans refer to this as Hodierna's cluster, because we think Giovanni Hodierna was the first to discover it back in the 17th century. Then for over 100 years it was lost or forgotten, only to be rediscovered by none other than Caroline Herschel in 1783. Look for it in Andromeda, around five degrees south-west of the star Almaak in the direction of Triangulum.

Regor (Gamma Velorum)
Famously named by Apollo astronaut Gus Grissom for his friend Roger, this beautiful system of at least six stars appears as a tiny open cluster at the eyepiece, and its most prominent pair are readily split with just binoculars. Regor is the star adjoining Vela to Carina, the great ship once known as Jason's Argo Navis.

M41
One of the greatest open clusters of all, and another discovered by Hodierna, M41 glitters in the constellation of Canis Major about four degrees south of Sirius, the brightest star in the whole sky. Even though they vary wildly in apparent brightness, a significant number of the cluster's 100 or so stars can be teased out with a rich-field telescope.



NGC 2808
Visible to the unaided eye in dark skies, this fine globular cluster is buried within the hull of the great ship Carina. It's easiest to find by sweeping a couple of degrees north-east from the star Alpha in the neighbouring constellation of Volans (the flying fish). In binoculars or a telescope, some of its 1 million stars can be individually resolved.

NGC 1300
We know the Milky Way's not just a spiral, but a 'barred' spiral like NGC 1300, a spectacular galaxy first discovered almost two centuries ago by John Herschel. 61 million light years away in the constellation of Eridanus (the river), NGC 1300 is also similar in size to our home galaxy, and can be seen with a large telescope. Look just over two degrees north of 16 Eridani.

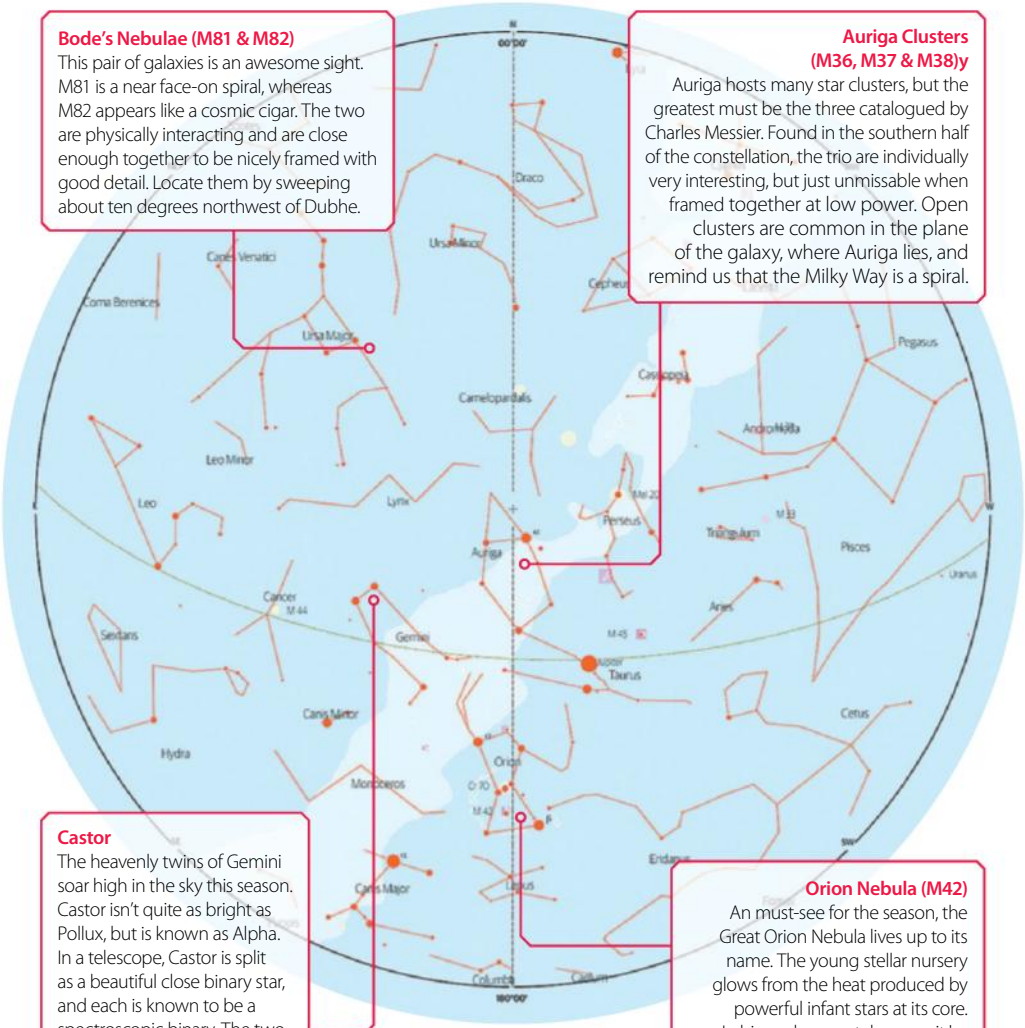
SOUTHERN HEMISPHERE

December

As the year comes to an end, many of us will celebrate another year of accomplishments. Why not celebrate the wonder of the sky, too?

Bode's Nebulae (M81 & M82)
This pair of galaxies is an awesome sight. M81 is a near face-on spiral, whereas M82 appears like a cosmic cigar. The two are physically interacting and are close enough together to be nicely framed with good detail. Locate them by sweeping about ten degrees northwest of Dubhe.

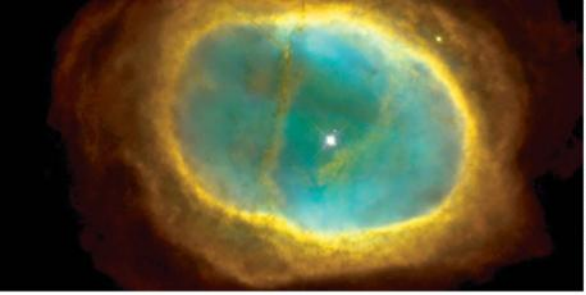
Auriga Clusters (M36, M37 & M38)y
Auriga hosts many star clusters, but the greatest must be the three catalogued by Charles Messier. Found in the southern half of the constellation, the trio are individually very interesting, but just unmissable when framed together at low power. Open clusters are common in the plane of the galaxy, where Auriga lies, and remind us that the Milky Way is a spiral.



Castor
The heavenly twins of Gemini soar high in the sky this season. Castor isn't quite as bright as Pollux, but is known as Alpha. In a telescope, Castor is split as a beautiful close binary star, and each is known to be a spectroscopic binary. The two visible stars orbit each other about once every 470 years.

Orion Nebula (M42)
An must-see for the season, the Great Orion Nebula lives up to its name. The young stellar nursery glows from the heat produced by powerful infant stars at its core. In binoculars or a telescope, it 'sa distinct 'bow' shape, and can be found in the middle of Orion's sword.

NORTHERN HEMISPHERE

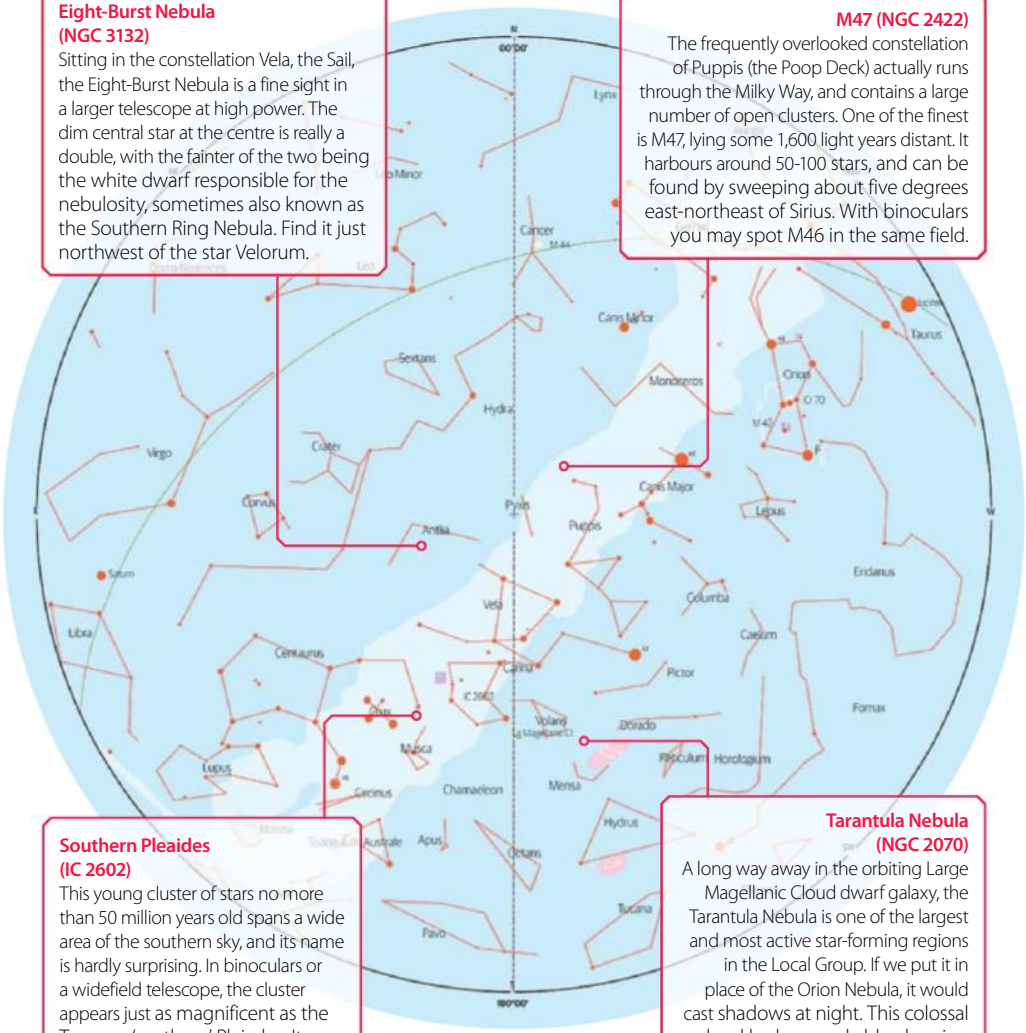


Eight-Burst Nebula (NGC 3132)

Sitting in the constellation Vela, the Sail, the Eight-Burst Nebula is a fine sight in a larger telescope at high power. The dim central star at the centre is really a double, with the fainter of the two being the white dwarf responsible for the nebulosity, sometimes also known as the Southern Ring Nebula. Find it just northwest of the star Velorum.

M47 (NGC 2422)

The frequently overlooked constellation of Puppis (the Poop Deck) actually runs through the Milky Way, and contains a large number of open clusters. One of the finest is M47, lying some 1,600 light years distant. It harbours around 50-100 stars, and can be found by sweeping about five degrees east-northeast of Sirius. With binoculars you may spot M46 in the same field.



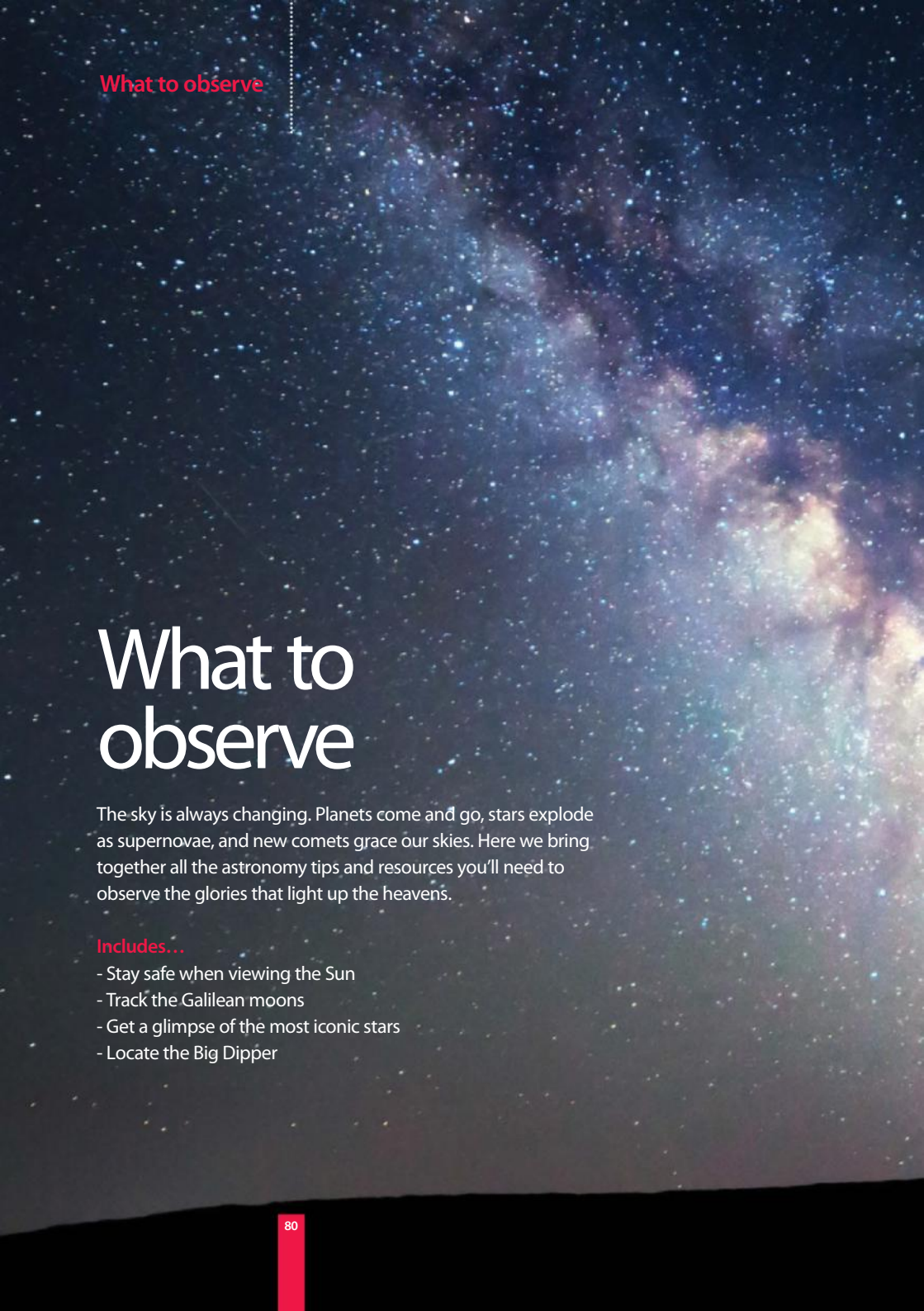
Southern Pleaides (IC 2602)

This young cluster of stars no more than 50 million years old spans a wide area of the southern sky, and its name is hardly surprising. In binoculars or a widefield telescope, the cluster appears just as magnificent as the Taurean, 'northern' Pleiades. It can be seen with the unaided eye, and found by locating Theta Carinae.

SOUTHERN HEMISPHERE

Tarantula Nebula (NGC 2070)

A long way away in the orbiting Large Magellanic Cloud dwarf galaxy, the Tarantula Nebula is one of the largest and most active star-forming regions in the Local Group. If we put it in place of the Orion Nebula, it would cast shadows at night. This colossal cloud looks remarkable, showing plenty of detail and structure. Try finding it with the unaided eye!



What to observe

The sky is always changing. Planets come and go, stars explode as supernovae, and new comets grace our skies. Here we bring together all the astronomy tips and resources you'll need to observe the glories that light up the heavens.

Includes…

- Stay safe when viewing the Sun
- Track the Galilean moons
- Get a glimpse of the most iconic stars
- Locate the Big Dipper

Discover how to view the Moon

Find out how to get the best out of your views of the Moon whether using your eyes, binoculars or a telescope…

The Moon is an object with which we are all familiar; however there are ways to observe it that will make your time spent looking at it more worthwhile.

The starting point for the cycle of the Moon's phases is when it's 'new'. It's fun to try to see the Moon when it is only a few hours old, just after the Sun has set below the horizon. Once the Moon is one day old it is easier to see and over the next few evenings you'll notice another phenomenon called 'Earthshine'. If you've got binoculars or a small telescope turn them on to the Moon and notice darker and lighter areas and you will see some craters.

As the Moon phase increases you will be able to see more of the surface and the so-called 'seas', properly termed Mare, stand out as darker regions of the surface. Run your gaze around the edge of the Moon and you'll spot it isn't smooth but broken up with the jagged edges of mountains. Take a look at the terminator line, this is where you can see the longest shadows and some of the most interesting lighting effects. Crater walls cast long shadows where peaks can catch the sunlight.

01: Align your finderscope

Make sure the finderscope on your telescope is aligned with the main scope. This will help you more easily find the Moon in the eyepiece and also 'zero in' on interesting parts of the surface.

02: Improve your disc viewing

Use a low-power eyepiece to start with for your observations. This will help you see the whole disc and orientate yourself with the view. You can increase the magnification later.

03: Reduce glare

A Moon filter is really helpful to dim down the brightness of the Moon, especially when it is near 'full'. This is a grey (neutral density) filter which screws into the telescope's eyepiece.

04: Use your motor drive

If your telescope has a motor drive, make sure to remember that you have it switched on. The Moon will appear to move swiftly across the field of view and especially at higher magnifications.

05: Find the terminator

Direct your scope on to the 'terminator', the line dividing the light and dark areas of the Moon. This is the most interesting place to look. Look out for sunlight catching crater rims and mountains.

06: Locate the lunar highlands

Another very interesting area to explore with your telescope is the 'highlands', especially in the northern and southern regions, as they show up well due to shadows, even near full Moon.

Learn to view the Sun

By looking at the Sun, our nearest star, you can see amazing processes going on all the time, but remember, you need to be very, very careful…

Safety first!

The Sun is incredibly bright and can easily damage a human eye if you were to look directly at it and will certainly destroy your eyesight if concentrated through binoculars, telescope or even a camera lens even for an instant. Only use proper solar filters to view the Sun and then only in strict accordance with the manufacturer's instructions.

If you are in the slightest bit doubtful about what you are doing, then don't do it. If you are careful and follow these guidelines, observing the Sun is fascinating.

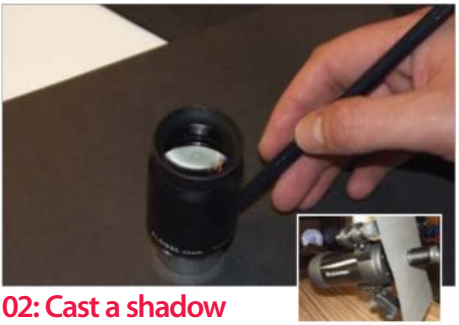
The safest way to see the surface of the Sun is to project the disc using a small telescope and two cardboard squares. You point the scope at the Sun by watching the shadow cast by the 'scope; when the shadow is smallest is when the telescope should be pointing in the right direction. Never attempt to look through the telescope!

You can get special solar filters to use with your telescope, which fit over the front aperture of your telescope, or a 'hydrogen-alpha filter', designed to block out dangerous radiation such as ultraviolet. Always check such filters before each and every use. If your telescope comes with a small filter for the eyepiece, do not use it! These are very dangerous as they can shatter in the heat thereby exposing your eye to the full force of the Sun's energy.

All in all, the Sun is an amazing, dynamic object and well worth your time as long as you make sure that you're extremely careful. After all, it's astronomy in the warm!

01: Get prepared

First of all you will need to get a sheet of white card or poster board on to which we are going to project the Sun's image.



02: Cast a shadow

You will also need another piece of card around the telescope tube to cast a shadow so you can see the projected image.

03: Beware of overheating

The best telescope to use to view the Sun is a small inexpensive refractor. However, beware of heat building up in the telescope tube.

04: Use a low-power eyepiece

Make sure that you are using a low power eyepiece in order to get the best results. Again, check regularly to make sure that it is not getting too hot.

05: Focus your telescope

You will need to focus the telescope so that you get a sharp, clear image of sunspots and other features on the Sun's surface.

06: Enjoy the results

The telescope will reflect light from the Sun on to your sheet of white card or poster board, giving you a fascinating and safe view of our star.

Observe the Milky Way

Discover the astronomical sights awaiting you in the galaxy we call home

Our galaxy is replete with iconic historical monuments, relatively young creations, and some quirky curiosities. Naturally we consider a handful of these to be the absolute best for observers and photographers, just as we do with the Colosseum, Forum and St Peter's in Rome, for which holidaymakers have plenty of information available to get clued up on before they travel.

There's an entire industry surrounding the research and sale of travel guides for Earth, but what if intergalactic tourism was viable? Suppose we astronomers could tour the universe and sample different skies. If travel-writers visited us from another galaxy, say the neighbouring Andromeda spiral, what might they pick for their absolute must-see objects? Unfortunately our perspective on the galaxy is limited, some of it is completely hidden from us but if we were Andromedans backpacking through the Solar System, these popular gems would most likely be on our bucket list… and we think they should be on yours too!

Orion Nebula (M42)

Equipment: Binoculars / telescope

This cosmic cloud of gas and dust is a majestic reminder of the ongoing process of star birth, as it surrounds a bright young stellar nursery 1,500 light years from Earth. The blazing infant stars have carved out an intricately decorated bowl with a very distinctive shape. Notable is the 'Trapezium' of four bright stars in the cluster.

Jewel Box Cluster (NGC 4755)

Equipment: Binoculars / telescope

"A casket of variously coloured precious stones," wrote John Herschel about this cluster. This object is unremarkable, but train a large aperture instrument on it and the colours of those 'stones' leap out of the eyepiece to produce a very fine sight, which Herschel likened to "a superb piece of fancy jewellery."

Omega Centauri (NGC 5139)

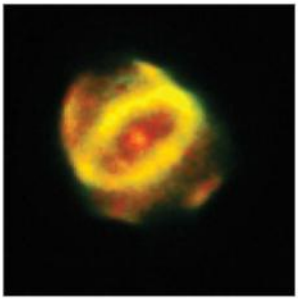
Equipment: Binoculars / telescope

It's not quite in the Milky Way, but this tightly bound swarm of millions of stars is the largest of its kind near the Milky Way, and it's an unforgettable sight – like an explosion of stars with many individually resolved.

Double Cluster (NGC 869 & NGC 884)

Equipment: Binoculars / telescope

These two clusters are beautifully framed and have a unique appearance. Each contain hundreds of young stars – just a few million years old! – and, they cruise the Milky Way together at a similar pace.



Ring Nebula (M57)

Equipment: Telescope

You'll need a telescope of at least 3" aperture and at least a low-medium magnification to resolve the ring shape. It's really just a cross-section of a rugby ball-shaped gas cloud gently shrugged off by a dying star not dissimilar to our Sun.

Veil Nebula

Equipment: Binoculars / telescope

Thousands of years ago, a big star exploded, scattering its atmospheric material into the galaxy. You'd never gauge the violence of this blast today when looking at the peaceful Veil Nebula it created.

Carina Nebula

Equipment: Binoculars / telescope

A sprawling complex of gaseous structures, containing one of the most striking stars in the galaxy: Eta Carinae. This unstable hypergiant is about four million times more luminous than the Sun!

NPleiades Star Cluster (M45)

Equipment: Naked eye / binoculars / telescope

Resembling a group of fireflies that are caught in a web, this thousand-strong, young star cluster has been admired since antiquity.

Viewing galaxies

Hundreds of billions of island universes drift through space and, with a little practice, you can see some from your garden

On the grandest of scales, these glowing lights form a delicate, web-like structure of wispy tendrils, punctuated with enormous cavities and, since they appear to permeate the universe as we know it, we suppose that the view would be equally serene from anywhere we could imagine. It's nice to know we're not missing out! The galaxies sing to us from the distant past. Their signals are not dissimilar, in the eyes of astronomers, to fossils as studied by the enthusiastic naturalist. Each individual galaxy we see is, from our perspective in space and time, a snapshot of the history of the universe, and some are so distant, they shine in our night sky tonight as they did not long after the Big Bang. Of course, at such immense distances, these are too faint for the amateur observer, but many more lay near enough to our Milky Way to be glimpsed – a small few even by the naked eye. However, a reasonable pair of binoculars, or a rich-field telescope, is certainly the best way to start. Here are some targets for the budding intergalactic voyager.

M87
Constellation: Virgo

How to find it:

M87 (sometimes denoted 'Virgo A') is nestled among the myriad galaxies of the Virgo Supercluster, about halfway between Denebola (Beta Leonis) and Vindemiatrix (Epsilon Virginis). It's slightly closer to the latter.

M31
Constellation: Andromeda

How to find it:

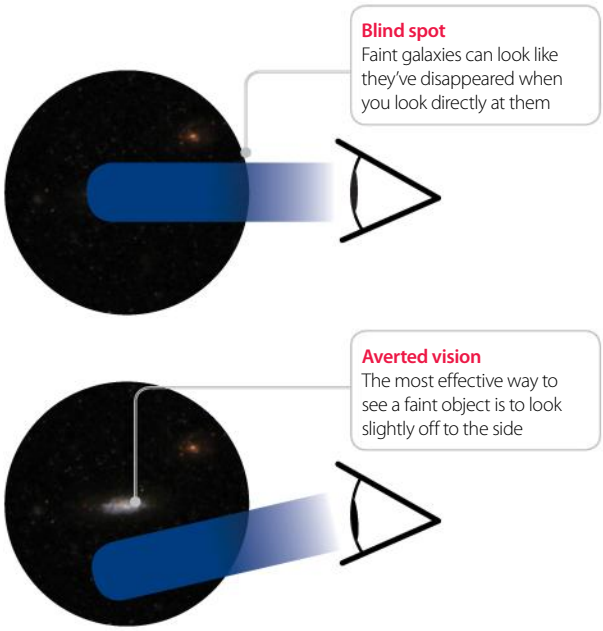
Find the star Mirach (Beta Andromedae) and from there sweep towards Mu Andromedae. Continue along this trajectory for almost the same distance again, and there you have the magnificent M31.

All space photos ©NASA

Peripheral vision

One of the best ways to get started is by allowing our eyes to become adapted to low illumination. When our pupils dilate, our eyes can harvest more of the incident light and the image appears brighter to us. Also, our colour vision virtually switches off as a more sensitive, monochromatic system begins to warm up. This second adaptation presents us with a problem, as each eye introduces a blind spot. However, with practice, you can teach yourself a new skill: 'averted vision'. By moving the blind spot off the object, you can use your peripheral vision to really 'see' what you're trying to see! Observers report best results when looking away from their own nose.

Observing something without looking directly at it is a fine art that requires patience and determination. With perseverance it'll become second nature to use averted vision to your advantage. You'll be amazed how often a friend will fail to see the galaxy you're trying to show them, while declaring that they're looking right where they should be! Well, now you know why.

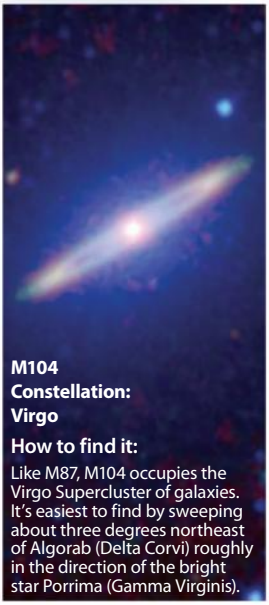


What to observe

M81 & M82
Constellation: Ursa Major

How to find it:

To locate this pair sweep from Phad (Gamma Ursae Majoris) to Dubhe (Alpha) and continue for the same distance again. M81 is the more conspicuous of the two, which are separated by less than one degree.



M104
Constellation: Virgo

How to find it:

Like M87, M104 occupies the Virgo Supercluster of galaxies. It's easiest to find by sweeping about three degrees northeast of Algorab (Delta Corvi) roughly in the direction of the bright star Porrima (Gamma Virginis).

■ You'll need the right conditions to get the most-impressive views of the planets

View planets through a telescope

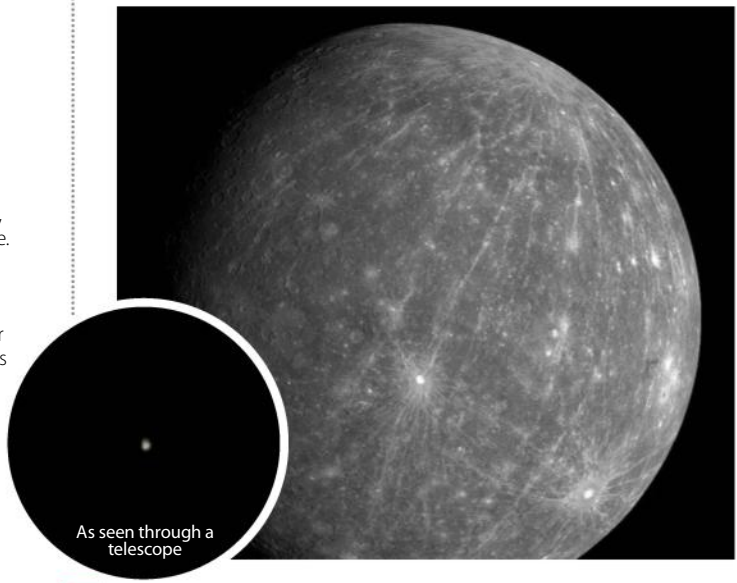
What do the planets of our galaxy look like through a telescope?

Would you like to see another world with your own eyes? These pictures will help to give you some idea of what to look for. To the eye, however, the view is quite different. Details are more subtle at the eyepiece, and your view depends which telescope you're using, and how favourable the atmospheric conditions are. Don't lose heart though, because to see the other planets – worlds as real as ours – with your own eyes, is an unforgettable experience.

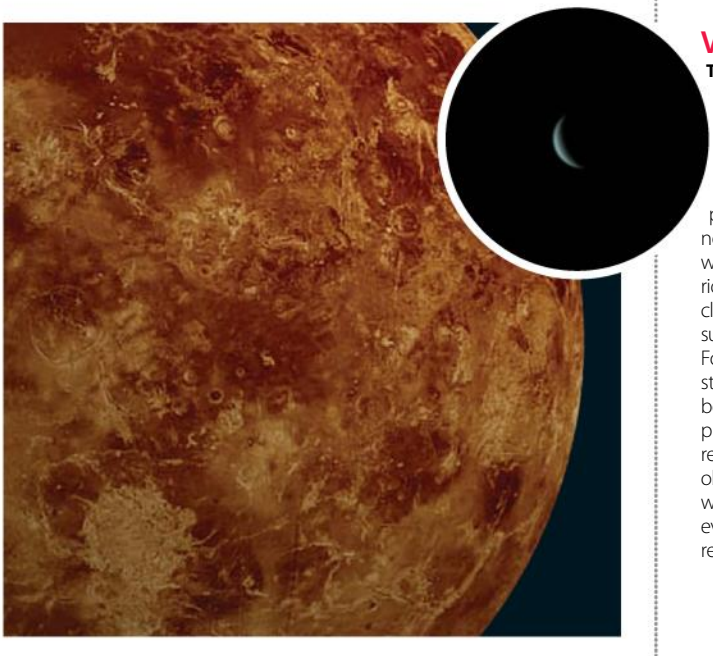
Mercury

Telescope: Astro-Physics Stowaway f5

In close-up, the smallest planet in our Solar System looks strikingly similar to the dark-side of our Moon, albeit almost twice as large. Unfortunately, we never get such a close-up from Earth, but large aperture instruments at high power will show Mercury's phases at the eyepiece. Make sure the Sun has set completely before trying to observe Mercury, as it will be obscured in its glare. It does rotate – however a Mercurian day lasts about 132 days!



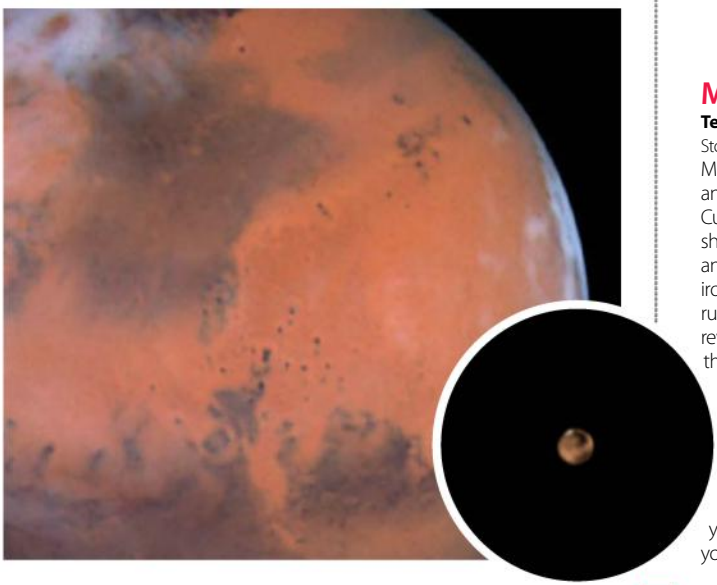
As seen through a telescope



Venus

Telescope: Astro-Physics Stowaway f5

Since the launch of the International Space Station, Venus is the third brightest object in the sky. Though peaceful in appearance, it is not the kind of place you'd want to go on holiday, with ridiculously high pressures, clouds of sulphuric acid, and a surface temperature of 735°K. Fortunately, we are able to stay at home and enjoy its beautiful set of 'moon-like' phases through a telescope, retracing the landmark observations of Galileo, which would provide strong evidence that the planets revolved around the Sun.



Mars

Telescope: Astro-Physics Stowaway f5

Mar is our closest neighbour and current home of Curiosity. The Red Planet shows a striking colour in any instrument thanks to its iron-rich soil that has literally rusted. Larger apertures will reveal the subtle shades of the major surface features, such as the dark and rocky Syrtis Major Planum, and even small telescopes can bring out the brilliant ice-covered polar caps. Mars looks small, though, so you'll need steady skies, and you won't see Curiosity either.

Larger planet images ©NASA; Circled planet images ©Tom Kerss

Jupiter

Telescope: Astro-Physics Stowaway f5

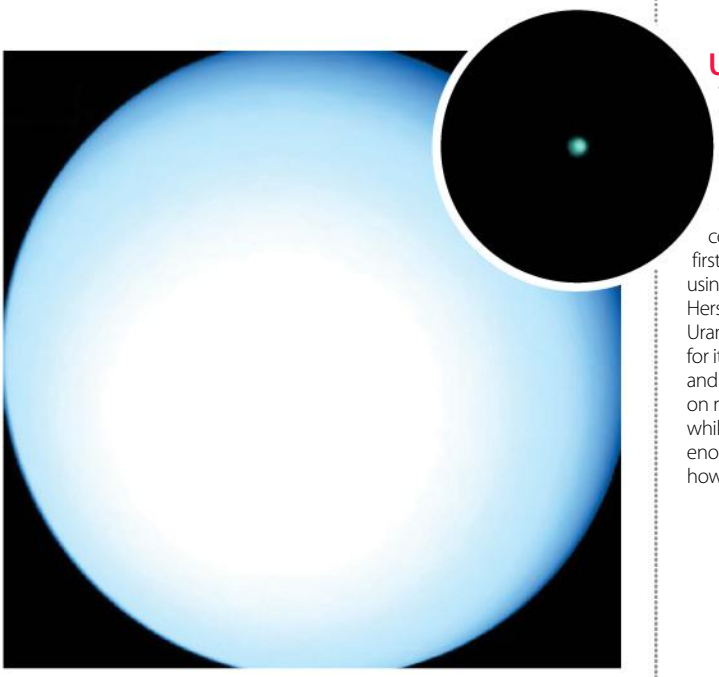
Jupiter is the largest planet in the Solar System, and despite being around 11 times wider than the Earth, it rotates once every ten hours! Hurricane winds craft intricate, swirling cloud formations in its upper atmosphere. You can see these different coloured layers of cloud that surround it through a reasonably powerful telescope, as well as the famous Red Spot super-hurricane. Also visible are the four stunning Galilean moons, Io, Europa, Ganymede, Callisto, each larger than our own Moon. Sadly, Jupiter's rings are too faint to observe though.

Saturn

Telescope: Celestron C6

With the naked eye, you can sometimes mistake Mars for Saturn. As almost everyone's favourite planet – the 'wow' factor of Saturn's gorgeous rings lights up the faces of many first-time planet-gazers. It's hardly surprising! The rings gradually tilt to and fro, periodically revealing the Cassini Division, a major gap. Saturn hosts many moons. The largest, Titan, is clearly visible in small telescopes. Some of the cloud layers will be a touch fuzzier than Jupiter's, as they are not as pronounced anyway.

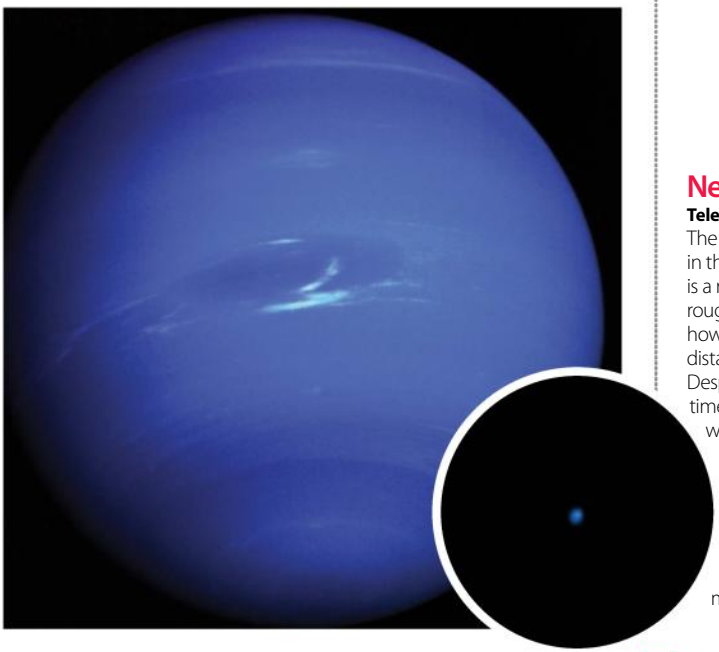
Larger planet images ©NASA; Circled planet images ©Tom Kerss



Uranus

Telescope: Meade LX200 12"

Uranus is one of the two planets in the solar system that are not visible to the naked eye. At first believed to be a star, and later a comet, Uranus became the first planet to be discovered using a telescope, with William Herschel taking the credit. Uranus is known to observers for its distinct greenish hue, and clouds have been spotted on rare occasions. Its moons, while large, are not nearly large enough to be easily noticed – however there are 27 of them.



Neptune

Telescope: Meade LX200 12"

The farthest outlying planet in the solar system, Neptune is a remote, cold world. It's roughly the same size as Uranus, however it's 50 per cent more distant than its light-blue cousin. Despite its size, almost four times wider than the Earth, it was not seen until 1846, and has only just completed one orbit since its discovery! It's great to see the gorgeous blue colour, while knowing you are looking over 4.2 billion kilometres (2.6 billion miles) away.

Viewing the Galilean moons

Named after their discoverer Galileo Galilei, the four moons which orbit around Jupiter are easily seen in binoculars and small telescopes

The moons of Jupiter are some of the most fascinating things to observe in the night sky. First recorded in 1610 by the Italian astronomer Galileo, the moons of Jupiter have proved to be an endless source of fascination for astronomers ever since. Jupiter has dozens of moons orbiting around it, but the four largest are the only ones visible using ground-based telescopes. Among the most interesting things to observe with respect to these moons are the ways they move almost on an hourly basis. They can change their position from two moons each side of the planet to all being in a row on just one side as well as various other combinations. Even more interesting are the occultations and transits. An occultation is where the moons pass behind the planet, so for a short time being obscured to us here on Earth, whereas when they pass in front of the disc of Jupiter, it is known as a transit.

Callisto

The third largest moon in the Solar System, Callisto is slightly smaller than Mercury. It's 'tidally locked' to Jupiter, and therefore it always presents the same face to the planet. It's made up from rock and ice and may even contain liquid water

Ganymede

Not only is Ganymede a moon of Jupiter, it is also the largest moon in the Solar System and is slightly larger than the planet Mercury! It also has the largest mass of any planetary satellite, being a little over twice the mass of our own Moon

Europa

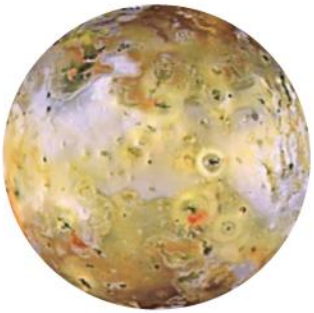
The smallest moon of Jupiter, Europa has a very tenuous oxygen atmosphere and it's thought that it may have an ocean of water under its surface ice. It is also thought that this ocean may possibly harbour extraterrestrial life

Jupiter

Jupiter was one of the first objects that Galileo viewed through his new telescope. When he saw the four moons travelling around Jupiter he realised the Earth could not be at the centre of the Solar System

Io

Io is the innermost of the four moons. It's being continually kneaded by Jupiter's gravitational pull and so has a molten core. It's the most geologically active object in the Solar System and has active volcanoes producing plumes of sulphur



Io

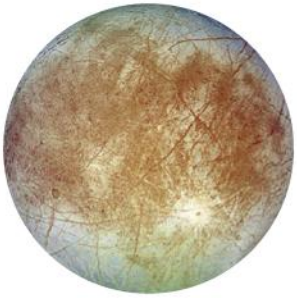
Diameter: 3,642km (2,263 miles)
Orbiting Jupiter every 1.8 days, it has over 400 active volcanoes which were only discovered during a flyby of Jupiter by the Voyager probes. Its surface is covered in sulphur and sulphur dioxide and is composed of silicate rock surrounding a molten iron core, the heat being produced by the gravitational effect of Jupiter.

Callisto

Diameter: 4,800km (2,985 miles)
Callisto is the second largest moon of Jupiter and the third largest in the Solar System. It is made up from equal amounts of rock and ice and we know that the surface is covered mostly in water ice, carbon dioxide and silicates with some organic compounds, although this isn't the same as having life.

Ganymede

Diameter: 5,268mm (3,273 miles)
Ganymede is the largest moon in the Solar System. With a molten iron core it has a magnetosphere. It also has a very thin atmosphere consisting mostly of oxygen. It's heavily cratered due to asteroid impacts, but mostly only on its darker regions, suggesting that the lighter areas are or have been renewed.



Europa

Diameter: 3,100km (1,900 miles)
Its icy surface seems to be scored with dark lines, but little cratering is evident, suggesting that there may be an ocean of liquid water under the surface, which could be warm enough to sustain life. Due to its potential habitability, Europa is now the focus of ideas for missions to explore its ocean in the search for life.

Which telescope?

In order to see them well, you'll need at least a three-inch aperture (75mm) refractor telescope or a six-inch (150mm) reflector. A reasonable magnification of around 120x or even more is also required, as is a good quality eyepiece. Here, the Plössl design of eyepiece is good as it provides a nice wide and flat field of view with minimal distortions. Longer focal length telescopes are better for planetary viewing, so this is where refracting telescopes also have an advantage, but again reflectors can also give you splendid views of the giant planet and its moons.

Spot 20 famous stars

Discover how to locate and view the 20 most famous stars in the sky, and for a lot you don't even need a telescope

There's a reason we consider our most celebrated performers to be 'stars'. Both brilliant and beautiful, the real stars have been revered since the dawn of humanity, often worshipped as avatars of the gods, or admired as tranquil windows to heaven. But there are celebrities in the sky, too. Some of the stars in the night sky have become so well known that they pervade popular culture, whether by their value for navigation, or their sheer brightness in the sky, and you can admire many of them without a telescope. Join us as we take a look at five of the biggest highlights of the night sky. From the fabulous red supergiant Betelgeuse, which can be found in the Orion constellation, to the brightest star in the sky, Sirius, which is situated in the Canis Major constellation; these are the stars among the stars. Get out there and track them down.

Polaris (Alpha Ursae Minoris)

Constellation: Ursa Minor (Little Bear)
Right ascension: 02h, 31m, 49s
Declination : +89 deg, 15′, 51″
Distance: ~430 ly

Many a nomad has found his way home thanks to the Polaris. It sits very close to the north celestial pole. Throughout the age of sail and the ensuing globalisation, Polaris was relied upon for navigation, and today aids astronomers in the northern hemisphere to correctly align their equatorial mounts for accurate tracking of the celestial sphere. Polaris is the most useful North Star in human history. It marks the tip of the tail of the Little Bear.

Sirius (Alpha Canis Majoris)

Constellation: Canis Major (Big Dog)
Right ascension: 06h, 45m, 09s
Declination: -16 deg, 42′, 58″
Distance: 8.6 ly

Scorching, searering, glowing – all words that spring to mind when we think of Sirius, the brightest star in the sky. Sirius is actually a binary star with a tiny white-dwarf companion. From northern temperate latitudes, Sirius often spends much of its apparition in the atmospheric soup, flashing almost every colour of the rainbow. It joins Procyon and Betelgeuse in the Winter Triangle asterism.

Vega (Alpha Lyrae)

Constellation: Lyra (Harp)
Right ascension: 18h, 36m, 56s
Declination: +38 deg, 47′, 01″
Distance: 25 ly

The fifth brightest star in the sky. Chosen as the benchmark by which astronomers would judge the brightness of all other objects in the night sky. It is an incredibly stable star.

Betelgeuse (Alpha Orionis)

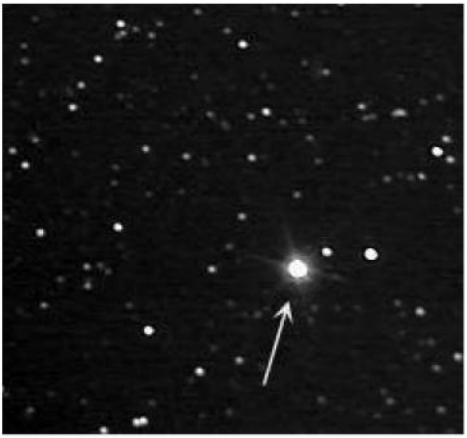
Constellation: Orion (Hunter)
Right ascension: 05h, 55m, 10s
Declination: +07 deg, 24′, 25″
Distance: ~700 ly

A huge red supergiant star nearing the end of its life, expected to die in a spectacular supernova explosion, which might happen within the next million years.

Rigel Kentaurus (Alpha Centauri)

Constellation: Centaurus (Centaur)
Right ascension: 14h, 39m, 36s
Declination: -60 deg, 50′, 02″
Distance: 4.3 ly

Alpha Centauri hosts two very Sun-like stars, of which one is now known to harbour an Earth-sized planet. Could it be that a habitable Earth-like world has co-habited our little corner of the Milky Way?



Barnard's Star

Constellation: Ophiucus
Right ascension: 17h, 57m, 48s
Declination: +04° 41′ 36″
Distance: 6 ly

The closest star to Earth after the Alpha Centauri system, and also a low mass red-dwarf. Although it is too dim to see with the naked eye, but fine to see with a telescope. It's also extremely bright in infrared compared to visible light.

Proxima Centauri

Constellation: Centaurus
Right ascension: 14h, 29m, 42s
Declination: -62° 40′ 46″
Distance: 4.2 ly

Proxima Centauri is the closest star to Earth other than the Sun. It's also a red dwarf, making it the closest red dwarf to Earth. It can only be seen through a telescope, although it undergoes random increases in brightness.

Antares

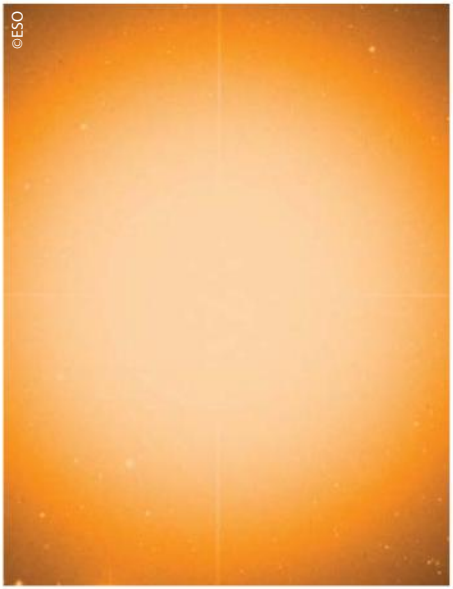
Constellation: Scorpius
Right ascension: 16h, 29m, 24s
Declination: -26° 25′ 55″
Distance: 550 ly

The brightest star in the Scorpius constellation, and a red supergiant star. It's one of the brightest stars in the night sky, and its apparent magnitude is just below +1. Even at such a great distance, it's much more visible than nearer red stars.

Procyon

Constellation: Canis Minor
Right ascension: 07h, 39m, 18s
Declination: +05° 13′ 30″
Distance: 11.5 ly

The brightest star in Canis Minor, and the eighth brightest star in the night sky. It's actually a binary star, and much like Sirius has a small white dwarf companion. It's part of the winter triangle comprised of Betelgeuse and Sirius.

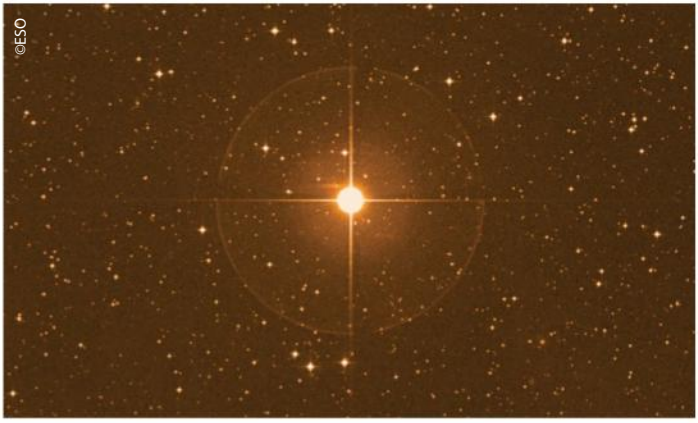


Arcturus

Constellation: Bootes
Right ascension: 14h, 15m, 39s
Declination: +19° 10′ 56″
Distance: ~36.7 ly
The brightest star in the northern celestial hemisphere, and very close to zero magnitude. Believed to have exhausted all its hydrogen and now fusing helium. It will likely end its life by becoming a white-dwarf inside of a nebula.

Canopus

Constellation: Carina
Right ascension: 06h, 23m, 57s
Declination: -52° 41′ 44″
Distance: ~310 ly
The brightest star in the Southern sky, and the second brightest star in the night sky. It's also a supergiant star, and looks very white to the naked eye. It's best seen in the southern hemisphere in the summer.



Sigma Octantis

Constellation: Octans
Right ascension: 21h, 08m, 46s
Declination: -88° 57′ 23″
Distance: 270 ly
If Polaris is considered the North Star, then Sigma Octanis is currently the closest thing we have to being the South Star. Its magnitude isn't particularly good though, so unfortunately it doesn't command the same prominence as Polaris does in the north.

Capella

Constellation: Auriga
Right ascension: 05h, 16m, 41s
Declination: +45° 59′ 52″
Distance: ~42.2 ly

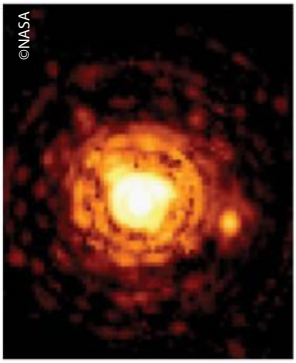
Capella is another bright northern star, although this one is special as it's not just one star, actually made up of four stars in two binary pairs. The first pair are giant stars with a radius ten times greater than the Sun's. The other two are red dwarfs.

"It's actually made up of four stars"

Altair

Constellation: Aquila
Right ascension: 19h, 50m, 46s
Declination: +08° 52′ 06″
Distance: ~16.7 ly

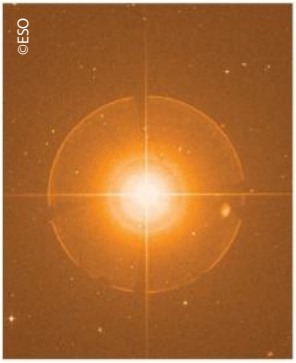
The name Altair comes from an Arabic phrase that means the flying eagle, very apt for a star in an eagle constellation. Altair actually spins incredibly fast, causing its poles to flatten due to this, making it non-spherical.



Kapteyn's Star

Constellation:
Right ascension: 05h, 11m, 40s
Declination: -45° 01′ 06″
Distance: ~12.8 ly

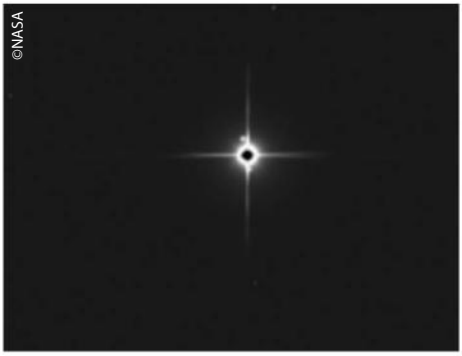
Named after noted Dutch astronomer Jacobus Kapteyn, who discovered galactic rotation. It's a red dwarf star that was named after him when he noticed that it had a very high proper motion, moving across the sky noticeably every year.



Tau Ceti

Constellation: Cetus
Right ascension: 01h, 44m, 04s
Declination: -15° 56′ 14″
Distance: 11.9 ly

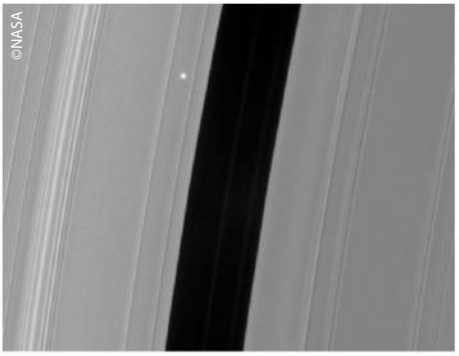
It's the nearest solitary star like our Sun. Originally believed there were no planets orbiting it, evidence now suggests that there are five planets in the system, and one possibly being habitable. Are we catching a glimpse of our first exosolar colony?



Pollux

Constellation: Gemini
Right ascension: 07h, 45m, 18s
Declination: +28° 01′ 34″
Distance: ~33.8 ly

Pollux is an evolved giant star, with a distinct orange hue, and is the brightest star in the Gemini constellation. This star is important as its spectrum is used as a reference to classify other stars. It has an exosolar planet orbiting it.



Aldebaran

Constellation: Taurus
Right ascension: 04h, 35m, 55s
Declination: +16° 30′ 33″
Distance: ~65 ly

Another red giant star, and the brightest star in the Taurus constellation. Its name means the follower, as it seems to follow the Pleiades in the night sky. It has about 44 times the radius of our Sun, but isn't even quite twice as heavy.

Rigel

Constellation: Orion
Right ascension: 05h, 14m, 32s
Declination: -08° 12′ 06″
Distance: ~860 ly

Made famous by Star Trek, Rigel is a blue-white supergiant star and the brightest star in Orion. It's almost 20 times heavier than our Sun, and has 74 times the radius. Even at such a vast distance from Earth, it outshines smaller, much closer stars.

Alnilam

Constellation: Orion
Right ascension: 05h, 36m, 12s
Declination: -01° 12′ 06″
Distance: ~1300 ly

The brightest star in Orion's Belt is a blue supergiant. It's the middle star of the trio, along with Alnitak and Mintaka. It is one of the 57 stars used in celestial navigation, and is another star whose spectrum is used as a reference for others.

Seeing double stars

It's a little known fact that around 50 per cent of all the stars in the night sky are double or multiple stars…

Double stars can either be stars which look very close to each other due to a line of sight effect for us here on Earth, or they can actually be bound to each other through gravitation – in other words, they orbit around their common centre of gravity. These are arguably the most interesting as their position relative to each other can change over time.

There are a couple of 'naked eye' double stars we can see from Earth, but for most you will need a telescope. The rule of thumb here is that bigger is better, so the larger your telescope, the more double stars you are likely to be able to resolve as two distinct stars, otherwise known as 'splitting'. Some doubles are so close that, even with the largest telescopes on Earth, you can never discern them as individual stars. Sometimes the stars can look like a single egg-shaped star as they are apparently very close to each other. Others are relatively easy to split and often can be of differing brightness or colours. For close doubles, you'll need to use a fairly high magnification if you can, around 100x or so.

Mizar and Alcor

How to find it:

Mizar and Alcor make up the 'star' in the middle of the handle of the famous 'Plough' or Big Dipper asterism. Look closely and you will be able to see that it's actually two stars.

Winnecke 4

How to find it:

You will Winnecke 4 resting just above the star Megrez which connects the handle of the 'Dipper' to the 'Bowl'. It is approximately 510 light years from Earth.

Epsilon Lyrae

How to find it:

Epsilon Lyrae can be found close to the bright star Vega in the constellation of Lyra the Lyre. It can be viewed just above the 'square' of the main part of the constellation.

Almach

How to find it:

Almach is the left-hand star at the end of the 'Y' shape of the Andromeda constellation. You will find that It is best seen in the autumn months.

Albireo

How to find it:

Albireo is the star marking the head of Cygnus in the constellation of the Swan. Best seen in the summer when it rides high in the night sky.

Interacting stars

There are binary stars, two stars that orbit around their common centre of gravity, that can interact with each other physically. Through this interaction the stars will vary in brightness as the matter from the 'ordinary' star crashes on to the white dwarf causing it to flare up often at irregular intervals due to nuclear fusion reactions converting hydrogen to helium at a very fast rate. These stars have intense and complex magnetic fields surrounding them and often form the basis of 'novas', stars which will suddenly increase in brightness many hundredfold.

If the stars are big enough then such interactions can trigger a supernova explosion.

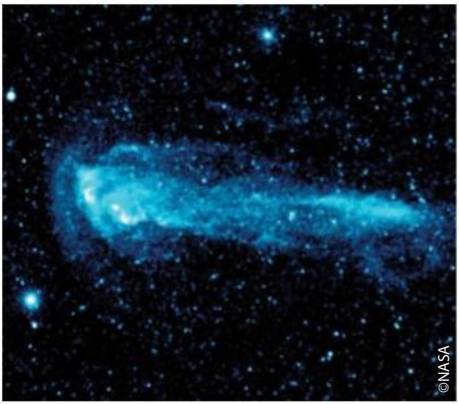
Observing variable stars

It's not very well known that more than half the stars in the night sky vary in brightness...

It is strange to think that so many stars vary in brightness, but most only vary by a small amount. Even our own Sun is a variable star over its 11-year cycle. As the number of sunspots increase and decrease so does the light output. However, there are some stars which actually have a huge change in brightness, going from a moderately bright star to only being detectable in medium to large telescopes.

What causes this odd behaviour? There are several reasons for this and there are also several types of variable star. Some stars actually vary in size, they pulsate like a balloon being filled with air and then let down again. Most well known of this type are the Cepheid variables. Variable stars can be put into two basic groups, short period and long period, with a third group of irregular and semi-regular variables, which have no pattern to the variation of their light output. One type of star in this category is the 'Mira Variable'. Another type of variable star is the 'Gamma Cassiopeiae' class, which fluctuate their light output due to it throwing off material around its equator because they rotate very quickly.

These are just a selection of the different types of stars whose apparent brightness as seen from Earth can vary. Observing variable stars is a fascinating and very popular area for those interested in stargazing.



Mira

How to find it:

Follow a line of stars from Aldebaran in Taurus into Cetus. A star chart will help you pin it down. It lies roughly midway between eta Eridanus and alpha Pisces.

Delta Cephei

How to find it:

Delta Cephei is actually relatively easy to find if you know where to look. You can find it at the lower easternmost corner of the constellation of Cepheus.

Algol

How to find it: Possibly the most famous out of all the eclipsing binary stars. Algol can be found by drawing an imaginary line between the star called Aldebaran in the Taurus constellation and the star called Shedir or alpha Cassiopeia. After you have done this then you will notice that Algol actually lies halfway along this line.

"As the number of sunspots increase and decrease, so does the Sun's light output"

Gamma Cassiopeiae

How to find it:

Just remember that Cassiopeia looks like a letter 'W' or 'M' in the night sky low down in the north during February, making it easy to spot. The middle star is 'gamma'.

Betelgeuse

How to find it:

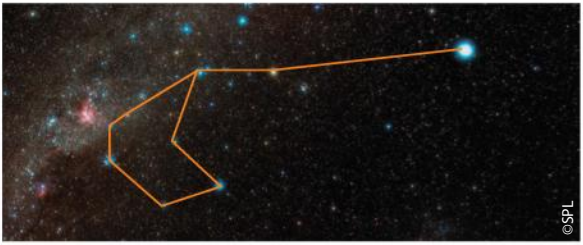
Orion is actually extremely easy to find, especially during the winter in the northern hemisphere. Betelgeuse is the star above and to the left of Orion's 'belt'.

Searching for constellations

Locate the constellations in the sky, and when's the best time to see them

In the past, every culture had its own way of seeing patterns in the stars. These patterns, or constellations, were connected with stories and folk legends. These patterns fall inside a defined box or area and divide up the whole of the night sky. Depending on where you live you may be able to see many but probably not all of them. In the northern hemisphere, for example, you probably won't be able to see constellations such as Octans the Octant or Pavo the Peacock.

You can use a whole constellation, part of it or even just a couple of known stars to point yourself to another, perhaps less familiar pattern. Some star patterns aren't constellations in the strict definition of the word and are known as asterisms, but are very useful. The Plough, or Big Dipper, in the Ursa Major constellation is an asterism which can be used to navigate to other constellations.



Carina

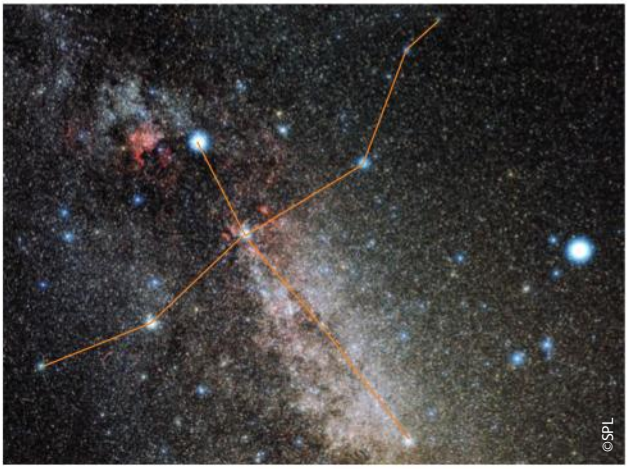
Southern hemisphere

January is the best time to view the constellation of Carina the Keel with its bright star Canopus high in the south. Nearby you'll find Puppis the Poop Deck and Vela the Sail, once part of this huge but now disassembled constellation. Canopus itself is the second brightest star in the night sky.

Centaurus

Southern hemisphere

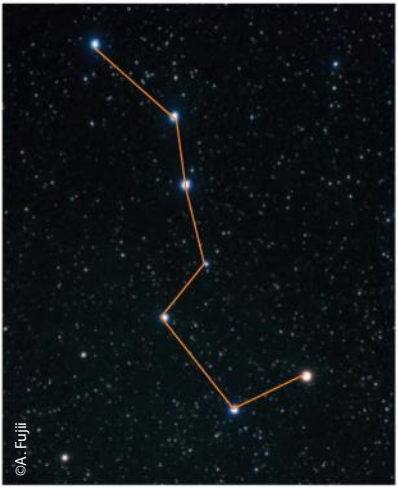
May is a great time of year to view the constellation of Centaurus the Centaur. It is quite a large constellation and contains many deep sky wonders such as Omega Centauri, the largest and brightest globular star cluster associated with our Milky Way galaxy. This constellation is also home to the star system of Alpha Centauri the closest star system to our own star the Sun, at just over four light years away.



Cygnus

Northern hemisphere

Sometimes known as the Northern Cross, Cygnus the Swan is a very ancient constellation with several stories attached to it. It rides high in the summer skies in the northern hemisphere and sitting as it does in the band of the Milky Way is full of star clusters and nebulas. The star Albireo, marking the head of the Swan, is a double star. You'll need a telescope to see this star as a pair, but it is worthwhile as it's one of the most beautiful doubles in the whole of the night sky, being a lovely contrasting orange and blue.



Ursa Major

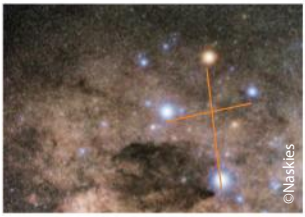
Northern hemisphere

Ursa Major is the constellation in which you can find the famous Plough or Big Dipper. The seven stars that make up this asterism are actually the brightest and most easily recognised out of the whole constellation and possibly out of the entire night sky. The second star in the handle of the Dipper is actually a naked eye double star. If you look closely you should be able to see that it actually consists of two stars that are very close together.

Orion

Northern hemisphere

Orion the Hunter is an easily recognised constellations thanks to the three stars of the Hunter's belt from which hangs his sword. The bright orange supergiant star Betelguese marks the Hunter's shoulder and the bright white star Rigel, in the opposite corner, his knee.



Crux

Southern hemisphere

You'll find the Southern Cross riding high in the south in June, the four stars describing a diamond or cross shape in the sky. The brightest star, Alpha Crucis or Acrux, marks the bottom of the cross and is 320 light years away from us. Crux lies in the band of the Milky Way and is surrounded by star clusters.

Viewing the Big Dipper

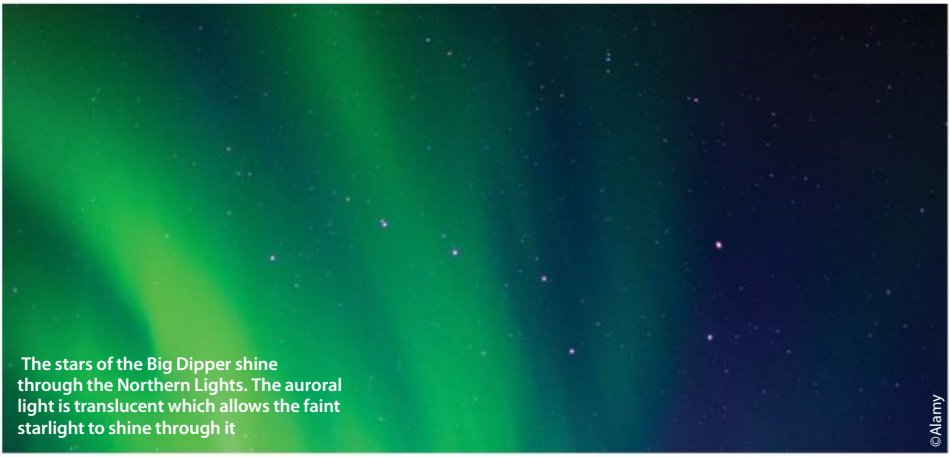
Let's take a closer look at one of the most easily recognisable patterns of stars in the northern hemisphere

The Big Dipper goes by several different names, including the 'Plough' and the 'Saucepan'. It is, though, very recognisable with its bowl-shaped pattern of four stars connected to a 'handle' of three more. This is a group of stars which has been recognised from time immemorial and by nearly all cultures around the world.

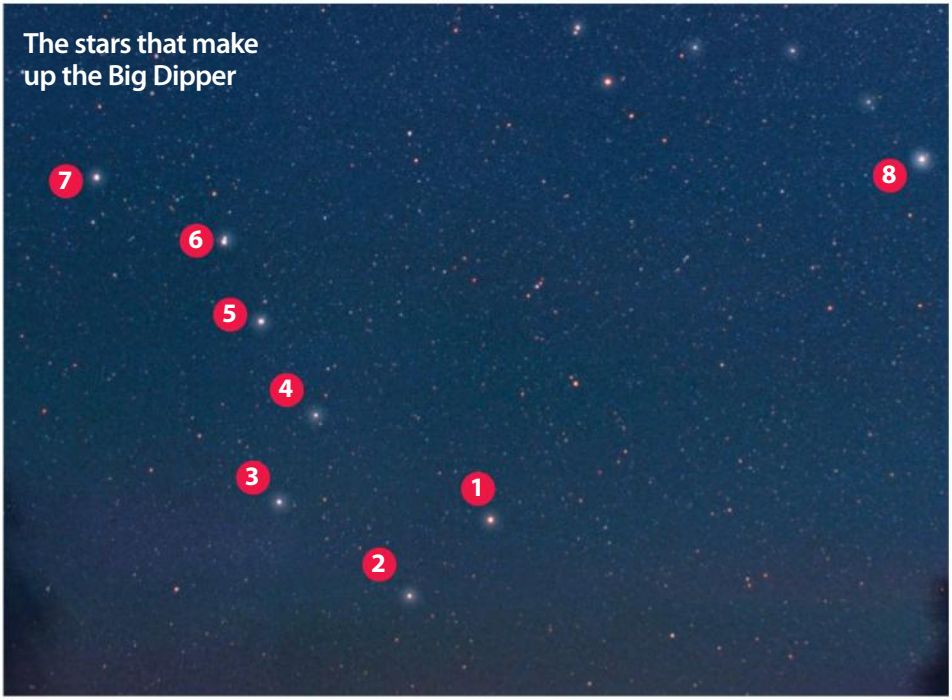
For anyone who happens to be living north of the latitude of southern Spain, the Big Dipper is circumpolar. This means that from these latitudes it never appears to set or disappear below the horizon. It rotates around the north celestial pole but because it resides near the pole it can always be found in the night sky.

All the seven stars in the Big Dipper have names. The two stars of the pointers are called Merak and the other, at the top of the 'bowl', is called Dubhe. This is the brightest star in the group. Ursa Major plays host to several amazing deep sky objects including several galaxies. You can use the stars of the Big Dipper to find a couple of them. If you draw an imaginary line from the bottom left star in the bowl through the top right one (Dubhe) and keep going for roughly the same distance again, you will come across a beautiful pair of galaxies known as M81 and M82. If you form an equilateral triangle with the two end stars of the handle, Mizar/Alcor and Alkaid as the base, at the other point of the triangle you will find the galaxy M101.

You should now be able to see what an amazing group of stars the Big Dipper really is.



The stars of the Big Dipper shine through the Northern Lights. The auroral light is translucent which allows the faint starlight to shine through it



01: Dubhe
The second brightest star in the Big Dipper and is one of the pointers to the pole star, Polaris. It is a giant star which lays approximately 123 light years distant.

02: Merak
Beta Ursae Majoris is the other star in the 'pointers' to the pole. It's 2.7 times more massive than our Sun and lays 79.7 light years away.

03: Phad
Also known as Phecda, Gamma Ursae Majoris is 83.2 light years from us. It was one of the original stars that was used to classify the spectra or light signature of other stars.

04: Megrez
This is the dimmest of the seven stars in the Big Dipper. For all that, Megrez is still 63% larger than the Sun and 14 times as bright!

05: Alioth
The brightest star in the Big Dipper and the 31st brightest star in the sky, Alioth is 82 light years away from Earth.

06: Mizar/Alcor
Consisting of the four-star system of Mizar and the double-star system of Alcor, this amazing six-star grouping is actually an extremely good test of vision. This is because only the two brightest stars are actually visible with the naked eye.

07: Alkaid
The last star in the handle of the Big Dipper is the third brightest in the asterism and one of the brightest in the entire night sky. It is around 10 million years old.

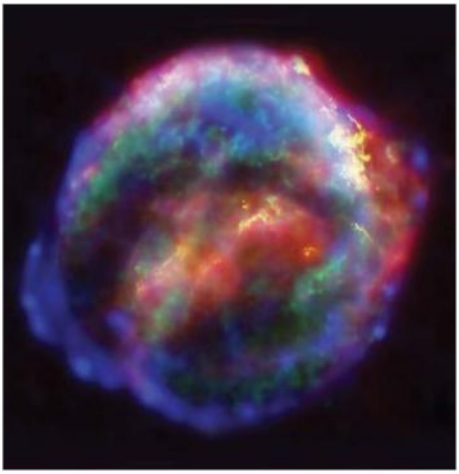
08: Polaris
Although the pole star isn't a member of the Plough or Big Dipper constellations, the pointers show the way to this important star around which all others seem to revolve.

Locate a supernova

At the end of their life, some massive stars explode with such ferocity that they outshine the rest of their galaxy's stars combined…

Stars are exploding all the time, but most of these events happen in distant galaxies where we need large telescopes to detect them. Just occasionally, though, a massive star will end its life in a cataclysmic explosion, known as a supernova, in our own Milky Way Galaxy and when it does it can lead to the sudden appearance of a star so bright it can be seen in broad daylight. This can last for several weeks until the remains of the star fade away.

This is a very rare event, though, and may happen only once in several centuries. Although none are visible now, we can never tell which stars are going to explode and stars are coming to the end of their life and could 'blow' at any time. There are plenty of potential supernova candidates, however, and astronomers monitor these regularly. None of the stars near to the Earth are big enough to become supernovas, so we are quite safe.



Kepler's supernova

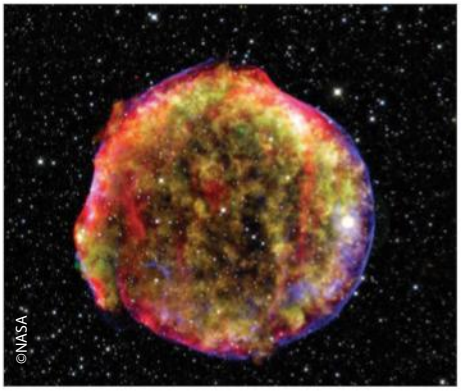
How to find it:

Kepler's supernova remnant lays near the easternmost foot of Ophiuchus the Serpent Bearer, about halfway between Sagittarius and Scorpius. It is best seen in the summer months for mid-northern latitude observers.

The Veil Nebula

How to find it:

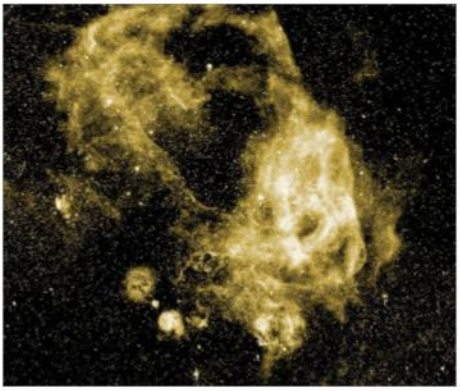
The Veil Nebula lays to the southwest of the star Gienah, the bright star in the southern wing of the Swan. It is faint, though, and in order to locate it you may find that you will need to be using a telescope with an Ultra High Contrast filter.



Tycho's supernova

How to find it:

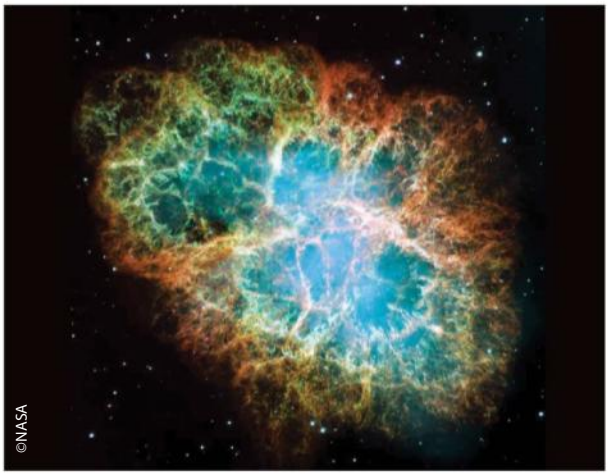
Although this remnant is beyond the reach of amateur telescopes, it actually lies to the north of the right-hand 'v' of the 'w' shape of the Cassiopeia constellation.



Vela supernova

How to find it:

The Vela supernova remnant lays to the southeast of the bright star Suhail in the Vela constellation. It is very faint and requires photography to show it up well.



The Crab Nebula

How to fiind it:

You will need a telescope to see it now as a faint misty smudge of light just north of the star Zeta Taurii, the tip of the left hand horn of the Bull. Known as the Crab Nebula due to its shape.

The next supernova

It really is difficult to predict when and where the next supernova will explode in our galaxy. There are some candidates, however, which we know are large stars that are reaching the end of their lives. One of the most well known of these candidates is Betelgeuse in the Orion constellation.

It is a red supergiant star and lays about 630 light years from us, so when it does finally blow it will be one of the most spectacular sights to ever be seen in the heavens. It might not happen for another million years, or it could happen next week. When it does eventually blow it will be easily seen in daylight, probably for several weeks. It will then fade away and will radically alter the look of the constellation. All we can do is watch and wait.

Meteor shower viewing

Speeding through the atmosphere at thousands of kph, meteor showers are always a thrill

If you enjoy gazing up at the stars on a clear night, you might have seen what is known as a meteor shower. Meteors are made when a piece of space debris called a meteoroid, micrometeoroid or space dust burns up in Earth's atmosphere. A streak of light can be seen when this happens, due to the glow of the fragmenting object and the trail of burning particles that it leaves in its wake. Meteors can be seen racing across a clear sky during any time of the night and from any location. A single meteor is unpredictable, so to spot one often creates a wave of excitement. During certain times of the year, meteors can appear in huge groups, raining one after the other through our atmosphere in their hundreds, in what are known as meteor showers.

These events occur roughly during the same time every year, as Earth periodically moves through the dusty trail left behind by an active or extinct comet. These showers also originate from the same

point in the sky, a radiant located within or near a constellation that earns the meteor shower its name. Head out in chilly November to catch the Leonids racing from the constellation Leo or, if you prefer the warmer nights, the Perseids will offer good views in August, hailing from constellation Perseus.

Many astronomers take great interest in recording meteor shower numbers, so you might like to report your observations – including details of their brightness, speed and colour – to official bodies such as the International Meteor Organization (IMO) and International Astronomy Union (IAU). To truly get the benefit of meteor-watching, you will need dark-adapted vision as well as a clear Moonless night to catch even the faintest streaks of light. However, that's not to say you won't see any meteors while the Moon is out.

There are also the exceedingly bright meteors, often hitting magnitudes greater than those of the planets. If these fireballs are brighter than magnitude -14, they are known as bolides or superbolides.

When you picture a meteor shower, you may wrongly think of many meteors bursting out of a single point. Viewing a meteor shower requires a degree of patience, so hunting for these flashes of light turns into a waiting game. The Zenithal Hourly Rate (ZHR) indicates the number of meteors that will appear, with some showers ranging anywhere from five to 100 per hour. When a shower reaches its peak, you might find the amount you see varies – not knowing what you'll get until you begin hunting for meteors is part of the fun.

Meteor-hunting toolbox

Deck chair

Meteor hunting means a lot of looking up. A deck chair will keep you at an inclined position for maximum comfort – without hurting your neck!

Warm clothing

Some showers are only observable during winter, so make sure you keep warm. Thick coat are essential for long periods of observing – maybe even a sleeping bag.

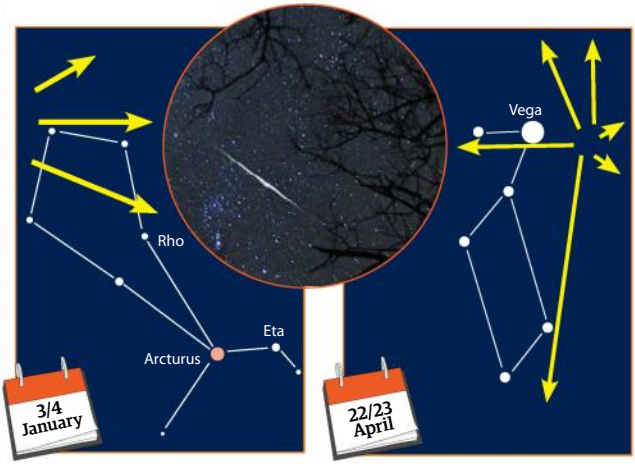
Hot drink

On cold nights it's also a good idea to keep warm by drinking hot liquids. Coffee and tea are often a popular way to keep awake after midnight. If you can, have a nap before heading out.

Red flashlight

If you are using a night-sky map or need to see in the dark, then you should use a red torch since the light will not ruin your vision.

Catch a meteor

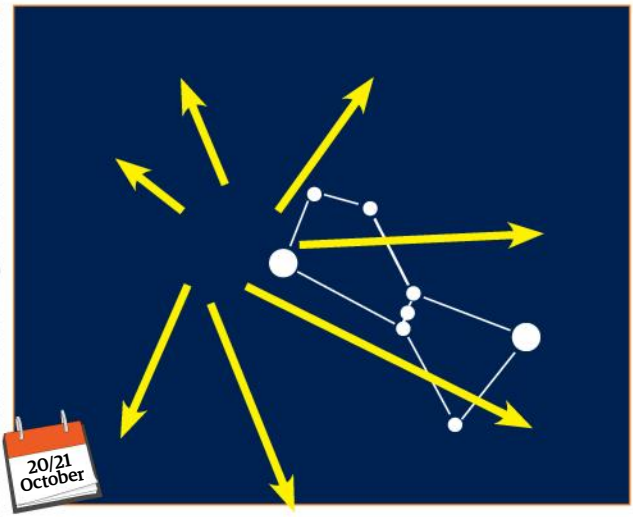


Quadrantids

Constellation: Boötes
ZHR: 80 per hour
Parent asteroid: 2003 EH1

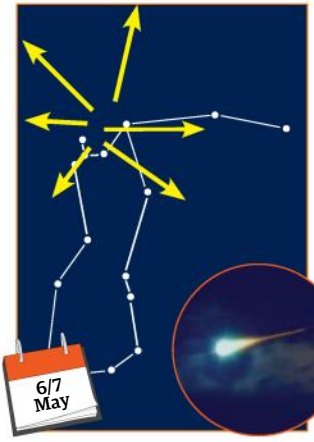
Lyrids

Constellation: Lyra
ZHR: 20 per hour
Parent comet: C/1861 G1 (Thatcher)



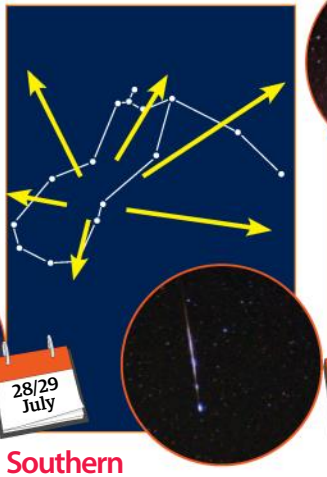
Orionids

Constellation: Orion (The Hunter)
ZHR: 20 per hour
Parent comet: Halley



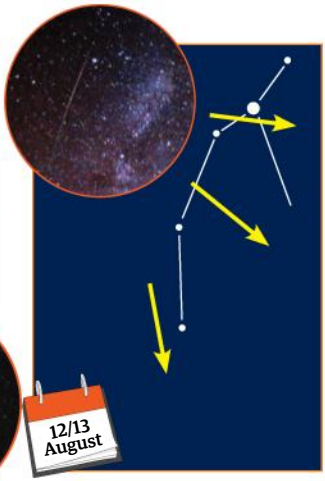
Eta Aquarids

Constellation: Aquarius
ZHR: 45 per hour
Parent comet: Halley



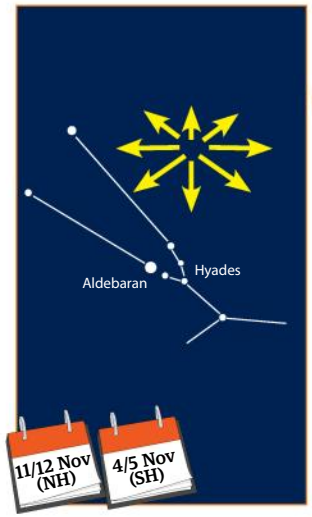
Southern Delta Aquarids

Constellation: Aquarius
ZHR: 20 per hour
Parent comet: Unknown



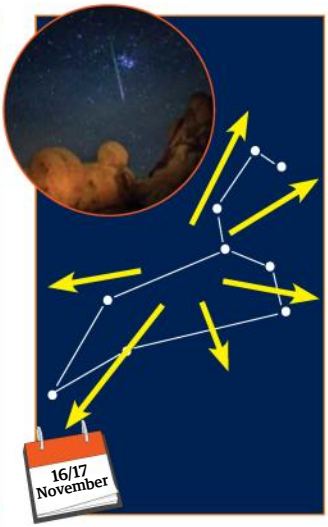
Perseids

Constellation: Perseus
ZHR: 100 per hour
Parent comet: Swift-Tuttle



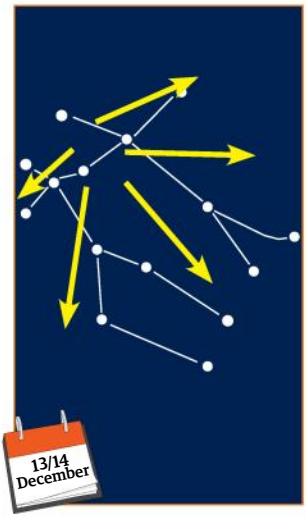
Taurids

Constellation: Taurus (The Bull)
ZHR: 5 per hour
Parent comet: 2P/Encke



Leonids

Constellation: Leo (The Lion)
ZHR: 15
Parent comet: Tempel-Tuttle



Geminids

Constellation: Gemini (The Twins)
ZHR: 120 per hour
Parent asteroid: 3200 Phaethon

Comet hunting

Want to find your very own comet? Follow our guide and you could make a rare discovery

Comets have fascinated and frightened humans in equal measure for thousands of years. They are icy relics from the formation of our Solar System. Occasionally they plummet in towards the inner Solar System and many astronomers believe that comets impacting the Earth were responsible for delivering much of the water our planet has today. What's certain is that they are responsible for the spectacular meteor showers that we are treated to every year.

The most famous of these repeat visitors is Halley's comet, which is also responsible for the Orionid meteor shower. An orbiting ball of ice and dust, it has been recorded by humans since at least 240 BC and even appears in the famous

The famous Halley's comet visits Earth only once every 80 years or so

Bayeux tapestry. The last time it came by was in 1986, when the European Space Agency dispatched the Giotto probe to study its nucleus. It won't return again until 2061.

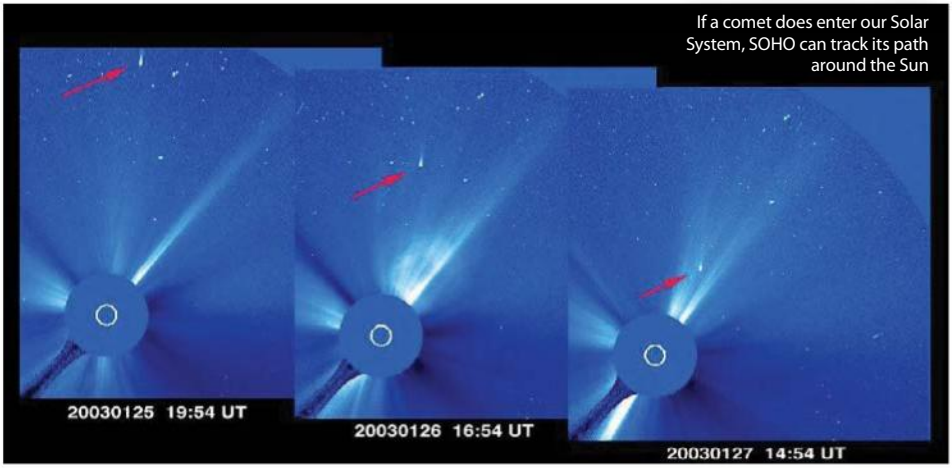
One such comet, Lovejoy, is among the most famous and spectacular comets of recent years. It streaked past the Earth back in 2011 and was discovered by Australian amateur astronomer Terry Lovejoy from his home in Queensland. He was using an amateur telescope costing around £750 ($1,250). Nevertheless, his find was later photographed by NASA's Solar and Heliospheric Observatory (SOHO) as it grazed past the Sun, as well as by the crew of the International Space Station. So, just how can you get in on the comet-hunting act too?

First you need to get to know the sky. Comets become visible when they reach approximately the same distance from us as Jupiter. So if you know exactly where everything should be, it's easier to tell when a new object suddenly appears. The best place to look is along the ecliptic plane – the area of the sky traced out by the 12 famous signs of the zodiac. This area is roughly aligned with the flat disc of our Solar System, so you are more likely to find comets close to this region. Another simple tip is to avoid nights with a bright or full Moon.

Although some amateurs have discovered comets using just binoculars, it's best to use a medium-sized telescope. You're after a wide field of view

Equipment

The more light you can grasp, the better, so it's recommended you use a minimum of a 4" refractor. Reflectors can also be used, and it's even possible to hunt down comets with nothing more than a pair of binoculars. Legendary British amateur astronomer George Alcock was able to discover five comets this way.
It pays to attach a CCD camera to your telescope, as it enables you to use image-processing software to get the most out of your observations. There are also free pieces of software which are invaluable to the comet hunter. They can take your observation data and compute the likely orbit of the comet, which is crucial if you're to submit your find for consideration by the Minor Planet Center.

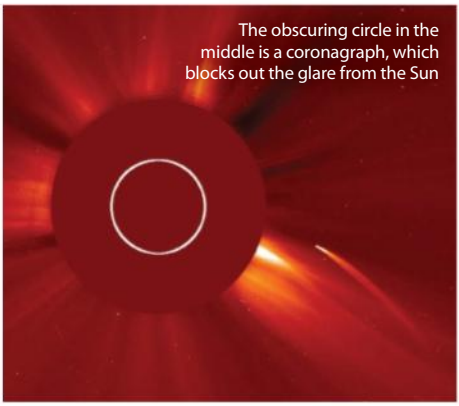


If a comet does enter our Solar System, SOHO can track its path around the Sun

so that you can sweep around large parts of the sky. This means selecting a wide eyepiece to give you low magnification. Many comet hunters also invest in a suitable CCD camera that can be attached to their telescope. By taking long-exposure photographs, you should be able to pick up objects that it would be hard to spot with your eyes alone. It also means you can record your find and use computer software to help you submit it to the proper authorities.

What you're looking for is something fuzzy that doesn't seem to belong. Be careful, however, as it is possible to be fooled by other fuzzy objects in the sky that can be easily mistaken for comets but they are not comets. In the late 18th Century, renowned French comet hunter Charles Messier was faced with the same problem. He was continually stumbling across potential comets, only to find they were distant galaxies, star clusters or nebulae instead. He assembled a list of these objects to help other comet hunters. This Messier catalogue is still widely used today by professional and amateur astronomers. Some famous night-sky objects appear in the list, including the Orion nebula (M42) and the Pleiades (M45). His list is an invaluable tool if you don't want to be led up the garden path.

Another key property to look out for is movement. Objects outside our Solar System – like stars and nebulae – will remain in a fixed location relative to the constellations. These constellations will also move throughout the night as the Earth rotates, but everything beyond the Solar System will appear to move along with them at the same rate. Objects close to home can move at high speeds – comets can reach hundreds of miles per second.


The obscuring circle in the middle is a coronagraph, which blocks out the glare from the Sun

Armchair comet spotting

It's possible to find your very own comet without setting foot out of the house. So far NASA's Solar and Heliospheric Observatory (SOHO) has picked up more than 2,700 comets in the last two decades. As the objects approach close to the Sun, they inadvertently appear in solar images. There are far too many images for professional astronomers to sift through, so almost all of these Sun-grazing comets were discovered by amateurs looking through the publicly available archive images on the NASA website. A new comet is discovered on average every three days and almost half of all known comets have been found this way. Around 70 people from 18 nations have so far struck gold. To find out more, visit http://sungrazer.nrl.navy.mil and read its official guide to comet hunting.

The Solar and Heliospheric Observatory (SOHO) was in a prime position to capture images of comet ISON as it orbited the Sun

If you're lucky enough to spot a brand-new comet, and it gets ratified by the Minor Planet Center, then you get to name the comet. So, just how hard is it to learn the skills required to be a good comet hunter? In truth, it's just like learning to play the violin – you can play a tune in a few weeks, but it takes years to become an expert. More information on the technical aspects of comet hunting can be found by reading the Minor Planet Center's Guide to Minor Body Astrometry, which can be easily found at most bookstores, as well as many online stores.

So, comet hunting means that it is possible that you could be the first human to set your eyes on an ancient lump of celestial ice that has been tumbling unobserved around the Solar System for billions of years. That comet could forever bear your name, or a name of your choice, as its discoverer.

What to do when you think you've found a comet

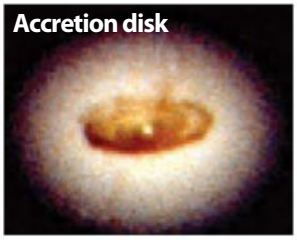
Any and all potential comet discoveries should be reported directly to the International Astronomical Union's Minor Planet Center. Guidelines for submissions can be found online at **www.minorplanetcenter.net**. It requires that you submit the details of the potential comet in a very specific format. This can be created by using computer software such as Astrometrica. The Minor Planet Center's computers can then calculate if the object is indeed newly discovered by you. If it is successfully validated, then it appears on their NEO confirmation page and you get naming rights!

Your astronomy glossary

There will be a lot of new terms to learn as you delve into astronomy. Here are some of the most common ones…

A

Accretion disk
A circular disk of stellar matter that has been captured by a large celestial body, such as a sun or black hole.



Achromatic
A lens that receives light without splitting it into its constituent colours. The opposite is apochromatic, which splits light into red, blue and green..

Altazimuth
This refers to a telescope mount that moves both vertically (azimuth) and horizontally (altitude).

Aperture
The diameter of a telescope's front lens or main mirror, usually stated in inches or mm.

Apparition
For any given object in the night sky, the annual window in which it's visible is known as the apparition. For latitude sufficiently far from the equator, there are objects that have no apparition, but are always visible. For everything else, there is a date at which it begins to appear and a date after which it can no longer be seen in the evening.

Asteroid
Asteroids are minor planets that are not defined as comets. They're mainly located in the inner Solar System, and orbit the Sun.

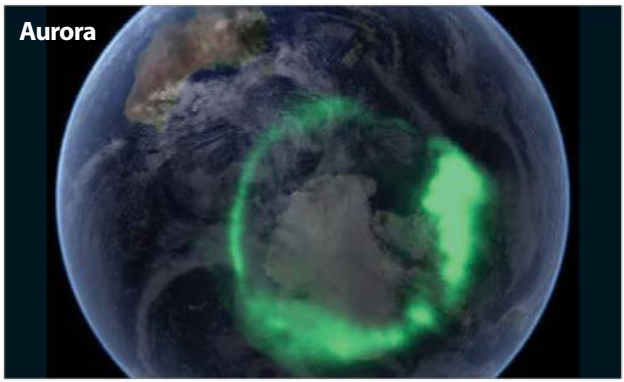
Asteroid belt
This refers to the region of space between Mars and Jupiter containing millions of asteroids that orbits the Sun with low-eccentricity.

Astronomical horizon
The imaginary horizon that lies perpendicular to the direction of gravity.

Astronomical Unit
This refers to the average distance that lays between both the Earth and the Sun, defined as just under 150 billion km.

Aurora
Sometimes charged particles from the Sun will meet a planet's magnetic field. When this happens, they automatically get funnelled along the magnetic field lines at the planet's poles. Once they hit the upper atmosphere they cause it to fluoresce. The product of this reaction is called an Aurora.

Azimuth
This refers to the angular measurement of an object that is along the horizon of the observer, which is relative to the direction of true north.



B

Binary stars
The term binary star refers to the stars which orbit around their common centre of gravity.

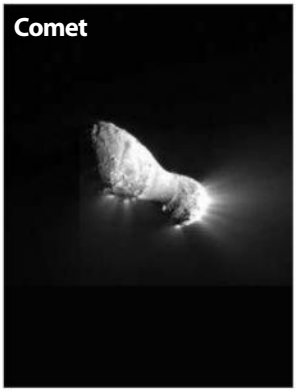
Blue moon
A blue moon is the second full moon in a single calendar month. The term can also be used to describe the blue-ish tint that is visible on the moon, which is caused by volcanic activity.

Blueshift
As an object moves towards you, the wavelengths of light it gives off will shift towards blue in the visible spectrum.

C

Catadioptric
This is a telescope that uses both refraction and reflection techniques to form an image.

Celestial equator
The Celestial equator is an imaginary line splitting the north and southern hemispheres, and runs along the Earth's actual equator.



Celestial pole
Like the celestial equator, the celestial pole is an imaginary line from the poles that signifies the axis on which the Earth rotates.

Cepheid variables
These stars pulsate and so the amount of light they put out changes along with this pulsation. It was found that the rate of change of this type of star was proportional to how brightly they seemed to shine. Because of this, it is possible to work out how far away they are by measuring how bright they appear to be and then by timing their pulsations.

Chromatic aberration
If a telescope has only one lens or has a poorly constructed doublet lens, then it might cause bright objects to have a red or blueish halo around them. Even the very best doublet lens can, however, show a little of this, but it is usually barely noticeable if they are of good quality.

Cloud belts
Saturn does not have a solid surface. It is made of gases, some of them frozen and these gases rotate around the planet as it spins on its axis. This rotation causes the gases to form into 'belts', which we can see as having slightly different colours.

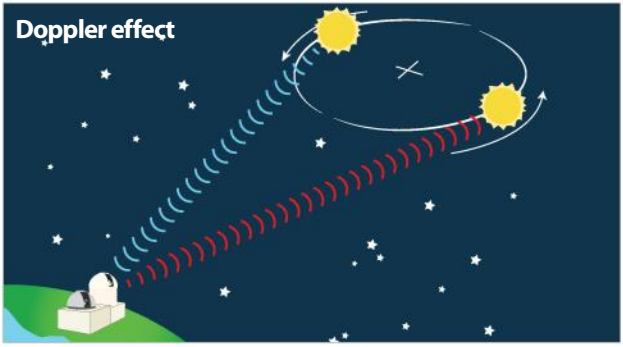
Colour index
A term to represent a value to measure the brightness of a star on different frequency bands of the electromagnetic spectrum.

Craters
Once thought to be volcanic in origin, the Moon's craters are now known to have been caused by impacts from asteroids and meteors. There is no atmosphere on the Moon and so no wind or rain to destroy the remains of the impacts which occurred in the early history of the Moon.

D

Doppler effect
The change in a frequency of a wave for an observer moving relative to its source. This results in a redshift or blueshift.

Doublet
This refers to the lens consisting of two pieces of glass is known as a 'doublet'. Each lens in the system is made to a different shape, one being convex (curving outward) and the other concave (curving inward). This helps to bring the light from the red and blue ends of the spectrum to the same focal point.



Dwarf planet
The official definition is a body in direct orbit of the Sun, large enough for its shape to be controlled by gravity, but has not cleared its orbital region. Dwarf star. These are small main sequence stars much like our Sun, contrasting giant stars such as Betelgeuse.

E

Eclipsing binary
Two stars in orbit around their common centre of gravity can pass in front or behind one another. When this happens they are in 'eclipse' and the usual combined light of the stars will be dimmed.

Ecliptic
An imaginary line that traces a great circle around the sky. It passes through each of the 12 constellations of the zodiac, and a 13th constellation, Ophiuchus. The ecliptic represents the path of the Sun as it appears on the sky throughout the year.

Epoch
This refers to the moment in time used as a reference point for co-ordinates or orbital elements of a celestial body.

Equinox
The Equinox is the position of a celestial body defined by where it lies from the celestial equator.

Exoplanet
This refers to a planet that is exosolar – outside of the solar system, and orbiting other stars.

Extinction
How dust and gas can absorb and scatter electromagnetic radiation between the object and the observer

F

Field galaxy
A galaxy that does not belong to a larger cluster of galaxies, but is gravitationally alone.

Field star
A star that is in the line of sight of associated stars under study, and is not only unrelated, but may tamper with a study's results.

Focuser
In order to see the image from the mirrors properly and to be able to magnify it, you need to view it through an eyepiece. This is placed in a moveable tube called the focuser which can be adjusted using the focusing knobs to give the observer a sharp, clear view.

G

Galilean moons
The Galilean moons are the four largest of Jupiter's moons as discovered by Galileo Galilei. These are Io, Europa, Ganymede and Callisto.

Gas giant
Refers to a large planet that is primarily composed of rock. An example would be the four outer planets in our solar system.

GEM
A term that is short for German Equatorial Mount, this type of mounting was first invented by Joseph von Fraunhofer. Using a simple T-joint this mount is ridiculously easy to make, as well as being incredibly versatile and accurate. It is also portable enough to pack for easier astroimaging at a remote site. However, it does need a counterweight.

Globular cluster
The collection of stars that orbits a galaxy's centre as satellites, tightly bound by gravity.

Goto
Computers that will 'goto' any object in its database.

Gravitational lens
The effect where light is bent due to the gravitational forces exerted on it between the source and the observer.

.

H

Halo
An optical phenomenon caused by ice crystals in the atmosphere that results in a ring of light around the Sun or Moon.

Heliocentric
Where as geocentric is revolving around the Earth, heliocentric objects orbit around a central star, such as our Sun.

Heliopause
The boundary of the heliosphere, where the solar winds stop and the interstellar medium begins.

Heliosphere
The bubble of charged particles created by our Sun or another star, protecting the planets from the harsher radiation in space.

I

Interstellar clouds
A denser-than-average region of space comprising of plasma and dust, very similar to a nebula.

Interstellar medium
The region of space that is between stars, outside of a star's heliopause.

Inverted image
Finder scopes and many telescopes will make the image appear upside down and back to front.

Irregular variables
These stars will vary in brightness at random intervals unlike many variable stars which still happen to follow a regular pattern to their variations.

K

Kuiper belt
A trans-Neptunian region comprised of asteroids and other small bodies that is 20 times larger than the asteroid belt.

L

Light year (ly)
Astronomers gauge cosmic distances in terms of the time it takes for their light – travelling at 300,000km per second (186,000 miles per second) – to reach us. One light year measures about ten trillion (ten million million) kilometres – just a quarter of the distance to the nearest star. Our home galaxy, the Milky Way, is 100,000 light years across. The nearest big galaxy is the Andromeda Galaxy, 2.6 million light years away.

Local group
Our group of galaxies, including the Milky Way. A total of 54 galaxies make up the local group.

Local/Virgo Supercluster
This refers to the supercluster than contains both the Virgo Cluster and Local Group, which in themselves contain the Milky Way and Andromeda galaxies.

Luminosity
This is the measurement of brightness, specifically the total amount of energy emitted by a celestial body.

M

Magnitude
The perceived brightness of a celestial object is called its apparent magnitude. The brightest star, Sirius, is magnitude -1.4, while the faintest stars visible with the unaided eye under a dark sky are around magnitude +6.0. A pair of 10x50 binoculars will show objects down to magnitude +11.0.

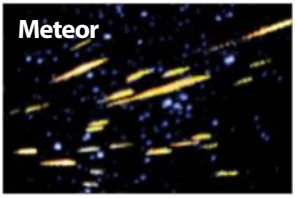
Mascon
This is basically shortening for mass concentration, it is referring specifically to a region of a planet or moon's crust that contains gravitational anomalies.

Messier object
A list of astronomical objects described by Charles Messier in the 1700s, bodies are designated M1, M2, M3 and so on.

Meteoroid
Refers to a small rocky or metallic object travelling through space. Meteoroids are much smaller than an asteroid.

Meteorite
If a meteoroid survives atmospheric entry and impacts with the surface, what remains is known as a meteorite.

Morning width
Also know as the rise width, this is the horizontal angular distance between the rise azimuth of a celestial body and the East direction.



Multicoated optics
Glass is naturally quite reflective and in good quality lenses, each surface should be coated with a special chemical which helps it transmit all the light falling on to it through the glass. This is then described as 'fully multicoated'. In a doublet lens only the front of the first lens and the back of the second are coated.

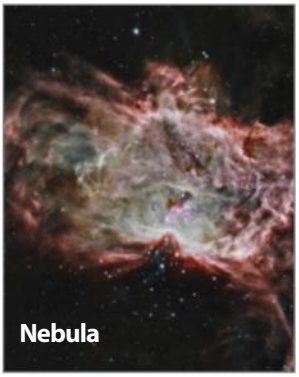
N

Natural satellite
A naturally occurring body that orbits a planet.

Nebula
An interstellar cloud consisting of dust, hydrogen, helium and other ionized gases. Stars and planets can form within them.

Neutron star
Remnants of a dead star that are composed almost entirely of neutrons. They are very hot.

Nova
A nova is a cataclysmic nuclear explosion in a white dwarf due to it pulling in material from a neighbouring star, characterised by a sudden brightening.


Nebula

Nutation
The gravitational attraction of other bodies in the Solar System causes changes to a planet's rotation or orbit.

O

OB Association
A group of massive stars that loosely move through space together without being gravitationally bound.

Observable universe
The amount of the universe that can be seen because its light has had enough time since the Big Bang to travel to us.

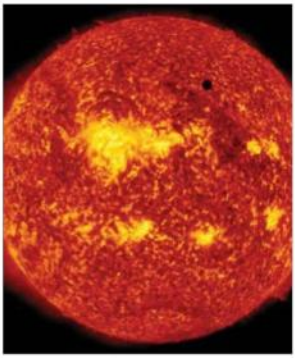
Open cluster
A group of up to a few thousand stars that were formed in the same cloud at the same time.

P

Parsec (pc)
A parsec is a measurement of cosmic distance based on parallax. Parallax is the change in an object's apparent position with respect to more distant objects caused when the viewing angle changes. Although the stars are at incredible distances, the Earth's orbit around the Sun is almost 300 million kilometres (186 million miles) in diameter, so nearby stars exhibit a small but measurable parallax against the celestial sphere during the course of half a year (from one side of the orbit to the other). Since we know the size of our baseline, the distance of stars displaying a measurable parallax can be ascertained. One parsec is the distance from the Sun to an object with a parallax angle of one arcsecond, and is equal to 3.262 light years. Proxima Centauri, the nearest star, is 1.29 parsecs away.

Periapsis
This refers to the point at which an object is at its closest to the body it's orbiting around.

Phase
The Moon and planets go through specific phases as they travel through space as seen from Earth, full, half, new, etc.



Pole star
This refers to the star Polaris which currently resides almost exactly over the rotational axis of Earth at the North Pole. If you extend the North Pole point out into space you get the north celestial pole. From the northern hemisphere all of the stars in the sky seem to rotate around this point.

Power
In astronomy, the term power is interchangeable with magnification. This means that lower powers, like those given by binoculars, afford a relatively wide field of view, while telescope power can be adjusted by changing the eyepiece. Traditionally, the term applied only to the magnifying ability of an element in an optical system but now it is often understood to mean the system as a whole, including the objective and ocular.

Precession
Precession causes different stars to assume the roles of the pole stars. As the Earth spins, it wobbles slowly, like a spinning top. The axis running from pole to pole also then rotates, a complete cycle taking about 26,000 years. During this time the Sun's position at the equinoxes drifts westward through the various zodiacal constellations.

Protostar
The beginnings of a star, as mass forms from the contraction of an interstellar cloud.

Pulsar
A type of Neutron star that is highly magnetised and rotating. It emits a beam of EM radiation that, due to the rotation, seems to pulse.

Q

Quasar
Extremely luminous celestial objects that are distant and with a highly energetic galactic core, surrounding a supermassive blackhole.

R

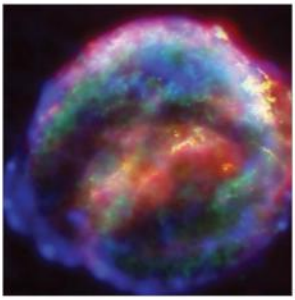
Radial velocity
This is referring to an object's velocity along the direct line of sight of the observer, with a positive value for receding objects.

Radiant
According to astronomers, shooting stars in a meteor shower appear to originate from a common point unique to that shower, and this that is known as the radiant. Since the meteors spread out from the radiant none are observed to pass through it, unless they're sporadic.

Ray system
The radial streaks caused by an impact crater, caused by the fine material thrown off the object that impacted the surface.

Red giant
A star which has used up most of its fuel and has expanded and cooled down giving it a distinctive orange/red tint. These are some of the largest stars in the universe.

Refraction
As light passes through a different medium, like glass, it bends or – to use an alternative term – is refracted. It was discovered that by controlling the shape of the glass (lens) it was possible to vary the point where the image is formed behind the lens. This is known as the focal length of the lens and has a direct bearing on how much the lens can magnify.



Rille
A rille is a narrow groove in the lunar surface with the appearance of a channel or river. They may be the result of ancient lava tube collapses.

Roche limit
The distance from an object where the tidal forces match the orbiting bodies self-attraction, resulting in it dispersing and forming a ring.

S

Semi-major axis
All circles have a fixed radius, where as an ellipse does not. The semi-major axis is basically the maximum length that the radius of that specific ellipse can be.

Semi-minor axis
The shortest distance to the edge of an elliptical orbit from the centre, the opposite of the semi-major axis.

Semi-regular variables
These are giant or super giant stars that normally follow a set pattern of change in their brightness but which can sometimes be interrupted.

Shadow transit
This refers to when the moon of a planet casts a shadow on the surface of the planet, it slowly moves across the disc as it orbits. This is known as a 'shadow transit'.

Solar mass
This is a unit of mass based around the mass of our Sun, used to weigh astronomical objects. It's 2 x 1030 kg.

Solar wind
This refers to the charged particles that are blown out by the Sun. These particles consist entirely of electrons and protons, which then causes auroras in our atmosphere, which protects the Solar system from cosmic rays.

Supermoon
A supermoon is the term used to refer to a full moon or new moon that occurs when the Moon is at its closest to Earth.

Supermassive black hole
A type of black hole thought to reside in the centre of most (or all) galaxies, and is thousands or billions of times larger than our Sun.

Sunspots
These are regions of complex magnetism on the Sun. They appear as dark blotches with a dark centre and lighter outer either by projecting the image through a telescope or using a 'white light' filter as described in this article. The reason sunspots are darker than the rest of the Sun is because they are cooler. They travel across the disc of the Sun as it rotates, growing and shrinking as the magnetic fields change.

■ Charles Messier discovered what is now known as Messier Objects in the 1700s

Synodic period
The time take for one object to complete its orbit around another. This is calculated as compared to relevant background stars.

T

Terminator
As the sunlight moves across the face of the Moon we see the dividing line between night and day on the surface. This is known as the terminator and is a great place to view through a telescope wherever it is on the lunar surface due to shadows throwing features into relief.

Tidal acceleration
The effect of tidal forces from an orbiting moon, causing the moon's rotation to initially stop, and the planet's rotation to slow.

Tidal locking
Due to tidal acceleration, most moons are tidally locked to their planet – they rotate at the same speed they orbit, meaning we only see one side of the Moon.

Transit
The opposite of an occultation – when a smaller body passes in front of a larger body. An example would be when a planet passes in front of the Sun.

Stars and planets can form within a nebula

Trinary stars
This refers to a system of three stars orbiting each other, much like a binary star.

True horizon
The actual horizon of the planet Earth, as opposed to one that is defined by gravity experienced by the observer.

True North
The classical North Pole, the point at which the Earth rotates around. This is used in relation to the celestial pole.

U

Umbra
Parts of the shadow caused when a body is in front of a light source. The umbra is specifically the darkest shadow cast behind the body.

V

Variable star
At first glance all stars seem to shine with a steady brightness, however, the light output of many will vary, increasing or decreasing brightness.

Variation period
The amount of time it takes for a star to change from its maximum to its minimum brightness and back again. For some this can be a matter of days or hours, for others it can be years.

Visual back
This is the hole at the rear of the telescope through which the light is brought to a focus. It consists of a threaded ring which can accept all manner of accessories including diagonal prisms to enable comfortable viewing through an eyepiece and also cameras for recording what you see.

Visual binary
A binary star which we know exists because we can see it, rather than need evidence from other parts of the em spectrum.

Vortex
A powerful spin set up in a gas or fluid around an axis, rather like the effect when stirring a cup of tea! A hurricane is a type of vortex where clouds swirl around the 'eye' of the storm.

W

Waning moon
This refers to the part of the Moon's phases where it's completely disappears from sight after there has been a full Moon.

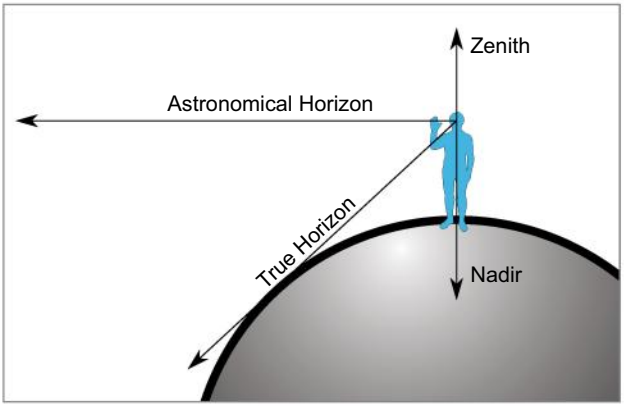
Waxing moon
This term is refering to when a Moon is approaching a full Moon, which is described by astronomers as a waxing moon.

White dwarf
This refers to a star which has neared the end of its life and collapsed down to a small hot ball of gas perhaps only the size of the Earth but with the same mass as our Sun.

Z

Zenith
This refers to the direction vertical above a location with respect to gravity, the opposite of nadir.

Zone of avoidance
The area of the night sky obscured by the Milky Way, limiting the amount we can observe in its direction.



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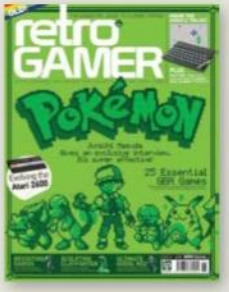

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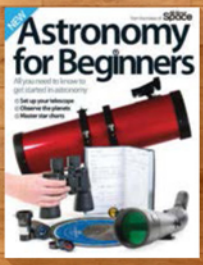

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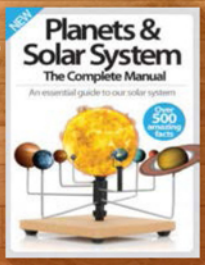

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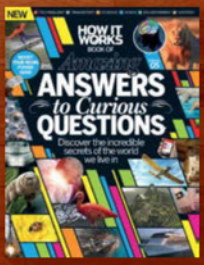

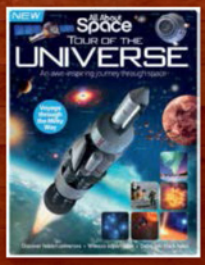

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