An Introduction to
VISUAL DEEP-SKY OBSERVING

Faith Jordan

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Photo: Stewart Moore

Faith Jordan

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About the author

I have been an amateur astronomer for 22 years, starting in 1992. Since 1993, I have been (almost) exclusively observing the Deep Sky – the realms of deep space beyond the solar system containing galaxies, nebulae and star clusters. I am a visual observer only; I don’t use CCDs or DSLRs, only eyepieces and notebooks.

I’m currently working my way through the Herschel 2500 list as well as observing specific groups of objects; apart from the H2500 my current ‘specialties’ are Hickson Compact Galaxy Groups, Arp Galaxies, galaxy trios and galaxy clusters. I also like observing globular star clusters and planetary nebulae.

I do most of my observing from the back yard at home, near Sandown, which is on the Isle of Wight located off the South Coast of England, but I also do a lot of observing at star parties, including the Isle of Wight Star Party and the Texas Star Party, plus I have made trips to the Southern Hemisphere to observe.


Over the years, I have used scopes ranging from small binoculars right up to a huge 111.8cm Dobsonian belonging to my friend Jimi Lowrey, of Ft. Davis, TX. My own scopes have included reflectors of 15cm, 22cm and 30cm and I currently use an 45.7cm f/4.3 Dobsonian, made by UK scope maker David Lukehurst, as well as 8x42 binoculars.
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Introduction

So you’ve been into astronomy a while, you know your way around the sky and want to do deep sky observing? You’ve made a good decision, as deep sky is the most rewarding, yet challenging, aspect of amateur astronomy; there are literally thousands of objects out there to observe and it will keep you happy and busy for many years. Why do I claim that deep sky is the most rewarding part of amateur astronomy? There are only seven planets, if you ignore the demoted Pluto and the one we’re standing on - the Earth - and, of these, only three – Mars, Jupiter and Saturn – really show any detail. There’s the Moon of course, but that can become passé after a bit. But beyond the Solar System lies a whole new realm of nebulae, remnants of dead stars, star clusters, double stars and, beyond the Milky Way itself, innumerable distant galaxies and galaxy clusters to hunt down and see. However, deep sky observing can be at times frustrating as most of the objects are faint and not that easy to locate, so this little book aims to provide advice for those people who want to get into this most fascinating type of observing.

At this point, the question may be asked: why bother with visual observing? Why not go out with a camera or a CCD imager? Well, there are several reasons. Firstly, for visual work, all you need, apart from optical aid, are a sketchbook, pencils, eraser and dim red torch, and this makes visual observing far less expensive than other methods. Another reason is that a well executed drawing, done with care and attention, can reveal more detail than an astrophotograph or sometimes even a CCD image. The reason for this is that in attempting to get the faint detail in objects photographically, the central regions can become overexposed, rendering the detail in those regions invisible. I have done some CCD imaging, but I found the experience fiddly and too much hassle, I felt divorced from the night sky and the results were a joke. I don’t find CCD imaging the pure experience that visual observing is and I found it too much like looking at the TV or the internet. Imaging also has a very steep learning curve, much more steep than visual observing, and very hard to get right. Why get frustrated trying to emulate the experts when there’s an easier method?

Too often I hear, and see posts on forums, about people who have just got into astronomy wanting to take the plunge straight into imaging. Why? What’s the hurry? Do some visual observing first – most established imagers began as visual observers and quite a lot of them are still visual observers, getting some eyepiece time in while the CCD does its thing. By going off the deep end and bypassing visual observing in favour of taking pictures, people are missing the best bits. Far too often visual observing is unfairly and wrongly dismissed as being a positively dinosaurian relic of the past and is bypassed or ditched in favour of the CCD chip or webcam. Despite what you may have heard or read, visual observing is far from dead, or even on the wane.

People may be concerned that their observations may not be taken seriously if they do not have fantastic electronic gadgets to observe with, and some beginners tend to feel that they have to do some science. This is just not the case. The point to be borne in mind is that astronomy is a hobby not a chore, and can be as scientific or as casual as the observer wishes to make it. Personally speaking, I have never felt the need to do serious science, but like anybody else, I like to share my observations. Drawings and visual notes are published in the Webb Society’s Deep Sky Observer magazine, the British Astronomical Association’s Deep Sky Section and in Amateur Astronomy Magazine (see References and Bibliography at the back of the book) alongside astrophotos and CCD images. If you get into serious observing, please send your observations and sketches into them, they love to have them. Should you wish to bring your observations and sketches to a wider audience, there is the internet and making a website is extremely easy, particularly with the growth of blogs and drag-and-drop online website building software provided by most webhosts. Should you be really concerned with doing “serious work”, there is plenty of time for that later, as you become a more proficient observer. Then you can become involved with variable star estimates, active galactic nuclei observing programmes…the list is long, and these things can be done visually. There’s only one golden rule and that is: go out and enjoy it.
When deciding to attempt sketching, people tend to worry slightly, thinking that they have to be expert artists to sketch deep sky objects. This is not true. Astronomical drawing consists largely of dots and smudges and anyone can draw dots and smudges, although there is a bit more to it than that. As with all things, skill is acquired with practice – the more you practice the better an observer and sketcher you will become. Who knows – you may never want to bother with that expensive CCD imager or imaging mount you saw in those glossy adverts!

I would hope you already belong to the Webb Deep Sky Society but you should also consider joining your local astronomical society, if you have not already done so. Details of contacts can often be found from your local public library or from the Federation of Astronomical Societies (UK) and the Astronomical League (USA). Alternatively typing your county or town name into Google, along with ‘astronomical’ will bring up links to astronomical societies in your area. However useful books may be, there is no substitute for chatting to people who have the experience to answer your questions and discuss how they approach observing. You'll find many shades of opinion on all subjects but there will certainly be some among their number who can help you. Societies often have observing sessions which members can go along to and observe with experienced people and even try out scopes and eyepieces before buying one of their own.

Since the 1980s the advent of large ‘light bucket’ Dobsonians and the ‘CCD revolution’ has enabled amateurs to view objects once thought to be the preserve of professionals. Newcomers to the hobby, on seeing the expensive looking equipment on view in magazines and at club observing sessions or star parties, may think that they need to spend a small fortune on a huge telescope or a complicated imaging rig to do any serious observing. Nothing could be further from the truth. To begin deep sky observing, as mentioned above, all that is required is optical aid, rigidly mounted, and a notebook and pencil. In this book, I hope to show newcomers to deep sky observing what they can do, what they can see, and how to go about it.

Have a go, it is highly enjoyable, very satisfying and easier than you think! You’ve made a start, by buying this little book.
There are many sizes and types of optical equipment, some of which is suitable for deep sky observing, and some which most definitely is not!

**Binoculars**

One of the best pieces of equipment to start with is a pair of binoculars which can be used to view the brighter Messier objects. Opera glasses are not suitable for astronomy, and neither are the small pocket binoculars of 25mm aperture. Obviously, the larger the object lenses, the brighter the image, but this will make the binoculars very heavy. The best ones for observing are 7x50, 8x40, 8x50, or 10x50 but any larger than this and they will need to be rigidly mounted on a tripod or they will shake so much you will see nothing except dancing stars, which is worse than useless.

For general looking round the night skies I use a pair of 8x42 binoculars and these show me more than I ever thought possible, including most of the Messier Catalogue.

One innovation in the field of binoculars has come in the form of image stabilized binoculars which are made by Canon. These stabilize the image of the object being observed and cost from £350. Large observation binoculars, such as 15x80 or 20x100, are ideal for wide field deep sky observing but need to be securely mounted. They vary in price – and quality – but can be bought from upwards of £199.

**Telescopes**

Everybody will end up wanting – needing - a telescope sooner or later and if you are serious about deep sky observing then you are going to have to invest in a good quality instrument. Unfortunately,
there are many unsuitable types of telescope on the market these days, usually sold in department stores and which are tempting to the unwary beginner. These are usually cheap – less than a hundred pounds or equivalent in US dollars – and are badly made. One of the worst examples I have ever seen, in the camera shop I worked in at the time, was a 9cm refractor which had plastic lenses and eyepieces and would not even focus. Not only this, but on closer inspection, the objective lens was found to be stopped down on the inside, thereby reducing the aperture even more. On the box was advertised the ludicrously impractical – and impossible – power of 700x; even a 30cm telescope will be pushing it to get to that kind of magnification. This instrument was worse than useless and should have been consigned to the trash rather than being bought by an unwary novice who might well have been put off astronomy after buying such a piece of rubbish. I eventually managed to ‘hide’ it in the darkest and most inaccessible recess of the stock room but, unfortunately, this sort of trash scope is all-too-common.

Fortunately, the sort sold in camera shops are much improved over how they used to be and often include well-respected makes such as SkyWatcher but, that said, personally I would seek out a reputable specialised astronomy dealer rather than the local camera store. You can find details of dealers in astronomy magazines or by doing a Google search.

If you are a newcomer to observing, seek advice from a knowledgeable member of your local society, prior to making a purchase.

A Newtonian reflector of 20 or 25cm aperture on an alt-azimuth (Dobsonian) mount is ideal, simply because these are perfect apertures to get you started being not too big to handle or store (once you get to 30cm and above, things begin to get a little awkward). An 20cm or, better yet, a 25cm scope will show you all the Messiers, the Herschel 400, the Herschel II (the next 400), the brighter Index Catalogue objects and a great deal more in addition, depending on the quality of your sky.

I began with a 15cm Dobsonian reflector but found it a bit small, selling it and getting a 22cm Newtonian within a year or two as I felt I’d exhausted its possibilities (in truth I probably hadn’t at that time, but that was inexperience). 20 or 22cm may not sound a lot larger but you get 77% more light
gathering power with it over a 15cm. As for anything less than 15cm, such as the little 11cm reflectors, unless you are only a casual viewer of bright deep sky objects such as the brightest Messiers, or you want a grab-and-go scope in addition to a bigger one, don’t bother. Aperture rules in deep sky observing, the bigger the scope you can afford and move around, the better.

That said, however, and at the risk of sounding contradictory, someone just starting out in deep sky observing really should not rush out and get the biggest light bucket money can buy. For beginners ‘not too small but not too big either’ is the key to successfully starting out in deep sky observing. I’ve heard of people literally only in the hobby a few months buying themselves 40cm, 45.7cm or 51cm Dobsonians; in most cases this is plain old naivety and inexperience although there are some people who just have to have a bigger scope than anyone else. For a beginner it’s overkill and like learning to drive in a powerful sports car or, probably more accurately in the case of a giant Dob, a tank and will inevitably lead to frustration due to the sheer size of these things. When I started deep sky observing in the early 1990s it wasn’t long before I got aperture fever, and looked covetously over the Coulter and Meade Starfinder ads in Sky and Telescope, which advertised colossal Dobsonian reflectors of up to 73.6cm aperture. I didn’t succumb to the aperture fever then purely because I didn’t have the money for anything larger but, more importantly, I wasn’t experienced enough – just as well, because I know now that a big, heavy 30cm or 40cm Starfinder or Coulter Dob with its massive tube would never have been used, due to its sheer bulk, weight and awkwardness. I am sure that there are plenty of large telescopes that have found themselves gathering dust and cobwebs in garages, sheds or the ‘for sale’ columns due to inexperienced observers who, having bought them, then found them too cumbersome and heavy to use.

Leave the big stuff for when you are an experienced, proficient observer and used to handling telescopes. Start out with that 20 or 25cm reflector and move up to larger apertures as your observing skills, and desire to see more, increase.

There are two main types of telescope which astronomers use, the reflector, which uses mirrors to gather light, and the refractor which uses lenses. Most amateur telescopes are of the reflecting type, because inch for inch of aperture, these are far less expensive than refractors. The advent of the Dobsonian mount means that there are now huge amateur telescopes of sizes undreamed of even a decade ago. Dobsonian reflectors of 51cm, 63cm and even 91cm aperture are a feature of star parties, in the United States especially but increasingly in the United Kingdom too, but an equivalent refractor would be prohibitively expensive.

However, there are some quality small refractors coming onto the market and which retail for a few hundred pounds or dollars. These are highly portable, a huge advantage in these days of chronic light pollution, and often come with digital setting circles.

Also in increasing use these days are catadioptric telescopes, which include Schmidt-Cassegrains and other hybrids. These are a combination of reflector and refractor and have long focal lengths (typically f/10) which makes them more suited to planetary astronomy due to their relatively small field of view. Nearly all catadioptric telescopes on the market in 2014 come with Goto systems, computerised automatic pointing devices, which eliminate the drudgery of star hopping – which can quickly become tedious if you cannot nail down that faint galaxy - and enable the observer to locate the desired object quickly.

Whatever type of telescope you choose, there is one extremely important point which should be borne in mind – it should be very rigidly mounted. There is no point in having a good telescope if the mount is flimsy, the scope will not stay still, and you will end up not seeing anything very well, which is very frustrating and can even lead to people losing patience and giving up altogether, which is a shame.

One of the most noticeable developments in amateur telescopes in recent years has been the introduction into the market of mass-produced, but good quality, Dobsonian telescopes. These are usually produced in China and made for brands such as Meade, SkyWatcher and Orion (USA). GSO,
of Taiwan, is another producer of Dobsonian telescopes and these are marketed under different brands, depending on the country or region of sale. In the UK, these are branded ‘Revelation’, in the USA ‘Zhumell’, in Australia ‘Bintel’ and in continental Europe ‘GSO’. The optics are generally of reasonable quality and fine for general deep sky observing and sizes range from 15cm right up to 40cm. I certainly wish these had been available when I was starting out because they are a good alternative to more expensive premium scopes, as even the 40cm models cost less than £2000/$2000.

Alternatively, consider the second hand market. There are plenty of scopes in the ‘for sale’ columns on Cloudy Nights, AstroMart and UK Astronomy Buy and Sell and most likely via your local club, too.

Once you have purchased your telescope, it is worth investing in decent eyepieces and finderscope. On my previous telescope, I used a Telrad finder, which is a 1x (“life size”) finder. It has three dimly lit concentric red rings which appear to lie among the stars as you look through it. The inner ring covers half a degree, which is the area covered by the full Moon. With the aid of a star atlas I can locate the area of sky where the object I want to observe is situated. Using the Telrad, I can star hop to the area, and if the finder is properly aligned, the object should be in the middle of the innermost ring. A look through the eyepiece of the telescope will confirm this. There are also other Telrad-like finders on the market as well, such as the increasingly popular little red dot finders, which, when used in conjunction with a finder scope are very accurate and well worth obtaining. I have used a Telrad for 18 years and would not be without one but whichever 1x finder you choose, a traditional finder is still useful to have.

If you go for a traditional finder, a 10x50 is the best size. This is because it has a nice big objective lens and decent magnification. There is no point in buying one which is too small because it will be hard to locate anything with. Some ones supplied with commercially made telescopes are often inadequate, due mainly to their small size – 6x30 is quite common but not much good.

**Looking after your scope**

When not in use store your telescope in a dry, cool area, such as a cupboard, spare room or secure shed. If you have garden of your own, or a generous relative who is willing to let you use part of their garden, you could build yourself an observatory. However, for most people storing the scope indoors is the only option. A shed is ideal for serving as an observatory. Keeping a scope set up and ready to wheel out makes observing so much easier and will increase the number of sessions, simply because there is less effort involved in setting up.

Reflector mirrors do get dirty and will need cleaning every so often. However, the aluminised surface of a mirror is very delicate and prone to damage and quite large amounts of dirt will not noticeably degrade the image, but scratches caused by clumsy cleaning will. If a mirror gets damaged and scratched, light will scatter, cause ghost images and the image lose contrast.

To clean your mirror, use a rocket blower or can of compressed air to remove any loose dirt. Then soak the mirror in a container of warm water containing a weak detergent solution. Once the mirror has soaked rinse it off with distilled water. If the mirror is clean, the distilled water will flow off the mirror evenly. Dab (do NOT rub!!) off any remaining droplets with soft cotton wool. If the water doesn’t flow evenly off the mirror then repeat the cleaning process as many times as necessary to thoroughly clean the mirror.

NB - If you are not confident or you have never cleaned your mirror before, then seek expert advice from your local astronomical society. The author and the Webb Deep-Sky Society accept no responsibility for any damage, however caused.

**Collimation**

Collimation is the process of aligning your primary mirror with your secondary mirror. If the telescope mirrors are out of alignment you will not be able to focus your scope properly and your observations will suffer as a result, besides which it is uncomfortable to use poorly calibrated equipment.
Quite often, inexperienced telescope owners are daunted by the thought of recollimating their telescope, as it is very much seen as a ‘black art’ and almost akin to dabbling in witchcraft, but it is actually very simple. However, if you are worried about performing the operation, then seek out experienced help. All astronomy societies will have at least one member who is an expert, and internet astronomy forums such as Cloudy Nights (www.cloudynights.com) are a mine of help and information. Performing an internet search for ‘collimating a telescope’ will also bring up websites with plenty of information on the procedure. However, some reflectors are manufactured with sealed systems, meaning that they are collimated at the factory and subsequently never need adjusting again.

I don’t want to go into too much detail here because there is a wealth of information on the internet about how to collimate a telescope but, basically, collimation involves ensuring the optical components – focuser, secondary mirror and primary mirror all line up, so you get the best possible views with minimal distortion.

To collimate the scope, especially if the optical tube assembly (OTA) is a long one, you’ll need two people; one to look into the focuser, using simple eyepiece-like device called a Cheshire, and one to turn the screws on the back of the primary mirror cell. First though, make sure the secondary mirror is properly aligned beneath the focuser but, that said, most mis-collimation is because the primary is out of alignment and it usually does not require a lot of adjustment, especially if the scope is kept fully assembled and is not moved around a lot.

At the rear of the telescope tube, you will find three screws. These will usually require a small Allen key to turn them unless you’re using a large scope, which will usually have three knobs to turn the screws instead. Guided by the person looking into the focuser, the person adjusting the primary mirror should turn each screw in one by one until the image of the secondary mirror is perfectly centred as seen though the focuser (with the eyepiece removed). I find using a laser collimator much easier because this enables the process to be carried out by one person – you can look at the laser display and turn the screws at the same time.

Typically, telescopes with longer focal ratios (‘slow’ telescopes) such as f/6 and higher are less sensitive to mis-alignment and do not need collimating as often as ones with shorter focal ratios (‘fast’ telescopes) of f/5 and below. The smaller the number, the ‘faster’ the mirror. Large Dobsonians of 51cm (20
inches) and above with short focal ratios, even down to f/3, from premium telescope makers have become very popular over the past few years, especially in the US, thanks to better mirror-making techniques and people’s desire for the eyepiece to be lower to the ground, thus negating the need for huge orchard ladders. With these short focal ratio scopes observers only need a short stepladder, a set of kitchen steps or even no steps at all, as some scopes are even short enough that you can observe objects at the zenith with your feet on the ground. Unfortunately the trade off is that these telescopes are more sensitive to collimation issues than longer scopes, and may need collimating more frequently, although they are not actually harder to collimate than more traditional longer focal length instruments.

Eyepieces

It is a true saying that the eyepiece is half your telescope and, as with the telescope, it is best to invest in good quality. It is much better to get a couple of good eyepieces and a Barlow rather than a load of bad quality eyepieces. It is difficult to recommend any particular make or brand as telescope type, focal ratio and the depth of your bank balance may play a big part in choosing one. However, go for the best you can afford, not the cheapest.

Eyepieces come in two fittings, the most common standard fitting is 1.25 inch and this will fit all modern telescope focusers – it’s a curious fact of amateur astronomy that eyepiece focal lengths are in millimetres but barrel sizes are usually spoken of in inches. Another common size is 2 inch, these are usually the large, low-power eyepieces which come in this fit. Most modern telescopes of 25cm and above in aperture have focusers which accept 2 inch eyepieces and they come with a fitting which adapts the focuser to take 1.25 inch ones.

For a beginner, I’d recommend a low power eyepiece – such as a 25mm or 30mm – a medium power eyepiece – around 15 to 12mm - and a higher power one such as a 9mm or 6mm. Add a Barlow (a magnifying lens which sits in the focuser and which the eyepiece fits into) of 2x and you’re set. Later, maybe, you can fill in any gaps in your collection.

The most popular type of eyepiece was, and still is, the Plossl. This is probably the most recommended type for deep sky observing and is made by most manufacturers. Plossls contain at least four glass elements, arranged in doublets (two lenses together) and have decent eye relief (the distance your eye can be from the glass yet still retaining the full field of view) which is of particular concern to spectacle wearers as specs tend to get in the way and mean you do not get the full field of view in eyepieces with poor eye relief. They are very good eyepieces indeed and quite a few observers are content with nothing more than a decent set of Plossls and a Barlow lens.

Before the Plossl, the most popular type of eyepiece was the Orthoscopic which has good eye relief and four lenses, three of which are arranged as a triplet. A good set of Orthoscopics, such as those made by Kasai of Japan, are well worth considering and typical focal lengths are 25mm, 16mm, 12.5mm and 6mm. Orthoscopics, with their simpler design, are also better for teasing out detail in faint objects than more complicated eyepiece designs would be. This is because less glass means more light gets through and, in deep sky observing, you need as much light to come to you from the object as possible. My first eyepieces were Orthoscopics and I still have a couple of them.

Kellner is another basic, but good design and still in use today. A Kellner eyepiece has three lenses, including a doublet, good eye relief and a 45 degree field of view.

Older types of eyepieces, such as Ramsden, Huygenian or Erfle, are rarely seen these days although you may still come across them in older or antique telescopes. Ramsden and Huygenian eyepieces are old-fashioned, poor eyepieces and only contain two elements. They have poor eye relief and a very narrow field of view and have been long since superseded by much more modern and higher quality designs. Erfles were originally intended for military use, such as in gun sights on tanks or in periscopes and, as such, have large fields of view. Until the advent of modern wide angle eyepieces such as the Nagler, made by Televue, or the Ultrawide, made by Meade, these were very good for low power wide-field views.
The well-known US optics maker Tele Vue manufacture and design some of the best eyepieces on the market today. Among their designs, not made by anyone else, are the popular Panoptic, Nagler, Radian, Ethos and the new Delos eyepieces.

**Panoptic** eyepieces, with their 68 degree apparent fields, come in focal lengths of 41mm, 35mm, 27mm and 19mm. The 22mm is now discontinued. The main disadvantage with Panoptics is their size and weight which is a consequence of the six glass elements in them; like the Naglers this can be enough to unbalance a smaller telescope. The largest Panoptic, the 41mm, is the size of a standard beer can. My 35mm and 22mm Panoptics are my main ‘finding’ eyepieces. Once I’ve got to the location of the object I want to observe, I use one of these to ‘zero in’ on the object and, with their wide fields, these eyepieces are ideal for this.

**Nagler** eyepieces, named after their inventor Al Nagler and known fondly among amateurs as ‘hand grenades’ due to their size, shape and weight, are quality eyepieces and highly popular due to their 82 degree apparent field of view. However, like the Panoptics, they are expensive and heavy, especially in the longer focal lengths. Naglers have 6 or 8 glass elements within them, which accounts for their size, weight and cost.

**Radian** eyepieces come in focal lengths of 14mm, 8mm (discontinued), 6mm, 5mm, 4mm and 3mm and have excellent eye relief, even in the short focal lengths, and six glass elements. I use mine for high powered observations of tiny galaxies, planetary nebulae or details in larger objects.

**Ethos** eyepieces are a more recent design and are incredibly expensive, even more so than Naglers and Panoptics. The longest focal length Ethos, the 21mm, retails at an eye-watering £675 (over $1000!) so they can cost more than a telescope. Ethos eyepieces come in focal lengths of 21mm, 17mm, 13mm, 8mm and 3.7mm and they have a massive apparent field of view of 100 degrees.

**Delos** eyepieces are a smaller – and cheaper! – version of the Ethos and don’t have such a wide field of view; instead of 100 degrees it is 72 degrees, still very generous. At the time of writing, Deloses come in focal lengths of 17.3mm, 10mm and 6mm.
**Meade Ultrawide** series eyepieces are another design with massive field of view and generous eye relief. I got to try one out and it is like looking though a porthole into space. If I didn’t already have a fairly complete eyepiece collection I would be very tempted by these.

**Pentax XL** and **XW** series are also designs with excellent eye relief and wide fields of view. They are also, like the Panoptics or Naglers, very large. Unfortunately the XL is apparently no longer in production but you should be able to pick them up second-hand, although I believe they can change hands for not insignificant sums.

**Zoom** eyepieces, usually 8-24mm or 7-21mm, are an alternative to fixed focal length ones especially if you don’t like fiddling about changing eyepieces. Personally, I don’t like them, as I have found the zoom mechanism can get jammed as it did in my zoom eyepiece. I don’t know that many people who use them.

![Foam insert box for the storage of eyepieces, filters etc.](image)

A **Barlow lens** is a device which effectively increases the magnification of an eyepiece by decreasing its focal length, similar to how a teleconverter works in photography. The Barlow is a tube with a lens in it, which slots into the telescope focuser and the eyepiece then fits into the top of the Barlow. The most common Barlows are 2x models but 1.5x, 2.5x, 3x and even 5x ones are also available and, as with eyepieces, they are available in 2 inch and 1.25 inch barrel sizes.

There are plenty of other designs and manufacturers out there too. Takahashi, Zeiss and Baader are excellent makes although the Zeiss eyepieces are similar to the long focal length Ethoses in price. You can also find cheaper, but adequate, eyepieces from makers such as Celestron, Orion (USA) and SkyWatcher/GSO. These don’t have the quality of the likes of Zeiss, Televue or Pentax, etc, but are good enough.

As with telescopes, seek advice as to what’s best for you and, if possible, try them out first at a club meeting or star party. Like all other precision optics, eyepieces need to be looked after and stored properly to prevent dirt and damage. When not in use, keep them safe in a foam-lined case, such as the aluminium or plastic cases photographers use. Cut-out foam is ideal for preventing them knocking against each other and getting scratched or dented. Looked after properly, a decent set of eyepieces will last forever.
Filters

Unfortunately, the night sky is being ever more encroached upon by the modern curse of light pollution, so filters are becoming an increasingly necessary piece of equipment for the deep sky observer. Even if you are not in a light-polluted area specialised filters, such as Oxygen III or UHC, will help in increasing the visibility of otherwise hard to see objects such as tiny, stellar-looking planetary nebulae. There are several types available on the market these days, from general light pollution reduction filters to specialised filters for certain types of object, such as Oxygen III for planetary nebulae. The prices vary and, like telescopes and binoculars, you get what you pay for. There are good ones and not-so-good ones, so shop around and also read independent reviews. The filters screw into the base of an eyepiece, and generally come in standard 1.25-inch and 2-inch fittings.

It should be pointed out that filters only really work on gaseous nebulae and will not help when observing sources of continuum radiation such as galaxies, reflection nebulae and star clusters.

Light pollution reduction filters

These work by suppressing the emission of street lights, and only allowing the light from the object through to the observer, enhancing the contrast and making faint objects easier to see. They have a wide band pass (‘broadband’) and this makes them suitable for viewing all objects, including galaxies and reflection nebulae. Typical brands here would be the Lumicon “Deep Sky” or the Orion “Sky Glow” filters, but others are available from makers such as SkyWatcher.

Nebular filters

These narrowband filters are the best general purpose filter for use on all types of emission or planetary nebulae. These filters are less specialised than the OIII or H-Beta and, as such, I would recommend that a Ultra High Contrast (UHC), made by Lumicon, or UltraBlock, made by Orion, would be your first choice when purchasing a filter for visual deep sky observing.

Oxygen III (OIII)

This filter allows oxygen emission lines through and so can be used on planetary nebulae, and on a lot of bright nebulae as well, and is a very useful filter. In the case of faint planetary nebulae, an OIII filter will improve the visibility of the object although this is not the case for all of these objects, some don’t respond. In the case of tiny, stellar-looking planetaries moving the OIII filter between your eye and the eyepiece, in a technique called ‘blinking’, will confirm whether the object that may be the planetary really is, or whether you’re in the wrong place and what you’re looking at is just another star.

OIII filters are also very good on the Veil Nebula.

Hydrogen Beta (H-Beta)

The uses for this filter are a lot more limited than the uses of an Oxygen III, and it can be used on a handful of objects, such as some bright nebulae. It is often known as the “Horsehead filter” from its ability to show the nebula (IC 434) that the Horsehead (B33) is silhouetted against; without the H-Beta filter, it would be very tough indeed to see IC434/B33. It also works on the California Nebula (NGC 1499), Campbell’s Hydrogen Star, Barnard’s Loop and the Cocoon Nebula (IC 5146), among a few others.

If you have more than one filter, experiment with them, see how they work on different nebulae. Try the H-Beta, if you have one, on other nebulae and see what happens. Try your OIII filter on emission nebulae and your UHC on planetary nebulae and so on. The results could be interesting and informative.
[Filters - clockwise from top: 2 inch Lumicon UHC, 1.25 inch Lumicon Oxygen III, 1.25 inch Lumicon H-Beta, 1.25 inch Lumicon UHC.]
Here are a couple of diagrams illustrating the difference in filters, UHC and OIII on the Crab Nebula (bottom) and on the Veil Nebula (below). [Stewart Moore]

*The Crab Nebula (M1) observed with a 35.5cm f/5 scope at 100x*

**UHC Filter**
- Much better contrast
- Brighter at N end
- Patchy brightness
- Fibrous structure

**OIII Filter**
- Bright
- Lost fibrous structure
- Very slight brightening on W edge
- ‘Bay’ not so clear
When setting out to observe deep sky objects, you need to know exactly where they are located in the sky. Obviously, a few objects are going to become well known to you – you are not going to need a map to find them. However, as there are literally thousands of deep sky objects out there, you are going to need guidance as to where they are, and this is where a decent detailed star atlas comes in. There are quite a few star atlases on the market, in book form, as CDROMS and as downloadable planetarium programs.

Basic paper atlases

When starting out in astronomy, a minimum requirement is a basic star atlas. These may show stars that can be seen with the naked eye or with small instruments such as binoculars. A basic star atlas should show which constellations can be seen at certain times of the year, and show stars down to about magnitude 6. The charts are usually large scale and show two or three constellations on the same page, to help the beginner find their way around.

One of the best is the Cambridge Star Atlas 2000 by Wil Tirion. This atlas show stars down to around magnitude 6.5, has 900 DSOs and tables describing the objects accompanying each chart. My copy of Star Atlas 2000 dates from the early 1990s and got a lot of use in my early years as a deep sky observer. It is now mouldy from dew and dog-eared, as well as written on, but for a long while I used it in conjunction with more advanced charts because what I found so useful about it is that it gave me the “big picture” to get my bearings as opposed to Uranometria, for example, which zooms in on a tiny portion of the sky. I still have my Star Atlas 2000, but it is now in semi-retirement on my bookshelves.

Sky Atlas 2000 is a popular large atlas. It comes in several editions, including desk, laminated desk, field and laminated field editions. There is also the option of buying an unbound edition. The desk editions have the objects plotted in colour while the field editions show white stars on a black background, as you’d see in the sky. It’s a big atlas, each fold-out chart is 51cm x 38cm, and shows stars down to magnitude 8.5 as well as 2700 deep sky objects.

A more recent addition to the stable of basic paper atlases is Sky Publishing’s Pocket Sky Atlas, first published in 2006. This is similar to the Cambridge Star Atlas but the stars are plotted to magnitude 7.6 and the galaxies to 11.5. It’s not quite pocket sized, measuring 16.5cm x 22.9cm, but is small enough to go into a backpack or camera bag for trips abroad. There are 80 charts and the entire Herschel 400 is plotted. Mine has replaced my much-loved Cambridge Star Atlas for binocular or small-scope observing sessions and for travel. It’s wire-bound which makes it a lot easier to open and keep flat.

Lastly, and certainly not least, there is the Webb Deep-Sky Society’s own Webb Society Star Atlas, compiled by member Mike Swan and first published in 2002. This is a spiral-bound soft cover atlas and, as such, is ideal for taking on observing trips abroad. It contains 44 charts, all in colour, with 17,494 stars and 1810 deep sky objects plotted and the limiting magnitude is 7.10.

More advanced paper atlases

Once you start to find your way around the sky, and/or progress to a larger instrument, then you will probably need to acquire a more detailed atlas. These have smaller scale charts, showing parts of constellations – maybe three or four charts to one constellation - and show fainter stars, down to magnitude 9.5 or below. I use Uranometria 2000 and in my opinion, it is the best paper atlas on the market. It is fairly expensive and heavy, but plots stars down to 9.75 magnitude and a massive 30,000 deep sky objects, 25,895 of which are galaxies. An alternative is the Millennium Star Atlas which was published, using Hipparcos data, in the 1990s. This comes in three volumes, covers the sky in order of right ascension and shows stars down to magnitude 11. Like the Uranometria it is heavy and expensive and I believe it is now also out of print but you may be able to get second hand copies. The Herald-Bobroff Astroatlas is a much sought-after advanced star atlas and shows deep sky objects down to 15th magnitude and stars to 14th magnitude. It is, however, out of print and commands ridiculous prices on the second hand market.
Software atlases

Inevitably, more atlases are coming onto the market in the form of CDROMS and downloadable software. One of the best of these is MegaStar, which allows you to customise the charts and also generate and print out your own charts for use at the telescope if you don’t want to take a laptop with you. It also allows you to zoom in and out, depending on how detailed you want the charts to be. You can also add Telrad, finder and eyepiece overlays and customise the software according to the aperture and focal length of your telescope, as well as add your eyepieces so you can generate charts matched to the field of view of your telescope. You can also filter objects according to magnitude, type and catalogue and if you know your telescope’s limiting magnitude (i.e. the faintest objects than can be seen with it) you can filter out those objects which are too faint to be seen.

MegaStar plots 208,000 deep sky objects, most of which are galaxies and these are shown rotated to their position angle in the sky. These atlases, however, can be more expensive than paper ones, MegaStar costs around £100/$129. The RealSky Star Atlas uses real images of objects taken from the Deep Sky Survey, and this can be used in conjunction with MegaStar in that once the MegaStar atlas page is on the screen, the RealSky image can be loaded and superimposed upon it.

There is also free downloadable planetarium software, such as Stellarium, which shows the entire NGC in a realistic sky. Type ‘Stellarium’ into a search engine and it will give you the link to their site. Increasingly, so-called ‘smartphones’ such as the Apple iPhone or Samsung Galaxy, are being used in astronomy. These use small programs, known as ‘apps’ (short for ‘applications’) which are quite powerful tools and can be downloaded from iTunes or Android Market for upwards of £8. Two examples for the iPhone are SkyVoyager, which contains 32000 deep sky objects and StarMap which has a mere 350000 stars and 150 DSOs. The advanced version, StarMapPro, contains 2.5 million stars and 25000 DSOs. These can also be used on the iPod Touch. Make sure though, if you’re using a smartphone, to not ruin your dark adaptation with it. Cover the display with red acetate and use it on its dimmest setting. The same applies when using a laptop or a tablet.
Techniques

Obviously the way you want to carry out your observations is entirely up to you, but the following chapter is based on the way that I observe and these methods have worked well for me over the years. However, you will quickly develop your own ideas and way of doing things, but I do hope you find the following chapter useful.

As stated in the introduction, apart from optical aid, all that is required for visual observation of the deep sky are pencils (2B to 6B), dim red torch, eraser and sketchbook. The next few paragraphs are crucial to the success (or otherwise) of your session and will make a big difference to what you see.

Setting up

Unless you are fortunate enough to have your own observatory – which doesn’t have to be the classic dome, it can be an ordinary garden shed - you’ll have to get set up before you observe. It sounds obvious but setting up can be time-consuming, particularly if the scope is kept inside the house and it is a collapsible truss design. You’ll need to get your telescope and mount out of the house or garage and, unless it’s very small indeed, you’ll be making at least two or three journeys into the house to get the bits. Before I got a shed for my scopes, I needed to take my old 30cm scope apart by removing the tube from the base, placing it on the floor, carrying the base outside and then going back for the tube. I then had to go and retrieve my eyepieces, finders and charts. This was a bit of a pain, so I invested in a shed. Now, I just wheel the scope out of my shed and am observing within minutes if it is dark enough. If you keep your scope in the house, it’s going to have to cool down to the ambient temperature, especially in winter when houses have the central heating on but the outdoors temperature is much lower. The reason for this is that a warm telescope mirror will create currents of air inside the tube and that will make the image boil, due to the turbulence caused by the currents. The larger and thicker the mirror, the more cooling-down time is needed; a 20cm reflector will reach the ambient temperature quicker than an 45.7cm will, for example. As the scope is cooling, you can align your finders and consult your observing lists for the session.

Setting up during twilight, as long as you don’t need to go back into a brightly-lit house for anything, allows you to become dark-adapted while actually doing something. As it gets dark you could look at any available planets while you’re waiting.

Night vision

Before starting your observing session you will need to get dark adapted. The reason for this is that after being exposed to bright light, for example television or fluorescent lighting, the eye cannot discern faint objects. It has also been said in various sources that one should stay out of bright sunlight for at least 24 hours prior to observing. This may sound slightly drastic, but will improve your night vision when you come to observe. If you have to go out and about, and it is unreasonable to assume anyone is going to spend a nice sunny day inside, then wear UV resistant sunglasses or even glacier shades to protect your vision. If you protect your vision from bright sunlight then you’ll become dark adapted that much faster, plus you’ll be able to see a magnitude or two fainter.

Avoid alcohol, because alcohol can temporarily impair your night vision – oxygen that could be used by the body for acute vision is instead assimilating booze! Eat before a session to keep the blood sugar levels at a normal level as this helps your night vision, too. Don’t smoke either because, along with swilling alcohol, smoking is the worst thing in the world for your night vision.

In order to become dark adapted, you need to spend at least half an hour in the dark, maybe just scanning the sky with binoculars or the naked eye, or setting up your equipment. Maybe you could make a black patch, like a pirate, and put that over your observing eye for an hour or so prior to observing.
I have certainly heard of this being done and it will prove useful for preserving your dark adaptation if you need to return to the house or otherwise finding yourself having to use white light. Also the use of a dim red torch, instead of a conventional white one, is essential as this enables you to see what you are doing, but preserves your night vision at the same time. Red light does not have the same detrimental effect on night vision as white light.

Once set up and dark adapted, you are ready to observe. Ideally, you should have some idea of your target objects before you start. It is good practice to have a plan, such as a project like the Messier List or the Herschel 400. At the very least, make a list of the objects you wish to observe, otherwise you could end up wandering aimlessly around the sky and not seeing very much at all.

**Keep warm**

It may sound obvious, but keeping warm is essential to the success or failure of an observing session. There is nothing worse than being cold and astronomy by nature is a chilly hobby, because the observer is out at night, often in very cold weather. Most observing is done in the winter because of the longer nights and better seeing conditions and having to pack up due to being so cold you can’t continue is a pity, especially if the conditions are very good.

Eating before an observing session helps, due to the digestion process creating heat within the body; the saying that food is fuel may be a slight cliche, but it is true. Eating also has another benefit because if you have an empty stomach and your blood sugar level is low your night vision will be affected.

The best method for being warm and remaining warm is to wear plenty of layers of loose clothing. Five layers of thin clothes are better than two layers of thick ones. For winter observing I wear, in ascending order, a t-shirt, a long-sleeved t-shirt, a fleece jumper with a high collar, a hooded top and a thick fleece jacket. I wear a pair of combat trousers over a pair of jeans, as jeans alone are no good for insulation, three pairs of socks, leather hiking boots with inch-thick soles, a scarf and a fleece hat with the hood pulled up over it. All those layers sound clumsy but, in fact, are actually easy to move about in. A hat or hood is also ideal for keeping creepy-crawlies off your head. I have had many encounters with giant spiders and crickets falling on me from the shed roof or trees in the dead of night, and as someone who really does not like things with more than four legs, particularly spiders, I am never without a hat or hood even in summer. A ball-cap with the peak reversed (otherwise the peak will hit the eyepiece, potentially knocking the scope off target) is good for keeping spiders and other multi-legged creatures off.

As for your hands, gloves can be very clumsy for the fiddly tasks required during an observing session. Focusing the telescope, changing eyepieces, taking notes, sketching, using filters, all are made awkward when your hands are encased in thick gloves. But freezing, stiff, hands are detrimental to the observing experience, too, so what is the solution? I have found that fingerless gloves are very useful, keeping my hands warm while, at the same time, allowing me to do the fiddly things. If necessary I can wear thicker gloves over the top, taking them off when I want to make notes or a sketch.

Take a hot drink outside with you in a flask or, if you are in your back yard or on your drive, go to the kitchen for drinking chocolate or coffee. Make sure the lights aren’t on though or your dark adaptation will vanish quicker than it arrived. Keep moving about, too. Observing is a pretty sedentary activity and you will get cold far more quickly if you are static for long periods of time. Walk up and down, stamp your feet, even run on the spot (I do know of people who go for a run round the block but that would look odd and rather suspicious in the dead of night!), anything to keep the blood flowing and stay warm. Muscles and joints stiffen up with cold and inactivity so moving about is essential for staying comfortable.

**Get away from lights**

Deep sky observing requires as dark an observing site as possible because deep sky objects are rendered invisible by extraneous light. Artificial light pollution is a real menace to deep sky observers as, not only does it make it extremely hard to see the objects, it makes it difficult, if not actually impossible, to even
find them in the first place. Light pollution - badly directed light going into the sky where it is wasted - from street lamps, (in)security lights, porch lights, car park lights, lights on business premises, etc, all combine to cause skyglow which wipes out all but the brightest stars. Even light from a window is a nuisance if it is shining out onto your observing patch. If you can’t get away from artificial lights, try and shield yourself and your telescope from them by erecting a screen, or putting bushes, trees or a building between you and them. Even better, if you can, take yourself and your scope to a darker site. This isn’t always practical, and personal safety at a remote site is an issue, but if you’ve got a friend or relative with rural property and you can stay there, or your club has a dark sky site, then you’re set.

Star hopping

This is the oldest technique used for locating celestial objects. Basically, all it involves, as the name suggests, is hopping from star to star, with the aid of charts, to the desired object. Many observers, including myself, use this method – I use it because I have a large Dobsonian scope which is undriven. I have used star hopping method since I first began as a deep sky observer in 1993 and have no plans to change, although an equatorial platform and digital setting circles would be very nice.

To star hop to your chosen object, a good star atlas and finder are essential. I’d also say that a Telrad 1x finder is also pretty essential. Most paper atlases and programs such as MegaStar have overlays (acetate ones in the case of paper charts) which show Telrad concentric circles scaled to the atlas. These are incredibly useful and get me on, or near, the object 9 times out of 10. I strongly recommend getting a Telrad finder if you don’t already have one.

Setting circles

If you have a drive for the telescope, and it is equatorially mounted and polar aligned, you can use the setting circles to locate objects. All deep sky objects have coordinates, and these are given in declination and right ascension. These are the celestial equivalent of latitude (declination) and longitude (right ascension or R.A.). The setting circles have to be set on the coordinates of a known object to calibrate them for the observing session, and then the motor drive has to be switched on. Once this is done, you are ready to observe.

To locate the desired object, set the declination coordinates first, and then the right ascension. The motor drive has to be running or the object will drift out of the field of view, and the setting circles will have to be reset. All you need is a motor on the R.A. axis, the declination will take care of itself, as long as the telescope is properly polar aligned.

Digital setting circles

This is the easy way to use setting circles – let a computer do it! Again the mount has to be properly polar aligned, but once this is done, all you have to do, depending on the system, is to calibrate the system on two known stars. Once this is done, you can begin. The main drawback is that these systems are fairly expensive and can go wrong. Systems, such as the Argo Navis and Sky Commander ‘push-to’ systems, are now available for Dobsonian telescopes, as well as the usual equatorial mounts, and mainstream Dobsonian manufacturers such as Orion (USA) and SkyWatcher also supply push-to systems with some of their scopes. Orion’s system is known as ‘Intelliscope’ and it works very well. They work by, firstly, being aligned on a couple of bright stars then the observer inputs the name or coordinates into the handset. The object is then found by pushing the scope to where the object is. The Argo Navis and Intelliscope systems indicate the direction you need to push the scope, by means of up and down arrows shown in the display. Numbers in the display next to the arrows count down and, once you’ve got to the object’s location, it will show zeros. If the scope is aligned properly and everything is working as it should, the object will be in the eyepiece field of view.

Goto systems

A lot of telescope kits sold today, especially those made by Meade and Celestron for their Schmidt-Cassegrain systems, have Goto systems installed. These mechanically move the scope to an object once the observer has input the object name or coordinates into a handset. Like the digital setting circles and
push-to systems, these need to be aligned on stars first, and the mount needs to be properly polar-aligned. They’re great for quickly locating objects but, like all precision electronics or mechanics, have more to go wrong.

Sometimes when you have found the field of the object it cannot be seen, due to its low surface brightness, or because it is very small, but there are several techniques that can be used at this point.

**Tricks at the telescope**

**Tap the telescope tube slightly**

This is the easiest method and works because the eye is better at picking up moving objects than stationary ones.

**Use averted vision**

This means looking at the object out of the corner of your eye. Here, you make use of the fact that the rods in your eye are better at picking up faint objects than the cones. The cones are in the middle of the eye and are used for daytime vision but are not sensitive at low light levels. The rods, which are at the edges of the eye, are far more sensitive at low light levels. Thus, by not looking directly at the object, you can see it. It sounds counterintuitive but it works well.

**Increase the magnification**

Despite past wisdom saying that you shouldn’t use high magnifications on deep sky objects, this is a good, useful technique. Increasing the magnifications doesn’t increase the contrast, despite what people say, but often you will see a large object more easily than a small one. Experienced observers always use this technique once they have found an object to see how much more they can see. It is particularly useful when observing galaxy clusters as sometimes more galaxies can be seen at higher power.

**Use a hood**

Covering your head with a hood to exclude stray light helps to increase contrast on faint objects, and you can see much deeper by using this method. I use a specialised observing vest with an oversized hood on it, made by Dark Skies Apparel in the USA (see links at the back of the book) but a t-shirt, coat or any other dark item of clothing will do as long as it is thick enough to keep out light.

Now what do you do once you have located the object...?

**Keeping records**

Much satisfaction from deep sky observing can be gained by keeping records of what is seen. I just made lists when I took up astronomy, but when I looked back at them, I could not remember what the objects looked like, or even what class of object they were. As I could not see the point of this, I decided to have a go at sketching and describing the objects I saw, and although the early results left quite a lot to be desired, with practice I improved greatly and now have a lot of nice observations to look back at on cloudy nights.

By keeping accurate and detailed notes and sketches, you can build up a record of your nights under the stars, and in the future you can read back over these. It is all too easy not to bother, but it is nice in future years to have something to look back on, to remind yourself of the things you have seen. Not only this, but by looking at the objects and making careful sketches and/or notes, you will become a better observer. This is because sketching and note taking forces you to really look at the object and study it, rather than just giving it a cursory glance and moving onto the next one. When I started out in astronomy, I merely made lists of the objects I saw, but quickly found that this was not very satisfactory, and I also very quickly discovered that I could not remember what the object looked like.

So, I hope to encourage others to make notes and sketches of what they see. It is a satisfying way of keeping a record of your observations and observing sessions and it is nice to have something to look back on in years to come. I only have to open an old observing notebook and I am instantly transported
back to sessions of years past - even down to the sounds and smells (barking dogs, distant rock festivals and the scent of foxes in the UK, howling coyotes and cooking burgers in the USA, the thumping of kangaroos in the dark and bush fires in Australia), even after a number of years. If there was some sort of disaster at home, the first things I’d save - after the pets, of course - would be my observing notebooks and ring binders.

**Sketching**

Before starting to sketch the object, draw, using compasses, a circle to represent the field of view. This can be any size you like, but I would suggest not making it too small - you could end up squashing the drawing to try and make it fit the circle, losing accuracy in the process – a diameter of ten to twelve centimetres is ideal. It is a good idea to draw several of these before going out to the telescope, but leave some space for a written description if you want to do one.

Before starting to sketch the object, thoroughly examine it and its surroundings in the field of view. Don’t forget to indicate the orientation of the drawing, i.e. where west and south (or north) is on the drawing. This is easy, switch off the telescope drive if you have one, and see which way the stars are drifting. This is west (or preceding). In a Newtonian reflector, north and south are reversed, but beware of field rotation.

Once this is done, you can start to put in the field stars. This has to be done with a high degree of precision, especially when drawing open star clusters, but is not too difficult once you have done it a few times. Varying star brightnesses are indicated by the size and shade of the mark on the paper – the brighter a star is, the bigger and darker the mark.

Now the field stars are in, you can begin drawing the object. Nebulous effects can be achieved by smudging soft pencil onto the paper, using either a finger or an artist’s smudging stick. You can achieve excellent and realistic results using this method.

At the telescope, in dim red light, your drawing will probably be rather rough and may look pretty bad once you get it into white light. This is quite usual and there is no harm in making a new “polished” version of the drawing as long as the finished article remains true to the original i.e. accurate. Also in the interests of accuracy keep the size of the circle the same as on the original.

When making a finished drawing, use good quality paper, such is found in artists’ supply shops. You can either use separate sheets of paper, or bound sketchbooks, and put the drawing at the top of the page, with a written description underneath. If you do written descriptions, you may want to put them into card index files, or in a lined notebook or on computer – it is up to you. I now use A4 card with the sketch redrawn on, which I file in large lever-arch ring binders. I also type up and print off my observations and file them with the drawings. These are arranged by constellation with a separate lever arch file for each type of object.

When you come to draw stars on your finished drawing, it is a good idea to draw them in ink, especially if you would like to get them published at a later date, and it looks nice, too. Another idea is to get hold of some black paper – easily obtained at an artists’ supply shop – and draw the object in white ink, or pastel for nebulous objects. If done with care, this is effective and will look very attractive. A modern alternative to doing this, and which I sometimes do, is to scan the white-on-black pencil sketch into the computer and reverse it in Photoshop or similar program.

**Making notes**

As well as, or instead of, making sketches of objects you may want to make written descriptions. Written descriptions should include the date, notes on weather conditions, seeing (of which more later), limiting magnitude and transparency, your location, the latitude e.g. 50 degrees north, and the naked eye visual limiting magnitude.
Once you have described the conditions, then you can start on the object. When making notes, you should include the following information: How bright is the object? What shape is it, i.e. round, oval, irregular, etc? Is the object equally bright right across, or does it vary? Does the object have any colour? Are there any other features? Once you become more proficient, you can include comments about the angular size of the object i.e. how big is it? Can you see the object in the finderscope? Don’t forget to include information about the object’s surroundings.

For different types of object, there may be extra information to include and I’ll cover that in each section, but as an example for open star clusters, include information on richness and compression (i.e. are the stars spread out or relatively close together?) as well as how easy it is to see against background stars. For a galaxy, is the centre brighter? Planetary nebulae may show colour, and also brightening or darkening towards the centre. Also, can you see the planetary’s central star? Globular clusters may be fairly loose or highly concentrated. Is the globular resolvable, either wholly or partly? In the case of diffuse nebulae look for any stars associated with it, and for sharp edges.

**Position angles.**

A lot of experienced observers use an object’s ‘position angle’ to describe its orientation. Each position angle corresponds to a cardinal point on a compass, so saying an object is elongated in position angle 90, for example, is just another way of saying that it is orientated east-west, or an object whose elongation in PA 45 is orientated northeast-southwest. The elongation of a deep sky object, is not greater than 180 degrees, although if you were to describe the position of one object, such as a star, relative to another, you’d use the whole circle up to 359 degrees. However, I wouldn’t worry too much about position angles to begin with, saying that an object is orientated E-W or NE-SW, for example, is perfectly fine.

This seems a lot to think about, but will become easier, the more experienced an observer you become.

**Seeing and transparency**

The visibility of most celestial objects depends critically on the two atmospheric effects known as seeing and transparency as well as on the darkness of the sky.

The seeing is a measure of how unstable the atmosphere is. If the stars are twinkling a lot then you have bad seeing, although the transparency may be good. If you are observing double stars, or other objects that require high resolution, then look for nights with good seeing. Often the presence of mist or high cloud gives good seeing but terrible transparency. Astronomers use the Antoniadi Seeing Scale to measure the seeing. The Antoniadi Scale is as follows:

I. Perfect seeing, without a quiver.

II. Slight quivering of the image with moments of calm lasting several seconds.

III. Moderate seeing with larger air tremors that blur the image.

IV. Poor seeing, constant troublesome undulations of the image.

V. Very bad seeing, hardly stable enough to allow a rough sketch to be made.

Bad transparency usually involves hazy, ‘milky’, skies and bloated stars. Another indication of bad transparency is the height of the skyglow from road lighting, as the higher it is the more pollution and vapour there is in the atmosphere. Clouds, of course, also affect the transparency as, drifting clouds, high cirrus and contrails from jets all play a part. It may look clear but high clouds will wipe out faint objects; galaxies and nebulae are particularly sensitive to this and the fainter ones will vanish like smoke if the transparency worsens even slightly.

There are various scales for rating transparency, some people use 1 to 10, where 1 is the best and 10 is the worst. The scale I use is this one, similar to the Antoniadi Scale.

I. Very clear and transparent. Milky Way ‘iridescent’. M33/M81 visible
II. Very clear. Milky Way bright but not iridescent. No clouds. M31 visible

III. Clear, some haze visible. Milky Way still visible but not detailed

IV. Milky skies, moderately hazy but observing of brighter NGCs doable/drifting cloud.

V. Poor to terrible. Very hazy, bloated stars, haloes round bright stars, Moon and planets or there’s lot of cloud. Not worth going out.

Sky darkness  is rated on the faintest star that can be seen with the naked eye, the naked eye limiting magnitude or ‘NELM’ for short. Astronomers use various sequences around the sky to get the limiting magnitude and this should always be noted when recording observations, as the detail recorded in an object depends very much on sky darkness as well as transparency. Obviously, rural locations have a better limiting magnitude than suburban ones but transparency also plays a part. High clouds will wipe out fainter stars just as well as deep sky objects. The NELM technique is rather subjective and does depend on how good, or bad, your eyesight is as one person might be able to see down to magnitude 6.5 while another person, standing right alongside, may only be able to see down to 5.8 or 6.0 and you need to be properly dark adapted but it at least gives another experienced observer an idea of what to expect at a given place. A more modern method is to get a little device called a Sky Quality Meter made by Unihedron and use that. This is more accurate than using the NELM method but these tiny devices are quite pricey, at over £100.
Observing

So now you know what’s involved, what’s all this great stuff you can see? There are different types of deep sky objects, some closer to home than others and some brighter than others, and they require various levels of skill to see. Some are very easy indeed and can be seen with the unaided eye, such as the Pleiades (Messier 45), Beehive (M44) open clusters in Taurus and Cancer, and the spectacular bright galaxy M31, in Andromeda, for example. Others need binoculars to see – and binoculars will indeed show you plenty of objects – a lot are visible with modest 15cm to 25cm scopes while still others will require larger scopes of 30cm and above. There’s something for everyone in the deep sky, no matter what instrument you use or where your level of skill is at.

In this section, I will describe each type of deep sky object and give a few examples of the best and brightest, or most interesting, to look at as well as how to observe and sketch them. I have also given some ideas of what to write (based on the Night Sky Observers’ Guide by Kepple and Sanner, 1999) and provided some of my own object descriptions for each class of object as examples.

Galaxies

Galaxies are the most numerous of all the deep sky objects, there being literally billions of them in the known universe and, of these, 20000 are visible in scopes of 30cm under dark skies. Moving up in telescope size, the amount of available galaxies increases exponentially (Luginbuhl and Skiff, Observing Handbook and Catalogue of Deep Sky Objects, 1989) so you could spend decades observing nothing but galaxies! Most of the available galaxies to amateurs are only visible through large telescopes, although there are still plenty to keep the owner of a modest 20cm telescope entertained for many years!

Galaxies are classified according to their structure, from elliptical galaxies through to spirals, barred spirals and irregular galaxies as well as interacting and peculiar galaxies, and these features can be discerned in even modest telescopes. Galaxy classification was developed by Edwin Hubble and can become highly complicated with the basic types being further subdivided, especially spirals.

Elliptical galaxies

These are the oldest galaxies and contain old, red stars (Webb Society Handbook No.4: Galaxies, 1981) and, as the name suggests they are elliptical in shape. Examples of elliptical galaxies include NGCs 4889 and 4874 in Coma Berenices, as well as M31’s companions M32 (NGC 221) and NGC 205.

Spirals

The structure of the spiral arms of these galaxies does vary, and this is reflected in the complicated sub-division of these types. These can be tightly wound spirals, to looser ones as well as barred spirals. A barred spiral has a bar extending from the central core to the point where the spiral arms begin. There are many spirals to observe, some of the best include M31 in Andromeda, M51 in Canes Venatici with its companion NGC 5195, M33 in Triangulum and NGC 6946 in Cetus. There are many more, too numerous to mention here. An example of a barred spiral galaxy is the

NGC 1566
100x
35’ Field
Large Magellanic Cloud which, unfortunately, is only visible from the southern hemisphere.

A lot of spiral galaxies are inclined edge on to our line of sight, including NGC 55 in Sculptor, unfortunately too low to been seen from northern latitudes, but which should be seen from southern Europe and the southern U.S.A., and NGC 253, also in Sculptor and which can be seen from more northerly latitudes such as the U.K. (It was discovered from the U.K. by Caroline Herschel in 1783. [Webb Society Handbook No.7: The Southern Sky, 1987]). NGC 4565 in Coma Berenices is another fine example of an edge-on spiral and is a most stunning sight in even modest instruments. There are many more of these fine objects awaiting your telescope.

**Irregular, peculiar and interacting galaxies**

Peculiar galaxies still fit into the galaxy classification systems, but show unusual structure, and some of these objects are what are known as ring galaxies, but as these are quite faint, the ring is not visible visually. An example of a ring galaxy is NGC 985 in Cetus, which also has an exploding nucleus.

Interacting galaxies are colliding with each other. The most well known example is NGC 4038/4039 in Corvus, also known as the Ringtail or Antennae. These galaxies are fairly faint and require averted vision to see, but with a good sky and large aperture, the tails which give them their name should be seen. The tails are streams of stars and other material pulled away from the galaxies by the force of the collision. NGC 4038/4039 are visible from mid-northern latitudes, but a better view would be obtained from the Southern Hemisphere.

Irregular galaxies have no definite shape and may appear distorted. One of the best examples for Northern Hemisphere based observers is NGC 3034 (M82) in Ursa Major, which appears elongated and with mottled patches in it. Another irregular galaxy for northern observers is NGC 4485 in Canes Venatici, but unfortunately, it is a rather small and faint object in amateur telescopes with moderate aperture e.g. around 20 to 25cm.

There is a catalogue of peculiar galaxies, known as the Arp Catalogue, a catalogue of 338 galaxies with strange structures compiled by US astronomer Halton Arp in 1966. These galaxies exhibit a range of odd characteristics, which are caused by interactions between them, the gravitational pull of each one affecting its neighbour. A lot are quite challenging but some are bright and easy to see, such as M82 and NGCs 4038/4039.

**Galaxy groups and clusters:**

Galaxies are mostly found in clusters – galaxy “cities” – and our own galaxy is in one, known as the Local Group.

Galaxy groups and clusters are popular observing projects among amateurs not only because the sight of an eyepiece full of galaxies is an awesome one indeed, but because a lot of them are quite challenging, particularly the Hickson groups and Abell clusters.

The Virgo Cluster and the Coma cluster are two excellent targets for observation when they are visible during the spring, and are accessible to most telescopes, but a good star atlas and finder scope are
a must because it is very easy to become lost while observing in these regions due to the sheer number of galaxies. As for the Hickson groups, the brightest is Hickson 44 in Leo and this is observable in scopes of 25cm aperture and larger. Hickson 92, or Stephan’s Quintet is a famous group in Pegasus and has been glimpsed in scopes as small as 15cm under exceptional skies. All these groups need dark skies as any light pollution will make them invisible.

**Super thin galaxies**

Another interesting group of galaxies are the super thin, or flat, galaxies. These are a bit different from your normal edge-on spirals and, as the name suggests, are very thin with not much of a nuclear bulge, or dust either, and a lot are quite faint, like looking for a faint needle or hair across the field of view. They make an entertaining project for the more advanced amateur although, for people with smaller scopes, NGC 4244 in Canes Venatici is a nice example as is NGC 5907 in Draco.

The galaxy examples given above are only a very tiny example of the huge numbers available to amateurs. Obviously, the bigger the aperture the more that can be seen, and more are discovered all the time, especially with instruments such as the Hubble Space Telescope. However, these are at the limits of detection, being towards the edge of the known universe – but that doesn’t stop advanced amateurs from trying to see them!

**Observing galaxies**

For quite a lot of galaxies, it can be a bit of a chore trying to write anything more meaningful than ‘Dim oval’ as they are often faint and the orientation of a lot of them means that they are indeed oval. However, there are a few things you can make a note of in order to make your records that bit more relevant and interesting.

Make a note of the galaxy’s brightness, size, shape and elongation - i.e. whether it is elongated from east to west or, alternatively, note its position angle. Is the centre brighter? Is the core diffuse, compact or stellar? Are the edges diffuse or sharp? As examples, here are a couple of my own descriptions:

**NGC 4414, galaxy in Coma Berenices**

A bright oval, elongated NNW-SSE. It brightens towards the core and has a stellar nucleus. The view at 190x is not good! 101x is much better. 30cm f/5 Dob 69x, 101x, 190x

**NGC 4244, galaxy in Canes Venatici**

This one is a real beauty. It’s a huge, edge-on thin galaxy which cuts SSW-NNE across the field of view. In the 22mm Panoptic (69x), it covers

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Sketch M108 (NGC 3556)
drawn by Stewart Moore
using a 22.2cm f/5.8 x72
Field Size 40'

Arp 243 in Cancer
Sketched using a 48-inch f/4 telescope
around a third of the diameter of the field of view, and stretches right across the field of view of the 15mm Plossl (101x). It has no nuclear bulge in the middle but brightens slightly towards the core. The galaxy, especially around the centre, looks mottled. Very nice indeed.

30cm f/5 Dob. 69x, 101x

Drawing galaxies is as easy as drawing any other nebulous looking object. First draw in any field stars and then draw the galaxy, starting with the nucleus and working outwards. Use an artists’ smudging stick or your finger to achieve the nebulous effect.

M109 (NGC 3992)
Drawn by Stewart Moore using a 22.2cm f5.8 Scope
72x, Field 40 arcmin

Two galaxies in the same field of view
NGCs 584 and 596
Drawn by W.P. Clarke with a 25cm Newtonian at 80x
Globular Clusters

These are also collections of stars, but are much older than open clusters. Instead of a loose grouping of relatively few stars, these are huge balls of many hundreds of thousands or millions of stars. These are to be found orbiting the galaxy in a spherical halo, and are intrinsically very bright. The stars contained in globular clusters are generally very old, and are much more yellow and reddish than the young stars of open clusters, although mysterious blue ones, known as ‘blue stragglers’ have been found at the centres of some globulars. These are thought to be the results of collisions between stars at the centre of the clusters, where it gets very crowded, or by stellar thieves stealing gas from other stars.

Visually, globular clusters range from very small and dim to very large and bright. The most spectacular example, Omega Centauri (NGC 5139) is, unfortunately, to be found in the Southern Hemisphere, and so is not visible from more northerly latitudes such as the United Kingdom and the northern United States. However, at certain times of the year, it can be seen from southern Europe and the southern states of the U.S. Our own northern globular showpiece is Messier 13 in Hercules, and while not as big and bright as NGC 5139, is certainly a spectacular object in its own right.

Similarly to planetary nebulae, globular clusters are not quite as susceptible to light pollution as galaxies and diffuse nebulae are and the bright ones can make good targets for amateurs in the cities and suburbs.

Globular cluster classification

Globular clusters are classified according to the Shapley-Sawyer Concentration Class. This is a system devised by astronomers Harlow Shapley and Helen Sawyer Hogg between 1927 and 1929. The classification is on a scale of one to twelve, with one being the most concentrated clusters, such as Messier 75 and twelve being the most loosely concentrated, an example being NGC 4372. Roman numbers, I to XII, are generally used for the Shapley-Sawyer system but Arabic numbers can also be used.

Observing globular clusters

Make a note of the brightness, size and shape. Is the cluster loosely, moderately or highly concentrated? Is any part of the cluster resolvable, i.e. can you see individual stars in it, at the centre or outer parts? Is the centre brighter than the outer parts? Is it denser than the outer parts?

Here are a couple of my descriptions as examples:

NGC 6723 in Corona Australia

This globular is located on the border of Sagittarius, Scorpius and Corona Australis. At a declination of –36° 38’, it is theoretically visible from the southern part of England, but is so low down that the view would be very poor. It is visible in the finder and lies in a star field just outside the Milky Way. 43x: Large and bright and appears condensed towards the centre. The whole thing has a granular appearance. 150x: The increased magnification does not help – in fact, the object does not take it very well. The core retains its granular appearance. Stars barely resolved. 25cm Dobsonian. Lobethal, South Australia. 1997 July 29. Seeing I-II; Mv 6.1

NGC 2808

Sketch by B V Gerd

100x, 35arcmin field
**NGC 5466, globular cluster in Boötes**

Faint and large. Dense. With averted vision some stars are resolved with others giving the whole thing a ‘granular’ appearance on a background glow. 25th April 2011. 30cm f/5 Dob 69x, 101x.

**Sketching globular clusters**

Attempting to sketch globular clusters presents some problems, especially in the case of the large, bright ones such as M13 or M15, as there are so many stars involved. The way to approach a drawing of a globular is not to attempt to draw every single star that you can see, but draw the brightest ones accurately, and then just dot the others in. For dense clusters, such as M13, draw in a nebulous background, to indicate unresolved stars, then accurately place the bright cluster members then, with a technique known as ‘stippling’, dot the fainter stars in but keep the pencil upright or you’ll end up with commas. Don’t try and plot each and every star or you’ll soon get fed up with it, unless you are super-patient, and the drawing may well end up being less accurate as a result. My sketch of M13, above, took over an hour to complete. A large and bright object, such as this, is rather ambitious for a first go, try some smaller and fainter examples first, before tackling the brighter objects.
Open Clusters

Open clusters, also known as galactic clusters, are probably the easiest of deep sky objects to observe. With the exception of some of the ones in the less well known catalogues outside of the RNGC and Messier lists, they are bright and obvious, as well as being very numerous. They are to be found along the galactic plane, in constellations along the Milky Way, such as Cassiopeia and Cygnus.

Open clusters are groupings of associated, young, stars that formed together. Because of their age, or lack of it, they have not had the chance to move apart yet, and contain a relatively small number of stars, compared with globular clusters. The number of stars in an open cluster may vary from a couple of dozen, to a hundred or so. The star colours tend to be blue, white or yellowish white, but the far southern cluster NGC 4755, the Jewel Box in Crux, has a conspicuous red giant at its centre which is very striking indeed.

Open clusters are among some of the objects that are most easily observed. In fact, some of the bigger clusters such as the Pleiades (M45) in Taurus and Collinder 399 in Vulpecula are best observed through binoculars. This is because binoculars have a much larger field of view than telescopes, allowing the entire object to be viewed at once. Open clusters are a class of deep sky object that can be observed comparatively easily from suburbs or in moonlit nights. Some of the fainter stars will be washed out, but the brighter ones will remain, and this actually makes the object easier to sketch, as the observer is not confronted by lots of faint stars.

Observing open clusters

Open clusters can be sparse and pretty boring or they are incredibly rich, with lots of detail. If you want to take notes on an open cluster you could describe the brightness, size, richness (i.e. are there less than 50 stars, 50 to 100 stars or more than 100 stars – you don’t have to count each and every star, you’d be there until dawn if you did that – just make an estimate) and shape of the cluster. Is it compressed (stars close together) or loose? Are the stars bright, faint or a mixture of bright and faint? What colours are the stars? Are there places where the stars are more concentrated or absent? Is there any nebulosity involved with the cluster? Is the cluster detached from its surroundings? Are there any other objects nearby? At what power does the cluster fit into the field of view?

NGC 6755, open cluster in Aquila - An attractive, small, compressed cluster set in a nice Milky Way field. Stars all white and evenly bright. Found at 69x as a misty knot, detached from MW star field. 101x shows a tiny, vaguely triangular clump of stars, with around a dozen or so on a hazy background and with a fainter patch next to it but at 138x, the cluster looks like a butterfly with the left wing richer than the right one. Very pretty! 4th August 2010. 30cm f/5 Dob. 69x, 101x, 138x

NGC 7128, open cluster in Cygnus - Very small, compact, compressed. There’s a ring of brighter stars on a hazy background. There is a conspicuous reddish star on the SE side, which is the brightest star in the cluster. Very nice. 29th August 2010. 30cm f/5 Dob. 69x, 101x

M103 (NGC 581) Sketch by Michael Sweetman 15cm f/5, 128x
**Sketching open clusters.**

This presents a problem in that a high degree of accuracy has to be employed in order to get the relative positions of the component stars just right. This will be difficult at first, but as with everything else it will become easier with practice. For the brighter members, employ larger, darker dots while the fainter members will be represented with smaller, fainter ones. When sketching open clusters, and stars in general, be careful to make the dots as round as possible, or you’ll end up with commas, but this isn’t easy in the dark. As with all sketches, your open cluster sketch can be redrawn the next day, when it will be easier to see what you are doing although care should be taken not to add in things that weren’t there. For maximum effect, when redoing your sketch, use black ink on white paper, or white ink on black paper (or you could scan your sketch and reverse it in Photoshop or similar program).
**Nebulae**

A nebula is a cloud of gas and dust in space, and there are two basic types – bright nebulae and dark nebulae. Of the bright nebulae there are again two types – emission nebulae and reflection nebulae. Planetary nebulae and supernova remnants are entirely different and will be discussed later.

**Bright Nebulae**

An emission nebula consists of glowing gas which has been ‘excited’ by ultraviolet radiation, and this is usually in star forming regions, such as M42 in Orion, or M16 in Serpens.

A reflection nebula is made up of dust, which is made to shine by the light of a nearby star. A famous example of a reflection nebula is the Merope Nebula around the brightest members of the Pleiades, but this can be notoriously difficult to see. It is the remnant of the nebula that the cluster formed from.

Despite the name, a lot of bright nebulae are anything but! Apart from the well known ones such as M42 or M8, most of them are faint and require large telescopes, dark skies and/or filters. The most awkward ones to see are large and faint. Some very large ones have a low surface brightness, due to being very diffuse. The North America Nebula, NGC 7000, in Cygnus is large, but can be seen in binoculars although it requires fairly dark skies and the use of a UHC filter will help. Under exceptional skies, it can be seen with the naked eye. In the southern hemisphere, the Eta Carina Nebula in the constellation Carina is a spectacular example as is NGC 2070, the Tarantula Nebula in the Large Magellanic Cloud. If NGC 2070 was in our galaxy, rather than an external one, and as close to us as M42 is, it would cast shadows. Unfortunately, both the Eta Carina Nebula and NGC 2070 are in the Southern Hemisphere and too far south to be seen from Europe or the United States, although Eta Carina can be glimpsed from the Florida Keys.

**Dark Nebulae**

These are the same as reflection nebulae, but do not have stars nearby to illuminate them, or they obscure the stars, thus appearing dark. There are spectacular examples of dark nebulae in Sagittarius, and along the plane of the galaxy through Cygnus where the dark lane through the Milky Way is made up of obscuring dust. A particularly well known, but notoriously difficult, example is the Horsehead Nebula, Barnard 33, in Orion. This requires a telescope of 20cm or larger with clean optics, dark transparent skies with excellent seeing and a H-Beta filter as well as patience. B33 shows up as a notch in the side of the faint reflection nebula IC 434 and is pretty small. If the transparency is even suspect and you can’t see the bright nebula NGC 2024 which is nearby, then it would be a waste of time to go after the Horsehead. A spectacular example of a dark nebula is the Pipe Nebula in Ophiuchus and this forms part of an even larger nebulous complex known as the Galactic Dark Horse because, from a dark site, the dark nebulousity looks like the figure of a horse. A famous example of a dark nebula is the Coalsack, just adjacent to the Southern Cross in far southern skies, which looks like someone has cut a piece out of the Milky Way. Unfortunately, unless you go to the Southern Hemisphere (and I highly recommend that you do!) it is only visible from the far southern United States, i.e. the Florida Keys or from the Canary Islands.

**Observing Nebulae**

*Bright nebulae* – Make a note of the brightness, size and shape. Is any portion of the nebula brighter or darker than the rest? Is the outer edge sharply defied or diffuse (fuzzy)? Are there any stars located in or near the nebula?

*Dark nebulae* – How easy is it to see? Note the size and shape. Are there any distinguishing features such as the shape or any bright areas or darker zones?

Here are a couple of example descriptions:
NGC 2070, the Tarantula Nebula in the Large Magellanic Cloud
Yet another fantastic southern object. This is relatively large and bright, despite being located in an external galaxy, and has large faint filaments stretching south west and north east. Many wisps and tendrils seen. There are also faint patches to the west and east of 2070, one of which is NGC2044. 25cm Dob, 43x, 100x. Lobethal, South Australia. 1997, July 30th. Seeing I-II, Mv 6.1

NGC 6888, emission nebula in Cygnus
Located among a conspicuous group of five stars, this can be seen without a filter, but only just. A UHC filter brings out the crescent shape nicely but an OIII isn’t much of an improvement. With each filter there are hints of more extensive nebulosity to the north east of the crescent. the SW portion of the nebula is the brighttest and the SE portion of the crescent is a bit fainter. 1st September 2010, Sandown, Isle of Wight, UK. 30cm f/5 Dob, 69x, UHC, OIII

M42, the Orion Nebula
drawn by Michael Sweetman
with a 15cm f5 reflector, 109x
**Drawing Nebulae**

This is comparatively easy, compared to other objects. Once you have drawn in the field stars, all you have to do is smudge in pencil in the shape of the object. As the drawing will be in negative, the brighter the object is, the darker the pencil mark will be. This is slightly confusing at first, but gets easier as you get used to doing it. To smudge the pencil you can use your fingertip, but a less messy way is to use an artist’s smudging stick although I find this somewhat less effective. A 5 or 6B pencil is ideal for rendering nebulous objects as it is soft. Do not use anything harder than a 3B, except for stars, as it will be too hard, and will not smudge, and you will end up with hard lines.

However, drawing dark nebulae presents some rather unique problems. This is because other types of deep sky object are light on dark, whereas dark nebulae are dark on light. Probably the way to approach this is to draw dark nebulae as you would other types, but maybe draw the outline of the dark nebula as a dotted line.

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![M20, The Triffid Nebula](image)

M20, The Triffid Nebula
130x, Field 26 arcmin
Drawing by Michael Sweetman
Planetary Nebulae and Supernova Remnants

These objects are often treated as nebulae, but are the remnants of dead or dying stars. A lot of stars, such as our own Sun, will die peacefully, expanding into a red giant and puffing its outer shell off as a planetary nebula, but stars of greater mass will explode as supernovae, and leave behind filaments of gas. Two of the best known of these are Messier 1, the Crab Nebula, in Taurus, and the Veil Nebula in Cygnus.

**Planetary nebulae**

These are usually ring, or oval, shaped, but can be bipolar. They are fairly numerous and have quite high surface brightnesses, and a lot of them can be observed using modest amateur equipment, such as a 20cm reflector. Because of this, and because the bright ones are less susceptible to light pollution, they make ideal targets for the visual observer.

Like bright nebulae, quite often the bigger a planetary the lower the surface brightness. This is because if a planetary is quite old its constituent gas will have become more diffuse with the result that it becomes fainter. NGC 7293, the Helix Nebula in Aquarius, is a well known large, but faint, planetary which requires the aid of filters to be seen at all, particularly in light polluted skies. Most planetaries, however, are small and a lot of them are fairly bright. Two of the most famous are in Messier’s catalogue and are worthwhile summer objects – M27, the Dumbbell Nebula, in Vulpecula and M57, the Ring Nebula, in Lyra. These are easily visible in telescopes of as small as 5cm aperture, and even binoculars, and show amazing amounts of detail when viewed in large telescopes.

As well as large bright ones, a lot of planetary nebulae are very small and stellar-looking and this can cause a problem when looking for them, because of the difficulty of distinguishing them from the stars in the area. The best technique for confirming that the star-like object in your eyepiece field of view is the tiny planetary you are hoping to see and not just another star, is to use your Oxygen III filter. Pass the filter between your eye and the eyepiece, in a technique called ‘blinking’, and the object that increases in brightness, or does not dim, is the planetary nebula you are after. IC 351 and IC 2003, both in Perseus, are good examples of this type of planetary.

** Supernova remnants**

These are far less common than planetary nebulae, there being only a handful of objects visible to the amateur observer. These objects, especially the older ones, are very tenuous, and require large telescopes, dark skies and filters to observe. Two good remnants for amateur observation are the Veil complex in Cygnus, observable with instruments as small as 10x50 binoculars, and M1 in Taurus. This last object is, by cosmological standards, very young. The supernova was observed to explode around AD 1054, by Chinese astronomers.
In southern skies, and requiring a trip to the Southern Hemisphere or the far southern United States, is the Vela Supernova Remnant, the remains of a star which exploded around 11000 years ago.

**Observing planetary nebulae and supernova remnants**

You can apply the same sort of descriptions to supernova remnants that you can to bright nebulae. Planetary nebulae (PN), though, are a bit different and these are some of the things you can write about them. Is the PN bright? How easy or hard is it to identify in the star field? Size and shape. Is there any noticeable colour? Is there a disk? Are the edges diffuse or sharp? Is the centre brighter, darker or the same brightness as the edges? Is the central star visible?

Object description examples:

**NGC 6781, planetary nebula in Aquila**

Set in a nice starry field this is large and oval and quite bright. It’s easily seen without a filter but my OIII brings it out nicely. With the OIII, the PN looks slightly rounder with some darkening in the centre, without the filter I can’t see the darkening very well. Very nice object. 4\(^{th}\) August 2010. 30cm f/5 Dob, 69x, 101x + OIII

**NGC 6894, planetary nebula in Cygnus**

A bit hard to find, faint and quite small. Not helped by milky sky. At low power, there is a hint of something fuzzy and oval. An OIII filter brings it out as a filled-in oval. At high power, and with the OIII, it has a darker middle and looks annular. 12\(^{th}\) September 2010. 30cm f/5 Dob, 69x, 190x, OIII filter.

**NGC 2392, planetary nebula in Gemini**

Easy to find. At 69x it’s round, fuzzy with bright middle. It’s a greenish-blue colour. OIII brings it out well. At 190x it looks very fuzzy with a very bright centre and a dark area between outer parts and centre. 11\(^{th}\) April 2010. 30cm f/5 Dob. 69x, 190x OIII

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*Part of the Veil Nebula in Cygnus drawn by Stewart Moore*
NGC 6960
...is the western portion of the Veil and is visible without a filter but UHC brings it out nicely. However, OIII gives the best view and the nebulosity looks fatter and more detailed with the OIII. It looks like a witches broom (in fact ‘Witches Broom’ is a nickname for it) with a bright star where the handle meets the brush. The northern part of NGC 6960 is brighter than the southern part and reminds me of cigarette smoke as it leaves the cigarette. In the southern end, it widens and gradually fades out. 25th September 2009 30cm f/5 Dob 38x + OIII

NGC 6992 and NGC 6995
...form the eastern portion of the Veil. This is huge and does not all fit into the 1 degree field of view of the 40mm TV Plossl (38x). It is very bright and I can see filaments, especially at the southern end. The eastern side is much brighter, while the western side is fainter and fades out. 25th September 2009 30cm f/5 Dob 38x, OIII.

Drawing these objects is easy – just use the same techniques as you would use for bright nebulae.
Suggestions for Observing Programmes

An observing plan is pretty important. Don’t just go out with nothing in mind and jump aimlessly from object to object because you won’t see much that way; make an observing list. If you’re a beginner start with the Messier 110 list, then go on from there...the Herschel 400...Herschel II...etc, the choice is endless. The Astronomical League website has ‘observing clubs’ and there you’ll find some ideas for all sorts of observing programs. A definite plan of what you intend to observe before you go out will make a huge difference to what you see and the amount of observing you do. ‘Just looking’ at a few bright objects is good for the first few sessions when you are an absolute beginner because it’ll give you a feel for deep sky observing. Once you are past the stage of just looking, however, you may feel you would like to embark on a structured observing programme, although you don’t have to. Most deep sky observers start with the Messier objects and progress onto the New General Catalogue and beyond onto more difficult targets.

Instead of observing objects by catalogue, you can stick with classes of object, or constellation by constellation, or in order of declination or right ascension.

Here are a few suggestions for observing programs of your own.

The Messier Objects

In the mid 18th century, a French astronomer called Charles Messier was interested in finding comets. As comets are in the main, faint fuzzy objects, they are easily confused with deep sky objects, also faint and fuzzy. Because of this, Messier compiled a catalogue of objects to be discounted when checking possible cometary sightings and it is ironic that, more than two hundred years later, he is better known for this deep sky catalogue than he is for any comet discoveries.

There are 110 objects listed in Messier’s catalogue, although there is an error with M101, a spiral galaxy in Ursa Major, as it is also known as M102, so in fact there are 109 objects. Beginning deep sky observers are advised to tackle the Messier Objects first because they are (mostly) bright and are easy to locate.

At the right time of year, around March, it is possible to observe all of the Messier objects in one night and some observers and astronomical societies hold Messier marathons where they try and see as many as possible. All of Messier’s objects can be seen with modest equipment, including large binoculars and I have seen 72 of them with 8x42 binoculars.

The Saguaro Astronomy Club’s 110 Best of the NGC

Put together by Phoenix, AZ’s, Saguaro Astronomy Club, this is a compilation of their best of the NGC after the Messier Objects. You can find details, including the downloadable book, on Saguaro Astronomical Society’s web site (www.saguaroastro.org). Some of the objects are also in the Herschel 400.

The Herschel 400

This list was devised by the Ancient City Astronomy Club in the U.S.A. and is based on the brighter objects in the New General Catalogue, which itself is based on a catalogue originally published in 1864 by John Herschel of objects discovered by himself, and William Herschel before him. When Dreyer enlarged this catalogue in 1888, it was called the New General Catalogue, and it contains thousands of non-stellar objects. (Observe the Herschel Objects. Ancient City Astronomy Club, 1992).

All of the objects, including a few Messier objects which crept in, within this list are observable through 15cm telescopes. Once this is complete, you can move onto the next 400 if you wish, see below. In all, there are 2500 Herschel objects, some bright and easy, others fainter and more difficult.
The Herschel II

This is the next step on from the H400 and is a good programme for those with 20cm and larger scopes who have done the H400 and wish to progress. The objects, between magnitudes 11 and 13, are more challenging than the ones in the H400 - there are no Messier interlopers for example!

The Herschel 2500

This, the Big One, is an ambitious programme for the more advanced observer and will take several years to complete. The Herschel 400 and Herschel II are part of the 2500. These observing programmes are the best way to become an advanced observer, as you learn a lot along the way and it improves your observing skills no end.

Of course, if you so wish you could eventually tackle the entire NGC, the ‘Whole Enchilada’ as Americans would say. That would probably take 20 or 30 years but isn’t impossible, I know of at least two observers who have done it. However, a number of trips to the Southern Hemisphere would be needed to get the objects not visible from further north.

Advanced Deep Sky Observing

Projects such as observing Hickson Galaxy Groups or Abell planetaries are well worth taking on once you have gained experience and have access to a larger scope. However, good, dark skies away from light pollution are essential for this, even more so than sheer aperture. Testament to this fact is that at the 2006 Texas Star Party I witnessed an observing friend do the TSP Arp program with a 10cm refractor and the pristine dark West Texas skies allowed him to bag each and every object. The Arp catalogue is perceived as being very difficult, but not all Arps are fiendish. Some are very easy. Messier 82, for example, is an Arp (Arp 337) is easy and visible through binoculars from dark skies while Arp 244, the interacting galaxy pair NGC 4038 and 4039, is easily seen with a 20cm scope. Hickson galaxy groups are fun to track down and observe, as there are few more inspiring sights than an eyepiece field full of galaxies, but most are quite tough, requiring large telescopes to see. However, they’re not all difficult and some, such as Hickson 44 in Leo and Hickson 92, Stephan’s Quintet, can be seen with modest apertures. Abell Planetaries are mostly faint and fiendish although there are some visible with modest scopes. Abell 21 in Gemini is one of the brighter ones as is Abell 12 in Orion, both of which I have seen with a 30cm – in fact, under dark skies, Abell 21 has been glimpsed in 16x80 binoculars with an OIII filter. Good dark skies are required to stand any chance of seeing the Abells.

Objects by type or constellation

If you do not want to follow lists, you can do your own thing, such as observing objects by their type such as open clusters or planetary nebulae, for example. You can observe one type of object in one constellation. Back in the 1990s I had a short project to observe open clusters in Cygnus. Some people devote years to observing one class of object, and these people can become quite knowledgeable about the objects they observe. You can generate your own observing lists with software such as SkyTools or online programs such as Messier45.com.

There are structured observing programmes run by organisations and it is possible to become involved with these once you become a proficient observer. The Webb Society’s sections run their own programmes, keep an eye out for them on the website and in the Deep Sky Observer.

Another observing programme for the more experienced observer is supernova hunting. This involves systematically searching specific galaxies for exploding stars. This is being taken over more these days by CCD users and people using remote-controlled scopes online, although it can still be carried out visually. The most successful supernova visual discoverer to date is an Australian, Rev. Robert Evans. Tom Boles, a UK amateur, is the most successful using CCDs.

There are many ways you can observe and many things you can see, and it is only the observer’s own imagination which sets the limit.
References and Links

**Recommended reading**

Archinal, B. And Hynes, S. *Star Clusters*, Willmann-Bell 2003


*Volume Two: Planetary and Gaseous Nebulae*, 1979  
*Volume Three: Open and Globular Clusters*, 1980  
*Volume Four: Galaxies*, 1981  
*Volume Seven: The Southern Sky*, 1987

Published by Enslow and Lutterworth, New Jersey and Guildford. Out of print but available second hand and for reasonable cost, just a couple of pounds/dollars in some cases. They’re a bit dated these days but they are worth getting hold of for the descriptions and sketches, despite the sketches not having reproduced very well in a lot of cases.


Harrington, P. *Cosmic Challenge: The Ultimate Observing List for Amateurs* Cambridge University Press 2010


*Volume 1 (Autumn and Winter)*  
*Volume 2 (Spring and Summer)*

Cooper, I., Kay, J., and Keppele, G. *Volume 3 (The Southern Sky)*.

Willmann-Bell, Inc. Richmond, Virginia, 1999 (Vols 1 and 2) and 2009 (Volume 3)


Steinicke W. *Observing and Cataloguing Nebulae and Star Clusters: From Herschel to Dreyer’s New General Catalogue*, Cambridge University Press, 2010

Steinicke W. And Jakiel R. *Galaxies and How to Observe Them (Astronomers’Observing Guides)*, Springer, 2007


### Star Atlases

Bonnano, E. *MegaStar 5*. Charting software available from Willmann-Bell, Inc. Richmond, Virginia


### Magazines and periodicals

*Amateur Astronomy Magazine*. Lebanon, Tennessee, USA. Subscription-only from www.amateurastronomy.com


*Deep Sky Magazine*. Unfortunately this has not been published since 1992 but it is available for download from Astronomy Magazine’s website, www.astronomy.com


*Sky At Night Magazine*. BBC Magazines, London. Monthly magazine aimed at the very beginner, in association with the BBC TV program of the same name. www.skyatnightmagazine.com


### Internet sites

A lot of good deep sky resources can be found on the internet, but bear in mind that quite a lot of material is never updated and can quickly become out of date or the websites can vanish altogether if the domain or hosting is not renewed. I’ll list a few of the more established ones here which are updated on a semi-regular or regular basis.


**Astronomy Sketch of the Day**  [www.asod.info](http://www.asod.info) Every day, a new astronomical sketch is featured.


**Cloudy Nights Telescope Reviews and forums**  [www.cloudynights.com](http://www.cloudynights.com) The best forum for in-depth knowledge and help. Also has equipment reviews.

**Faint Fuzzies**  [www.faintfuzzies.com](http://www.faintfuzzies.com) downloadable observing guides, written by us deep sky observer Alvin H. Huey. NB, these are mostly for advanced observers with big scopes only but the *Planetary Nebulae, Local Group, Selected Galaxy Trios, Selected Small Galaxy Groups and Globular Clusters*
guides have content suitable for less-advanced amateurs with 8-inch or larger scopes.

**Messier 45** [http://messier45.com](http://messier45.com). Database of deep sky objects and observing list generator.

**Stellarium** [www.stellarium.org](http://www.stellarium.org) Free planetarium software with a realistic sky and the entire Messier and NGC catalogues.

**The NGC/IC Project** [http://www.ngcicproject.org/](http://www.ngcicproject.org/) A great resource for NGC and IC data.

**Uncle Rod’s Astro Blog** [http://uncle-rods.blogspot.com/](http://uncle-rods.blogspot.com/) ‘Uncle’ Rod Mollise is an American amateur of many year’s experience. His blog is full of useful information and anecdotal stories, a lot aimed at beginners.

**Visual Deep Sky Observing** [www.fjastronomy.com](http://www.fjastronomy.com) A bit of a shameless plug but I have got sketches, accounts of observing sessions and a few articles on here, which you may find useful or entertaining.

### Societies

- **The Astronomical League** – [www.astroleague.org](http://www.astroleague.org)
- **The British Astronomical Association** – [www.britastro.org](http://www.britastro.org)
- **The Society for Popular Astronomy** – [www.popastro.com](http://www.popastro.com)
- **Federation of Astronomical Societies** – [www.fedastro.org.uk](http://www.fedastro.org.uk)

### Book and equipment manufacturers and dealers

- **Amazon** – [www.amazon.co.uk/www.amazon.com](http://www.amazon.co.uk/www.amazon.com)
- **Camera Concepts** (USA) – [www.cameraconcepts.com](http://www.cameraconcepts.com)
- **Dark Skies Apparel** (USA) - [http://www.darkskiesapparel.com/](http://www.darkskiesapparel.com/)
- **David Lukehurst Telescopes** (UK) – [www.dobsonians.co.uk](http://www.dobsonians.co.uk)
- **First Light Optics** (UK) – [www.firstlightoptics.com](http://www.firstlightoptics.com)
- **Green Witch** (UK) – [www.green-witch.com](http://www.green-witch.com)
- **Obession Telescopes** (USA) - [http://www.obsessiontelescopes.com/](http://www.obsessiontelescopes.com/)
- **Starmaster Portable Telescopes** (USA) - [http://www.starmastertelescopes.com/](http://www.starmastertelescopes.com/)
- **Telescope House** (UK) – [www.telescopehouse.com](http://www.telescopehouse.com)
- **Televue** (USA) – [www.televue.com](http://www.televue.com)

### Acknowledgements

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Any errors that remain are my own!

I must also record my gratitude to all those amateur astronomers who have welcomed me around the world in my quest for new objects and different skies. Their thoughts and experiences have added to my enjoyment of the deep-sky on many clear nights.
(Top Left) A drawing of the Orion Nebula (M42) by Michael Sweetman
(Top Right) The galaxy Arp 243 in Cancer drawn by Stewart Moore
(Bottom Left) The Globular Cluster M3 drawn by Michael Sweetman
(Bottom Right) The Galaxies NGC 584 & NGC 596 drawn by W.P. Clarke