OBSERVING BRIGHT NEBULAE

Amateur astronomers often divide the visible universe into two components: the shallow sky, including the Moon and Sun, the planets, and anything else within our solar system; the deep sky, meaning everything outside our solar system. The deep sky is the realm of stars. There are open clusters and globular clusters of stars, double and multiple stars, and galaxies of stars beyond counting. But not everything in the deep sky is stellar, and these non-stellar objects include among them such wonders as the Great Nebula in Orion, one of the best known deep sky objects of all. The Orion Nebula is an example of a bright nebula, in this case a combination of two sorts of bright nebula (reflection and emission). Bright nebulae, while non-stellar, are intimately associated with stars all the same. The Orion Nebula is a stellar nursery, a place of star birth, lit by the young stars that formed within it. The Ring Nebula (M57) marks the site of an old star in the last stage of its life, while the Crab Nebula (M1) is the remnant of a star that ended its life in a brief blaze of glory, a supernova. It would seem that at each end of its life, a star is and then becomes again, the stuff of nebulae.

The bright nebulae (and as soon as you look at M1 for the first time you will understand this to be a relative term) are wonderful and sometimes frustrating objects to view through a modest telescope. Since they are very popular subjects for astrophotographers people feel very familiar with these objects, and so have expectations of what they will see through the eyepiece. Such expectations, based on long exposure photographs and CCD images (to say nothing of the Hubble Space Telescope) are bound to be disappointed. The human eye simply does not perceive color under such low light conditions, and so where the marvelous structure and color seen in photos of the Orion Nebula are expected, the beginning amateur astronomer sees instead a ghostly glow sprinkled with tiny points of light from hot, young stars. Learning to properly appreciate deep sky objects visually can take time and patience, as you shake yourself free of the images brought down to us by telescopes used as cameras. And as if that isn't enough, some of these objects are by their diffuse nature very difficult to see through the light pollution so common in urban and suburban areas. "Light pollution" filters can help with this, but even the view through a filter is vastly improved by viewing the objects from a dark sight. An object that is an unimpressive smudge when viewed from your backyard – even with a filter in place – can present a surprisingly different aspect when seen from out at TIMPA, with or without a filter.

Births and Deaths of Stars

The sorts of nebulae we will deal with in this program can be classified as emission, reflection, and planetary nebulae, and in one case as a super nova remnant. The emission nebulae are those that give off their own light as a result of being energized by nearby stars. In part, the Orion Nebula is an example of an emission nebula, although it also reflects light from nearby hot, young stars and so can be considered a reflection nebula. Not all such nebulae are combinations: the Swan Nebula (M16) is an emission nebula, while the faint wisps of nebulosity sometimes seen around the Pleiades (M45) are reflection nebulae. Generally these two types are associated with the stuff of new stars and star birth. The planetary nebulae and super nova remnants are evidence of stellar mortality, the remains of stars that have expelled much of their mass out into space, or simply blown themselves apart completely. While planetary nebulae suited for this program exist in fair numbers, super nova remnants accessible to modest telescopes are harder to come by, and there is in fact just one on the BSIG list: M1, the Crab Nebula.

Although this program will not get terribly 'hung up' on exact classifications of nebula types, knowing in advance which you are dealing with can be useful if you plan to use filters.

Light Pollution and Nebula Filters

All sorts of filters are used in amateur astronomy. Neutral density and variable polarizing filters cut down the glare of bright moonlight and various colored filters are used to bring out subtle details on Jupiter and Mars. For deep sky observing three filters are commonly used: broadband 'light pollution' filters, narrowband 'nebula' filters, and 'line filters', most commonly in the form of oxygen III (OIII) filters. Each of these filters is designed to alter the transmission of light through your eyepiece in particular ways, and each has the ability to enhance the nebulae you observe in different ways.

One of the factors that can render nebulae difficult to observe is, of course, light pollution. A softly glowing night sky robs any deep sky object of contrast with the background sky, making the object difficult to find and observe. A broadband or Light Pollution Filter (LPF) uses special coatings to selectively block or pass different wavelengths of light with the intension of increasing contrast. Generally these filters block the yellowish light of common street lighting while transmitting the blue, green, and red light wavelengths produced by nebulae. Neither the blocked wavelengths nor the light allowed to pass through represent highly restricted portions of the visible light spectrum, which is why these filters are referred to as 'broadband.' However, calling them Light Pollution Filters is a bit misleading. While they can indeed enhance the contrast seen between an object the surrounding sky when used in moderately light polluted areas, they are not a solution to the problem of light pollution. In fact, their effectiveness has been reduced in some places by the replacement of municipal lighting dominated by yellow mercury vapor and low pressure sodium vapor lamps with more efficient lights that have a more continuous spectrum of light output. Ironically, broadband filters retain a degree of usefulness at a dark site. Even at a location such as TIMPA (and darker sites) the sky itself gives off a subtle glow that can somewhat reduce the contrast between the sky and a nebula. A broadband filter can enhance the contrast in these situations, so if you own one and have been disappointed by its in town performance, try it at TIMPA before giving up.

A narrowband filter uses the same coating technology to determine which wavelengths of light are passed and which are excluded, but the coatings applied to the filter glass are far more selective. Most of them allow only light of wavelengths for hydrogen beta (H-β) and oxygen III (OIII). In more technical terms, 486 nanometers for H-β and wavelengths 496 and 501 nm for OIII. These filters are especially effective for viewing emission nebulae and can also help with planetary nebulae. From a backyard location a narrowband filters can make a very large difference in the contrast and detail seen, rendering a faint smudge into a much more satisfying view. At a dark site the effect is even more pronounced. M8 (Lagoon Nebula) provides an especially good example of the difference in the level of detail you can see using one of these filters. With an 8" Newtonian M8 when viewed from within the city is a faint smudge with a bright cluster of stars to its east. There appears to be no relationship between them. With a narrowband filter in place (Orion Ultrablock and Lumicon Ultra-High Contrast are readily available examples) the bright area becomes a swirl of nebula that extends well out into the star cluster and the object is far more interesting to view. Under darker skies the effect is pretty amazing, with dark lanes and patches visible in the nebula.

A line filter (the OIII filter type is the example we will use here) takes the exclusion of undesirable light wavelengths to an extreme. OIII filters could very well be called 'planetary nebula filters,' since the wavelengths they allow to pass (the 496 and 501 nm wavelengths of ionized oxygen) are most strongly produced by these objects. As with the narrowband filter, an OIII filter will dramatically darken the sky around the nebula, greatly enhancing contrast and the level of detail revealed. And like the narrowband it will dim stars, in this case leaving only the brighter stars showing. To use such a filter it is necessary to locate the object before putting the filter on the barrel of the eyepiece, or the stars that will help you find your way might not show up. There are line filters that pass wavelengths other than OIII, but these are more highly specialized items and we do not cover them here.

Since all of these filters are a bit on the expensive side it is likely that you will not want to invest in a complete set right away. If one nebula enhancing filter is all you can afford, buy a narrowband filter such as the Orion Ultrablock or the Lumicon UHC. You do not need to have such a filter to work this part of the program, but if you will be observing primarily from a suburban back yard, the investment in a narrowband filter is highly recommended. The results of using a filter will vary from object to object, so record the view that pleases you most.

Finding Nebulae

Not all of the nebulae in the list at the end of this section are visible, even from a dark site, with eyes alone, and may not be easily spotted with binoculars or a finder scope. If you are not using a computerized 'go to' or 'push to' telescope you will most likely need to employ the technique of 'star hopping' to find your way to these objects. For a brief account of how to use this technique, please skip ahead to the section on observing galaxies, or find a copy of either *Astronomy Hacks* or *The Backyard Astronomer's Guide.*

Making Nebular Observations (Without Being Unclear…)

The list of nebulae for the BSIG program contains examples of emission, reflection, and planetary nebulae, with M1 the sole representative of a true super nova remnant. There are 20 objects on the list; you need to observe and sketch 12 of them. (As always, you are encouraged to exceed the requirements of the program.) An effort had been made to select objects that will show up in telescopes with small apertures (60 to 70mm). Since it is difficult to predict how a given small telescope will perform we have made the list larger than the actually number of objects you will be asked to observe. If several objects elude detection you should still be able to "bag" enough of them to complete the program. As always it is recommended that you record objects attempted but did not see, since all observations have value, even if all a given observation does is teach you a bit more about what to expect from your telescope.

For your observations include the usual time, date, equipment, and conditions information, making sure to record which filter, if any, you use. When taking notes on your observations pay special attention to how much of the field of view the object fills, using your knowledge of the eyepiece's true field of view (TFOV) to estimate the extent of the object. For example, if the eyepiece gives a 0.3° TFOV and the object spans well over half of it, call the extent 'appears to be roughly 0.2°' or words to that effect. The accepted apparent size according to modern catalogs is included in the lists. Convert your estimate into arc minutes or arc seconds (1 degree equals 60 arc minutes, and 1 arc minute equals 60 arc seconds, so the example would be 0.2° = 12 arc minutes since a tenth of a degree is 6 arc minutes – often written as 6′) and compare your result with the list. How close did you get? With time and practice you will become better at making these estimates. When writing your notes, consider the following questions:

1. Does the edge of the nebula stand out clearly from the background or fade away without sharp boundaries?
2. Are there stars embedded within the nebula?
3. Is the nebula a uniform glow, or uneven, with bright patches or dark lanes?
4. Does its shape remind you of anything?

Make a sketch of the object. The easiest way to approach a sketch of a nebula is to mark in the brightest field stars first, then use these to guide the area you shade in the represent the cloud of gas and dust. Make the correct extent and shape of the nebula your number one priority, and shade this area lightly and evenly. To indicate a brighter area simply shade that spot more darkly with the pencil. A dark lane through the nebula would be indicated by simply leaving that area blank white. (Those of you with scanners and image processing software might consider scanning these sketches and reversing them. The effect can be surprisingly realistic.) As always, do not make yourself crazy trying to depict every subtle nuance. If you have such skills employ them to the extent that it pleases you to do so – such is not required to fulfill the requirements of this program.

Nebula References

Deep Sky Companions: The Messier Objects Stephen James O’Meara (Sky Publishing)

The Next Step: Finding and Viewing the Messier Objects Ken Graun (Ken Press)

The Night Sky Observer’s Guide (two volumes) George R. Kepple and Glen W. Sanner (Willmann-Bell)

Burnham’s Celestial Handbook (three volumes) Robert Burnham Jr. (Dover Publications)

The Backyard Astronomer’s Guide Terence Dickinson and Alan Dyer (Firefly) –Filter information.

Astronomy Hacks Robert B. and Barbara F. Thompson (O’Reilly) – Filter information.

Bright Nebula List

CONST.	OBJECT	MAG.	R.A.	DEC.	TYPE	SIZE
Per	M76	10.1	01h 42.4m	+51° 34'	PL	2'x1'
Eri	NGC 1535	9.0	04h 14.2m	-12° 44'	PL	20'
Aur	NGC 1931	11.3	05h 31.4m	+34° 15'	EM	3'
Tau	M1	8.4	05h 34.5m	+22° 01'	SR	6'x4'
Ori	M42	3.7	05h 35.4m	-05° 27'	EM	66'x60'
Ori	M43	6.8	05h 35.6m	-05° 16'	EM	20'x15'
Ori	M78	8.0	05h 46.7m	+00° 03'	RF	8'x6'
Mon	NGC 2261	10.0	06h 39.2m	+08° 44'	RF	2'
Gem	NGC 2392	9.2	07h 29.2m	+20° 55'	PL	40"
Hya	NGC 3242	7.8	10h 24.8m	-18° 38'	PL	16"
Uma	M97	9.9	11h 14.8m	+55° 01'	PL	3'
Dra	NGC 6543	9.0	17h 59.0m	+66° 38'	PL	22"
Sgr	M8	4.6	18h 03.8m	-24° 23'	EM	90'x40'
Ser	M16	6.0	18h 18.8m	-13° 47'	EM	120'x25'
Sgr	M17	7.0	18h 20.8m	-16° 11'	EM	46'x37'
Sgr	M20	6.3	18h 22.6m	-23° 02'	EM	28'x28'
Lyr	M57	8.8	18h 53.6m	+33° 02'	PL	1.3'
Vul	M27	7.3	19h 59.6m	+22° 43'	PL	8'x4'
Aqr	NGC 7293	7.3	22h 29.6m	-20°48'	PL	12'
And	NGC 7662	8.3	23h 25.9m	+42° 33'	PL	25"