



How to observe planetary nebulae

Unlike many nebulae which merge into the sky background, many planetary nebulae present well-defined and even colourful features that make them appealing to observe visually, as *Owen Brazell* explains.

Of all the different types of deep-sky objects, planetary nebulae are some of the most rewarding to observe. The range of brightness and sizes found among them makes them a popular target for all sizes of optical instruments from binoculars through to the largest amateur telescopes. They are also available in all the observing seasons as seen from the UK. Formed at the end of the life cycle of stars with masses between 0.9 and 8 times that of the Sun, they show a wide variety of structures. They may be formed in different ways, with some coming

from binary systems as well as others from single stars, and the origin and evolution of them is still a subject of much scientific debate.

The first planetary nebula to be discovered had to wait until the invention of the telescope. It was discovered by Charles Messier in 1764 and became number 27 in his famous catalogue of objects that might be confused with comets, although he did not know its true nature at the time. Messier added another three planetary nebulae by the time he completed the catalogue, numbers 57, 76 and 97.

Overlapping with the end of Messier's observing career was perhaps the greatest of the visual observers, William Herschel. He discovered many more of the objects that we now call planetary nebulae in his own catalogue. Most of these were found from Windsor and Slough with his 18.7-inch speculum metal reflector. He coined the name planetary nebula because he thought they looked like the planet Uranus that he had found earlier in his career, and he created a special category (IV) in his classification system for such objects. Not all the

◀ The Ring Nebula is easy to locate between Beta (top right) and Gamma Lyrae (bottom left). The width of the field of view here is two degrees and north is upwards. Credit: Robin Scagell.

objects that he added to this category are recognised today as planetary nebulae, however. It was his discovery of the planetary nebula that we now know as NGC 1514 that convinced him that there were true nebulous objects in the heavens rather than simply star clusters too remote for the individual stars to be seen.

Other observers, including his son John, added to the numbers discovered and there are 96 objects classified as planetary nebulae in the New General Catalogue (NGC) published in 1888 by Dreyer, based on Herschel's work. This is a relatively small number compared to the 7,840 objects in that catalogue. The advent of photography combined with spectroscopy added to the list in the two Index catalogues and most of these are small and were discovered as part of the programme to classify stellar spectra at Harvard. The distinctive emission-line spectra of the nebulae made them relatively easy to spot on these plates. From then on most of the new nebulae were discovered by photographic or emission line surveys. Today the current planetary nebula catalogues contain perhaps 3,000 objects.

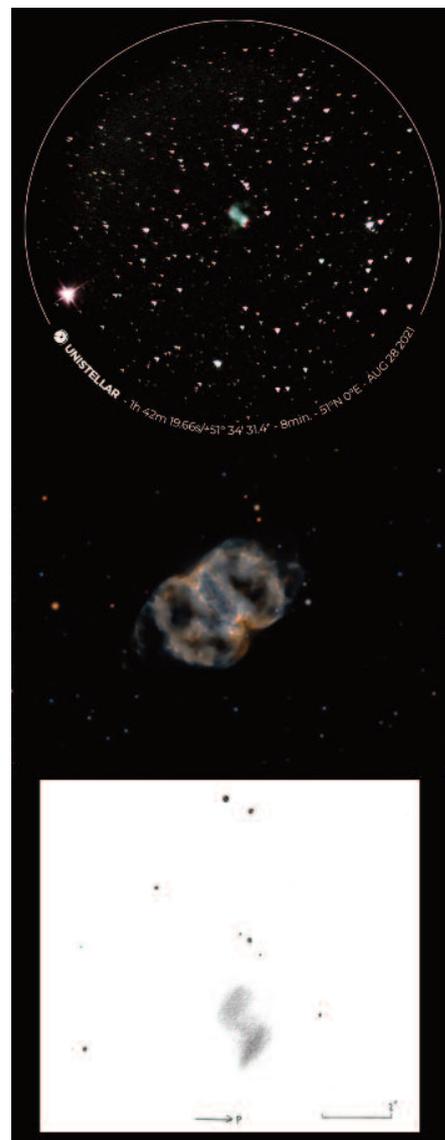
Using nebula filters

What really changed the observation of planetary nebulae was the invention of the nebula filter in the late 1970s and early 80s, first by Del Woods of Daystar and then by Jack Marling at Lumicon. The Lumicon filter names have become the standard in defining what we think of as nebula filters. For planetary nebulae these are the UHC (for ultra-high contrast) filter, which passes the spectral lines of the oxygen OIII (pronounced O3) line and the H-beta hydrogen line, commonly known as a narrowband filter; and the OIII filter which passes only the lines of OIII at

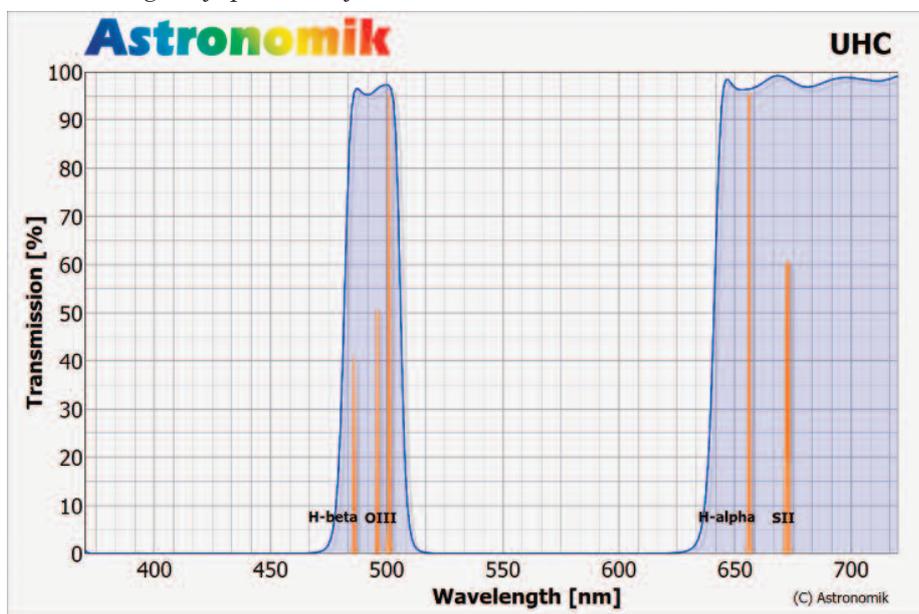
wavelengths of 500.7 and 495.9 nm, commonly known as a line filter. There is also a more extreme filter that may be used on certain planetary nebulae, known as an H-beta filter, which is a very narrow band filter passing only the hydrogen beta line at 486.1 nm. This is only worth using on a small number of planetary nebulae with abnormal properties.

These filters take advantage of the fact that planetary nebulae (and indeed all diffuse nebulae) only emit their light at certain specific wavelengths, so the filters are designed to pass only those lines and block out the rest of the spectrum, notably the light pollution and other skyglow. This makes it possible to observe them from more light-polluted environments than objects composed of stars, such as star clusters and galaxies that emit across the spectrum, in which case the light from the object is dimmed by the same proportion as the background. It should be noted that these filters increase the contrast of the object but will always reduce the amount of light transmitted because they are not 100 per cent efficient in passing light. They will also potentially add a colour cast to the nebulae, as well as to stars.

These filters are typically screwed into the bottom of an eyepiece but can also be used in a filter slide or "blinked" or moved repeatedly between the eyepiece and eye, to find small planetary nebulae, which may appear to blink on and off. They generally come in two sizes, 1.25 inch to fit normal eyepieces and 2 inch for larger eyepieces. If you are



▲ Three views of M76, the Little Dumbbell in Perseus. Top, an 8-minute image made with a 110-mm electronic eVscope by Jan Drozd. Centre: A long-exposure image by Ian Smith. Bottom: a drawing by Martin Lewis made using a 444 mm Dobsonian with a magnification of 254 from Pembrokeshire.



▶ The transmission curve of a UHC filter transmits only the strongest visual lines from nebulae and blocks the majority of other light, such as from light pollution. Credit: Astronomik.

buying filters then the recommendation is to start with a UHC type filter and then add an OIII filter for the more challenging objects.

It is recommended to use an OIII filter at a low power and then at medium power use a UHC type filter and at high powers perhaps no filter at all. Unfortunately, it is difficult to recommend filter brands as the proliferation of Chinese clones means that even within a brand the filter bandwidths and quality change with time. I have found that the filters from Astronomik in Germany and the specialist filters they have made for TeleVue (Bandmate 2) have the most consistent properties, although some people would say that their bandpasses are slightly wide. Unfortunately, the standard Lumicon filters have undergone a number of changes of ownership of the last few years and the quality of filters produced has been very variable although their current Generation 3 filters are pretty good again. It is worth noting that because these filters are expensive to make, being interference filters, quality also tends to vary with cost. You can buy a cheap Chinese filter that may help somewhat but it will not have the same effect as a high-quality one. There was a spreadsheet of filter types and passbands published on the online Cloudy Nights Forum in 2019 and this will give some form of guide.

Most nebulae show little or no colour, but some planetaries are exceptions. The eye contains two types of receptors: cones, near the centre of the eye, which are colour receptive but not very light sensitive; and rods, which are towards the edge of the retina, which are very sensitive to light but have no colour reception. The sensitivity of the rods in terms of colour lies in the green and falls off quite rapidly so there is no sensitivity at the red line of H-alpha shown so prominently on images of nebulae. It turns out, however, that certain planetary nebulae are both small and bright so their surface brightness is high enough that it can trigger the colour receptors in your eyes. These colours may be bluish or greenish depending on your colour sensitivity. This varies from person to person, and gender can also play

► Dark areas within the shell of M97, The Owl Nebula, give rise to its popular name as a result of a resemblance to the face of an owl. Credit: Ian Smith.

a part in what colours are perceived.

Lists of planetary nebulae

There are a number of specialist sources that give lists of planetary nebulae including the *Webb Society Deep Sky Observers Handbook Volume 2* and *Sky Atlas 2000 Companion Volume 2*. The Astronomical League in the US has a planetary nebula observing club that lists objects that should be visible to amateurs.

The most common way nowadays, however, is to generate lists using software programs such as SkyTools 4, Deep-Sky Planner 8 and perhaps apps such as SkySafari Pro.

In terms of locating the objects probably the best paper deep-sky atlas out there today is the *Interstellarum Deep Sky Atlas* and its companion *Deep Sky Guide* from Cambridge University Press. But I expect that most people are now using computer charting and there are a plethora of charting programs out there that will plot most of the common planetary nebulae. On the phone and tablet probably the best program right now is SkySafari Plus and Pro which runs on all forms of tablets.

Favourite targets

Most people will start off by looking for the planetary nebulae in Messier's catalogue, and indeed M27 and M57 are two of the showpiece planetaries. M27 in Vulpecula is visible in binoculars, and a small telescope and filter will show up both the apple-core shape and some of its extensions. M57 in Lyra is visible in any small telescope, although it is probably too small to be seen in normal binoculars. M76 in Perseus is one of the smaller and more challenging objects in the Messier catalogue but will still show excellent detail once found and will respond well to a filter. M97 (Ursa Major) is a more challenging object because of its size but it is visible as a large circular patch in a 100 mm



instrument using an OIII filter.

Moving away from the Messier objects, a number of the planetaries in the NGC are at least as bright as those found in Messier's catalogue so don't be afraid to chase them down just because they don't have M numbers. In the autumn and winter skies we have the Eskimo Nebula in Gemini, NGC 2392, which is a fine bright object that responds well to a filter and through a telescope will start to show some of the details that gave it its name. NGC 7662 in Andromeda lives up to its name of the Blue Snowball. Try and observe it without a filter in order to see the colours. There is also NGC 1535 in Eridanus which is a bright object, albeit a little low from the UK. As we move more towards spring we get NGC 3242, known as the Ghost of Jupiter, in Hydra. This again is a fine object that takes magnification well and will show lots of detail.

The summer skies give us the plethora of planetaries in Cygnus and Aquila and it is difficult to choose favourites here. My personal favourites include NGC 6905, the Blue Flash in Delphinus, NGC 6826, the Blinking Planetary, and NGC 7008, both in Cygnus. Hover these are only a few of many and I would encourage you to go out and find others and create your own list of interesting objects.

Owen Brazell is President of the Webb Deep-Sky Society and makes visual observations with instruments ranging in size from 100 mm to 510 mm.