Nebula filters cut sky glow and let you see more with less.

/// BY PHIL HARRINGTON

ALL FILTER IMAGES *ASTRONOMY*: WILLIAM ZUBACK

Secret weapons

It seems inevitable. No sooner do you get a new telescope than you begin to wonder what to buy next. Maybe some filters? Sounds like a good idea, but which ones? Amateurs use many different filters, but the most intriguing — and least understood — are light-pollution reduction (LPR) filters and nebula filters.

How filters work

Can we actually filter out light pollution? Yes, because many outdoor lighting sources do not shine evenly across the visible spectrum. Instead, they emit radiation at only a few distinct wavelengths. For instance, the common high-pressure sodium-vapor streetlight used throughout North America radiates principally in yellow wavelengths. Mercury-vapor lamps radiate green and blue wavelengths. LPR filters suppress those light wavelengths, while allowing others through.

"Nebula filters" have a different mission. They are designed for the sole purpose of observing emission and planetary nebulae. Fluorescence causes ionized atoms in these objects to glow.

Because these nebulae are composed largely of hydrogen, most of their visible-light emissions occur in the far-red and blue ends of the visible spectrum, but they emit greenish light from doubly ionized oxygen as well.

Most nebula filters muffle all wavelengths except those associated with ionized hydrogen and doubly ionized oxygen. Because they block all but a small part of the spectrum, these filters are more correctly called "narrow-band filters."

Other nebula filters suppress all visible light except for a specific wavelength, or line, that they allow to pass through. "Line filters" come in two varieties: Oxygen III (abbreviated OIII) and Hydrogen-beta (Hβ). As we will see, some narrowband and line filters are more appropriate for certain objects than others.

All three filter types are made essentially the same way: Within a vacuum chamber, a machine deposits precise, ultra-thin layers of inorganic coatings with known optical characteristics on thin glass blanks. When certain light wavelengths strike specific layers, the layers reflect the light rather than passing it through.

Setting the record straight

There are misconceptions about these filters. Some people mistakenly believe LPR filters reduce all forms of light pollution. This seems like a natural assumption given the filter's name, but it's just not the case.

LPR filters block certain wavelengths, but they do little to reduce the impact of car headlights, lights directed onto buildings, and other fixtures using incandescent bulbs, which (unfortunately for the astronomer) shine at all visible wavelengths.

Rather than the term "light-pollution reduction filter," it would be better to use their proper name: "broad-band filter." That's because they filter out a wide range of wavelengths. Similarly, nebula filters should be referred to as either "narrowband" or "line" filters.

Another common fallacy is that these filters make deep-sky objects look brighter. Not so. Filters decrease all light at all wavelengths, but they transmit more of the desireable wavelengths. As a result, the background sky and field stars darken more than the target. This boosts the contrast, making objects easier to spot.

NEBULA IMAGE: JASON WARE

/// HOW FILTERS WORK ON SELECTED OBJECTS

Company	Type	B33	NGC 2371-2	M76	NGC 1514	M42	M1	M37	M81
	No filter	0	2	3	0	3	3	4	3
Astronomik									
CLS	B	0	2	4	1	3	2	5	4
UHC	N	0	3	4	2	5	4	3	2
O-III	O	1	3	4	3	5	4	3	2
H-Beta	H	2	1	1	1	4	2	2	1
Baader									
UHC-S	N	0	3	4	1	4	4	3	2
OIII	O	1	3	5	3	4	4	3	2
Neodymium	B	0	2	3	2	3	3	4	3
Celestron									
UHC-LPR	N	0	3	4	1	4	4	3	2
DGM Optics									
VHT	B	0	2	4	1	4	4	4	3
NPB	N	1	4	5	3	5	5	3	2
IDAS									
LPS-P	B	0	2	3	1	3	3	3	3
Lumicon									
Deep Sky	B	0	2	3	1	3	3	4	4
UHC	N	0	3	4	3	5	3	3	2
O-III	O	0	4	5	2	5	4	2	2
H-Beta	H	2	1	1	0	5	1	1	1
Meade									
908B	B	0	3	3	2	3	3	4	4
908N	N	0	3	4	3	4	4	3	2
908X	O	0	4	5	3	5	4	3	2
Orion									
SkyGlow	B	0	2	3	2	4	4	4	4
UltraBlock	N	0	4	4	3	5	4	2	2
Tele Vue									
Nebustar	N	0	3	4	3	4	5	3	2
O-III	O	0	4	5	3	5	4	2	2
Thousand Oaks									
LP-1	B	0	2	3	1	4	4	4	4
LP-2	N	0	3	4	2	4	3	3	2
LP-3	O	0	4	5	3	5	4	3	1
LP-4	H	2	1	1	0	4	2	1	1

I rated the view of each object on a 0–5 scale adapted from my book *Star Watch* as follows: 0 — object invisible; 1 — visible only with great difficulty; 2 — visible with moderate difficulty; 3 — visible with little difficulty; 4 — visible easily; and 5 — wow!
B = Broadband; H = Hβ ; N = Narrowband; O = OIII

Some amateurs believe these filters dim the view so much they can't be used with small telescopes. That's not true. Any telescope can benefit from these filters. I even have used identical filters taped to the eyepieces of binoculars to detect faint celestial objects that were invisible otherwise.

Finally, there's the myth that filters are only for urban and suburban observing — that they're not needed for observing out in the country. Although broadband filters make their biggest impact under severe light pollution, narrowband and line filters enhance the view of emission and planetary nebulae no matter where you are.

Testing

To find out just how well today's most popular filters perform, I gathered more than two dozen broadband, narrowband, and line filters. Although many manufacturers make both 1¼" and 2" sizes, I restricted my tests to 1¼" models only to include all manufacturers.

A visual examination showed all the filters were made to high optical standards. Coatings appeared uniform, and the machined metal housings were either anodized or painted. Each was labeled for easy identification under dim lighting, and each screwed into my threaded eyepiece barrels smoothly. Most were black, which could make them difficult to find at night if misplaced. Only the four Thousand Oaks filters were anodized with different colors.

The winter constellations were riding high during these tests, which gave me a great choice of deep-sky objects to observe. All observing sessions were conducted from my light-polluted backyard, where I typically can see magnitude 5 stars with my naked eyes. Sky glow is severe in some directions, but I still get a good view overhead. These conditions let me see how well the filters work against moderate light pollution.

I tried each filter on showpiece objects like the Orion Nebula (M42) and the Crab Nebula (M1), as well as on some difficult targets, including the Horsehead Nebula (B33). I also checked several planetary nebulae as well as a few open clusters and galaxies.

To judge how well the filters performed, I laid them on a table, mixing up their order so I couldn't recognize one from another during the test. Only after I observed an object through a filter did I turn on a red light to identify the filter and write down my results.

Filtering through the results

Not surprisingly, the broadband filters did best against objects such as star clusters and galaxies, which radiate a wide range of wavelengths. While a filter seldom showed more detail than an unfiltered view or revealed an otherwise invisible target, broadband filters improved the visual aesthetics by darkening the background.

Of the seven broadband filters I tested, the Orion SkyGlow delivered the best results. It added just enough contrast to make an object stand out nicely without sacrificing too much image brightness. I also judged the DGM Optics Very High Throughput (VHT), Meade 908B, and Thousand Oaks LP-1 filters effective. Images remained bright and clear through all three test telescopes: my 4-inch refractor, and 8- and 18-inch reflectors.

The VHT did better on nebulae, while the others were better on star clusters and galaxies. Rounding out the pack were the Astronomik CLS, followed by the Baader Neodymium and Lumicon Deep Sky filters in a tie, and finally the IDAS LPS-P.

Of the nine narrowband filters, I judged DGM Optics' Narrow Pass Band (NPB) filter the best on emission and planetary nebulae. What sold me were the views I had of the Crab Nebula, the Little Dumbbell (M76), NGC 1514, and especially M42.

Phil Harrington *is the author of the observing guidebook* Star Watch*, published by John Wiley & Sons.*

The faint tendrils of M42 looked as though they were stretching outward like fingers grasping at nearby stars. I also was impressed with the images delivered by Orion's UltraBlock and Tele Vue's Nebustar Bandmate filters.

Views through Meade's 908N, Lumicon's UHC, and the Astronomik UHC filters also were pleasing although not quite as contrasty as the others. Readers looking for a narrowband filter would be satisfied with any of these. I found the Baader UHC-S, the Celestron UHC-LPR, and Thousand Oaks LP-2 less effective, however.

Results were exceptionally close in the OIII round of testing. I wasn't disappointed with any contender, but found the views through the Meade 908X were the best. I enjoyed the details revealed in M42, as well as some otherwise invisible features in several planetary nebulae. Likewise, the Astronomik, Baader, Tele Vue, and Thousand Oaks filters each showed some subtleties in objects that eluded detection in the other filters, save for the 908X (and, in some cases, the DGM NPB). The Lumicon filter darkened the field of view more than the rest.

Finally, I tested three Hβ filters. They produce positive results with only a handful of emission nebulae. Here, the Astronomik Hβ filter rose above the others, but only by the narrowest measure. Through my 18-inch reflector, all three Hβ filters revealed the dim silhouette of the Horsehead Nebula against the subtle backdrop glow of IC 434 when there wasn't a hint of this object through the others. All three also showed finer structure in M43 — the tiny appendage hanging off the northern edge of the Orion Nebula — than any of the OIII or narrowband filters, and even added new dimensions to M42 itself.

All tested filters increased contrast between deep-sky objects and the background sky. If you live under a dome of light pollution, consider adding a broadband filter to your equipment arsenal. If you enjoy searching for tough planetaries or challenging emission nebulae, then either a narrowband or OIII filter is a must-have. For us deep-sky diehards who already own the others, an Hβ filter will prove handy, even though it likely will see less starlight than other filters.

Once you start using filters, you'll be amazed at what you've been missing. It's the same pleasant experience as putting on your "shades" on a sunny day.

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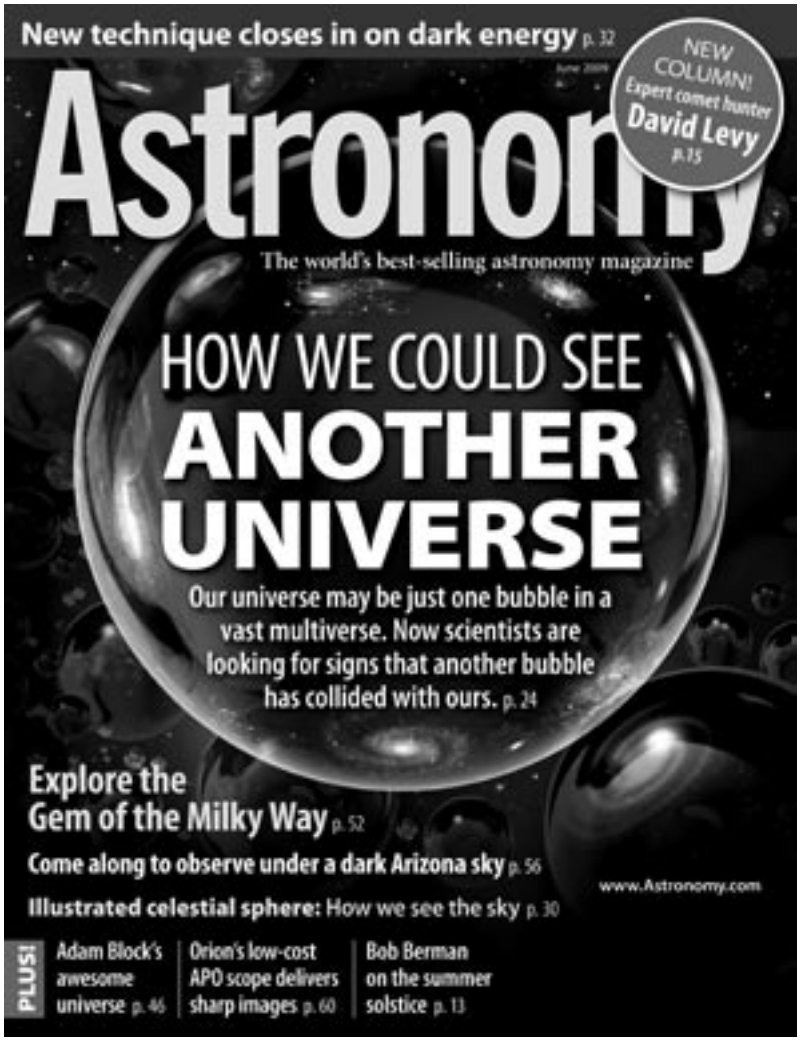

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