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Winter's Best Reflection Nebulae

Point your telescope at some of the prettiest sights in the night sky.

Tips for Observing Winter Reflection Nebulae

The winter sky offers numerous reflection nebulae, but seeing these objects requires extra care during your observing sessions. Here are a few tips on how to view these celestial gems.

Clean Your Optics.

Scattered light from dust and dirt on your objective and eyepieces creates a glow around brighter stars that resembles reflection nebulae. Clean your eyepieces and use a dust-removal tool to loosen debris from your objective.

Fight Dew and Condensation.

Use a dew heater or dew shield for your optics, if possible. If you're having problems with condensation on the eye lens of your eyepiece on cold nights, keep one eyepiece in your pocket to gently warm it and swap your eyepieces during your observing session.

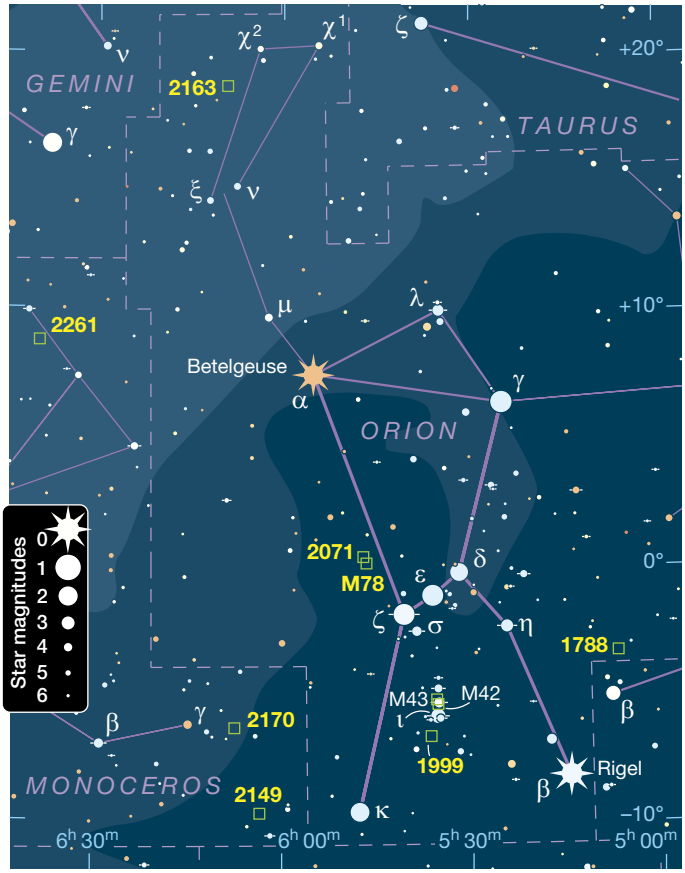
In 1912, the industrious astronomer Vesto Slipher turned the 24-inch refractor at Lowell Observatory (Arizona), mounted with a state-of-the-art spectrograph, towards the Pleiades to capture the spectrum of the faint nebula around the star Merope. He expected to find an emission spectrum, spiked with lines from ionized oxygen and hydrogen like those astronomers had observed in objects such as the Orion Nebula. Instead, his data showed a continuous spectrum from the Merope Nebula that matched that of the star itself. Slipher suggested, correctly, that the nebula emitted no light of its own and instead simply reflected starlight. We now understand such reflection nebulae arise when interstellar clouds of fine grains of dust scatter light from the relatively young stars embedded within. This process — *Rayleigh scattering* — preferentially scatters blue light, which renders these nebulae a striking color in photographs.

Astronomical catalogs now list more than 1,200 reflection nebulae. Winter brings many into view, and though observing them requires patience and deliberation, each year I enjoy testing my eyesight (and cold tolerance) on a few brighter specimens. I also muse on how the same process that makes our sky blue also yields shimmering patches of ethereal blue-white light reflected by rarefied clouds of dust light-years across.

To see reflection nebulae — which visually appear whitish-grey — I rely on my 10-inch f/4.7 Dobsonian, which is what I used for the targets described here (unless otherwise noted). The aperture helps, but I don't usually use nebula filters since they offer limited benefits with these broadband objects. I observe in Bortle 3–4 or darker skies on nights of high transparency (see the sidebar below for tips on how to better observe reflection nebulae). For this tour, I selected nebulae that have an overwhelmingly reflective component and excluded objects such as the Orion Nebula that are primarily emission nebulae.

Tiny Blisters of Nebulosity in Orion

Let's begin in Orion with **M78**, the brightest of several reflection nebulae in a large complex. Located 2.5° northeast of 1.8-magnitude Zeta (ζ) Orionis (Alnitak), M78 is a good test of sky conditions. If you can't see it, you're not likely to see the rest of the nebulae on this tour until you find darker or clearer skies. About 8′ long, M78 surrounds two stars of magnitudes 10.4 and 10.8 that resemble a ghostly set of eyes. With a 24-mm Panoptic eyepiece delivering 50×, M78 looks distinctly fan-shaped, like a comet that splays to the southeast. In a 13-mm Ethos at 92×, the nebula appears split into two uneven parts by an arc of darkness with a thinner curved section to the northwest. The northern edge appears sharply defined, while the southern limb fades to darkness.



▲ **WINTER'S HUNTER** Many of the targets on this tour of reflection nebulae lie in one of the night sky's most iconic constellations, Orion, and in its neighbor Monoceros, the celestial Unicorn.

◀ **GEMS IN THE SKY** Many brand-new star clusters emerge from dusty cocoons, but at 100 million years old, the stars of the Pleiades pushed away the remains of its birth cloud through radiation pressure long ago. The nebulosity we see in this image results from the cluster serendipitously passing through interstellar dust.

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Sky Conditions. A dark (Bortle 4 or darker), transparent, and moonless sky is essential for observing reflection nebulae.

Averted Vision. Move the center of your gaze away from the nebula to expose the most sensitive part of your retina.

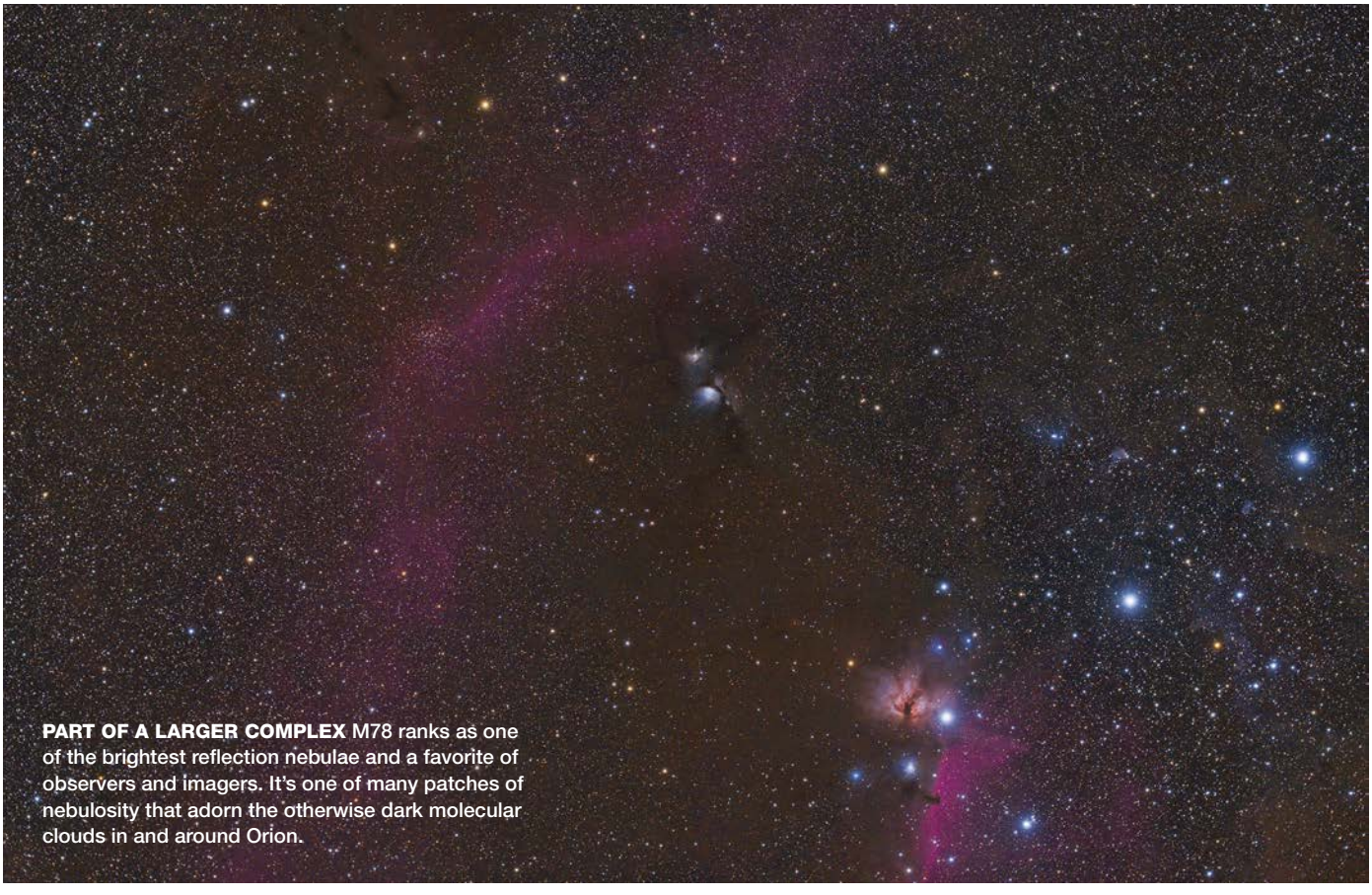
Filters. Some observers see slight contrast improvement using wideband "deep sky" light-pollution filters. Some do not. See what works for you.

Warmth. Above all, stay as warm as possible! You'll see more if you're comfortable.

About 15′ north-northeast of M78 lies a pair of 10th-magnitude stars that shine as frosty beacons in the dark Orion B molecular cloud, which is about 1,300 light-years away. The eastern star (HD 290861) appears enveloped in the small, featureless, round haze of 8th-magnitude **NGC 2071**. The nebula spans nearly the same angular diameter as M78, but its lower surface brightness makes it appear smaller.

Now, locate the 2.8-magnitude star Iota (ι) Orionis in Orion's Sword and look 50′ south-southeast to find tiny **NGC 1999**, a dust cloud reflecting light from the 11th-magnitude star V380 Orionis. At 50×, I see the star embedded in a faint nebula that renders it slightly fuzzy. The little haze spans only 2′. Higher magnification reveals a striking dark "keyhole" structure at the center of the object. I could spot the keyhole — barely — at 133× in binoviewers in my 10-inch at the 2017 Winter Star Party in the Florida Keys. With averted vision it looks like a dark donut hole that pops in and out of view just southwest of V380 Orionis. At that magnification, I get a hint of wispy structure at the nebula's outer edges. At 133× and above, I see no other field stars, which accentuates the nebula's ghostly appearance. Astronomers once thought the keyhole was a *Bok globule*, a dense blob

◀ **COSMIC KEYHOLE** A tiny reflection nebula south of M42, NGC 1999 harbors a thick and dark dust cloud that resembles a hole in space. Careful observation will reveal its remarkable shape, reminiscent of a keyhole, which is much easier to discern in images.



PART OF A LARGER COMPLEX M78 ranks as one of the brightest reflection nebulae and a favorite of observers and imagers. It's one of many patches of nebulosity that adorn the otherwise dark molecular clouds in and around Orion.

M78: BERNHARD HUBL; NGC 1999: ALSON WONG

of cold, dark gas where new stars form — but it's really just a region in space devoid of gas or dust. How it formed remains a mystery (see, e.g., *S&T:* Feb. 2022, p. 57).

Our next target, **NGC 1788**, lies in southwestern Orion about 1.7° northwest of 2.8-magnitude Beta (β) Eridani in a star-forming region on the edge of the Orion Molecular Cloud. The stars illuminating the nebula are just a million years old and still ensconced in the remnants of a dusty cocoon. At 50×, NGC 1788 resembles a fuzzy star. Averted vision coaxes an elliptical nebulosity about 5′ long into view oriented northwest to southeast, but with little other detail. At 92× I start to see a few knots. Tenth-magnitude HD 293815 shines as the brightest star of an unresolvable cluster at the heart of the nebula. More magnification offered diminishing returns.

Now to **NGC 2163**, an appealing little nebula among the stars of the Hunter's upraised club about 1.7° southeast of 4.6-magnitude Chi^2 (χ^2) Orionis. This 11th-magnitude nebula spreads north-south from a central 11.3-magnitude star and resembles a tiny celestial butterfly at higher magnification. At 50× I see no signs of the nebula. At 92× the star looks elongated, and at 185× I see hints of the nebula's bipolar lobes. The northernmost lobe is clearly brighter, which gives NGC 2163 the appearance of a tiny comet. About 3′ long, this nebula isn't an easy object but it's worth the effort.

Variability and More in Monoceros

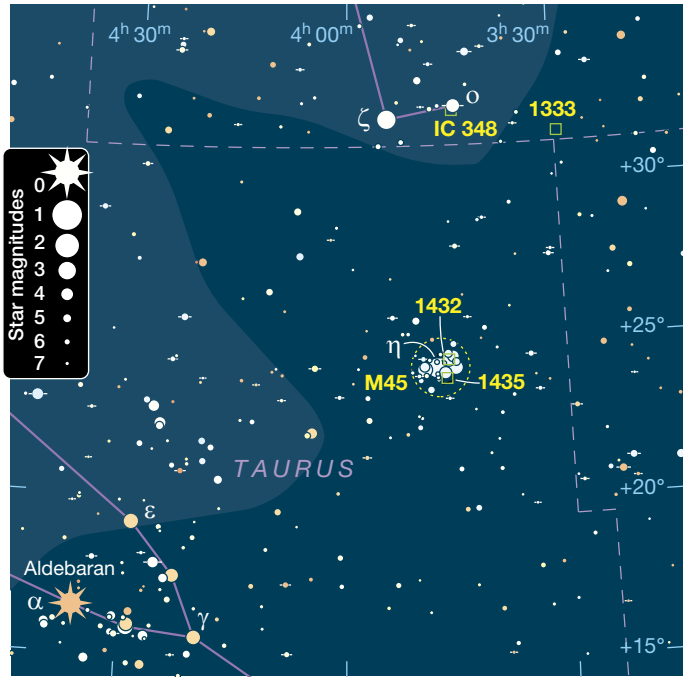
Monoceros harbors cometary reflection nebula **NGC 2261**, also known as Hubble's Variable Nebula. It sits about 1.2° south-southwest of 4.7-magnitude 15 Monocerotis, the brightest star in the superb Christmas Tree Cluster (cataloged as NGC 2264 along with the Cone Nebula). Eleventh-magnitude R Monocerotis anchors the nebula at its southeastern point. John Mellish, an unpaid observer at Yerkes Observatory, first suspected the nebula's variability in 1915, while Edwin Hubble, then a graduate student at the University of Chicago, confirmed it in 1916. NGC 2261 shines by the light of R Monocerotis, itself a variable star and in a newly minted binary system enshrouded in nebulosity — but the nebula's variability is unrelated to the star's. Instead, R Monocerotis and its accretion disk rotate, dragging matter from the surrounding dusty envelope and ejecting it in two directions (toward and away from us). Occasionally, some of that ejected material passes in front of the star, dimming it. At 50×, I see R Monocerotis and a 10.5-magnitude star 2′ to its northeast, which gives the appearance of a wide double. It's only when I use averted vision that I get a hint of this striking nebula curving north-northwest away from the star. At 150× I see a well-defined fan shape, like a flickering candle, extending 2′ to 3′ from R Monocerotis, while 185× brings out bright edges and traces of structure in the nebula's interior.

Before we leave Monoceros, let's examine two more highlights. **NGC 2149** lies on the edge of the Orion-Eridanus Superbubble, a clearing in the interstellar medium that formed when half a dozen stars in and around Orion exploded as supernovae in the last 10 to 15 million years. The shock waves stimulated new star formation, and NGC 2149 is a conspicuous result. This minute nebula lies nearly 4° east of 2.1-magnitude Kappa (κ) Orionis (Saiph) in a pleasing star field between a pair of 11th-magnitude stars. At 92×,

▲ **VARIABLE FAN** The subject of one of Edwin Hubble's first research papers, NGC 2261 resembles a flickering flame set aglow by the star R Monocerotis (the magnitude of which varies between 10.7 and 13.2). Time-lapse images show changes in the nebula's brightness and structure, which can occur in as little as a few weeks.

▲ **SMALL BUT SPLENDID** Tiny, fan-shaped NGC 2149 lies on the edge of the Orion-Eridanus Superbubble, a structure of overlapping shock fronts that were likely formed by supernovae from young stars in the Orion OB1 association.

NGC 2261: MAKIS PALAIOLOGOU / STEFAN BINNEWIES / FRANK SACKENHEIM / CAPELLA OBSERVATORY; NGC 2149: GARY IMM



▲ **SHIMMERING CLUSTER** Head to northwestern Taurus for the Pleiades and then scan north into Perseus for two delightful nebulae.

I see a small fan about 3′ wide that opens eastward. To the west it falls off suddenly. A 12th-magnitude star lies near the nebula's western side. Images of the nebula show a tiny, dark blob on its western side, but I can't see it.

While it's only 3.5° to the north-northeast of NGC 2149 and 1.5° west of 4.0-magnitude Gamma (γ) Monocerotis, **NGC 2170** inhabits the more distant Monoceros R2 molecular cloud. It lies 2,900 light-years away, twice as far as NGC 2149. At 92× and 150× I see it as a frosty and uniform circle about 2′ across with a partially obscured 10th-magnitude central star.

The Dusty Nebulosity of the Pleiades

Now, at last, let's turn our attention to the **Pleiades** (M45). On nights of excellent transparency, faint nebulosity appears around many of the cluster's bright stars. To ensure you're not seeing the effect of condensation on your optics, nudge your scope towards the neighboring Hyades star cluster. If you see nebulosity there, too (where none exists), it might be time to fire up a dew heater. Perhaps uniquely, the Pleiades' nebulosity results from the cluster passing through an unrelated cloud of interstellar dust.

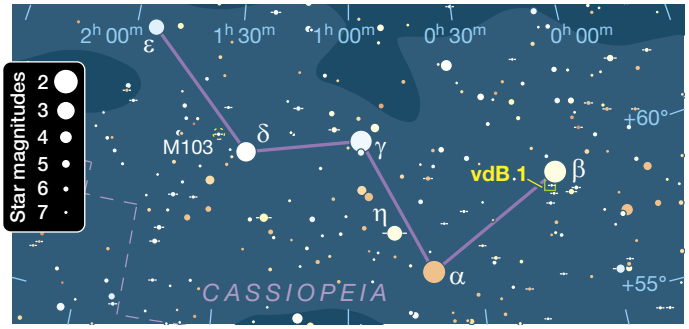
The brightest nebulosity (where Slipher measured his spectra more than a century ago) lies south of 4.2-magnitude Merope in the form of **NGC 1435**. First seen by German astronomer Wilhelm Tempel in 1859 with a 4-inch telescope, this patch extends nearly 0.5° and is within reach of 10×50 binoculars in ideal conditions. I've seen it in a 66-mm refractor. In my 10-inch at 50×, I detect a tapered fan of faint light arcing southward from Merope with evidence of delicate structure and striations. Unlike other reflection nebulae, this one looks better to me with a wideband deep-sky filter, and I saw more detail after placing Merope just outside the field of view.

Before you leave the Pleiades, try for **NGC 1432** surrounding the 3.9-magnitude star Maia. At 50×, the reflection nebula appears round and largely featureless and less distinct than its brighter, hazy neighbor.

Winter's Finest Reflection Nebulae

Object	Constellation	Magnitude	Size	RA	Dec.
M78	Orion	8.0	8′ × 6′	05h 46.7m	+00° 05′
NGC 2071	Orion	8.3	7′ × 5′	05h 47.1m	+00° 18′
NGC 1999	Orion	9.5	2′ × 2′	05h 36.4m	–06° 43′
NGC 1788	Orion	—	5′ × 3′	05h 06.9m	–03° 20′
NGC 2163	Orion	~11	3′ × 2′	06h 07.8m	+18° 39′
NGC 2261	Monoceros	—	3′ × 1′	06h 39.2m	+08° 45′
NGC 2149	Monoceros	—	3′ × 2′	06h 03.5m	–09° 44′
NGC 2170	Monoceros	—	2′ × 2′	06h 07.5m	–06° 24′
M45	Taurus	1.5	120′	03h 47.5m	+24° 06′
NGC 1435	Taurus	—	30′ × 30′	03h 46.2m	+23° 46′
NGC 1432	Taurus	—	26′ × 26′	03h 45.8m	+24° 22′
IC 348	Perseus	7.3	10′	03h 44.6m	+32° 10′
NGC 1333	Perseus	5.7	6′ × 3′	03h 29.3m	+31° 25′
vdB 1	Cassiopeia	—	5′ × 5′	00h 11.0m	+58° 46′
NGC 7023	Cepheus	7.2	10′ × 8′	21h 01.6m	+68° 10′

Angular sizes are from recent catalogs. Visually, an object's size is often smaller than the cataloged value and varies according to the aperture and magnification of the viewing instrument. Right ascension and declination are for equinox 2000.0.



▲ **IN CASSIOPEIA** You'll visit another recognizable constellation when you search for tiny vdB 1.

▶ **BEACONS IN THE DARK** Just southwest of 2nd-magnitude Beta Cassiopeiae, vdB 1 calls to mind three distant searchlights on a foggy night. This small, nebulous patch bears the name of Canadian astronomer Sidney van den Bergh, who listed it as the first target in his 1966 catalog of 158 reflection nebulae.

BERNHARD HUBL

Wrapping Up with a Quirky Quartet

Let's move northward into Perseus to locate 3.9-magnitude Omicron (o) Persei (Atik) and then scan just to the southeast. There lies **IC 348**, a lovely little cluster of brand-new blue-white stars a bit more than 1,000 light-years away. At 92×, I see perhaps a dozen stars. The most striking is the wide double star Struve 439, which has components of magnitudes 8.8 and 10.3 separated by 23″. Under ideal conditions, at 92× and 150× I see fleeting evidence of interstellar haze around these stars. The designation IC 348 refers to both cluster and nebula, but the nebula itself is also vdB 19 in Canadian astronomer Sidney van den Bergh's 1966 catalog of reflection nebulae.

Just 3.3° west-southwest of Atik we see an easier target in **NGC 1333**, which Contributing Editor Stephen James O'Meara describes in his book *Deep-Sky Companions: Hidden Treasures* as "a simple but beautiful reflection nebula." Eduard Schönfeld discovered it with a 3.1-inch refractor at Bonn Observatory (Germany) in 1858. Despite its brightness (magnitude 5.7) and size (about 6′ × 3′), this object escaped the attention of Charles Messier, Pierre Méchain, and the Herschels. I've detected it and its central 10th-magnitude star with little effort in an 85-mm refractor. In my 10-inch scope, I initially see only the central star and some attendant fuzziness. But averted vision or a tap on the telescope snaps its larger oval shape into view. A magnification of 50× reveals a few 12th-magnitude stars sprinkled around the nebula's outer reaches. At 92×, about 3′ southwest of the central star, I note hints of a smaller bright patch cut off by a puff of dark nebulosity. NGC 1333 is a highly active star-forming region in the Perseus Molecular Cloud, with a cluster of some 150 members within.

Let's conclude with two nebulae along the northern Milky Way. Less than ½° southeast of 2.3-magnitude Beta Cassiopeiae (Caph) lies the tiny patch of nebulosity known as **vdB 1**, which wraps itself around a trio of 8th- and 9th-magnitude stars. At 50×, I see the stars but no nebula. At 92× with averted vision, a uniform fog around the stars reveals itself. The nebula appears slightly brighter around the northeastern star of the trio. I popped in a widefield eyepiece with a 2° field of view, large enough to include Caph in the field, and patiently looked south-southeast for the broad arc of the dark nebula LDN 1265 extending about 0.7°. I see not a single star over its inky surface.

While it's considered an autumn target, **NGC 7023**, the dazzling Iris Nebula, in Cepheus lies almost halfway to the zenith in early evening in January and February. Some 3.5° southwest of 3.2-magnitude Beta Cephei, the nebula shines at magnitude 7.2 and spans 10′ × 8′. A 4-inch telescope shows it easily. In my 10-inch at 50×, with direct vision, I see a round central region enshrouding the brand-new 7.4-magnitude star HD 200775. With averted vision, the nebula balloons in size and reveals an irregular box shape with a faint bar oriented roughly north-south and a slight hook on its southern edge. NGC 7023 is an astrophysicist's paradise, with a central star that has yet to settle onto the main sequence, dynamic molecular gas clouds, and spectroscopic evidence of fine dust grains and complex carbon-based molecules scattering blue-white starlight into the interstellar medium.

While they're not easy to see, reflection nebulae have an undeniable allure. Viewing them increases your visual acuity and skill. They reward patient observation with fleeting glimpses of delicate structure. And these outposts of star formation offer a glimpse into the complex star-making machinery of the Milky Way Galaxy as it turns cold, dark clouds of gas and dust into newly formed stars.

■ Contributing Editor **BRIAN VENTRUDO** is a writer, scientist, and longtime amateur astronomer based in Calgary, Canada. He writes about astronomy and stargazing at his website **CosmicPursuits.com**.