

IMAGING TARGETS by Ron Brecher

Treasures of the Sharpless Catalog

NEBULOUS SPLENDOR

The Sharpless Catalog was the first exclusive listing of emission nebulae visible from the Northern Hemisphere.

Many of the nebulae listed as several objects in earlier catalogs are grouped as single, larger objects. For example, NGC 7000 (top left) and IC 5070 (right) are together listed as Sh 2-117.

Sample some of the delights in the first comprehensive catalog of nebulae.

Like most astrophotographers today, my imaging adventures began on a well-trodden path of celestial showpieces, including the Andromeda Galaxy (M31), the Hercules Cluster (M13), and the Dumbbell Nebula (M27). I occasionally revisit these familiar landmarks to see how my imaging techniques have improved with time. But as my experience and skills developed, I began to look beyond the popular Messier list in search of new and exciting vistas to explore.

While the Messier and NGC catalogs guide us to many splendors for imaging with amateur equipment, other, more obscure compilations are available for those who want to delve into less familiar deep-sky objects. The Sharpless catalog is one such great resource for imagers in the Northern Hemisphere who want to embark on an “off-road” adventure.

A Catalog of Galactic Nebulae

Stewart Lane Sharpless (1926–2013) was a graduate student at Yerkes Observatory who helped with the calculations used to define the UBV photometric system that photographically classified stars according to their colors. This later expanded into the UBVR system as photographic emulsion sensitivity in the mid-20th century became more responsive to red and infrared wavelengths. Sharpless focused on determining the true structure of the Milky Way Galaxy. In so doing, he estimated the distances to H II regions and hot, young star clusters. This work culminated in a paper published in 1952 with Don Osterbrock in which they conclusively established the spiral nature of our home galaxy.

Sharpless continued his research into the structure of the Milky Way when in 1953 he took a position at the United States Naval Observatory Flagstaff Station in Arizona. There he continued surveying and cataloging H II regions within the Milky Way. But he didn't use a telescope for this task. Rather, he pored through the available plates of the ongoing National Geographic Society – Palomar Observatory Sky Survey (NGS-POSS). This groundbreaking survey, begun in 1949 using the 48-inch Samuel Oschin telescope at Palomar Observatory in California, was the first to image the entire sky down to a declination of -27° in both blue and red light. Because emission nebulosity consists primarily of ionized hydrogen, which emits light at 656.28 nanometers, Sharpless concentrated his efforts on identifying and cataloging emission nebulae exclusively recorded on the red-sensitive Kodak 103a-E plates.

First published in the *Astrophysical Journal Supplement* in 1953, “A Catalogue of Emission Nebulae Near the Galactic Plane” contained 142 objects. Sharpless continued to add to his list as new plates became available. In December 1959, the second and final edition of the catalog appeared; it was titled “A Catalogue of H II Regions” and lists 313 entries. The second edition supersedes the first, prefacing each object with the designation “Sh 2.”

Sharpless's goal was to produce a comprehensive catalog of every known emission nebula north of the southerly declination of -27° , although some objects in the catalog lie farther south. His quest focused primarily on H II regions, though his list contains some planetary nebulae and even several supernova remnants like the famous Crab Nebula (M1), designated **Sharpless 2-244**.

Targets for Any Scope

Today, the Sharpless catalog is one of the most comprehensive lists of emission nebulae in the sky for Northern Hemisphere astronomers and astrophotographers. It includes both bright and faint targets — objects suitable for most any telescope.

When I wrote previously about objects that tend to get ignored in favor of their brighter neighbors (*S&T*: Oct. 2018, p. 58), friends noted that I drew heavily from the Sharpless catalog. They're right — the list includes all the familiar bright nebulae visible in northern skies, as well as many faint obscure objects. It's exciting to go after the fainter members of this list, but you probably have unknowingly shot a few Sharpless objects already. Here are a few of my favorites.

In the Wings of the Swan

I could spend the whole summer — maybe several — just imaging the Sharpless objects in Cygnus. This single constellation contains no less than 26 individual targets, including several showpieces such as the North America Nebula and Pelican Nebula complex (NGC 7000 and IC 5070) east of 1st-magnitude Deneb that make up **Sh 2-117**. Just over 3° to its west lies **Sh 2-119**, an equally large though faint nebula punctuated with several small, dark nebulae.

Almost 10° south of Sh 2-119 is the Cygnus Loop, **Sh 2-103**, which partly spills into Vulpecula. Sharpless

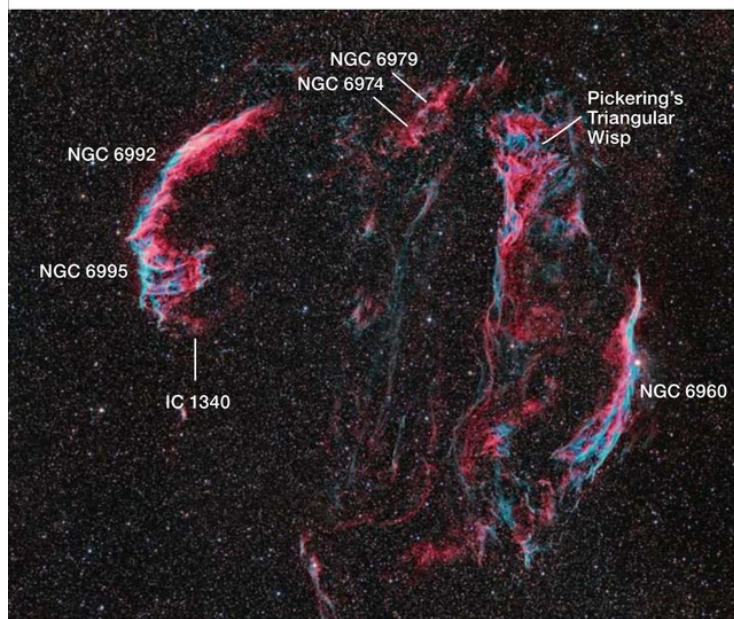
▼ **FAMILIAR FRIENDS** While the Sharpless catalog contains many faint objects, it was meant to be a comprehensive listing of all emission nebulae visible from the Northern Hemisphere. So it includes many well-known objects such as M1, the Crab Nebula, designated Sh 2-244 (below).



Imaging Targets

SOME REFLECTIONS The vast majority of nebulae that made the Sharpless list are exclusively emission nebulosity, which emits light at the red end of the spectrum. But several objects, including NGC 1977 at top (Sh 2-279) and M42 (Sh 2-281) seen below contain bluish reflection nebulosity.





▲ **SUPERNOVA UNITED** (Left) All the individual segments of the nearby Cygnus Loop supernova remnant (noted in the image) are included on the Sharpless list as Sh 2-103. **BIG PLANETARY** (Right) Sh 2-290 is one of the closest planetary nebulae visible from Earth, and the only Sharpless nebula in Cancer.

neatly combined the individual segments of NGC 6960, NGC 6992, NGC 6995, NGC 6974, NGC 6979, IC 1340, and Pickering's Triangular Wisp into Sh 2-103.

About 2° southwest of 2nd-magnitude Sadir (Gamma Cygni) is the Crescent Nebula (NGC 6888), cataloged as **Sh 2-105**. This complex nebula is produced by the stellar wind from the Wolf-Rayet star WR 136 at its center. The Crescent is another object that contains a bluish oxygen III (O III) component consisting of a gossamer shell seen along its outer edge.

Continuing about 3° farther along the imaginary line formed by Sadir and the Crescent brings us to **Sh 2-101**, the Tulip Nebula. This moderately bright emission nebula displays small dark lanes in deep exposures.

For a tough summertime challenge, look 3½° south of Sh 2-101 and try to image **Sh 2-98**. As one of the fainter Sharpless catalog members in Cygnus, it looks like a ghostly red smoke ring in a rich field of brightly colored stars. Like Sh 2-105, Sh 2-98's glow is caused by energy from a powerful Wolf-Rayet star, in this case WR 130.

In the northeastern corner of the constellation, **Sh 2-124** tends to be overlooked due to its proximity to so many better-known objects. Lying in a dense star field 3.5° northeast of IC 5146, the Cocoon Nebula, this little nebula is bisected by a wide, meandering dark lane.

Skipping farther south, the Eagle Nebula in Serpens is often referred to as M16, but Messier actually cataloged the open cluster at the Eagle's heart and didn't see the surrounding nebula. Sharpless includes this expansive nebulosity as **Sh 2-49**. Long exposures are required to reveal the extended

"wings" of nebulosity that give the nebula its nickname, while larger instruments producing a higher pixel-scale are required to get good detail in the central pillars of dark nebulosity. Just 2° north of the Eagle and part of the same tenuous hydrogen cloud is **Sh 2-54**, which adds additional interest to wide-field photographs of the area.

Northerly Declinations

Targets in the summer Milky Way remain available to northern imagers as the nights lengthen during autumn. But you might also find yourself drawn towards other Sharpless treasures along the Milky Way in Cassiopeia, Cepheus, and Perseus.

One of the best-known deep-sky objects in this region is the Bubble Nebula, NGC 7635, denoted as **Sh 2-162** on the Sharpless list. This thin shell of nebulosity is found about 37' southwest of the open cluster M52 and is being hollowed out by the strong stellar winds of the young star SAO 20575 within. The Bubble should reveal itself in relatively short exposures. Slightly more than 1° south-southwest of the Bubble Nebula lies the expansive Lobster Claw Nebula, **Sh 2-157**. The Lobster Claw contains a strong O III component and is particularly colorful when imaged through narrowband filters. A wide-field astrograph with a 4° field can frame both objects in the same field and make a nice composition that also includes another interesting nebula, NGC 7538, also known as **Sh 2-158**.

Heading west just over the border in Cepheus, 3⅓° to the northeast lies the Cave Nebula, **Sh 2-155**. This faint target is a

Imaging Targets



CLUSTERED GROUPING This image features four distinct nebulae near the border of Cassiopeia and Cepheus, including Sh 2-162; the Bubble Nebula (left); Sh 2-161 (top); Sh 2-158, the smaller, bright nebula at top right; and Sh 2-157 (bottom).



OVERSHADOWED Sh 2-119 in Cygnus is a complex object with dark nebulous detail usually passed over in favor of the nearby North America Nebula a little more than 3° to its west.

mix of emission, reflection, and dark nebulosity that makes for a wonderful multi-hued image but requires long exposures.

South-central Cepheus is home to the expansive nebula **Sh 2-131**, better known as IC 1396. This large emission complex is almost 3° across and is a fine autumn target for northern imagers using most any optic. It contains many dark nebulae as well as the well-known Elephant's Trunk Nebula, vdB142, a great target for big telescopes.

Slightly more than 4° northwest of Sh 2-131 is **Sh 2-129**, sometimes referred to as the Flying Bat Nebula. This faint emission nebula was revealed to host a large and even fainter bipolar nebula known as Ou4, the Squid Nebula, which consists entirely of doubly ionized oxygen nebulosity. Discovered just nine years ago by French astrophotographer Nicolas Outters, Ou4 is *exceedingly* faint. I needed more than 100 hours of exposure before I was satisfied with the result.

Targets for Long Nights

One of my favorite winter targets is the Sword of Orion, which contains

two well-known objects that also grace Sharpless's list: the Great Nebula in Orion (M42), also known as **Sh 2-281**, and the Running Man Nebula (NGC 1977), which makes the catalog as **Sh 2-279**. While much can be said about these two famous clouds of glowing gas, both sport large- and small-scale details in camera lenses and large telescopes alike. As one of the brightest emission nebulae, Sh 2-281 is among the most photographed regions of the sky, beckoning to both beginners and seasoned astrophotographers.

Far north and straddling the borders of Camelopardalis and Perseus lies **Sh 2-205**, sometimes referred to as the Peanut Nebula. This large, faint nebula requires a wide-field camera and telescope combination producing at least a 3° field of view to record the entire object's irregular shape.



◀ **STELLAR WINDS** Another familiar object to deep-sky imagers is NGC 6888, the Crescent Nebula, cataloged as Sh 2-105 on the Sharpless list. This nebula is the product of a fierce stellar wind emanating from the Wolf-Rayet star at its center colliding with the surrounding molecular cloud that fills most of Cygnus.

Imaging Targets



◀ **HIDDEN GEM** (*Top*) Located in the northeast corner of Cygnus, Sh 2-124 is an emission nebula bisected by a prominent dark lane.

◀ **BONUS CONTENT** (*Middle*) The large, faint Flying Bat Nebula, or Sh 2-129, in southwestern Cepheus also hosts the extremely faint bipolar outflow Ou4, often called the Giant Squid.

◀ **WINTER TREATS** (*Bottom*) Another popular nebula during the winter months, supernova remnant IC 443 makes the catalog as Sh 2-248 (lower right), as well as the fainter, diffuse nebulosity of Sh 2-249 (IC 444) seen in the image at middle left.

For a more formidable challenge, aim your rig at the similarly sized and very faint supernova remnant **Sh 2-221** in Auriga. Although the hydrogen-alpha ($H\alpha$) signal in this target is relatively strong, long exposures through an O III filter will reveal teal-colored tendrils and a foglike haze surrounding this mostly red nebula.

While most of the fainter Sharpless objects lack common names, I refer to a few by the shapes they remind me of as I spend time processing their images. For example, **Sh 2-232** in Auriga reminds me of a jelly donut and so will forever be the Jelly Donut Nebula in my mind. This roughly 40' circular nebula gives great results when imaged through an $H\alpha$ filter. It also contains two snake-like dark nebulae, and a trio of prominent stars near its center. Smaller, brighter **Sh 2-235** is right next door to the southwest, enhancing the field of view. Astro-imagers with longer focal-length instruments targeting Sh 2-235 can reveal several orangish Herbig-Haro objects just off its southwestern edge, hinting at newly formed stars within.

Planetaries and Supernovae

Besides general emission nebulae, the Sharpless catalog includes quite a few nebulae produced during the final stages of a star's life cycle.

One excellent target is the Jellyfish Nebula, IC 443, found just east of the 3rd-magnitude star Propus in Gemini. Sharpless lists this complex nebula as **Sh 2-248**. It's a little less than 1° across, but if you use a wide-field astrograph, you can also sweep up the adjacent nebulosity of **Sh 2-249**. The Jellyfish is another example of a large supernova remnant that can appear as a striking, multi-colored image when shot through narrowband filters. Another interesting target is the large, faint planetary nebula **Sh 2-290** (Abell 31) found in southern Cancer. Estimated to be about 2,000 light-years distant, it's one of the closest and largest planetary nebulae, measuring 17' in diameter. Sh 2-290 has a core dominated by teal-colored O III encased in a faint red hydrogen shell and wispy features visible in high-resolution images taken with larger instruments.

Plan Your Approach

Imaging targets from the Sharpless catalog is in some ways easier than photographing galaxies. While galaxies emit light across the visible spectrum, emission nebulae emit light at specific wavelengths that can be isolated from most

sources of light pollution. This means that urban imagers equipped with narrowband filters will be rewarded with colorful results and rich details despite their bright skies.

Regardless of your sky's darkness, if you are using a monochrome camera, narrowband filters are a good option for imaging Sharpless objects. Hydrogen-alpha provides the predominant signal for most Sharpless objects, so imaging through an H α filter is beneficial and can give you great results on its own or combined with O III- and S II-filtered images. Plan on gathering plenty of exposures for the particularly dim nebulae in the catalog — that will give you the best chance of revealing the faintest structures that your gear and sky conditions will permit. You can even achieve good narrowband images of bright emission nebulae under a gibbous Moon.

Extended nebulae in the catalog are best imaged with short-focal-length instruments combined with a large sensor. Shoot the faintest targets on the most transparent, Moon-free nights. Conversely, longer focal lengths are helpful for the smaller

targets. For objects that contain small-scale detail, nights of good seeing will produce the most satisfying results.

Additional Information

This article barely scratches the surface of this wonderful resource. If you'd like to delve deeper into the Sharpless catalog, perhaps the best place online today is Dean Salman's *The Best of the Sharpless Catalog* at sharplesscatalog.com. There you'll find a list of all 313 objects and their J2000 coordinates, as well as Dean's images of many Sharpless objects taken through color and narrowband filters.

Whether you prefer imaging showpiece targets or like to hunt for obscure treasures, think about consulting the Sharpless catalog. This comprehensive list of objects reveals the rich distribution of nebulosity within the Milky Way.

■ By night, **RON BRECHER** is a deep-space imager residing in Guelph, Ontario. Visit his website at astrodoc.ca.

Select Nebulae of the Sharpless Catalog

Object	Common Name	Constellation	Size	RA	Dec.
Sh 2-49	M16	Serpens Cauda	35' × 28'	18 ^h 19 ^m	-13° 58'
Sh 2-54		Serpens Cauda	60' × 30'	18 ^h 18 ^m	-11° 40'
Sh 2-98		Cygnus	15'	19 ^h 59 ^m	+31° 25'
Sh 2-101	Tulip Nebula	Cygnus	18' × 10'	20 ^h 00 ^m	+35° 17'
Sh 2-103	Veil Nebula	Cygnus / Vulpecula	210'	20 ^h 51 ^m	+30° 55'
Sh 2-105	NGC 6888	Cygnus	18' × 13'	20 ^h 12 ^m	+38° 21'
Sh 2-117	NGC 7000, NGC 5068	Cygnus	240'	20 ^h 55 ^m	+44° 13'
Sh 2-119	LBN 400	Cygnus	160'	21 ^h 18 ^m	+43° 56'
Sh 2-124		Cygnus	70'	21 ^h 38 ^m	+50° 21'
Sh 2-129	Flying Bat Nebula	Cepheus	110' × 100'	21 ^h 12 ^m	+59° 57'
Sh 2-131	IC 1396	Cepheus	170' × 140'	21 ^h 39 ^m	+57° 30'
Sh 2-155	Cave Nebula	Cygnus	50' × 30'	22 ^h 57 ^m	+62° 37'
Sh 2-157	Lobster Claw Nebula	Cassiopeia	90'	23 ^h 16 ^m	+60° 02'
Sh 2-162	Bubble Nebula	Cassiopeia	15' × 30'	23 ^h 21 ^m	+61° 12'
Sh 2-205	Peanut Nebula	Camelopardalis / Perseus	100' × 30'	03 ^h 56 ^m	+53° 12'
Sh 2-221		Auriga	120'	05 ^h 02 ^m	+46° 21'
Sh 2-232	Jelly Donut Nebula	Auriga	40'	05 ^h 42 ^m	+36° 12'
Sh 2-235		Auriga	7' × 5'	05 ^h 41 ^m	+35° 51'
Sh 2-244	Crab Nebula, M1	Taurus	6' × 4'	05 ^h 35 ^m	+22° 01'
Sh 2-248	IC 443	Gemini	50' × 40'	06 ^h 17 ^m	+22° 47'
Sh 2-249	IC 444	Gemini	8' × 4'	06 ^h 20 ^m	+23° 16'
Sh 2-279	NGC 1977	Orion	20' × 10'	05 ^h 35 ^m	-04° 52'
Sh 2-281	Orion Nebula	Orion	65' × 60'	05 ^h 35 ^m	-05° 27'
Sh 2-290	Abell 31	Cancer	17'	08 ^h 54 ^m	+08° 55'

Angular sizes and separations are from recent catalogs. Right ascension and declination are for equinox 2000.0.