Observing Wolf-Rayet Shells

Having been an amateur astronomer for well over 40 years now, I'm always looking for new and interesting observing projects of objects that I've never seen before. A few years back I became aware that a type of star called Wolf-Rayets can generate shells and bubbles of gas and dust, similar to planetary nebula. From reading one of the 'observing' sub forums on the *CloudyNight*s website and a little online research, I was able to put together a list of 12 Wolf-Rayet Shells that are observable from my mid-northern latitude of +40 degrees. I've recently finished that list and thought I would share my EAA observations of these shells of dying stars. These objects run from easily located extended disks showing great detail to challenging faint wisps of nebulosity. So today, I would like to bring these ethereal Wolf-Rayet Shells 'down to Earth' by discussing what they are, the historical astronomers behind these objects, and how to go about observing them. Hopefully, when we are done, you will find these mysterious deep-sky objects as interesting to hunt and observe as I do.

What are Wolf-Rayet Shells:

Before we discuss observing Wolf-Rayet Shells, lets level-set on what they and their progenitor stars are.
Wolf-Rayet (WR) Stars are a rare type of highly evolved, very massive, "O" supergiant stars, (weighing in at over 20 solar masses), and are extremely hot (> 100,000K), and luminous. WR Stars are near the end of their stellar lives, and prior to exploding begin shedding the mass of their outer layers at a high rate, upwards to 10(-6) solar masses per year in high speed wind outflows of ~300 to 2,000 kps. They generally only last a few million years or less before tearing themselves apart in a supernova/gamma ray burst (GRB) explosion, resulting in either a neutron star or black hole. (Kanipe & Webb, 2016, 256). Only about 600 WR stars have been identified in our Milky-Way home galaxy.

The first Wolf-Rayet Stars were discovered in 1865 by French astronomers Charles Joseph Etienne Wolf and Georges Antoine Pons Rayet working together at the Paris Observatory. Charles Wolf was born on November 9th, 1827 in Vorges, France to a family of 11 siblings, where his father Pierre was the local mayor. Charles attended Rollin College where he studied physics and then afterwards at the University of Metz where he graduated with his doctorate in 1856. Prominent French astronomer Joseph Le-Verrier was impressed by Wolf's work with the 1860 total solar eclipse and hired him in 1862 as an assistant at the Paris Observatory. Later in life, Charles was elected President of the French Academy of Sciences in 1898, retired to Vorges and lived there till his death in June 1918. Georges Rayet was born in Bordeaux, France on December 12th, 1839. He began working at the Paris Observatory in 1863, where Georges specialized in what was then the new field of spectroscopy. Rayet was the founder and 1st director of the Bordeaux Observatory in France from 1879 where he studied double-stars, comets, and nebulae till his death in June 1906.

The two astronomers were initially studying the spectrum of nova T Corona Borealis, when they noticed an unusual emission pattern from helium in the wavelengths of light, which no other astronomer had observed prior. They decided to begin a search for this emission pattern in other stars. There, the pair of astronomers visually used the observatory's 15.7" reflector, built by the French physicist and telescope maker Leon Foucault, to spectroscopically discover the first three WR Stars in the constellation of Cygnus. The 15.7" (40-cm) telescope was mounted in an equatorial fork mount and utilized a silver-on-glass mirror and is considered to be the first modern telescope built using the Foucault optical figure test method. (Kanipe & Webb, 2016, 261-262). Later it was determined thru spectroscopic analysis by American astronomer Edward Pickering that WR Stars were similar to the white-dwarf central stars of planetary nebula.

But it wasn't until the 20th century that the nature of WR Stars was determined to be in an entirely different classification. WR stars are very young and very rare (generally, only 1 out of every 100 million "O" class stars) (Telescope Live, 2024). They have burned thru their initial hydrogen and helium cores, shedding their outer layers.
As these supergiant very massive "O" type stars begin fusing heavier elements beyond helium, that process generates high-velocity winds which quickly strip away the star's remaining outer layers, creating a Wolf-Rayet star.
This is the last phase of the stars life, lasting only a few 100,000's of years before the star experiences core collapse and ends in a supernova explosion. WR Stars are identified by their spectra of broad emission lines formed by their outflowing mass rather than narrow absorption lines found in normal "O" type main-sequence stars.

Based on their prominent emissions lines, which indicate the absence of a hydrogen envelope, WR stars are classified into three categories based on the state of the stars fusion cycle: WN (nitrogen), WC (carbon), or WO (oxygen). The WO state is the precursor to the star going supernova. (Monterroza, V. & Mussie, J. & Tuazon A. 2024, 34). The closet and brightest WR Star visible, located in the constellation of Vela, is +1.8 magnitude Gamma Velorum at about 1,096 light-years distant. (Wikipedia. 2025).

WR Stars are one of the few interstellar objects that could possibly have an adverse effect on us. In 2008, astronomers using the Keck Telescope determined that the stellar pole of binary star WR-104 was pointing in our direction. Once the star goes supernova, it could possibly generate a powerful collimated gamma-ray burst of high energy rays from its pole that would sweep thru our solar system, impacting the Earth. The star, located in the direction of Sagittarius is about 8,400 light-years away, and expected to detonate into a supernova within the next few hundred thousand years. Fortunately, there is no need to lose any sleep over this, as additional studies have narrowed the direction of any potential GRB such that it should miss us. (Universe Today, 2009).

Wolf-Rayet Shells are rings of dust and gas formed by interacting collisions of powerful stellar winds blowing from binary WR Stars. During the two stars orbit around their common barycenter, their high speed winds mold and shape the gas and dust released by the individual stars from their previous orbital encounters into shock-wave layers and rings expanding outwards from the binary system. The newer higher-velocity layers eventually collide with older layers from the star's main sequence supergiant phase that have slowed down, compressing them into forming intricate shaped bubbles with carbon-rich dust that emits infrared light. (Kanipe & Webb, 2020, 162). The radiation and winds from the WR Stars continue to ionize and shock the nebulous shell expanding it out into the interstellar medium where it interacts with existing molecular hydrogen gas further generating asymmetrical shapes. These shells have often been misidentified as HII regions or planetary nebula. Only careful multi-wavelength spectroscopic studies of the star and shell can determine whether the object is a WR shell or a more traditional planetary.

How to Observe Wolf-Rayet Shells:

Most Wolf-Rayet Shells that we can visually observe are located within the spiral arms of our own home galaxy, and can be found all along the glowing band of light that we call the "Milky-Way". There's also a number visible in our nearby Magellanic Cloud satellite galaxies. Currently, there are about 44 known observable Wolf-Rayet Shell nebulas, but only 12 are observationally accessible from mid-northern +40 latitudes. (Most WR Shells are visible from regions closer to the Equator or in the Southern Hemisphere). Of the 12 telescopically available to us northerners, the majority, 7, are observable during the summer season, with 3 more visible during the fall season and the last 2 visible during the winter season. (There are no WR Shells visible during the spring season).

Unlike the irregular shaped glow of diffuse emission nebula, most WR Shells somewhat resemble structural detailed oval planetary nebula such as M27, or filamentary supernova remnants like the Veil Nebula. Some are fairly bright, while others have a fainter more difficult observable shape. And like in some planetary nebula, the central WR Star that created the WR Shell can be seen. WR Shells can be very faint, requiring a specialized line-filter such as an OIII filter to be able to see them. Narrowband filters, such as Optilong's L-eNhance, or Lumicon's UHC or Orion's UltraBlock will help to visually enhance viewing WR Shells. General broadband 'light-pollution' filters also will enhance WR Shells, though not as much as narrowband filters. Visually, WR Shells will have a grayish color in the telescope.
EAA observers/astrophotographers using narrowband filters can bring out green, red, and blue colors in their images. These colors are from double & triple ionized oxygen and hydrogen caused by the intense UV radiation of the WR Star.

While most Wolf-Rayet Shells can be challenging, this is what makes them interesting to find and attempt to visually see or capture an image of. Observing them visually requires maintaining dark-adaptation, good starcharts, and slow sweeping with a wide-field low-power eyepiece and a fast low focal-length telescope. An 80mm F5 or shorter refractor piggybacked on a 10" or greater telescope would work very well. The 80mm acts as a low-power RFT giving you a wide-field in which to find the shell and the larger telescope it is attached to allow use of higher magnification.

In general, for visual observers, it's best to hunt WR Shells starting off with low-power, wide-field eyepieces to identify the target area. Once the shell is centered, you can then switch to higher magnifications and filters to try and pull out details in the shells, along with the central WR Star. Most WR Shells are difficult to visually observe, and will require a medium size or larger reflector or some type of imaging setup to pull these in.
You'll need all your visual observing skills to find and bring out these subtle nebula.
Many Wolf-Rayet Shells are very faint, and depending on what size telescope you are using, may not be visible. But like any deep-sky object, half the fun is just successfully finding the shell and knowing what it is that you are observing.

For the Imagers, Wolf-Rayet Shells can also be challenging due to their faintest or large scale, in that even with an accurate GOTO mount, it may not position the telescope squarely on the shell to where it's framed the way you want it, showing the most interesting details. Having a photographic atlas or picture of the nebula will help you in both locating and identifying the object and in framing your image. I've found that using short-exposure EAA camera techniques works great in positioning and identifying Wolf-Rayet Shells.

There are a number of Wolf-Rayet Shells related observing guides available to the amateur astronomer.
Here's a few of my favorites: "*The Night Sky Observers Guide – Glories of the Milky-Way*", by George Kepple:
This is the 4th in the series of handbooks written by George Kepple and Glen Sanner, each chapter covering a specific constellation, with finder charts, sketches, images, and visual descriptions of various deep sky objects.
Volume 4 focuses specifically on constellations and their objects that lie along the path of our Milky-Way galaxy.
Each constellation 'chapter' lists all nebulae visible within its boundaries in a convenient layout, including WR Shells.

And "Annals of the Deep Sky!" – along with observations, it goes into deep details on all the current astrophysical characteristics of both Wolf-Rayet Stars and their Shells.

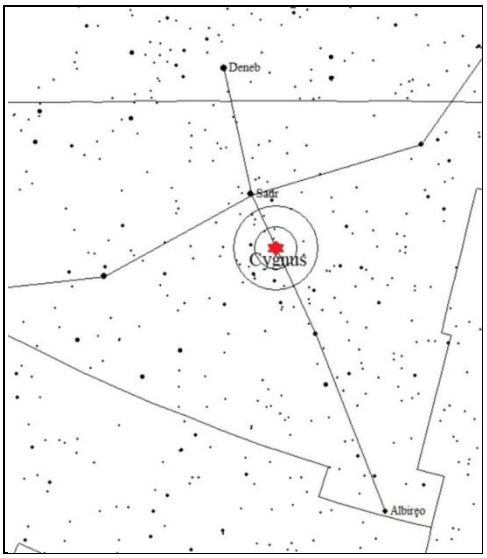
On the internet, there are a number of good sites for finding and observing WR Shells:
German amateur astronomer Reiner Vogel has an excellent observing resource on his website for the 12 visible WR Shells from northern latitudes that includes detailed visual descriptions with both amateur and DSS photographic images, and a PDF guidebook containing finder charts: http://www.reinervogel.net/index_e.html

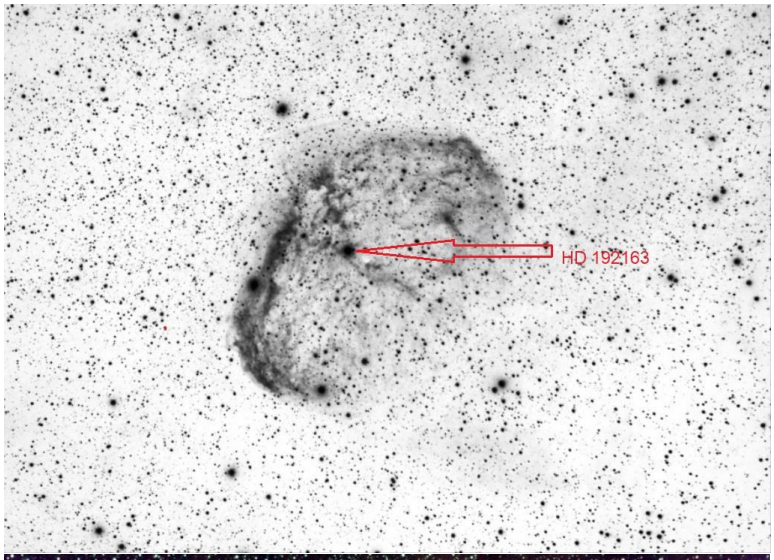
You can also find a full Wolf-Rayet Star & Shell catalog covering the entire sky from the University of Sheffield, England at: http://pacrowther.staff.shef.ac.uk/WRcat/

Wolf-Rayet Shell Observations:
Below are the EAA observations of my three favorite Wolf-Rayet Shells that are visible from around +40 N latitude, using my 8" SCT optical tube at f6.3 on an Atlas Gem mount with an ASI294MC camera & L-eNhance narrowband filter.
An additional eight EAA observations can be found on my website at: http://stellar-journeys.org/wolfrayettour.htm

WR136: NGC6888 – "Crescent Nebula", located in Cygnus, near the center of the 'Northern Cross' asterism, just south of the bright +2nd mag star Sadr, at RA: 20 12 02 & DEC: +38 20 59.
This shell (Also known as SH2-105), is somewhat faint, requiring a moderate size telescope (10" to 12") to visually see the brightest arc shaped portion of the nebula that bisects a triangle of 7th and 9th magnitude stars in a rich FOV.
With larger telescopes and narrowband filters under dark skies, the crescent shape is more pronounced, and using EAA techniques, the interior is filled with nebulous knots and filaments that give the object the look of a brain. Located slightly off-center is +7th HD192163 (WR136), the central star forming the shell, and is about 6,700 light years distant. (livestacked using Sharpcap).

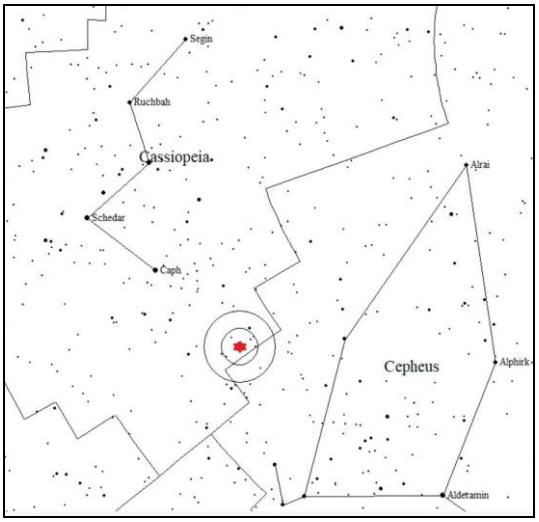
8" SCT optical tube @ f6.3, Atlas Gem, ASI294MC & L-eNhance filter @ 180 seconds livestacked for 75 minutes.

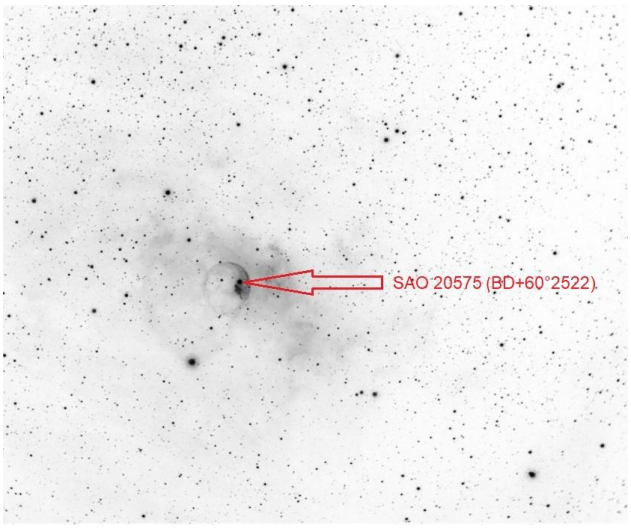




(180 second exposure, livestacked for 75 minutes using Sharpcap).

BD+60°2522: NGC7635 - "Bubble Nebula", in Cassiopeia, close to the border with Cepheus, at RA: 23 20 42 & DEC: +61 11 52.Near the open cluster M52, this extremely faint shell (Also known as SH2-162), embedded within an HII region is best seen visually using telescopes 16" or larger, along with using nebula filters. Most noticeable is the NE arc section of the bubble. EAA observers will be able to pull out the entire oval shaped shell using a OIII narrowband filter. The bright +8th magnitude "O" type star (SAO20575) near the NE arc is the central star of the shell, and is considered by some sources to be in the early WR stage of its life-cycle. The star is about 9,800 light years distant.
(livestacked using Sharpcap).
EVO50mm f4.2 Refractor, ASI294MC & L-eNhance narrowband filter @ 180 seconds livestacked for 60 minutes.
8" SCT optical tube @ f6.3, Atlas Gem, ASI294MC & L-eNhance filter @ 300 seconds livestacked for 60 minutes.

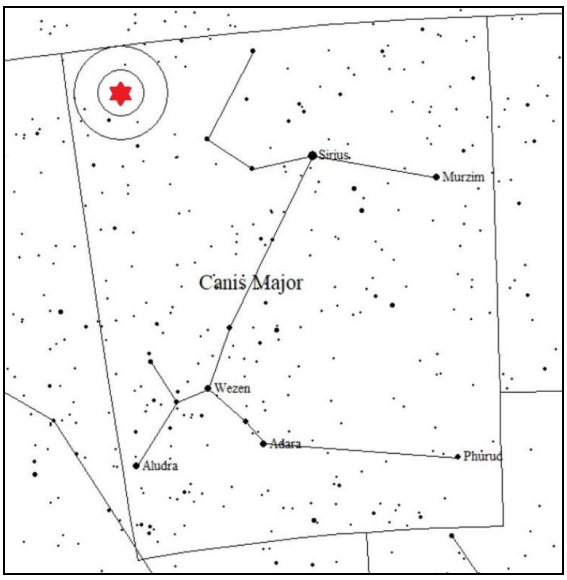


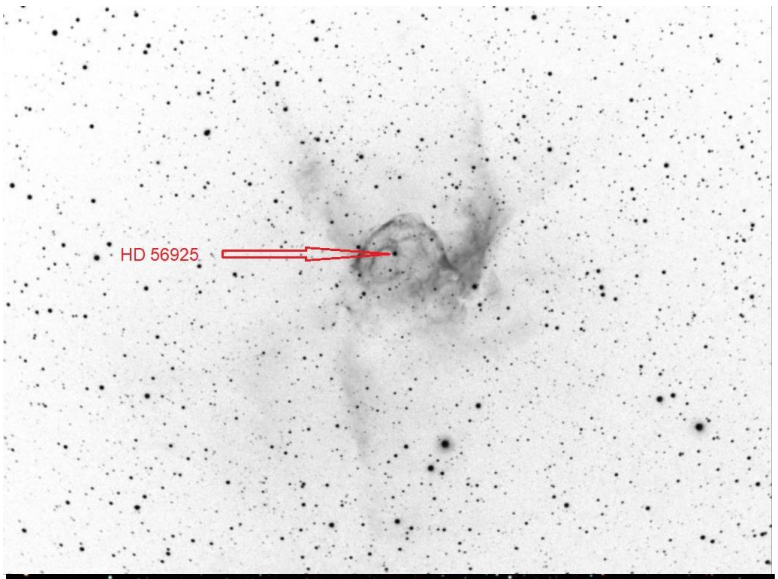


(EVO50mm: 300 sec exp, livestacked for 60 min).

(8" SCT: 300 sec exp, livestacked for 60 min).

WR7: NGC2359 - “Thor's Helmet”, located in Canis Major near the border with the constellations of Monoceros and Puppis, at RA: 07 18 38 & DEC: -13 11 55 .
(Also known as SH2-298, and sometimes called the "Duck Nebula" by visual observers who see the profile of a duck).
This WR Shell is easily visible as a crescent shape in small telescopes under a dark sky, with larger scopes showing more details such as two ‘extrusions’ on either side of the crescent. A UHC or OIII filter will greatly improve the view.
Imagers or EAA’ers will be able to pull out much more interior filaments and striations. Using just a little imagination, it’s easy to see the upward pointing two-horned Viking helmet shape, along with the fainter lower helmet-strap extensions.
The intricate shape of the emission nebula is caused by strong stellar winds coming off of its central star, +11th magnitude HD56925, (WR7). The star/nebula is about 12,000 light years distant.
(livestacked using Sharpcap).





(180 second exposure, livestacked for 30 minutes using Sharpcap).

So in conclusion, today, I've introduced you to a class of wispy shells of deep sky objects – Wolf-Rayet Shells. We learned a little about how these objects formed, along with the historical individuals behind these objects and reviewed amateur EAA-capture image examples of members of the WR catalog. Hopefully this has inspired you to search-out and explore these very rewarding celestial objects.

I encourage everyone to get out tonight and try their hand at finding and observing these elusive deep-sky objects, the ghostly shells created by the dying stars of astronomers Charles Wolf and Georges Rayet.

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Astronomical Webportal: http://www.stellar-journeys.org/

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Wikipedia. 2025. "Gamma Velorum", https://en.wikipedia.org/wiki/Gamma_Velorum
Finder-Charts: "Earth Centered Universe" (ECU) planetarium program by David Lane.

Misc Credits:

Books:

"*The Night Sky Observer's Guide*", by George Kepple & Glen Sanner, 1998

Internet:

"*Wolf-Rayet Nebula*", Reiner Vogel - http://www.reinervogel.net/index_e.html
"What is a Wolf-Rayet Star?", https://telescope.live/academy/what-wolf-rayet-star
Google & Wikipedia: *various entries*