How to observe exploded stars

A violent event called a supernova happens in a galaxy once or twice a century. A star heavier than about 12 solar masses ends its brief life span in a dramatic explosion called a core-collapse supernova. The supernova ejects most of the star’s material while creating heavy elements such as lead, silver, and gold. This process forged many of the elements in our bodies and the solar system.

The blast releases as much energy as all of the other stars in the galaxy combined. The star then shines intensely enough to be visible in the daytime for several days. The blast’s expanding shock wave propagates into space, compressing and heating interstellar molecular clouds. The star’s debris mixes with the interstellar medium, forming a delicate supernova remnant (SNR). It’s a spectacular telescopic target. Radio and X-ray surveys have revealed 265 such SNRs — a type of nebula, or glowing gas — but only a few of them are visible in backyard scopes. Follow along for a tour of the most spectacular sights.

A cosmic motivation

On July 4, 1054, Chinese astrologers announced the appearance of a “guest star” in Taurus. This supernova quickly surpassed Venus in brightness and remained visible for 23 days during daylight and 21 months at night. The debris from this event is an SNR now known as the Crab Nebula (M1).

In 1731, British physician and amateur astronomer John Bevis made the first telescopic observation of the 1054 remnant. French comet-hunter Charles Messier rediscovered the nebula in 1758, describing “a whitish light, elongated in the shape of a flame of a candle, discovered while observing the comet of 1758.” This observation inspired Messier to compile his famed catalog of 103 deep-sky objects; he placed this SNR first, designating it M1.

When Irish astronomer William Parsons (the third Earl of Rosse) trained his 36-inch reflector on M1 in 1844, he described “resolvable filaments singularly disposed, springing principally from its southern extremity, and not, as is usual in clusters, irregularly in all directions.” A remarkable sketch by Lord Rosse, published in the Philosophical Transactions of the Royal Society of 1844, shows filaments or appendages streaming out the sides and inspired the name “Crab Nebula.”

In 1967, Cambridge University graduate student Jocelyn Bell and advisor Anthony Hewish used a radio telescope to discover the first pulsar — a rapidly rotating neutron star with an intense magnetic field producing a narrow beam of radiation that sweeps through our line of sight. Before this observation, astronomers suspected neutron stars were the corpses of massive stars that died in supernova explosions. One year later, in 1968, astronomers discovered the Crab Nebula’s corpse star: a 16th-magnitude pulsar that rotates about 30 times a second.

Steve Gottlieb gave readers a tour of Wolf-Rayet bubbles in the February 2006 issue. He observes under the skies of northern California.

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After observing the Veil from a dark site countless times over the past 25 years, I'm still astonished by its intricate, lacy threads. With my 10x30 image-stabilized binoculars, the eastern section, NGC 6992/3, is faintly visible as a narrow, ghostly arc in a rich star field. At 80mm refractor at low power will frame both the eastern and western arcs and reveal the Veil as a huge, glowing bubble. With an 8-inch scope and a narrowband filter, the main arcs resolve into delicate, filamentary wisps. The western arc, NGC 6960 or the “Witch’s Broom,” is more than 1° long and pierced by 52 Cygni. The southern end broadens and bifurcates, while the brighter northern end tapers to a spike. Larger scopes show a breathtaking view, in which the brighter filaments take on a noticeable electric appearance. The more detailed eastern arc, sometimes dubbed “The Waterfall,” has a surreal amount of lacy, filamentary detail and multiple strands that appear three-dimensional and braided. Feathery, side branching nebulosity streams to the west on the nebula’s southern end. A triangular piece known as “Pickering’s Wedge” sits between the two main branches on the northern side. This 45'-long triangular wisp is widest at the northern end and shows a split. It displays much of the wavy structure as its brighter counterparts.

The sky creature

As the nickname suggests, the Jellyfish Nebula (IC 443) is a strange creature. This expanding cloud of debris has sculpted a shell of shocked gas about 50' northwest of 3rd-magnitude Eta (η) Geminorum. Ten years ago, it was considered a challenging target. The situation changed with the introduction of digital photo and substantial observing time. The Veil is now a star-party object — both William and John Herschel missed it during their sky surveys. Edward Emerson Barnard and Max Wolf photographically discovered the Jellyfish in the 1890s. Observers can glimpse IC 443 through a 20-80mm finder scope or large, hand-held binoculars. A 6-inch scope will reveal a 6' by 4' glow with pinched-in sides. This pinch creates an irregular potato shape with extensions toward the northwest and southeast. In my 18-inch, I see subtle motting in the interior, while the nebula’s periphery looks tattered. An OIII filter brings out some filamentary streaks, particularly on the southeast side.

In my 18-inch at 6x4, the brightest section appears as a gently curving band of nebulosity oriented northwest to southeast and roughly 10' by 3'. A well-defined arc forms the eastern boundary southeast of the bright arc. At the bright arc’s southern end, the glow dims and appears to hook toward a triangle of stars.

A southern delight

At a distance of roughly 815 light-years, the Vela Supernova Remnant is one of the nearest. Its faint tendrils of nebulosity are splashed across 5° of sky. Even though the Vela SNR is fainter than the Veil, you can trace much of the Vela in an 8-inch using an OIII filter. Larger amateur scopes will show multiple strands of wide, diffuse swaths of nebulosity and delicate, twisted gas plumes that span numerous eyepiece fields of view. In 1968, astronomers discovered a pulsar spinning 11 times per second at the Vela’s heart. By carefully timing the “slow- down” rate, astronomers determined the supernova occurred 11,000 years ago. To explore the Vela SNR, begin just north of 4th-magnitude Epsilon (ε) Velorum, located at right ascension (R.A.) 8h37.6m and declination (Dec.) –44°55’ (2000.0), and follow a meandering stream of nebulosity to the southwest. You can follow another long, narrow filament to the west of the 5th-magnitude double star HD 72127 at R.A. 8h26.5m and Dec. –44°45’.

The Vela SNR’s brightest section is the Pencil Nebula (NGC 2736). This isolated linear filament is 4.5° east of the Vela pulsar. The nebula’s form suggests the supernova’s shock front has compressed a dense region of interstellar gas in the galactic plane. When I observed the Pencil Nebula from Costa Rica with a 13.1-inch scope and a UHC filter, I found it easily. It’s a 20' long splinter of light extending southwest to northeast with weak filamentary structure and hints of two intertwined threads.

Cygnus’ little-known SNR

In 1977, astronomers Theodore Gull, Robert Kirshner, and Robert Parker were conducting an emission-line survey of the galactic plane when they unexpectedly found a huge filamentary shell in Cygnus. This shell (G65.3+5.7) is a whopping 4° by 3°. Subsequent radio and X-ray observations confirmed this incomplete ring is a SNR. The shell’s brightest section is Sharpless 2–93, a 1° by 0.5° strip of nebulosity that resides less than 3° northeast of Altareo (Beta [β] Cygni), a double star with magnitudes 3.3 and 5.5. Due to Sh 2–91’s low surface brightness, the observing challenge is to detect among the maze of Milky Way stars. Fortunately, like other SNRs, it exhibits strong OIII emission. A narrowband filter increases contrast and enhances the view. When I first took a look with my 18-inch in 2001, I was amazed to find a gossamer filament, just 1° wide but stretching across 16' of a crowded Milky Way field. This gossamer wisps dangle from an 8th-magnitude star on its southwest end. From there, the nebula gracefully arcs to the northwest, passing by a 9.5-magnitude star. With careful viewing, portions of the filament resolve into two strands. To find this obscure SNR, head to a dark site, and search 15' south of 4.7-magnitude Pui (π) Cygni. Scientists using data from the European Space Agency’s International Gamma-Ray Astrophysics Laboratory (INTEGRAL) recently confirmed a supernova rate of 2 per century in our galaxy. Although Tycho Brahe and Johannes Kepler witnessed supernovae in 1572 and 1604, respectively, a galactic supernova has not been observed in the past 400 years — one is long overdue. While waiting for the next one, why not grab your telescope, head to a dark site, and spend some time exploring these objects. You’ll be witnessing the aftermath of one of nature’s grandest spectacles.