The Cygnus Loop

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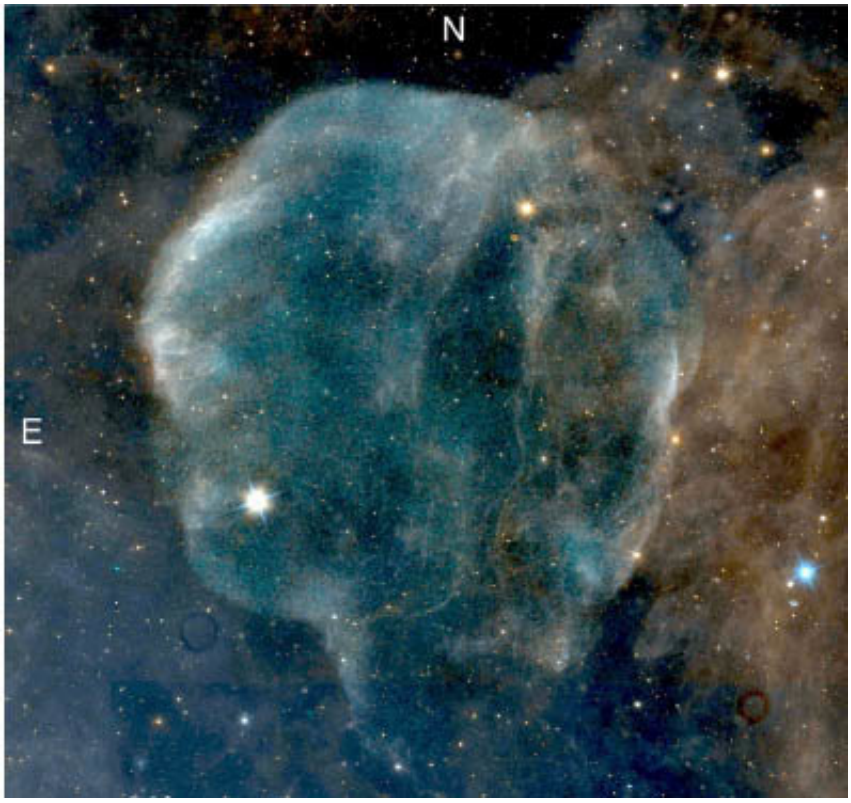

A composite image of the Cygnus Loop (Veil) Nebula, the detritus of a supernova explosion, as seen in X-ray (blue), UV (white), and 12 and 22 μm infrared data (blue and red, respectively) with the ROSAT, GALEX and WISE missions. Astronomers have used new astrometric data from the GAIA mission to determine the distance to the nebula: about 2420 light-years. Credit: NASA; Fesen et al. 2018

The Cygnus Loop (also known as the Veil Nebula) is a supernova remnant, the detritus of the explosive death of a massive star about ten to

twenty thousand years ago. Detailed modeling of its spectacular filamentary shape suggests that the explosion occurred inside an interstellar cavity created by the progenitor star. As is common in astronomy, many of the precise physical properties of the object are rendered uncertain by the uncertainty of its distance. For decades scientists used a value of about 2500 light-years based on analyses of its gas motions by Hubble in 1937 and Minkowski in 1958. Many recent distance estimates have varied over a wide range generally consistent with this one, but the most cited value is a 2005 measurement of between 1500 and 2100 light-years.

During the past two decades astronomers have tried to pin down the distance by measuring the distances to stars either behind or within the nebula as determined by seeing absorption lines from the nebula in their spectra but the distances to those stars are in turn likewise uncertain, and parallax measurements of some of the stellar distances have also been unreliable. Efforts have also been made recently to measure the distance using the motions of the nebular gas directly, with published estimates suggesting a firm distance less than 2600 light-years and consistent with the old value of 2500 light-years.

The Gaia satellite has been making very precise measurements of stellar parallaxes, and the most recent catalogs have now been released. CfA astronomer John Raymond joined with four colleagues to apply the Gaia data to the problem of the Cygnus Loop distance by looking for absorption signatures from the gas in the two dozen stellar spectra, thereby constraining the stars as being foreground or background objects. Their result: 2420 light-years to the central part of the nebula, with a 3.4 percent uncertainty. They also identified a star whose wind is interacting with the supernova remnant. The new distance result has several important implications. It means that the supernova that created the Loop had less energy than previously thought by perhaps as much as a factor of four (about as much energy as the current Sun would emit in

six billion years). It also means that the nebula is probably aspherical in shape with the eastern being limb being closer to us than the western side and with a diameter of about one hundred and twenty light-years.

More information: Robert A Fesen et al. The Cygnus Loop's distance, properties, and environment driven morphology, *Monthly Notices of the Royal Astronomical Society* (2018). DOI: 10.1093/mnras/sty2370

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