Observing the Vela Supernova Remnant

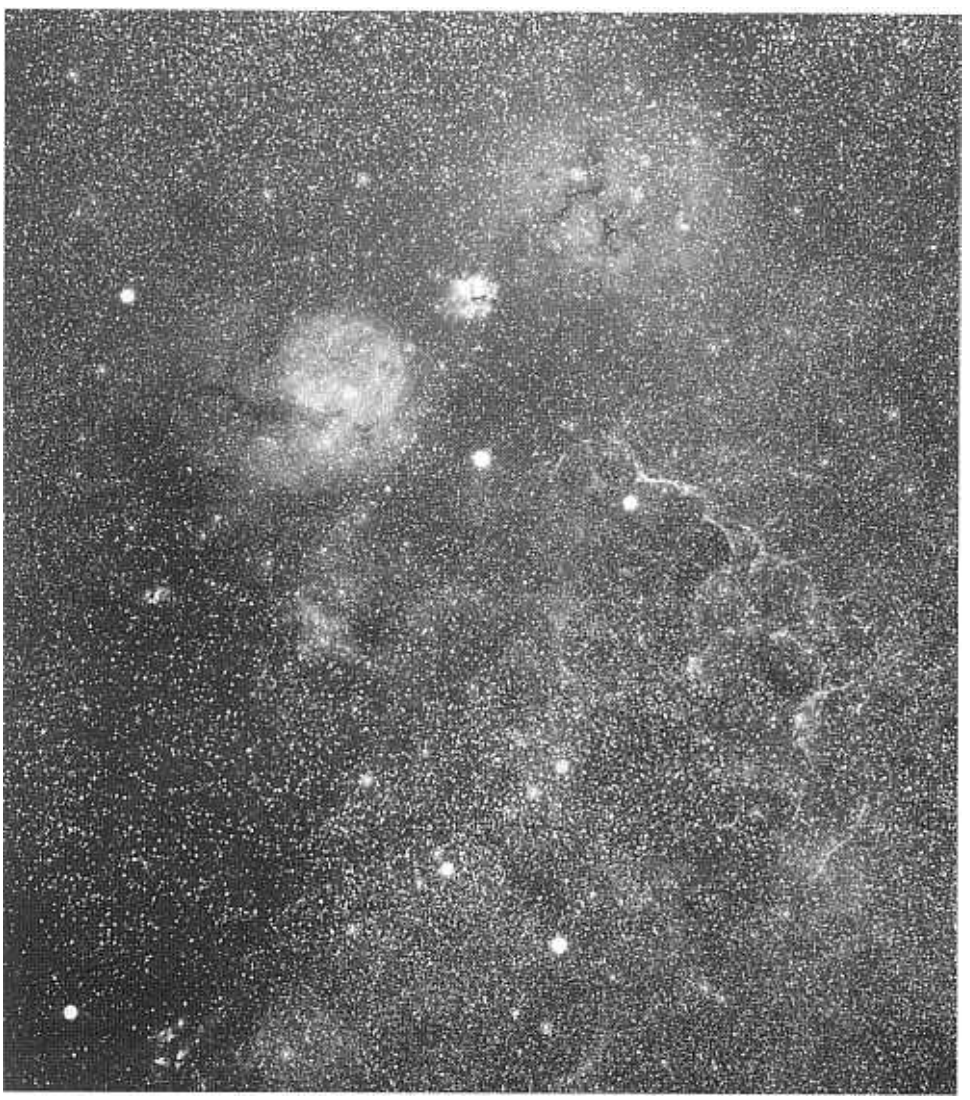
by Zac Pujic

Supernova remnants are my favourite variety of objects. Photographs of supernova remnants are among the most spectacular, yet visually they are challenging to observe and yield little detail even in large telescopes.

Amongst the many supernova remnants (SNRs) which have been observed (such as the Crab Nebula, IC 443, Simeis 147, the 29 SNRs in the Large Magellanic Cloud and so on), the most interesting example must be the supernova remnant in Vela.

Several years ago, I spied a photograph of the Vela SNR and desperately longed to observe it for myself. I could find no mention of the object in any observing guides or magazines and so had great difficulty in locating it. Using my 42-cm Newtonian with a 25-mm eyepiece, I scanned the sky around Vela but found no hint of the beautiful nebula. Without any nebula filters, the light-polluted skies of my suburban home in Kingston, Queensland obliterated any hints of the object. However, after obtaining an OIII filter, I tracked down the nebula, and with trembling hands, guided my reflector over several large filaments of the remnant. I was seeing the enormous remains of a cataclysmic explosion which occurred thousands of years ago and I was spellbound!

The region around the Vela SNR by Luke Dodd. 2 hour exposure onto 6 x 7 format hypered Kodak Tech Pan 6415 film through Hα filter using a 300 mm f/4 lens guided with an ST-4 autoguider. Photographed from Tamworth NSW, April 16, 1994.



The entire remnant is massive, spanning about 5° X 6° near the galactic equator and was produced by a supernova explosion about 12,000 years ago. The core of the progenitor star which produces a supernova may end up as a neutron star, which, under special circumstances, can produce a pulsar.

Interestingly, although a pulsar, designated PSR 0833-45 was found near the centre of the Vela SNR in 1968, a report about six years ago in *The Astrophysical Journal* (1988, volume 325) by two Italian astronomers suggested the assumption that the pulsar belongs to the Vela SNR may be incorrect as the pulsar is about 1.5° to the west of the geometric centre of the circular outline of the remnant. Since the pulsar displays very little proper motion (it moves very slowly across the sky), it may be possible that the pulsar is located near the Vela SNR only by chance line-of sight. Consequently, the Vela SNR may be a remnant with no obvious pulsar and the Vela Pulsar may be a neutron star with no obvious supernova remnant!

I have observed several filaments of the Vela SNR through telescopes of 25 - 51 cm apertures. Although the larger telescopes show the filaments more convincingly, they do not show more detail within the curlicues of light. While an OIII filter usually enhances the visibility of emission nebulosity, it is an absolute must while observing the Vela SNR. Without the filter, even larger aperture telescopes will fail to show anything.

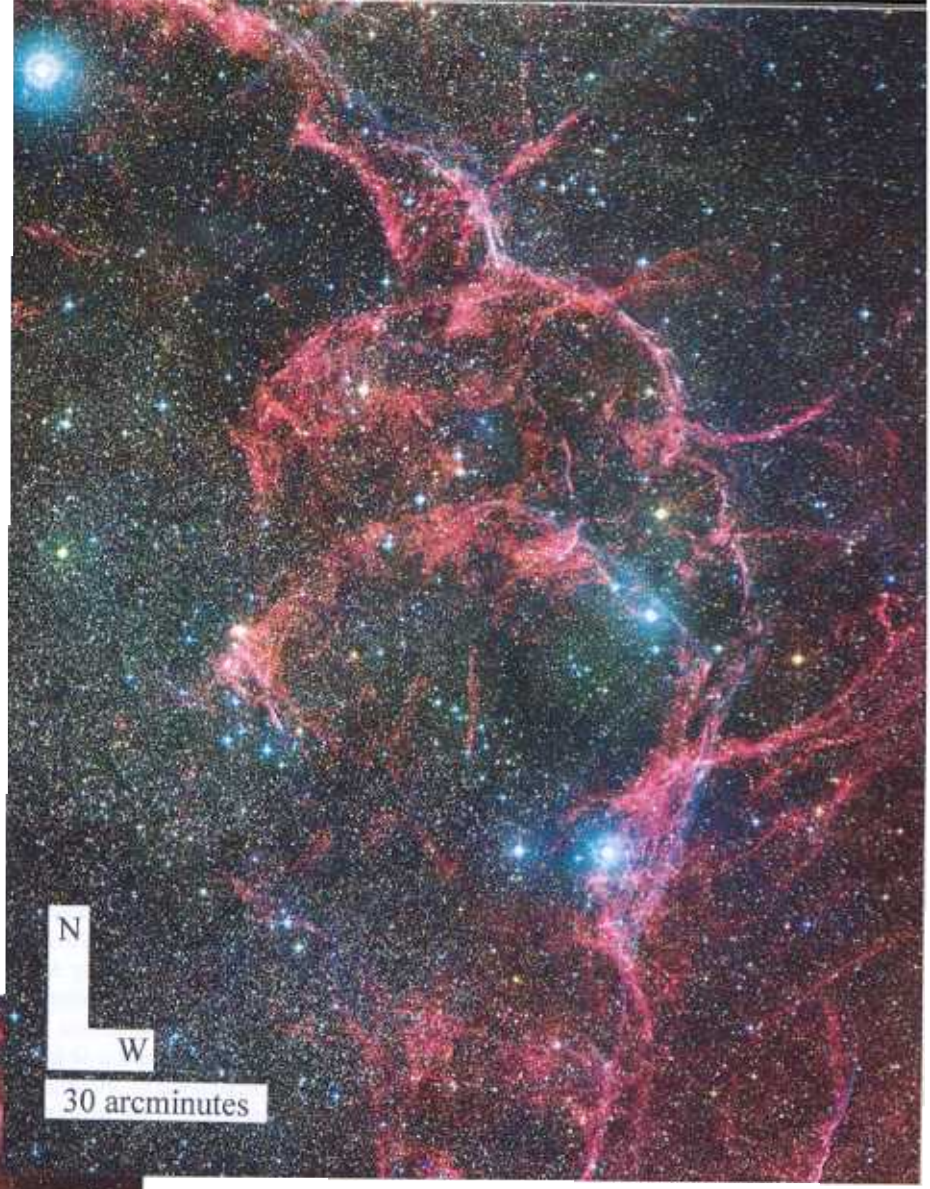
Low magnification using 20 - 32 mm eyepieces will provide wide field views which are required to show the large structures of this remnant. The nebula is visible with a Lumicon OIII filter from a suburban site with a 42 cm telescope, but a dark sky site is, as always, preferable. For chart ref-

erence, page 397 of Uranometria 2000.0 Volume 2 shows most of the filaments visible in backyard telescopes, though the maps were made using photographs in Hα light. This means that if you are observing with an OIII filter beware of any differences in appearance which may result from observing at another wavelength.

Photo UKS-2 is a tri-colour photograph of the western region of the Vela SNR taken by David Malin using the UK Schmidt camera at the Anglo-Australian Observatory, Siding Spring. It is centred on RA 8hrs 32m, DEC -44° 00' (2000) and is 2° 42' x 2° 10' wide. Near the top left hand (northern) corner is the star e-Vela (HR 3426), an A6-type star of apparent magnitude 4.14 which is easily visible to the naked eye. Near the lower right is the 5th magnitude B2-type star, HR3359, also visible to the naked eye.

The majority of the brightest Vela SNR filaments lie between these two stars. If you aim a telescope with at least 25 cm of aperture, a wide-field eyepiece and an OIII filter between these two stars, you will see some of the numerous filaments and patches of nebulosity visible in the UKS-2 photo. I suspect that in very dark sky sites, even 20 cm telescopes will show the brightest of these filaments.

The blue, faint filaments in the photographs cor-

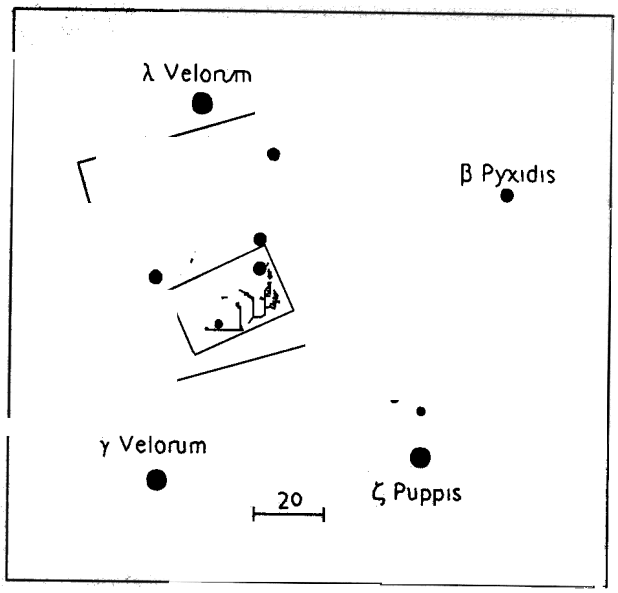


Above: UKS-2 Tricolour photograph by David Malin taken with the UK Schmidt camera at the AAO showing western region of the Vela SNR

Left: AAT-78 Tricolour photograph by David Malin using the 3.9m reflector at the AAO showing a section of the Vela SNR near the star HR 3359.

respond to light of 500.7 and 495.5 nm originating from doubly ionised oxygen (OIII) which results when debris from the supernova impacts onto the surrounding interstellar medium. This violent shock releases enough energy to ionise the oxygen in the debris to the OIII state. Just behind the blue filaments are the red filaments whose light originates from hydrogen as Hα light (656.3nm). Since hydrogen requires less energy to be ionised, these filaments are located on the back side of the expanding shells which impact less violently onto the surrounding interstellar material. The nebula is striking for the number of crescent filaments found on this western side of the remnant. About 5 of these crescents, visible in the upper half photo UKS-2 are visible using an OIII filter , a telescope of at least 25 cm aperture and low magnification.

Photo AAT-78 is centred on RA 8hrs 29m, DEC -44° 38' (2000) and shows a small region of the SNR near the star HR 3359. Using an OIII filter, I could see only the blue bar of



Finder chart for the Vela Supernova Remnant. The remnant lies in the triangle of λ Velorum, γ Velorum and ζ Puppis. The small box represents the area depicted in UKS-2 by David Malin. The large box represents Luke Dodd's image (see page 397 of Uranometria 2000.0 Volume 2 for this area). Clearly, several Gum nebulae are located within this triangle.

light passing the bright star (the thin green line was caused by an artificial satellite passing through the field during the green filter exposure on the 3.9m Anglo-Australian Telescope). The field is about 24 X 29 arcmintues wide, so about 50X magnification will show this field well. I could see none of the red filaments since their light (in Hα) is blocked by the OIII filter. The bar, which is one of the brightest filaments of the Vela SNR is straight for about 25 arcminutes.

The western half of the remnant is the brighter, while the eastern half is ill-defined and lacks the bright, sharply curving filaments visible in the UKS photo. It has been suggested that this may by due partly to the presence of obscuring dust in front of the eastern half, dimming the light from filaments on that side. This is highly probable since the bright OB-type stars in this region show a colour excess (ie interstellar reddening) greater than those in the western half.

The complex, fractured appearance of the remnant may be due to factors such as turbulent motions in the interstellar medium surrounding the filaments, or temperature instabilities. Other supernova remnants, such as the Veil Nebula are more circular in outline and lack the complexity found in the Vela SNR. Observations by astronomers in 1979 led to the suggestion that the interstellar medium surrounding the Veil Nebula may have been 'smoothed' by a strong stellar wind generated by an early-type progenitor star, allowing the Veil Nebula remnant to expand in a relatively gas and dust-free void.

Conversely, it is possible that the Vela supernova progenitor star was of a later spectral type or had an unusually weak stellar wind leaving the interstellar medium non-uniform, and causing the Vela SNR to assume its present structure.

Furthermore, the area surrounding the Vela SNR is filled with diffuse nebulosity, seen particularly well on large scale Schmidt-telescope images. This nebulosity may represent the fossil Stromgren sphere produced by the ionisation of the local interstellar medium by the radiation released during the supernova explosion.

I have seen only a few photographs of the Vela SNR taken by amateurs. One such image was a 43-minute exposure through a 20 cm f/1.7 Schmidt camera onto hypered Kodak Technical Pan 2415 film and a Wratten #92 filter (in issue 33 of the magazine *Deep Sky)*. The use of this filter/film combination will detect Hα light well and should produce the most detailed photographs of this magical object.

Luke Dodd of Singleton Heights NSW has used this combination to produce an intriguing photograph. The 2 hour exposure onto 6 x 7 format hypered Tech Pan 2415 film (but known as 6415 in this size) through a Ha filter using a 300 mm f/4 lens was guided with an ST-4 autoguider.

In its lower right hand corner is the entire Vela Supernova Remnant. Near the centre is the star d-vela and to the left of this is the large Gum 17 emission nebula and the Sandqvist-Lindroos 4 dark dust cloud. To the north of d-Vela is the small Gum 15 complex while near the top of the photograph is the large Hα emission and dust complex.

Lastly, eagle-eyed readers will find at least two fragments of the Puppis Supernova Remnant at the extreme right hand edge. Also in the photograph is a plethora of smaller emission and dust nebulae and numerous open clusters.