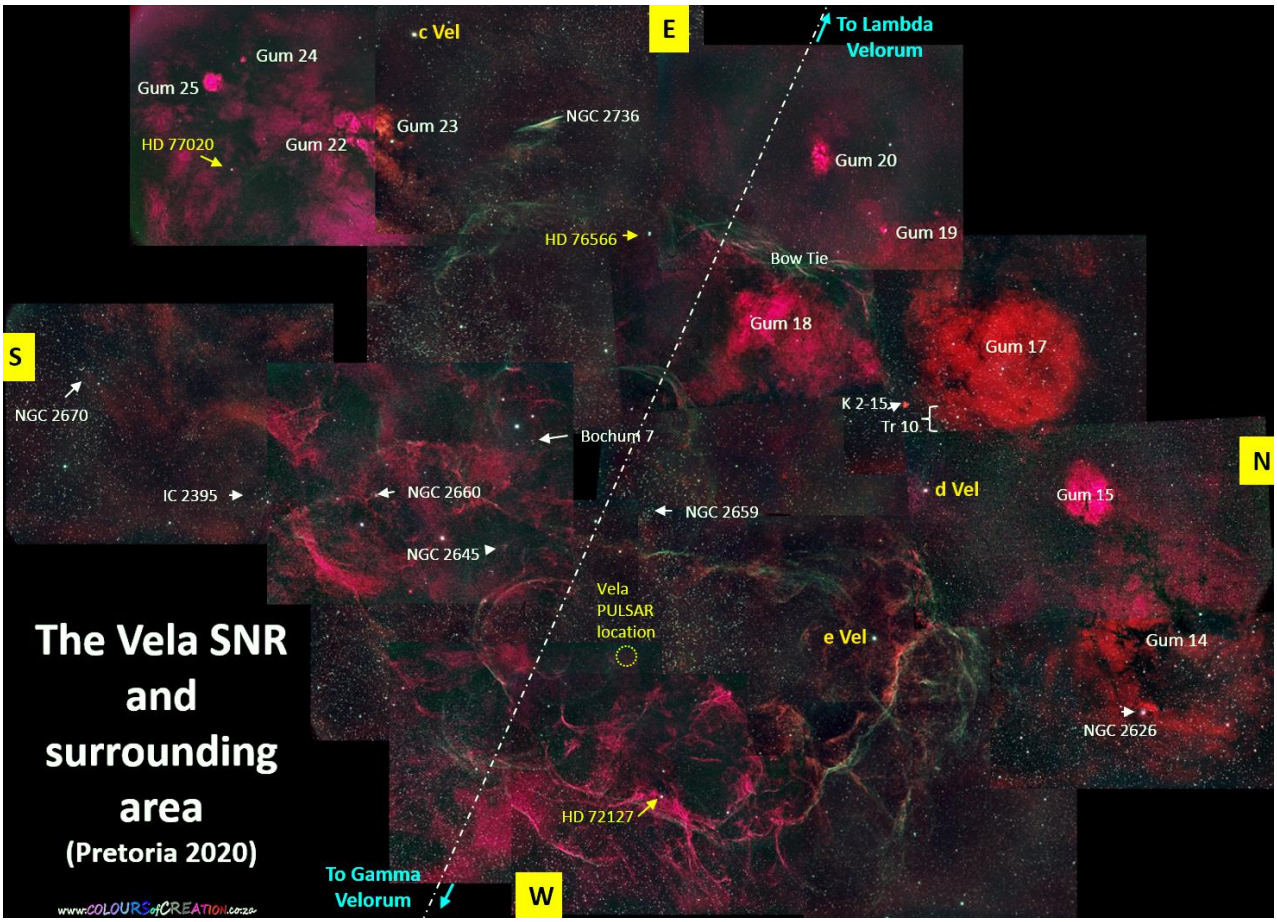
The Vela Supernova Remnant and Surrounds – a Photographic Tour.

Johan Moolman

"MAGNIFICENT CHAOS"

The 2020 lockdown with compulsory leave days afforded some opportunity to catch up on imaging, and an "old friend", the **Vela super nova remnant** (Vela SNR), was revisited. Last paid attention to in the Karoo in 2017, a few rewarding weeks between late March and early June could now be spent in its company. The information in the following text was derived mostly from public Internet sites.

[All photos imaged from my balcony, Pretoria. Wide field views: Tele Vue 127mm f/5.2, fl 660mm apochromatic refractor; Narrow fields: Optimized Dall-Kirkham OTA: 250 mm, f/6.8, fl 1700mm; Filters: Radian quad-band narrow-band and Hutech IDAS LPS V4; Cameras: modified /cooled Canon 6D and Nikon D850; Mounts: Celestron CGX and Losmandy Gemini II; Camera control in BYE and BYN; Mount control in Cartes du Ciel; Auto-guiding in PHD.]



As a reference and for orientation purposes several bright stars and prominent deep sky objects (DSOs) are annotated in the above "patch work", consisting of 18 photo "tiles". The individual areas and photo "tiles" are discussed in more detail below.

A feature prevalent in these scenes are the "**wisps of magnificent chaos**" (some poetic license!) – intertwined filaments of ionized hydrogen and oxygen appearing reddish-pink and green, respectively.

The **Vela supernova remnant** can be found in our southern skies' Vela, the "sails" constellation and is currently (March – June 2020) favourably positioned during the evenings. What we now see is the expanding debris cloud, moving outward at tremendous speed. The initial millions of kilometres per hour has now slowed to a "mere" 500 000 km/h...
Its source **Type II supernova** exploded approximately 11,000–12,300 years ago: the so-called "spin down rate" of the resident pulsar was used to derive this estimate. (Bill Blair's Vela Supernova Remnant File). As the ejecta from the explosion expanded into space and collided with the surrounding interstellar gas, shock waves were formed and heated the gas and ejecta to millions of degrees. The supernova that produced the Vela pulsar and supernova remnant must have appeared extraordinarily bright on Earth, estimated to have been some **50 times brighter than Venus**.

A **Type II supernova** results from the rapid collapse and violent explosion of a massive star. A star must have at least 8 times, but no more than 40 to 50 times, the mass of the Sun ($\underline{M_{\odot}}$) to undergo this type of explosion. Type II supernovae are distinguished from other types of supernovae by the presence of hydrogen in their spectra. They are usually observed in the spiral arms of galaxies and in H II regions (see below), but not in elliptical galaxies; those are generally composed of older low-mass stars, with few of the young highly massive stars necessary to cause a supernova.

You can locate this SNR roughly between the 2 bright stars **Gamma** and **Lambda** Velorum: **Gamma Velorum** (γ Vel) is a **quadruple (multiple)** star system. At a combined magnitude +1.7, it is one of the brightest stars in the night sky.

The brightest member, **Gamma^2 Velorum** or γ Velorum **A**, (Mag. 1.83) is a spectroscopic binary composed of a blue supergiant of spectral class O (~30 M⊙ - "Solar masses"), and a **massive Wolf-Rayet star** (~9 M⊙, originally ~35 M⊙). The latter is by far the closest and brightest **Wolf-Rayet star** to earth. (More below). **Gamma^2** has the traditional name **Suhail al Muhlif** and the modern name **Regor -** neither approved by the International Astronomical Union. "Regor" stems from a joke between "**Roger**" Chaffee and Gus Grissom, Apollo 1. It is located in line with the short axis of False Cross.
Close to **Gamma^2** is the bright **Gamma^1** Velorum (aka Gamma Velorum **B** - apparent magnitude +4.27), a blue-white subgiant B star. Gamma^1 lies 41.2 arcseconds from Gamma^2 - a separation easily resolvable with binoculars. **Gamma Velorum** has several other fainter companions as well (See photo).

(By the way, you can find Johan Smits' favourite open cluster - the **"Heart"** (NGC 2547; ASSA 29) - to the SE of Gamma…).

λ Velorum (Lambda Velorum) shares the traditional name Suhail with the brighter Gamma Velorum. A class K **orange** star, it is classified as an **LC-type slow irregular variable star**. Its brightness varies between apparent magnitudes +2.14 to +2.30. These are variable star that exhibit no or very poorly defined periodicity in their slowly changing light emissions.

(During this imaging project the above two were my **"Go-To"** stars: **Gamma**, an **easy double** on screen, was used to "sync" too after awakening the mount from hibernation and to confirm alignment of the setup, and dimmer **Lambda** to tweak the focus).

The Vela Molecular Ridge

Some background information prior to the discussion that is to follow.
The Vela Molecular Ridge (**VMR**) is a large complex in the Milky Way that contain multiple sites of ongoing star-formation. It is located in the constellations Vela and Puppis. This cloud complex lies on the sky in the direction of the Gum Nebula (foreground) and the Carina–Sagittarius Spiral Arm (background). Radio ^{12}CO observations of the region showed the ridge to be composed of several **clouds**, each with masses 100,000–1,000,000 $M\odot$.
Several of the Gum nebulae discussed here form part of this Ridge - RCW 36/ Gum 20 for instance is embedded in the VMR **Cloud C (Vela-C)**. Located roughly 2300 light years away, **Vela-C,** the most massive component of the VMR, saw the onset of star formation less than a million years ago – relatively recently on astronomical timescales.
Massive, as well as low- and intermediate-mass stars are being born in this region, making it an ideal laboratory to study the birth of different populations of stars. Other associated RCW regions include RCW 33, -32, -27, -36 and RCW 34.
The **Gum/ RCW** regions photographed and discussed in this piece are located FURTHER away from earth than the foreground **Vela SNR**.

Back to the SNR: Different estimates of the **distance** to the Vela SNR suffer from large uncertainty: from 250 ± 30 pc to +/- 350 pc. Hubble Space telescope parallax observations of the Vela pulsar give a distance to the pulsar of +/- 294 pc (Caraveo et al. 2001), and the best estimate is from the VLBI parallax which measures +/- 287 pc (Dodson et al. 2003).
Similarly uncertain are the estimates of the **Vela SNR age**, which range from a few thousand years (Stothers 1980) to approximately 2.9×10^4 yrs. (Aschenbach et al. 1995). The most commonly cited estimate is $\simeq 1.14 \times 10^4$ yrs.

The **NE/SW asymmetry** of the Vela SNR: In a January 2011 publication (Astronomy and Astrophysics) the authors explain observable characteristics of the **Vela SNR**. The **main peculiarity** of Vela SNR is the difference in the X-ray brightness and radius of its south-west (**SW**) vs. its north-east (**NE**) parts. The volume-averaged density of clouds evaporated by the shock from the SN explosion in the north-east (NE) part is about four times higher than the one in the south-west (SW) part.

The **observed asymmetry** between the NE and SW parts of the Vela SNR (the observed **density contrast**) could be explained by the presence of a stellar wind bubble (**SWB**) blown by the ***nearest-to-the Earth*** **Wolf-Rayet** (WR) star in the **γ2 Velorum** system. The hypothesis

of **intersection** between the **Vela SNR** and **γ2 Velorum SWB** is further supported by the simple geometrical form of the boundary between the bright and the dim part of the SNR shell. Indeed, the boundary roughly follows the contour of an ellipse whose major axis is perpendicular to the direction from the centre of Vela SNR toward the γ2 Velorum, so that the minor axis is aligned with the direction toward γ2 Velorum. (Refer to the "patchwork" above).

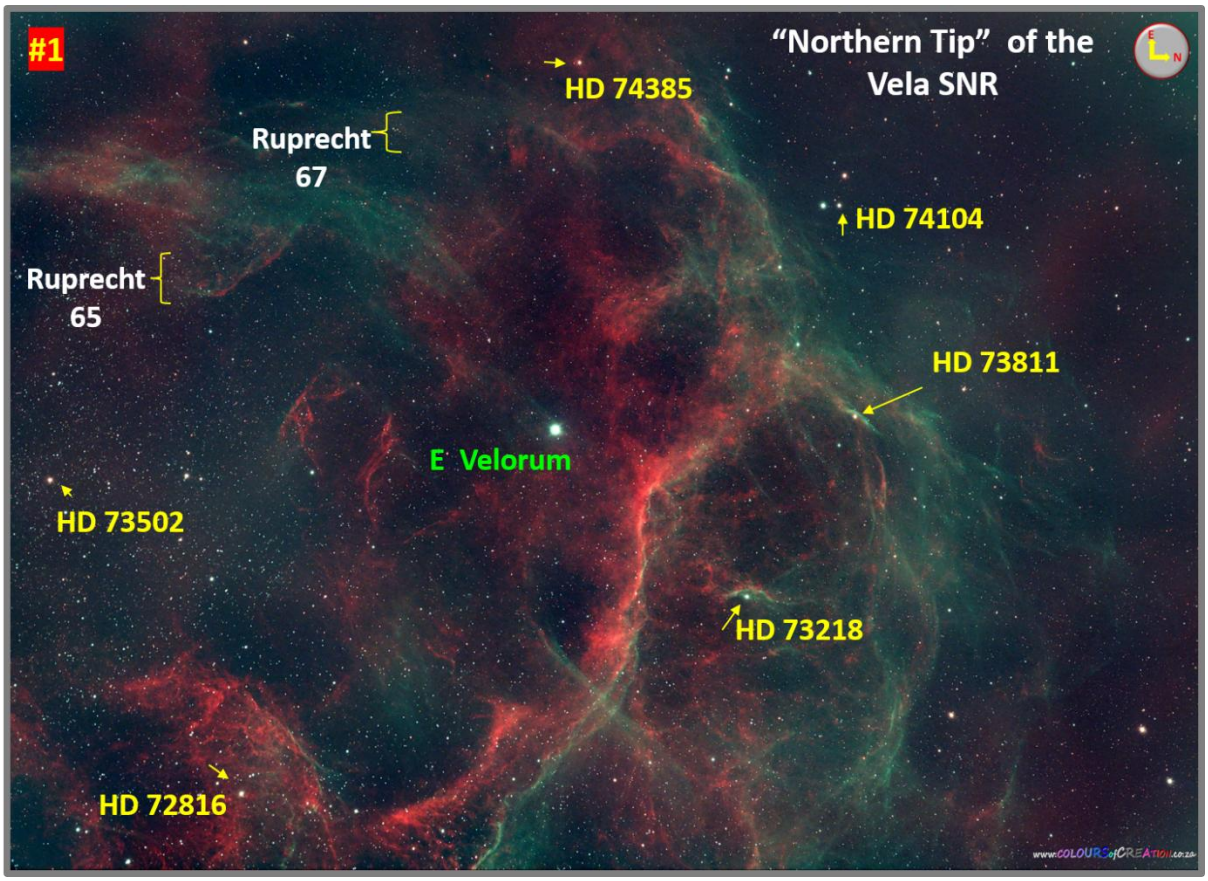
Finally, the **Vela SNR** is peculiar in still another aspect**: the main shock of the SNR is not observed**. Instead, the bulk of the X-ray emission is distributed **all over** the SNR volume. Such an observational appearance can be caused by the SNR expanding into a highly **inhomogeneous ("cloudy") interstellar medium (ISM)**. ***In this case***, the main shock advances through a low-density **ISM**, leaving behind denser clouds, which are subsequently heated and partially evaporated by thermal conductivity and transmitted shocks. This results in the appearance of a **distributed emission *throughout*** (**"magnificent chaos"**) the **entire volume** of the SNR, instead of from a **thin shell** at the interface of the main shock with the low-density ISM.

The **younger Vela SNR** is likely embedded/ superimposed on a larger and older H II region, the **Gum Nebula**. More specifically this is **Gum 12**, but it is usually referred to as simply "The Gum nebula". Reynolds (1976) suggested that the Gum nebula is a 1 Myr old SNR, which is now heated and ionized by the two very hot stars zeta Puppis and gamma Velorum within it. Later Woermann et al. (2001) showed that the Gum nebula can possibly be a SNR of the **zeta Puppis companion**. They showed that the **runaway O-star zeta Puppis** was within <0.5 deg of the expansion centre of the Gum nebula about 1.5 Myr ago, which is evidence of the relation between the SN explosion of the binary companion and the Gum nebula expansion. Assuming a distance of 400 pc, the radius of Gum nebula ***would then*** be such that both the Vela SNR and γ2 Velorum are **situated inside** the cavity formed by the expansion of the SNR associated to the **Gum** nebula.

Gum nebulae are named for a cosmic cloud hunter, Australian astronomer Colin Stanley Gum (1924-1960). He published his nebula catalogue in 1955, and although Gum's catalogue has largely been superseded by the **RCW** catalogue published in 1960, many **HII regions** are still referred to by their Gum numbers – even today. The **RCW Catalogue** (**R**odgers, **C**ampbell & **W**hiteoak) describes Hα-emission regions in the southern Milky Way. It contains 182 objects, including 84 of the earlier Gum catalogue.

With a diameter of at least 36^{o}, **Gum 12** is one of the largest structures in angular extend in the sky - sprawling across the Ship's southern constellations Vela (the sails) and Puppis (the stern). The **Gum 12** nebula is so large and close that it is hard to see. In fact, we are only about 450 parsecs from the front edge and 1,500 parsecs from the back edge of this interstellar expanse of glowing **hydrogen** gas. It has a width of about 300 parsecs.

The red hydrogen glow of the background **Gum 12** is prevalent in some of the photos.



In **photos #1** to **#3** the **Vela SNR's** "wisps" of "magnificent chaos" - optical filaments showing indications of heating by fast shock waves from the supernova - dominate the scenes. **Hydrogen (H II** – see below**)** appears orange-red-pink and oxygen green in all these images. (Imaged through a narrow-band quad-band filter).

Some clarification…

"H two (HII) and H two (H_2)"

An **HI region** (read **"H one"**) is a **cloud in the interstellar medium** composed of **neutral atomic hydrogen** (**HI**), in addition to the local abundance of helium and other elements. It is customary in astronomy to use the Roman numeral **I** for **neutral atoms**. These regions do not emit detectable visible light.

H II: The Roman numeral **II** is used in astronomy for **singly-ionised atoms**: Thus a region of interstellar atomic hydrogen that is **ionized** would be **HII** (pronounced **"H two" by astronomers**): This is **H+** in *other sciences*… We see these **HII** regions as the familiar **emission** nebulae (reddish-pink), created when young, massive stars ionise nearby gas clouds with high-energy UV radiation.

H_2: This is a **molecule** formed by two hydrogen atoms that share their electrons. In astronomy, **molecular hydrogen** is notoriously difficult to detect. However, it has been shown that for every 10,000 hydrogen molecules in the interstellar medium there exists a carbon monoxide molecule (CO), and it is by searching for this CO that astronomers have been able to map out the H_2 distribution in the Galaxy. This has revealed that molecular

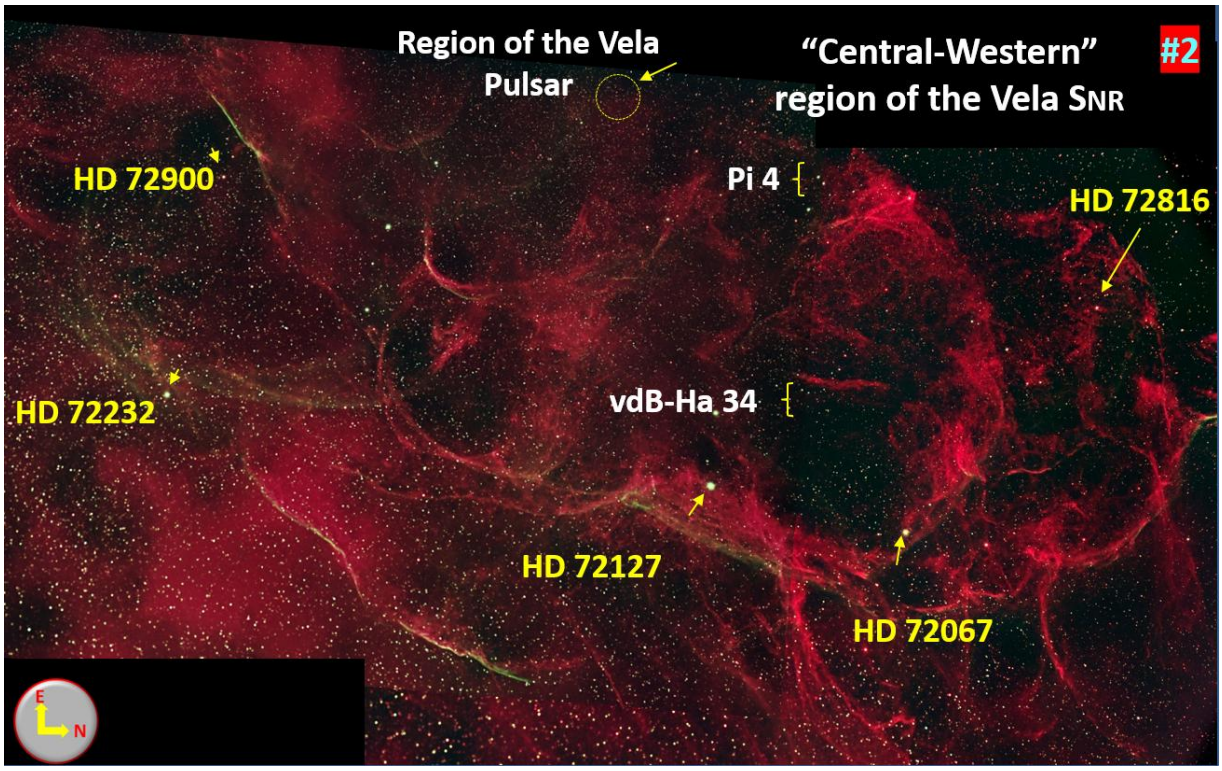
hydrogen is found primarily in **molecular clouds**. These are **interstellar gas clouds** which have been demonstrated to trace the spiral arms in the disks of spiral galaxies, and contain the material out of which new stars are born**.**

The Vela Pulsar

The association of the Vela supernova remnant with the **Vela pulsar**, made by astronomers at the University of Sydney in 1968, **was direct observational evidence that supernovae form neutron stars**.

Per the Internet sources: "Vela is the brightest pulsar (at radio frequencies) in the sky and spins 11.195 times per second (i.e. a period of 89.33 milliseconds—the shortest known at the time of its discovery). It has the third-brightest optical component of all known pulsars (V = 23.6 mag) which pulses twice for every single radio pulse. It is the brightest, persistent object in the high-energy gamma-ray sky. ["A **pulsar** (from ***pulse*** and ***-ar*** as in quasar) is a highly magnetized rotating neutron star that emits beams of electromagnetic radiation out of its magnetic poles"].

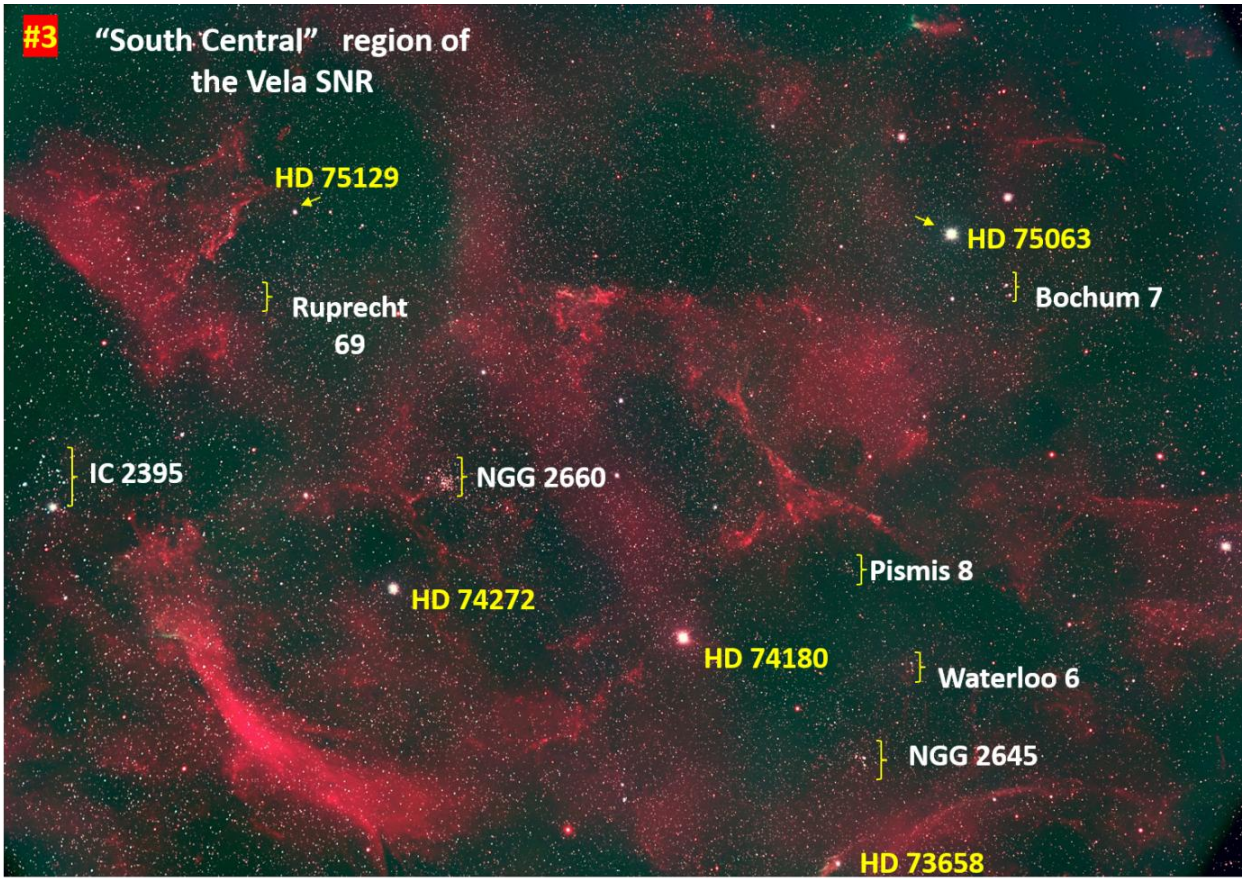
The **Vela pulsar** is located "somewhere" in the circled area on **photo #2** - centre-top (East) - **RA:** $08^{h}\ 35^{m}\ 20.65525^{s}$; **Dec:** −45° 10′ 35.1545″. With a visual magnitude of +23.6 it will most certainly NOT show up in any of these images.



The field in photo #2 also abounds with deep sky objects (DSOs): here we see the 2 open clusters **Pismis** 4 (Marie Paris **Pişmiş** de Recilas: 1911-1999) and **vdB-Ha** 34 (Sidney **van den Bergh** and Gretchen Luft **Hagen**).

Open cluster “united nations”

The “South Central” region of the Vela SNR is literally strewn with open clusters of various designations – representing **several open cluster catalogues**. These include our well known NGC (**N**ew **G**eneral **C**atalogue) and IC (**I**ndex **C**atalogue) catalogues, as well as the more



obscure **Ru** (Jaroslav **Ru**precht), **Wa** (**Wa**terloo) and **Bochum**. The “Bochum” Star Cluster Catalogue of only **15 objects** comes from a photometry study of young OB stellar associations / open star clusters made in 1977 by astronomers at the Ruhr-University **Bochum**, Germany. All the “Bochum” objects are unique objects, not listed in any other ***prior*** catalogue. The “local” **Bochum 7** cluster in Vela shines at Magnitude 7.8.

Though quite faint, these DSOs did make for an interesting photographic hunting experience. An observing and/or imaging challenge perhaps?

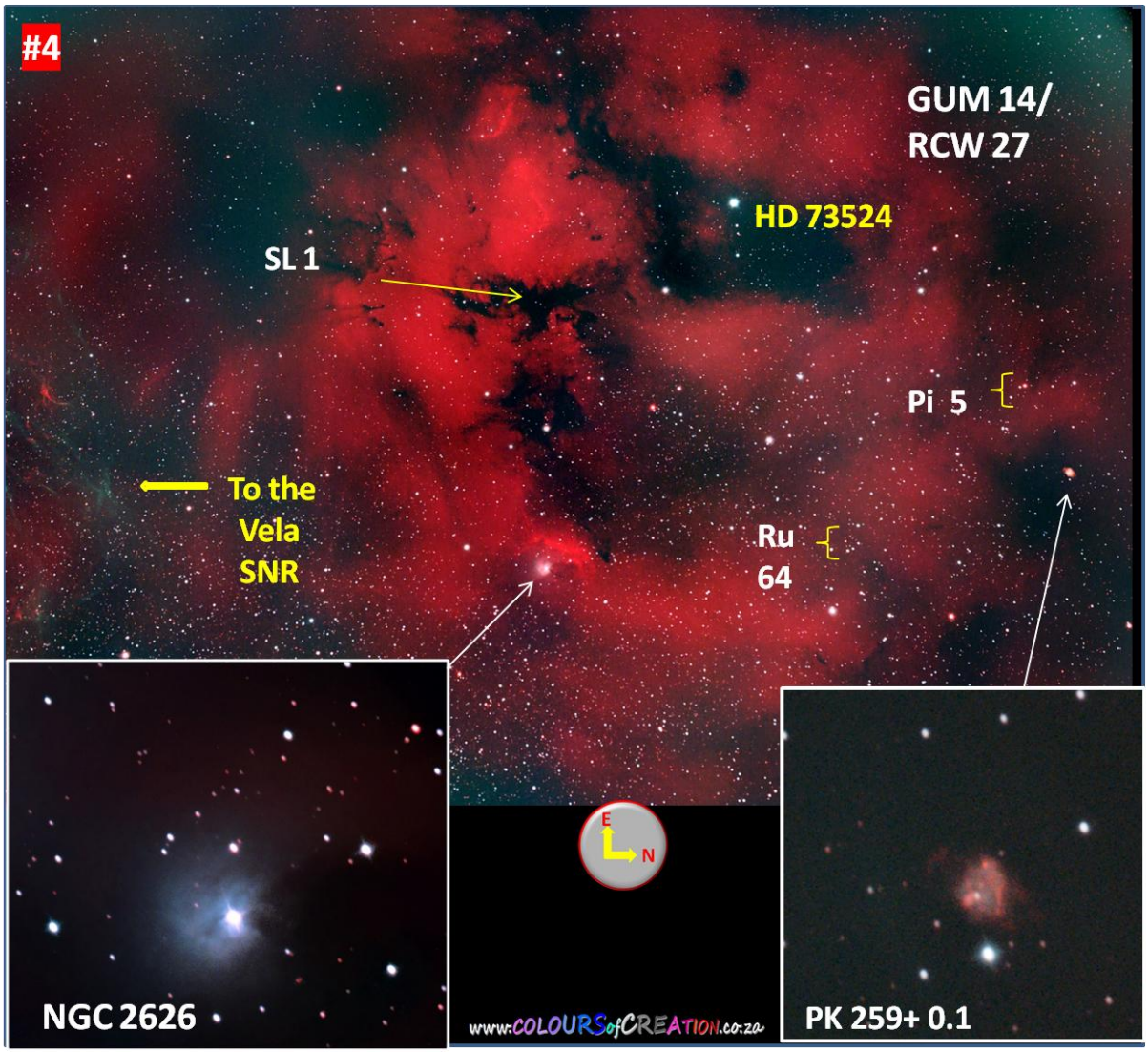
Newfound favourites – for now...

Spending time with this southern gem revealed numerous ***other*** appealing and interesting DSOs in its vicinity – my new found favourites – for now!

Starting north of the SNR, our “tour” will progress towards the south east, and then “turn left” (heading south) to further explore the area directly east of the Vela SNR. (Please refer to the “patch work”).

Astronomy 101

First stop - **Gum 14** (aka RCW 27) and associated DSOs. (Photo #4).



Gum14 is an emission nebula covering a large area of approximately **two degrees**. It hosts many planetary nebulae, cometary globules and dark nebulae along with various open clusters.

One of its more prominent DSOs is the dusty blue **reflection** nebula known as **NGC 2626**. It is in fact an example of "faint reflection-, emission- and dark nebulae rolled into one". NGC 2626 is estimated to be 3300 light years distant. The dark nebula sweeping towards it from the north is designated **HMSTG93**. (**DC 259-9-00** in other sources?).

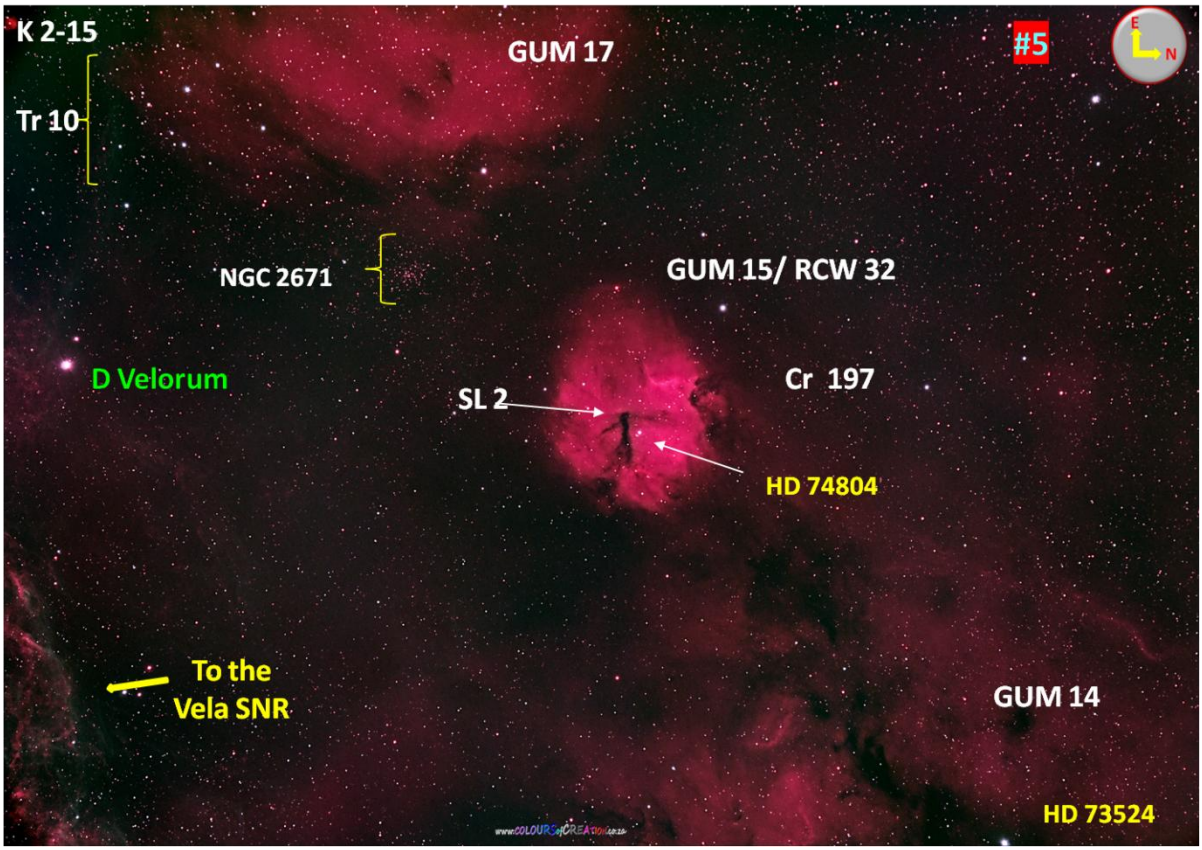
The magnitude 13.8 planetary nebula **PK 259+ 0.1** (aka Henize 2-11) lurks in the northern outskirts of Gum 14. It measures 75.0 x 75.0 ".

Both the above 2 objects were imaged separately at higher focal length with different filters than the wide field.

The dark nebula SL 1: This nebula belongs to the group of **42 dark dust clouds** of high visual opacity, studied by A. **S**andqvist and K.P. **L**indroos - "Interstellar formaldehyde in southern dark dust clouds"; published in *Astronomy Astrophysics*, 53, 179-189 (1976).

Two open clusters – Pismis 5 and **Ruprecht 64** also share the same field of view (FOV).

Gum 15 (Aka RCW 32), see photos #5 & #5B, situated roughly direction SE from Gum 14, is about 3,000 light-years from Earth. It is shaped by aggressive winds flowing from the stars within and around it.



Its central region shows dark patches of obscuring dust, known as **SL2**.
The various combinations of **emission**, **reflection** and **dark nebulae** make the nebula resemble a larger and fainter version of the better known **Trifid Nebula**, and **Gum 15** has indeed been nicknamed the **"Southern Trifid".** See text below.

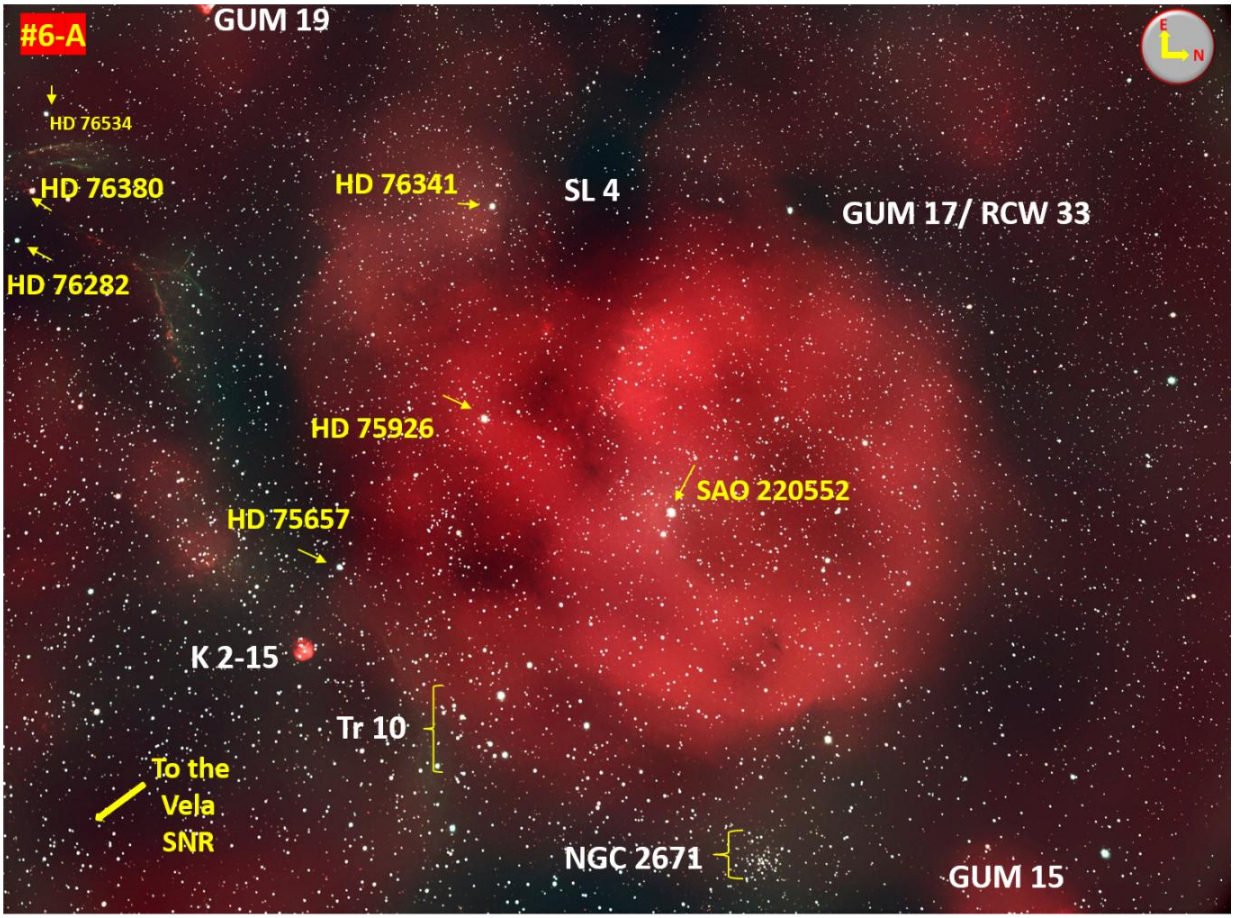
A faint magnitude 11.6 open cluster, **NGC 2671,** is nestled between Gum15 and 17. It lies +/- 5 400 light years (1.7 kpc) from us. It is described as "fairly rich in stars, little compressed toward the middle, covering about 4' of sky and containing about 40 stars of magnitude 12 to 13."
Located in the center of the nebula, we find the star **HD 74804** (Mag 7.34) - it is responsible for the ionization of the gas. This B-class multiple star it is the brightest member of the open star cluster **Collinder 197 (Cr 197)**.
The Collinder catalogue is a catalogue of 471 open clusters by Swedish Astronomer Per Collinder, published in 1931. **Cr 197** is visible in the photo of Gum 15 below.

The “Wannabe look-alikes”

The two **“TRIFIDS”** shown here were imaged using an IDAS LPS V4 filter. This filter reveals more detail in **blue reflection nebulae** and stars vs. in the image above (**photo #5**), for which a Radian quad-band narrow-band filter was utilized. The latter allows for more transmittance in H-alpha. The OTA used for the Trifids was an Optimized Dall-Kirkham, fl 1700mm, and for the wider field in photo #5 a Tele Vue refractor, fl 660mm. Apparent Diameters: Gum 15 = 20- and the Trifid = 28 arcmin.

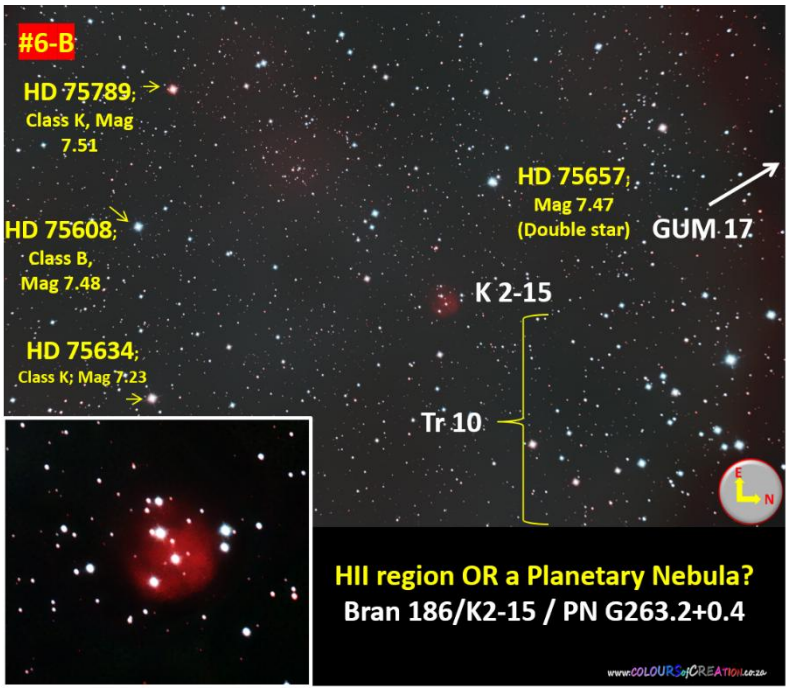
Distance dispute

Next stop - again a bit further SE: **Gum 17** and surrounds. **Photo #6A**. It’s any bodies guess as to how far this object is located from earth…? There are *at least* two conflicting distance



estimates: If the source of the excitation of the hydrogen gas (which makes it glow) is the **Trumpler 10** star cluster (Tr 10), then the distance of the nebula is about **1,300 light years** (ly) (400 pc). However, if the source is **SAO 220552,** the bright hot blue star dead centre in the nebula, then the nebula is much further away, at about **3 200 light years** (1000 pc). Another possible clue? - as part of the Vela Molecular Ridge, Gum 17 should be expected to be about **2 300 ly** away?
On the south-western border of Gum 17, we found our next target for exploration: **K2-15**.

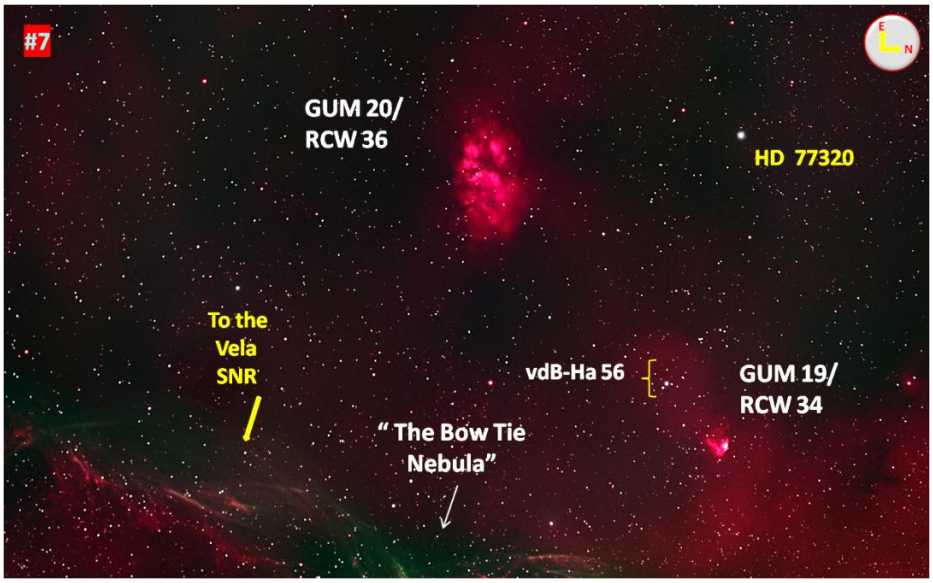
To be or NOT to be a "HII region" or a "Planetary nebula"?



One cannot blame this little patch to somehow feel a bit schizophrenic… a DSO with an identity crisis it appears? The true nature of this object has been contested and debated in our astronomy literature. One visual observer described this object as: "A lovely ***planetary nebula***. Barely perceptible without filters, it responds well to the OIII filter, showing as a pretty large, rather faint but very even nebulous glow. It is an unusual "squarish" shape. No colour that I could see, and no sign of its central star. A line of roughly mag 12 stars stretch in an east-west direction across its centre, and there is a close pair of also roughly mag 12 stars on its northern edge**."** (sandandstars.co.za).

Also known as "**Bran 186**" this object is discussed in a 2010 paper in *Astronomy and Astrophysics*. (Spectral classification and distance determination of stars in nine southern Galactic Hii regions (M. C. Pinheiro, M. V. F. Copetti, and V. A. Oliveira).
A roughly 3 deg, round, low surface brightness emission nebula, it was discovered by Kohoutek (1971) on a plate of the Palomar Sky Survey and designated as **PN K 2-15**, and classified as ***a possible planetary or diffuse nebula***.
It also appeared as the suspected planetary **ESO 260-8** on the ESO/Uppsala survey of the ESO (B) atlas by Holmberg et al. (1978), and as **PN G263.2+00.4** in the Strasbourg-ESO Catalogue of Galactic Planetary Nebulae by Acker et al. (1992). Based on a spectroscopic analysis, Kohoutek & Pauls (1994) included **PN K 2-15** among their list of confirmed planetary nebulae.
However, the **status of H ii region** for **Bran 186** was strongly indicated by the detection of a site of **recent star formation** at the eastern border of the optical nebula, 1.8 deg from the centre. An embedded star cluster, named [DBS2003], was detected by the 2MASS survey. The authors discovered that a B0 star, Bran 186-3, is the ionisation source of Bran 186. Thus, "not a planetary nebula" after all, it appears…

A Mirrored Question mark (Or perhaps a seahorse?)



We have now "turned the corner" and are heading south, exploring the rich area east of the Vela SNR, where we first encounter Gum 20 and 19.
Gum 20 is the most prominent object in this field. At first glance it resembled a mirrored (or Arabic) question mark - that has misplaced its ball – now drifting away to the NW. "Seahorse shape" also comes to mind.

On a more scientific note: **Gum 20**, also designated **RCW 36**, is an emission nebula containing an open cluster. This H II region is also part of a larger-scale star-forming complex known as the Vela Molecular Ridge (VMR). As mentioned earlier, the VMR is made up of several distinct clouds, and RCW 36 is embedded in the VMR Cloud C.

Gum 20 is one of the sites of massive-star formation closest to our Solar System, located at distance of approximately 700 parsecs (2300 light-years). The most massive stars in the star cluster are two stars with late-O or early-B spectral types, but the cluster also contains hundreds of lower-mass stars. This region is also home to objects with Herbig–Haro jets, HH 1042 and HH 1043.

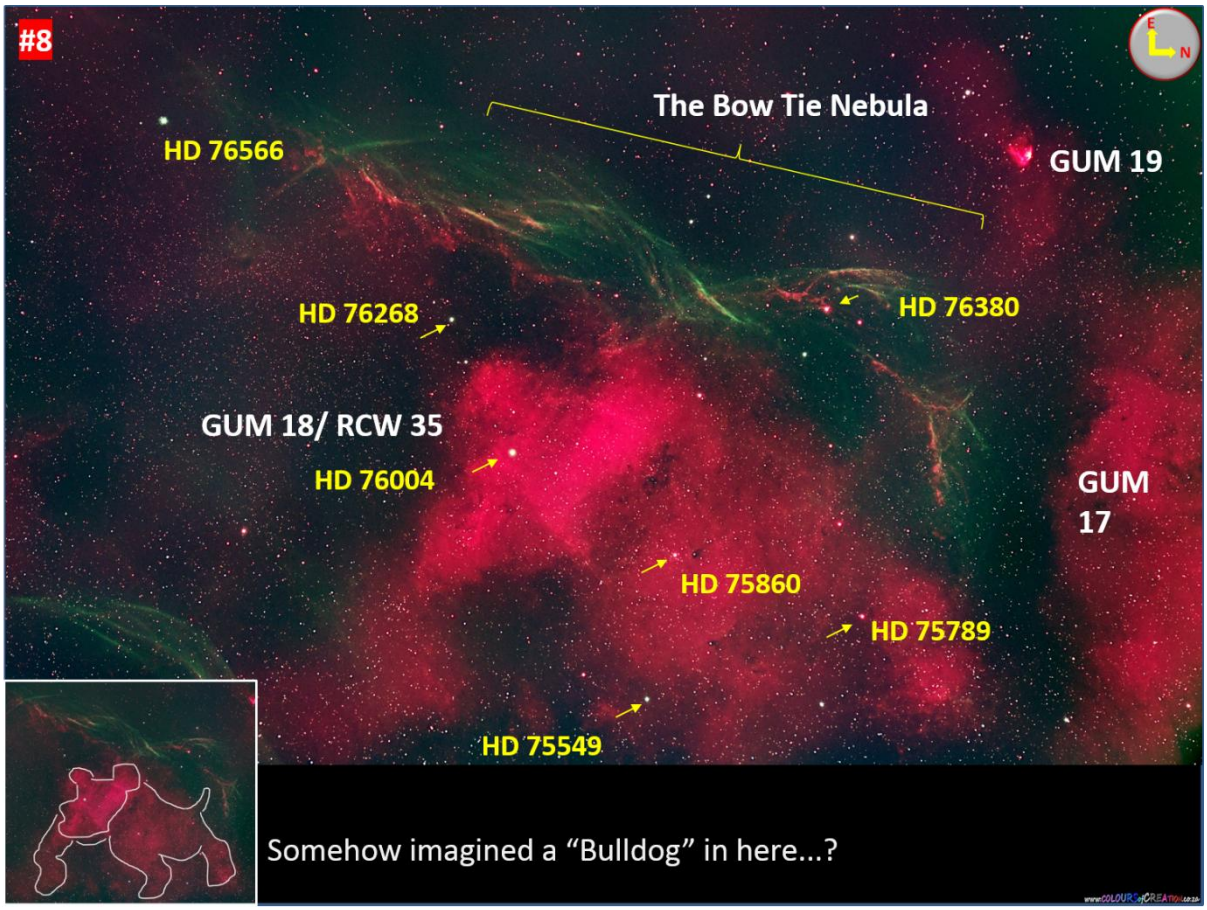
Gum 19/ RCW 34 - a "rip is space-time"

Our "misplaced question mark ball": a small hydrogen nebula, known as Gum 19 or RCW 34. Although being one of the lesser known, it is considered as one of the most interesting of the Gum nebulae. It is also located further away, at about 22,000 light-years.
A new and provocative view of Gum 19 has been released by the European Southern Observatory (ESO). Observers used Sofi, an infrared spectrograph and imager mounted on the ESO's New Technology Telescope (NTT) in Chile, to record the nebula at three wavelengths out to 2.2 microns. Although faint in visible light, the new infrared view reveals this little nebula to be **dark on one half** and **bright on the other**, punctuated by a bright stripe of nebulosity slashing vertically through its midsection. The bright half results from illumination by a supergiant blue star called **V391 Velorum**. New stars are forming both there and in the clouds of dark material on the opposite side.

With a surface temperature near 50,000°F (30,000°C), massive V391 Velorum has a temperamental nature. Its brightness can fluctuate suddenly, likely caused when it ejects shells of matter into the surrounding space. Stars in this mass range typically exist for only 10 million years before exploding as a supernova.
As noted in the ESO's online press release, Gum 19 has an eerie **"rip in space-time"** look to it in the infrared, with a narrow, near-vertical bright region slashing its middle. Thousands of years from now, the blink of an eye in astronomical terms, V391 Velorum's demise will likely alter forever the intriguing appearance that Gum 19 has now.

The "B&B" region

Directly west of Gum 19 and 20 we run into the "**Bow Tie and the Bull dog**". (Note: the latter designation is NOT an official one). This filamentous structure that occupies the eastern regions of the Vela SNR is called the "**Bow Tie nebula**". In all fairness, it can also be likened to a "bird's wings" in appearance. It forms part of the expanding debris cloud resulting from the Vela supernova explosion between 11 000 and 12 000 years ago.



Bow-Tie confusion

It is only prudent to alert the reader to a possible confusing scenario regarding other nebulae referred to as "***Bow Tie***": All these are planetary nebulae: First, planetary nebula **NGC 40** in Cepheus. Its familiar shape in astro-photos leads it to be referred to as the "Bow

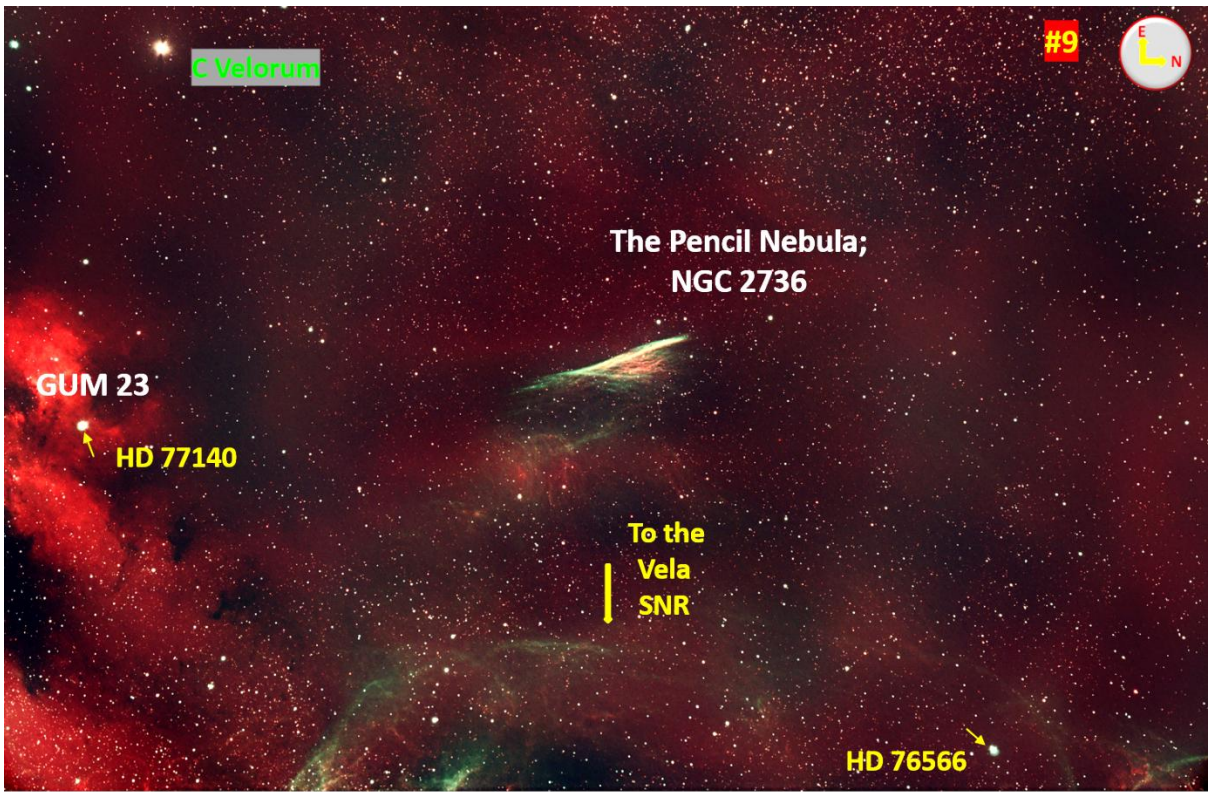
Tie". Next the Boomerang Nebula (**PGC 3074547**), a protoplanetary nebula located in the constellation Centaurus. The Boomerang Nebula is also known as the "Centaurus Bipolar Nebula" or the "Bow Tie Nebula". And not to be outdone, **NGC 2440** in Puppis also reveals an intriguing "bow-tie" shape…

Gum 18, aka RCW 35.

Found directly west of our Bow tie. This HII region, together with surrounding areas, somehow conjured up the outlines of what could resemble a "Bull dog"- but my imagination probably just got the better of me.

The Space Pencil

NGC 2736 (also known as the Pencil Nebula) is a small part of the Vela Supernova Remnant - its linear appearance triggering its popular name. It resides about 815 light-years (250 parsecs) away from the Solar System and is thought to be part of the shock wave of the Vela



SNR. The Pencil Nebula is about 5 light-years long and moving at roughly 644,000 km per hour (400,000 miles per hour). In these images the red and green colours represent the characteristic glow of ionized hydrogen and oxygen atoms. It is the brightest patch of the Vela SNR, with a relatively bright star immersed in it.

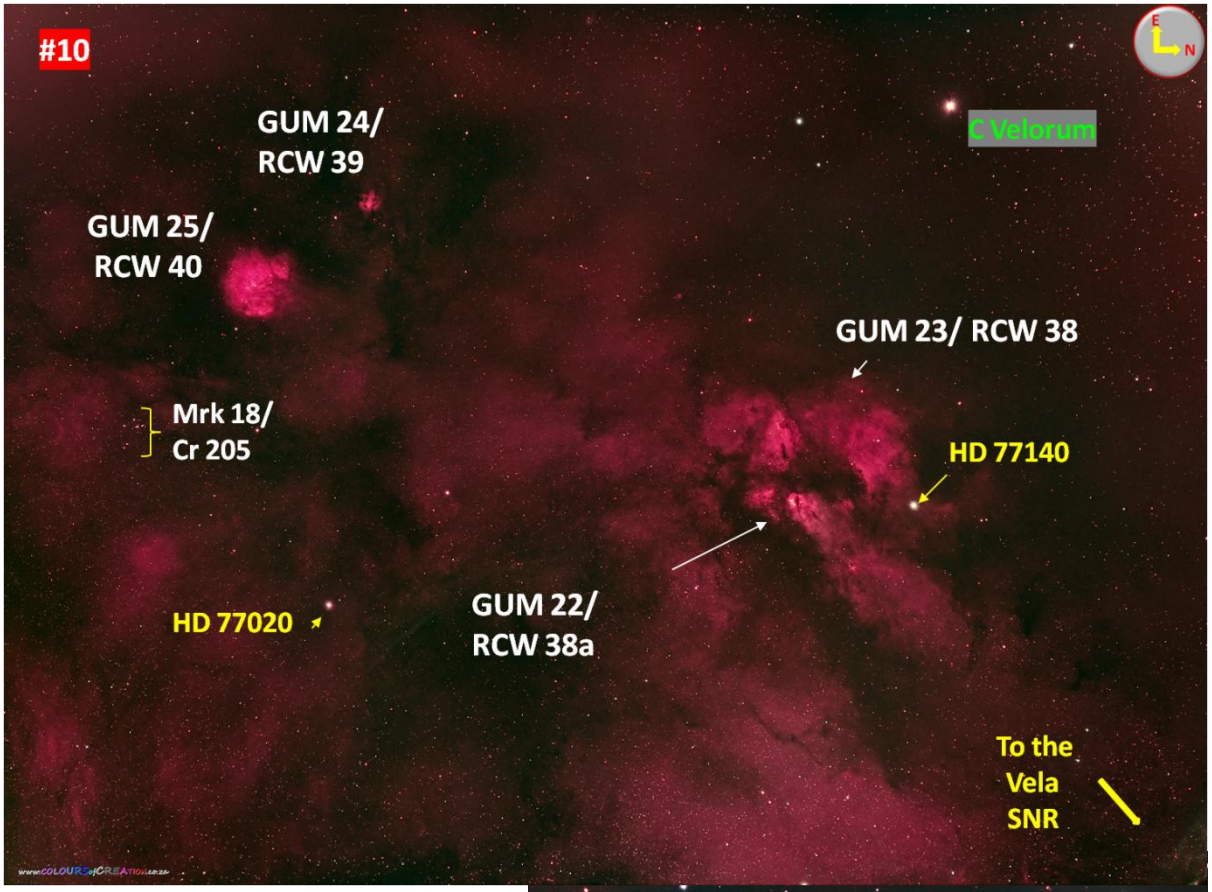
The thin, bright, braided filaments are actually long ripples in a cosmic sheet of glowing gas *seen almost edge-on*.

On 1 March 1835, John Herschel discovered this object from the Cape of Good Hope and described it as "eeF, L, vvmE: an extraordinary long narrow ray of excessively feeble light; position 19 ±. At least 20' long, extending much beyond the limits of the field...". His description agrees with the ESO data that lists it as N2736 = E260-N14, “a nebula with dimensions 30'x7', position angle of 20 and described as a luminous filament”.

More Gums

RCW 38 and 38a (Gum 23 and 22)

This giant star formation region at the boundary of the Vela OB1 association is a compact HII region lying just inside the edge of a giant molecular cloud. It is ionised by an **enormous star cluster**, [BDB2003] G267.92-01.06, that is less than 1 million years old and contains about 10 000 stars (including candidate O or B class stars). The hottest of these is the O5.5V class [FP74] **RCW 38 IRS 2.**



(Imaged through an IDAS V4 filter, the narrow-field photo on the right reveals more stars).

A 2016 publication in *The Astrophysical Journal* sheds more light on the processes involved in this

cluster and clouds interplay: Two molecular clouds, with velocities of 2 and 14 km s^{-1} respectively, have been heading towards the region – now containing RCW 38, the **youngest super star cluster** in the Milky Way. The velocity separation of 12 km s^{-1} is too large for the clouds to be gravitationally bound, and the authors have suggested that the clouds encountered each other by chance. They presented a scenario in which the two clouds collided with each other 0.1 Myr ago at 17 km s−1 to trigger formation of the O stars in the cluster.

RCW 38 is unique because it is the youngest cluster where the initial conditions prior to the O star formation *still hold* without significant cloud dispersal brought about by stellar feedback beyond 1 pc.
These present findings suggest a possible recipe for O star formation in a super star cluster. Multiple O star formation is triggered where two clouds collide at a velocity of 10–30 km s−1. Since O star formation takes place only at the points of collision, the distribution of O stars retains the distribution of the collisional interaction - as long as gravitational rearrangement of O stars after the collision does not play a role.
This is the third super star cluster alongside **Westerlund 2** and **NGC 3603** where ***cloud–cloud collision*** has triggered the cluster formation. cloudshttps://iopscience.iop.org/article/10.3847/0004-637X/820/1/26.

RCW 39; Gum 24

"There is little information available in the scientific literature on this mysterious nebula. The Bran catalogue identifies RCW 39 with the nebulae **Bran 226** and **Wray 19-18** and finds two CO clouds with distinct velocities in this direction.
Avedisova places RCW 39 in star formation region **269.11-1.08** along with **Gum 12a**, three masers and the multiple Wolf-Rayet star **gamma Velorum**. If these *associations* are correct, RCW 39 is a local object and not at a large distance of 3000 pc as other estimates suggest. RCW 39 is prominent in infrared". (http://galaxymap.org/cat/list/rcw/31)

RCW 40; Gum 25

This HII region appears to be part of the Vela OB1 association and per Avedisova it is ionised by the O9 V star CD -48 4352.
Infrared images "strip away" the surrounding dust to reveal a spectacular bubble structure with a central star cluster.

Both SIMBAD and the RCW catalogue identify RCW 40 and Gum 25 - but given the limited accuracy of Gum's coordinates - a question remains as to whether these 2 designations describe the same object? There is an unusually large distance between the two sets of coordinates in the two catalogues, suggesting the possibility that they are distinct.

End of the tour

The Vela SNR and surrounds… a patch of sky that truly is a treasure-trove of "assorted" DSOs that will keep you occupied for many a rewarding evening under the stars.
To go "hunting", just locate **Gamma** and **Lambda Velorum** – aim for an area between them, "somewhere in the middle" – and start shooting away. You will NOT be disappointed!

PS. For interest re. time spent on THIS project:
Total exposure time, that is the time camera sensors were actively capturing ancient photons, was +/- 50 to 60 hours.
Additional time spent: setting up systems for imaging, capturing DARKS, several "re-takes", dismantling and packing up, sorting subs into folders, image stacking and processing images in DeepSkyStacker and PixInsight, image manipulation in Paint.Net and Picasa, image cropping, annotation etc. in PowerPoint, and final saved image tweaking again in Paint.Net and Picasa.
Plus, literature search and compiling this piece (With several drafts…).