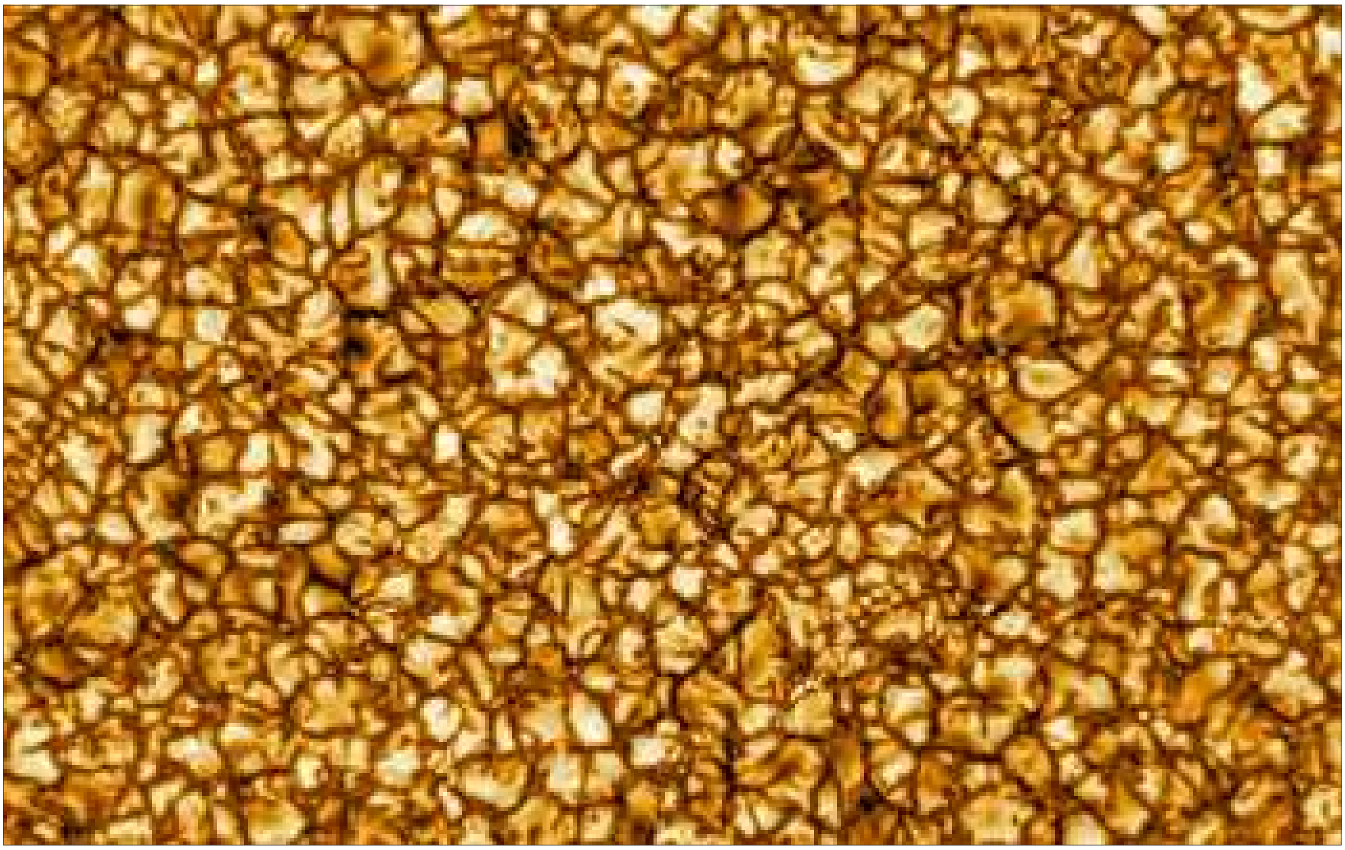
# The Astronomers' Bulletin

**Newsletter of the Sydney City Skywatchers** **Volume 10, Issue 11 Jul/Sep 2020**

## New Telescope Shows Detailed Solar Images



Just released first images from the National Science Foundation's Daniel K. Inouye Solar Telescope reveal unprecedented detail of the sun's surface and preview the world-class products to come from this preeminent 4-meter solar telescope. The telescope, on the summit of Haleakala, Maui, in Hawaii, will enable a new era of solar science and a leap forward in understanding the sun and its impacts on our planet.

Activity on the sun, known as space weather, can affect systems on Earth. Magnetic eruptions on the sun can impact air travel, disrupt satellite communications and bring down power grids, causing long-lasting blackouts and disabling technologies such as GPS.

The first images from the Inouye Telescope show a close-up view of the sun's surface, which can provide important detail for scientists.

"Since NSF began work on this ground-based telescope, we have eagerly awaited the first images," said France Córdova, NSF director. "We can now share these images and videos, which are the most detailed of our sun to date. The Inouye Solar Telescope will be able to map the magnetic fields within the sun's corona, where solar eruptions occur that can impact life on Earth. This telescope will improve our understanding of what drives space weather and ultimately help forecasters better predict solar storms."

The sun is our nearest star - a gigantic nuclear reactor that burns about 5 million tons of hydrogen fuel every second. It has been doing so for about 5 billion years and will continue for the other 4.5 billion years of its

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lifetime. All that energy radiates into space in every direction, and the tiny fraction that hits Earth makes life possible. In the 1950s, scientists figured out that a solar wind blows from the sun to the edges of the solar system. They also concluded for the first time that we live inside the atmosphere of this star. But many of the sun's most vital processes continue to confound scientists.

"On Earth, we can predict if it is going to rain pretty much anywhere in the world very accurately, and space weather just isn't there yet," said Matt Mountain, of the Association of Universities for Research in Astronomy. "Our predictions lag behind terrestrial weather by 50 years, if not more. What we need is to grasp the underlying physics behind space weather, and this starts at the sun, which is what the Inouye Solar Telescope will study over the next decades."

The motions of the sun's plasma constantly twist and tangle solar magnetic fields . Twisted magnetic fields can lead to solar storms that can negatively affect our technology-dependent modern lifestyles. Finally resolving these tiny magnetic features is central to what makes the Inouye Solar Telescope unique. It can measure and characterize the sun's magnetic field in more detail than ever seen before and determine the causes of potentially harmful solar activity.

"It's all about the magnetic field," said Thomas Rimmele, director of the Inouye Solar Telescope. "To unravel the sun's biggest mysteries, we have to not only be able to clearly see these tiny structures from 93 million miles away but very precisely measure their magnetic field strength and direction near the surface and trace the field as it extends out into the million-degree corona, the outer atmosphere of the sun."

Better understanding the origins of potential disasters will enable governments and utilities to better prepare for inevitable future space weather events. It is expected that notification of potential impacts could occur earlier - as much as 48 hours ahead of time instead of the current standard, which is about 48 minutes. This would allow more time to secure power grids and critical infrastructure and to put satellites into safe mode.
To achieve the proposed science, this telescope required important new approaches to its construction and engineering. Built by NSF's National Solar Observatory and managed by AURA, the Inouye Solar Telescope combines a 4-meter mirror - the world's largest for a solar telescope - with unparalleled viewing conditions at the 10,000-foot Haleakala summit.

Focusing 13 kilowatts of solar power generates enormous amounts of heat - heat that must be contained or removed. A specialized cooling system provides crucial heat protection for the telescope and its optics. More than seven miles of piping distribute coolant throughout the observatory, partially chilled by ice created on site during the night.

The dome enclosing the telescope is covered by thin cooling plates that stabilize the temperature around the telescope, helped by shutters within the dome that provide shade and air circulation. The "heat-stop" (a high-tech, liquid-cooled, doughnut-shaped metal) blocks most of the sunlight's energy from the main mirror, allowing scientists to study specific regions of the sun with unparalleled clarity.

The telescope also uses state-of-the-art adaptive optics to compensate for blurring created by Earth's atmosphere. The design of the optics ("off-axis" mirror placement) reduces bright, scattered light for better viewing and is complemented by a cutting-edge system to precisely focus the telescope and eliminate distortions created by the Earth's atmosphere. This system is the most advanced solar application to date.

"With the largest aperture of any solar telescope, its unique design, and state-of-the-art instrumentation, the Inouye Solar Telescope - for the first time - will be able to perform the most challenging measurements of the sun," Rimmele said. "After more than 20 years of work by a large team devoted to designing and building a premier solar research observatory, we are close to the finish line. I'm extremely excited to be positioned to observe the first sunspots of the new solar cycle just now ramping up with this incredible telescope."

The Inouye Solar Telescope image on page 1 is the highest resolution image of the sun's surface ever taken. Taken at 789 nanometers, it shows features as small as 30km in size for the first time ever. The image shows a pattern of turbulent, "boiling" plasma that covers the entire sun. The cell-like structures - each about the size of Texas - - are the signature of violent motions that transport heat from the inside of the sun to its surface. That hot solar plasma rises in the bright centers of "cells," cools, then sinks below the surface in dark lanes in a process known as convection. In these dark lanes we can also see the tiny, bright markers of magnetic fields. Never before seen to this clarity, these bright specks are thought to channel energy up into the outer layers of the solar atmosphere called the corona. These bright spots may be at the core of why the solar corona is more than a million degrees.

**National Science Foundation**

## The First Flares of Solar Cycle 25

Solar flares occur in sunspots of great magnetic complexity with strong fields. Spotless flares are rare, but do occur, usually at sites of long-lived complex fields, often termed Hyder Flares.

At present the Sun is in a deep solar Minimum; but about a dozen new SC25 spots have appeared, mostly small singles with a few bipolar pairs. How then, do we understand a sudden burst of solar flaring that peaked with a GOES **M1.2** flare on May 29 at 07:24UT? The flare site lay just behind the solar NE limb at latitude 32N and was unseen from Earth. At Nowra the limb at the flare site showed no H-alpha flare transients, when the Sun became visible some 16h later.

When next viewed on May 31 at 23:00UT in WL a large mass of bright faculae was mapped at the presumed flare site: +35, ln170 (centre) and spread across some 6-8º longitude. A small bright surge on the limb at +40, 138 may have been related. Some 30º rotation of the site since the flare makes it likely that the faculae was the flare site. Bright plage persisted at the site over the next ~14days as it crossed the solar disc.

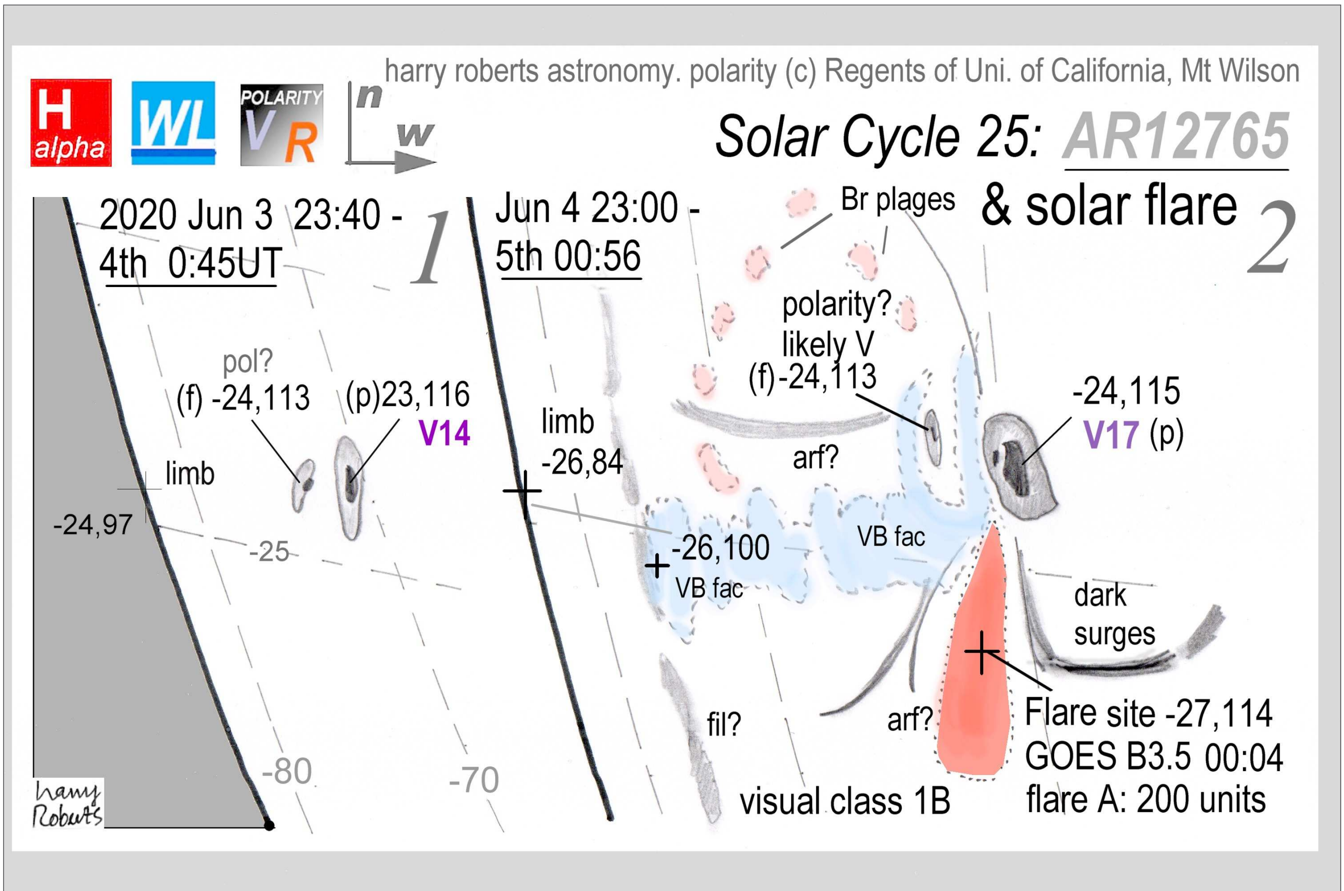
No spots were detected at the site in WL or by SDO instruments. The high latitude faculae and flare site mean it is a SC25 active site. The causes of the big flare remain unknown.

**GOES B3.5 flare.** The big flare was still in mind when a small SC25 spot-group appeared at the SE limb on Jun 3 at 23:00UT, some 18º onto the solar disc. The group, dubbed AR12765 (Fig 1) had two penumbral spots separated by 3º and sited at -23, ln115. Cloud prevented any H-alpha log.

Next day (Jun 4-5) was clear and WL showed the two spots had an Area of ~120units. An unusually long 'tail' of faculae followed the two spots, stretching 15º of longitude toward the limb at 30º east. This was a rare sight, suggesting that a huge active region had earlier occupied the site. Yet no smaller (f) spots were seen despite good seeing. H-alpha began at 23:30.

Strong activity was soon obvious in this band. Many active region filaments (arf) clustered around the two spots as well as one or more active surges that could be seen by 'tuning' the H-alpha filters – indicating rapid motions. In H-alpha filaments were seen to accompany the 15º 'tail' of faculae. Much activity was logged: all suggesting imminent flares.

While logging these transients, at 23:50, a very dark surge south of the (p) spot was seen to herald a bright solar flare GOES B3.5 at 00:0 near the site (Fig2). The log showed a flare area of 200 standard units, making it (just) a B1 Visual Class event with the peak



at 00:04.

**Polarity.** As the B3.5 erupted the AR had a field in the (p) spot of 1700 Gauss violet polarity. The field in the small (f) spot was not noted by Mt Wilson. However, by June 7-8 AR12765 had a few more spots (Fig3), two of (p) polarity like the main spot and a few 3º east of (f) polarity (i.e. red) a total of 7 spots in the eyepiece. Clearly some new flux had emerged over 48 hours.

**Big filament.** Together with the now more complex spot group a very long arf ran E from the main (p) spot, past the three or so (f) spots, to a point at -25,108 (6º behind the main spot) where it made a right-angle bend southward a further ten degrees; an unusual sight.

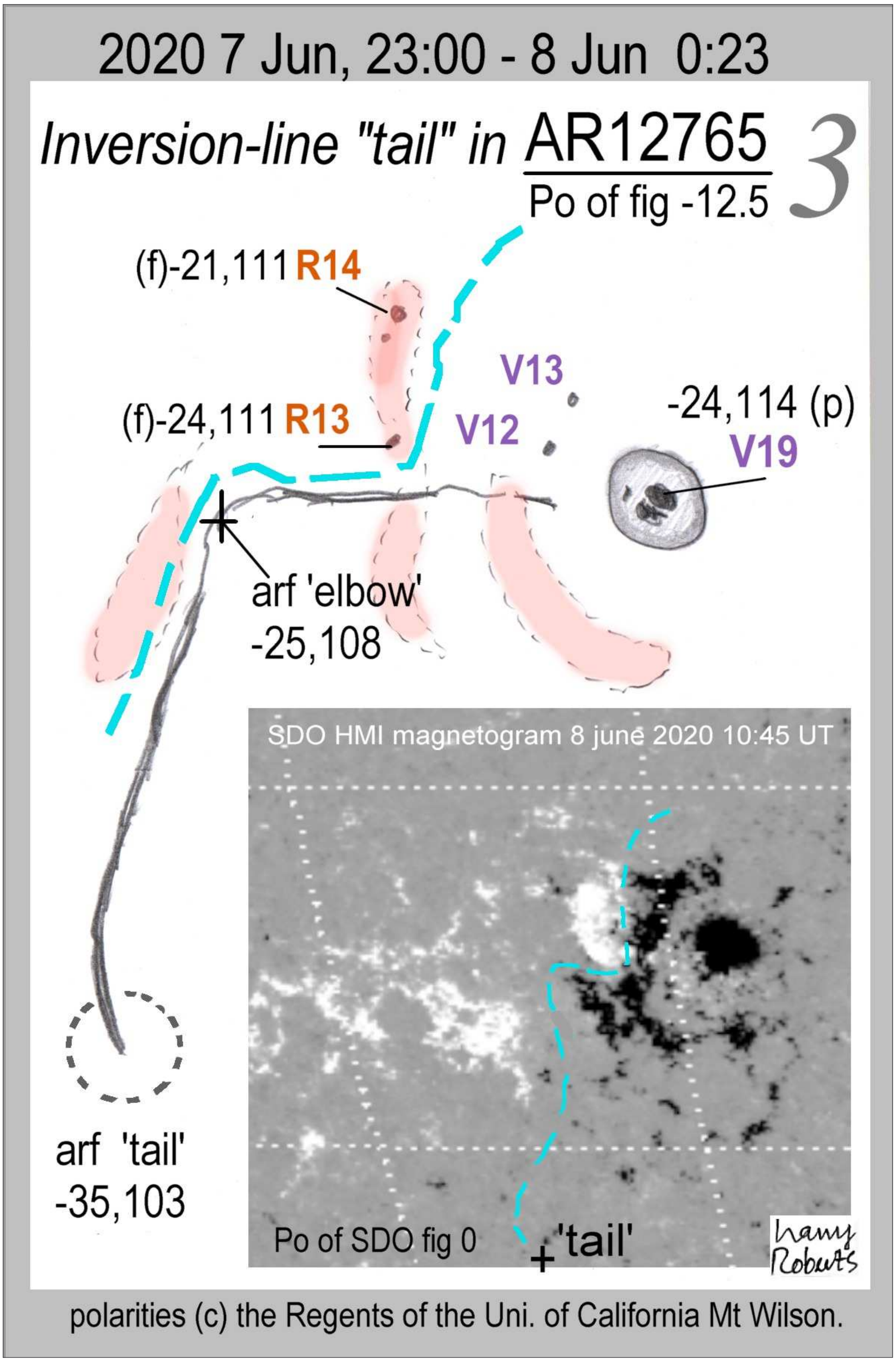
The last time flares of this kind occurred was in mid 2019, in active regions of SC 24. The two events related here (GOES M1 and B3.5) were both new cycle SC25 events.

**Flux emergence.** The 'footprint' of the group's field is shown in Fig3 (below, SDO, HMI. Note Po for HMI is 12.5º dif. to the sketch). The HMI shows (p) field BLACK and (f) WHITE. We presume this field had just got stronger (e.g. new spots) and that the big filament followed the 'Inversion line' between regions of opposite magnetic sign. Note that complex inversion lines (IL) are a requisite for strong flares. These IL lines are drawn in blue Fig 3 and show the polarity difference between (p) and (f) spots and plages.

**To conclude.** Perhaps this explains the recent flares: as new Cycle flux emerges – it may not yet be so well collimated at the early stages of SC25 – and may explain the rather weak but very extensive current fields. The HMI image shows only weak ±100 gauss field, not the field needed for spots to form (±1000G) or big spots to host flares (±2-3000G)! The Mt Wilson fields are noted as V19, meaning 1900G, and are close to what we need for big solar flares.

Enjoy the Sun.

**Harry Roberts**



# Solar Observations

**by Monty Leventhal OAM**

**May 2020 Solar Report**

No Sunspot activity was seen on the Sun the month of May.

On the 2nd May a mound type Prominence was observed on the SE limb reaching a height of 56,000 kilometres.

As the Sun rotated from east to west the Prominence became more apparent on the following day the 3rd reaching a height of 65,000 kilometres.

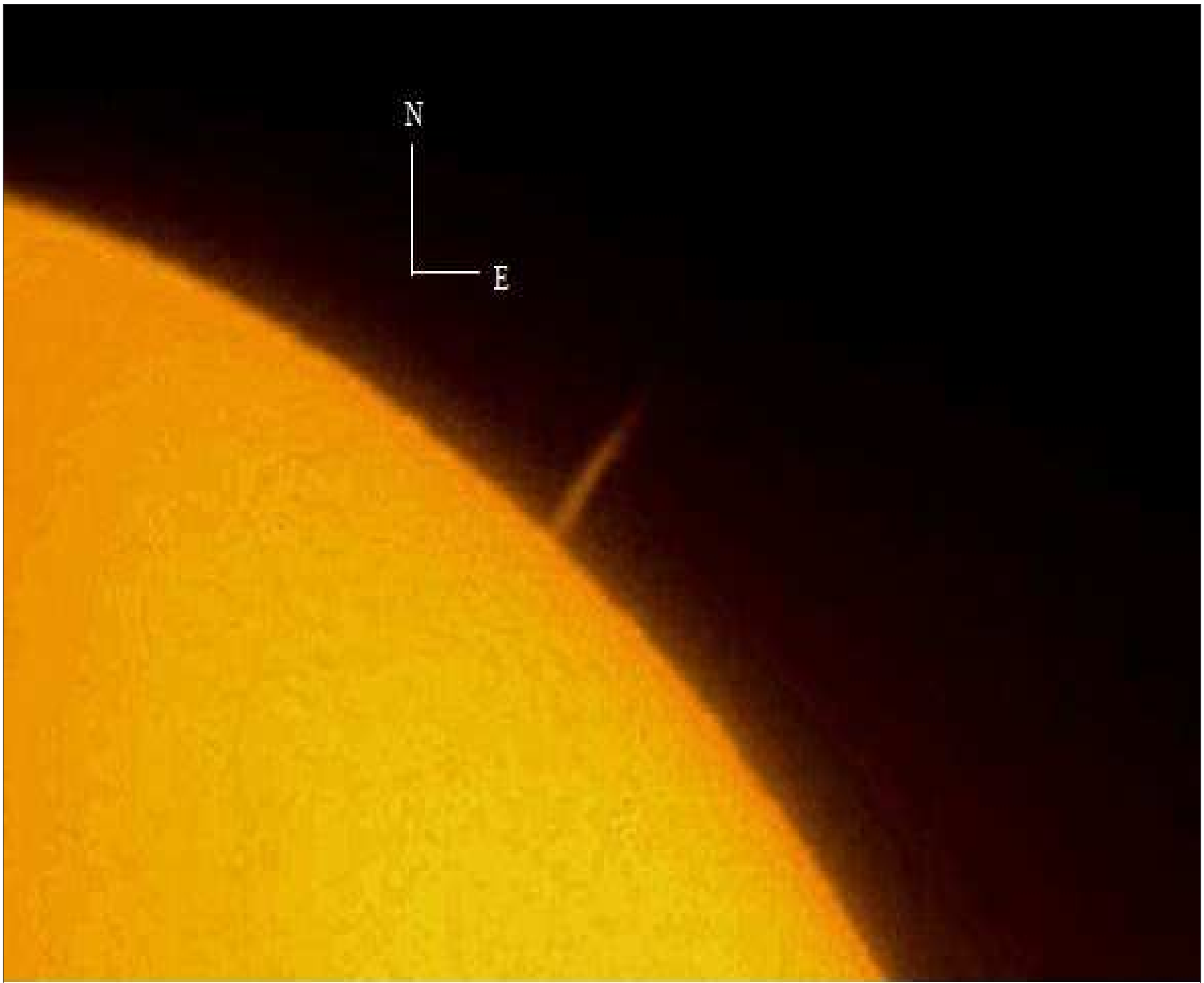
On the 4th May another single arched Prominence was seen on the NW limb and by the 5th it had grown to a height of 84,000 kilometres.

Until the 9th further Prominences remained very faint and small, on that day however a column type Prominence reached a height of about 130,000 kilometres.

The only other significant activity occurred on the 31st May when some slightly stronger Prominence activity appeared on the NW limb, the highest reaching about 84,000 kilometres.

No activity was seen on the Sun on 10th & 11th.

For the month of May a total of only 20 observations were made with the remaining 11 days being cloud covered or rain.




Digital filtergram. 23.05hrs UT 9th May 2020. Straight type Pillar Prominence, height approximately 130,000km. Exposure 1/5 sec. ASA 400. Conditions poor (4). Clear sky.
Monty Leventhal OAM.

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**SYDNEY CITY SKYWATCHERS, AUSTRALIA.**
**BRITISH ASTRONOMICAL ASSOCIATION**
**SOLAR OBSERVERS SOCIETY, POLAND**
**Lat. 33° 54'S – Long. 151° 15'E**

**E.A.S.T. DATE** **4th May 2020.** **TIME 09hrs 30mins.**

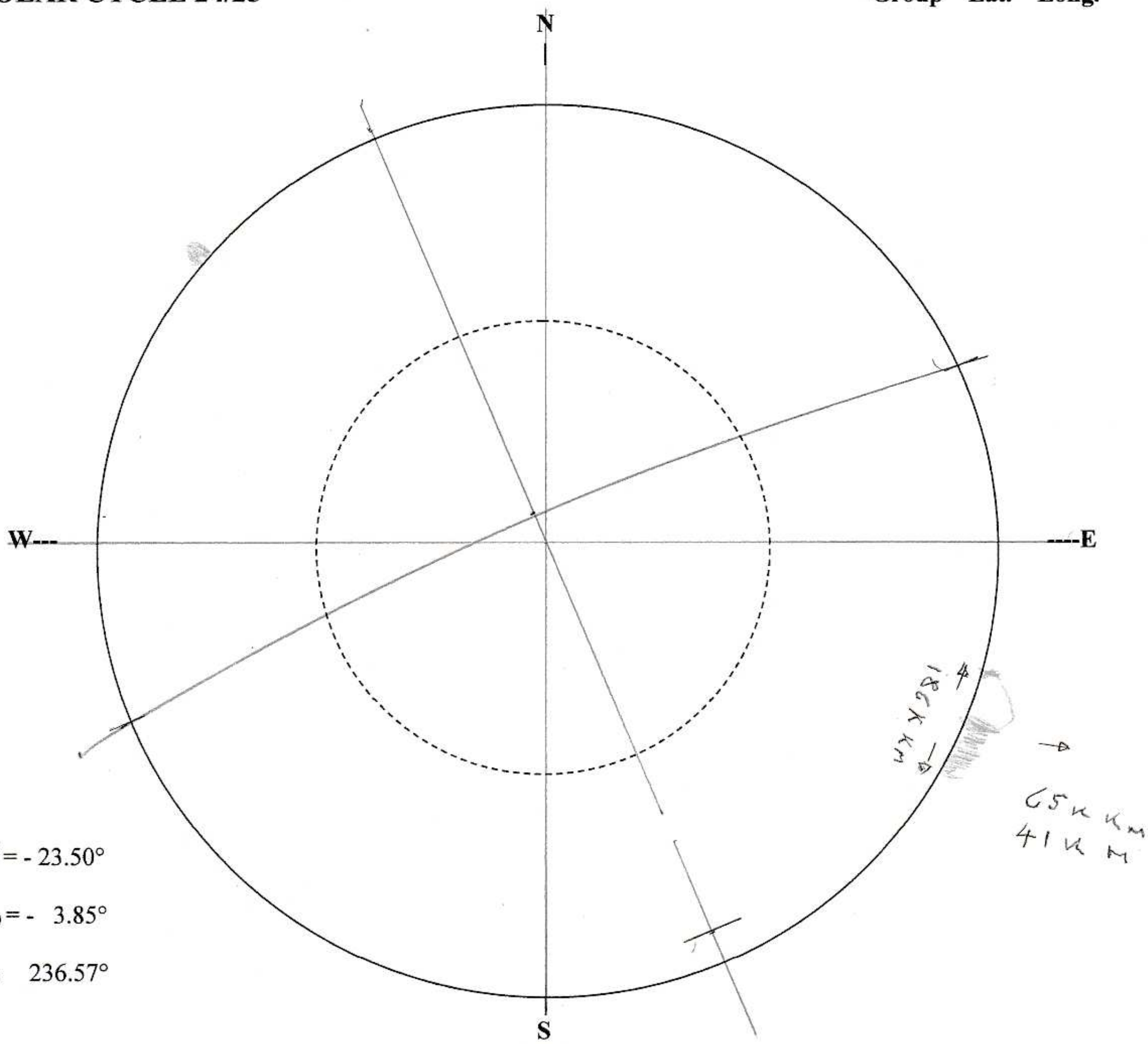
**U.T. DATE** **3rd May 2020.** **UT: 23hrs 30mins.**

**INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5**

**ROTATION No. 2230 (at 00.00hrs). Synodic Rotation No. 9 CONDITIONS (2) Good. WIND: W. 11 - 13km/h**

**TRANSPARENCY: (1) Very good. Clear sky. CURRENT TEMP.: 15°C. 59°F.**

**SOLAR CYCLE 24/25** **Group Lat. Long.**




$P^0$ = - 23.50°

$B_0$ = - 3.85°

$L_0$ 236.57°

Sun: 1,392,000 km. dia.
Earth: 12,713 km. dia. Average distance to the Sun 150,000,000 km
→●←

NOTES: ***Region Nos. above Group Nos. for year – month in brackets above groups.***
Flares: 0 Prominence's: 2 Filaments: 0 Faculæ: 0 Plage: 0 Surges: 0 Active areas incl.: 2
Total Sunspot groups: 0 Total single Sunspots: 0 Total Sunspots: 0 R = 0 C.M.E: 0 Total C.V: = 0
Sun limb in slight motion. Total Q. CV: = 0
***www.sydneycityskywatchers.org*** NAME: **Monty Leventhal OAM**
**= Plage.** **= Faculæ** **= Flare** **Supported by the Donovan Astronomical Trust.**

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**SOLAR OBSERVERS SOCIETY, POLAND**
**Lat. 33° 54'S – Long. 151° 15'E**

**E.A.S.T. DATE 6th May 2020. TIME 08hrs 50mins.**

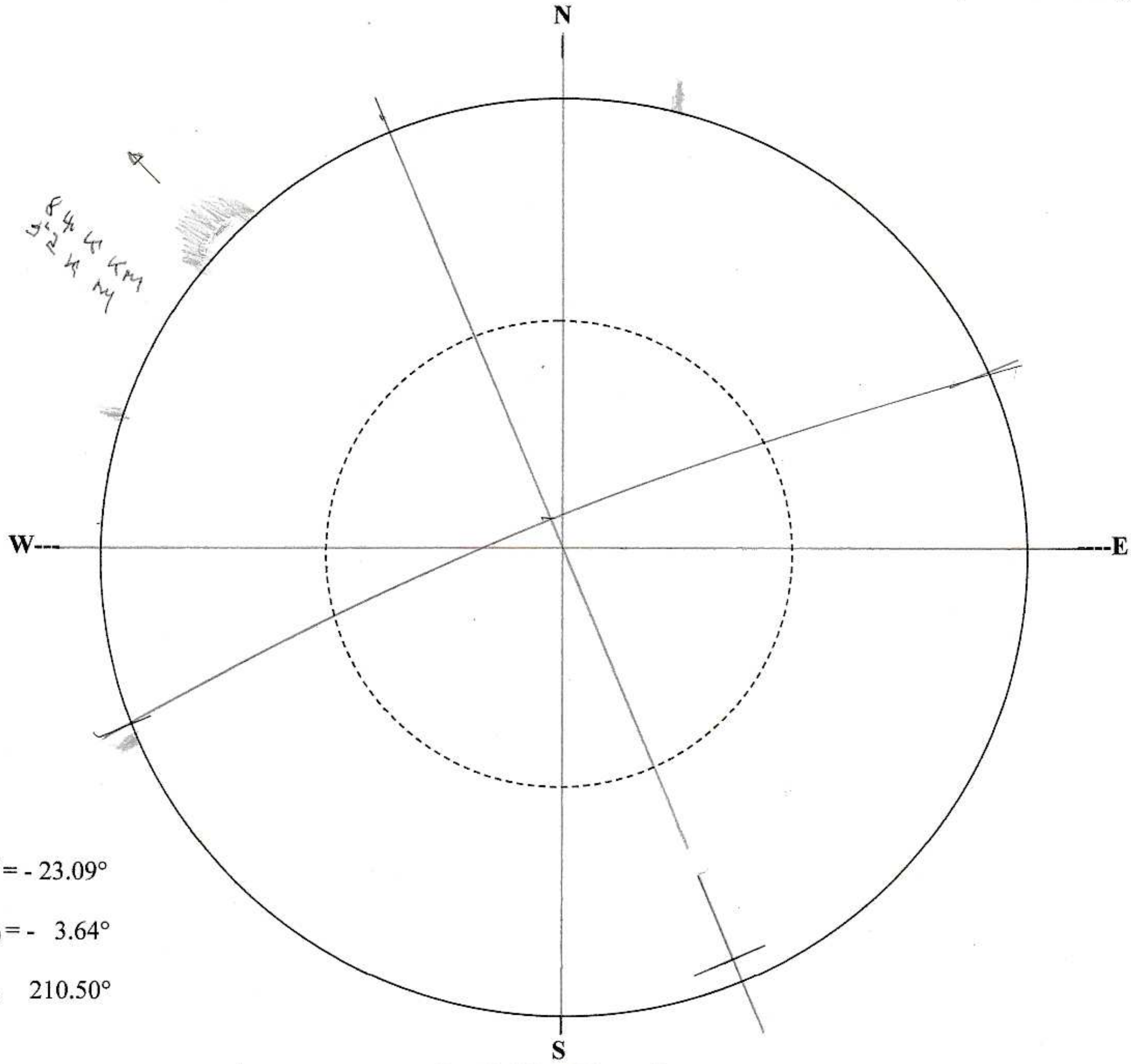
**U.T. DATE 5th May 2020. UT: 22hrs 50mins.**

**INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5**

**ROTATION No. 2230 (at 00.00hrs). Synodic Rotation No. 11 CONDITIONS (2) Good. WIND: NW. 14 - 17km/h**

**TRANSPARENCY: (2) Good. Clear sky. CURRENT TEMP.: 16°C. 61°F.**

**SOLAR CYCLE 24/25** **Group Lat. Long.**




$P^0$ = - 23.09°

$B_0$ = - 3.64°

$L_0$ 210.50°

Sun: 1,392,000 km. dia.
Earth: 12,713 km. dia. Average distance to the Sun 150,000,000 km
→•←

NOTES: ***Region Nos. above Group Nos. for year – month in brackets above groups.***
Flares: 0 Prominence's: 4 Filaments: 0 Faculæ: 0 Plage: 0 Surges: 0 Active areas incl.: 4
Total Sunspot groups: 0 Total single Sunspots: 0 Total Sunspots: 0 R = 0 C.M.E: 0 Total C.V: = 0
Sun limb in slight motion. Total Q. CV: = 0

***www.sydneycityskywatchers.org*** **NAME: Monty Leventhal OAM**

= Plage. = Faculæ = Flare **Supported by the Donovan Astronomical Trust.**

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**Lat. 33° 54'S – Long. 151° 15'E**

**E.A.S.T. DATE** **10th May 2020.** **TIME 09hrs 05mins.**

**U.T. DATE** **9th May 2020.** **UT: 23hrs 05mins.**

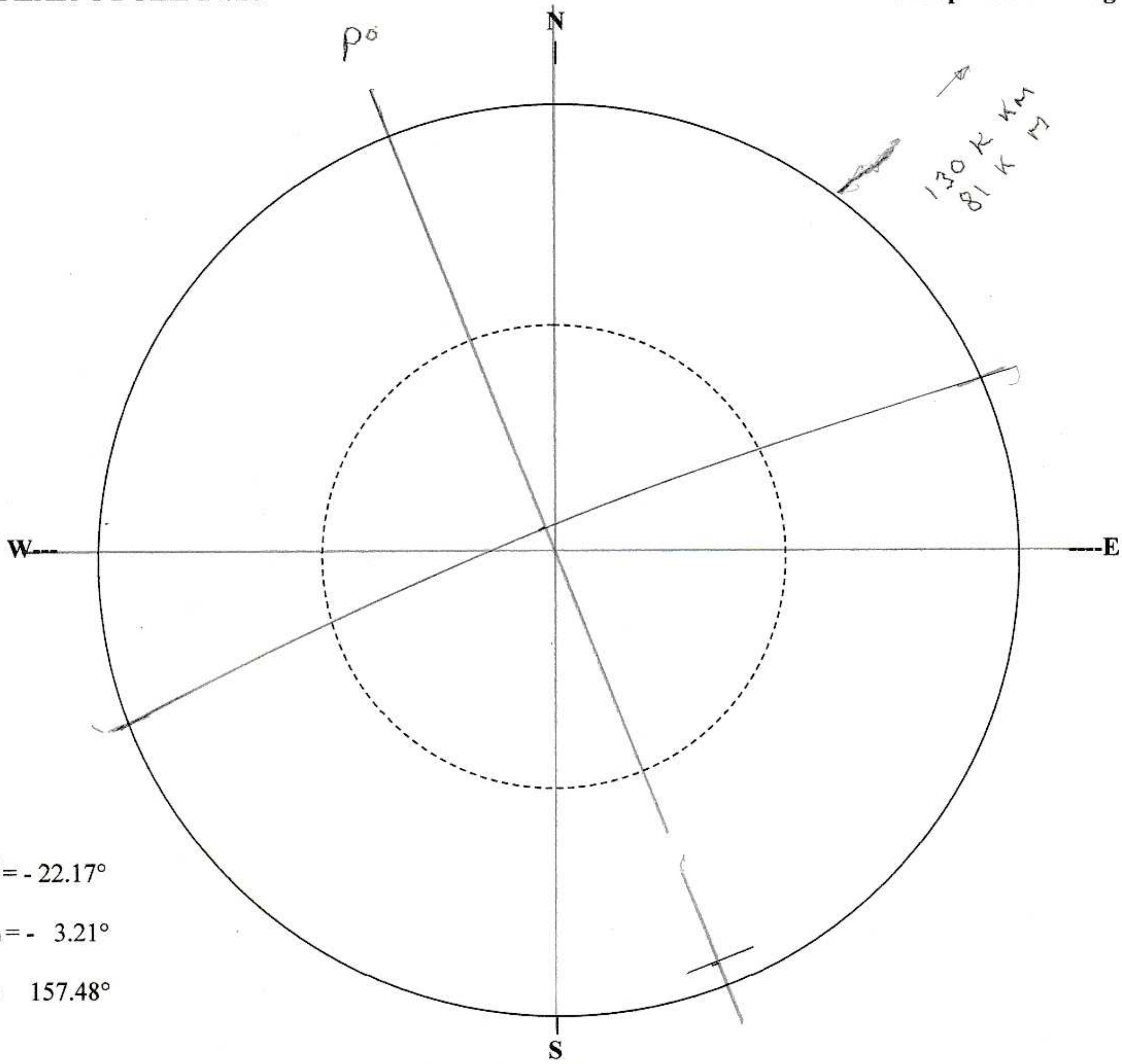
**INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5**

**ROTATION No. 2230 (at 00.00hrs). Synodic Rotation No. 15 CONDITIONS (4) Poor. WIND: SW. 31 - 33km/h**

**TRANSPARENCY: (1) Very Good, clear sky. CURRENT TEMP.: 14°C. 57°F.**

## SOLAR CYCLE 24/25

**Group Lat. Long.**




$P^0 = -22.17°$

$B_0 = -\ 3.21°$

$L_0$ 157.48°

Sun: 1,392,000 km. dia.
Earth: 12,713 km. dia. Average distance to the Sun 150,000,000 km
→●←

NOTES: ***Region Nos. above Group Nos. for year – month in brackets above groups.***
Flares: 0 Prominence's: 1 Filaments: 0 Faculæ: 0 Plage: 0 Surges: 0 Active areas incl.: 1
Total Sunspot groups: 0 Total single Sunspots: 0 Total Sunspots: 0 R = 0 C.M.E: 0 Total C.V: = 0
Sun limb in medium to strong motion. Total Q. CV: = 0

***www.sydneycityskywatchers.org*** NAME: **Monty Leventhal OAM**

**= Plage.** **= Faculæ** **= Flare** **Supported by the Donovan Astronomical Trust.**

## Eta Carina: Central Region

Describe it! It looks like some luminous 'thing' from the abyssal zone? It fills five fields of the 9mm eyepiece – each field unique! The Eta Carina Nebula, NGC3372, is a huge southern nebula. A sketch may be worth a thousand words- but more than that is needed for even a brief account. Sketch? Viewed first in a 4inch reflector in 1963, a sketch was planned- but the detail was daunting! At last, lockdown lent the impetus; but where to begin?

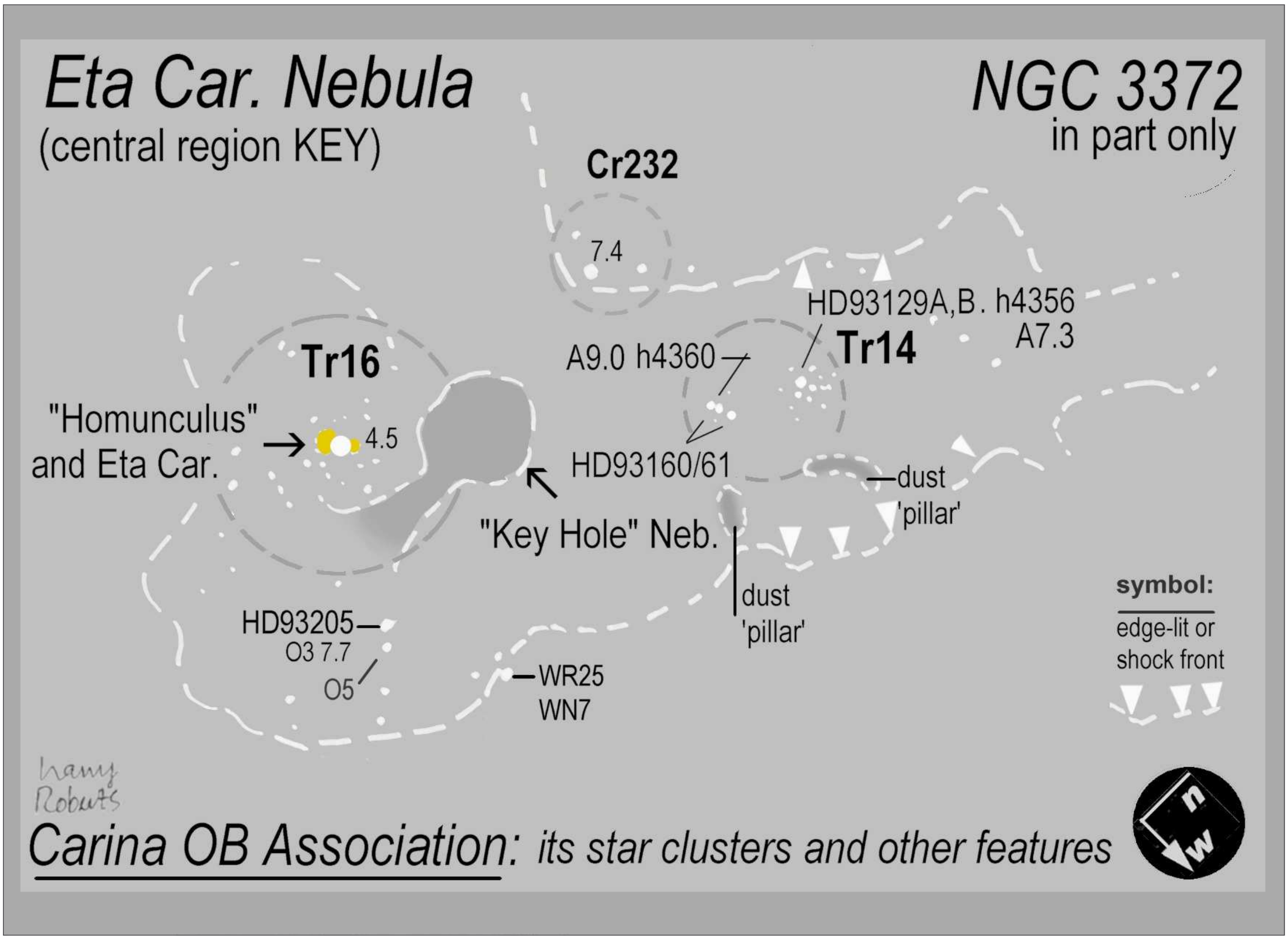
The Central Region. A sketch of the entire Eta-Car nebula (to the resolution of the ten inch 'scope) is impractical. Since the central Carina OB Association is hedged-in by surrounding dark nebulae, this Central Region is our subject; just one fifth of the whole Nebula! It happens that this is where the major stars and features of the Nebula are mostly sited (Key Map, below). The Region is ~40ly across and 20ly wide.

An old C8 photo was used to make a grid of the brighter stars – and that, at the eyepiece, allowed the visible nebulae to be mapped as well as hundreds of fainter stars over several nights. The nebula could then be toned in pastel and the visible stars added. The big challenge with Eta Car is its distance, some 8,000ly. Most well-known nebulae are much closer and stars in them are bigger. A mapping pen and white ink was needed for the myriad faint stars.

This nebula is many times the size of the Orion Nebula M42, and is rather fainter. The brightest star in the focus is Eta Car itself at ~4.5mag and brightening! We will discuss its stellar properties in a separate piece as it is a unique star. Eta is the brightest member of star cluster Trumpler 16 and, amazingly, lies itself inside the tiny orange coloured emission nebula dubbed the "Homunculus". This tiny nebula is exaggerated in the sketch because although easy in the e.p, bright Eta tends to hide him, as do full-field photos.

Tr16. Recent work on Eta Car and the Trumpler clusters have expanded the historic size of Tr16 to include even some stars of cluster Tr14, 20 light-years to the NW. We will keep the 19thC usage here for these two clusters as a useful guide in the Key Map. Thus, all the many stars, some in chains, left (SE) of the dark "Keyhole" as well as those below (SW) including the HD 93204/205 pair are Tr16 stars. Many we can see are super-giants.

Tr14. At first glance this seems a faint open cluster, yet it is strangely luminous and is the brightest part of the whole field. Go to the exotic triple HD93161/60




and, at the edge of your focus, a hundred or so tiny stars light-up in the Tr14 cluster! With a direct view they are hard to see in a 10in. Bigger 'scopes will better show them. The background to Tr14 is so rich it looks like a rather sparse globular cluster.

Stars of Tr14. Brightest is HD93129A, a name that strikes awe into astrophysicists. It's among the brightest stars known! Some sources give it a brightness of 3+ million times solar and a mass 120 times solar! As a double it is h4356 (J. Herschel) and primary A is type O2If. Visually it's 7.3mg. Companion B, 2.8arcsec away, is type O3.5. These are the brightest of the Tr14 cluster stars and the companion is easy to see. "Similar stars" says Kaler "are seen in the Tarantula Neb in the LMC" (ref "Stars and their Spectra", p204). Tr14 has an extensive reflection nebula like the Pleiades, giving the cluster a faint blue tinge.

HD93160/61. This is the bright pair (a triple really) at the SE edge of Tr 14. Again, like the Homunculus, the 2 arcsec separation of the HD93161 pair is exaggerated in the sketch, though it is a tight 2arcsec double in the e.p; both are ~ mag9. This pair are also megastars of spectral types O8 and O6.5.

Trunks or Pillars. Dark structures are often present in cooler parts of emission nebulae and Central Eta Car has several. In this context we also see edge-lit margins to denser molecular clouds. Some are shock-fronts where high-velocity stellar winds impact such clouds. We see this in Eta Car above and below Tr14 (Key: white arrows). Likely the mega starHD93129A in this cluster causes the brighter edge to the molecular clouds SW of the cluster and also excites a bright shock-front NE of it. In the intense stellar winds of this star two dark 'pillars' or 'trunks' are seen – presumably denser dusty structures in the process of disintegration. A fainter one lays N of Tr14. As HD93129 is only a million years old, these are all young structures.

Keyhole. At the SE end of the Nebula we see the Daddy of all dark dust clouds, the Keyhole Nebula. This name is attributed (wrongly?) to John Herschel whose sketch of the 'thing' so much looks like a keyhole. Yet today the dark structure is not as dark as it seemingly was in 1837? Why? When John Herschel took "Dad's" 18inch reflector to the Cape of Good Hope 1834-8, he spent some time sketching the Eta Car Neb. At the time Eta was very much brighter ,~1$^{st}$ mag 1843. His sketch of the Keyhole is cited today as evidence of major changes in that dark nebula due to nova-like outbursts of star Eta Car.

As Hartung puts it: "On a clear dark night the region is beautiful beyond description, even for small apertures". It is indeed a cosmic treasure chest!

**Harry Roberts**

## Southern Moretus: Guide To The South Polar Regions

Moon sketching is a great way to unravel the complexity we find in the informally named lunar southern highlands - the region in the Moon's south where there are few distinct features, and a confusion of overlapping craters. Here, identifying individual craters can be a challenge, and learning to recognise any distinct formations can be the key – and large (115km), deep (5km) Moretus is one of these.

Moretus is an Eratosthenian Era crater, i.e. its age is between 3.2 to 1.1 billion years old. It always looks the freshest of the big craters in its neighbourhood – and having a tall pyramidal central peak helps to identify it.

On the 6th the sky was clearing and the seeing wasn't too rough: the morning terminator stood only 5º degrees west (left in the Fig) from the central peak of Moretus. It was a dramatic scene, with the crater and its neighbours almost filled with shadow – but the western walls of Moretus were lit by the rising Sun and showed remarkable detail. It's clear that younger Moretus is superimposed over its neighbours –Pre-Nectarian craters Short, Greumburger and Cysatus, all over 4 billion years old.

A well-lit narrow scarp marked the SW top of Moretus' rim, with bright bead-like patches strung along it. At the foot of this scarp were several thin parallel terraces mostly in shade, and below these terraces were large slump blocks and scree slopes. Radial grey "valleys" seemed to divide the screes into units. (Note: Moretus is drawn in a "look down from above" orientation).

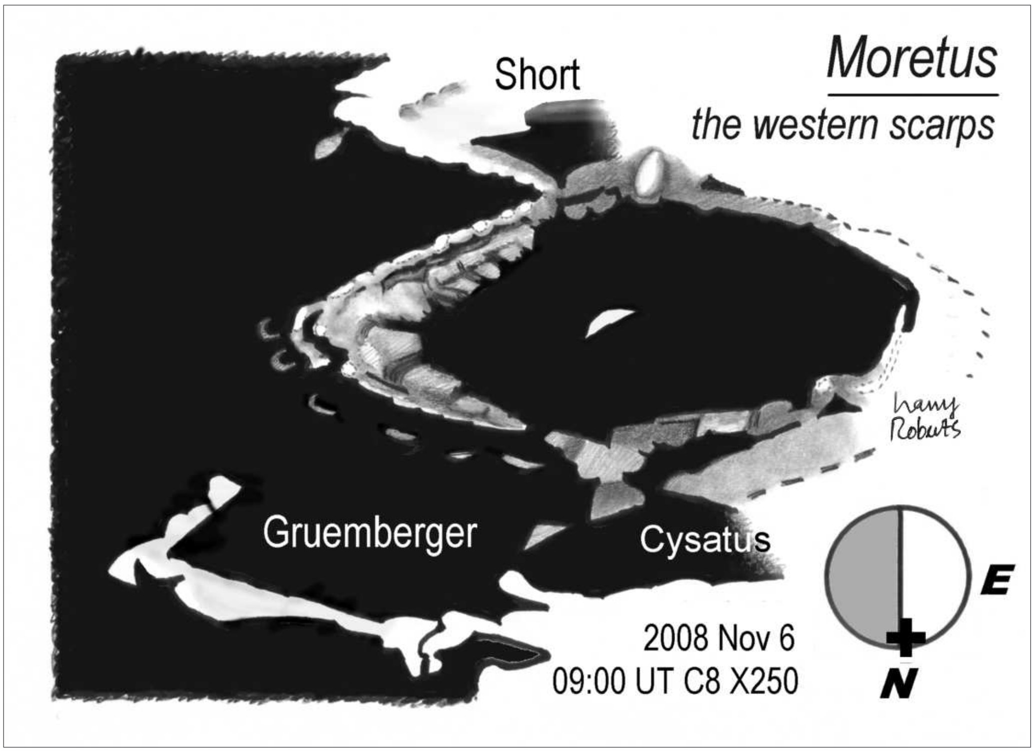
The western rim of Moretus is unusual and seems not to follow a regular circular geometry. Perhaps this is because rotational collapse of the crater wall ate its way further back into the crater's rim – an effect often seen in craters neaer the Moon's centre – that results in scallop-shaped bites in a round rim. In Moretus the effect results in an outward bulge in the crater's west rim. A much larger slippage block can be seen here with deep shadow between the top scarp and the lower block. Also several bits of dimly lit terrace beyond the main rim showed faintly.

Also on the west rim a deep trench-like valley stretched from the crater's shadow-filled interior half way up the slope. It looked dark and parallel-sided. This feature was interpreted as a shadowed secondary crater in Harold Hill's "Portfolio of Lunar Drawings", but Lunar Orbiter images show no craters inside Moretus. Indeed Hill also interprets the "beads" and wavy terraces on the SW rim (see above) as a string of small craters – a catena – but this was also not seen. The dark "trench" may actually be the shadow of the 2.7km high central peak cast on the western slopes 40km away – or it may be a deep rift between adjoining slump blocks.

Only partly lit, the central peak showed no detail– and the vent known to exist at the summit was unseen. This vent led to many TLP sightings in Moretus in the 1950's, and Hill made many drawings of it (Ibid. p123-124). Hill's "Portfolio" is a wonderful resource but only available now in paperbound edition with very poor reproductions of his drawings.

Enjoy moon watching.

**Harry Roberts**



# Sydney City Skywatchers

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## Sydney City Skywatchers Club Meetings

**Ordinary Meeting:** 6:30 pm, 1st Monday of each month, Sydney Observatory**.**

**Committee Meeting:** 6:00 pm, 3rd Monday of each month, Sydney Observatory

## Membership Fees

**$40.00 Individual**

**$20.00 Family/Junior/Concession**

Everyone is invited to submit articles, reports and photos of astronomical interest.

Items should be about 500 to 1000 words (plain text format if on CD/email).

Diagrams must be in black ink.

Contributors wishing their work returned must supply a S.A.S.E. for hardcopy submissions.

Your feedback about The Astronomers' Bulletin is needed and appreciated.

Members may submit advertisements (For sale, Wanted, etc approx 5 lines) free of charge, which will be published for 3 issues unless withdrawn or renewed.