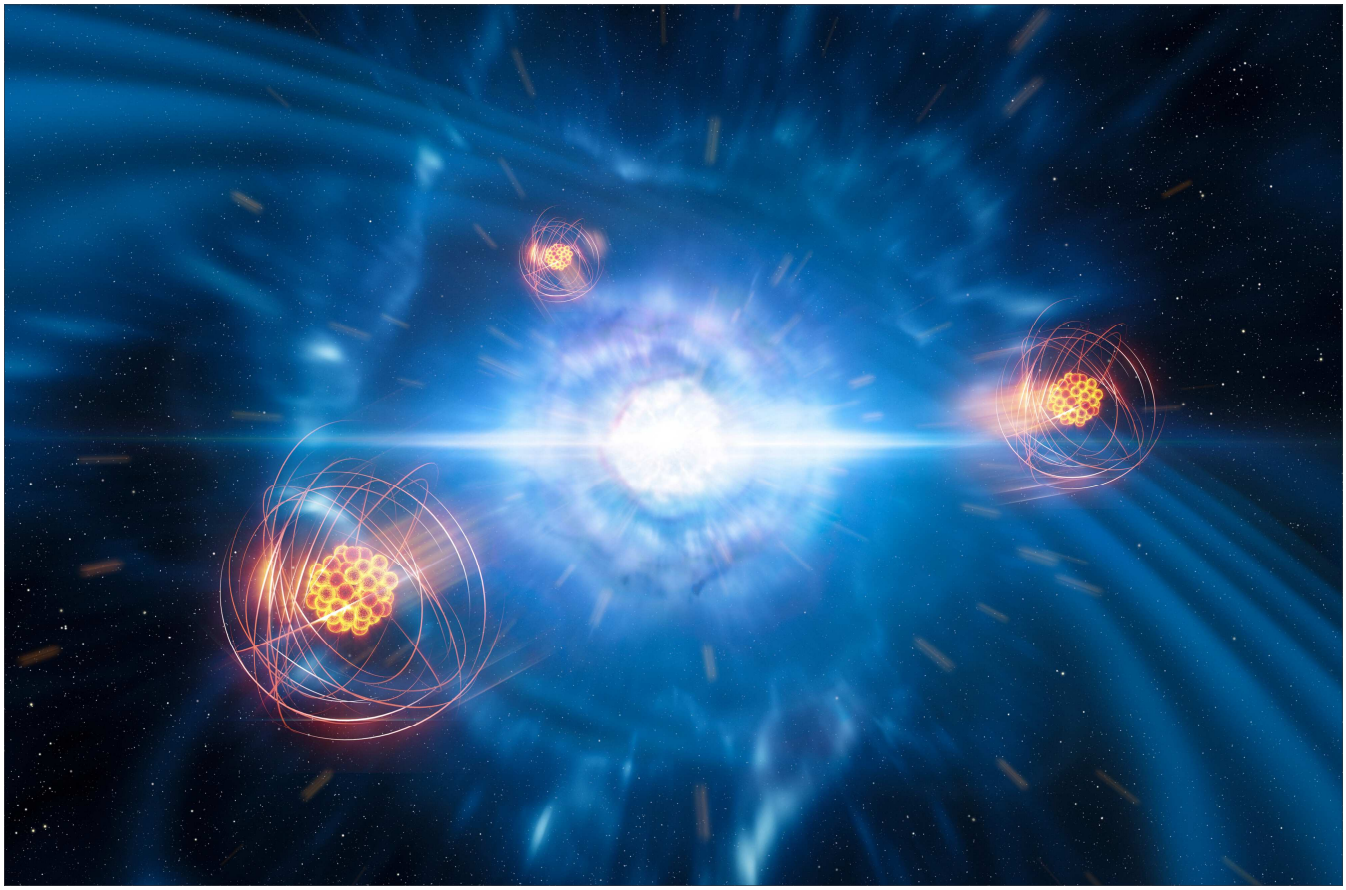
# The Astronomers' Bulletin

**Newsletter of the Sydney City Skywatchers** **Volume 10, Issue 9 Jan/Mar 2020**

## First Identification of Strontium in Space



For the first time, a freshly made heavy element, strontium, has been detected in space, in the aftermath of a merger of two neutron stars. This finding was observed by ESO's X-shooter spectrograph on the Very Large Telescope. The detection confirms that the heavier elements in the Universe can form in neutron star mergers, providing a missing piece of the puzzle of chemical element formation.

In 2017, following the detection of gravitational waves passing the Earth, ESO pointed its telescopes in Chile, including the VLT, to the source: a neutron star merger named GW170817. Astronomers suspected that, if heavier elements did form in neutron star collisions, signatures of those elements could be detected in kilonovae, the explosive aftermaths of these mergers. This is what a team of European researchers has now done, using data from the X-shooter instrument on ESO's VLT.

Following the GW170817 merger, ESO's fleet of telescopes began monitoring the emerging kilonova explosion over a wide range of wavelengths. X-shooter in particular took a series of spectra from the ultraviolet to the near infrared. Initial analysis of these spectra suggested the presence of heavy elements in the kilonova, but astronomers could not pinpoint individual elements until now.

"By reanalysing the 2017 data from the merger, we have now identified the signature of one heavy element in this fireball, strontium, proving that the collision of neutron stars creates this element in the Universe," says Darach Watson (University of

**In This Issue**

Copenhagen). On Earth, strontium is found naturally in the soil and is concentrated in certain minerals. Its salts are used to give fireworks a brilliant red colour.

Astronomers have known the physical processes that create the elements since the 1950s. Over following decades they uncovered the cosmic sites of each of these major nuclear forges, except one. "This is the final stage of a long chase to pin down the origin of the elements," says Watson. "We know now that the processes that created the elements happened mostly in ordinary stars, in supernova explosions, or in the outer layers of old stars. But, until now, we didn't know the location of the final, undiscovered process, known as rapid neutron capture, that created the heavier elements in the periodic table."

Rapid neutron capture is a process in which an atomic nucleus captures neutrons quickly enough to allow very heavy elements to be created. Although many elements are produced in the cores of stars, creating elements heavier than iron, such as strontium, requires even hotter environments with lots of free neutrons. Rapid neutron capture only occurs naturally in extreme environments where atoms are bombarded by vast numbers of neutrons.

"This is the first time that we can directly associate newly created material formed via neutron capture with a neutron star merger, confirming that neutron stars are made of neutrons and tying the long-debated rapid neutron capture process to such mergers," says Camilla Hansen from the Max Planck Institute for Astronomy.

Scientists are only now starting to better understand neutron star mergers and kilonovae. Because of the limited understanding of these new phenomena and other complexities in the spectra that the VLT's X-shooter took of the explosion, astronomers had not been able to identify individual elements until now. "We actually came up with the idea that we might be seeing strontium quite quickly after the event. However, showing that this was demonstrably the case turned out to be very difficult. This difficulty was due to our highly incomplete knowledge of the spectral appearance of the heavier elements in the periodic table," says researcher Jonatan Selsing.

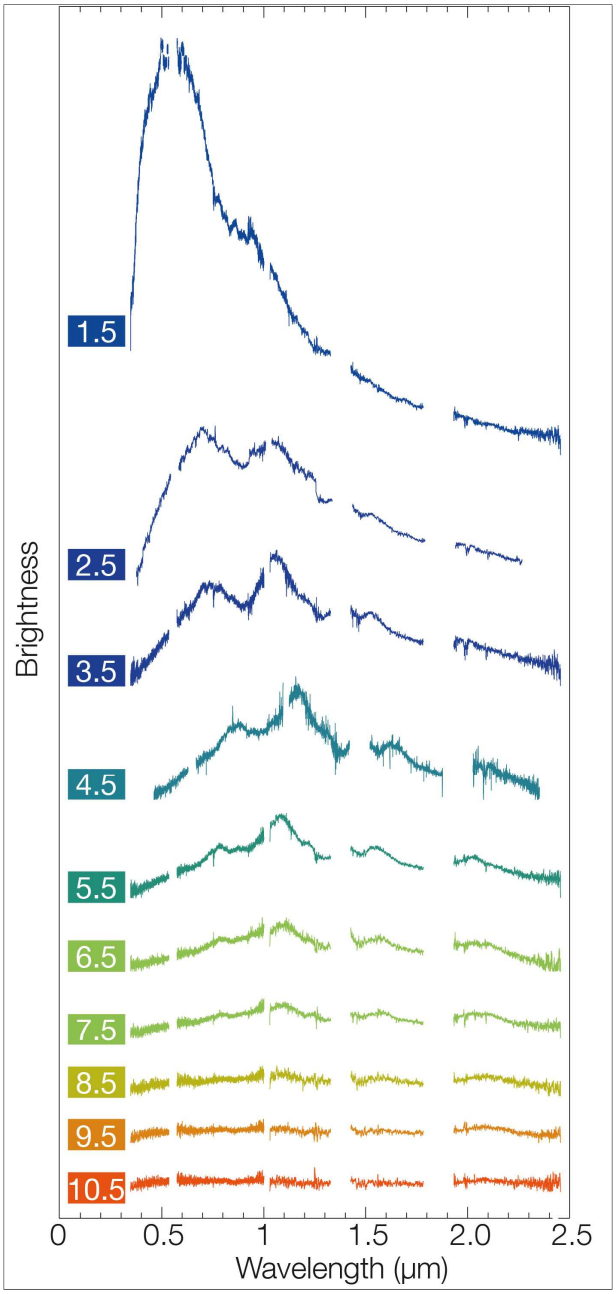
The GW170817 merger was the fifth detection of gravitational waves, made possible thanks to the NSF's Laser Interferometer Gravitational-Wave Observatory and the Virgo Interferometer in Italy. Located in the galaxy NGC 4993, the merger was the first, and so far the only, gravitational wave source to have its visible counterpart detected by telescopes on Earth. With the combined efforts of LIGO, Virgo and the VLT, we have the clearest understanding yet of the inner workings of neutron stars and their explosive mergers.

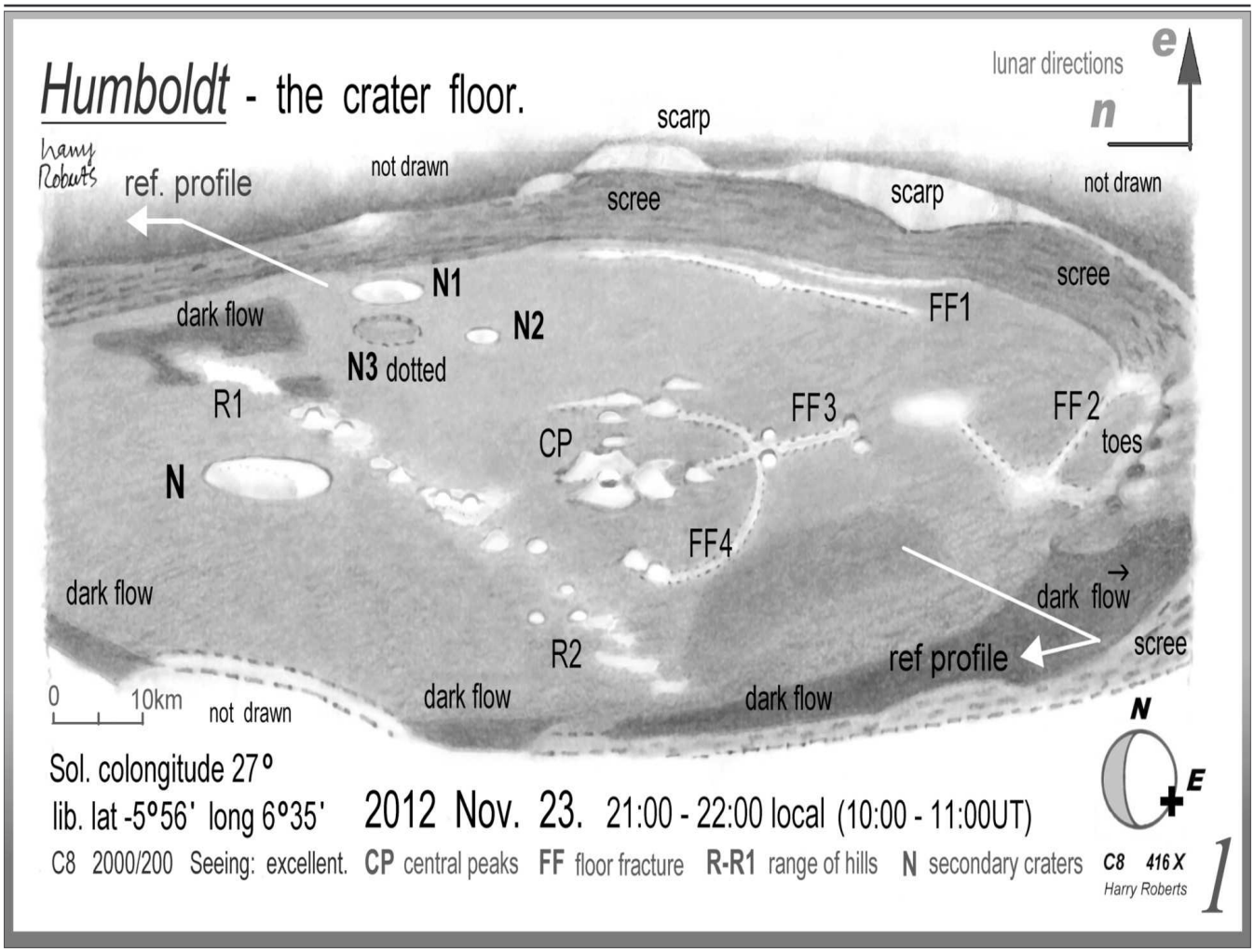
The image on page 1 is a artist's impression showing two tiny but very dense neutron stars at the point at which they merge and explode as a kilonova. In the foreground, we see a representation of freshly created strontium.

On this page is a montage of spectra taken using the X-shooter instrument on ESO's VLT, that shows the changing behaviour of the kilonova in the galaxy NGC 4993 over a period of 12 days after the explosion was detected on 17 August 2017. Each spectrum covers a range of wavelengths from the near-ultraviolet to the near-infrared and reveals how the object became dramatically redder as it faded.

**European Southern Observatory**
**October, 2019**

**Image Credit:**
**ESO/E. Pian et al./S. Smartt & ePESSTO/L. Calçada/M. Kornmesser**






# 'Hide and Seek': Crater Humboldt

The Moon is a fine example of a rocky planet – and one that is not being changed by on-going geological forces. Most lunar landforms date from the early days of our solar system: gaze at the Moon and you look far back in time. Let's examine an ancient and huge formation that would be famous, if only it was easier to see.

**Libration.** Our target, crater **Humboldt** (not the lunar sea named for his brother), is mostly hidden behind the lunar SE limb. While the Moon is always Earth-facing, the complex motions called libration allow us, at times, to see things normally behind the Moon's limbs. Humboldt, sited at longitude 80ºE, is a good example, and freeware, like "Virtual Moon", can show us when Humboldt is briefly visible.

Several logs of this crater have been made over the years– each adding a bit more of its topography, as did this sketch made in 2012: Humboldt is a long-term project (Fig1)! As well, we now have on-line models that add much to our understanding of lunar terrain (Fig2).

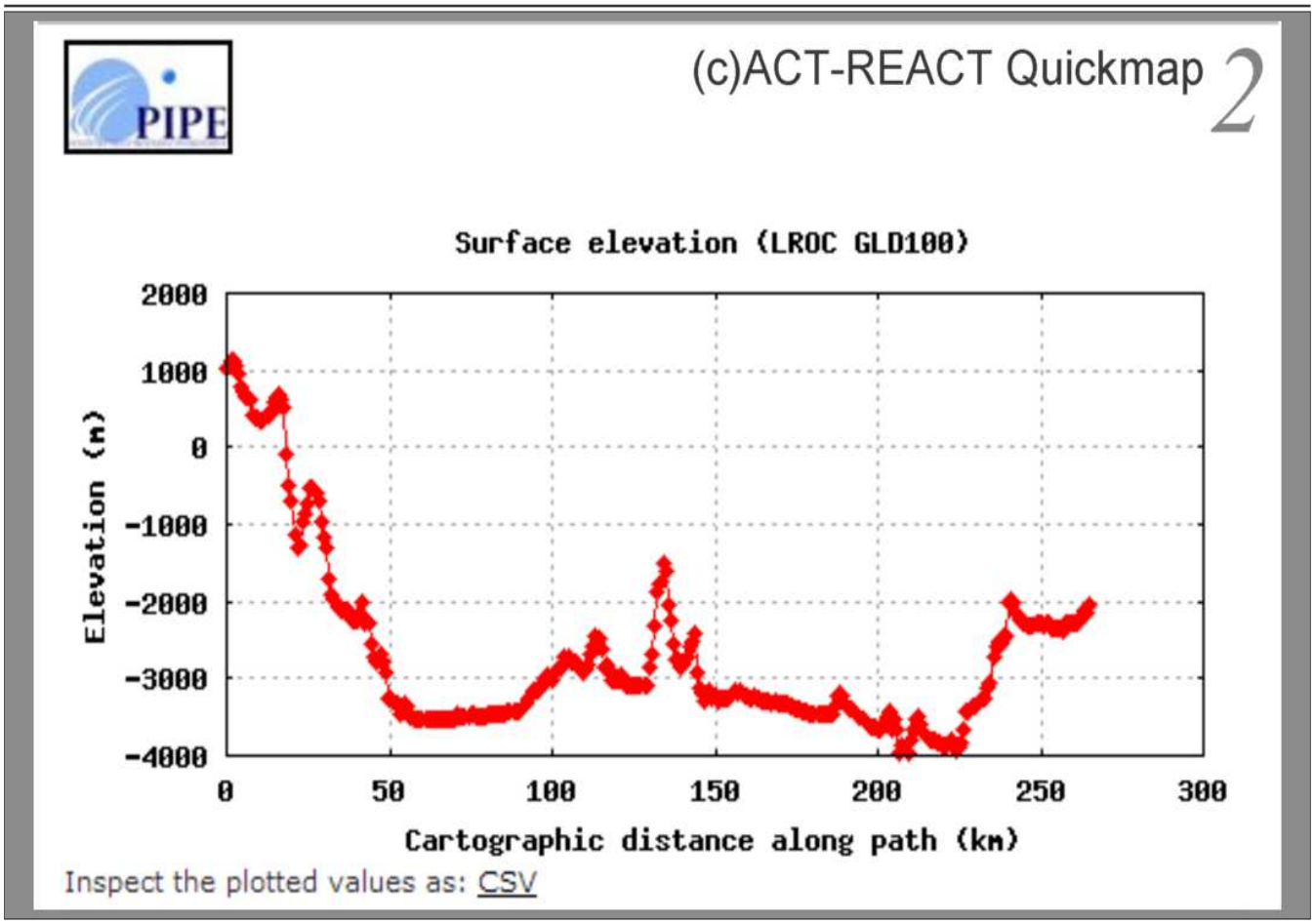
**Lighting:** The other big variable in viewing lunar features is the lighting: the altitude of the Sun at the site of interest. In our case the Sun was almost overhead at the site: giving a shadow-free low contrast view, with little detail apart from the albedo differences - not ideal conditions.

Still, the eyepiece showed a huge elongated crater – some 200km in diameter. Only the central parts were logged and details outside the crater's rim were not drawn, though there was much to see.

Within the crater large bright scarps towered above grey scree-slopes on the eastern crater wall: featureless but for faint striations – hinted at in the sketch. To the right, i.e. south side, the scree produced 'toes' where collapsed material met the crater floor.

The only shadow in the whole field was a dark speck in the central peaks (CP) like a vent atop one of them: a glimpse maybe of dark floor material between the rounded bright peaks.

**Floor fractures.** In the strong sunlight several white lines crossed the crater's floor – some radial to the central peaks, some concentric. These were a few of the well-known floor fractures, captioned FF. It's




thought they arose when a bulb of lunar volcanism formed below the big crater long after the initial impact, pushing up Humboldt's floor and causing both radial and concentric fractures, as are found in craters like Petavius and Gassendi.

The quikmap section (Fig2) shows the crater's floor is elevated near the CP. Humboldt is perhaps the Moon's best example of a floor-fracture crater. Several round bright patches were likely the haloes of unseen small fresh craters.

**R – R1.** A range of smaller peaks and unresolved bright craters stretched across the field from upper left the lower centre – what caused this feature? Surely they were not survivors of the initial Humboldt impact! Yet they looked much like the central peaks.

**Dark flows.** Most striking on the crater's grey floor are four very dark patches: lava flows that, it seems, emerged where the crater's floor meets the walls – in deep fractures – it's from these that the dark lavas have flowed. But in which epoch?

The dark flows would be contemporary with the uplift of the crater's floor (causing the fractures), so it seems the lava stayed put, in the lower areas around the crater's periphery: its uphill all the way to the crater's centre! The dark flows contrast starkly with the much older and lighter floor material.

**Craters.** There were just three secondary craters to be seen. Only one has an IAU number, Humboldt **N**, ~15km diameter. There are three others in the field but only two were seen. With no official numbers, they are captioned **N1** and **N2**: both are very bright and presumably fresh.

As well Humboldt contains a rare concentric crater – and consulting the texts etc. I see I missed it for an odd reason: it is dotted **N3** in the Fig. The three visible craters all have bright interiors – but lunar images show that the concentric crater does not have a bright interior, due to its double-ring form. I must look more closely next time!

Chuck Wood in LPOD 2014 Jan 7 says of it: "C*an you find it? I have never noticed it before in a terrestrial image…*" Let's be the first: you'll need a big telescope, high magnification and good seeing. The best of luck!

Humboldt is named for Wilhelm von H, brother of more well known Alexander von H. the explorer. This Humboldt was a German statesman and philologist.

**Harry Roberts**

# Solar Observations

**by Monty Leventhal OAM**

**September 2019 Solar Report**

Sunspot activity for the month of September remained extremely low however, on the 1st September two very small Bxi spots were observed in AR12748 and remained on the solar disc the following day as a single Axx spot.

No further Sunspots were seen on the Sun for the rest of the month.

**Prominences**. The most significant Prominences were on the 7th when a triple arched Prominence reached 65,000km in height, and 158,000km across the NW limb.

Another single arch Prominence on the 8th reached a height of 74,000km. On the 18th another double arch Prominence reached a height of 42,000km on the SE limb.

Finally on the 22nd another double arched Prominence reached a height of 65,000km on the NW limb.

Most other Prominences were small, faint and insignificant.

The Sun appeared to be void of Flares, Filaments, Faculæ and Surges throughout the month.

Due to bad weather no observations were made on the 11th 13th 15th 16th 17th 19th 20th 25th to 28th & 30th.

For the month of September a total of 18 observations were made with the remaining 12 days either cloud covered, rain or other reasons.

The total average classification value was 0.2 and the relevant total Sunspot number was 1.

# Solar Observations

**by Monty Leventhal OAM**

**October 2019 Solar Report**

Sunspot activity for the Sunspot activity on the Sun is now proving to be very rare as the Solar Cycle 24 is now at minimum.

Not one Sunspot was observed by me for the whole of the month. The only activity seen on the face of the Sun was a very small faint Filament seen on the first of October about 60° east and 10° south.

Prominences were a little more active though most were very faint due to the magnetic fields being so weak.

An active Prominence was observed on the 2nd on the NW limb and by the following day had reached a height of 47,000km.

No activity at all could be seen on the 6th.

The next significant Prominence was observed on the 11th when a double column Prominence was seen on the NE limb reaching a height of approximately 65,000km'

On the 12th the Sun was once again clear of all activity.

On the 13th an active single arched Prominence was seen on the NE limb and by the 14th it reached a height of about 56,000km.

Due to cloud cover no observation was made until the 16th when a mound type active Prominence was observed on the SE limb. Though this was quite faint a bright Surge appeared within it and lasted about 20 minutes.

The following day the same Prominence was still visible but on the NW limb another large mound type Prominence reached a height of about 65,000km.

For the rest of the month all activity remained extremely low

The Sun was clear of all activity on the 6th 12th 18th 20th 22nd & 23rd .

Due to bad weather no observations were made on the 4th 5th 7th 8th 10th 15th & 29th .

For the month of October a total of 24 observations were made with the remaining 7 days either cloud covered or rain.

The total average classification value was 0.0 and the relevant total Sunspot number was 0.

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

**E.A.S.T. DATE** 8th September 2019. **TIME 08hrs 40mins.**

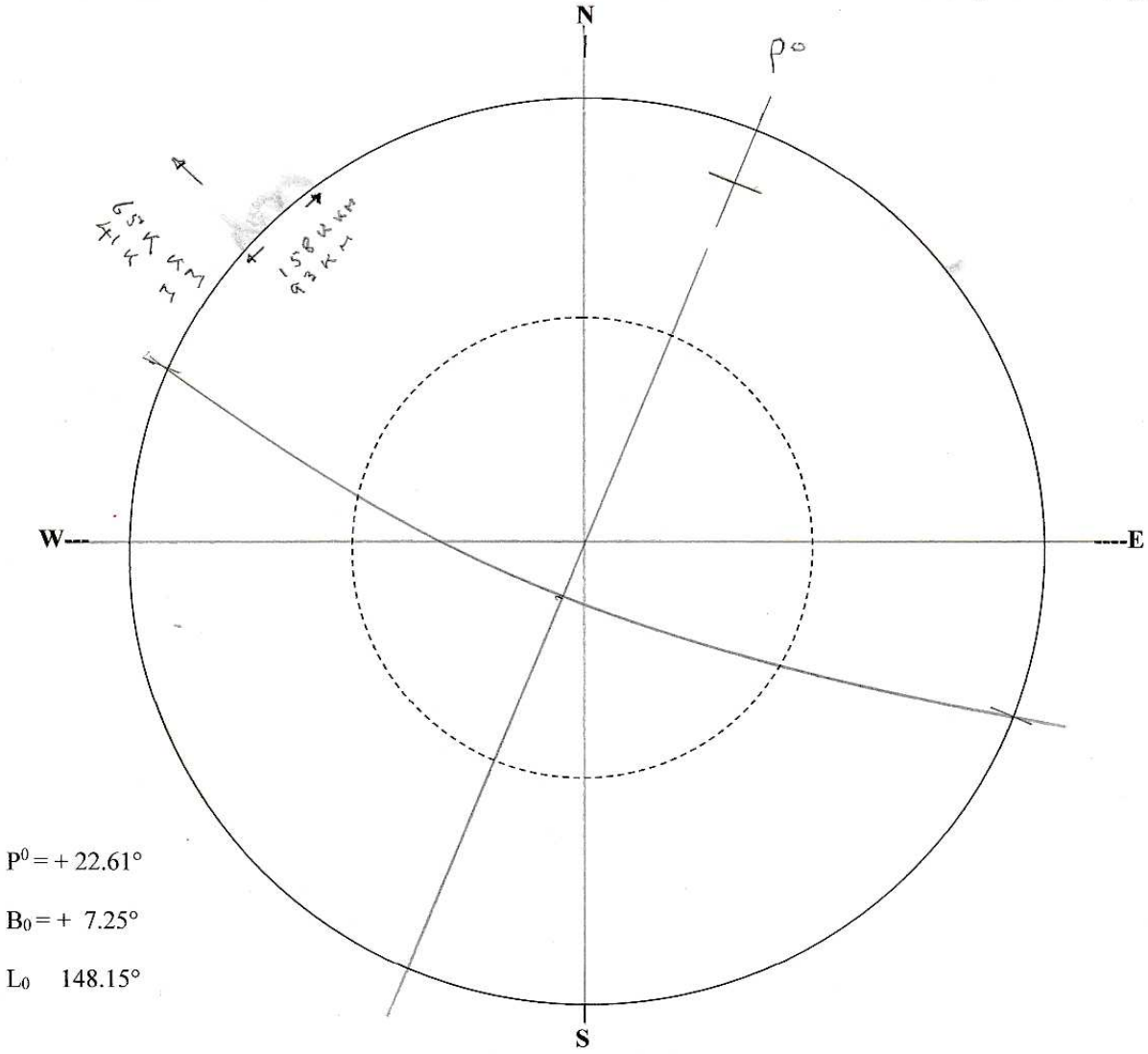
**U.T. DATE** 7th September 2019. **UT: 22hrs 40mins.**

**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. 2221 (at 00.00hrs). Synodic Rotation No. 15 CONDITIONS (4) Poor. WIND: SW. 33 - 39km/h**

**TRANSPARENCY: (1) Very good. Clear sky. CURRENT TEMP.: 13°C. 55°F.**

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




$P^0 = +22.61°$

$B_0 = +7.25°$

$L_0$ 148.15°

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 medium to strong motion. Total Q. CV: = 0

***www.sydneycityskywatchers.org***

**NAME: Monty Leventhal OAM**

**= Plage. = Faculæ = Flare**

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**Lat. 33° 54'S – Long. 151° 15'E**

**E.A.S.T. DATE** 9th September 2019. **TIME 08hrs 30mins.**

**U.T. DATE** 8th September 2019. **UT: 22hrs 30mins.**

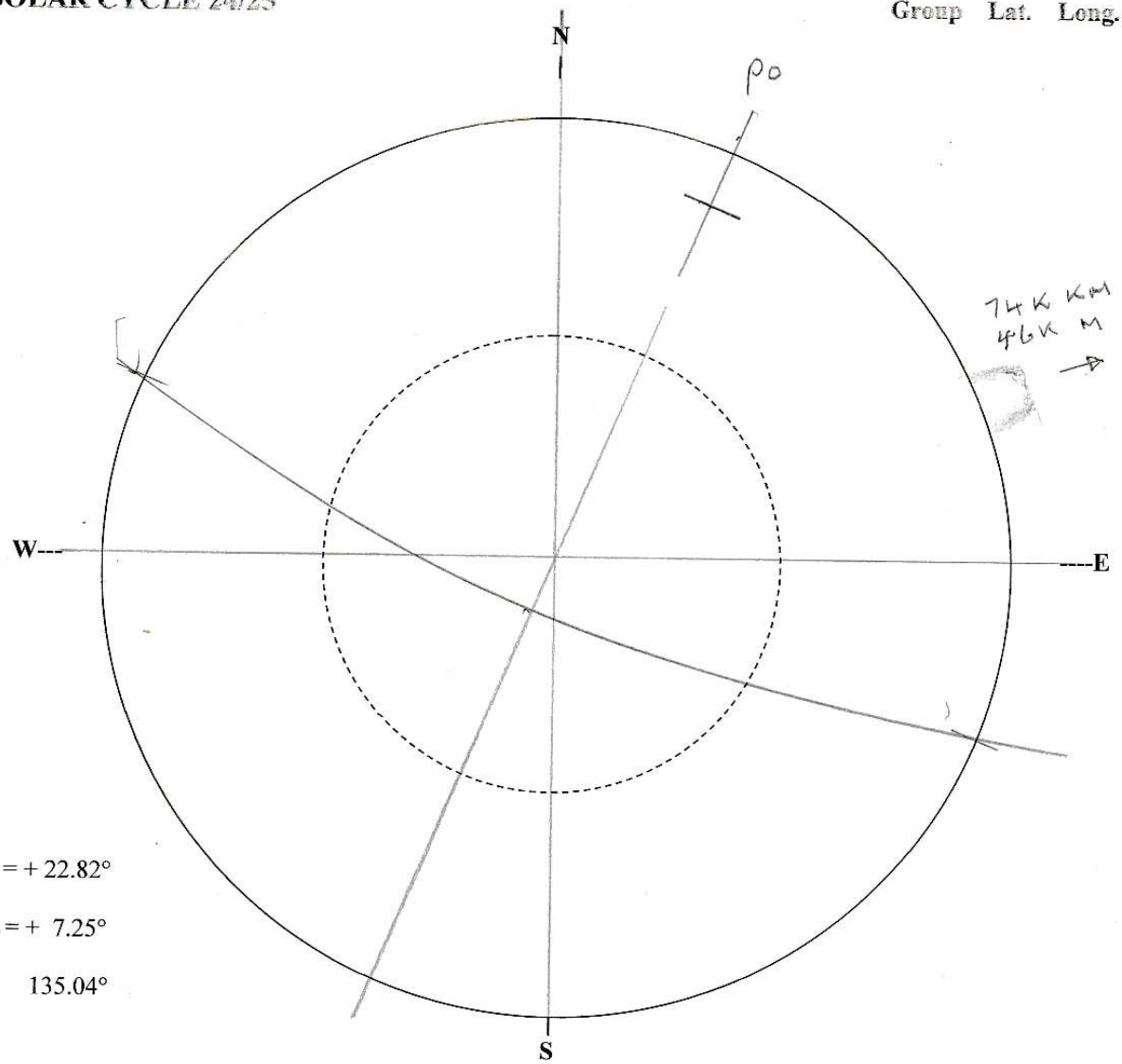
**INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5**

**ROTATION No. 2221 (at 00.00hrs). Synodic Rotation No. 16 CONDITIONS (3) Fair. WIND: SW. 37 - 43km/h**

**TRANSPARENCY: (1) Very good. 50% Altostratus cloud. CURRENT TEMP.: 13°C. 55°F.**

**SOLAR CYCLE 24/25**

Group Lat. Long.




$P^0 = +22.82°$

$B_0 = +7.25°$

$L_0$ 135.04°

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 motion. Total Q. CV: = 0

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**= Plage.** **= Faculæ** **= Flare**

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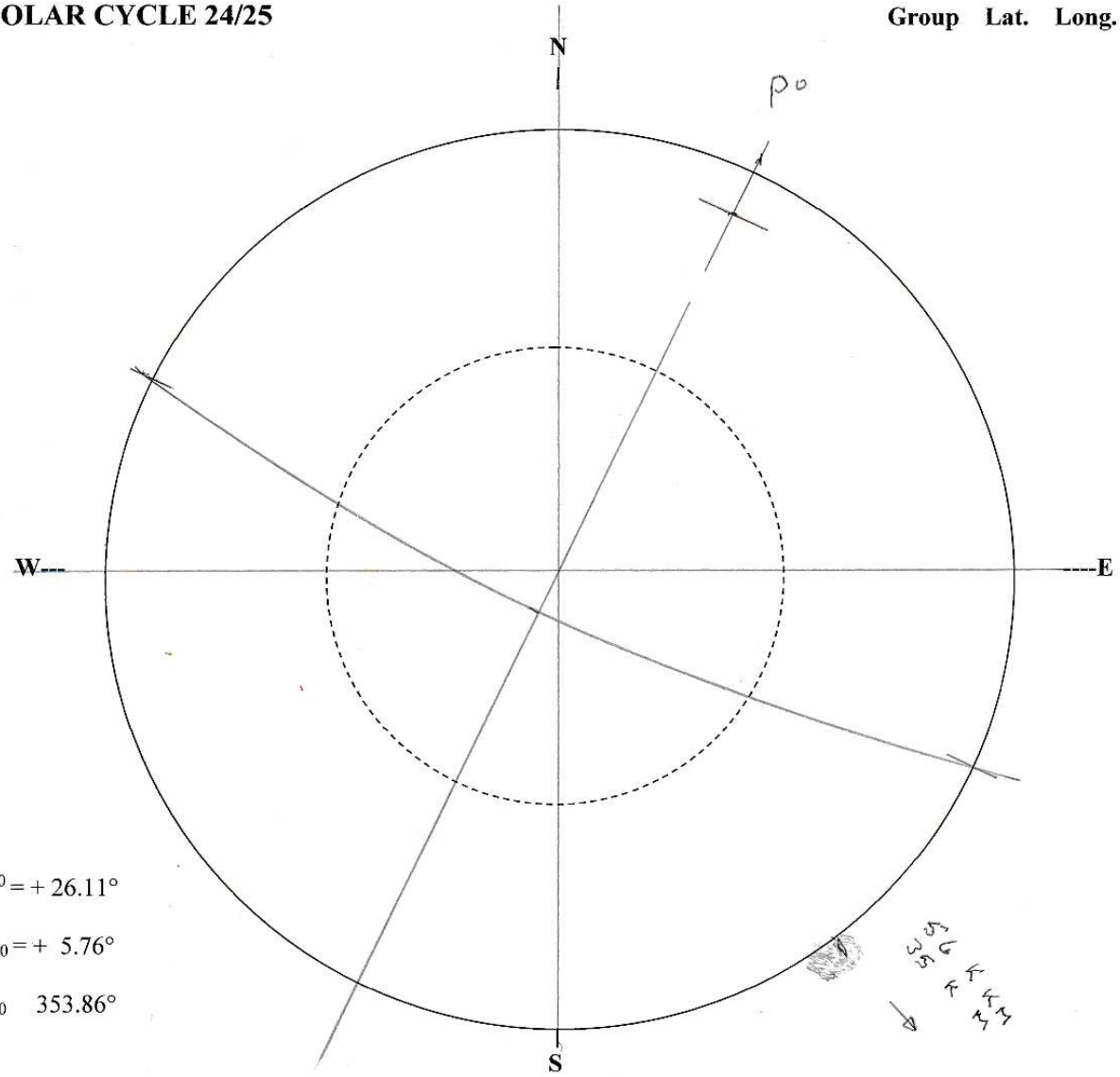
| | | |
|---|---|---|
| **E.A.S.T. DATE** | **17th October 2019.** | **TIME 07+1hrs 55mins.** |
| **U.T. DATE** | **16th October 2019.** | **UT: 21hrs 55mins.** |

**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. 2223 (at 00.00hrs). Synodic Rotation No. 0 CONDITIONS (2) Good. WIND: NW. 9 - 11km/h**

**TRANSPARENCY: (1) Very good. Clear sky. CURRENT TEMP.: 21°C. 70°F.**

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




$P^0 = +\ 26.11°$

$B_0 = +\ 5.76°$

$L_0$ 353.86°

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 slight motion. Total Q. CV: = 0

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**NAME: Monty Leventhal OAM**

**= Plage. = Faculæ = Flare**

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**Lat. 33° 54'S – Long. 151° 15'E**

**E.A.S.T. DATE** **12th October 2019.** **TIME 08+1hrs 40mins.**

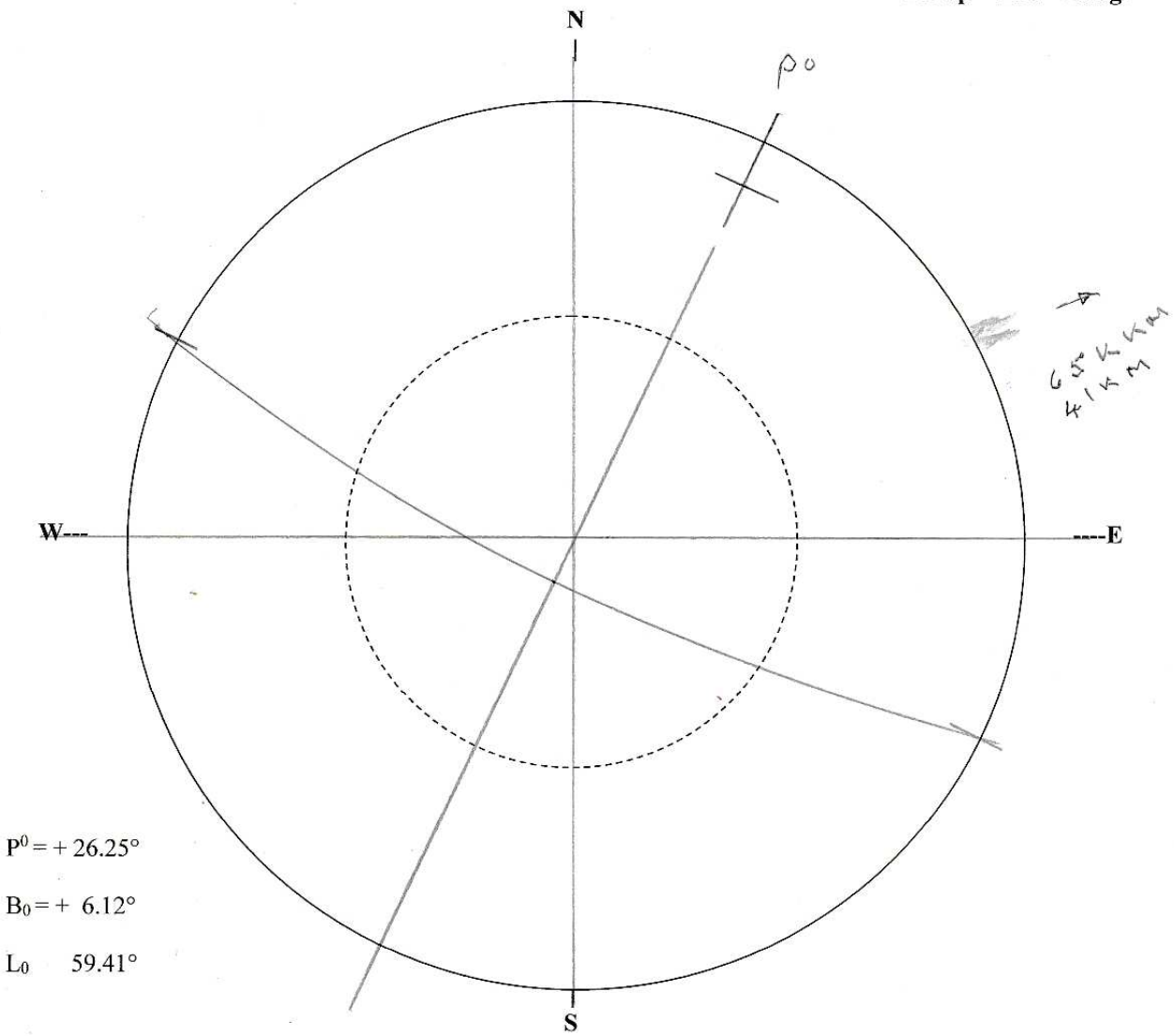
**U.T. DATE** **11th October 2019.** **UT: 22hrs 40mins.**

**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. 2222 (at 00.00hrs). Synodic Rotation No. 22 CONDITIONS (2) Good. WIND: SE. 25 - 31km/h**

**TRANSPARENCY: (2) Good, 60% Cumulus/Stratus cloud, increasing. CURRENT TEMP.: 17°C. 63°F.**

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




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 slight motion. Total Q. CV: = 0

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

**= Plage.** **= Faculæ** **= Flare**

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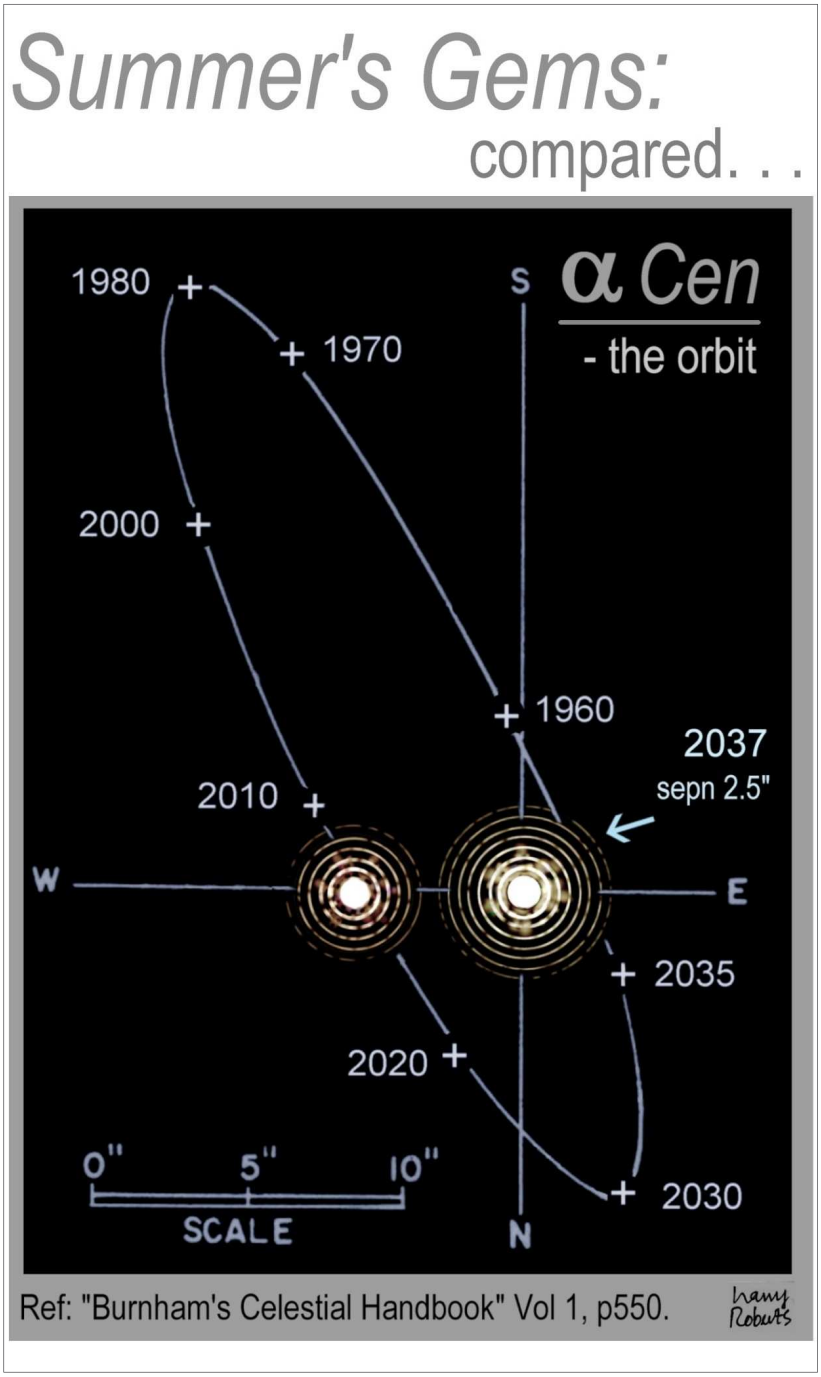
# Alpha Centauri and Acrux: The Finest Doubles?

Double stars can be one of amateur astronomy's greatest treats, and in the south we have some of the very finest. Big scopes are not needed, a 4 inch reflector is ideal. My old 72 Mak brings a smile every time it displays Alpha Cen or Alpha Cru. Let's compare the two systems.

Alpha Centauri, brightest and nearest double, is a magnificent sight in almost any scope! It was the first double I saw with a 4" scope back in the Sixties. Curiously, the separation of the two bright stars, A and B, was then about the same as it is today, ~6 arcsec. Yet, since that time, orbital motion of star B has carried it across a wide range of separations, and through sixty percent of its 80-year period.

The pair was sketched 2009 (Fig1) with an eight-inch SC, in good seeing. Although only ~ four light years away, the stellar discs are not seen – instead we see their Airy Discs, the interference patterns that vary in size depending on the 'scope used.

On that night the number of rings in each Airy disc was noted and their separation, features related by equations I don't understand, except to say that brighter stars have more rings and larger discs.




**Colours:** the pair showed a slight difference in their colours. Star **A** is spectral type G2, a yellow hue identical to the Sun. While dazzling to us, the Sun would have the same colour if it was four Ly away (Fig1).

Secondary **B**, however, was more orange; a subtle difference, as Fig shows. **B** is type K1 and both are dwarf stars, like the Sun: a G2 dwarf.

Few dwarf stars are visible - most stars seen at night are giants. *"We should not slight the dwarfs (stars). Unlike type M, some of these (G and K dwarfs) are visible to the unaided eye. The brightest K type is the fainter member of the Alpha Centauri pair, type K1 V."* (Kaler, J. "*Stars and their Spectra*". P106).

**Orbit:** The apparent orbit of the two stars is an "eccentric and elongated ellipse" (Burnham). The dates on the orbital diagram (Fig) show how the separation varied over the past fifty years. From closest about 2.5" arc (periastron) in 1955, the gap widened to 5" arc by 1960. In twenty years it widened to 22" arc. By 2000 it was closing again.

In 2015 the gap had closed to 5" arc, and will now widen until 2030. From then on it will close rapidly to 2" arc by 2037 (arrowed), spectacular but hard to split: I hope to try then!

Take a close look at the Alpha Cen double: it's a system where

things happen quickly - and the two stars are widening in 2020. You will also see how our Sun would look from an alien spaceship 4ly away, or view the Sun with a **safe** solar -scope and you will see what Alpha Cen A would look like from only eight light minutes away!

Or, we might ask, is Alpha Crucis the finest double?

*"Acrux is a brilliant double star, one of the very finest in the heavens",* noted by missionaries to Siam in 1685, says Burnham ("Celestial Handbook"). Had he seen it in a telescope? Presumably.

My first log of Acrux (1967) notes *"two equal mag. stars very close and a companion some dist. off."* A pretty sight in my 8inch DK at 280X or, indeed any scope; it splits nicely in a 72mm Mak. "A test for (a)1 inch" says Norton.

What makes for a good double? Here's some thoughts:


**Colour contrasts** can make for great doubles. Star colours can be subtle and show best with the scope out of focus, with larger Airy discs. Put two stars side by side and colour differences become clear. Early writers liked exotic terms: "Topaz and Green", "Gold and Blue" are examples.

In Alpha Cru all are spectral type B, Blue stars. A and B are B1 and B3 and technically blue. Hartung sees them bluish white; I see plain white. Star C, 90 arcsec away, looks very blue at type B5 (Fig).

**Bright stars make great doubles**. A and B are mags 1.4 and 1.9, very bright, and C is 4.9, a naked eye star but for its proximity to the others! C, a less luminous type shares their motion through space and is a true member of the triple. The system has six components in fact, but we see only three.

**Separation**. A and B are 4.0 arcsec apart and C 90arcsec away. This star trio has little or no orbital motion and no orbits are known (Fig).

However, Acrux is ~100 times more distant than Alpha Cen, and both stars are giants - while Alpha Cen stars are dwarves!

Both A and B are early class B stars with surface temperatures of about 28,000 K. Their luminosities are 25,000 and 16,000 times solar.

**Challenges?**. These are doubles so close they are hard to split like Gamma Cen or Beta Mus. or bright stars with a tiny companion, like Rigel or Sirius. Challenges are a test of aperture, optics and seeing conditions. Neither Acrux nor Alpha Cen can be called a challenge at present, but the latter will be in 2030!

Take a look at Alpha Cen and Acrux – many think they are the finest doubles in the southern sky. What do you think? Enjoy!

**Harry Roberts**

# Sydney City Skywatchers

**www.sydneycityskywatchers.org**

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**Minor Planets** …… ...vacant

**Solar**……....Monty Leventhal

**Lunar**……... …….....Harry Roberts

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**Assistant Librarian**……....vacant

**Curator of Instruments**.....…….vacant

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**Bulletin Assistant Publisher**.....……...Elizabeth Cocking

**Historian**……...……..….Garry Dalrymple

**Webmaster**……...Jorge Isaias

## 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.