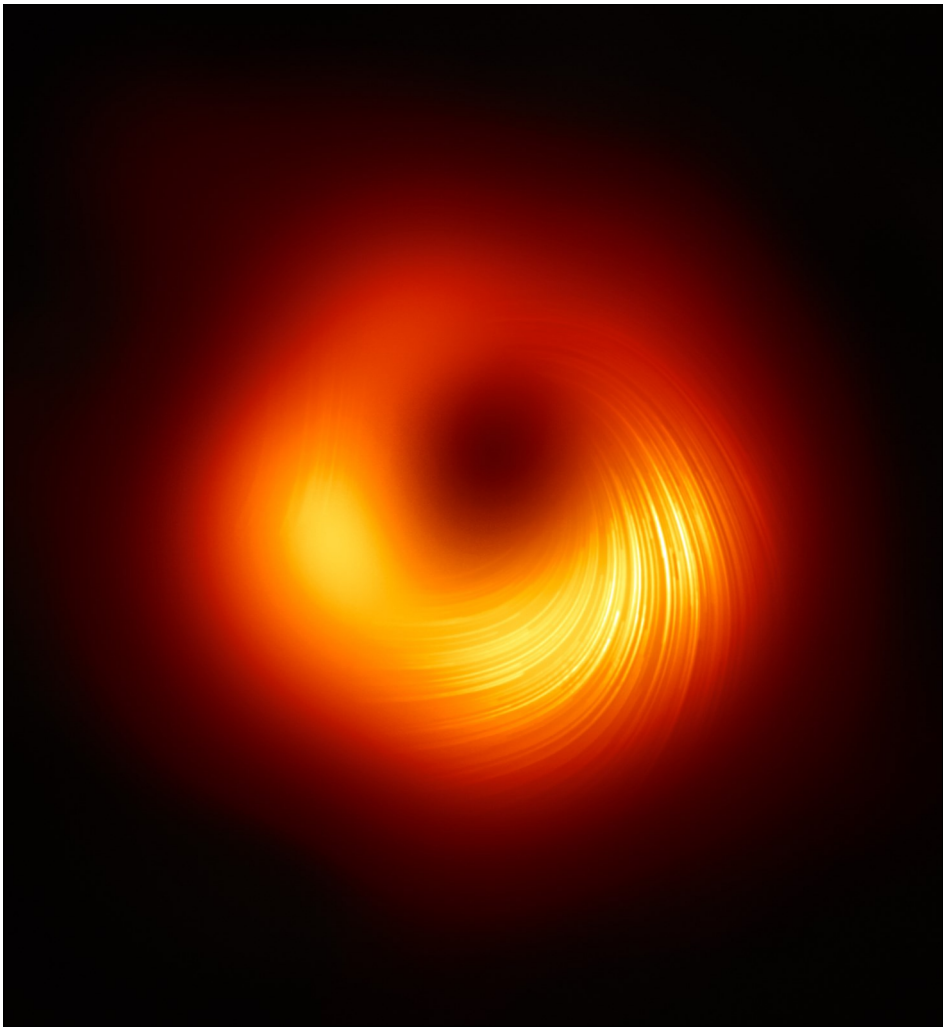
The Astronomers' Bulletin

Newsletter of the Sydney City Skywatchers **Volume 11, Issue 2 Apr/Jun 2021**

Magnetic Fields Imaged At The Edge Of M87's Black Hole

The Event Horizon Telescope collaboration, who produced the first ever image of a black hole, has revealed a new view of the massive object at the centre of the Messier 87 galaxy: how it looks in polarised light. This is the first time astronomers have been able to measure polarisation, a signature of magnetic fields, this close to the edge of a black hole. The observations are key to explaining how the M87 galaxy, located 55 million light -years away, is able to launch energetic jets from its core.

"We are now seeing the next crucial piece of evidence to understand how magnetic fields behave around black holes, and how activity in this very compact region of space can drive powerful jets that extend far beyond the galaxy," says Monika Mościbrodzka, Assistant Professor at Radboud University in the Netherlands.



On 10 April 2019, scientists released the first ever image of a black hole, revealing a bright ring-like structure with a dark central region - the black hole's shadow. Since then, the EHT team has delved deeper into the data on the supermassive object at the heart of the M87 galaxy collected in 2017. They have discovered that a significant fraction of the light around the M87 black hole is polarised.

"This work is a major milestone: the polarisation of light carries information that allows us to better understand the physics behind the April image, which was not possible before," explains Iván Martí-Vidal, GenT Researcher. He adds that "unveiling this new polarised-light image required years of work due to the complex techniques involved in obtaining and analysing the data."

Light becomes polarised when it goes through certain filters, like the lenses of polarised sunglasses, or when it is emitted in hot regions of space where magnetic fields are present. In the same way that polarised sunglasses help us see better by reducing reflections and glare from bright surfaces, astronomers can sharpen their view of the region around the black hole by looking at how the light originating from it is polarised. Specifically, polarisation allows astronomers to map the magnetic field lines present at

In This Issue

the inner edge of the black hole.

"The newly published polarised images are key to understanding how the magnetic field allows the black hole to 'eat' matter and launch powerful jets," says Andrew Chael, a NASA Hubble Fellow at the Princeton Center for Theoretical Science.

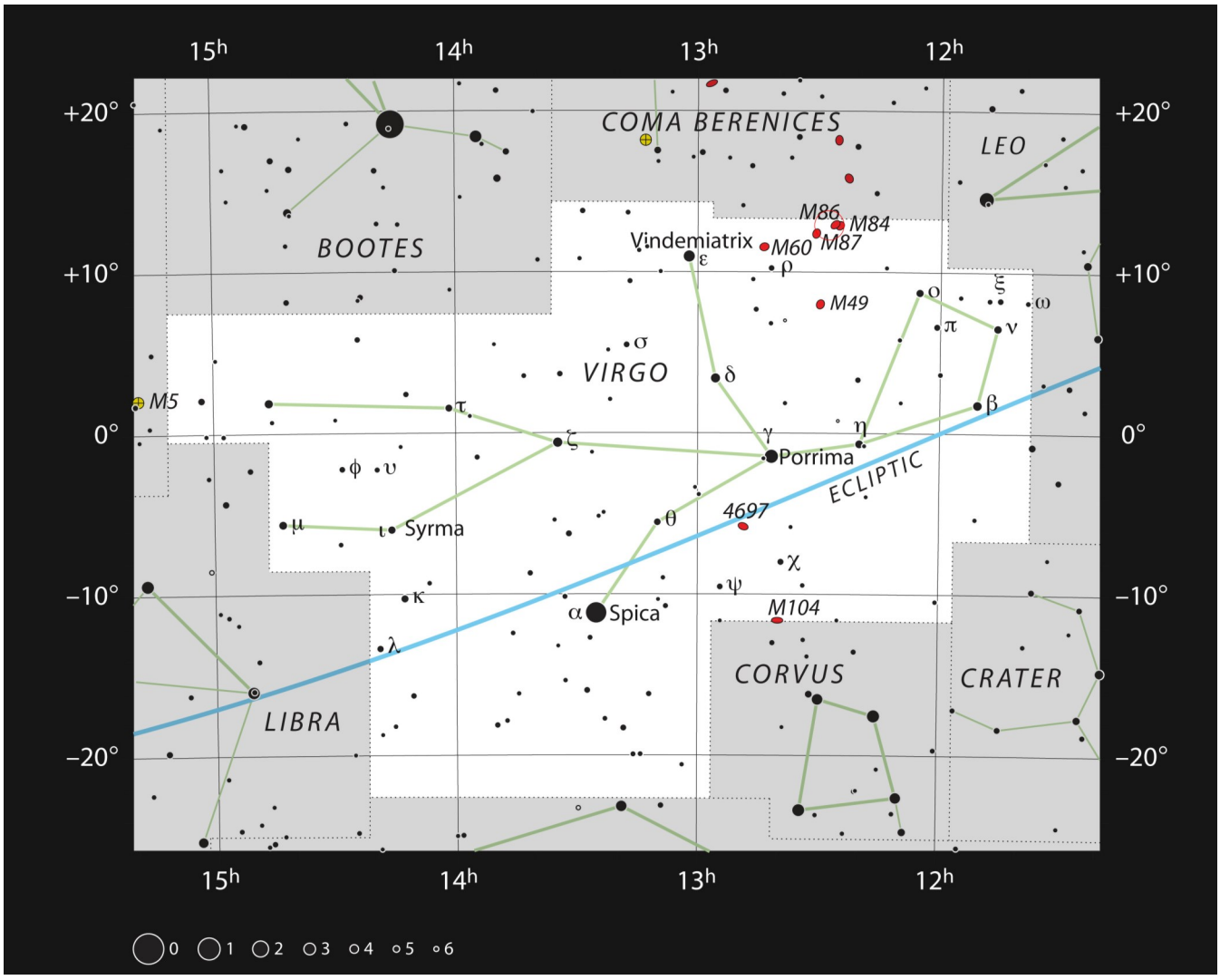
The bright jets of energy and matter that emerge from M87's core and extend at least 5000 light-years from its centre are one of the galaxy's most mysterious and energetic features. Most matter lying close to the edge of a black hole falls in. However, some of the surrounding particles escape moments before capture and are blown far out into space in the form of jets.

Astronomers have relied on different models of how matter behaves near the black hole to better understand this process. But they still don't know exactly how jets larger than the galaxy are launched from its central region, which is comparable in size to the Solar System, nor how exactly matter falls into the black hole. With the new EHT image of the black hole and its shadow in polarised light, astronomers managed for the first time to look into the region just outside the black hole where this interplay between matter flowing in and being ejected out is happening.

The observations provide new information about the structure of the magnetic fields just outside the black hole. The team found that only theoretical models featuring strongly magnetised gas can explain what they are seeing at the event horizon.

"The observations suggest that the magnetic fields at the black hole's edge are strong enough to push back on the hot gas and help it resist gravity's pull. Only the gas that slips through the field can spiral inwards to the event horizon," explains Jason Dexter, Assistant Professor at the University of Colorado.

To observe the heart of the M87 galaxy, the collaboration linked eight telescopes around the world - including the northern Chile-based Atacama Large Millimeter/submillimeter Array and the Atacama Pathfinder Experiment - to create a virtual Earth-sized telescope, the EHT. The impressive resolution obtained with the EHT is equivalent to that needed to measure the length of a credit card on the surface of the Moon.



The EHT setup allowed the team to directly observe the black hole shadow and the ring of light around it, with the new polarised-light image clearly showing that the ring is magnetised. The research involved over 300 researchers from multiple organisations and universities worldwide.

On page 2 is a chart showing the position of giant galaxy Messier 87 in the constellation of Virgo. The map shows most of the stars visible to the unaided eye under good conditions.

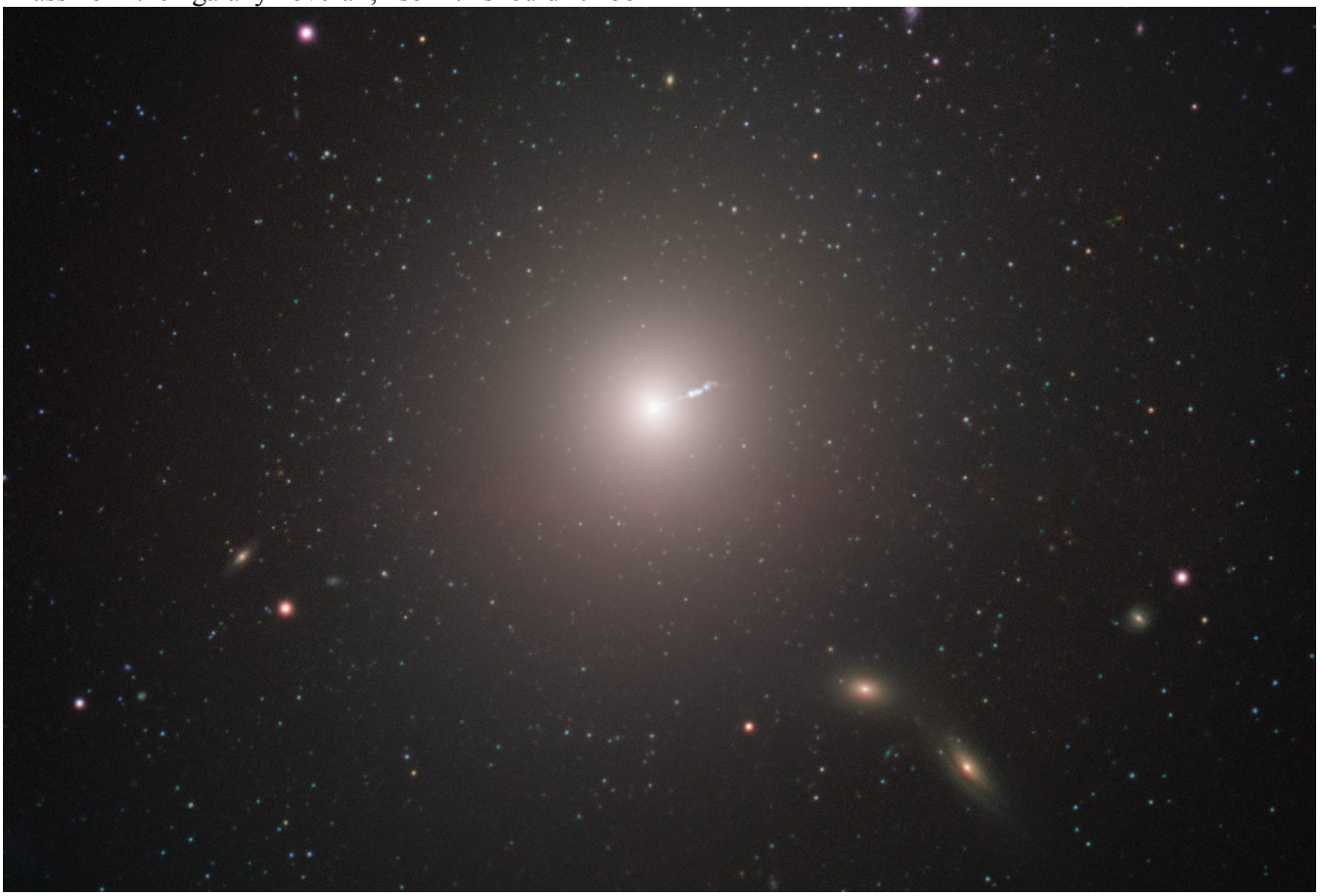
Image below: Messier 87 is an enormous elliptical galaxy located about 55 million light years from Earth, visible in the constellation Virgo. It was discovered by Charles Messier in 1781, but not identified as a galaxy until 20th Century. At double the mass of our own galaxy, the Milky Way, and containing as many as ten times more stars, it is amongst the largest galaxies in the local universe. Besides its raw size, M87 has some very unique characteristics. For example, it contains an unusually high number of globular clusters: while our Milky Way contains under 200, M87 has about 12,000, which some scientists theorise it collected from its smaller neighbours.

Just as with all other large galaxies, M87 has a supermassive black hole at its centre. The mass of the black hole at the centre of a galaxy is related to the mass of the galaxy overall, so it shouldn't be surprising that M87's black hole is one of the most massive known. The black hole also may explain one of the galaxy's most energetic features: a relativistic jet of matter being ejected at nearly the speed of light.

The black hole was the object of paradigm-shifting observations by the Event Horizon Telescope. The EHT chose the object as the target of its observations for two reasons. While the EHT's resolution is incredible, even it has its limits. As more massive black holes are also larger in diameter, M87's central black hole presented an unusually large target—meaning that it could be imaged more easily than smaller black holes closer by. The other reason for choosing it, however, was decidedly more Earthly. M87 appears fairly close to the celestial equator when viewed from our planet, making it visible in most of the Northern and Southern Hemispheres. This maximised the number of telescopes in the EHT that could observe it, increasing the resolution of the final image.

The image on page 1 shows the polarised view of the black hole in M87. The lines mark the orientation of polarisation, which is related to the magnetic field around the shadow of the black hole.

European Southern Observatory April 2021
Images credit: ESO, IAU and Sky and Telescope EHT Collaboration



Alpha Cen 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.

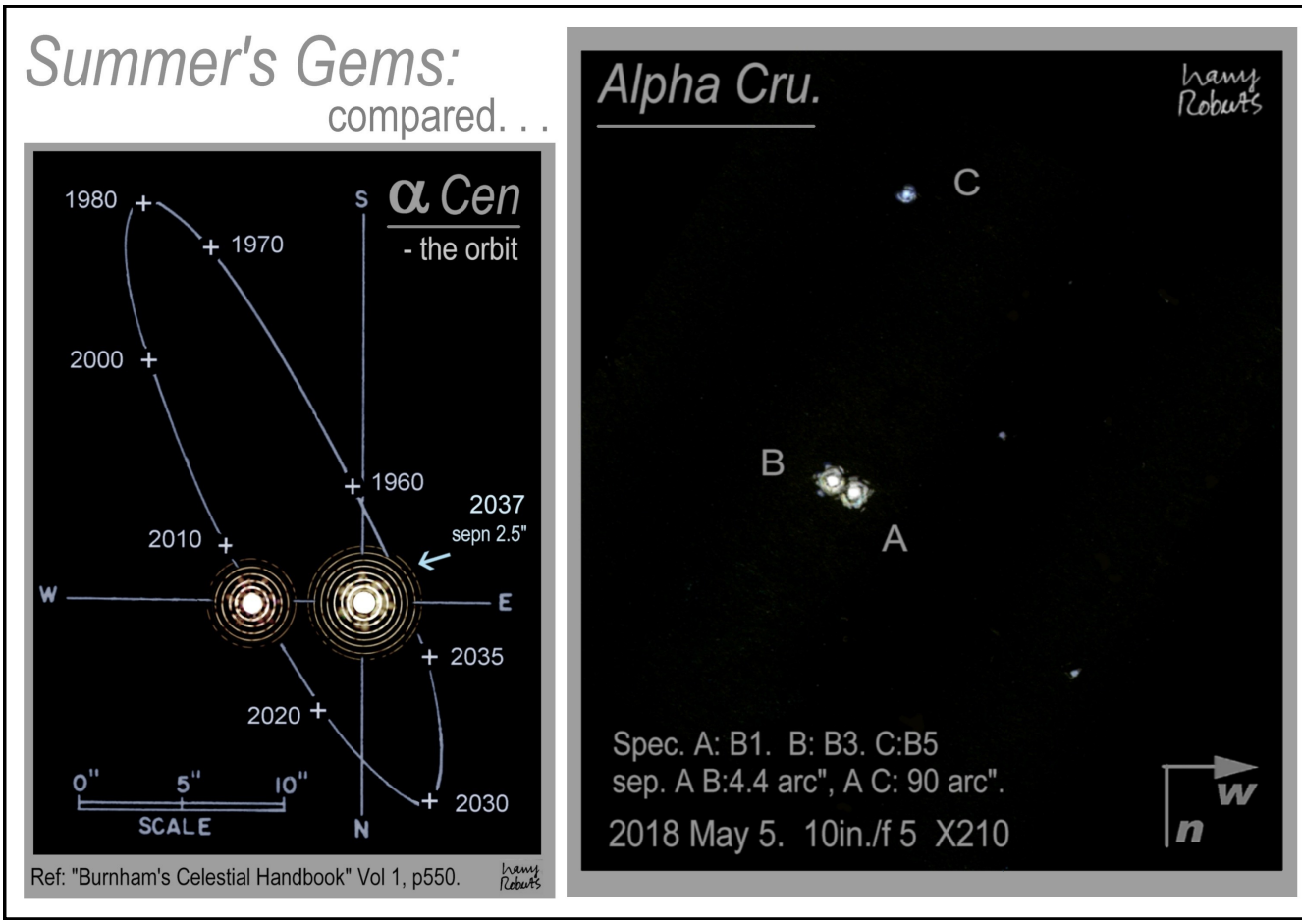
Colours: the pair showed a slight difference in their colours. Star **A** is spectral type G2, a yellow hue identical to the Sun. While dazzling to us, the Sun would have the same colour if it was four Ly away (Fig1).

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 'scope? 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

Solar Observations

by Monty Leventhal OAM

January 2021 Solar Report

January observations got to a bad start with rain and cloud cover until the 4th UT. On that day the only activity that could be seen was a curved pillar Prominence on the NW limb reaching a height of about 47,000km.

Due to cloud cover the next observation was made on the 6th when all that could be seen was a filament in the SW quadrant.

On the SW limb a hedgerow Prominence reached a height of 56,000km and stretched across the limb for approximately 177,000km.

No significant observations were made until the 12th January when a double arched Prominence was seen on the NW limb reaching a height of about 65,000km.

It was not until the 15th that I saw my first Sunspots of the month. It was a small Cri group with a CV (6) in AR12796. Its position was at a latitude of -23 & longitude of 94.

No Prominences or any other activity could be seen.

The following day all that could be seen of that group in AR12796 was a single Axx spot with a CV of 1.

On the 17th a new Cri group appeared close to the SE limb in AR12797 and remained on the solar disc to the 20th where it had grown to a CV of Dao (19)

The next day 21st the group in AR12797 became smaller to a CV of Cso.

On the 22nd the same group in AR12797 again reduced in size to a CV of Csi (12).

In the NW a new single Axx spot appeared in AR 12799 but could not be seen the following day. The group in AR12797 continued on the solar disc until the 25th though much smaller with a CV of Bxi (3).

No Prominences were seen on the Sun since the 21st January 2021. No further observations were made in January due to total cloud cover and rain. Total observing days = 19. R = 7. Q = 1. CV = 6.4

February 2021 Solar Report

Though towards the end of January Sunspot activity became more active but now this activity became much less.

On the 1st February only one single Axx spot could be seen in the NW in AR12801. It had disappeared on the 2nd leaving the solar disc clear of Sunspots until the 20th. No Prominences could be seen.

On the 20th February a further single Axx spot was seen in the NE in AR12803, but by the 21st it too had disappeared. Two other groups were seen by other observers in different parts of the world but not during my watch.

On the 23rd February two new groups of Sunspots appeared and for the first time I think in years one group appeared in the northern hemisphere and the other in the south.

In the north It was a Bxo group with two spots in AR12804 and in the south another single Axx spot in AR12805. By the 25th these two groups grew much larger in size and all had Penumbra that I could see.

The group in the north had a CV of Dro (13) in AR 12804 and the group in the south was a single Hax (7) spot in AR12805.

Cloud cover prevented observations on the 26th and by the 27th the single southern spot in AR12805 had faded away.

The group in AR12804 had now reduced in size to a CV Csi (12) and was expected to rotate around the western edge of the Sun on the following day.

Bad weather prevented observations until the 27th when all that could be seen was AR12804 about to rotate around the NW limb. On the 28th a new Axx spot was observed in AR12806.

I only saw two significant Prominences though most were very faint. On the 9th a type Broken Pyramid Prominence with two foot points observed on the SE limb reached an approximate height of 112,00km.

A similar type Pyramid Prominence on the 20th was also observed on the NE limb reaching a height of about 70,000km.

Prominence observations were very limited due to a defective H-alpha filter. Total observing days = 18. R = 5. Q = 1. CV = 2.1

March 2021 Solar Report

No observations were made until the 3rd March UT due to bad weather. On that day two small groups of Sunspots were seen. One, previously seen in February, a Bxi group in AR12806. The other a Bxo group in AR 12807.

The following day the 4th the active group in AR 12806 had faded away. This does not mean the AR itself has disappeared as noted later. The group in AR 12807 had now reduced to a single Axx spot.

A Pyramid type Prominence on the SE limb reached a height of 74,000km. On the 5th the Prominence seen on the SE limb had now grown active, to a height of 112,000km. No Sunspots could be seen.

As mentioned earlier AR 12806 appeared again on the 7th very close to the SW limb with a single Axx Sunspot. Again on the following day all that could be seen of AR 12806 was some Faculæ but no Sunspot..

Due to very bad weather no observations were made until the 12th March with a single Axx spot seen in the NE in AR 12808. No prominences could be seen.

Again no observations could be made until the 23rd due to very bad weather. However on that day the single Axx spot in AR 12808 could still be seen out in the NW.

In the NE at a Lat. of +16 & Long. of 229, 2 spots within a single penumbra was observed in AR 12812. I also observed a single Axx spot very close to the limb. On the NE limb a single arched Prominence reached a height of 56,000km.

On the 27th the Sunspot in AR12812 was the only one seen and on the 28th it had reduced in size to Axx spot. By the 31st no further spots could be seen. Prominences remained very faint and small.

Prominence observations were limited due to a defective H-alpha filter. Total observing days = 13. R = 13. Q = 2. CV = 4.9 (CV = Classification Value).

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E.A.S.T. DATE **13th January2021.** **TIME 07 + 1hrs. 50min.**

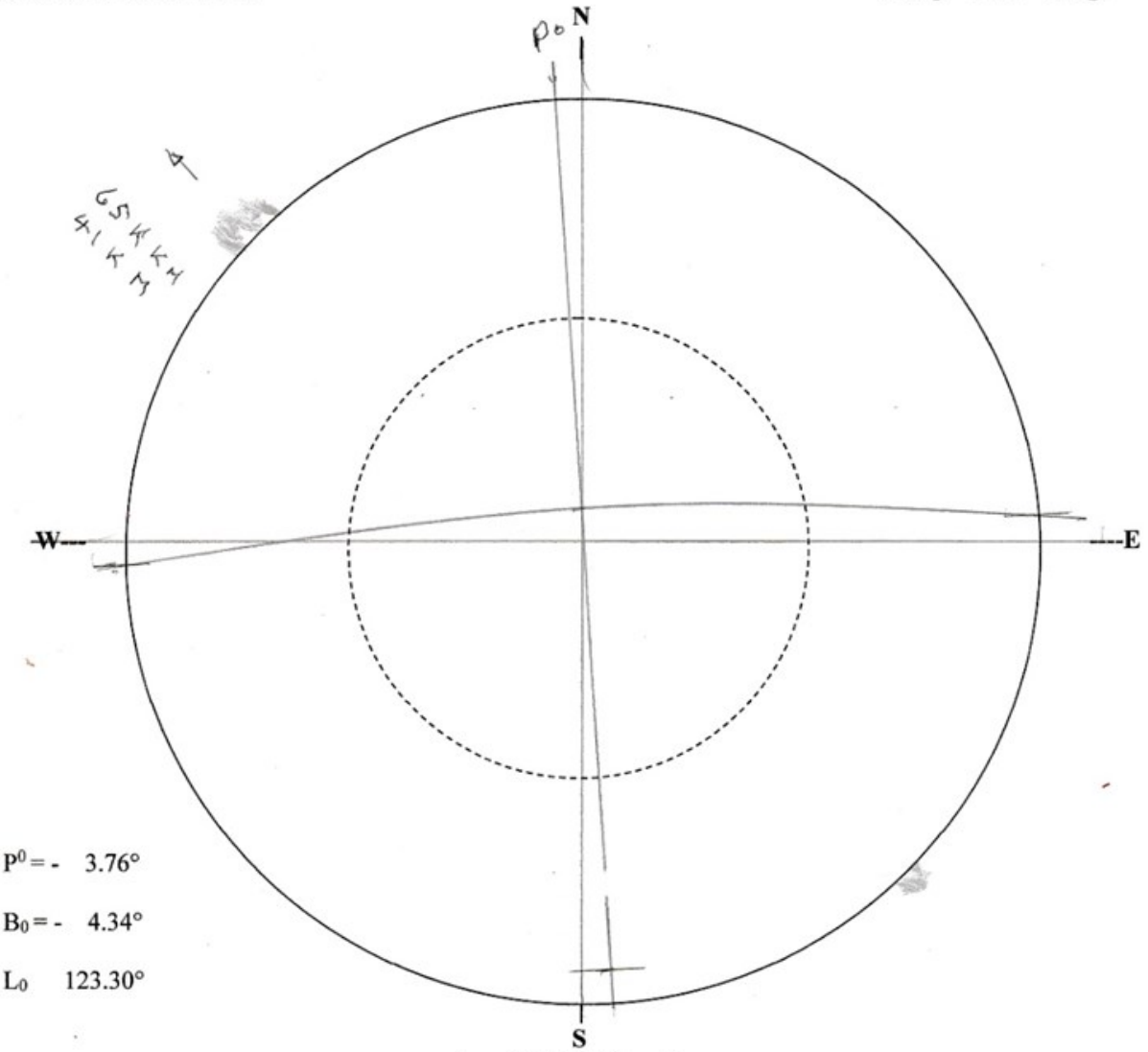
U.T. DATE **12th January 2021.** **UT: 21hrs 50mins.**

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. 2239 (at 00.00hrs). **Synodic Rotation No. 17** **CONDITIONS (2) Good.** **WIND NE. 20 – 24km/h**

TRANSPARENCY: (1) Very good, 40% Cumulus cloud, increasing. **CURRENT TEMP.: 26°C. 79°F.**

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



P^0 = - 3.76°

B_0 = - 4.34°

L_0 123.30°

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 = C.M.E: 0 Total C.V: =
Sun limb in slight motion. Total Q. CV: =

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E.A.S.T. DATE	**18th January2021.**	**TIME 07 + 1hrs.45min.**
U.T. DATE	**17th January 2021.**	**UT: 21hrs 45mins.**

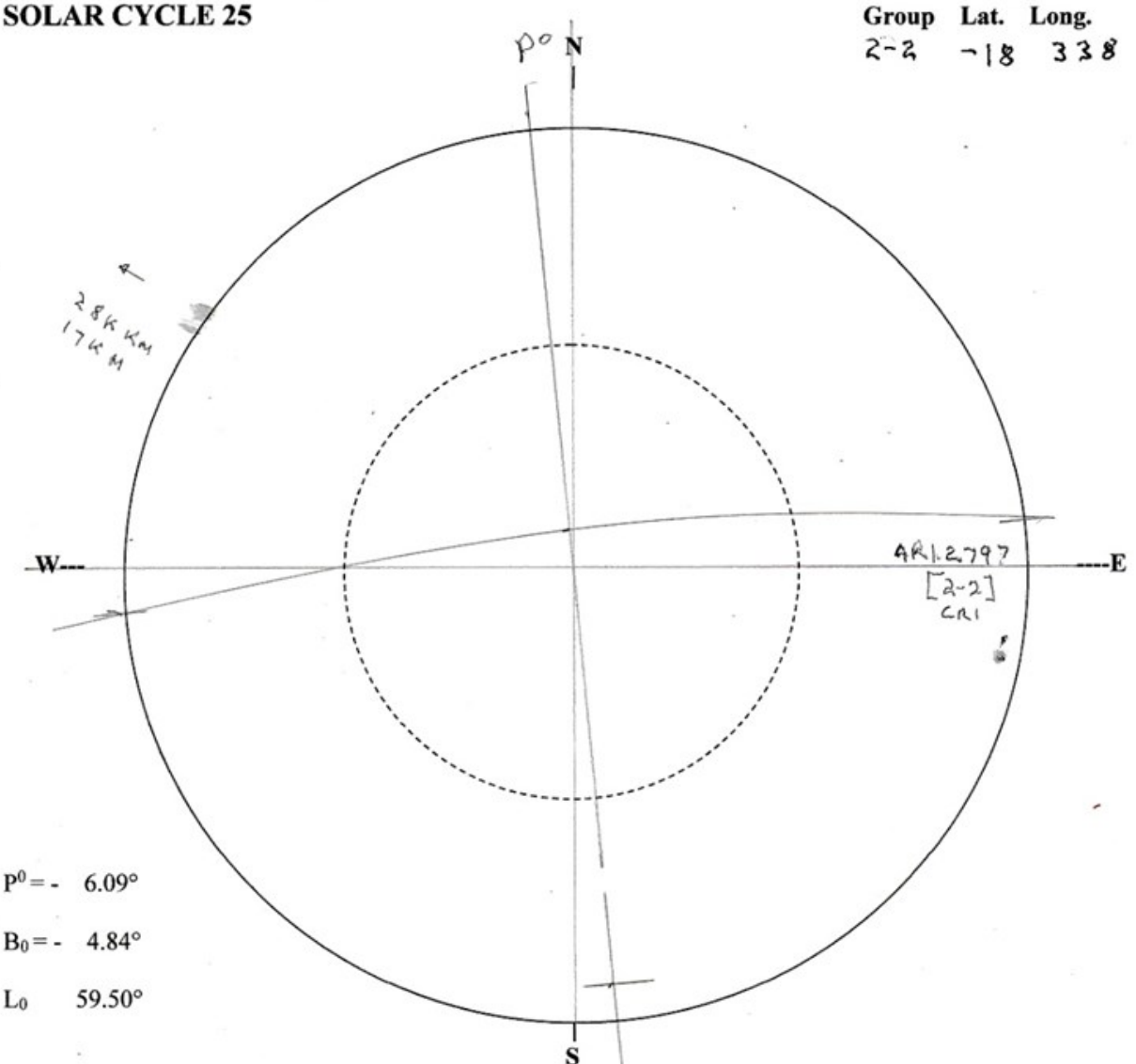
INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5

ROTATION No. 2239 (at 00.00hrs). Synodic Rotation No. 22 CONDITIONS (1) Excellent. WIND NW. 14 – 17km/h

TRANSPARENCY: (1) Very good, clear sky. CURRENT TEMP.: 25°C. 77°F.

SOLAR CYCLE 25

Group	Lat.	Long.
2-2	-18	338



P^0 = - 6.09°

B_0 = - 4.84°

L_0 59.50°

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: 1 Filaments: 0 Faculæ: 0 Plage: 0 Surges: 0 Active areas incl.: 2

Total Sunspot groups: 1 Total single Sunspots: 0 Total Sunspots: 2 R = 12 C.M.E: 0 Total C.V: = 6

Sun limb steady. Total Q. CV: = 3

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E.A.S.T. DATE	**23rd January2021.**	**TIME 07 + 1hrs.45min.**
U.T. DATE	**22nd January 2021.**	**UT: 21hrs 45mins.**

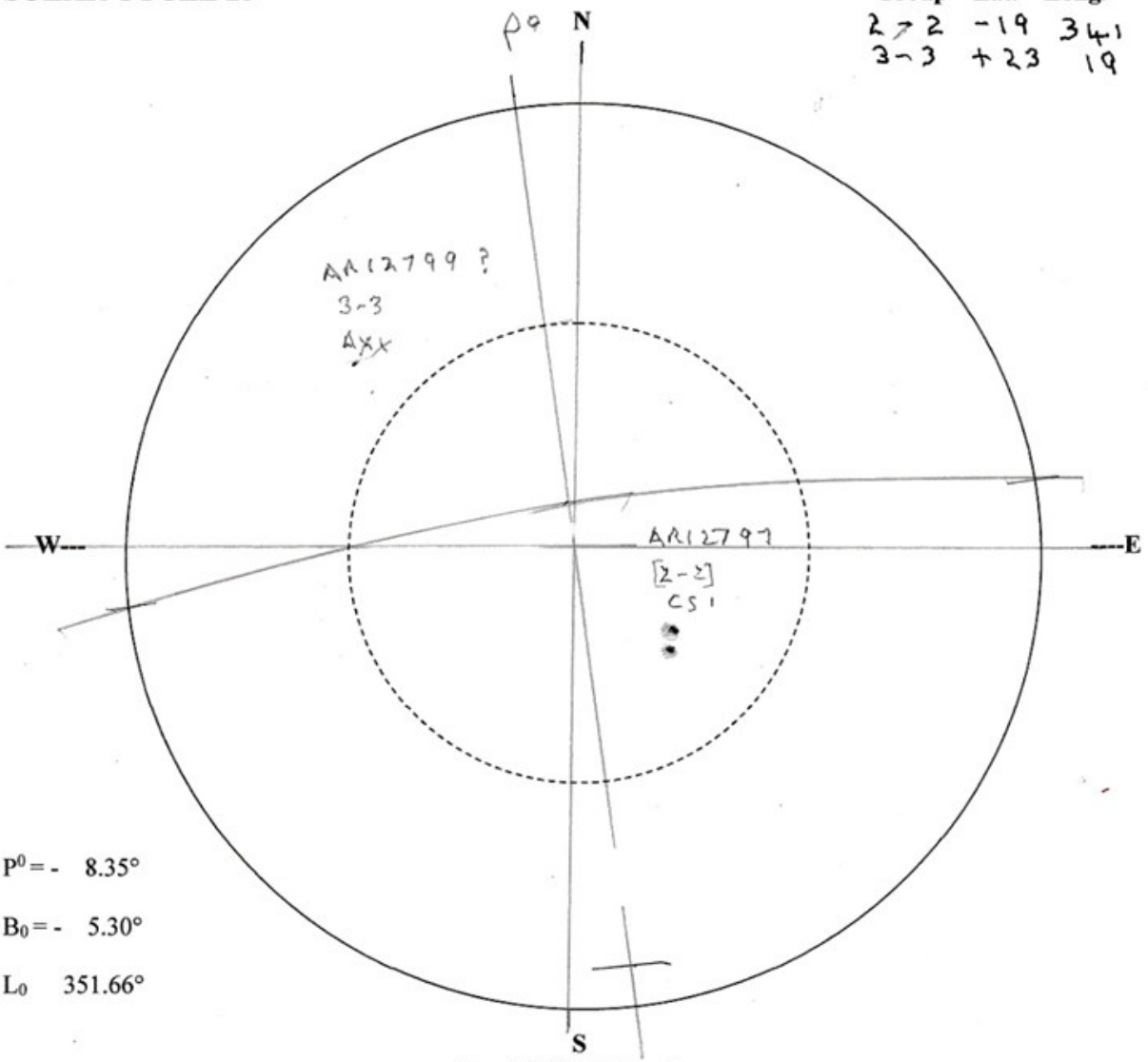
INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5

ROTATION No. 2240 (at 00.00hrs). Synodic Rotation No. 0 CONDITIONS (2) Good. WIND S. 25 – 31km/h

TRANSPARENCY: (1) Very good, clear sky. CURRENT TEMP.: 24°C. 75°F.

SOLAR CYCLE 25

Group	Lat.	Long.
2→2	-19	341
3-3	+23	19



P^0 = - 8.35°

B_0 = - 5.30°

L_0 351.66°

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: 0 Filaments: 0 Faculæ: 0 Plage: 0 Surges: 0 Active areas incl.: 2

Total Sunspot groups: 1 Total single Sunspots: 1 Total Sunspots: 3 R = 23 C.M.E: 0 Total C.V: = 13

Sun limb in slight motion. Total Q. CV: = 4

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E.A.S.T. DATE	**26th February 2021.**	**TIME 07 + 1hrs. 45min.**
U.T. DATE	**25th February 2021.**	**UT: 21hrs. 45mins.**

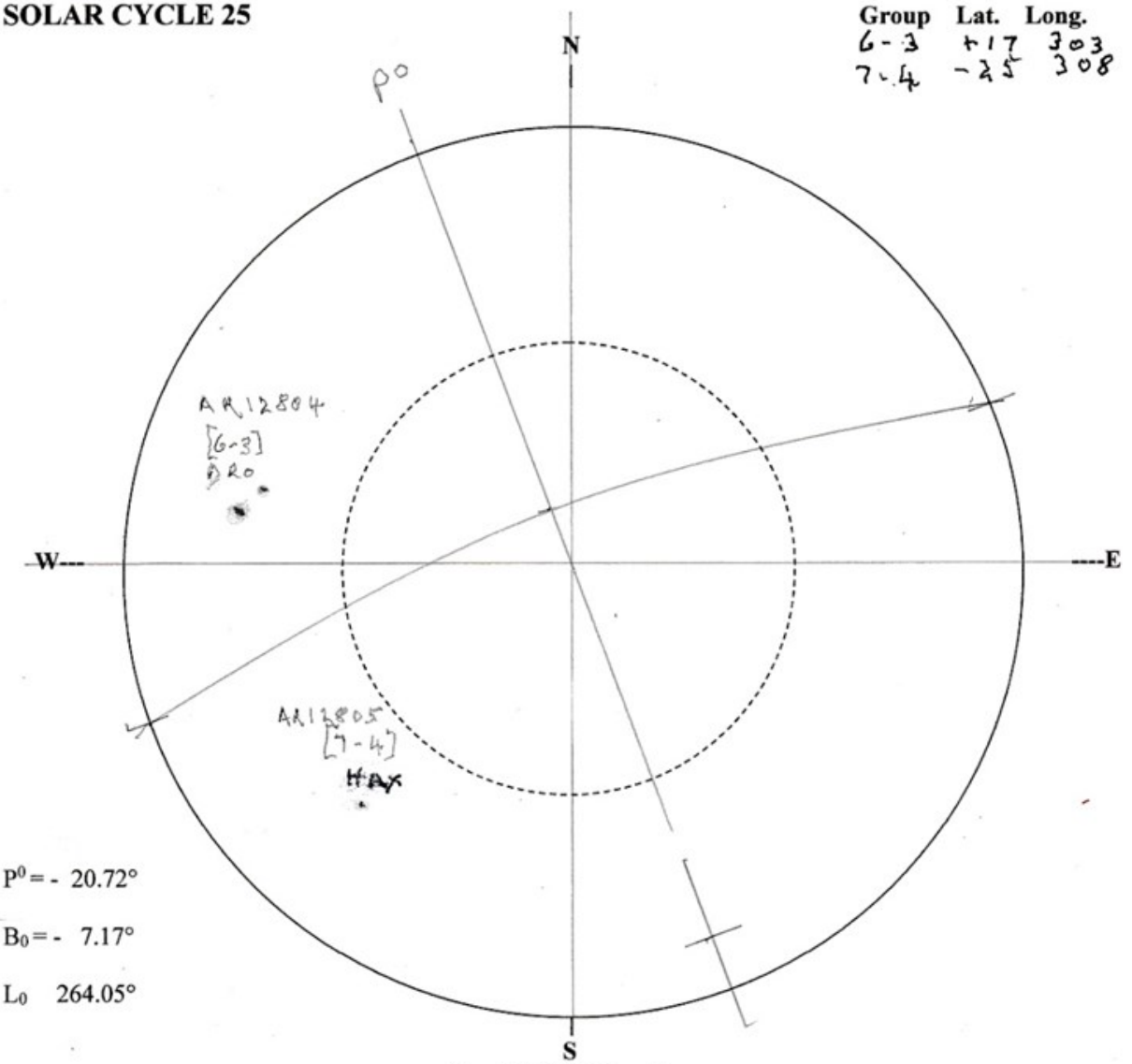
INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5

ROTATION No. 2241 (at 00.00hrs). Synodic Rotation No. 7 CONDITIONS (2) Good. WIND SW. 11 - 13km/h

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

SOLAR CYCLE 25

Group	Lat.	Long.
6-3	+17	303
7-4	-25	308



P^0 = - 20.72°

B_0 = - 7.17°

L_0 264.05°

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: 0 Filaments: 0 Faculæ: 0 Plage: 0 Surges: 0 Active areas incl.: 2

Total Sunspot groups: 1 Total single Sunspots: 1 Total Sunspots: 3 R = 23 C.M.E: 0 Total C.V: = 13

Sun limb in slight motion. Total Q. CV: = 7

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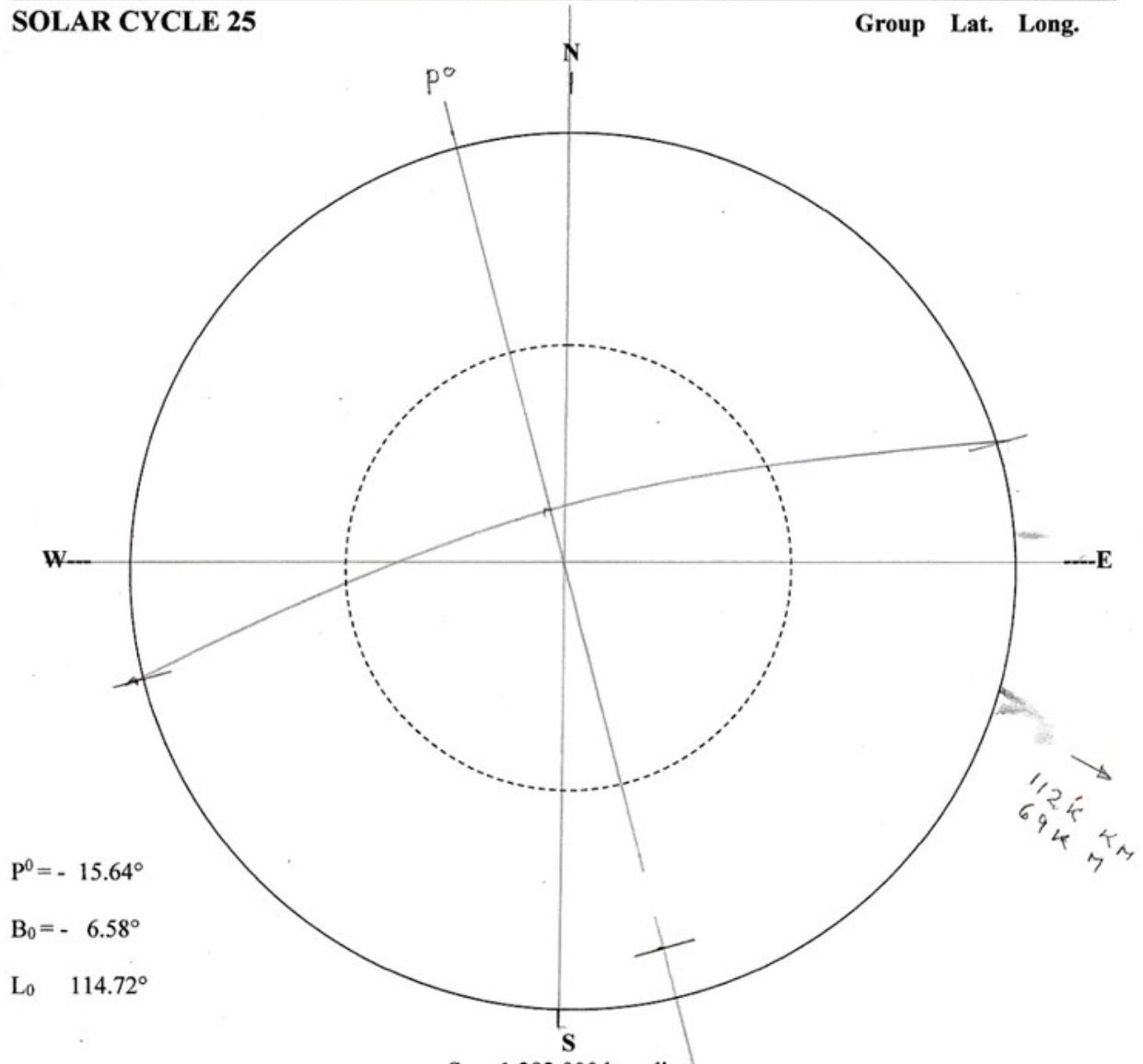
E.A.S.T. DATE	**10th February 2021.**	**TIME 07 + 1hrs. 35min.**
U.T. DATE	**9th February 2021.**	**UT: 21hrs. 35mins.**

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. 2240 (at 00.00hrs). Synodic Rotation No. 18. CONDITIONS (3) Fair. WIND SE. 22 - 26km/h

TRANSPARENCY: (2) 75% Cumulus cloud. CURRENT TEMP.: 22°C. 72°F.

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



$P^0 = -\ 15.64°$

$B_0 = -\ 6.58°$

L_0 114.72°

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 motion. Total Q. CV: = 0

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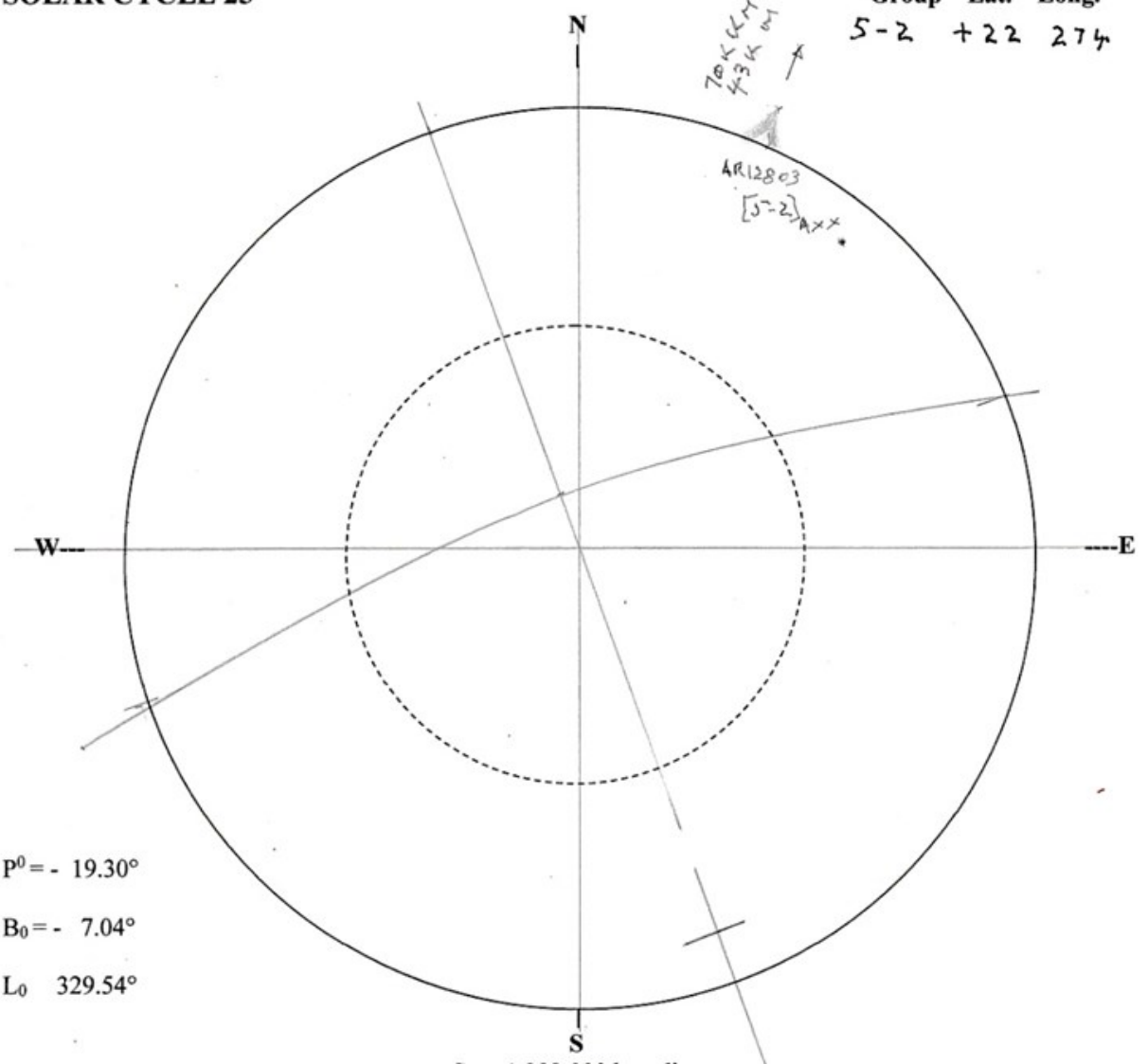
E.A.S.T. DATE	**21st February 2021.**	**TIME 08 + 1hrs. 10min.**
U.T. DATE	**20th February 2021.**	**UT: 22hrs. 10mins.**

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. 2240 (at 00.00hrs). Synodic Rotation No. 2 CONDITIONS (2) Good. WIND SE. 18 - 20km/h

TRANSPARENCY: (3) Fair. 75% Cumulus cloud, moving fast CURRENT TEMP.: 24°C. 75°F.

SOLAR CYCLE 25



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.: 2
Total Sunspot groups: 0 Total single Sunspots: 1 Total Sunspots: 1 R = 11 C.M.E: 0 Total C.V: = 1
Sun limb in slight motion. Total Q. CV: = 1

www.sydneycityskywatchers.org

= Plage. = Faculæ = Flare

NAME: **Monty Leventhal OAM**
Supported by the Donovan Astronomical Trust.

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	**9th March 2021.**	**TIME 07 + 1hrs. 45min.**
U.T. DATE	**8th March 2021.**	**UT: 21hrs. 45mins.**

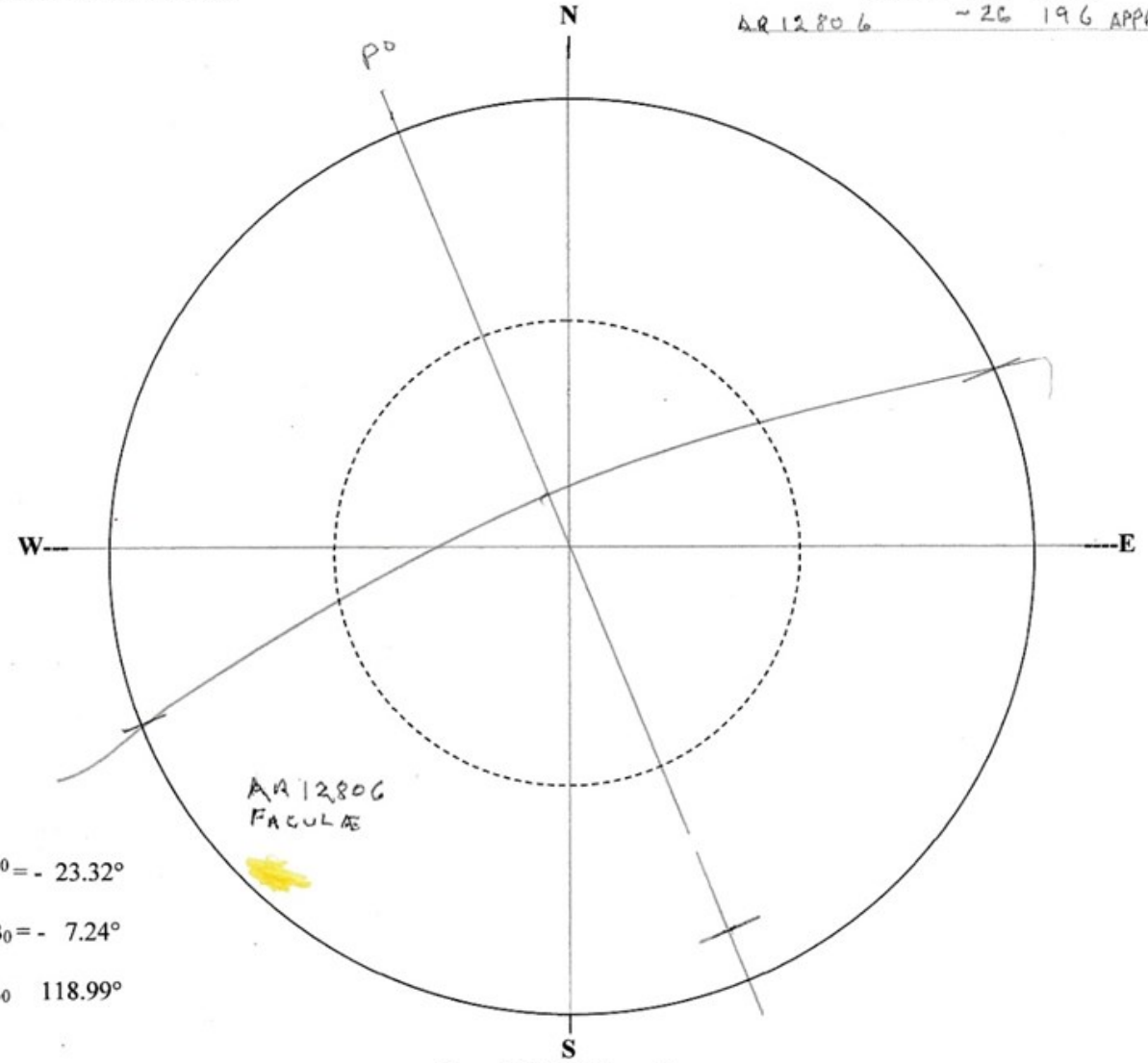
INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5

ROTATION No. 2241 (at 00.00hrs). Synodic Rotation No. 18 CONDITIONS (2) Good. WIND NW. 12 - 15km/h

TRANSPARENCY: (4) Poor, 90% Cirrus cloud, increasing. CURRENT TEMP.: 24°C. 75°F.

SOLAR CYCLE 25

Group Lat. Long.
AR 12806 −26 196 APPROX.



$P^0 = -\ 23.32°$

$B_0 = -\ 7.24°$

L_0 118.99°

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: 0 Filaments: 0 Faculæ: 1 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. C.V: = 0

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

E.A.S.T. DATE	**24th March 2021.**	**TIME 07 + 1hrs. 30min.**
U.T. DATE	**23th March 2021.**	**UT: 21hrs. 30mins.**

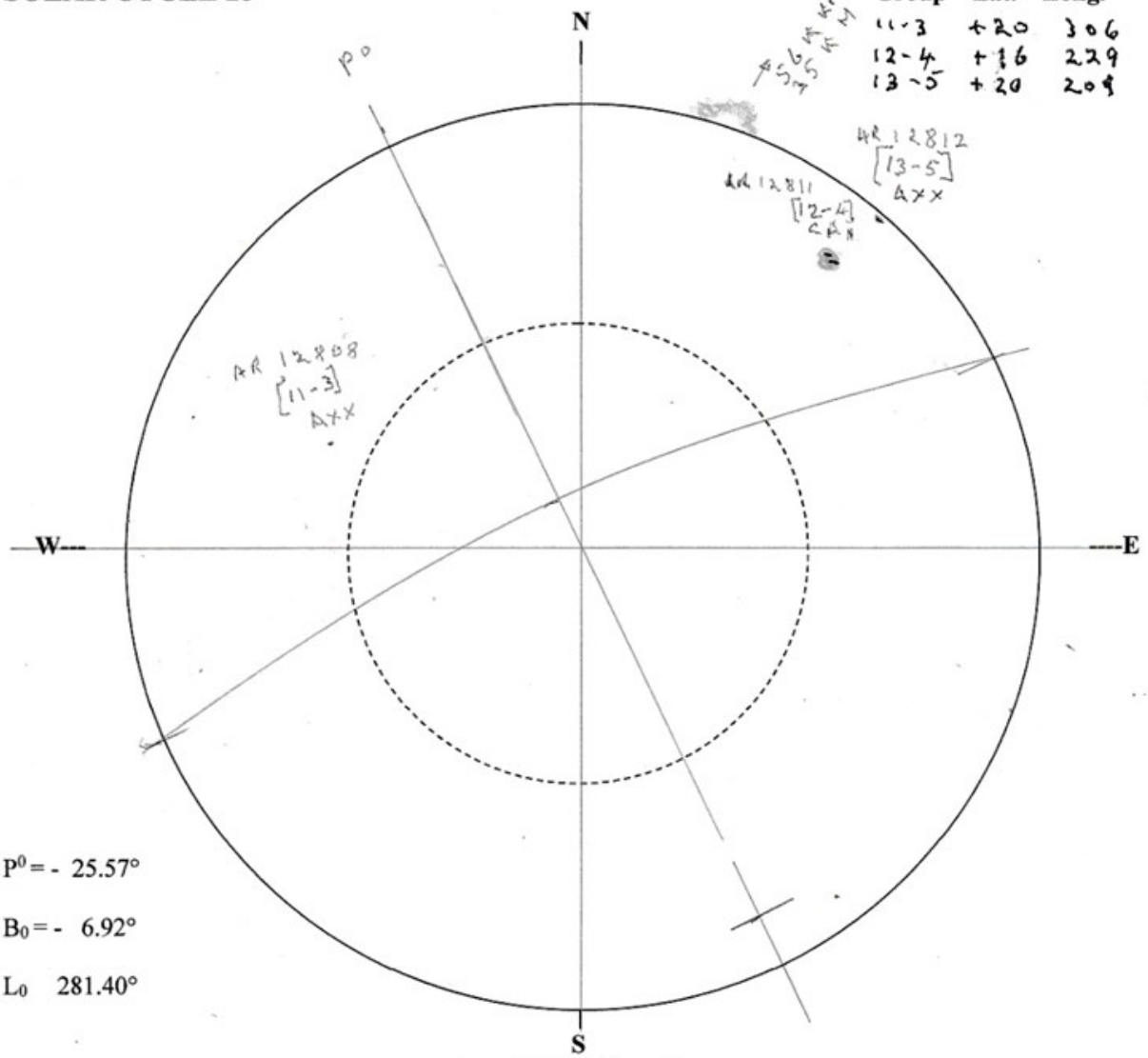
INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5

ROTATION No. 2242 (at 00.00hrs). Synodic Rotation No. 6 CONDITIONS (3) Fair. WIND NW. 18 - 20km/h

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

SOLAR CYCLE 25

Group	Lat.	Long.
11-3	+20	306
12-4	+16	229
13-5	+20	209



P^0 = - 25.57°

B_0 = - 6.92°

L_0 281.40°

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.: 3

Total Sunspot groups: 1 Total single Sunspots: 2 Total Sunspots: 4 R = 34 C.M.E: 0 Total C.V: = 1

Sun limb in medium motion. Total Q. C.V: = 5

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

E.A.S.T. DATE	**28th March 2021.**	**TIME 07 + 1hrs. 55min.**
U.T. DATE	**27th March 2021.**	**UT: 21hrs. 55mins.**

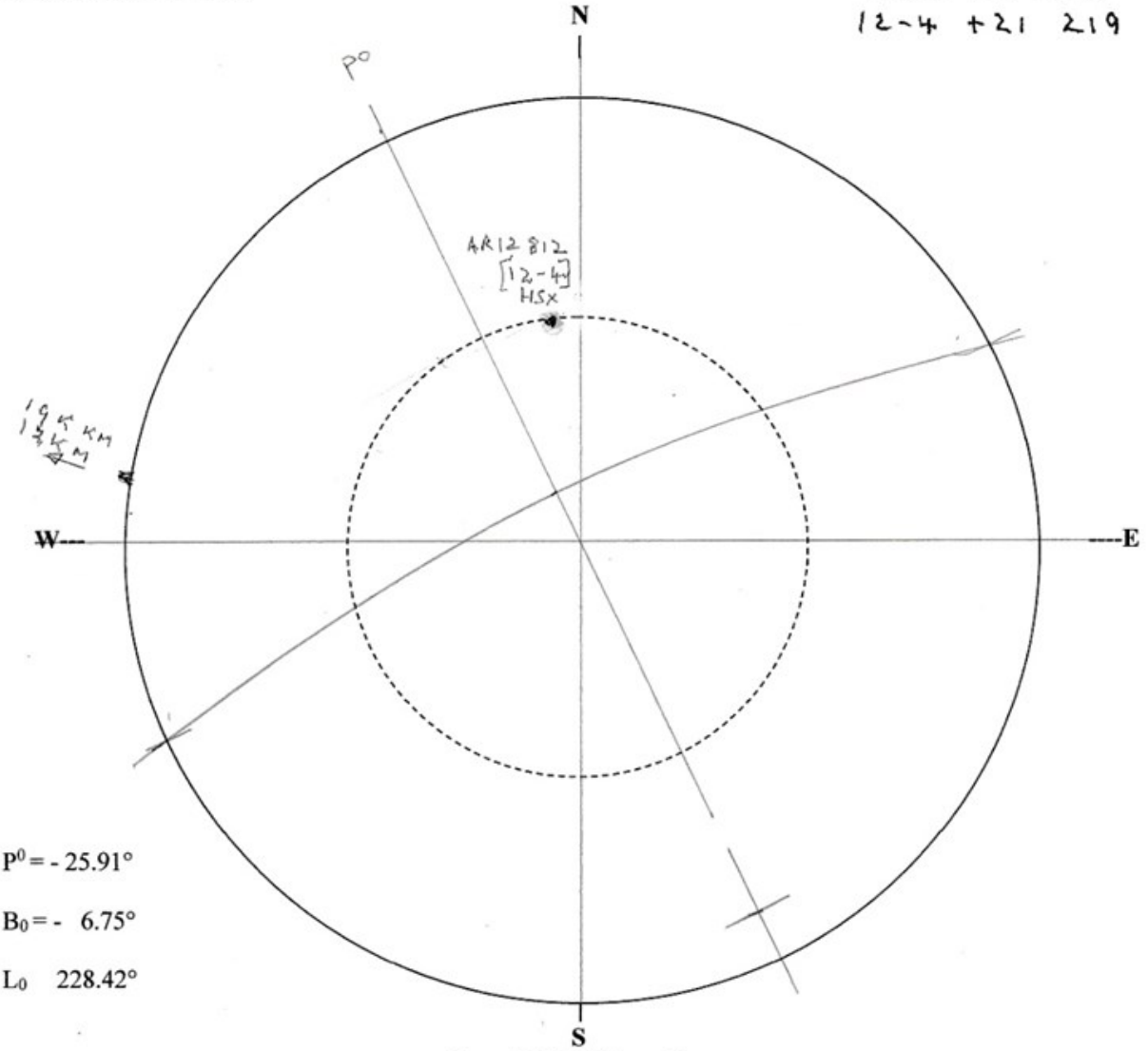
INSTRUMENT: S.C.T. 10". F=2,500 mm. f / 10. 40 mm Eyepiece. Full Aperture filter & 6Å H-alpha filter, f / 32. Mag: X62.5

ROTATION No. 2242 (at 00.00hrs). Synodic Rotation No. 10 CONDITIONS (2) Good. WIND SW 12 – 15km/h

TRANSPARENCY: (1) Very good 25% Cumulus cloud, increasing. CURRENT TEMP.: 19°C. 66°F.

SOLAR CYCLE 25

Group	Lat.	Long.
12-4	+21	219



P^0 = - 25.91°

B_0 = - 6.75°

L_0 228.42°

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.: 2

Total Sunspot groups: 0 Total single Sunspots: 1 Total Sunspots: 1 R = 11 C.M.E: 0 Total C.V: = 10

Sun limb in slight motion. Total Q. C.V: = 3

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AR12786: Synoptic Evolution

When sunspots and other solar features are daily recorded to the same image scale and orientation, a range of activity is revealed. At Nowra, NSW, spots etc are recorded to a scale where the solar disc is 1.6meters dia. This allows much detail to be logged as well as heliocentric coordinates, areas, etc.

A big spot group like AR12786 prompts the question: "did it have any precursors?" which earlier logs may answer. Big spot complexes can result from merging earlier groups, yet 786 had none – but it had successors aplenty!

Spot histories are best shown by 'synoptic mapping'. As viewed, a round spot will appear round only when near the central Meridian (CM). It's a skinny ellipse when near the solar limbs. Helio freeware (Meadows, P.) compensates for these distortions on our spherical star. When spot coordinates are available, spot outlines may be plotted on a synoptic grid. This reveals spot growth or decline, proper- motion, polarity changes etc. and the complex lives of active groups as they evolve.

AR12786: successors. With no precursors 12786 must have grown quickly on the solar back side. Due to cloud it was first logged here on 2020 Nov 25 when 40° W of the E limb and already700MH units in size. Yet it *had* earlier been 900MH (NOAA), "Synoptic" (Fig1). The big (p) spot had strong umbral field of V25 (violet 2500G), with V24 as it ended its FIRST disc transit. For more on rotation 1, see earlier report..

AR12794. On its SECOND transit, Dec 23, renamed AR12794, much of the old (p) spot remained at its original site, its field still strong at V22. But its train of minor (f) spots had, it seemed, now gone. See "Synoptic"(fig2). Yet, surprisingly, *they will soon be back!*

AR12797. At its THIRD transit, 2021, Jan 19, the group again had following PU spots at sites very close to the (f1) and (f2) sites of its FIRST transit! "Synoptic" (fig3). The old (p) had now become two simple PU spots aligned ~N-S with field of 1800 gauss.

Fourth Return? As this is written (early Feb, 2021) a 4th return is plausible, around Feb 13 at the solar east limb.

Proper Motion. The three transits, "Synoptic" Figs 1 to 4, show a steady drift or proper-motion eastward by the big (p) spot; the *reverse* of normal westward proper motion! Why?

As well, the smaller (f) spots show this drift too. In "Sunspots", 1964, Bray and Loughhead's Classic they state "...both (p) and (f) spots show proper motions in longitude ...initially the (p) moves westward the (f) eastward (p230)". They also cite Greenwich observers: "...the westerly motion of the (p) spot ceases when the group attains its maximum area; thereafter the motion is *easterly"*. Our big (p) spot conformed to this rule. When first seen on the solar disc it was already at its biggest and shrank slowly as it completed its first and later transits of the disc, while drifting eastward.

Polar drift. However, other forces are at work. They cite (p231) work by Tuominen (who) using Greenwich data found that at latitudes >± 16° the (p) spots drift poleward.

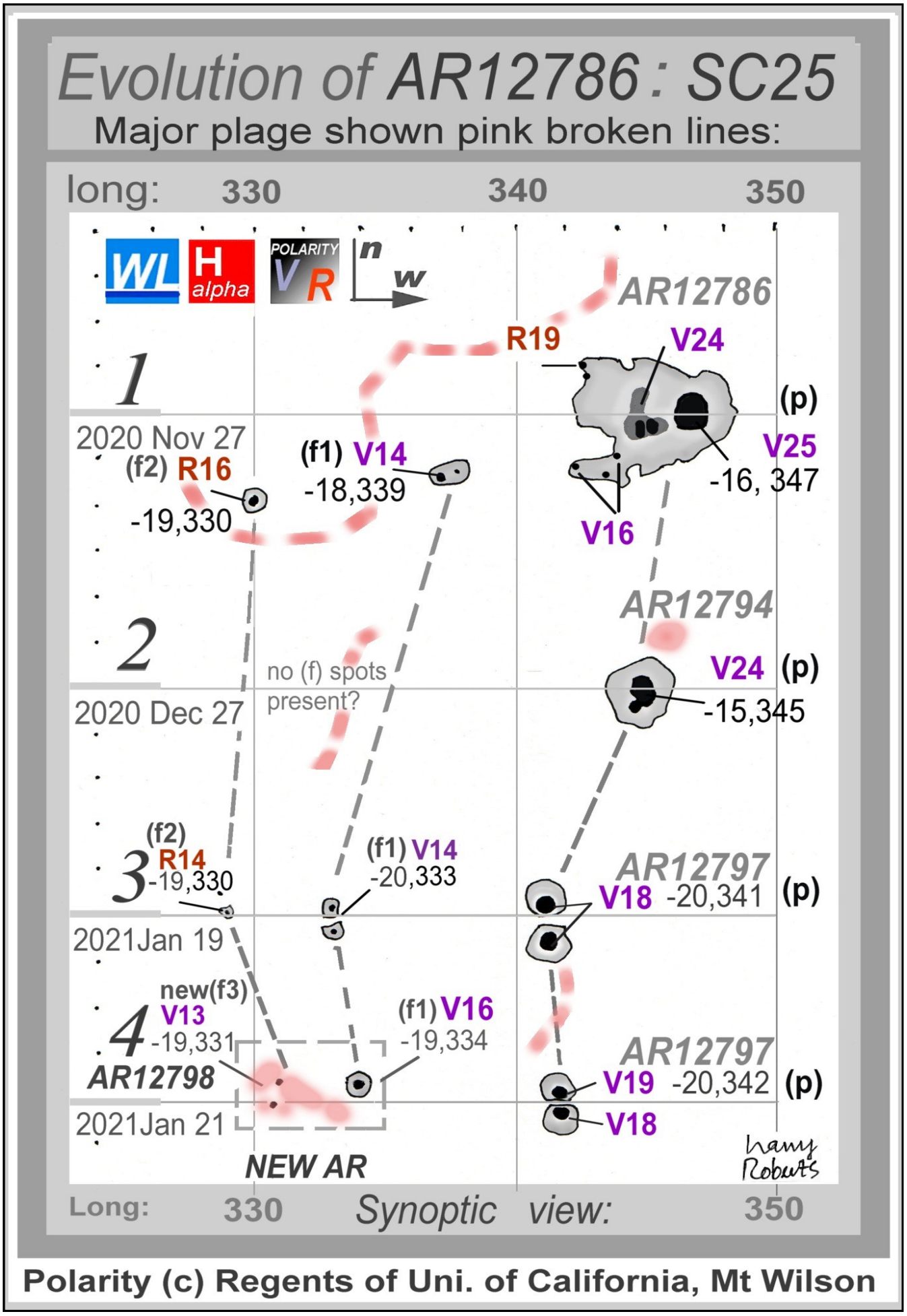
The big (p) spot AR786 in "Synoptic" Fig1, with area 780MH (NOAA) is already shrinking from its largest area of 1000MH (NOAA) 24hr earlier- and contracts further in figs2 to 4. Over this period the (p) spot sited at -16deg also drifts poleward ~4° while the (f) spots remain static.

Complex field in fig1. The brief Hale Delta magnetic Class of AR786 was discussed elsewhere, but the persistence of the R and V fields of the small (f1) and (f2) spots is remarkable - as no spots were present on the Group's SECOND transit – but reappeared with the same locations and polarity on its THIRD transit! Note the R14 (f2) spot in particular. These fields must have been refreshed after the SECOND transit – yet the big (p) spot's field had much declined?

New Fields. "Synoptic" Fig4. Surprisingly, the (f2) spot at -16,330 on Jan 20 was replaced on the 21st by a pair of V13 polarity spots at -19,331! This changed the whole AR12797structure, covering 17° longitude, to violet mono-polarity? A rare event! NOAA now split the old group into AR12797, the two (p) spots, and 'new group' AR12798, the old (f1) and new (f2) spots. The average separation of the two groups is just over ten degrees which justifies the split.

Activity Nest? Field Longevity at this site is notable. The old (p) site may well reappear – likely much reduced in mid-Feb 2021- a FOURTH transit? Yet SDO HMI disc images show fields at the site spread very thinly across 40° longitude and 30° latitude. Can this nest of activity again put on a show? Time will tell!

Harry Roberts


Evolution of AR12786 : SC25
Major plage shown pink broken lines:
long: 330 340 350
WL
H alpha
POLARITY
V R
n
w
AR12786
R19
V24
(p)
1
2020 Nov 27
(f2) R16
-19,330
(f1) V14
-18,339
V25
-16, 347
V16
AR12794
2
no (f) spots present?
V24 (p)
-15,345
2020 Dec 27
(f2)
R14
-19,330
3
(f1) V14
-20,333
AR12797
V18 -20,341 (p)
2021Jan 19
new(f3)
V13
-19,331
4
(f1) V16
-19,334
AR12798
AR12797
V19 -20,342 (p)
V18
2021Jan 21
NEW AR
Long: 330 Synoptic view: 350
Polarity (c) Regents of Uni. of California, Mt Wilson

Wolf Revisited

Crater Wolf draws me often to the Sea of Clouds (M. Nubium) to view the unusual landform - a Valentine's Day heart shape, with the pointy end of the heart missing – and to wonder how it got that way?

Wolf missed out on being imaged close-up by the Apollo side-view cameras – and only a single look down Orbiter view exists, it shows pretty much what we see in Earthly 'scopes.

The challenge with Wolf is to explain the formation's unusual shape. How did this landform come to be high enough to protrude well above the lava at a point close to the centre of the basin where no other high ground survived? Did the Nubium impact produce an uplifted central peak – none of the other basins have them? Clearly Wolf existed before the Nubium lava flooding occurred, so it is an ancient and battered formation – and it must be a high one compared to features nearby.

Try as I might I can't believe that the main crater got its heart shape from multiple impact events. The wreath surrounding Wolf is unusually wide and flat-topped, with toe -like features leading down to the mare surface on the SE/SW sides. Schultz in "Moon Morphology(1986)" states that "the cloverlike plan is probably the result of multiphased formation along such structural weaknesses. Wolf is interpreted as a caldera that was formed prior to the last stages of mare emplacement" (P 246).

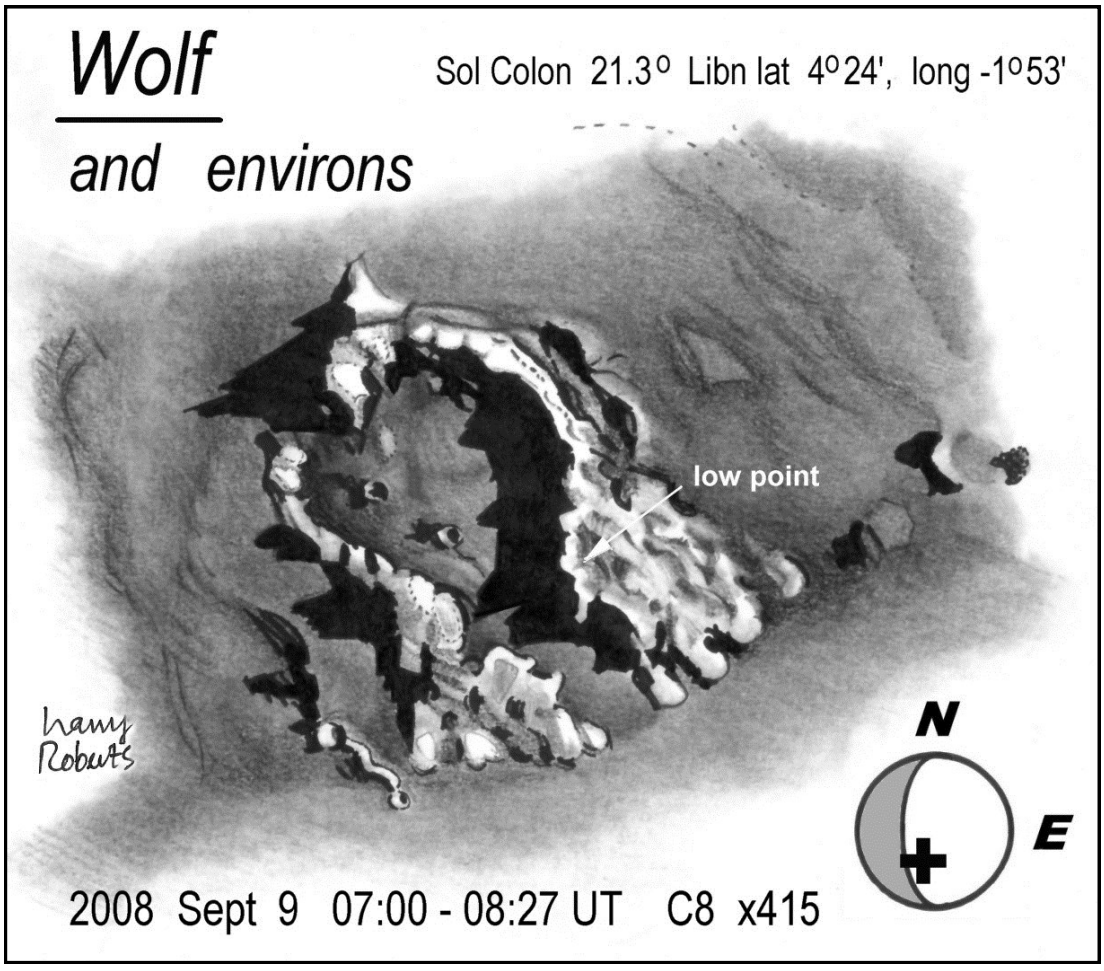
I wish I could accept that Wolf is a volcanic caldera – like those found on Earth and Mars – it would be by far the largest on the Moon. Sadly, there are now no accepted volcanic cones on the Moon bigger than 5km, much less Wolf's 25 km diameter!

Wolf's floor is covered by lava that seems darker than the mare surroundings – or is this an illusion? I saw two small fresh craters there, but maps show more. Was Wolf's floor higher than the surroundings it would prove the formation arose as a volcano – but nothing suggests it is. On Wolf's SW side a short bright rille seemed to connect two small craters – and this is probably a lava channel. Strangely, the broad gap in Wolf's rim on the south side is mapped as secondary impact crater Wolf B.

The impressive shadows cast by Wolf's east rim on the crater floor reach about 10km in length(at solar altitude 5º), but equate with a rim only 800m high – so the surviving walls are uneven in height and quite low. Arrowed in the image is a low point in the wall, revealed by the deep notch in the shadows on Wolf's floor. The Wolf formation is ringed by lava ridges giving the impression of a surrounding caldera naerly buried in the mare – note the ridge about ten km to the west throwing shadows across the mare's wrinkled surface.

Point your 'scopes at Wolf, and see if you can unravel its strange genesis.

Harry Roberts



Sydney City Skywatchers

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SYDNEY CITY SKYWATCHERS

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.

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