

# Breckland Astronomical Society

Affiliated to the British Astronomical Association and the Federation of  
Astronomical Societies

## ***EXTRA*** ***TERRESTRIAL***

**Newsletter March 2022**



Registered Charity no, 1044478

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Copy is always needed for this newsletter. Articles with an astronomical theme are welcome but anything of likely interest to the membership will be considered. Text or Word documents preferred but handwritten submissions also welcome.

Chris Bailey is the newsletter editor. [newsletter@brecklandastro.org.uk](mailto:newsletter@brecklandastro.org.uk)

Mick Ladner is visitor organiser. [visitors@brecklandastro.org.uk](mailto:visitors@brecklandastro.org.uk)

# Chairman's Notes, March/April 2022

Dear Astronomers

Firstly, we are at the point in the pandemic where it is time we should return to bimonthly newsletter editions. It was our editor's kind idea to provide monthly editions since April of 2020, and as well as that written a huge amount of informative articles. These are all available on the facebook page, as files, downloadable. This work was all, as with all our society's roles, unpaid and shows there is a big love of astronomy among us. 24 editions, well done. So the next edition will be on 1<sup>st</sup> May 2022.

Stormy weather has hampered our observing and imaging efforts. It was lovely to see some of you at the open night and talk after a long period of me being away from Great Ellingham. I certainly haven't been as productive over the Christmas period as some of you will know the reason why. But we have all been emerging from a period of caution and it looks like the skies are now clearing for us, in a metaphorical sense at least.

It is a lovely time of year as the weather improves but along with that the nights shorten. Not so much obvious in the sky in spring, even the planets have disappeared, but here's hoping for a surprise comet, or supernova. It is galaxy season, and I love a nice galaxy, you can't beat a faint fuzzy blob at the edge of your vision. Try exploring the Virgo cluster from a dark site such as Haw Wood Farm (the star party being at the end of April this year). Period comet 19P/Borelly is visible at the moment, check it out in my accompanying article in this edition.

We have some tall hedges to the west of the patio, but it looks like we may not be able to get together to cut them before nesting season starts again this year. The roadside hedge is now starting to encroach on the South East horizon for the 20 inch telescope.

We will aim for a normal annual schedule of an AGM after Jerry Workman's talk in May. At the moment, I have lost the speaker in June, due to a secrecy contract and am engaged in looking for some speakers for the summer. Suggestions or contacts welcome to chairman@.... Professor Chris Lintott is now coming to visit us in October.

## A brief history of Asteroids

Andy did an amazing and entertaining talk on Friday February 11<sup>th</sup>, it being his 7<sup>th</sup> talk. While the initial thrill of achievement of giving a first lecture may have passed, some confidence and experience was now evident. Andy is doing a talk soon for our neighbouring astronomical society DASH about neutrinos.

The title of Andy's talk was ASTEROIDS. For those of you who know him, we were expecting him to turn up with a 1980's computer playing the flickering line graphics. As it happened he came with a lot of printed Bingo cards and had trawled through 20,000 Asteroid names, looking for funny ones, and managed to memorise about 90 of his favourites.

The definition of an asteroid is rather vague, in fact if you died in space you would be an asteroid (minor planet according to the preferred IAU term.), only if you were also naked.

A history of their discovery dates back to late 18<sup>th</sup> century, and the two Johanns, Titius and Bode, predicted a crude empirical law that fit the positions of the known planets. When Herschel discovered Uranus in 1781, the law seemed to have been vindicated. Thus were launched the 'Celestial Police' and in 1801 Piazzi discovered Ceres, the new planet. Piazzi was an accomplished comet astronomer in Palermo. The next year, Pallas was discovered, then in 1804 Juno, and 1807 Vesta. For some reason, it took until 1845 for the next to be found, Astraea. But they soon started to turn them up quickly thereafter 1847, Hebe and Iris, etc. The numbers came later.

The asteroid 'belt' is not as was depicted on our childhood posters, similar to the Empire Strikes Back, it is very sparse and you would not be at much higher risk of collision passing through it on your way to Jupiter in the Millennium Falcon (I presume they meant the 3<sup>rd</sup> millennium). The density of the belt is about one asteroid in between Earth and the Moon.

The asteroids have clearance zones, like the rings of Saturn, called Kirkwood Gaps, at 2.5 AU 2.82 and 3.27 AU, due to resonances with Jupiter's orbit of 3:1, 5:2 and 2:1 kicking anything out of those orbits. Many are elliptical orbits. There are several bunches of asteroids, families as Andy describes in the picture.



One of those asteroids not in a family with any others is called 9007 Jamesbond, it was also the 9007<sup>th</sup> to be discovered (it needs an initial digit to work), as James Bond always worked solo. The outer family is the Trojans these resonate with Jupiter's orbit in an orbit that can be viewed as a 3 revolution elliptical orbit meeting up with Jupiter or opposite Jupiter regularly. There are

thousands of these Trojans, especially sitting at Lagrange points L4 and L5 60 degrees round from Jupiter at 5 AU out.

The asteroids are not a destroyed planet as some have hypothesised. This can be proven due to  $\Delta^{17}\text{O}\text{‰}$  and  $\delta^{18}\text{O}\text{‰}$  values, comparisons of isotopes of oxygen and thus all the families and Earth that have been sampled, can be put on to a plot where they form distinct clusters. The asteroids are too varied to have ever been one body. What a great piece of science. Also magnetometry has confirmed this conclusion.

People have searched for evidence of their formation, and it looks like the history of Jupiter and Saturn slinging outer disk and inner disk objects around when the gas giants initially moved inwards, had led to their current position.

The classifications by type used to be simple, but ended up being this:

SC(BCFG)X(EMP)ADQRTV – can anyone think of a simple mnemonic for that. X types are related to asteroid Psyche and are metallic.

Some have been confused with comets, such as 4015 Wilson-Harrington, 1979VA is comet 107P, and 133 El Pizarro.

Some enter the inner solar system (us!) and there are 10000 Apollo type asteroids that cross Earth's orbit, such as the object that fell on Chelyabinsk. There is also a class called Aten that go inside Earth's orbit and Amor that is just outside, such as 21 mile long 433 Eros – an occasionally close passing asteroid (next visible August 2023, at 0.75 AU 11<sup>th</sup> magnitude). Atiras are completely less than 1AU, and there are zero Vulcanoids, orbiting within 0.4 AU, that of Mercury. There could be a Venus Atira group, as one was discovered and initially named Vatira, however this was later changed to an unpronounceable name by the IAU. Earth has 2 trojans, one called Cruithne, pronounced Croo-eeenay.

Thanks for a great talk Andy.

Our speaker this month is Dr Stuart Clark FRAS. Stuart is an astronomer and award-winning science writer for the Guardian, New Scientist, BBC Focus and many other publications. He is writer and presenter of the Music of the Spheres series for BBC Radio 3 and author of several works of non-fiction and fiction, which have been translated into more than twenty-five languages. He holds a first class honours degree and a PhD in astrophysics. He is a Visiting Fellow at the University of Hertfordshire, a Fellow of the Royal Astronomical Society, former Vice Chair of the Association of British Science Writers and a consultant for the European Space Agency. In September 2020, the University of Hertfordshire awarded him a DSc for services to astronomy and the public understanding of science.

I have read his book, the focus of his upcoming talk on March 11<sup>th</sup>, here is my review.

### **Beneath the Night – a short review**

Think of it as a historical backbone, Stuart Clark's "Beneath the Night" is a fascinating description of how human cultures grew up intimately intertwined with the stars. They governed out timings and remained god-like and mysteriously out of our touch, e.g.:

"Ra the sun-god, was said to travel in a celestial barge across the sky by day. He then transferred to a second barge and moved unseen through the underworld by night."

The book is written for “anyone who has stood beneath the night sky and wondered about the stars”

Due to the precession of the equinoxes over centuries, Sirius, was invisible from Turkey until 9300 BC. It's appearance on the South horizon must have been a fascinating discovery, worthy of building a temple. Perhaps the word discovery is too modern a word, not conveying the omen implying, supernatural feeling it may have brought at the time. It is now, amazing for us to conceive of the time that has elapsed since those civilisations and how the stars themselves have imperceptibly changed over what has been the blink of an eye in celestial time.

Back in ancient “Egypt”, clocks were made of stars rising on the eastern horizon. And if you've ever wondered why some constellations look nothing like their name suggests, think of it more as an aide-memoire of the pattern, rather than a literal interpretation. The Pleiades crop up in many folk tales. All in all, there are some interesting ancient theories described in the book, plenty of colour picture pages at the centre and a chronology of how we got to where we are now. Right up to Holst's inspiration, the moon missions, satellites, and the modern age where I was lucky enough to get a signed copy of all this when Stuart visited Norwich Science Festival last autumn.

*Dan Self*



# **BRECKLAND ASTRONOMICAL SOCIETY**



## **Beneath the Night How the stars have shaped the history of humankind**

**Dr Stuart Clark, PhD DSc FRAS**

**Stuart is an astronomer and award-winning science writer for the  
Guardian, New Scientist, BBC Focus**

**Friday March 11<sup>th</sup> 7:30pm start**

**Great Ellingham Recreation Centre**

**Watton Road (B1077) NR17 1HX**

**£2.50 entry £1 under 18s**



**Observatory  
Open Day  
March 25<sup>th</sup>  
2022  
from 8pm**

**Great Ellingham Recreation Centre, Watton Road (B1077), NR17 1HZ**

**What to see:**

**The many galaxies of  
Leo & Ursa Major  
Castor A and B  
Beehive Cluster  
ghost of Jupiter nebula**



**[www.brecklandastro.org.uk](http://www.brecklandastro.org.uk)**

# JOHN'S NEWS BITS

## March 2022

Reported on [livescience.com](https://livescience.com), NASA's asteroid monitoring system has been upgraded to scan the entire sky once every 24 hours looking for hazardous asteroids.

Named ATLAS for Asteroid Terrestrial-impact Last Alert System located in Chile.

NASA's Parker solar probe WISPR instrument has snapped the very first glimpse of the red-hot surface of Venus revealing continents, plains and plateaus as well as detecting an oxygen halo in the atmosphere.

The solar probe was launched in 2018 to make observations of the outer corona of the Sun but will have to make seven Venus flybys over seven years to shrink its orbit to get it within 3.83 million miles of the Sun.

The NASA mission to metallic asteroid Psyche has been moved to the summer of 2022, earlier than originally planned 2023.

Sci-tech news report that the JWST is near completion of the alignment of the 18 primary mirror segments.

The alignment is done using the NIRS instrument with each segment collecting light from the same star creating an 18 star mosaic.

For the latest status on the JWST go to [www.webb.nasa.gov](https://www.webb.nasa.gov) and "where the Webb is".

NASA's Mars Curiosity Rover has detected large quantities of carbon 12 isotope which is lighter than carbon 13 isotope.. 98% of carbon in Earth is the isotope carbon 12 which is indicator of life. The C12 was in a sample analysis of sandstone rock on Mars' Gale

crater. It could be caused by past life microorganisms. indicator of life.

Reported in livescience.com by Paul Sutter, astrophysicist at the SUNY Stony Brook university in N.Y. The Pacific Ocean Neutrino Experiment P-ONE will place huge photodetectors sunk at the bottom of the ocean to pick up Cherenkov radiation from neutrinos. Neutrinos participate in the weak nuclear force responsible for nuclear fusion and decay. There's lots of them about but difficult to detect as their mass is so small, some 60 billion neutrinos will pass through you thumbnail every second if you face it towards the Sun, and you won't feel a thing!!.

Scientists at the Max Planck Institute for Physics have confirmed that the mass of a neutrino has an upper limit of 0.8 eV. This required work of unprecedented precision by the KATRIN experiment. Reported in sciencedaily.com..

NASA has announce that the ISS will plunge (de-orbit) into the sea on January 2031 at point Nemo in the remote area of the south pacific ocean.

The JWST will study the black hole at the centre of the Milky Way, Sagittarius A. Joining the JWST team will be a team working on the Event Horizon Telescope, EHT which captured the first black hole image in M87 in 2019.

NASA's Artemis 1 uncrewed Orion spacecraft on a Space Launch System (SLS) still on schedule for launch in early April. This is a 26 day mission with a 6 day moon orbit before returning to Earth.

Technology.org report, NASA's IXPE (Imaging X-ray Polarimetry Explorer) has just sent the first image of Cassiopeia A, a supernova remnant, in glowing magenta x-ray light . Cassiopeia A is the remnant of a star the exploded in the 17<sup>th</sup> century.

China's Yutu-2 moon rover has spotted two strange glass spherules on the far side of the moon. It is believed that the spherules come from minerals being rapidly superheated, probably from an explosive eruption in the Moon's volcanic history or from a high speed meteorite impact. Reported on [livescience.com](http://livescience.com).

John Gionis

# The solar system in March and April 2022

## Lunar antics

The month begins with a new moon. The earliest opportunity to spot the crescent (something Dr Becky calls the 'toenail moon') in the West after sunset at 18:30 is Friday March 4<sup>th</sup>, when it is a VERY thin crescent at 5%, but poking fairly high above the houses. This, and the next lunation are a great opportunity to spot it at a thin phase, as the plane of the moon's orbit makes a large angle with the horizon at sunset. Jupiter at this point is a degree away from the Sun.

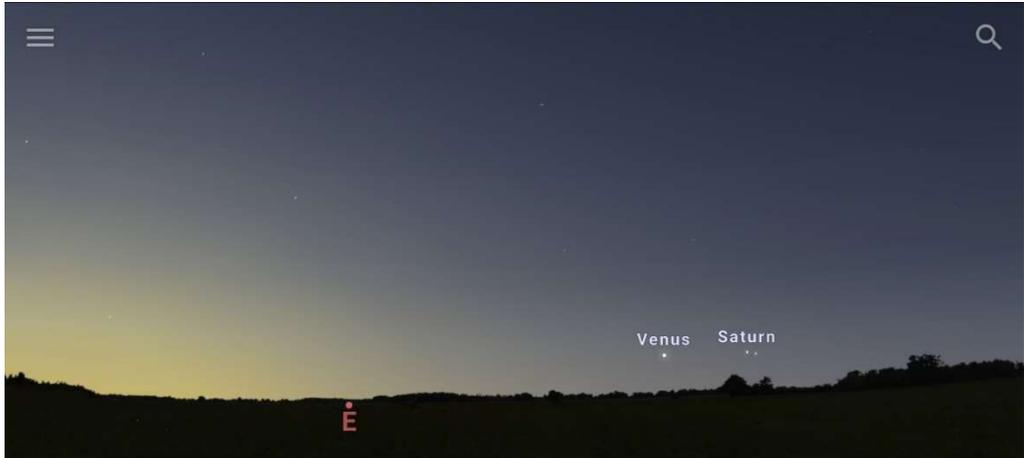
It is dark from 19:21 on the 5<sup>th</sup>, shifting to 20:01 on the 25<sup>th</sup>. The 35% crescent moon makes a nice pairing with the Pleiades on the 8<sup>th</sup>, and this doesn't set until after midnight. If this Tuesday night is clear, at around 11pm there is a good photo opportunity of the Hyades, moon and Pleiades lying along the WNW horizon. From this point in the month, the moonlight will start to interfere with deep sky viewing, until the 21<sup>st</sup>, when the waning gibbous moon rises later 22:36, as opposed to 21:08 on the 20<sup>th</sup>. The moon's orbital plane is again making a steep angle with the horizon at this time, causing it to rise 1 ½ hrs later each night at 52°N latitude.

For April, the moon is a very thin crescent in the evening on the 3<sup>rd</sup>, crosses the Hyades and Pleiades on the 4<sup>th</sup> and 5<sup>th</sup> and interferes (i.e. is too bright and too late for deep sky observations in the evening) from the 7<sup>th</sup> when the 29% moon doesn't set until 2:02am. By the 19<sup>th</sup> it's starting to get a little late for twilight to finish 21:59, and the moon rises at 00:08 (on the 20<sup>th</sup>), giving the first dark observation window again. This is Virgo cluster time! And also the time for the Haw Wood Star Party this Spring. ( see [hawwoodfarm.co.uk](http://hawwoodfarm.co.uk) ) especially on Saturday April 23<sup>rd</sup>.

We are nearly past the time to observe Orion, and soon Hydra becomes the constellation visible in the South. Gemini is still very high and Ursa Major is overhead, presenting a good opportunity to hunt for M81 and M82 in Ursa Major.

In early March, Venus is slightly fading and recessing from crescent to half phase in the the South East at 5:30 ish in the mornings, Mars is below it and very faint and low. On March 27<sup>th</sup> (Sunday morning, the waning crescent moon sits at a very low declination (below the most southerly point on the ecliptic) and attempts to join Mars Venus and Saturn. It is closer to the trio but too southerly to be visible on the 28<sup>th</sup> – this is more of a southern hemisphere morning conjunction. The planets continue to mingle and Jupiter joins them, but the angle of the ecliptic is so shallow, that it is not worth looking for them unless special circumstances allow.

Mid and late March has another sequence of ISS passes in the evening. Heavens above or an ISS app is good for watching when these are coming over. In the morning of Friday March 25<sup>th</sup> the moon's orbit shows how far south it now moves, the half moon sitting well below the Lagoon nebula – completely spoiling the view of course. A month later on April 25<sup>th</sup> there is an ISS pass (hopefully) at 5am above the low lying crescent moon. The Lunar orbit is approaching a



“standstill” in 2025 where the Moon's orbit can graze the south horizon from Northern Scotland.

### Comets

Periodic Comet 19P/Borely is visible this month and next, and can be found moving from Aries to Perseus, to the upper right of the Pleiades throughout the month. See these charts. It is fairly faint, at 9<sup>th</sup> magnitude, so will probably need better charts. On the 20<sup>th</sup> and staying close shortly after, it passes the star Atik or omicron Persei, which is 3° below the California nebula, the large red photographic emission nebula, NGC 1499. Get detailed charts on the night from heavens-above.com



C/2017 K2 PANSTARRS looks pretty modest in apparent brightness and sits fairly still in Ophiuchus/Aquila near the tip of the pointy bit of the asterism with zeta and epsilon Aquilae in the north of the constellation. It is visible in the early morning in March, but is huge and distant, it crosses the 4 AU line on March 10<sup>th</sup>, and should be around 10<sup>th</sup> magnitude or so. Note the year in the designated name, it was discovered at 16 AU, this is very rare, it was actually precovered on an image from 2013. It should be nice by July and pass M10 globular cluster on July 16<sup>th</sup>.

Another distant comet C/2019 L3 ATLAS is visible moving past Alhena in Gemini, along the milky way. Again charts from heavens-above.com may be sufficient, but Stellarium (updated) would work better with fainter stars. This one is a little fainter, but is running brighter than predicted at around 10<sup>th</sup> magnitude.

Look out for new comet C/2021 O3 PANSTARRS (call it what you like, these panstarrs comets need to be named something more interesting in my opinion) emerging from the western sky in early May, post perihelion. It tracks vertically upward from the North West horizon until circumpolar in Perseus. It passes 0.6AU from us, on May 9<sup>th</sup> and moves fairly rapidly toward Camelopardalis and bends past Polaris in late May.

Philae and 67P/Churyumov-Gerasimenko is still visible looping round the top of Cancer, it is a bit faint now. Enjoy hunting down these fickle snowballs.



Pic: The 'gegenschein' from Haw Wood Farm D.Self 18 x 5 min 18mm f/2.8 lens on tracked mount.

*Dan Self*

# Solar Cycle 25 Update

Solar Cycle 25 is heating up. New sunspot counts from NOAA confirm that the young solar cycle is outrunning the official forecast. You are here:



Actual sunspot counts have now exceeded predictions for 15 straight months. The monthly value at the end of December 2021 was more than twice the forecast, and the highest in more than 5 years.

The “official forecast” comes from the Solar Cycle Prediction Panel representing NOAA, NASA and International Space Environmental Services (ISES). Using a variety of leading indicators, the Panel predicted that Solar Cycle 25 would peak in July 2025 as a relatively weak cycle, similar in magnitude to its predecessor Solar Cycle 24. Instead, Solar Cycle 25 is shaping up to be stronger.

Geomagnetic activity has nearly tripled since the new solar cycle began. In 2020, the first full year of Solar Cycle 25, there were 9 days with at least minor (G1-class) geomagnetic storms. That number skyrocketed to 25 days in 2021. One of those “storm days” (Nov. 4, 2021) was a borderline G4-class (severe) event

with auroras sighted as far south as California and New Mexico. A similar progression may be expected in 2022.

Another sign of increasing solar activity is the X-flare. X-flares are the most powerful type of solar flare. They can cause strong radio blackouts, pepper Earth's atmosphere with energetic particles, and herald intense geomagnetic storms. The sun produced zero of these flares from late 2017 until mid-2021. Solar Cycle 25 busted the drought on July 3, 2021, with an X1.6 category explosion, followed by an X1-flare on Oct. 28, 2021.

Two down, 98 to go? Typical 11-year solar cycles produce more than 100 X-flares during the years around Solar Max. Stay tuned for updates as Solar Cycle 25 intensifies.



# Light is logarithmic

If you think logarithms and log tables are a boring thing of academic types, then let me inform you that your eyes and ears work with logarithms to allow you to judge brightness and loudness. Nature works with logarithms, so it pays to appreciate that when taking astrophotos. I will look at celestial objects in this context.

A logarithm or log is just the power of something. The easiest way is using powers of 10, that's pretty much just the number of zeroes a number has.

log of 10 is 1, as there is 1 zero.

log of 100 is 2, as there are 2 zeros.

log of 1,000,000 is 6 as there are 6 zeros.

This sounds pretty simple right. Well it is, but it can be extended.

The logs above have a 'base', that is base 10. It can be base anything, maybe base 2, even base 'e' – that tricky number you may remember from maths. Never mind that for now.

log (base 2) of 2 is 1

log (base 2) of 4 is 2

log (base 2) of 8 is 3

I think you can spot the pattern, the log is how many times you multiply the base.

Just to go a bit further, you can also have negatives.

log (base 10) of 10 is 1

and the log of 1 is 0 (there are zero zeros!)

but also log of 0.1 is -1

and the log of 0.01 is -2

etc.

Now we can introduce nature. Specifically, the stars. More specifically, this weird magnitude scale you hear of:

Aldebaran is magnitude 1.0

Vega is magnitude 0.0

Sirius is magnitude -1.4 and is the brightest star in the sky

That is a log scale. And the base is 2.512 and it is backwards i.e. brighter stars and objects are more negative. So every time you go down by 1 magnitude, you get about  $2\frac{1}{2}$  times brighter. It fits so that if you go down by 5 magnitudes, it is exactly 100x brighter.

It came about as the brightest stars were of the 1<sup>st</sup> magnitude, then the 2<sup>nd</sup>, 3<sup>rd</sup> etc. What the ancients who classified stars by brightness may not have cared about was that those numbers don't correspond to the amount of light coming from them!

A typical random star field, contains one or two stars that are maybe a thousand times brighter than others, a few more that are a hundred times brighter, many that are ten times brighter than the faintest ones that pepper the background. But then, there is the faint light intensity of the nebulae, galaxies, or Milky Way. If you are lucky the background sky glow is fainter than those faint stars.



So a sample of pixel values on your camera chip would not 'see' a range of brightnesses like:

55, 92, 20, 102, 63, 15, 77, 29, 37, 125, 112, 120, 200, ...

such as your typical daytime JPEG images may show. JPEGs pixel values go up to a maximum of 255 and pretty much all of them you will encounter have had image processing done on them.

A RAW pixel readout would 'see' a more extremely non-linear range of digitised values eg:

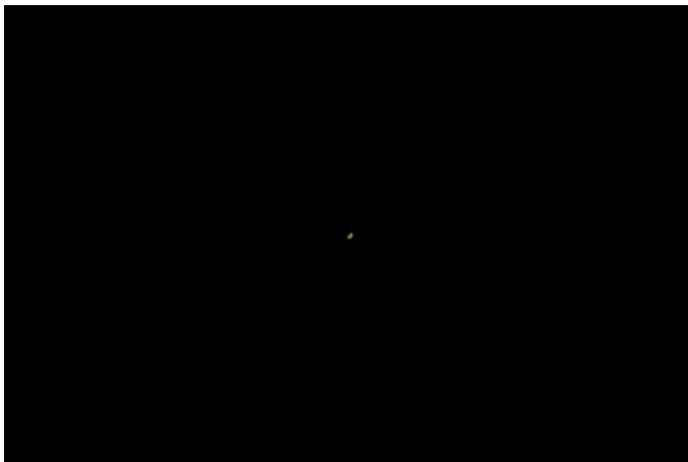
2, 4, 2, 3, 2, 5, 1, 432, 3928, 65535, 2, 16, 3, ...

I chose the 65535 above as this is the maximum value a common 16-bit image pixel can take, and any light intensity over that just reads out the maximum. That is why you see white blobs in the middle of over-exposed stars. This would by the way look a very dull image.

Since photography was available to people, cameras had 'stops' which are also logarithmically spaced for good reason  $f/22$ ,  $f/11$ ,  $f/5.6$ ,  $f/2.8$ . There are exposure values EV, that summarise how long the camera was open combined with how sensitive the film was and how open the aperture was. The total intensity of light, basically that falls on the film, then this value is logarithmed to compress it into a neat linear scale.

The above effect explains why LIGHT POLLUTION is so debilitating for astronomy. All it takes is one distant light to ruin a dark place, because it shifts the position on the log scale by a great deal. For example from 1 to 2 in terms of brightness, or twice as bright. Whereas a sky surrounded by 100 distant lights wouldn't be so different from 101, a tiny fraction brighter, and a tiny step along the log scale.

I was inspired to write this article as I had found some photographs of Venus in the 20 inch telescope taken many many years ago, where the exposure of each was 100 times the last. i.e. a hundred times the light intensity is registered in the raw image. See for yourself the huge range of brightness that has to be covered in this sequence of photographs that cover an exposure range of 1 million. I will leave you with the fact that the Sun is ~ 1 million times brighter than the Moon.



Venus 1x exposure revealing details of the phase



Venus 100x the previous exposure, overexposed, bloated showing spectral dispersion.



Venus 1000000x the original exposure, showing background stars and light pollution.



Venus 10000x the first exposure, showing diffraction spikes and a background star.

*Dan Self*

# Webb Team Begins Aligning the Telescope

In early February the three-month process of aligning the telescope began – and over the last day, Webb team members saw the first photons of starlight that travelled through the entire telescope and were detected by the Near Infrared Camera (NIRCam) instrument. This milestone marks the first of many steps to capture images that are at first unfocused and use them to slowly fine-tune the telescope. This is the very beginning of the process, but so far, the initial results match expectations and simulations.

A team of engineers and scientists from Ball Aerospace, Space Telescope Science Institute, and NASA’s Goddard Space Flight Centre will now use data taken with NIRCam to progressively align the telescope. The team developed and demonstrated the algorithms using a 1/6th scale model telescope testbed. They have simulated and rehearsed the process many times and are now ready to do this with Webb. The process will take place in seven phases over the next three months, culminating in a fully aligned telescope ready for instrument commissioning. The images taken by Webb during this period will not be “pretty” images like the new views of the universe Webb will unveil later this summer. They strictly serve the purpose of preparing the telescope for science.

To work together as a single mirror, the telescope’s 18 primary mirror segments need to match each other to a fraction of a wavelength of light – approximately 50 nanometres. To put this in perspective, if the Webb primary mirror were the size of the United States, each segment would be the size of Texas, and the team would need to line the height of those Texas-sized segments up with each other to an accuracy of about 1.5 inches.

Scott Acton and Chanda Walker of Ball Aerospace, along with Lee Feinberg of NASA Goddard, walk through the basic steps below:

“With deployment of the mirror segments now complete, and the instruments turned on, the team has begun the numerous steps required to prepare and calibrate the telescope to do its job. The

telescope commissioning process will take much longer than previous space telescopes because Webb’s primary mirror consists of 18 individual mirror segments that need to work together as a single high-precision optical surface. The steps in the commissioning process include:

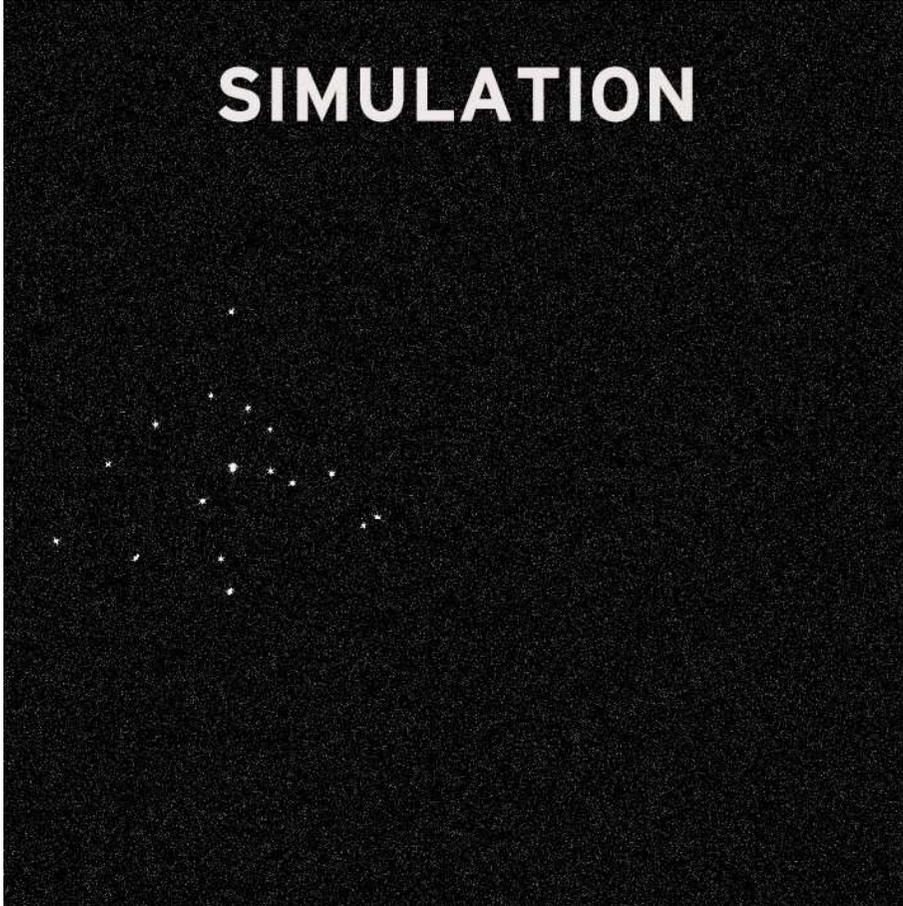
1. Segment Image Identification
2. Segment Alignment
3. Image Stacking
4. Coarse Phasing
5. Fine Phasing
6. Telescope Alignment Over Instrument Fields of View
7. Iterate Alignment for Final Correction

### **1. Segment Image Identification**

First, we need to align the telescope relative to the spacecraft. The spacecraft is capable of making extremely precise pointing moves, using “star trackers.” Think of star trackers as a GPS for spacecraft. At first, the position of the spacecraft from the star trackers does not match the position of each of the mirror segments.

We are pointing the telescope at a bright, isolated star (HD 84406) to capture a series of images that are then stitched together to form a picture of that part of the sky. But remember, we don’t have just one mirror looking at this star; we have 18 mirrors, each of which is initially tilted towards a different part of the sky. As a result, we’ll actually capture 18 slightly shifted copies of the star – each one out of focus and uniquely distorted. We refer to these initial star-copies as “segment images.” In fact, depending on the starting positions of the mirrors, it may take multiple iterations to locate all 18 segments in one image.

# SIMULATION

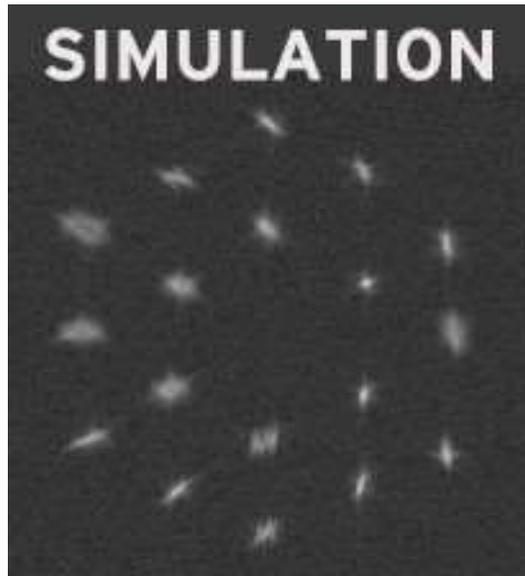


One by one, we will move the 18 mirror segments to determine which segment creates which segment image. After matching the mirror segments to their respective images, we can tilt the mirrors to bring all the images near a common point for further analysis. We call this arrangement an “image array.”

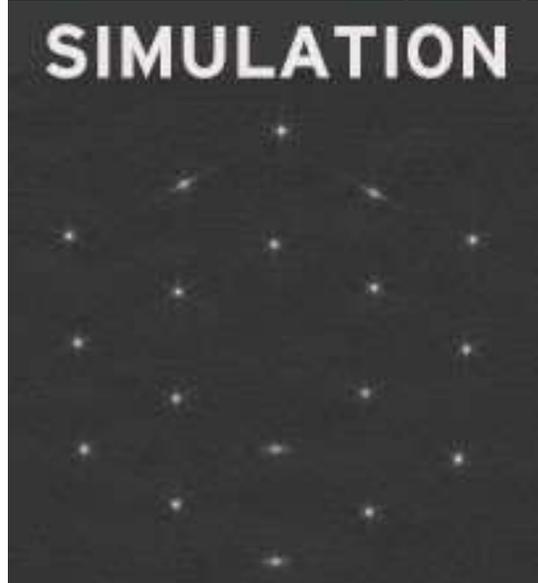
## **2. Segment Alignment**

After we have the image array, we can perform Segment Alignment, which corrects most of the large positioning errors of the mirror segments.

We begin by defocusing the segment images by moving the secondary mirror slightly. Mathematical analysis, called Phase Retrieval, is applied to the defocused images to determine the precise positioning errors of the segments. Adjustments of the segments then result in 18 well-corrected “telescopes.” However, the segments still don’t work together as a single mirror.



Before: Simulated initial array of images

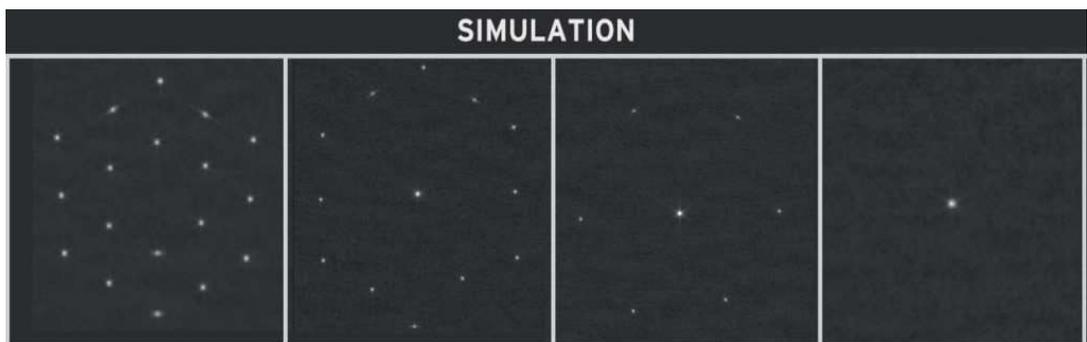
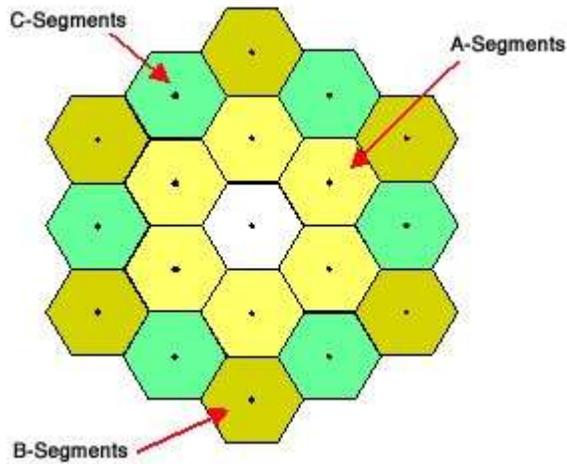


After: Simulated array of 18 corrected segments

### 3. Image Stacking

To put all of the light in a single place, each segment image must be stacked on top of one another. In the Image Stacking step, we move the individual segment images so that they fall precisely at the centre of the field to produce one unified image. This process prepares the telescope for Coarse Phasing.

The stacking is performed sequentially in three groups (A-segments, B-segments, and C-segments).



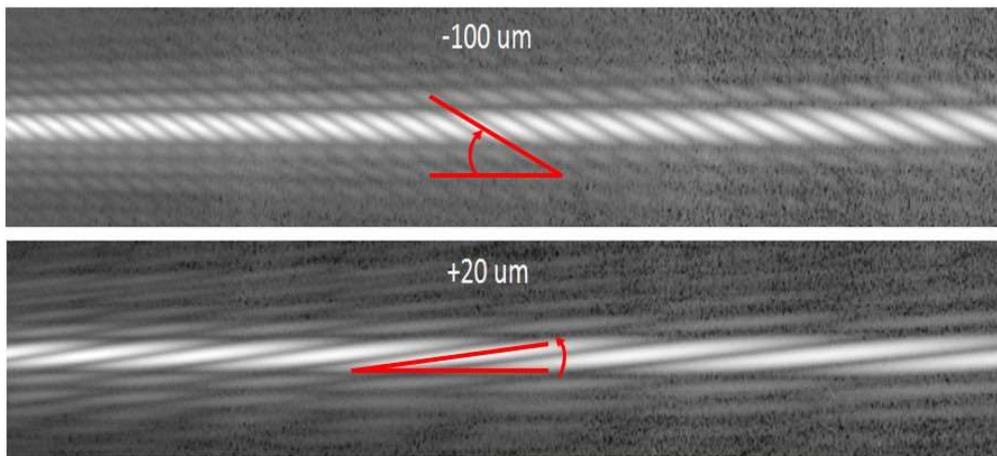
Simulation of image stacking. First panel: Initial image mosaic. Second panel: A-segments stacked. Third panel: A- and B-segments stacked. Fourth panel: A-, B-, and C-segments stacked.

#### 4. Coarse Phasing

Although Image Stacking puts all the light in one place on the detector, the segments are still acting as 18 small telescopes rather than one big one. The segments need to be lined up with each other with an accuracy smaller than the wavelength of the light.

Conducted three times during the commissioning process, Coarse Phasing measures and corrects the vertical displacement (piston difference) of the mirror segments. Using a technology known as Dispersed Fringe Sensing, we use NIRCam to capture light spectra from 20 separate pairings of mirror segments. The spectrum will resemble a barber pole pattern with a slope (or angle) determined by the piston difference of the two segments in the pairing.

## SIMULATION



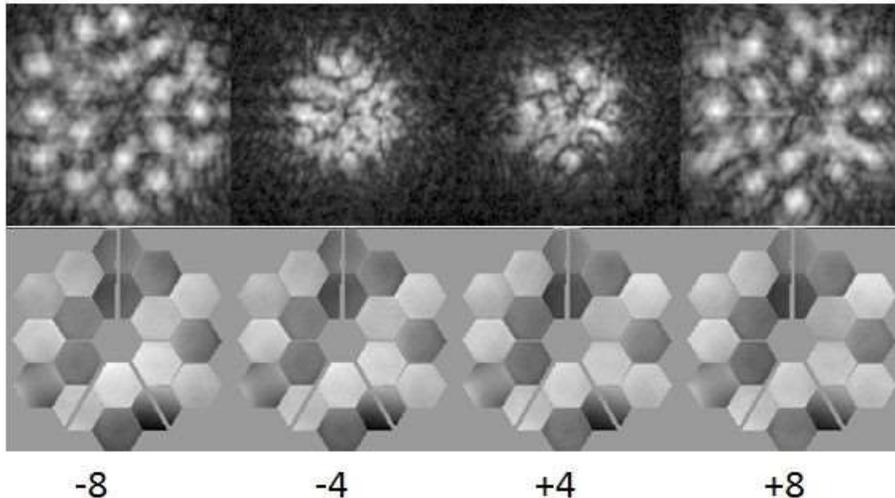
In this simulation, the “Barber pole” patterns are created by the Disperse Fringe Sensor indicating a large piston error (top) or a small piston error (bottom).

#### 5. Fine Phasing

Fine Phasing is also conducted three times, directly after each round of Coarse Phasing, and then routinely throughout Webb’s lifespan. These operations measure and correct the remaining alignment errors using

the same defocusing method applied during Segment Alignment. However, instead of using the secondary mirror, we use special optical elements inside the science instrument which introduce varying amounts of defocus for each image (-8, -4, +4, and +8 waves of defocus).

## SIMULATION

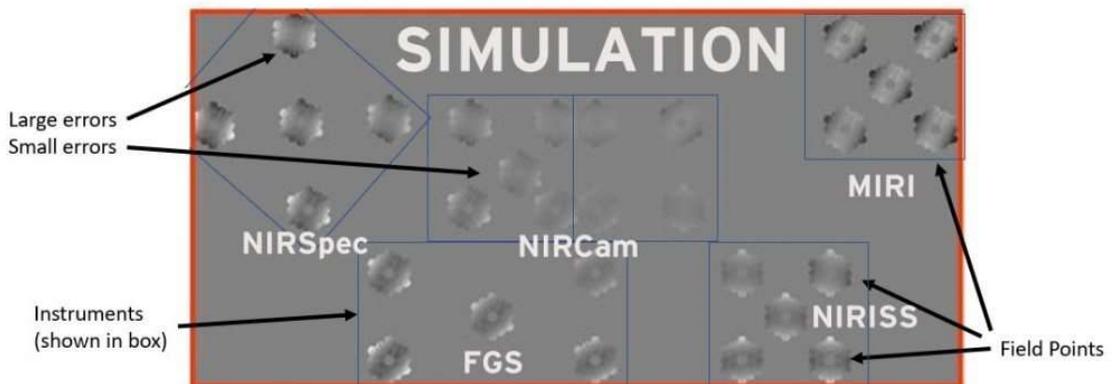


A simulation of the defocused images used in Fine Phasing. The images (top) show defocus introduced to an almost aligned telescope. The analysis (bottom) indicates the errors associated with each telescope segment. Segments with very bright or dark colours need larger corrections.

### 6. Telescope Alignment Over Instrument Fields of View

After Fine Phasing, the telescope will be well aligned at one place in the NIRC*am* field of view. Now we need to extend the alignment to the rest of the instruments.

In this phase of the commissioning process, we make measurements at multiple locations, or field points, across each of the science instruments, as shown below. More variation in intensity indicates larger errors at that field point. An algorithm calculates the final corrections needed to achieve a well-aligned telescope across all science instruments.



Simulated analysis of the Field of View correction

## 7. Iterate Alignment for Final Correction

After applying the Field of View correction, the key thing left to address is the removal of any small, residual positioning errors in the primary mirror segments. We measure and make corrections using the Fine Phasing process. We will do a final check of the image quality across each of the science instruments; once this is verified, the wavefront sensing and controls process will be complete.

As we go through the seven steps, we may find that we need to iterate earlier steps as well. The process is flexible and modular to allow for iteration. After roughly three months of aligning the telescope, we will be ready to proceed to commissioning the instruments.”

NASA’s Goddard Space Flight Centre

# History of Radio Astronomy

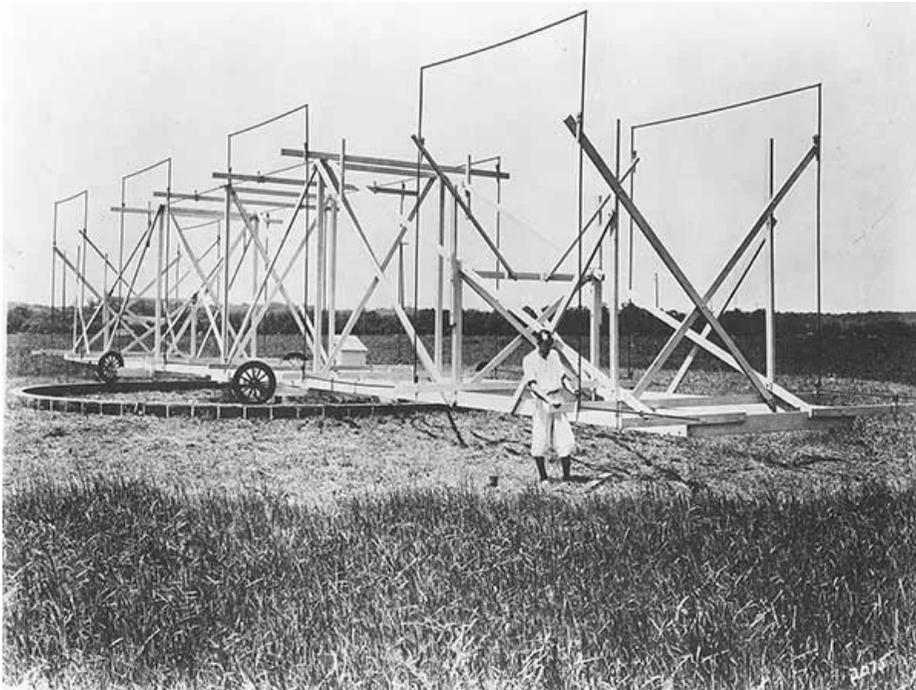
## Introduction

Radio Astronomy, a field that has strongly evolved since the end of World War II, has become one of the most important tools of astronomical observations. Radio astronomy has been responsible for a great part of our understanding of the universe, its formation, composition, interactions, and even predictions about its future path.

It is almost impossible to depict the most important facts in the history of radio astronomy without presenting where everything started, the development and understanding of the electromagnetic spectrum. Even though scientists like Faraday and Volta performed experiments with electricity and magnetism, it was not until many years later that a scientist was able to relate both as two aspects of the same force. James Clerk Maxwell (1831-1879) developed the theory of electricity and magnetism by the coherent integration of four equations. These equations not only summarized the relationship between electric and magnetic forces, but also predicted that there is a form of radiation involved (soon known as electromagnetic waves). Nevertheless, it was Oliver Heaviside who in conjunction with Willard Gibbs in 1884 modified the equations and put them into modern vector notation. A few years later, Heinrich Hertz (1857- 1894) demonstrated the existence of electromagnetic waves by constructing a device that had the ability to transmit and receive electromagnetic waves of about 5m wavelength. This was actually the first radio wave transmitter. Just like Maxwell's theory predicted, the waves were polarized. The radiation emissions were detected using a 1mm thin circle of copper wire. Now that there is evidence of electromagnetic waves, the physicist Max Planck (1858-1947) was responsible for a breakthrough in physics that later developed into the quantum theory, which suggests that energy had to be emitted or absorbed in small packets or "quanta" of energy. Quantum physics is the primary field for the in-depth study of electromagnetic radiation. Other contributors to this field are Albert Einstein with his quantum theory- photoelectric effect, Louis de Broglie and "particle wave duality",

and Erwin Shcrodinger and his quantum physics wave equations, among others.

After all these discoveries, scientists were able to apply their studies on electromagnetism and radio waves to develop ways of communication. In 1901, Guglielmo Marconi (1874-1937) was the first to send and receive signals across an ocean from Newfoundland to Cornwall. He improved radio transmissions, and, because of his contribution, commercial radiotelephone service became available in later years (F. Ghigo, 2003). Evolution of radio astronomy astronomical observations have been greatly improved since the moment it was possible to measure regions on the electromagnetic spectrum outside the optical range. Radio observations became one of the most productive means of astronomical research and expanded greatly in the twentieth century. The study of astronomy using radio frequencies started with unsuccessful attempts to find solar radio waves. As mentioned earlier, the first significant application of radio waves in the beginning of the twentieth century was the creation of long-distance radio communication. Further radio communication investigations led to the discovery of radio waves from the Milky Way. It was the decade of 1930's and the Bell Telephone Company was having trouble with the functioning of their transatlantic service, due to static of some sort. The company asked the physicist Karl Jansky (1905-1950) to find the source of such interference. To track and identify the source of static, Jansky built a big rotating antenna, given the name of "Jansky's Merry-go-round".



The antenna was designed to receive radio waves at a frequency of 20.5MHz, and with its rotation ability it was able to locate the direction of any radio signal. After several months of studying such static, Jansky was able to classify it into three different types. The source of the first two originated from nearby and distant thunderstorms. However, there was a third source of static that was somehow different. He began to realize that there was a pattern characterizing these wave signals. It was very similar to the known location of the Sun, but after a few months and more accurate measurements (signals repeated every 23 hours and 56 seconds) Jansky concluded that the radiation came from the constellation Sagittarius in the Milky Way Galaxy. This discovery was a fundamental contribution to radio astronomy.

Jansky's discovery motivated Grote Reber (1911-2002), a radio operator and engineer, to apply for jobs with Karl Jansky and Bell Laboratories to further investigate radio waves. He wanted to find out what was the process that led to the development of radio waves in space and verify if the waves were in fact coming from the Milky Way or other celestial objects. However, since all of this happened during the Great

Depression, Bell Labs were not hiring at that time. Reber was determined to achieve his goals and answer his questions, even if it meant he had to do it all from his back yard... which he did. Reber decided to investigate on his own, and in 1937 he constructed a telescope that had a parabolic dish reflector and 3 receivers: 3300MHz, 900MHz and 160MHz.



Reber's self-built telescope in the backyard of his home in Wheaton, Illinois, circa 1938. It is widely considered to be the world's first radio telescope.

A year later, in 1938, the last receiver gave him what he was looking for, galactic radio waves. Reber presented the data as contour maps showing the Milky Way as bright areas. Reber became one of the pioneers of what we call today radio astronomy.

After World War II, many scientists began to build bigger and better antennas to study the universe. War surplus equipment became available giving a boost to the science.

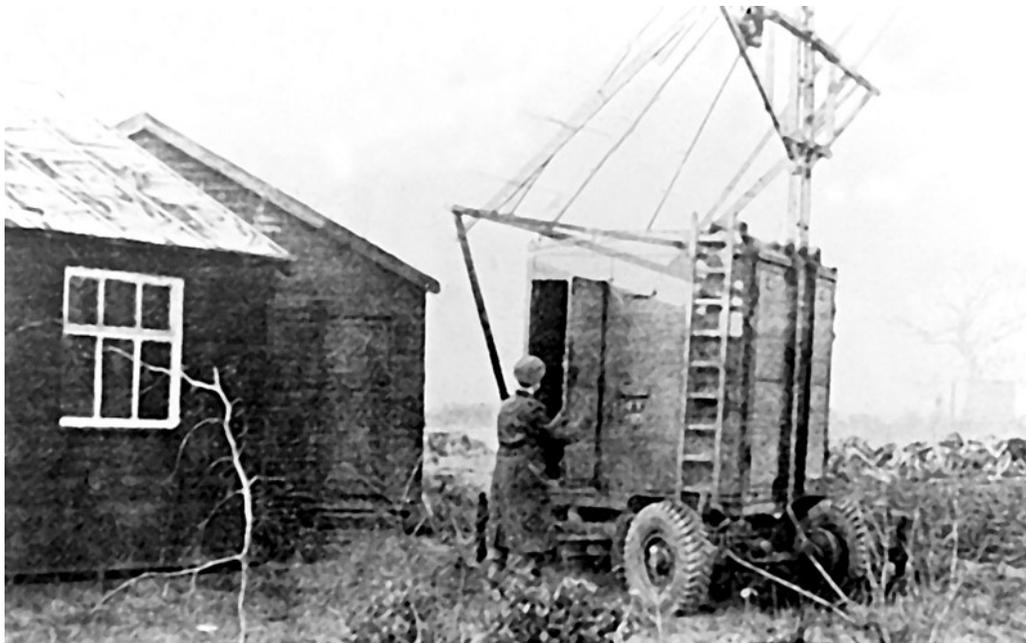
In 1947 Reber was in the audience at a radio engineers' conference listening to a talk given by Edward Condon, the director of NIST (National Institute for Standards and Technology). Condon described NIST's role "to undertake research that commercial companies couldn't do well or couldn't do at all." Reber quickly dashed off a letter to Condon explaining that this was the exact type of research he was doing. Intrigued, Condon sent two physicists to meet with Reber and take a look at his backyard radio telescope.

The meeting went well. Using funding provided by the US Defense Department, Condon offered to hire Reber and purchase his backyard dish, with the proviso that Reber and his equipment move to NIST's radio-propagation research station near Sterling, Virginia.

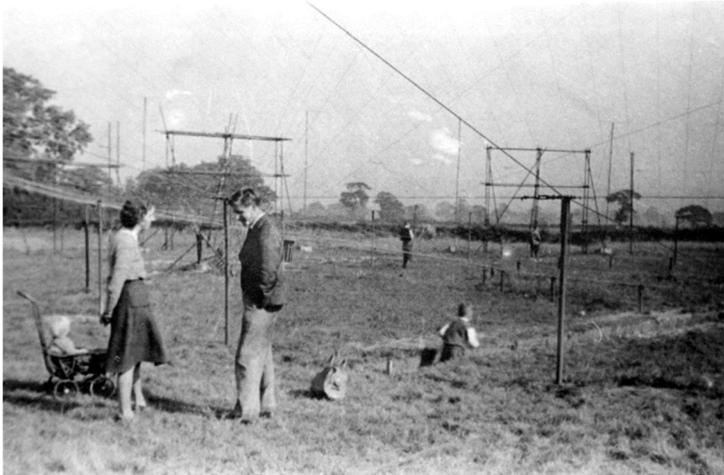


Reber with the dish of the Giant Würzburg during its reassembly at NIST Sterling, Virginia, field station, circa 1948. Although it was built by Nazi Germany as an anti-aircraft radar antenna, NIST repurposed the instrument for radio astronomy.

In the UK, Jodrell Bank Radio Observatory started operation on a site owned by the University of Manchester and previously used for botany. The site was first used for astrophysics in 1945, when Bernard Lovell used some equipment left over from World War II, including a gun laying radar, to investigate cosmic rays. The equipment was a GL II radar system working at a wavelength of 4.2 m, provided by J. S. Hey. He intended to use the equipment in Manchester, but electrical interference from the trams on Oxford Road prevented him from doing so. He moved the equipment to Jodrell Bank, 25 miles (40 km) south of the city, on 10 December 1945. Lovell's main research was transient radio echoes, which he confirmed were from ionized meteor trails. The first staff were Alf Dean and Frank Foden who observed meteors with the naked eye while Lovell observed the electromagnetic signal using equipment. The first time Lovell turned the radar on – 14 December 1945 – the Geminids meteor shower was at a maximum.



December 1945 The first day at Jodrell Bank. The receiver trailer with aerial attached outside the wooden botany hut.



Family affair, building the 218ft diameter paraboloid at Jodrell Bank.

Over the next few years, Lovell accumulated more ex-military radio hardware, including a portable cabin, known as a "Park Royal" in the military (see Park Royal Vehicles). The first permanent building was near to the cabin and was named after it.

It was from these beginnings that Bernard Lovell went on to build the 250 foot diameter radio telescope that now carries his name.



250 foot radio telescope at Jodrell Bank from control room with Bernard Lovell

Mullard Radio Astronomy Observatory (MRAO): Radio interferometry started in the mid-1940s on the outskirts of Cambridge, but with funding from the Science Research Council and a donation of £100,000 from Mullard Limited, construction of the Mullard Radio Astronomy Observatory commenced at Lord's Bridge, a few miles to the west of Cambridge. The observatory was founded under Martin Ryle of the Radio-Astronomy Group of the Cavendish Laboratory, University of Cambridge and was opened by Sir Edward Victor Appleton on 25 July 1957.

On November 28, 1967, Jocelyn Bell (now Dame Jocelyn Bell Burnell) and Anthony Hewish discovered the first Pulsar, a fast-rotating neutron star that emits a beam of electromagnetic radiation. The radiation of a pulsar can only be observed when the beam of emission is pointing toward the Earth, much the way a lighthouse can only be seen when the light is pointed in the direction of an observer and is responsible for the pulsed appearance of emission.



Jocelyn Bell with the array that she discovered the first Pulsar

Techniques such as radio interferometry became available as early as 1946. This technique— using multiple antennas to record radio data— became more sophisticated over the years including a technique known

as Very Long Baseline Interferometry (VLBI) and the latest one, Space Very Long Baseline Interferometry (SVLBI). SVLBI uses a space-based antenna as one of its elements. Projects like the JPL SVLBI, funded by NASA, use this kind of technique to provide “3 to 10 times the resolution of VLBI”

Improvements in the radio astronomy field made possible the detection of radio emissions from planets like Jupiter, observations of energetic objects such as pulsars, quasars, and radio galaxies, and “imagery” of many astronomical objects by recording multiple overlapping scans and putting them together in an image.

Solar Radio Observations data had their beginnings very early in the radio astronomy field. The Sun was the first astronomical object scientists thought of as a source for radio waves, from the idea that it is the closest energetic body to Earth. However, many of these early investigations were unsuccessful. The first recorded attempt to detect radio waves from the Sun was made by Thomas Alva Edison in 1890. Kennelly, his laboratory assistant sent a letter to Lick Observatory describing the construction of a detector made by winding a number of cables around a mass of iron ore. However, there is no further evidence of this effort. Nonetheless, we know that the detection of solar radio waves would not have been possible since the ionosphere prevents the long waves – the only waves the apparatus could detect– from reaching the Earth.

Sir Oliver J. Lodge around 1897-1900 built a more sophisticated solar radio detector than the one Edison did. Still, it was not sensitive enough to have detected the Sun. Following this attempt, the astrophysicists Johannes Wilsing and Julius Scheiner constructed a device and tried the experiment for eight days, but they were also unable to detect radio radiation from the Sun. However, they were the first ones to formally write up and publish their attempt to detect solar radio data. They incorrectly concluded that the atmosphere was absorbing the radio waves. A few years later in 1900— trying to solve problems from

previous attempts— a French graduate student Charles Norman constructed a long wire antenna and set it up on a glacier on the alpine mountain Mont Blanc at about 3100m (10000ft). He reasoned that if Wilsing and Scheiner were right, the solution was to gather data at a higher altitude. He was very close to detecting low frequency radio bursts. Unfortunately, the experiment was performed in solar minimum.

Solar radio observations were neglected for many years. It was not until the 1920s, when Oliver Heaviside demonstrated the existence of the ionosphere, that many questions about solar radio data were answered. After this discovery was made, radio astronomers realized that they had to develop high frequency radio receivers (around 20MHz) for these waves to penetrate the ionosphere. World War II not only had an influence on the foundation of radio astronomy, it also had a direct impact on the history of solar radio observations. In February 26-27, 1942, an English radar station received a strong noise signal thought to be a new source of interference created by enemy transmitters. It turned out to be radio wave emissions from the Sun associated with a group of sunspots that appeared at that time. That same year, Dr. G.C. Southworth detected solar microwaves at wavelengths of 1 and 10cm, while he was working at the Bell Telephone Laboratories in New York. These observations were published years later, but Grote Reber, who continued to record radio observations since his great accomplishment of 1937, was the first one to publish solar radio observations (1944). Once the war was over, astronomers began to closely observe the Sun and by that time they started to discover many properties of the Sun, such as types of radio bursts, noise storms, and even to establish the relationship between radio bursts and solar flares. Many countries like Australia, Great Britain and Canada joined forces in the study of the Sun using radio data. This became more popular after the International Geophysical Year (July 1957-December 1958) and the International Year of the Quiet Sun (IQSY: 1964-1965)

## Conclusion

Radio astronomy had its beginnings with the discovery and application of electromagnetic waves, and it has gradually evolved since then. History

proves that radio observations expanded astronomy's horizons. It was primarily responsible for the discovery of objects such as pulsars, quasars and radio galaxies. It is also partly responsible for the idea that dark matter is an important component of our universe; radio measurements of the rotation of galaxies suggest that there is much more mass in galaxies than has been directly observed (see Vera Rubin). Overall, it provides a better understanding of the components and interactions of the universe. It is expected that radio astronomy will continue to evolve in the following years, perfecting its techniques and providing many astronomical discoveries.

Chris Bailey

# Members Astro-photographs.

Dan Self



Thor's Helmet 15mins de-noised



IC 424



Open evening 25<sup>th</sup> February.

Malcolm James Dent



Monkey Head Nebula



Mick Ladner



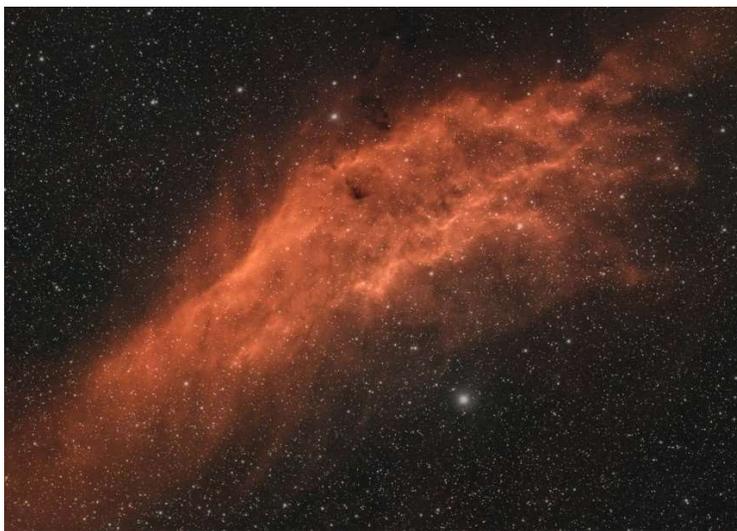
Tadpole Nebula. with the Flaming Star

39 x 180 sec subs

Neil Wilson



Orion Nebula (M42) Celestron 9.25" EdgeHD and Hyperstar, this is a stack off 2, 10, 25 and 60 second exposures blended in Photoshop.



2 images, stitched together of the California Nebula NGC 1499/Sh2-220

Skywatcher AZ-EQ6 Mount, Celestron EdgeHD 9.25", Hyperstar V4

Altair Hypercam 26C, Pro Tec Altair tri-band filter

Processed with AstroPixelProcessor. Tweaked with Photoshop.

30 x 60 Sec light frames x2



NGC 1333 a blue reflection nebula in the constellation of Perseus.

Skywatcher AZ-EQ6 Mount, Celestron EdgeHD 9.25", Hyperstar V4

Altair Hypercam 26C Pro Tec, Altair tri-band filter

Processed with AstroPixelProcessor. Tweaked with Photoshop.

118 x 60 Sec light frames



M81 (Bode's Galaxy) and M82 (Cigar Galaxy) Also NGC 2976, 2961 and 2959

19 x 120s light frames. Celestron 9.25" EdgeHD + Hyperstar

Altair Hypercam 26C Pro Tec Altair tri-band filter

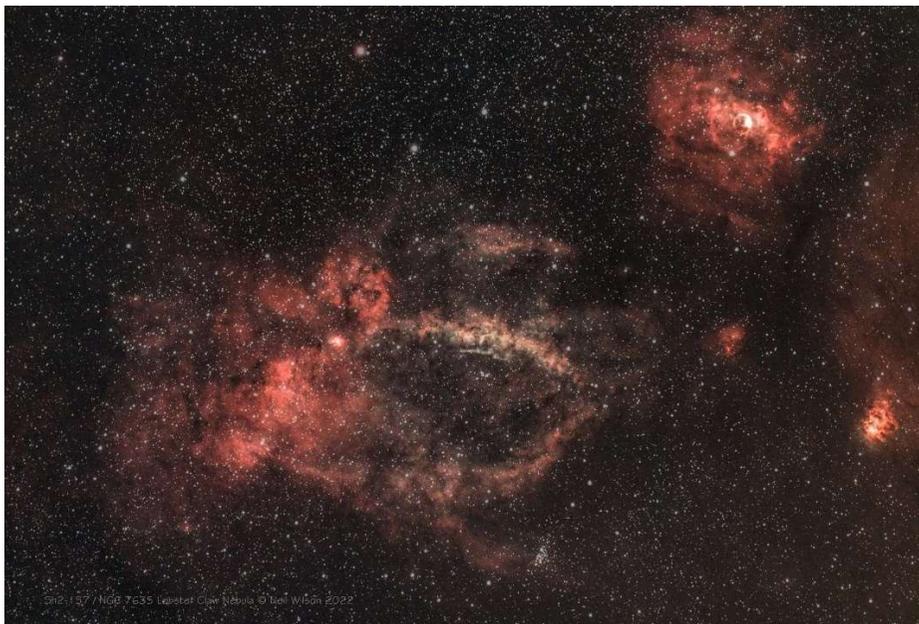
Captured with N.I.N.A.Stacked in AstroPixelProcessor Tweaked with Photoshop



Sh2-171 a composite of two images stacked in Astropixelprocessor, stiched together with Microsoft ice and then tweaked with Photoshop.

Skywatcher AZ-EQ6 Pro mount, Celestron 9.25" EdgeHD + Hyperstar V4

Altair 26C Protec @ -10'C, Altair Tri-band Filter. 60 x 45 Sec light frames (x2)



Lobster Nebula Sh2-157. Celestron 9.25" EdgeHD + Hyperstar V4

Altair Hypercam 26C Protec @ -10'C Altair Tri-band Filter.

60 x 45 Sec light frames. Stacked in Astropixelprocessor. Tweaked with Photoshop.

Darren Carter



atic16200 Camera, Altair Astro 102 triplet. 3 hours of HA in 10min exposures. Processed in PixInsight

Roger Hyman



ZS126 with AA183C Pro camera with UV/IR cut filter. Using SharpCap Pro 4.0 and processing in AS!3 (best 25% from 250 frames) finishing with Photoshop 2022 and Topaz Sharpen



Horsehead Nebula ZS126 and AA183C Pro camera. Captured with SharpCap Pro 4.0, stacked in APP, finished in Photoshop, Topaz DeNoise and Sharpen AI.



Hamburger Galaxy (NGC 3628. 120 x 60 seconds, AA183C Pro with ZS126 Captured with SharpCap Pro 4 Processed in APP and Photoshop 2022.

Michael Wilson



iPhone 13 Pro, 1x3 second exposure

Edited in Photoshop Express app and Apple iPhone image editor app

Chris Bailey



Markarian's Chain.

William Optics Star 71 (5 Element Mk1), Canon D750 Modified camera

27 X 120sec lights. Processed in PixInsight and Affinity.



## Invitation to Gresham Lectures

Dear Local Astronomy Society

I thought you and your members might be interested in these free public astronomy lectures held online by Professor Katherine Blundell and Professor Roberto Trotta in 2021-2.

### ASTRONOMY

#### Cosmic Revolutions by Professor Katherine Blundell

[gres.hm/cosmic-revolutions](https://gres.hm/cosmic-revolutions)

This series will expound in context and in detail some key realisations about cosmic history that are now regarded as fundamental in the modern understanding of how the cosmos came to be, and of our place in it.

#### **Structures in the Universe**

##### **Planetary Universe**

Wednesday, March 30, 2022 6:00 PM [gres.hm/planetary-universe](https://gres.hm/planetary-universe)

Museum of London / Online Or watch later

How can new worlds be discovered, and how many exo-planets might be out there? What does today's technology in astronomical observatories now enable, and what is it that holds us back from finding what is actually out there? What hinders us from pushing forwards the frontiers of space science?

##### **Life in the Universe**

Wednesday, June 1, 2022 6:00 PM [gres.hm/life-universe](https://gres.hm/life-universe)

Museum of London / Online Or watch later

How can life form in the Universe, and what are the necessary ingredients for habitability so that planets can sustain life? Can we expect life elsewhere in the solar system, or on exo-planets? This lecture offers a broader perspective from astrobiology, astrochemistry, and astrophysics on the habitability or otherwise of other planets beyond Planet Earth.

# The Frontiers of Knowledge by Professor Roberto Trotta

[gres.hm/frontiers](https://gres.hm/frontiers)

We have progressed far in our understanding of the Universe, and yet so much is still tantalisingly unknown. What explains the accelerating expansion of the Universe? Can physics mend the broken Cosmic Distance Ladder? What is the future for life on our planet?

## **The Future of Life on Earth**

Monday, May 9, 2022 1:00 PM [gres.hm/future-life](https://gres.hm/future-life)

Barnard's Inn Hall/ Online Or watch later

Although life is probably widespread in the universe, our pale blue dot, Earth, is the only known place harbouring intelligent life. Even if we manage to stave off extinction by climate change, avoid a nuclear apocalypse and the dangers of runaway AI, biological life on our planet will eventually come to an end in about 5 billion years' time. What are the astrophysical dangers to life on Earth, and the prospects for life's survival into the distant future.

## For Sale or Wanted

This section is for the sale of Astronomical items and any wants from members. Details of items for sale (With photographs where applicable) should be forwarded to the newsletter editor at [newsletter@brecklandastro.org.uk](mailto:newsletter@brecklandastro.org.uk)

It is suggested that a donation of 5% of the final sale price be given to the Society to assist with funds. If sellers do not wish to make their contact details public then please make this known to me and I will field any enquiries on a box number system. Please send any sales details to me before the 26<sup>th</sup> of the month for inclusion in the next issue.

Please ensure that if any item is sold by another means prior to publication that I am advised so it can be removed to avoid confusion.

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## **Equipment available for loan to Members**

As well as our fantastic library members of the society can borrow our equipment. Here is an equipment list that can be used or borrowed by members, subject to personal responsibility for replacement value. Discuss your plans with one of the regulars first, as it is not easy for beginners to use some of this kit. We are here to help show you how to use it, when the weather holds up, then you will need to sign it out and get approval by a member of the committee. We can discuss a reasonable term.

### **Refractors:**

William Optics Megrez 102 S.V. F7 D102mm f/7 and reducer to f/5.6 – this may be unavailable soon.

William Optics GT-102 2019 D102mm F703mm f/6.9

Vixen 4" Refractor f/9

### **SCT/Maks:**

Celestron C925 Starbright F10 SCT FL D234.95mm F2350mm f/10 Refractor – preferably this should not be taken off the premises.

Celestron C8 SCT D203.2mm F2000mm f/10 Refractor (orange tube)

Meade LX200R SCT D203.2mm F2000mm f/10

Konus Motormax-90 Maksutov-Cassegrain 90mm F1200mm f/13 #1795

Meade ETX125 D127mm F1900mm f/15 Maksutov-Cassegrain Reflector

#### **Mak-Newt:**

Skywatcher 190MN DS Pro Maksutov-Newtonian Optical Tube Assembly D190mm F1000mm

### **Dobsonians:**

Skywatcher Skyliner 200mm F1200mm Dobsonian Reflector

Helios D200mm F1000mm Dobsonian Reflector

8-inch Dobsonian (turquoise tube, hand-made)

### **Solarscope:**

Coronado Solarmax 40

Meade 8x50mm Guide Scope

### **Binoculars:**

Vanguard KR-7500 7X50mm Field 7 degrees Binoculars – a little out

Konus #2253 7x50 Field 6.8° Binoculars

Chinon RB Optics 8-20 x 50 HB Zoom Binoculars

Prinzlux 10x50 Binoculars – needs optically cleaning

## **Mounts:**

Berlebach Planet Tripod with Double Clamps  
Orange EQ4 telescope mount  
Skywatcher SynScan EQ5 Equatorial Mount & Tripod  
SynScan mount controller  
Meade LXD German Equatorial Mount & Autostar Controller  
SynScan mount controller  
iOptron IEQ45 Mount and Pier  
iOptron Go2Nova mount controller

## **Eyepieces:**

Tele Vue Delos 17.1mm 2"  
Antares Speers-Waler 4.9mm SWA Series 2 2"  
Antares Speers-Waler 9.4mm SWA Series 3 2"  
Meade Ultra Wide Angle 14mm 1.25/2"  
Antares W70 Series 8.6mm  
Meade Super Wide Angle 18mm 1.25"  
Celestron 32mm Plossl 1.25"  
Celestron 26mm Plossl 1.25"  
Antares 17mm Plossl FMC 1.25"  
Intes-Micro Q74 WA 21mm 1.25"  
Orion (Or) Circle-T 9mm 1.25"  
Vixen K 18mm 1.25"  
Fullerscope K 25mm 1.25"  
66 Ultrawide 20mm Long Eye Relief 1.25"  
Or 6mm 1.25"  
Plossl 40mm Multi-coated  
Plossl 17mm Multi-coated  
14mm (7mm 21mm) 1.25"  
Super 20mm 1.25"  
Soligor PE-6mm 1.25"  
Super Plossl 32mm 1.25"  
Lanthanum LV 2.5mm 45 degree 20mm 1.25"  
Televue 2x Barlow 1.25"  
Televue 2.5x Barlow Powermate 1.25"  
2x Barlow Lens  
Meade Telenegative 2x Barlow 1.25"

## **Telescope accessories:**

William Optics AFR-IV Adjustable Flattener Reducer  
Meade Zero Image-Shift Microfocuser  
Meade 4000 Series f6.3 Focal Reducer  
Meade 4000 series f3.3 CCD Focal Reducer with T-Adapter  
Celestron Reducer/Corrector f6.3 (Model: 94175)  
Tamron Adaptall-2 Custom Mount

## **Eyepiece accessories and filters:**

Meade Electronic Eyepiece  
Meade Illuminated Reticle MA12mm  
Celestron Radial Guider (#94176)  
Light Pollution Filter 1.25"  
Meade #908 O-III Nebular Filter  
Variable Polarizing Filter #3  
Baader Planetarium Contrast-Booster Filter (#2458360) 1.25"  
Celestron Colored Eyepiece Filters (#25 Red, #38A Blue, #47 Violet, #53 L Green)  
Baader G-CCD Filter 1.25" (Cat: 2458470G)  
Baader R-CCD Filter 1.25" (Cat: 2458470R)  
Baader B-CCD Filter 1.25" (Cat: 2458470B)  
Baader UV/IR Cut/L-Filter 1.25" (Cat: 2459207A)  
Baader H-alpha 7nm CCD Narrowband-Filter 1.25" (Cat: 2458382)  
Baader O-III 8.5nm CCD Narrowband-Filter 1.25" (Cat: 2458435)  
Baader S-II 8nm CCD Narrowband-Filter 1.25" (Cat: 2458430)  
Baader H-beta 8.5nm CCD Narrowband-Filter 1.25" (Cat: 2458425)  
Astronomik L-RGB Type 2c Filterset 1.25" (4 filters, Cat: 10220125)  
Astronomik CLS-Filter 2" (Cat: 10213200)  
Astronomik CLS-Filter 1.25" (Cat: 10213125)  
Astronomik CLS CCD-Filter 1.25" (Cat: 10208125)  
Star Analyser 100 (Model: PHEL-SA100) – produces spectra

## **Cameras:**

Atik Focal Reducer 58mm  
Atik 383L + FW 11/4"+Filters  
Atik Infinity Camera  
Atik 314L+ CCD Camera (SN11003041)  
Atik One 6.0 Monochrome CCD Camera (SN: 1191452-0093)  
Atik 460EX Color (SN21223-26)  
ZWO ASI290MM Mini USB 2.0 Monochrome Small Format CMOS Camera  
Imaging Source DBK21AU618.AS 640x480 USB2 planetary camera  
STV ('vintage video CCD AV camera) and Filter Wheel  
Astrovid 2000 ('vintage' CCD camera)  
Nikon D100 DSLR  
Sigma EX DG Macro 105mm 1:2.8 DLSR Lens  
Geoptik CCD Adapter x Canon (Model: 30A189)

## CONTACTS

**Chair** Dan Self  
**Contact** [chairman@brecklandastro.org.uk](mailto:chairman@brecklandastro.org.uk)

**Observatory/Visits** Mick Ladner  
**Contact** [visitors@brecklandastro.org.uk](mailto:visitors@brecklandastro.org.uk)

**Webmaster** Andrew Luck (temporary)  
**Contact** [webmaster@brecklandastro.org.uk](mailto:webmaster@brecklandastro.org.uk)

**Newsletter** Chris Bailey  
**Contact** [newsletter@brecklandastro.org.uk](mailto:newsletter@brecklandastro.org.uk)

**Membership/Treasurer** Andy Jones  
**Contact** [treasurer@brecklandastro.org.uk](mailto:treasurer@brecklandastro.org.uk)

**Secretary** Rebecca Greef  
**Contact** [secretary@brecklandastro.org.uk](mailto:secretary@brecklandastro.org.uk)

**Please check with any of the contacts in bold before visiting the observatory. Please ensure you are wearing appropriate footwear and clothing and bring a torch (preferably one showing a RED light)**

## Breckland Astronomical Society Events –Spring 2022

7:30pm Great Ellingham Recreation Centre, Watton Road, Great Ellingham, Attleborough, Norfolk

**Talk entry £2.50 u18s £1.**

|  |  |  |
|--|--|--|
| Saturday, March 2 <sup>nd</sup>  | <b>Star Party (main night)</b>                 | Hosted by Haw Wood Farm.                       |
| Friday, March 11 <sup>th</sup>   | <b>Beneath The Night</b>                       | Stuart Clark, author                           |
| Friday, March 25 <sup>th</sup>   | <b>Public Open Night</b>                       | Observatory                                    |
| Friday, April, 8 <sup>th</sup>   | <b>From the Big Bang to the Periodic Table</b> | Dr Richard Miller,<br>Miller-Klein Assoc.      |
| Friday, April 29 <sup>th</sup>   | <b>Public Open Night (last of the season)</b>  | Observatory                                    |
| Friday, May 13 <sup>th</sup>   | <b>The Moon (+AGM)</b>                         | Jerry Workman                                  |
| Friday, June 10 <sup>th</sup>  | <b>Galaxy Formation</b>                        | Dr Orlando Warren,<br>Penn State<br>Pittsburgh |
| <p>* Haw Wood Farm Caravan Park, Hinton, Saxmundham, IP17 3QT.<br/> <a href="http://www.hawwoodfarm.co.uk">www.hawwoodfarm.co.uk</a></p> <p>to book:<br/> <a href="mailto:info@hawwoodfarm.co.uk">info@hawwoodfarm.co.uk</a><br/>           01502 359550. £12 per pitch per night subject to updates</p> |  |  |
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