NWASNEWS

Volume25, Issue 6

February 2020

Newsletter for the Wiltshire, Swindon, Beckington Astronomical Societies

Commercial Returns From Space

It has become clear that the commercialisation of space is now taking great leaps forward, regardless of its affects on astronomy and science.

The Starlink commercial satellites are becoming more a nuisance every launch, with 60 satellites being launched nearly every week, I have had streaks coming across deep sky (120 second) exposures now at multiple angles. These are to gain a monopoly in communications for Space X and Elon Musk. That Tesla car doesn't look so neat now when useful satellites are limited and threatened by the not retrievable bits of metal that already have a 10% failure rate.

Russians are wanting to put advertising into the skies as are StarRocket and Rocket Lab with bright Humanity Star to name a few. France and Germany went to take this further and China and India wont be far behind.

The fun side, NASA are engaging Lego to produce a new ISS model (about half the price of the existing module).

Now the International Space station is building a new module for commercial companies to use in space, from advertising M&Ms to producing gravity zero drug manufacture.

Space is now for sale, and the consequences for proto scientists and real science are moved back in the concerns of space controllers.

Rant over.

After the last meeting in the next two days I received 8 communications from Schools and other societies and clubs (not Astro) have been in touch for us to do talks or help in education. I had help at the Westbury Leigh school where we got a chance to go out and view. Thank you to the volunteers for turning up.

Clear skies Andy Burns.

A group of members went to Silbury Hill for the penumbrial lunar eclipse, It was very wet where Peter and I trampled round before finding a useable strip of ground a few feet higher than the seasonal moat at the hill. While setting up a time lapse I also used my bridge camera to grab large Moon images while we waited for the eclipse shadow to show. Within 5 minutes I had two aircraft fly I front of the Moon. This one a Flybe flight the day before holders Virgin threatened to close the airline unless the government coughed up funds.

Andy

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

Facebook members page: https://www.facebook.com/groups/wiltshire.astro.society/

Meetings 2018/2019Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

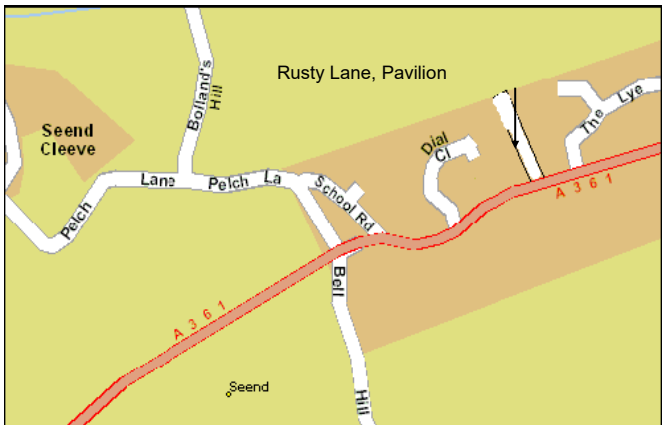
Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Andy Burns Chair, anglesburns@hotmail.com
Andy Burns Outreach and newsletter editor.
Bob Johnston (Treasurer) Debbie Croker (vice Treasurer)
Philip Proven (Hall coordinator) Dave Buckle (Teas)
Peter Chappell (Speaker secretary)
Nick Howes (Technical Guru)
Observing Sessions coordinators: Chris Brooks, Jon Gale,
Web coordinator: Sam Franklin
Contact via the web site details.

NEW SEASON 2019/2020
2020

4th Feb Jon Gale 'Observing the Herschel 400'.
3rd Mar Dr Lilian Hobbs 'Armchair Messier Marathon'.
7th Apr Pete Williamson 'The Moon and Moons of the Solar System'.
5th May Martin Griffiths 'The Habitable Zone – What is it and How is it determined'.
2nd Jun Paul Money 'Triumphs of Voyager (part 2) – Where no probe has gone before'.



Jonathan Gale

Observing The Herschel 400

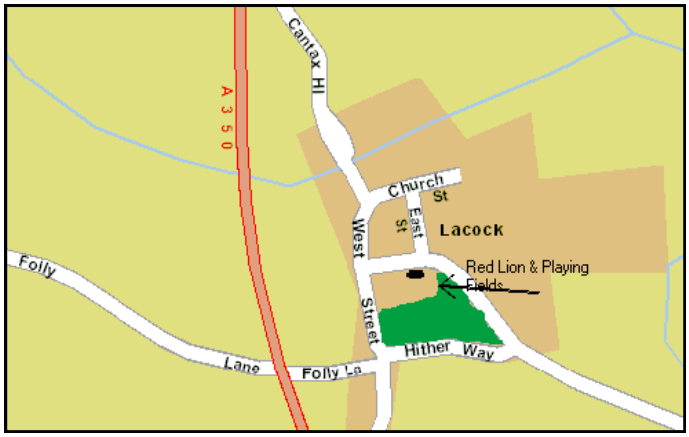
Jonathan is one our long serving members who cherishes the art of eye to the telescope observing.

A member of the web society he has been skilled in hunting deep sky objects using star hopping techniques and careful choice of dark sites to increase his chance in hunting the faint objects.

The Herschel 400 is a list of challenging objects from the general catalogue that William, Caroline and John Herschel worked on in the 18th and early 19th century, finding over 5700 objects. The Herschel 400 search takes over from the Messier catalogue and was promoted within the American Astronomers Association by the Rose City Society based in Portland, Oregon.

I was privileged to give talks to the AAA in Portland in 2009.

Observing Sessions see back page



Members for sale/wanted
Hi Andy. I tried to put my for sale stuff on the web page but was unavailable.

Briefly this is. For sale. I EQ6pro. Go to equatorial mount (hardly used)wth controls. 1 Sealy Power Products Road Start. battery. Model RS102 v2. All for £860.00. Inspection anytime just across Rusty Lane in my garage. Phone 01380828407/ philipproven@gmail.com

Please advise if you can put in NL or not

As ever Philip Proven
.

Swindon's own astronomy group

February meeting

On February 21st we welcome Dr Jane Clark.

Jane Clark is an amateur astronomer who earns her living as an engineer. She has a Ph.D. in physics and an MBA from Warwick University. She completed two years of postdoctoral training at Case Western Reserve University in Ohio before returning to England to begin an industrial career.
She became interested in both astronomy and photography as a teenager in the 1970s, photography much more seriously, although as her career progressed and family commitments increased, both interests lapsed. She acquired a telescope in 2006, shortly after completing her MBA, and quickly became hooked on observing. This experience made her realize that astronomy is a lot more fun than business administration. She is a member of Bristol Astronomical Society.

Ad-hoc viewing sessions

Regular stargazing evenings are being organised near Swindon. To join these events please visit our website for further information.

Lately we have been stargazing at Blakehill Farm Nature Reserve near Cricklade, a very good spot with no distractions from car headlights.

We often meet regularly at a lay-by just outside the village of Uffcott, near Wroughton. Directions are also shown on the website link below.

Information about our evenings and viewing spots can be found here:

http://www.swindonstargazers.com/noticeboard/noticeboard06.htm

For insurance reasons you need to be a club member to take part.

If you think you might be interested email the organiser Robin Wilkey (see below). With this you will then be emailed regarding the event, whether it is going ahead or whether it will be cancelled because of cloud etc.

We are a small keen group and I would ask you to note that you DO NOT have to own a telescope to take part, just turn up and have a great evening looking through other people's scopes. We are out there to share an interest and the hobby. There's nothing better than practical astronomy in the great cold British winter! And hot drinks are often available, you can also bring your own.

Enjoy astronomy at it's best!

Meetings at Liddington Village Hall, Church Road, Liddington, SN4 0HB – 7.30pm onwards

The hall has easy access from Junction 15 of the M4, a map and directions can be found on our website at:

http://www.swindonstargazers.com/clubdiary/directions01.htm

Meeting Dates for 2020

Friday 21 February
Programme: Dr Jane Clark: Orbits in the Solar System

Friday 7 March
Programme: AGM / Bob Gatton: The Red Planet
Friday 17 April
Programme: Gary Poyner - Variable Stars around the Perseus Double Cluster

Friday 15 May
Programme: Mike Foulkes: Herschel's Planet
Friday 19 June
Programme: Graham Bryant - Pluto from Myth to Discovery

-------Summer Break------

Friday 18 September

Programme: Ian Smith - Narrowband Imaging

Friday 16 October

Programme: Dr James Fradgley MSc, FRAS: The Universe - 'A brief overview of what we know, or think we know'

Friday 20 November

Programme: Dave Eagle FRAS PGCE BSc (Hons): 'Comets, Enigmatic and Beautiful Visitors'

Website:
http://www.swindonstargazers.com

Chairman: Robin Wilkey

Tel No: 07808 775630
Email: robin@wilkey.org.uk
Address: 61 Northern Road
Swindon, SN2 1PD

Secretary: Hilary Wilkey

Tel No: 01793 574403
Email: hilary@wilkey.org.uk
Address: 61 Northern Road
Swindon, SN2 1PD

dark sky wales
dywyllwch awyr cymru

The Night Sky in February 2020

Winter is upon us but beautiful constellations of Orion, Auriga, Taurus and Gemini are available in the early evening and the spring groups rise after midnight.

Moon in February
New: 23rdFebruary
First quarter: 2ndFebruary
Full: 9thFebruary
Last Quarter: 15thFebruary

Planets in February

Mercury: is at greatest eastern elongation on the 10th of the month where it will shine as a bright star-like object on the western horizon. By months end it will be at superior conjunction.

Venus: moves into Pisces and is getting brighter at magnitude -4 and unmistakable as a bright white star-like object in the west

Mars: is an early morning object in the constellation of Sagittarius, rising at 02:00 by mid month and shining feebly at magnitude 1.5

Jupiter: Is still in Sagittarius rising about the same time as Mars and although shining at magnitude -1.8 it is not at its best until later in the year

Saturn: Is also in Sagittarius and rises after 4 am but is a dim object through its rings can still be seen well.

Uranus: is in the constellation of Aries shining at magnitude 5.9. It can be seen as a small disk in a moderate telescope but sets by 10 pm.

Neptune: can be found in Aquarius but it shines feebly at magnitude 7.9 setting by 19:00 by mid-month

Meteor showers in February

There are no major showers this month

Interesting Events in February

Mars is within half a degree of the moon on the 18th February and a day later on the 19th, Jupiter is also very close. All three make a good photo opportunity at this conjunction.

Comets in February

There are no bright comets reported for observation this month though Comet 2017 T2 PanSTARRS remains a target for northern observers at magnitude 9 and at 57 degrees north. It sets about an hour after the Sun.

Constellation of the Month: Cancer

The constellation of Cancer, the "Crab" is an undefined grouping of faint stars in an area between Gemini and Leo. It is an ancient constellation, although why it should have been given such prominence is not known, perhaps early astrologers created the asterism to fit in with their theories that the monthly movement of the Sun through various constellations had some bearing on Earthly life. Legends abound regarding this little creature; the Greeks thought the crab came to the assistance of Zeus when he wrestled with his brother Poseidon for mastery of the Earth. Poseidon killed the crab, whereupon a victorious Zeus rewarded it with a place in the heavens. It also features in the myth of Orion and that of Hercules as an unfortunate creature sent by Hera to antagonize the heroes, but being killed and placed in the sky.

Cancer contains two of the most absorbing star clusters in the heavens; one of them is a treat for binocular observers. Disappointingly, Cancer contains few other objects of note despite it astrological prominence.

The cluster that most casual observers will be familiar with is the wonderful M 44, the Beehive or "Praesepe" or “Manger” as it is called. Praesepe is one of the closest clusters to the Earth lying 525 light years away and is visible as a small cloudy patch of light to the naked eye. Due to its visual appearance it has been remarked upon by every ancient civilization, being known as the "cloudy one" or "misty one" by famous astronomers of ages past.

The beehive contains over 200 recognised members, but for the most part these are faint dwarf like stars that are impossible to see in binoculars. The stars that give Praesepe its lovely visual appearance are all white and blue "O" and "B" type suns shining with luminosities of up to 150 times that of our Sun.

Praesepe is brilliant in binoculars, as these instruments define the cluster rather well and show the central condensation of stars plus the doubles at the core of the cluster. A telescope will not show Praesepe to great effect because its high magnifying power tends to look "through" the cluster rather than at it. Telescopes will however resolve the central binaries well. The cluster core has a diameter of 13 light years, and contains over 60 stars that can be seen with a modest telescope.

The beehive is a curious object in that it shares some common qualities with the Hyades in Taurus. Studies of the cluster show that their common proper motions are very similar, it is possible that they were born around the same time and place in our galaxy and have become slowly separated, although this assumption is total conjecture. The cluster however, is a real showpiece object, one of the kind that make a cold Spring night in the darkness worth the effort.

Another cluster of particular interest is M 67, lying east of alpha Cancri. This is a lovely compressed gathering of stars numbering over 500 suns in total. However, to a binocular observer it looks just like a hazy smudge of 7th magnitude light, whilst telescopes will reveal the 70 or so central bright members of this awesome cluster. The main attraction of M 67 is that it appears to be the oldest star cluster yet found in our galaxy - at least 4 billion years old!

Most of the stars within M 67 are "K" type giants evolving away from, or already evolved from the main sequence. In addition, the luminosity of these giants appears to be far below that of usual stars of this type. This could be due to the fact that we are looking at Population II stars, very old halo objects rather than disc population I stars. Therefore the chemical compositions of the stars are slightly different; these being deficient in metals compared to stars such as our Sun, and this may be the reason for their low luminosity.

M67 lies at a great distance from us, 2600 light years, and some 1500 light years above the galactic plane. The cluster appears more like the globular clusters in composition than the normal galactic clusters. NGC 188 in Cepheus has a similar life history and composition. M 67 is not difficult to pick out with a telescope as it lies close to some 5th magnitude stars that act as stepping stones to it from alpha Cancri.

Another object worth viewing in this small constellation is the star Zeta Cancri, which is a multiple system. However, most observers will only spot the one companion as the closer companion to Zeta is not well resolved, lying very close to the primary and visible only in very large telescopes.

The star 55 Cancri has a number of worlds in orbit around it, including one with an orbit comparable to Jupiter’s at a distance of 5.5 AU from the star. This planet has a 13 year orbit and is 3.5 to 5 times the mass of Jupiter.

Cancer can become a fascinating constellation due to the fact that it lies along the "Zodiac" or the plane of the ecliptic. The bright planets can then pass close by such famous objects such as M 44 making an interesting contrast and a good target for photographers. For example in 2002 Jupiter passed very close to this cluster, presenting a pleasing photographic opportunity.

Martin Griffiths

BECKINGTON ASTRONOMICAL SOCIETY

Society Details & Speakers programme can be found on our Website www.beckingtonas.org

General enquiries about the Society can be emailed to chairman@beckingtonas.org.

Our Committee for 2016/2017 is

Chairman: Steve Hill (email chairman@beckingtonas.org)
Treasurer: John Ball
Secretary: Sandy Whitton
Ordinary Member: Mike Witt

People can find out more about us at www.beckingtonas.org

Meetings take place in Beckington Baptist Church Hall in Beckington Village near Frome.

See the location page for details of how to find us on our website……

Post Code for Sat Nav is BA11 6TB.

Our start time is 7.30pm

Date	Title	Speaker
17th January	*The Herschel 400*	Jonathan Gale
21st February	*Asterisms: Jewels of the Starry Sky*	Bob Mizon
20th March	*TBA*	Steve Hill
17th April	*Planetarium in the Bedroom*	Lilian Hobbs
15th May	*It's Not Rocket Science*	Martin Budzynski
19th June	Annual General Meeting *Member Talks*	

STAR QUEST ASTRONOMY CLUB

This young astronomy club meets at the
Sutton Veny Village Hall.
Second Thursday of the Month.

The Herschel 400

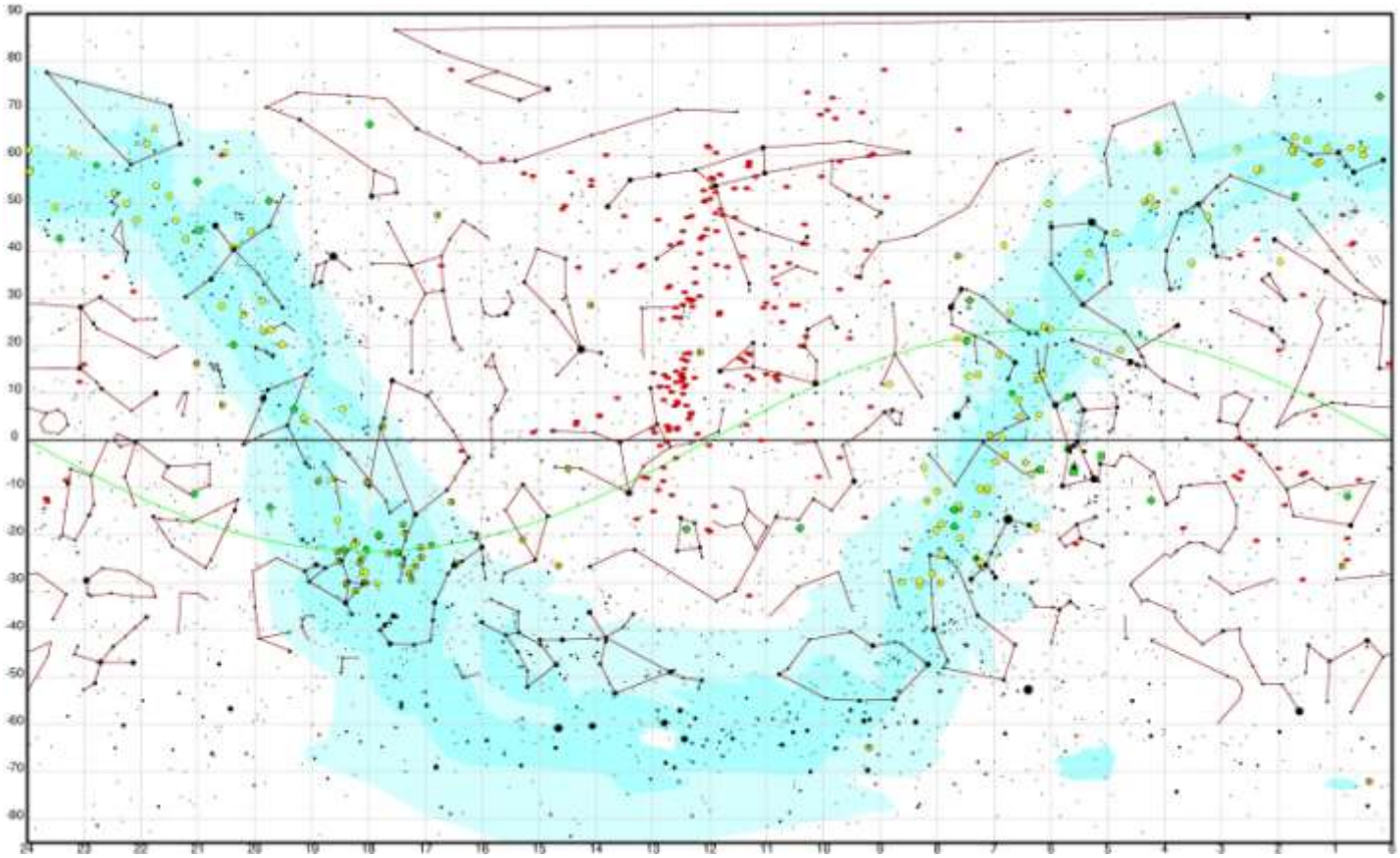
Herschel 400 Catalogue
From Wikipedia, the free encyclopedia
Jump to navigationJump to search
The **Herschel 400 catalogue** is a subset of William Herschel's original *Catalogue of Nebulae and Clusters of Stars*, selected by Brenda F. Guzman (Branchett), Lydel Guzman, Paul Jones, James Morrison, Peggy Taylor and Sara Saey of the Ancient City Astronomy Club in St. Augustine, Florida, United States c. 1980. They decided to generate the list after reading a letter[1] published in *Sky & Telescope* by James Mullaney of Pittsburgh, Pennsylvania, USA.[2]
In this letter Mr. Mullaney suggested that William Herschel's original catalogue of 2,500 objects would be an excellent basis for deep sky object selection for amateur astronomers looking for a challenge after completing the Messier Catalogue.
The Herschel 400 is a subset of John Herschel's *General Catalogue of Nebulae and Clusters* published in 1864 of 5,000 objects, and hence also of the *New General Catalogue*.
The catalogue forms the basis of the Astronomical League's Herschel 400 club. In 1997, another subset of 400 Herschel objects was selected by the Rose City Astronomers of Portland, Oregon as the Herschel II list, which forms the basis of the Astronomical League's Herschel II Program.
Vital statistics[edit]

- The catalogue contains 400 objects
- All objects are from the NGC
- All visible in mid northern latitudes (they were all observed by Herschel from the UK)

All visible in 150 mm (6") or larger telescopes

Distribution of Herschel 400 objects[edit]

Distribution of Herschel 400 objects
Red = Galaxies, Green = Nebulae, Yellow = Star Clusters
Herschel 400 objects which are also Messier objects [edit]
The Herschel 400 contains 17 objects which are part of the Messier catalogue:
M20 NGC 6514 Trifid Nebula
M33 NGC 598 Triangulum Galaxy
M47 NGC 2422
M48 NGC 2548
M51B NGC 5195 companion to the Whirlpool Galaxy
M61 NGC 4303
M76 NGC 651 Little Dumbbell Nebula/Barbell Nebula (northern portion)
M82 NGC 3034 Cigar Galaxy
M91 NGC 4548
M102? NGC 5866 Spindle Galaxy (not certainly a Messier object)
M104 NGC 4594 Sombrero Galaxy
M105 NGC 3379
M106 NGC 4258
M107 NGC 6171
M108 NGC 3556
M109 NGC 3992
M110 NGC 205
Herschel 400 objects which are also Caldwell objects [edit]
The Herschel 400 catalogue pre-dates the Caldwell catalogue. The Caldwell catalogue contains 44 objects which are members of the Herschel 400:[3]
C2 NGC 40 Bow-Tie Nebula
C6 NGC 6543 Cat's Eye Nebula
C7 NGC 2403
C8 NGC 559



C10 NGC 663
C12 NGC 6946
C13 NGC 457 Owl Cluster
C14 NGC 869 Double Cluster
C15 NGC 6826 Blinking Planetary
C16 NGC 7243
C18 NGC 185
C20 NGC 7000 North America Nebula
C21 NGC 4449
C22 NGC 7662 Blue Snowball
C23 NGC 891
C25 NGC 2419
C28 NGC 752
C29 NGC 5005
C30 NGC 7331
C32 NGC 4631 Whale Galaxy
C36 NGC 4559
C37 NGC 6885
C38 NGC 4565 Needle Galaxy
C39 NGC 2392 Eskimo Nebula / Clown Face Nebula
C40 NGC 3626
C42 NGC 7006
C43 NGC 7814
C44 NGC 7479
C45 NGC 5248
C47 NGC 6934
C48 NGC 2775
C50 NGC 2244
C52 NGC 4697
C53 NGC 3115 Spindle Galaxy
C54 NGC 2506
C55 NGC 7009 Saturn Nebula
C56 NGC 246
C58 NGC 2360
C59 NGC 3242 Ghost of Jupiter
C60 NGC 4038 Brighter of two Antennae Galaxies
C62 NGC 247
C64 NGC 2362 Tau Canis Majoris Cluster
C65 NGC 253 Sculptor Galaxy / Silver Coin Galaxy
C66 NGC 5694

Number of objects by type in the Herschel 400
Number of Herschel 400 objects in each constellation

SPACE NEWS FOR February 2020

Our Facebook page carries a lot of these news items throughout the month.

When did the universe 'wake up'?

By Paul Sutter 8 hours ago

Distant, ancient galaxies could help scientists understand how the universe turned back into plasma.
(Image: © NASA's Goddard Space Flight Center)

Paul M. Sutter is an astrophysicist at Stony Brook University and the Flatiron Institute, host of Ask a Spaceman and "Space Radio," and author of "Your Place in the Universe." Sutter contributed this article to Space.com's Expert Voices: Op-Ed & Insights.

It was a big moment for our cosmos when the first stars awoke, but it's an elusive one for scientists.

In new research, however, a team of astronomers has identified some of the oldest galaxies ever seen. These objects were already fully formed when the universe was just 680 million years old, according to the scientists, who also found evidence that these galaxies were flooding their surroundings with extreme ultraviolet radiation.

That flood formed gigantic bubbles, where the neutral gas became energized and ionized, offering astronomers the first direct image of a major transformational epoch in our universe.

Before the dawn

A long time ago, there wasn't a single star shining across the universe. In the early days of our cosmos, everything was pretty uniform: just about the same average density from place to place. A bit boring, really.

It was also depressingly neutral, quite a change from the first days of the universe. Even earlier, in the first few hundred thousand years after the Big Bang, our universe was so dang hot and dense that it was plasma; the constant cheek-to-jowl jostling had ripped apart atoms into their constituent electrons and nuclei.

But all that chaos ended when the universe turned a ripe old 380,000 years old. That's when things were spread out enough, and the temperatures were low enough, for the electrons to combine with their nuclear families and form the first atoms of hydrogen and helium. With that event came the release of a tremendous amount of radiation that we still know and love today: the cosmic microwave background.

For millions of years, the universe hung around in this state of quiet neutrality. But as the universe expanded and cooled, tiny seeds began to form; patches of that gas were, by random chance, slightly denser than their surroundings. That minuscule enhancement gave them a tiny gravitational edge, drawing material from their neighborhood onto them. Because they had grown, they had an even greater gravitational influence, pulling more material onto them, and so on.

Bit by bit, over eons, the first stars and galaxies grew in the silent, dark, neutral universe.

The cosmic dawn awakens

We don't know exactly when the first stars formed, but we know that when they did, they did so in a big, fantastic way. That's because the universe isn't neutral anymore — it's ionized.

Most of the material that you interact with daily is made of complete atoms; all of the nuclei are dutifully surrounded by shells of electrons, whizzing about and combining with each other in the wonderful, complicated dance that we call chemistry.

But this situation is unique. By far, the vast majority of matter in the universe today is a plasma, the same state it was in long, long ago, electrons and nuclei free to live their separate lives. The sun? Plasma. Other stars? Plasma. Nebulae? Plasma. The stuff between all the stars and nebulae? Plasma.

When our universe was 380,000 years old, it transformed from plasma into a neutral gas. Today, over 13 billion years later, it's mostly plasma again. Something must have happened; something must have ripped apart all those atoms in the universe. And considering that we observe the universe to be plasma as far back as we can look, to some of the first stars and galaxies to appear on the cosmic stage, whatever caused this "reionization" must have happened pretty early on.

Astronomers think the extreme ultraviolet radiation pumped out by the first generation of stars (and their deaths as supernova explosions) turned our universe back into plasma. But, frustratingly, we don't know exactly when. Even our most powerful telescopes and deepest surveys don't have the ability (yet) to peer back that far into the universe. We can clearly see the cosmic microwave background, and we can clearly see the universe as it is today, but the middle bits are currently a cosmological mystery.

We don't know when the first stars appeared — an event astronomers dub the "cosmic dawn" — and we don't know when the ensuing "epoch of reionization" began.

Blowing bubbles

But that situation is beginning to change. The hunt is on for older and older galaxies, along with surveys of the gas in their surroundings, as we try to get a handle on this important pubescent phase in the growth and evolution of our universe. Recently, an international team of researchers found three galaxies that are extremely faint, incredibly small and mind-bogglingly distant.

These diminutive galaxies were already fully formed and operating when our universe was just 680 million years old. That isn't surprising — we've found galaxies that old before — but in this study, the researchers added a new wrinkle: By examining the radiation emanating from the environment near the trio, they discovered that the galaxies had already begun to blow bubbles of ionized plasma into their surroundings.

In other words, the radiation pumping out of the galaxies had already begun to transform the universe around them, like the pimples on the forehead of a teenager. This is the first clear sign of the epoch of reionization in progress. And while astronomers had deduced that the universe had finished reionizing by the time it hit its first billionth birthday, nobody suspected that it could happen this early.

These galaxies make excellent targets for the upcoming James Webb Space Telescope, which is specifically designed to study this era of our cosmic history. If the result holds up and more examples of reionization are found, we might finally be able to understand this transformative epoch from our universe's ancient, violent past.

Lego releases International Space Station, offers bonus space patch

Lego VIP members can receive this space patch with purchase of the Lego Ideas International Space Station set (Image credit: collectSPACE.com)

Like the orbiting outpost on which it is modeled, Lego's new International Space Station has its own mission patch.

Released Saturday (Feb. 1), on the same day that Lego debuted the 864-piece International Space Station (ISS) set for sale, the colorful space patch is a bonus for the members of Lego's loyalty program, "VIP."

"VIPs receive this cool space patch February 1-9 for free when they purchase the International Space Station!" Lego announced on its website.**PLAY SOUND**

The 2.75-inch-square (7 centimeters) woven patch depicts the Lego ISS orbiting over the blue and green Earth, set against a black sky dotted with white stars. The patch reads "International Space Station Set" at its top and has both Lego's logo and NASA's "ISS 20" logo, the latter celebrating 20 years of continuous occupancy on board the real space station as of this November.

The patch, which comes packaged in its own small box, has an adhesive backing for easy application.

The "ISS 20" logo also appears on the box for the new Lego Ideas ISS set, which includes the toy bricks needed to build a desktop model of the orbital outpost.

"Build a legend with the exclusive new Lego International Space Station," reads the product page on Lego's website. "For over 20 years, the International Space Station has welcomed cooperation from different nations to achieve common goals that benefit all mankind. The largest spacecraft ever built, it continues to unlock discoveries not possible on Earth — and push the boundaries of human space exploration further than ever before."

The new Lego Ideas International Space Station toy model set on display in the front window of a Lego Store in Houston, Texas. (Image credit: collectSPACE.com)

The $69.99 ISS set, when assembled, forms a 12-inch-long (31 cm) model of the space station, including its habitable modules, eight solar array wings and backbone truss, as well as its multi-window Cupola, robotic arm and expandable activity module. Two microfigure astronauts, three visiting vehicles and a shuttle orbiter are also part of the set, as is a stand on which to support and display it all.

"Use a robotic arm to launch a satellite into orbit. Bring in the next crew of astronauts. Send the microfigure[s] out to perform repairs," Lego described.

More of a model than a toy, though, the ISS set is recommended for builders 16 years of age and older.

The Lego International Space Station was based on a project submitted to the Lego Ideas website by fan designer Christoph Ruge of Germany. On Friday (Jan. 31), the Lego Store in Nuremberg hosted Ruge for a box signing, providing fans with their first chance to purchase the set.

"That was quite a crowd today — thanks everybody for stopping by!" Ruge wrote on Twitter, retweeting a video showing that the line for his signature filled the store.

The International Space Station VIP bonus is the second space patch that Lego has given away with one of its space-themed sets. In May 2019, members who purchased the NASA Apollo 11 Lunar Lander received a similar patch celebrating that set's release and the 50th anniversary of the first moon landing mission.

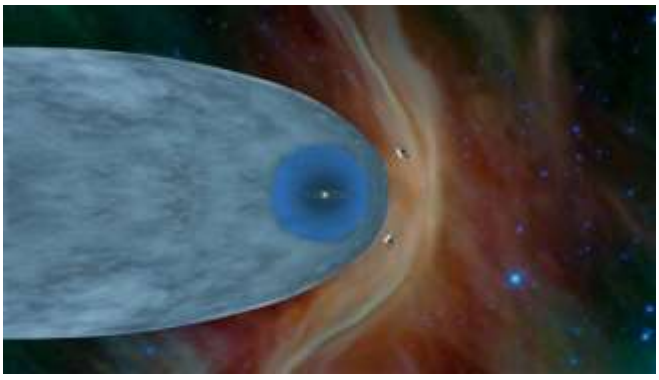
The International Space Station set and its space patch are available exclusively from Lego Stores and the company's online shop.

Voyager 2 Went Into Fault Protection Mode, But Engineers Brought it Back Online

NASA's Voyager 2 spacecraft went into fault protection mode on Tuesday January 28th. The fault protection routines automatically protect the spacecraft in harmful conditions. Both Voyagers have these routines programmed into their systems.

After it happened, NASA engineers were still in communication with the spacecraft and receiving telemetry.

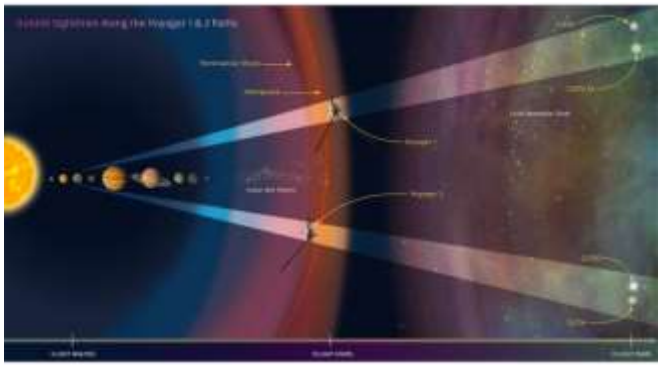
The fault protection stems from a maneuver attempted on January 25th. On that day, Voyager 2 was supposed to execute a scheduled rotation maneuver. The spacecraft rotates itself 360 degrees to calibrate one of its instruments, MAG, the triaxial fluxgate magnetometer. That instrument is investigating the solar wind boundary with the interstellar magnetic field and beyond.



NASA's Voyager 2 Probe Enters Interstellar Space This illustration shows the position of NASA's Voyager 1 and Voyager 2 probes, outside of the heliosphere, a protective bubble created by the Sun that extends well past the orbit of Pluto. Voyager 1 exited the heliosphere in August 2012. Voyager 2 exited at a different location in November 2018. Credit: NASA/JPL-Caltech

NASA says there was a delay in the maneuver, which caused two systems that draw a lot of power to be on at the same time. There's a tight power budget on Voyager 2, because its radioisotope thermoelectric generators are running down. To protect itself, the spacecraft went into its fault-protection mode. In that mode, it shut down scientific instruments to make up for the power deficit. By January 28th,

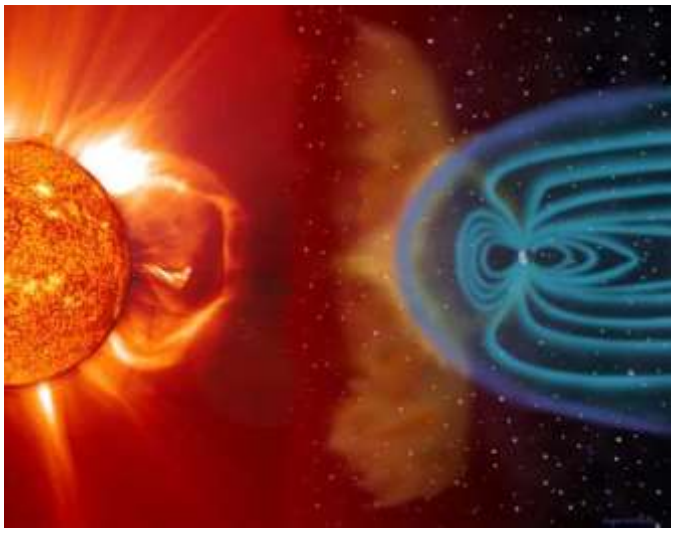
engineers had successfully shut down one of the two high-power-drawing systems, and turned its science instruments back on.
After that, they still weren't receiving data from the spacecraft.
Voyager 2 is still running, but its power situation is precarious. Mission engineers are constantly evaluating the status of the power system, and they know that it's losing about 4% of its power each year. A lot of power is needed to keep systems on the spacecraft from freezing, including fuel lines. If those lines froze, and broke, then Voyager 2 would no longer be able to point its antenna towards Earth, and the mission would effectively be over.



In this illustration, NASA's Hubble Space Telescope is looking along the paths of NASA's Voyager 1 and 2 spacecraft as they journey through the solar system and into interstellar space. Hubble is gazing at two sight lines (the twin cone-shaped features) along each spacecraft's path. The telescope's goal is to help astronomers map interstellar structure along each spacecraft's star-bound route. Each sight line stretches several light-years to nearby stars. Credit: NASA, ESA, and Z. Levy (STScI).
Voyager 2 is about 18.5 billion kilometers (11.5 billion miles) away, so communicating takes a long time. It's a 34 hour round trip for mission engineers to send a signal to the spacecraft and for the spacecraft to respond. So it's taken several days to work through this scenario.
On January 29th, NASA sent out this Tweet:
So it looks like Voyager 2 is back on track, though we're still waiting for things to get back to normal.
Voyager 2 is currently in interstellar space, having left the heliosphere in November 2018. In November 2019, three papers were published outlining what Voyager 2 found as it left the heliosphere. The spacecraft's power is running down, and some of its instruments have been turned off. But it should have enough power to keep transmitting data.
NASA has said in the past that Voyager 2 has enough power to keep working until roughly 2020, so at some point in the near future, we may hear the spacecraft's final transmission. Then it'll head off into space, lost to humanity forever.

Destructive Super Solar Storms Hit Us Every 25 Years Or So

Solar storms powerful enough to wreak havoc on electronic equipment strike Earth every 25 years, according to a new study. And less powerful—yet still dangerous—storms occur every three years or so. This conclusion comes from a team of scientists from the the University of Warwick and the British Antarctic Survey.
These powerful storms can disrupt electronic equipment, including communication equipment, aviation equipment, power grids, and satellites.
The team identifies two types of powerful magnetic storms: 'great super storms' are the most powerful and occur every 25 years on average. The weaker but still dangerous 'severe super storms' occur every three years on average.
The new paper presenting these results is titled "Using the *aa* index over the last 14 solar cycles to characterize extreme geomagnetic activity." It's published in the journal Geophysical Research Letters. The lead author is Dr. S.C. Chapman from the University of Warwick.
Solar storm are also called geomagnetic storms. They're caused by disturbances in the Sun that send charged particles into space. When those particles strike Earth's magnetosphere, they cause the storm. The particles can come from coronal mass ejections (CME), co-rotating interaction regions (CIR), and coronal holes that emit a high-speed stream of solar wind that can travel twice as fast as normal solar wind.
The most famous geomagnetic storm is the Carrington Event of 1859. The Carrington Event is also the most powerful geomagnetic storm ever recorded. That storm knocked out some telegraph systems in different parts of the world, started some fires, and even shocked some telegraph operators.
More recently, a 1989 storm in Quebec disrupted the power distribution system, and created powerful auroras that were seen as far south as the state of Texas.
Solar storms pose an increasing risk as our world becomes more linked electronically. Not just our power distribution systems, but our global communications systems, too. Our satellites might be the most vulnerable, and modern society relies on them more than many people realize. It's been calculated that a storm as powerful as the Carrington Event, if it were occur today, would cause billions, possibly even trillions of dollars worth of damage.
Scientists are interested in these storms because of the need to predict them. This new paper is based on magnetic field data going back 150 years. The authors say they can detect how many powerful storms there were in that time period, and how often they occurred.



This visualization depicts what a coronal mass ejection might look like like as it interacts with the interplanetary medium and magnetic forces. Credit: NASA / Steele Hill
In a press release, lead author Professor Sandra Chapman, from the University of Warwick's Centre for Fusion, Space and Astrophysics, said: "These super-storms are rare events but estimating their chance of occurrence is an important part of planning the level of mitigation needed to protect critical national infrastructure."
In their paper, the authors show that 'severe' magnetic storms occurred in 42 out of the last 150 years, or about every three years. The more powerful 'great' super-storms occurred in 6 years out of 150, or about every 25 years. Usually these storms only last a few days, but they can still be very disruptive to modern technology. Super-storms can cause power blackouts, disrupt or damage satellites, disrupt aviation and cause temporary loss of GPS signals and radio communications. (GPS is not just for navigation. Believe it or not, the modern banking system relies heavily on GPS to synchronize financial transactions.)
"This research proposes a new method to approach historical data, to provide a better picture of the chance of occurrence of super-storms and what super-storm activity we are likely to

see in the future," said Chapman.
The Carrington Event was not part of the study, because the data the researchers looked at doesn't go back that far. Their magnetic field data is from the opposite ends of the Earth, from stations in the UK and Australia. It covers the last 14 solar cycles, dating back to well before the space age.
Their analysis shows that super storms as powerful as the Carrington Event may be more common than thought, and that they can happen at any time, with very little warning. Professor Richard Horne, who leads Space Weather at the British Antarctic Survey, said: "Our research shows that a super-storm can happen more often than we thought. Don't be misled by the stats, it can happen any time, we simply don't know when and right now we can't predict when."
These storms are born in the Sun, but space weather can be monitored by observing changes in the magnetic field at the earth's surface. There's high quality data from multiple stations on Earth going back to the start of the space age, around 1957. Scientists know that the sun has an approximately 11-year cycle of activity, and during that cycle the Sun varies in intensity. The problem is that there's not enough of this data. It only covers five solar cycles.
A better understanding of powerful solar storms and their rate of occurrence requires a larger data set spanning more solar cycles. In this new study, the researchers went back further in time. They looked at the *aa* geomagnetic index, which comes from sites in the UK and Australia, at opposite ends of the Earth. The *aa* index cancels out Earth's background field, and reaches back 150 years, or 14 solar cycles. It's the longest, almost continuous record of changes in magnetic fields across the earth's surface.

Aurora during a geomagnetic storm that was most likely caused by a coronal mass ejection from the Sun on May 24, 2010, taken from the ISS. Image Credit: By ISS Expedition 23 crew

The team used annual averages from the top few percent of the *aa* index to reach their conclusion. That's how they found that a 'severe' super-storm occurred in 42 years out of 150, and the rarer but more powerful 'great' super-storm occurred in 6 years out of 150. That means these extreme storms occur once in every 25 years. As an example, the 1989 storm that caused a major power blackout of Quebec was a great storm.
A few years ago there was a near miss. In 2012, the Sun unleashed a powerful burst from an exceptionally large and strong coronal mass ejection. Luckily for us, Earth was not in its path. But data showed that it would have been a super storm if it had struck us.

On August 31, 2012 a long filament of solar material that had been hovering in the sun's atmosphere, the corona, erupted out into space at 4:36 p.m. EDT. The coronal mass ejection, or CME, traveled at over 900 miles per second. The CME did not travel directly toward Earth, but did connect with Earth's magnetic environment, or magnetosphere, causing aurora to appear on the night of Monday, September 3. The image above includes an image of Earth to show the size of the CME compared to the size of Earth. Credit: NASA/GSFC/SDO

There's more and more interest in the Sun and the space weather it sends our way. As our economy and way of life become more and more reliant on satellites, communications, and power grids, governments and agencies have made understanding and predicting space weather a priority.
There are several spacecraft studying the Sun right now, including SOHO (Solar Heliospheric Observatory), SDO (Solar Dynamics Observatory), and the Parker Solar Probe. These spacecraft are growing our understanding of the Sun, and our ability to predict these dangerous storms.

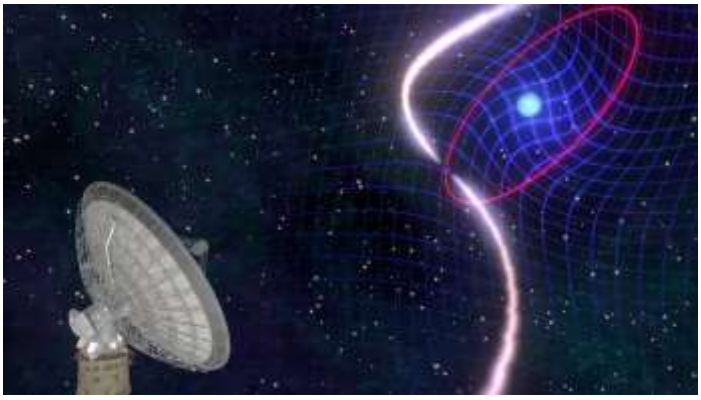
This is the Spot Where ESA's Schiaparelli Crashed Into Mars

On October 19th, 2016, the NASA/ESA ExoMars mission arrived at the Red Planet to begin its study of the surface and atmosphere. While the Trace Gas Orbiter (TGO) successfully established orbit around Mars, the Schiaparelli Lander crashed on its way to the surface. At the time, the Mars Reconnaissance Orbiter (MRO) acquired images of the crash site using its High Resolution Imaging Science Experiment (HiRISE) camera.
In March and December of 2019, the HiRISE camera captured images of this region once again to see what the crash site looked like roughly three years later. The two images show the impact crater that resulted from the crash, which was partially-obscured by dust clouds created by the recent

planet-wide dust storm. This storm lasted throughout the summer of 2019 and coincided with Spring in Mars' northern hemisphere.

POSTED ON JANUARY 30, 2020 BY BRIAN KOBERLEIN

Astronomers See Space Twist Around A White Dwarf 12,000 Light Years Away

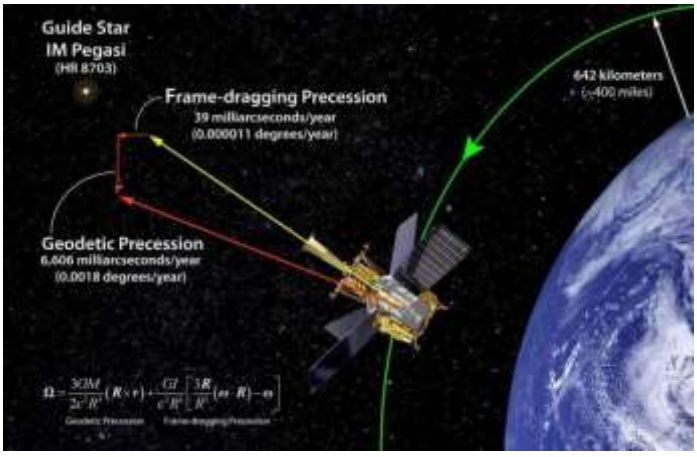


The theory of general relativity is packed with strange predictions about how space and time are affected by massive bodies. Everything from gravitational waves to the lensing of light by dark matter. But one of the oddest predictions is an effect known as frame-dragging. The effect is so subtle it was first measured just a decade ago. Now astronomers have measured the effect around a white dwarf, and it tells us how some supernovae occur.

In general relativity, gravity is not a force. The presence of a mass bends space around it, and this means that objects moving near the mass are deflected from a straight path. This deflection looks as if the object is being pulled toward the mass as if by a force we call gravity. When a large mass is rotating, space also twists slightly in the direction of rotation. It is this effect that is known as frame-dragging.

You can see an illustration of frame-dragging in the figure above. The central object is a massive rotating body, such as a black hole. The red dots represent points that are "at rest," which means they aren't moving *through* space. Instead, they move because space around the body is twisting due to the rotation. This frame-dragging effect is in addition to any orbital motion an object might have, and it is part of the reason why the accretion disk around a black hole can get so extremely hot.

Near Earth, the frame-dragging effect is very small. So small that it took a special satellite to measure it. Known as Gravity Probe B, the spacecraft contained one of the most spherical objects ever made. Once in space, the sphere was set spinning and watched over time.



The precession effect of Gravity Probe B. Credit: Gravity Probe B Team, Stanford, NASA

Without frame-dragging, a spinning sphere orbiting the Earth should always keep the same orientation, like a gyroscope. Earth's gravity can't cause it to twist on its own. But frame-dragging can. Because of Earth's rotation, the region of space closer to the Earth twists just slightly faster than the region of space farther away. This means the part of the sphere that's closer to Earth gets a little push, and as a result, it's orientation changes over time. We call this Lense–Thirring precession. In 2015 the team measured this precession, and it agreed perfectly with general relativity.

While the frame-dragging effect is larger around massive bodies like white dwarfs and neutron stars, it isn't easy to measure. To measure the frame-dragging of a body you need to have something orbiting it. Luckily for us, many white dwarfs and neutron stars are part of a binary system. So recently a team used a binary system to study frame dragging.

In 1999, the Australian Parkes Radio Telescope discovered the pulsar PSR J1141-6545. It is a neutron star that's in a binary orbit with a white dwarf star. The distance between these two stars is only about the width of the Sun, and they orbit each other every five hours.

Because pulsars emit a sharp radio pulse at regular intervals, astronomers can use them to make extremely accurate measurements of the pulsar's motion and orbit. The measurements are so precise that we can use them to measure the effects of general relativity, including frame dragging. Because the white dwarf is rotating, the orbit of the pulsar precesses slightly over time. The amount of precession depends on the mass and rotational speed of the white dwarf.

Parkes radio telescope viewed from the visitor's area. Credit: Stephen West

After observing the pulsar for twenty years, the team not only observed frame-dragging, they used it to measure the rotational speed of the white dwarf. They found that it rotates once every 100 seconds, which is quite fast for a white dwarf.

The results agree with a popular model about how close binary systems evolve. Pulsars form when large stars die and become supernovae. This means the binary system was once a binary system where a large star orbited the white dwarf. As the star reached the end of its life, material from its outer layer would have been captured by the white dwarf, causing it to spin faster. The observations show that the white dwarf formed before the pulsar.

All this from an amazing work of astronomy, measuring relativistic frame-dragging in a star 12,000 light-years away.

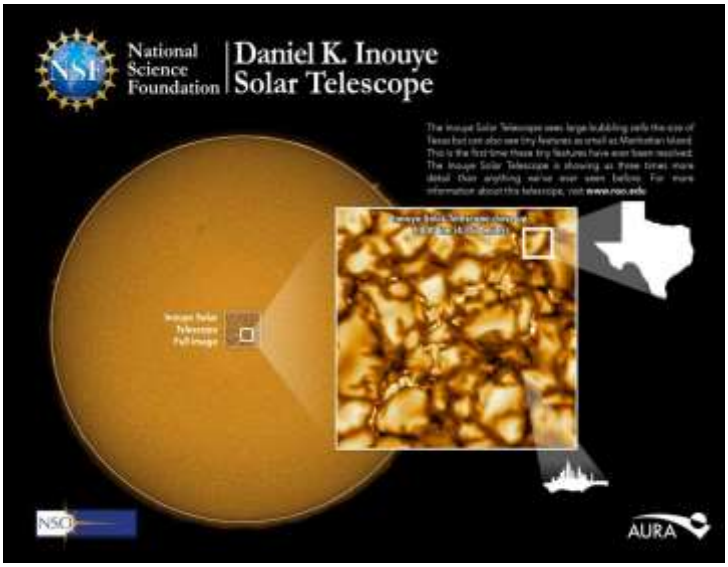
This is the Highest Resolution Image Ever Taken of the Surface of the Sun

The Sun's activity, known as "space weather", has a significant effect on Earth and the other planets of the Solar System. Periodic eruptions, also known as solar flares, release

considerable amounts of electromagnetic radiation, which can interfere with everything from satellites and air travel to electrical grids. For this reason, astrophysicists are trying to get a better look at the Sun so they can predict its weather patterns.

This is the purpose behind the NSF's 4-meter (13-ft) Daniel K. Inouye Solar Telescope (DKIST) – formerly known as the Advanced Technology Solar Telescope – which is located at the Haleakala Observatory on the island of Maui, Hawaii. Recently, this facility released its first images of the Sun's surface, which reveal an unprecedented level of detail and offer a preview of what this telescope will reveal in the coming years.

These images provide a close-up view of the Sun's surface that shows turbulent plasma arranged in a pattern of cell-like structures. These cells are an indication of violent motions that transport hot solar plasma from the interior of the Sun to the surface. This process, known as convection, sees this bright plasma rise to the surface in cells, where it then cools and sinks below the surface in dark lanes.



Inouye Solar Telescope can image a region of the Sun 38,000 km (23,600 mi) wide. Credit: NSO/AURA/NSF

By obtaining these kinds of precise and clear images of the Sun, astronomers hope to be able to improve their understanding of this process so they can predict sudden changes in space weather. As France Córdova, the NSF director, explained:

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

To put it plainly, the Sun is a G-type (yellow dwarf) main-sequence star that has existed for about 4.6 billion years. This puts it about halfway through its life cycle, which will last for about another 5 billion years. The process of self-sustained nuclear fusion which powers the Sun (and provides all of our light, heat, and energy) consumes about 5 million tons of hydrogen fuel every second.

All of the energy created by this process radiates into space in all directions and reaches to the very edge of the Solar System. Since the 1950s, scientists have understood that Earth resides within the Sun's atmosphere and that changes in its weather have a profound impact on Earth. Even now, decades later, there is much about the Sun's most vital processes that remain unknown.

This photo shows the sunspot group before a flare explosion. Credit: Chris Schur

Matt Mountain is the president of the Association of Universities for Research in Astronomy, which manages the Inouye Solar Telescope. As he explained the goal of solar astronomy:

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

Astronomers have determined that the motion of the Sun's plasma is related to solar storms because of the way that they cause the Sun's magnetic field lines to become twisted and tangled. Measuring and characterizing the Sun's magnetic field is crucial to determining the causes of potentially harmful solar activity – something for which the Inouye Solar Telescope is uniquely qualified.

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

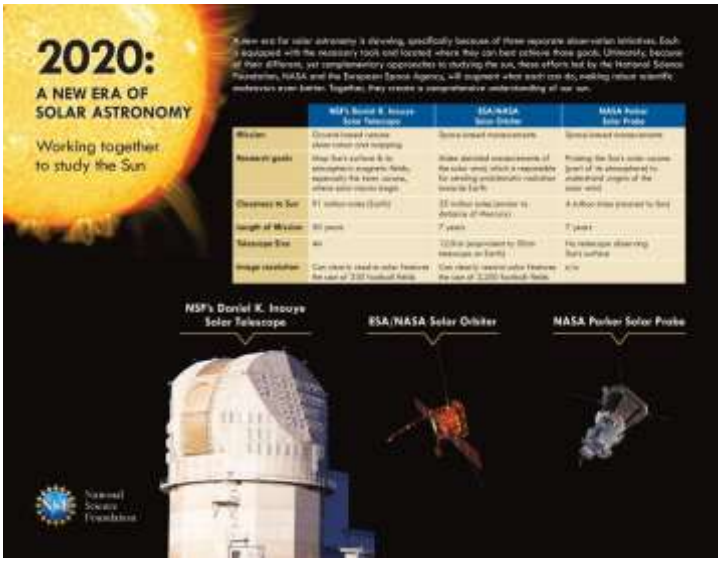
This zoomed-in image shows how the Sun's magnetic field shapes hot coronal plasma. Credit: NASA/LMSAL/SAO

One of the biggest benefits to come from a better understanding of solar dynamics is the ability to predict major weather events. At present, governments and space agencies are able to anticipate events about 48 minutes ahead of time. But thanks to the research being conducted by the Inouye Solar Telescope and other solar observatories, astronomers expect to get this up to 48 hours.

This would give us more time to ensure that these events don't knock out power grids, critical infrastructure, satellites,

and space stations. Naturally, the business of monitoring the Sun is no easy task and comes with its fair share of hazards. For this reason, the Inouye Solar Telescope leverages many recent developments in terms of construction, engineering, and astronomy. This includes its 4 m (13 ft) mirror (the largest of any solar telescope), adaptive optics to compensate for the distortion caused by Earth's atmosphere, and the pristine viewing conditions atop Haleakala's over 3000 m (10,000 ft) summit. The telescope also relies on several safeguards to ensure that it does not become overheated from focusing 13 kilowatts of solar power from the Sun.

This is done via a high-tech, liquid-cooled metal torus (the "heat-stop") that keeps most of the sunlight away from the main mirror and cooling plates that cover the dome and keep temperatures stable around the telescope. The interior of the observatory is also kept cool using 11.25 km (7 mi) of coolant pipes, which are partially chilled by ice that accumulates during the night, and interior shutters that provide air circulation and shade.



World-class instruments combine for a new era of solar astronomy. Credit: NSF

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

David Boboltz, a program director in NSF's Division of Astronomical Sciences, is also responsible for overseeing the facility's construction and operations. As he indicated, these images are just the tip of the iceberg for the Inouye Solar Telescope:

"Over the next six months, the Inouye telescope's team of scientists, engineers and technicians will continue testing and commissioning the telescope to make it ready for use by the international solar scientific community. The Inouye Solar Telescope will collect more information about our sun during the first 5 years of its lifetime than all the solar data gathered since Galileo first pointed a telescope at the sun in 1612."

The Inouye Solar Telescope is part of a trio of instruments that are poised to revolutionize solar astronomy in the coming years. It is joined by NASA's Parker Solar Probe (which is currently orbiting the Sun) and the ESA/NASA Solar Orbiter (which is soon to be launched). As Valentin Pillet summarized (the director of the NSF's National Solar Observatory), it's an exciting time to be a solar physicist:

"The Inouye Solar Telescope will provide remote sensing of the outer layers of the sun and the magnetic processes that occur in them. These processes propagate into the solar system where the Parker Solar Probe and Solar Orbiter missions will measure their consequences. Altogether, they constitute a genuinely multi-messenger undertaking to understand how stars and their planets are magnetically connected."

It Looks Like James Webb's Launch Date is Going to Slip to July 2021

Put "James Webb Telescope launch" into your search engine and you'll be flooded with links, some reaching back to the 'scope's first proposed launch date in 2010. The delayed launch of the space telescope is a running theme in the space community, even though we all know it's going to be worth the wait. So nobody will be surprised by this latest development in the story of the world's most anticipated telescope.

NASA is Going to Add a Commercial Module to the Space Station

NASA's plan to open up the International Space Station (ISS) to commercial activity is gaining ground. They have a vision for an economy in Low-Earth Orbit (LEO) called the Plan for Commercial LEO Development. According to NASA, they intend to foster economic development in LEO and to drive innovation, all for the benefit of the American economy. Now they've selected Axiom Space of Houston to provide a commercial habitation module for the ISS.

China Releases New Pictures From the Surface of the Moon

Ever since it made its historic landing on Jan. 3rd, 2019, the *Chang'e-4* mission and its *Yutu 2* rover have been busy exploring the lunar surface. Just recently, the mission passed its first year of operations and earned the distinction of being the first rover to travel a record 357.695 meters (1,173.5 ft) on the far side of the Moon. And in between all that, the mission has also provided some truly fascinating images of the

lunar surface.
Thanks to a data release issued on Monday (Jan. 20th), the public can now peruse through all of the high-resolution images taken by the Chang'e-4 mission. The data, which was released by the Ground Research and Application System (GRAS) of the Chinese Lunar Exploration Project, includes images of the far side of the Moon that were taken with the lander's terrain camera and the panoramic camera on the Yutu-2 rover.
Included in the release are many images of the Von Kármán Crater (located in the South Pole-Aitken Basin) where the lander and rover made their soft landing last year. These images feature close-up and long-distance shots of everything surrounding the lander and rover. The data was transmitted back to Earth via the *Queqiao* orbiter, which is acting as a communications relay for the mission's surface elements.

Image of the Chang'e-4 lander, taken by the Yutu 2 rover. Credit: CNSA/GRAS/Doug Ellison

These images are something of a retrospective, providing a visual timeline for key points in the mission while also calling attention to the rover and lander's surroundings. To make all these images accessible to the public, the GRAS team has uploaded the full archive of mission data to a dedicated website used by the China Lunar Exploration Program's (aka. Chang'e Program) information services.
The release of all of this data is already causing quite the stir in the astronomical community. As *Space.com* reports, Doug Ellison – the engineering camera team lead for the *Curiosity* rover mission at NASA's Jet Propulsion Laboratory (JPL) – downloaded a range of the data, processed many of the images, and made them available in a gallery (which you can see here).
These processes images show close-up views of small craters and lunar soil (aka. regolith) on the floor of the Von Kármán Crater. Also featured are shots of the distant skyline, multiple shots of the lander and rover, and *Yutu-2*'s tracks in the soil. A few of the images also show the rover looking back towards the lander as it ventures farther away from it.
In addition to coloring and sharpening the raw images, Ellison also combined single images together to create larger images and panoramas – some of which he shared via Twitter. As you can see, some of the panoramas provide a wide view of the landscape, others give a cylindrical view of the terrain in the immediate vicinity of the rover.
Another brave soul to take a crack at the data is Philip Stooke of the Centre for Planetary Science and Exploration (CPSX) at Western University in London, Ontario. As a lunar cartographer, Stooke used the new data to refine maps that chart the progress of the *Yutu 2* rover as it traveled over 357 meters (1,170 ft). Many more galleries have sprung up since the release, all of which detail the mission's progress during its first 13 lunar days.
Because it is tidally-locked with our planet, each lunar day is equivalent to about 14 Earth days; during which time, the Sun is constantly in the sky. These are followed by lunar nights (also 14 Earth days), which are characterized by extremely cold conditions. Because the lander and rover are solar-powered, they go into hibernation mode during a lunar night and awaken again 24 to 48 hours after the next lunar day commences.
The rover began its 14th lunar day of operations last weekend (Saturday, Jan. 18th) while the lander followed on Jan. 19th. As of the writing of this article, the lander and rover have been operating on the lunar surface for a total of 389 days. Originally, the rover was intended to remain operational for three months while the lander was to remain in operation for a full year.

Cylindrical panoramic of the Yutu 2 rover. Credit: CNSA/GRAS/Doug Ellison

Looking ahead, the China National Space Agency (CNSA) plans to send several more missions to the Moon, which includes the *Chang'e-5* mission that will land on the Moon by the end of 2020. This will be China's first sample-return mission and will consist of collecting 2 kg (4.4 lbs) of lunar regolith from the Mons Rümker region and returning it to Earth.
This will be followed by *Chang'e-6* and *Chang'e-7*, which will launch in 2024 and 2023 (respectively) and also land in the South Pole-Aitken Basin. The former, the second sample-return mission of the program, will bring lunar soil back from the south pole. The latter, meanwhile, will carry on where *Chang'e-4* leaves off by conducting a comprehensive survey to determine if a lunar outpost can be built in the region.
The final mission, *Chang'e-8* (which is scheduled to launch in 2027) will test technologies and lay the groundwork for China's first crewed lunar mission – at this point, that mission is scheduled to take place by the 2030s. These are exciting times for space exploration, and even more exciting times lay ahead! If and when humanity sets up a permanent outpost on the Moon, we can expect that several nations will have had a hand in building it.

E Mails Viewings Logs and Images from Members.

Letter from La Palma

In my last letter from La Palma, I mentioned that there was a possibility that another new telescope might be joining those already at *the Observatario de El Roque de los Muchchos* (ORM), here on La Palma. Here, I will try to outline briefly the new generation of Extremely Large Telescopes (ELTs) that will be coming along around the World in the next decade. I will also outline the issues that may cause one of them to be relocated here.

When it comes to telescopes, as we all know, bigger is better. Currently the largest single aperture telescope in the World is the *Gran Telescopio de Canarias* (GTC) or GRANTECAN here on La Palma which has a 10.4 metre segmented primary mirror. The Large Binocular Telescope (LBT), located on Mount Graham in Arizona, USA, has 2 primary mirrors of 8.4 metres which can be combined to form an image, the two Keck telescopes on Mauna Kea in Hawai'i, each of 10 metres can also be used together using interferometry and the same technique is used by the European Southern Observatory's (ESO) Very Large Telescope (VLT) which has 4 individual units with primary mirrors of 8.2 metres. The technologies used on these telescopes such as segmented mirrors and adaptive optics, now make it possible to build much larger telescopes.

Giant Magellan Telescope (GMT)

The first of these ELTs currently under construction is the Giant Magellan Telescope (GMT). It will be sited at Las Campos in Chile at an altitude of 2,516 metres. The $1 billion project is led by the US, but with partners Australia, Brazil and South Korea and Chile as the host country. GMT is a bit 'old school' in that instead of a segmented mirror, the primary mirror will consist of 7 x 8.4 metre mirrors, which will give GMT a primary mirror of 25 metres diameter or a total light-gathering area of 368 square metres. First light is scheduled for 2029.

The mirrors will be some of the largest mirrors ever made. These mirrors will then be arranged with one mirror in the centre (no.4 which has a hole in the middle) and the other six arranged symmetrically around it. The outer six segments will be off-axis and although identical to each other, will not be individually radially symmetrical, this allows the mirrors to occupy any position and an eighth mirror is planned as a replacement as the others are removed for maintenance and re-silvering, required by each mirror every 1-2 years. It is planned to start operations with four mirrors.

The mirrors are being constructed at the University of Arizona's Steward Observatory Richard F. Caris Mirror Lab, which is located underneath the college football field! Traditionally, telescope mirrors are initially produced by grinding two flat blanks together in a random motion. This results in one blank becoming convex and one concave. The process can take years with big mirrors. So, in order to speed the process, the mirrors for GMT are cast in a rotating furnace. This technique involves building a honeycomb mounting for the mirror and then placing 20 tons of E6 borosilicate glass from Japan upon it. The furnace is then heated to melt the glass and spun to create a concave shape. The process takes about 12-13 weeks. The rotation is kept on whilst the glass cools. After being cast the mirrors need to cool for about six months. After which grinding and polishing take place to get the correct profile. This process can 5-6 years. The mirrors are ground to an accuracy of 19 nm.

GMT Mirror Status

Mirror Number	Casting date	Notes
1	October 2005	Completed August 2012
2	January 2012	Completed August 2019
3	August 2013	Processing
4	September 2015	This is the Central mirror Processing
5	November 2017	Processing
6		In early construction phase
7		In planning Expected to be cast in 2020
8		Not yet planned Expected to be cast in 2021

Table 1 - GMT Mirror Status

European Extremely Large Telescope (E-ELT, from 2017 ELT)

The European Extremely Large Telescope (ELT) was born out of another programme, the Overwhelming Large Telescope (OWL). This was a project study by ESO and would have had a primary mirror of an eye-watering 100 metres! To put that in some sort of context, the Lovell *radio* telescope at Jodrell Bank, which many of you will have visited, has a diameter of 76 metres. This would have given OWL a total light gathering area of 7,854 square metres. It was under active consideration between 1998 and 2015. This project was eventually considered to be far too expensive and probably beyond what was possible in terms of engineering, so that it morphed into a scaled-down version that has become ELT. ELT will still be the largest telescope in the World when completed, having a primary mirror of 39.3 metres, which will give it a total light-gathering area of 970 square metres. It is being constructed at the ESO site of Cero Amazonas in Chile at an altitude of 3,046 metres. First light is currently expected in 2027.

Thirty Meter Telescope (TMT)

The last of the ELTs currently planned is TMT, which will have a primary mirror of, guess what, 30 metres. By the spelling you can tell this is American-led but involves partners from Canada, Japan, China and India. It will have a total light-gathering area of 665 square metres. It is currently planned to be built of Mauna Kea in Hawai'i at an altitude of 4,050 metres, but therein lays the problem - Mauna Kea is sacred to Native Hawaiians.

The TMT project is a response to a recommendation in 2000 from the US National Academy of Sciences that a thirty metre telescope be a top priority and that it be built within a decade. Urgency in construction is due to the competitive nature of science with the European ELT also under construction. The two projects are also complementary, in that E-ELT (and GMT) would only be able to view the Southern Celestial Hemisphere, it was considered pointless to put all three in the same place, so the TMT project, as the last out of the blocks, decided it would be placed at Mauna Kea as this is considered to offer the best views of the Northern Celestial Hemisphere.

TMT is to be a Ritchey-Chrétien telescope with a segmented main mirror made up of 492 1.4m individual hexagonal segments, which will be controlled actively. A 3.1m diameter secondary mirror is used to produce an unobstructed 20 arcminute field of view. A 3.5 x 2.5m flat tertiary mirror will direct the light path to instrumentation mounted on large Nasmyth platforms. TMT will have an alt-azimuth mount. The design has been developed from the Keck telescopes and an integral part of the telescope is a Multi Conjugate Adaptive Optics (MACAO) System. MACAO will use a combination of real and laser guide stars and based on the measurements a pair of deformable

mirrors will be adjusted many times a second to correct optical wave-front distortions caused by the atmosphere.

Whilst from a scientific point of view, Mauna Kea, which is located on the Big Island of Hawai'i and measured from its base, beneath the sea, is the tallest on the planet. Undoubtedly it offers one of the best views of the sky in the Northern hemisphere, the atmosphere being dry and stable, Mauna Kea is sacred to the Native Hawaiian people and culture.

A very brief overview of Hawaiian History

The earliest habitation of the Hawaiian islands date to around 300AD, probably by Polynesian settlers from the Marquesas Islands. A second wave of migration from Raiatea and Bora Bora took place in the 11th.Century. The 1778 arrival of British explorer Captain James Cook marked the first documented contact by a European with Hawai'i. After his second visit in 1779, he was killed by natives in a dispute over stolen boat. A trading post had been set up by Cook and trade with the British continued. (The union flag still occupies the upper canton of the Hawai'i State Flag).

The islands were a mix of independent kingdoms at this time. Legend has it that in 1758, Halley's Comet made its way across Hawaiian skies, portending the birth of the man who would eventually unite the islands King Kamehameha I.

The economy of the islands changed with outside contact as well. Whaling was, at one point, a big part of the kingdom's economy, especially on Maui, with Lahaina acting as a major whaling port. Later, agricultural interests such as the Sandalwood trade, followed by sugar and later pineapples, brought businessmen from America and Europe to Hawai'i, but labourers came from China, Japan and the Philippines and they settled on the plantations to work the land. In the meantime the traditional lifestyle of the native Hawaiians was in flux. Many traditional ways were hidden and practiced in secret, as the clashed with the teachings of the Christian church.

The Kingdom of Hawai'i was sovereign from 1810 until 1893 when the monarchy was overthrown by resident American capitalists and landowners. It then became an independent republic from 1894 until August 12 1898, when it was annexed as a territory by the United States. Hawai'i was admitted to the US as the 50th state on August 21 1959.

United States Public Law 103-150 of 1993, informally known as the Apology Resolution, is a Joint Resolution of the US Congress that acknowledges that the overthrow of the Kingdom of Hawai'i, occurred with the active participation of agents and citizens of the US and further acknowledges that the Native Hawaiian people never directly relinquished sovereignty to the US. The then President, Bill Clinton, made a formal apology speech to the Hawaiian people.

Astronomy on Mauna Kea

In the 1960s astronomer Gerard Kiuper began searching for an arid site for studies in the infra-red. At first he looked at Chile, but he also looked at the Hawaiian islands. Tests on Maui's Haleakalā proved promising but the mountain was too low in the inversion layer and was often covered in clouds. On the 'Big Island' of Hawai'i, Kuiper looked at the possibility of an observatory on Mauna Kea. After testing he discovered that the low humidity was perfect for infra-red signals. He persuaded the then-Governor, John Burns to bulldoze a dirt road to the summit where he built a small telescope on Pu'u Poli'ahu, a small cinder cone peak. This peak was the second highest on the mountain with the *highest peak being holy ground*, so Kuiper avoided it. (my italics)

Kuiper then tried enlisting NASA to fund a larger facility with a large telescope, housing and other necessary structures. NASA decided to make the project open to competition. Professor of Physics John Jefferies of the University of Hawai'i (UH) placed a bid on behalf of the University. The proposal was for a two metre telescope to serve both the needs of NASA and the University. Whilst large telescopes are not normally awarded to universities, Jefferies and UH won the NASA contract, infuriating Kuiper who felt that 'his mountain' had been 'stolen from him'. Kuiper would abandon his site (the first telescope on Mauna Kea) and begin work in Arizona on a different NASA project. After further testing by Jefferies' Team, the best locations were determined to be near the summit of Mauna Kea at the top cinder cones. Testing also showed Mauna Kea to be superb for night-time viewing due to many factors including the thin air, constant trade winds and being surrounded by sea. Jefferies would build a 2.24 metre telescope with the State of Hawai'i agreeing to build an all-weather road to the summit. Building began in 1967 with first light seen in 1970.

Opposition to the observatories

Opposition to the observatories has existed since 1964. In Honolulu, the Governor and legislature have always been enthusiastic about the development and have set aside ever larger areas for the observatories, causing opposition in the city of Hilo. The native *kānaka ōiwi* believe that the entire site is sacred and that development of the mountain even for science, would desecrate the area. (It has been suggested that to native Hawaiians, the building of telescopes on Mauna Kea is like demolishing the Sistine Chapel in the Vatican to build them would be to the Roman Catholic Church). Environmentalists were concerned about rare native bird populations and some citizens of Hilo were concerned about the site of the domes from the city. Using town hall meetings, Jefferies was able to overcome opposition by weighing the economic advantage and prestige the island would receive. Over the years, the opposition to the observatories may have become the most visible example of the conflict science has encountered over the access and use of environmental and culturally significant sites. Opposition to development began shortly after the expansion of the observatories. Once access to the summit was opened up by the road, skiers began using it for recreation and objected when the road was closed as a precaution against vandalism when the telescopes were being built. Hunters voiced concerns as did the Hawaiian Audubon Society, who were supported by the Governor, George Ariyoshi.

The Audubon Society objected to further development on Mauna Kea over concerns to the habitat of the endangered *palila*, an endemic species to only specific parts of the mountain. This bird is the last of the finch-billed honeycreepers existing on the island. Over 50% of native bird species have been killed off due to loss of habitat from early western settlers and non-native species competing for resources. Hunters and sportsmen were concerned that hunting of feral animals would be affected by telescope operations, though none of these concerns proved accurate. A 'Save Mauna Kea' movement was inspired by the proliferation of telescopes with the opposition believing development of the mountain to be sacrilegious. Native Hawaiian non-profit groups such as *Kahea,* whose goals are the protection of native Hawaiian cultural heritage and the environment, oppose development on Mauna Kea as a sacred space to the native Hawaiian religion. Today Mauna Kea hosts the World's largest location for telescope observations in infra-red and sub-millimetre astronomy. The land itself is protected by the US Historical Preservation Act due to its significance to Hawaiian culture, but still allowed development.

Further development of the Mauna Kea observatories is still opposed by environmentalists and Native Hawaiians. A 2006 proposal for the outrigger telescopes to become extensions of the Keck Observatory were cancelled after a judges' determination that a full environmental impact statement must be prepared before any further development. The "outrigger" would have linked the Keck I and Keck II telescopes. Environmental groups and Native Hawaiian activists were a lot

stronger at this time that they had been in the past but NASA went ahead with the proposal due to lack of an alternative site. The group *Mauna Kea Anaina Hou* made several arguments against the development stating Mauna Kea was a sacred mountain to Native Hawaiians where many of the deities had lived and that the cinder cone proposed for the site was holy in Hawaiian tradition as a burial site for a demi-god. The group raised several other concerns such as environmental over native insects and the question of 'Ceded Lands'. These were lands owned by the Hawaiian Kingdom, they were annexed by the US Government and, since statehood are administered by a QUANGO the Bureau of Land and Natural Resources (BLNR) which leases the land to UH which sub-lease the land to individual observatories. An audit report critical of the mountain's management by the BLNR was also produced. Each time a new telescope is built, Native Hawaiians have been promised it will be the last and there would be no more than eleven in total. There are now, according to the opposition, who count sub-telescopes, twenty six!

TMT – A line in the sand.

TMT being an ELT, has to be housed in an extremely large dome, the equivalent of a nineteen story building which is currently planned for the summit of Mauna Kea. It has become the focus of opposition to further development of the observatory site, with a current ongoing legal battle in the Hawai'i courts system. The proposal continues to spawn a great deal of controversy over the use of the site for science.

The current protests began locally in October 2014, but went global within weeks of the arrest of 31 people on 2nd April 2015 when they blockaded the roadway leading to the summit to keep constructors off. The project was expected to be completed by 2024, at that time, nearly simultaneously with the ELT in Chile, however, on the 2nd December 2015, the Supreme Court of Hawai'i invalidated TMTs construction permits. The court ruled the due process had not been followed. All construction equipment was removed from Mauna Kea and a new construction permit was applied for, meant to respect the court's ruling. This was granted on 28th September 2018. On the 30th.October 2018, the court validated the new permit.

The issue of native peoples, their religious freedoms and rights in regards to authority for large science-based projects has become a major issue to contend with. Mount Graham, in Arizona had and issue with the sanctity of the mountain raised by activists. Observatories have succeeded in being built, but only after protracted and expensive litigation and effort.

On the 7th October 2014, the ground breaking ceremony for TMT was being streamed via webcam. The proceedings were interrupted when the official caravan encountered several dozen protestors picketing and chanting in the middle of the roadway. The non-violent protest did not stop or block any people but when the ground breaking began, protesters interrupted the blessing, stopping the proceedings as well as the ground breaking. That same day protesters demonstrated outside the headquarters of the Gordon and Betty Moore Foundation, Principal sponsors for TMT, at Palo Alto, California, USA.

Second Mauna Kea blockade & arrests, 2015. Beginning in late March 2015, demonstrators halted construction crews near the visitor centre, again by blocking the access road to the summit. On the 2nd April 2015, 300 protesters were gathered at the visitor centre where 12 people were arrested. 11 more were arrested at the summit. Protestors ranging in age between 27 and 75 years were handcuffed and led away by local police. A number of celebrity activists of Native Hawaiian descent began campaigning over social media , including Jason Momoa, the *Game of Thrones* and *Aquaman* star, who urged Dwayne Johnson (*The Rock*), to join the protests with him on Mauna Kea. Construction was halted for one week at the request of Governor David Ige on the 7th.April 2015 after the protest on Mauna Kea continued and demonstrations began to appear all over the State. Gary Sanders, the TMT project manager agreed to the one-week halt for continued dialogue Kealoha Piscottia, president of *Mauna Kea Anaina Hou*, viewed the development as positive but said opposition to the project would continue. Piscottia would continue to be within a *Kapu Aloha* 'moving in Aloha' with steadfast determination.

Temporary Halt. Governor Ige announced that the project was being temporarily postponed until the 20th April 2015 in response to the growing protests. TMT took to social media to respond to the opposition's growing momentum by having public relations firms to assist the project's voice in the islands. TMT sub-lease payments were also put on hold in order for the contested case hearing.

National and International demonstrations. The protests sparked international attention to Hawaiian culture, Mauna Kea and to the 45-year history of 13 other telescopes on the mountain. At UH, Manoa, hundreds of students lined the streets for blocks as one-by-one they passes the stone from the student taro patch of the University's Centre on Hawaiian Studies down the human chain to the lawn in front of the office of the University president, David Lessner. The stones were used to build an *ahu* (the alter of a *heiau*) as a message to the University. On the 21st.April 2015, hundreds of protesters filled the streets of Honolulu, protesting against the TMT.

2019 Demonstrations. Following the approval of the new Building Permit, the construction of TMT was scheduled to restart on the 15th.July 2019. Shortly after sunrise on the 13th.July, the Royal Order of Kamehameha along with Mauna Kea protectors began the process of designating *Pu'uhluhulu* as a *Pu'uhomua*, which historically, has served as a space of protection during contentious times. The *Pu'uhomua o Pu'uhluhulu* boundaries were secured through ceremony and the approval of the Royal Order of Kamehameha, establishing a site of protection, sanctuary and refuge for Mauna Kea protectors. Situated on a 38-acre conservation district, directly across from the Mauna Kea access road, *Pu'uhomua o Pu'uhluhulu* has access to food medical supplies, education, cultural practices and ceremony.

On the 15th.July, protesters blocked the access road to the mountain preventing the planned construction from commencing. On the 16th.July, thirteen astronomical facilities on the mountain stopped activities and evacuated their personnel. On the 17thJuly 33 protestors were arrested, all of whom were *kūpuna* or Elders. This was, from a PR point of view, a very shrewd move. The sight of these Elders, many in wheelchairs being arrested by police, many themselves native Hawaiians, went around the globe. The blockage of the access road continued.

More than 1,000 people marched in Waikiki and gathered at Kapiolani Park on the 21st.July to protest about the TMT project. The protest continued into August 2019 at the entrance to the Mauna Kea access road in front of *Pu'uhluhulu* or Hawaiian Route 200. It was announced on the 9th.August that astronomers would return to work after halting for many weeks in response to the gathering protest. There had been fears that staff would be submitted to violence and intimidation, but in another PR triumph the protectors of Mauna Kea stated that theirs was a non-violent protest and they were not anti-science and fully appreciated that maintenance had to be carried out at these facilities, particularly in respect of replenishing the Liquid Nitrogen used to cool the Infra-red detectors, which would be ruined if not maintained.

Governor Ige then stated that the *Pu'uhomua o Pu'uhluhulu* was a hotbed of alcoholism and drug-taking; that conditions were were unsanitary and the place was covered in litter, therefore the camp would have to be

		Sun Angle		Sub-Solar Point		Librations		Phase
Date	Time UT	Azimuth	.	Long.	Lat.	Elong.	%Illum.	Age
02/01/2020	20:24:54	90.5635		-1.579	6.864	85.703	46.854	7.633
01/02/2020	10:15:05	91.4447		-4.464	6.024	83.699	43.959	7.523
01/03/2020	23:52:56	92.0331		-6.640	3.667	79.563	41.848	7.348
31/03/2020	13:05:18	92.1654		-7.674	0.282	80.302	40.967	7.151
30/04/2020	01:44:46	91.8243		-7.183	-3.286	79.426	41.595	6.971
29/05/2020	13:52:08	91.1227		-5.033	-5.962	83.393	43.720	6.843
28/06/2020	01:36:21	90.2559		-1.612	-6.774	85.534	46.926	6.788
27/07/2020	13:11:50	89.4489		2.156	-5.348	91.262	50.435	6.819
26/08/2020	00:54:34	88.9108		5.264	-2.186	92.778	53.372	6.926
24/09/2020	12:58:26	88.7919		7.106	1.591	96.654	55.102	7.082
24/10/2020	01:32:38	89.1429		7.523	4.798	95.169	55.368	7.251
22/11/2020	14:40:13	89.8847		6.585	6.605	95.384	54.235	7.398
22/12/2020	04:17:20	90.8112		4.470	6.675	91.728	51.978	7.500

Average age: 7.2 days.

removed for public health and public order reasons. In yet another PR coup, the press were shown that the camp was well-organised, with everyone joining the protest being given an induction briefing, which included that alcohol, drugs and violence were strictly prohibited. There were dormitories, Portaloos or "Jiffy Johns" as they are known in the US - cleaned regularly, education centres and a canteen supplying free food donated by supporters, cooked on site in field kitchens. Ige, who had declared a state of emergency and called out the Hawaiian National Guard to deal with the camp, was 'left with egg all over his face' and promptly withdrew from further day-tot-day involvement, delegating the problem to Harry Kim, the mayor of the Big Island who has made little progress in solving the impasse. The stalemate continues – the protectors say they are there to stay and construction of TMT remains halted. Telescope parts have been manufactured around the World, but without a dome to house it, the TMT cannot be built. Time is slipping by and with it, costs are rising, but TMT has a Plan B.

Alternative sites

Mauna Kea is generally considered a remarkably good place to conduct astronomical observations, but there are other possible sites for the telescope. Back in 2016 fearing such a situation with native Hawaiian protests and legal difficulties, all of which have come to pass, the steering committee of TMT, the TMT International Observatory (TIO) formed in 2014 to carry out the construction and operational phases of the TMT project, started looking at alternative sites for TMT *should the preferred site at Mauna Kea prove to be unachievable.* (my italics) It found a back-up location on the island of La Palma. There are already a number of observatories and necessary infrastructure at ORM. They also consider high mountains in India, China and Mexico, but most of these were too remote or had bad observation characteristics. In addition, support facilities would have had to have been built from scratch, adding to the costs. Eventually it was announced that ORM had been selected as the back-up site. "ORM has full capacity to meet the scientific objectives of TMT and provides similar atmospheric characteristics to Mauna Kea.at visible and near infra-red wavelengths" the assessment report states.

Site	alti-tude	Lati-tude	Lon-gitude	Comments
Mauna Kea (MKO) Hawai'i, USA	4050 m	19.82° N	155.5 °W	Current TMT Site, data from TMT site testing.
ORM La Palma Spain	2250 m	28.8° N	17.9° W	Data from IAC and ESO site testing groups
San Pedro Mátir (SPM) Cerro El Altar, Mexico	2790 m	30.75° N	115.5 °W	TMT site testing data on Cerro Pelado (2 km away)
Cerro Vicuña Mackenna, Chile	3114 m	24.59° S	70.0° W	TT site testing on Cerro Armazones (25 km away)
Cerro Honar, Chile	5400 m	23.07° S	67.8° W	TMT site testing on Cerro Tolonchar (100 km away)
Hanle, India	4500 m	32.8° N	78.9° E	Some site testing measurements available.
Ali, China	5100 m	32.3° N	80°E	Some site testing measurements available.

Table 2 - Sites examined by TIO as viable alternatives to Mauna Kea.

Site Characteristics (median values, unless stated)

	USA	ORM La Palma
Altitude of Site (m)	4050	2250
Fraction of yearly usable time (%)	72	72
Seeing at 60m above ground	0.50	0.55
Isoplanatic angle (arcsecond)	2.55	2.33
Atmospheric coherence time (ms)	7.3	6.0
Calculated Adaptive Optics Strehnl Merit Function	1.0	0.93
Preciptable water vapour (% time <2mm)	54	>20
Mean night-time temperature (°C)	2.3	7.6
Extinction (Vmag/airmass)	0.111	0.137

Whilst Mauna Kea remains Plan 'A,' TIO continues to pursue the alternative site at ORM. They are proceeding with obtaining the necessary building permits and hosting agreements and this seems to proving far easier that it has been in Hawai'i.

Rafael Robolo, the director of the Canary Islands astrophysics Institute, stated "We are observing what happening in Hawai'i with maximum respect. Our position is that we a here if TMT needs us," The TMT study of alternative locations showed that "…the turbulence profile above ORM is similar in character to that of Mauna Kea and only second among all five sites considered regarding Adaptive Optics (AO) performances. Using the ORM turbulence profile with our own performance model for NFRAOS, TMT's AO facility, we could demonstrate that TMT will perform excellently in its defraction-limited regime at ORM". Also "…because there are various stories in the astronomical community regarding the dust above the ORM site, and intensive analysis has been carried out by the TMT project The study shows that the operational and scientific risks related to dust at ORM are well within the range of the other potential sites for TMT"

Relocating to La Palma, would seem on the face of it, the only way out for the TIO to get TMT constructed and operational. With escalating costs and delays at Mauna Kea and with no end in sight, I'm sure most of the astronomical community would say move to ORM and get it built. There is no opposition here, all government departments are cooperating to get the necessary paperwork done and there are no native *Guanches* left to complain - the Spanish *Conquistadors* slaugh-

tered them all in the 15th.Centuary! There is a real risk that if the delays at Mauna Kea continue, the project could fold. One of the problems for TMT is that unlike the other ELTs, it is not yet fully-funded. If one of the contributing organisations or countries was to lose patience and pull out, then the whole enterprise might collapse which would be a great loss to science. Suppose TMT is not built and a major astronomical event was to occur in the Northern hemisphere where GMT and ELT can't see it, not to mention the other opportunities that would be lost.

The fixation with Mauna Kea and continuing to push for it is hard for some of us to understand. Whilst it is accepted that it is the best site in the Northern Hemisphere, in the modern World, the high-handed and bullying tactics used by authorities in the past just do not work anymore. People have 'rights', social media ensures that the World knows when a minority's rights are abused. There are always nationalistic interests in international projects. TMT is American led and of course they would like to see it built in America, just as when the alternative site survey was carried out China and India were keen for a site in their country to be selected. However, there are also financial considerations. The budget for TMT is $1.4 billion. In addition, the project will donate $1 million annually to local education, so that local people will have the right skills to become the support staff that will be needed. There are also lucrative construction contracts, many have already been awarded in Hawai'i and they would not be happy to lose them.

At the beginning of December 2019, in a deal brokered by Big Island Mayor Harry Kim, Governor Ige announced that the Police and National Guard would be withdrawn from Mauna Kea, until the end of February 2020. The TIO have also stated that there will be no further attempts to begin construction of TMT during this period. The protectors have agreed to remove some of the temporary structures erected at the protest site, but a token number of *kūpuna* have remained throughout the winter months. The stated intention of this action is to allow a cooling off period for both sides of the argument to consider their positions. The protectors have vowed that they will not give up the fight and TMT and Ige are still determined to build TMT on Mauna Kea so by the end of February 2020, the whole saga will likely kick-off again. With time running out for TMT, La Palma is ready and waiting.

The city hall of Puntagorda, a small municipality on la Palma on 29th.November 2019, opened the door to the construction of TMT. All the paperwork to build the 19-story dome to house the $1.4Bn telescope in Puntagorda in now in order. It is just up to the TIO to decide whether it will continue to push ahead with its original plan to build TMT on Mauna Kea, or switch to Plan B, in the Canary Islands. If approved construction would begin in the Spring of 2021.

The TIO held a meeting on the 23rd.November 2019, but sources explained that "currently, there is no set date to determine our next steps for building TMT". They added: "The TMT board of directors regularly meets, these are scheduled meetings to follow the evolution of the project both in Hawai'i and La Palma, as well as other issues". The TIO requested the building licence from Puntagorda city hall some weeks previously. Under the licence, 10 Hectares of land will be ceded to the Canary Astrophysics Institute (IAC).

It is expected to take ten years to build the telescope and its supporting installations. The project is likely to generate many jobs – and not only in construction. Numerous technical positions will be needed to oversee the scientific programmes, and more work could come from the development of the equipment for the TMT. Spanish scientists would also receive 10% of the TMT's observing time as Host Nation. "TMT hopes to be a good neighbour to La Palma and is expected to make significant investment in training and education".

More than a dozen telescopes are already functioning at ORM some of which are run by scientists and engineers from the area.The TMT could multiply the work opportunities for the locals. Spanish authorities at all levels from Congress to the regional government of the Canary Isles, have shown public support for the construction of TMT. In addition, according to *El Pais*, a Spanish national newspaper, the operating costs in La Palma would be half the $40 mn needed for the site in Hawai'i. – an important saving for an instrument that is supposed to operate for 50 years. This period is guaranteed by ORM with an option to extend. The UH lease on Mauna Kea expires in 2036 with no certainty of renewal.

The project has received some criticism in Spain from the environmental group Ben Magec, which says that TMT will harm the environment, and has promised in the media to oppose the plans.

Mike Alexander

From Peter Chappell:

Viewing Log for 19th of January

Had a free evening and the sky was clear, so this could only really mean one thing, viewing session? For a change I thought I would drag out the Sky-Watcher EQ3-2 Pro mount, I was sure this had not seen action in quite a while (while doing the set up the last date used was 12 Jan 2018, so had just been over two years since last action!)? Trouble with equatorial mounts, it takes a lot longer to set up than using my Meade scope, you have to balance telescope first and then balance telescope with the mount using counter balance weights plus there is more cables and others bits which are internal to the Meade scope.

After doing all the balancing required, I was ready by 19:22 being no wind and a temperature of + 2 C, it should be a good evening for viewing. With the EQ 3-2 Pro mount I was using a William Optic's 98mm refractor and 14 mm Pentax eye piece. While setting up a van went pass slowly (rubber necking I guess?), so did not affect my night vision. Soon afterwards another car came up and stopped in the same lay-by as me, this was Robin and Hilary Wilkey from Swindon Stargazers (I had arranged a possible session at the previous Friday's club meeting). As they did not have a working red light they said they would keep a car between them and me, so I would not lose my night vision completely. For a while I had been having problems finding planets with my Meade telescopes (I have mentioned this in previous viewing logs?), so I thought bringing out a different mount I should find the planets, how wrong I was! Venus was starting to set in the west, when I slewed to this planet it was just at the edge of my red dot finder, so doing some adjustments it came into view. With it being so bright (around – 4 mag?) and low in the sky I could not really make anything out, no real phases of the planet, this will become better once it is pass greatest elongation east. Had a go at Uranus and likewise I could not see it in the scope? Slewing around the general area did not pick it up, have I got trouble with this set up as well, might need an upgrade in software if one is available (that will be for another night). All of a sudden a bank of clouds came in and we wondered if the session would stop? There had been no forecast of cloud for the evening but above us was cloud! After about 30 minutes Robin and Hilary decided it was time to pack up as it was about the limit for Robin staying out viewing, so I would have the place to myself. I noticed the sky was clearing to the east, could make out Leo and Ursa Major so it was possible I could carry on?

After Hilary and Robin had gone Orion was clear, so I slewed around to M42, this was at the edge of the telescope field of view, so I released the locking clamps and

centred this object! By now I could make out Cygnus in the other direction, slewed the telescope around but could not make out M29 a fine open cluster (O C) I look at a lot. Back to M41 just below Sirius, this O C looked good to view (one thing I noticed using a refractor over a SCT, the sky and objects seems brighter?). M46 is an O C I often to not look at, it is to the east of Sirius and right next door to M47, as for seeing M46, not sure? M50, yet another O C is about the third of the way from Sirius in a straight line to Procyon? This O C also looked good to look at. M35 in Gemini was nearly overhead, this O C was large and bright to see. One thing I am not happy with EQ mount's is when they go overhead, a lot of valuable equipment is held in place by one bolt only that being eye piece, 90 ° prism and telescope! Going over to Ursa Major I could make out M81 and M82 in the same eye piece, they looked like dim grey blobs? Think I could just make out my nemesis in M97, this is one of the harder planetary nebulas in his list to see? Tried M31 and it was not there, time for a reset and do the set up again!

I am sure in the past the telescope has to be roughly aligned with Polaris, this time I would see it in the telescope eye piece! After set up I went back to M31, bright and nearly centreJ! On to the Double Cluster (NGC 884 and NGC 869), only one word to say: wonderful! This object is far better for a Newt or refractor than a SCT, the SCT goes thru the object! Back to M29, this time I found it at the edge of the view of the telescope, it was dim to look at, did not help being close to the horizon? Time to change to a 20mm eye piece, this would give less mag but more field of view. Back to Uranus and again I could not see it, thinks I need an upgrade with the hand controller? M45 was centre of field of view, all looked good here? M44 in Leo was a large but loose O C. I just happen to touch the telescope and noticed it rocked a bit, turns out the main locking bolt had come loose a bit! With that tighten back up I went into Auriga and found M38, a compact O C. Give M46 another try after the reset, this time I found it in the same field of view as M47, M47 was large and bright with M46 a lot dimmer, easy to miss this object? Might have done that earlier on in the evening? Back to M36, again in Auriga looked good and then disappeared, eh! Looked up and noticed a large bank of cloud had rolled in and I did not notice it? By now there was a nice coat of frost on the gear, it was – 1 °C and time to start packing up (21:44), everything was in the car by 21:58 and time to go home only to take all of the kit out of its boxes to dry overnight before packing it up again the following morning. After the van had gone past while I was setting up not another came past me apart from Hilary and Robin leaving during the whole viewing session. Noticed with going out on a Sunday evening not much traffic goes pass me?

Clear skies.

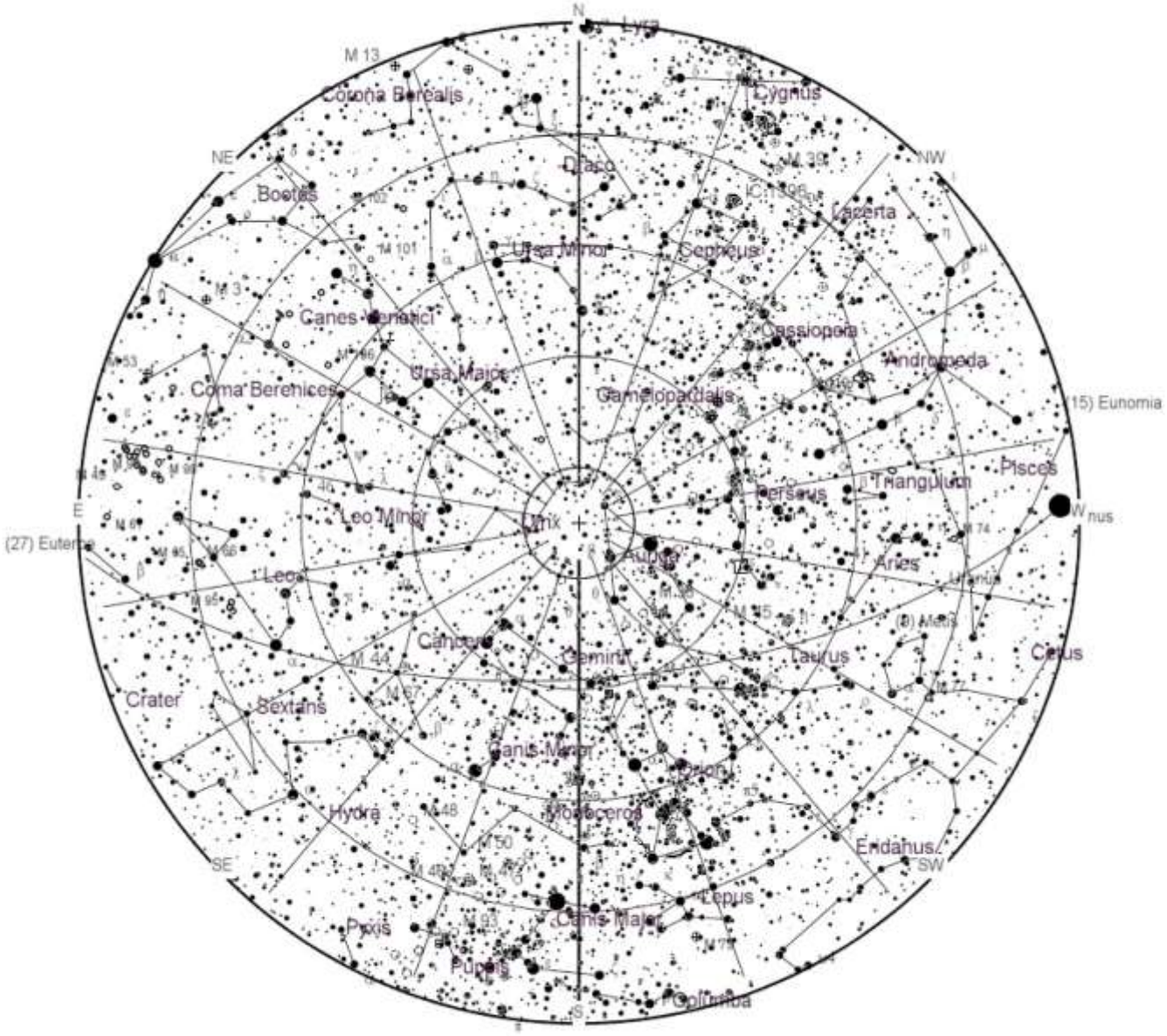
Peter Chappell

Follow up report on the hand controller upgrade.

I spoke to Andy Burns the following day about if he had upgraded and would he help me out with it? We met at Andy's house that evening, he said the best thing to start with is try my hand controller on his mount set up in his observatory. After doing the set up's we tried various objects around the sky and all were pretty much centre. Even tried Uranus and it was just off centre a bit but it looked like another star! When I am using my SCT I can make it out as a planet, it is possible I saw it the previous night but thought it was a star, easy to do? Andy said he thought the hand controller was working fine and would not need the upgrade? I made the conclusion that I did not do my set up the previous evening very well and could not make out Uranus if it was in the field of view? One thing I have learnt is to make sure Polaris is in the telescope field of view to start with and 'park' the scope before switching off the power, this is something I do not normally do, just switch off the power and pack up! Hopefully next time I go out with this mount I can learn from my mistakes I made on Sunday? Never know the EQ 6 might even come out, sometime!.

Very glad to have helped. Seeing Neptune, we were using the 120mm refractor, about 600mm focal length as opposed to SCT around 2400mm, so a very different view. I also had problems when switching from lunar viewing to deep sky objects and getting trailing because the hand controller sets lunar rate tracking and does not switch back. After Peter left I installed a new level 5 hand controller and this \i used last night and swopped between Lunar and Sideral rate and back. Worked perfectly (except on images where I fiddled with wires over the counterweights during a two minute exposure. Doh.

WHATS UP, February 2020



The Month of Supermoons in the Month of a Moonth… no self important roman leaders demanding more days in their ' name months' but we do have a season correcting leap day this February.

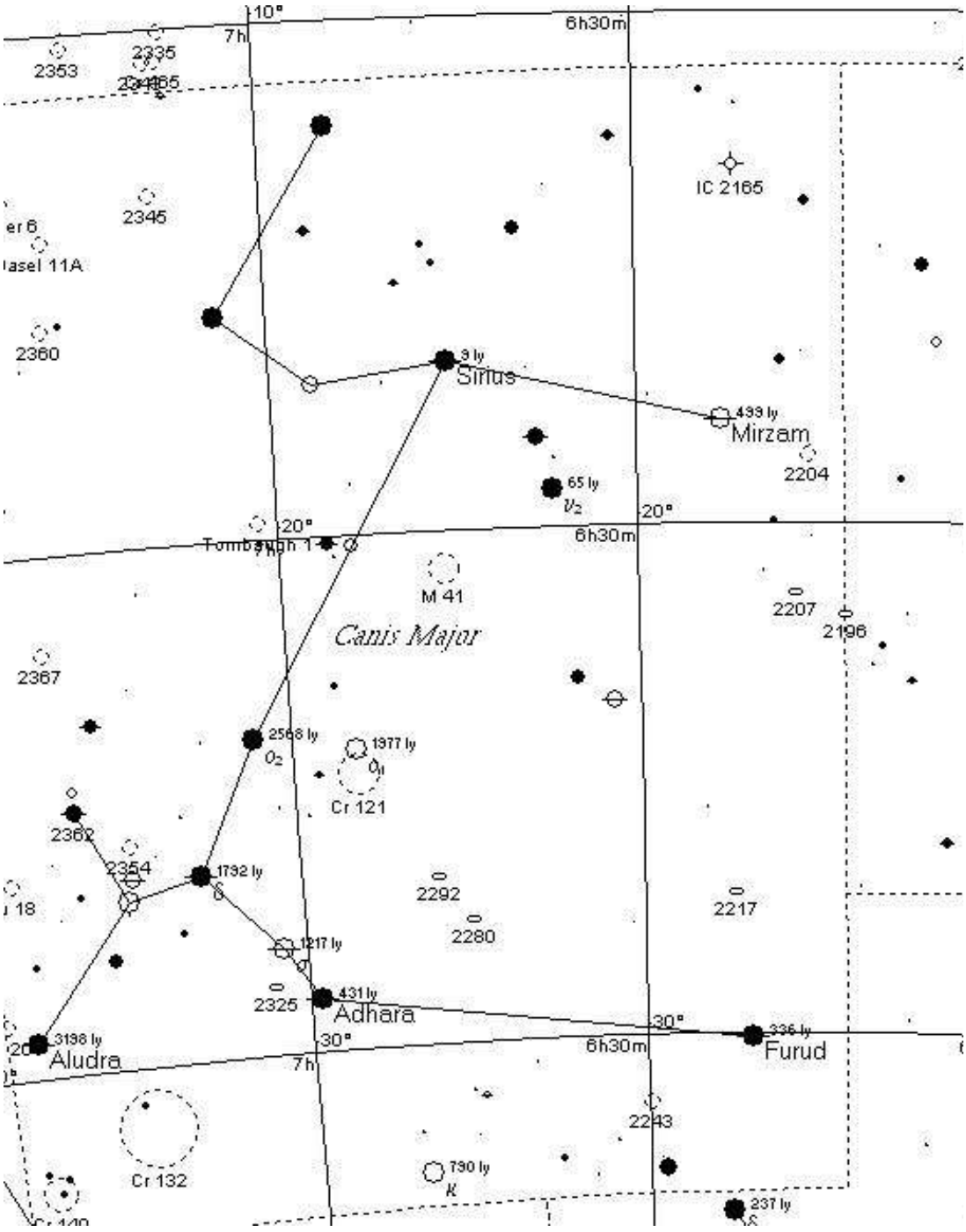
February 9 - **Full Moon, Supermoon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 07:34 UTC. This full moon was known by early Native American tribes as the Full Snow Moon because the heaviest snows usually fell during this time of the year. Since hunting is difficult, this moon has also been known by some tribes as the Full Hunger Moon, since the harsh weather made hunting difficult. This is also the first of four supermoons for 2020. The Moon will be at its closest approach to the Earth and may look slightly larger and brighter than usual.

February 10 - **Mercury at Greatest Eastern Elongation.** The planet Mercury reaches greatest eastern elongation of 18.2 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the evening sky. Look for the planet low in the western sky just after sunset.

February 23 - **New Moon.** The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 15:33 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

March 9 - **Full Moon, Supermoon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs at 17:48 UTC. This full moon was known by early Native American tribes as the Full Worm Moon because this was the time of year when the ground would begin to soften and the earthworms would reappear. This moon has also been known as the Full Crow Moon, the Full Crust Moon, the Full Sap Moon, and the Lenten Moon. This is also the second of four supermoons for 2020. The Moon will be at its closest approach to the Earth and may look slightly larger and brighter than usual.

CONSTELLATIONS OF THE MONTH: Canis Major



Three Star Each tablets (ca. 1100 BCE). In this account, Sirus (KAK.SI.DI) was seen as the arrow aimed towards Orion, while Canis Major and part of Puppis were seen as a bow.

(STScI)

To the ancient Greeks, Canis Major represented a dog following the great hunter Orion. Named Laelaps, or the hound of Prociris in some accounts, this dog was so swift that Zeus elevated it to the heavens. Its Alpha star, Sirius, is the brightest object in the sky (besides the Sun, the Moon and nearest planets). The star's name means "glowing" or "scorching" in Greek, since the summer heat occurred just after Sirius' helical rising.

The Ancient Greeks referred to such times in the summer as "dog days", as only dogs would be mad enough to go out in the heat. This association is what led to Sirius coming to be known as the "Dog Star". Depending on the faintness of stars considered, Canis Major resembles a dog facing either above or below the ecliptic. When facing below, since Sirius was considered a dog in its own right, early Greek mythology sometimes considered it to be two headed.

Together with the area of the sky that is deserted (now considered as the new and extremely faint constellations Camelopardalis and Lynx), and the other features of the area in the Zodiac sign of Gemini (i.e. the Milky Way, and the constellations Gemini, Orion, Auriga, and Canis Minor), this may be the origin of the myth of the cattle of Geryon, which forms one of The Twelve Lab ours of Heracles.

In the 2nd century CE, Greek-Egyptian astronomer Claudius Ptolemaeus (aka. Ptolemy) compiled a list of all the then-known 48 constellations. This treatise, known as the *Almagest*, would be used by medieval European and Islamic scholars for over a thousand years to come, effectively becoming astrological and astronomical canon until the early Modern Age.

One of these constellations included in Ptolemy's collection was Canis Major, an asterism located in the southern celestial hemisphere. As one of two constellations representing "the dogs" (which are associated with "the hunter" Orion) this constellation contains many notable stars and Deep Sky Objects. Today, it is one of the 88 constellations recognized by the IAU, and is bordered by Monoceros, Lepus, Columba and Puppis.

Name and Meaning:

The constellation of Canis Major literally translates to "large dog" in Latin. The first recorded mentions of any of the stars associated with this asterism are traced back to Ancient Mesopotamia, where the Babylonians recorded its existence in their

Artist's impression of Sirius and the "Summer Triangle". Cred-

it: G. Bacon (STScI)/ESA/NASA

Sirius has been an object of wonder and veneration to all ancient peoples throughout human history. In fact, the Arabic word *Al Shi'ra* resembles the Greek, Roman, and Egyptian names suggesting a common origin in Sanskrit, in which the name Surya (the Sun God) simply means the "shining one." In the ancient Vedas this star was known as the Chieftain's star; and in other Hindu writings, it is referred to as Sukra – the Rain God, or Rain Star.

Sirius was revered as the Nile Star, or Star of Isis, by the ancient Egyptians. Its annual appearance just before dawn at the Summer Solstice heralded the flooding of the Nile, upon which Egyptian agriculture depended. This helical rising is referred to in many temple inscriptions, where the star is known as the Divine Sepat, identified as the soul of Isis.

To the Chinese, the stars of Canis Major were associated with several different asterisms – including the Military Market, the Wild Cockerel, and the Bow and Arrow. All of these lay in the Vermilion Bird region of the zodiac, on of four symbols of the Chinese constellations, which is associated with the South and Summer. In this tradition, Sirius was known *Tianlang* (which means "Celestial Wolf") and denoted invasion and plunder.

This constellation and its most prominent stars were also featured in the astrological traditions of the Maori people of New Zealand, the Aborigines of Australia, and the Polynesians of the South Pacific.

Isis depicted with outstretched wings in an ancient wall painting (ca. 1360 BCE). Credit: Wikipedia Commons/ Ägyptischer Maler

History of Observation:

This constellation was one of the original 48 that Ptolemy included in his 2nd century BCE work the *Amalgest*. It would remain a part of the astrological traditions of Europe and the Near East for millennia. The Romans would later add Canis Minor, appearing as Orion's second dog, using stars to the north-west of Canis Major.

In medieval Arab astronomy, the constellation became *Al Kalb al Akbar*, ("the Greater Dog"), which was transcribed as *Alcheleb Alachbar* by European astronomers by the 17th century. In 1862, Alvan Graham Clark, Jr. made an interesting discovery while testing an 18″ refractor telescope at the Dearborn Observatory at Northwestern University in Illinois.

In the course of observing Sirius, he discovered that the bright star had a faint companion – a white dwarf later named Sirius B (sometimes called "the Pup"). These observations confirmed what Friedrich Bessel proposed in 1844, based on measurements of Sirius A's wobble. In 1922, the International Astronomical Union would include Canis Major as one of the 88 recognized constellations.

Canis Major as depicted in Urania's Mirror, a set of constellation cards published in London c.1825. Credit: Library of Congress

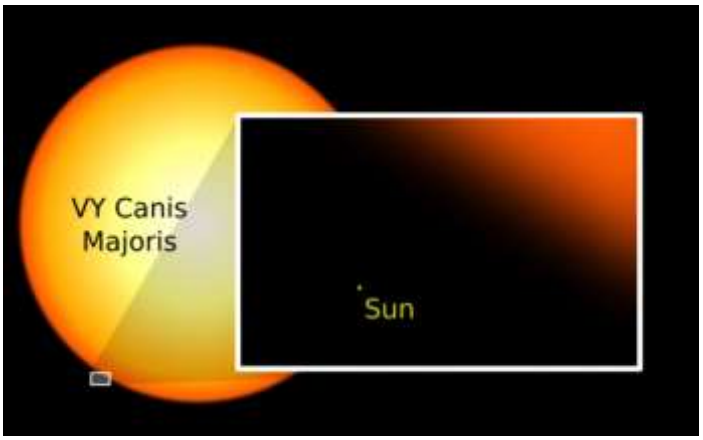
Notable Features:

Canis Major has several notable stars, the brightest being Sirius A. It's luminosity in the night sky is due to its proximity (8.6 light years from Earth), and the fact that it is a magnitude -1.6 star. Because of this, it produces so much light that it often appears to be flashing in vibrant colors, an effect caused by the interaction of its light with our atmosphere.

Then there's Beta Canis Majoris, a variable magnitude blue-white giant star whose traditional name (*Murzim*) means the "The Heralder". It is a Beta Cephei variable star and is currently in the final stages of using its hydrogen gas for fuel. It will eventually exhaust this supply and begin using helium for fuel instead. Beta Canis Majoris is located near the far end of the Local Bubble – a cavity in the local Interstellar medium though which the Sun is traveling.

Next up is Eta Canis Majoris, known by its traditional name as *Aludra* (in Arabic, "*al-aora"*, meaning "the virgin"). This star shines brightly in the skies in spite of its distance from Earth (approx. 2,000 light years from Earth) due to it being many times brighter (absolute magnitude) than the Sun. A blue supergiant, Aludra has only been around a fraction of the time of our Sun, yet is already in the last stages of its life.

Another "major" star in this constellation is VY Canis Majoris (VY CMa), a red hypergiant star located in the constellation Canis Major. In addition to being one of the largest known stars, it is also one of the most luminous ever observed. It is located about 3,900 light years (~1.2 kiloparsecs) away from Earth and is estimated to have 1,420 solar radii.



Size comparison between the Sun and VY Canis Majoris, which once held the title of the largest known star in the Universe. Credit: Wikipedia Commons/Oona Räisänen

Canis Major is also home to several Deep Sky Objects, the most notable being Messier 41 (NGC 2287). Containing about 100 stars, this impressive star cluster contains several red giant stars. The brightest of these is spectral type K3, and located near M41's center. The cluster is estimated to be between 190 and 240 million years old, and its is believed to be 25 to 26 light years in diameter.

Then there's the galactic star cluster NGC 2362. First seen by Giovanni Hodierna in 1654 and rediscovered William Herschel in 1783, this magnificent star cluster may be less than 5 million years old and show shows signs of nebulosity – the remains of the gas cloud from which it formed. What makes it even more special is the presence of Tau Canis Major.

Easily distinguished as the brightest star in the cluster, Tau is a luminous supergiant of spectral type O8. With a visual magnitude of 4.39, it is 280,000 times more luminous than Sol. Tau CMa is also brighter component of a spectroscopic binary and studies of NGC 2362 suggest that it will survive longer than the Pleiades cluster (which will break up before Tau does), but not as long as the Hyades cluster.

Then there's NGC 2354, a magnitude 6.5 star cluster. While it will likely appear as a small, hazy patch to binoculars, NGC 2354 is actually a rich galactic cluster containing around 60 metal-poor members. As aperture and magnification increase, the cluster shows two delightful circle-like structures of stars.

For large telescopes and GoTo telescopes, there are several objects worth studying, like the Canis Major Dwarf Galaxy (RA 7 12 30 Dec -27 40 00). An irregular galaxy that is now thought to be the closest neighboring galaxy to our part of the Milky Way, it is located about 25,000 light-years away from our Solar System and 42,000 light-years from the Galactic Center.

It has a roughly elliptical shape and is thought to contain as many stars as the Sagittarius Dwarf Elliptical Galaxy, which was discovered in 2003 and thought to be the closest galaxy at the time. Although closer to the Earth than the center of the galaxy itself, it was difficult to detect because it is located behind the plane of the Milky Way, where concentrations of stars, gas and dust are densest.

Globular clusters thought to be associated with the Canis Major Dwarf galaxy include NGC 1851, NGC 1904, NGC 2298 and NGC 2808, all of which are likely to be a remnant of the galaxy's globular cluster system before its accretion (or swallowing) into the Milky Way. NGC 1261 is another nearby cluster, but its velocity is different enough from that of the others to make its relation to the system unclear.

Finding Canis Major:

Finding Canis Major is quite easy, thanks to the presence of Sirius – the brightest star to grace the night sky. All you need to do is find Orion's belt, discern the lower left edge of constellation (the star Kappa Orionis, or Saiph), and look south-west a few degrees. There, shining in all it glory, will be the "Dog Star", with all the other stars stemming outwards from it.

Unfortunately, Sirius A's luminosity means that the means that poor "Pup" hardly stands a chance of being seen. At magnitude 8.5 it could easily be caught in binoculars if it were on its own. To find it, you'll need a mid-to-large telescope with a high power eyepiece and good viewing conditions – a stable evening (not night) when Sirius is as high in the sky as possible. It will still be quite faint, so spotting it will take time and patience.

Between Sirius at the northern tip, and Adhara at the south, you can also spot M41 residing almost about halfway. Using binoculars or telescopes, all one need do is aim about 4 degrees south of Sirius – about one standard field of view for binoculars, about one field of view for the average telescope finderscope, and about 6 fields of view for the average wide field, low power eyepiece.

Thousands of years later, Canis Major remains an important part of our astronomical heritage. Thanks largely to Sirius, for burning so brightly, it has always been seen as a significant cosmological marker. But as our understanding of the cosmos has improved (not to mention our instruments) we have come to find just how many impressive stars and stellar objects are located in this region of space.

M41

ISS PASSES For December 2019 From Heavens Above website maintained by Chris Peat

Date	Brightness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
04 Feb	-2.8	18:21:00	10°	W	18:24:17	46°	SSW	18:27:08	13°	SE
04 Feb	-0.7	19:59:01	10°	WSW	20:00:07	12°	SW	20:00:07	12°	SW
05 Feb	-1.2	19:10:44	10°	W	19:13:06	18°	SW	19:14:59	12°	S
06 Feb	-1.6	18:22:50	10°	W	18:25:40	25°	SSW	18:28:30	10°	SSE
08 Feb	-0.6	18:25:24	10°	WSW	18:26:52	12°	SW	18:28:19	10°	SSW
21 Feb	-0.8	06:29:20	10°	S	06:31:24	15°	SE	06:33:29	10°	ESE
22 Feb	-0.5	05:43:20	10°	SE	05:43:53	10°	SE	05:44:26	10°	SE
23 Feb	-1.9	06:29:19	10°	SSW	06:32:19	30°	SSE	06:35:20	10°	E
24 Feb	-1.5	05:42:03	10°	SSW	05:44:42	22°	SE	05:47:22	10°	E
25 Feb	-1.2	04:55:40	12°	SSE	04:57:06	15°	SE	04:59:08	10°	ESE
26 Feb	-2.7	05:42:59	14°	SW	05:45:38	40°	SSE	05:48:50	10°	E
27 Feb	-2.3	04:57:14	27°	S	04:57:56	29°	SSE	05:00:56	10°	E
28 Feb	-1.2	04:11:24	18°	ESE	04:11:24	18°	ESE	04:12:54	10°	E
28 Feb	-3.6	05:44:21	18°	WSW	05:46:40	68°	SSE	05:50:02	10°	E
29 Feb	-3.4	04:58:26	48°	S	04:58:53	53°	SSE	05:02:12	10°	E
01 Mar	-1.7	04:12:28	26°	ESE	04:12:28	26°	ESE	04:14:18	10°	E
01 Mar	-3.8	05:45:24	18°	W	05:47:46	89°	N	05:51:09	10°	E
02 Mar	-3.8	04:59:23	60°	WSW	04:59:54	81°	S	05:03:18	10°	E
03 Mar	-2.1	04:13:20	34°	E	04:13:20	34°	E	04:15:26	10°	E
03 Mar	-3.8	05:46:16	16°	W	05:48:51	86°	N	05:52:15	10°	E
04 Mar	-0.4	03:27:16	12°	E	03:27:16	12°	E	03:27:32	10°	E
04 Mar	-3.8	05:00:12	51°	W	05:00:58	85°	N	05:04:21	10°	E

Third Starlink Launch Visible Passes

This is just two days of the most recent launch of these annoying intrusions...

Date	Satellite	Brightness	Start			Highest point			End		
		(mag)	Time	Alt	Az	Time	Aly	Az	Time	Alt	Az
04 February	Starlink V	6.0	17:34:06	10°	W	17:36:48	21°	SW	17:39:31	10°	S
04 February	Starlink H	6.1	17:37:15	10°	W	17:39:54	20°	SW	17:42:32	10°	S
04 February	Starlink F	6.1	17:40:26	10°	W	17:43:00	19°	SW	17:45:34	10°	S
04 February	Starlink G	6.1	17:43:37	10°	W	17:46:06	18°	SW	17:48:34	10°	S
04 February	Starlink L	6.2	17:46:48	10°	W	17:49:12	17°	SW	17:51:35	10°	S
04 February	Starlink A	6.2	17:50:00	10°	W	17:52:18	16°	SW	17:54:36	10°	S
04 February	Starlink R	6.2	17:53:12	10°	W	17:55:25	16°	SW	17:57:37	10°	S
04 February	Starlink K	6.3	17:56:26	10°	W	17:58:32	15°	SW	18:00:36	10°	S
04 February	Starlink M	6.3	17:59:40	10°	WSW	18:01:39	14°	SW	18:03:38	10°	S
04 February	Starlink T	6.7	18:16:47	10°	SW	18:17:19	10°	SW	18:17:50	10°	SW
05 February	Starlink Q	6.4	17:41:32	10°	WSW	17:43:09	13°	SW	17:44:45	10°	SSW
05 February	Starlink P	6.5	17:44:45	10°	WSW	17:46:12	12°	SW	17:47:38	10°	SSW
05 February	Starlink U	6.6	17:47:59	10°	WSW	17:49:13	11°	SW	17:50:28	10°	SSW
05 February	Starlink B	6.7	17:51:19	10°	WSW	17:52:16	11°	SW	17:53:15	10°	SSW

END IMAGES, OBSERVING AND OUTREACH

The Double Cluster, NGC869 and 886 with some excellent red stars, and across the the small smudge which is the 9.1 magnitude brightest comet in the skies at the moment. Panstarrs C/2017 T2,
The next brightest comet is 14th magnitude blob in Andromeda,, this is 100 times dimmer!

Andy Burns
Albion mount, 120mm esprit Skywatcher telescope. Very close to the Moon and my northern horizon over the town .
Using the LPro light pollution filter from Optilong in front of the chip on my Nikon D810a.
I am very impressed with the imaging BUT it is fiddly to fit and introduces dust and lots of vignette to the image.

Wiltshire Astronomical Society	Observing Sessions 2019/20	
Date	**Moon Phase (%)**	**Moonrise/Targets**
2020		
28th February	16% 4day crescent	Venus, Messier Marathon Day.
27th March	6% 2.3day set before start	Venus, Milky Way South to North
24th April not dark until 9:30pm	0%	Venus high, galaxies of Leo and Virgo clusters
22nd May not dark until 10pm	0%	Summer triangle rising

OUTREACH

After our last meeting I was suddenly inundated by requests for help from scouts, beavers and schools.

I will be at Stonar after half term but this is school time.

Westbury Leigh and Wellington Academy at Ludgershall were visited for talks.

We still need to get some viewing sessions in at Chippenham Beavers on Wednesdays and Chippenham scouts on a Thursday.