

Winter 2020/21 Number 30

# Kielder Observatory Newsletter



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Wolfendale

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## EDITORIAL

The strange world of lockdown continues - a sentence I was unfortunately also able to use in the last newsletter. Once again the physical doors of the Observatory are closed to the public, but there has been much activity on-line, and, if we have one, we are still allowed to admire the sky from our back gardens! Unfortunately the weather here in the North East didn't play ball on the day of the Great Conjunction in December, although there were opportunities on the days either side. Let's hope for better weather during the Northumberland Dark Skies festival later in February - it isn't looking great for this week's CPRE star count.

*Nigel Metcalfe*

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*admin@kielderobservatory.org*

### Kielder Observatory Astronomical Society

Registered Charity No: 1153570.

Kielder Observatory Astronomical Society is a Charitable Incorporated Organisation.

Its aims are to

- \* Promote interest in the science of astronomy to the general public
- \* Facilitate education of members of the public in the science of astronomy
- \* Maintain an astronomical observatory in Kielder Forest to support the above aims



<https://kielderobservatory.org>

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*Front cover: This all-sky image is a mosaic of 60 x 8 second exposures shot at 24mm on a Sony A7III. Dan Monk.*

*Rear cover: Orion in the snow. Sony A7III, Sigma 24mm lens - 13 seconds, f/1.8, ISO 5000. A fog filter was used to enhance the stars. Dan Monk.*



## Sir Arnold Wolfendale FRS 1927-2020

Readers will be saddened to learn of the death of our Patron, Sir Arnold Wolfendale, who passed away on 21st December 2020 at the age of 93.

Sir Arnold opened the observatory in 2008, and was delighted to take up the role of Patron. He was always keen to promote public understanding of science, and gave several talks at the observatory over the years.

He was a prolific and internationally esteemed researcher. He was elected a Fellow of the Royal Astronomical Society in 1973 (being President 1981-1983), a Fellow of the Royal Society in 1977 and served as the 14th Astronomer Royal from 1991 to 1995. He was knighted in 1995 and served as President of the European Physical Society from 1999 to 2001.

Arnold started his academic career at the University of Manchester in the 1950s, beginning a lifelong study of Cosmic Rays, energetic particles which come from space. In 1956 he moved to the Physics departmental at Durham University along with George Rochester. He became professor in 1965 and was responsible for re-igniting astronomical research in the department, which today has become a world-leading centre for cosmological and astrophysical studies.



***Sir Arnold opens the observatory in 2008.***

Arnold had three spells as Head of the Physics Department at Durham University, 1974-1977, 1980-1984 and 1986-1988, before retiring in 1992 [and I should know, as he was Head of Department when I was appointed to Durham! - ed.].

Arnold's passion for physics did not fade after his retirement. He continued active research as an emeritus professor well into his late eighties, and the breadth of his knowledge and insight continued to be appreciated by his many friends and collaborators.





## OBSERVATORY NEWS



The new year is always a time for reflection, and despite the challenging circumstances we can look back at 2020 with some satisfaction. Here are just a few of our highlights:

- \* Securing a new SPIDER 500 radio telescope, courtesy of the Tanlaw Foundation
- \* Winning funding from the North East Social Tech Fund to start developing an augmented reality app
- \* Engaging with 5,000 school children, courtesy of our contract with the North of Tyne Combined Authority
- \* Launching a new events calendar, including relaxed events for people of different needs
- \* Seeing record ticket sales when we reopened after lockdown
- \* Receiving so much positive visitor feedback about our COVID-secure procedures
- \* Securing emergency funding from the



## OBSERVATORY NEWS

National Lottery Heritage Fund

- \* Launching "Paint the Sky", allowing artists to exhibit at the Observatory
- \* National coverage in The One Show, The Times, and The Guardian
- \* Launching "Escape Velocity", an astrophotography project for children, courtesy of Northumberland County Council
- \* Supporting literacy charity, The Reading Agency, with the launch of Ann Cleeves's new novel
- \* Launching "From STEM to stars", to restore an original Herschel telescope, courtesy of the Reece Foundation

To expand on the last point, in December the Observatory secured a grant from the Reece Foundation to help restore an original Herschel telescope at Newcastle University to full working order. The restoration will be used to inspire thousands of school children, with an initial pilot of our programme, "From STEM to Stars", at schools across Northumberland and Sunderland in the WISE Academies Trust. The telescope will be at the centre of a project to create Kielder Observatory Star Groups - groups of school children who will study the restoration of the telescope to learn about the science and engineering skills



***A replica of one of Herschel's telescopes. Credit: Science Museum***

involved while learning more about the night sky from our enthusiastic science team.

At the time of writing, the Observatory remains closed under the national lockdown rules. Naturally we are monitoring government guidelines to see when we can re-open again, which hopefully won't be too far away. Don't forget we have reviewed and revised our normal terms and conditions to give



## OBSERVATORY NEWS

visitors greater flexibility - please see this page on our website for full details  
<https://kielderobservatory.org/news/latest-news/152-coronavirus-measures>

We are now nearly a year on from the start of the pandemic, and we have been developing our strategy as to how we reach out beyond the Kielder Observatory site and connect with people in innovative and pioneering ways - some of this is already in development, such as the augmented reality app and the digital learning platform, but there are many other projects in the pipeline. We have grouped these initiatives into a new approach: Kielder Constellations. It has three aims:

1. To put people at the heart of everything we do, extending our reach to more people and to a more diverse audience
2. To build on our reputation as a gold standard in dark sky observation, imaging and outreach
3. To strengthen our organisation, building resilience and inspiring innovation

As part of the process we have restructured our team to better deliver

these goals. The new staff structure is as follows:

- \* Dan Pye: Director of Astronomy and Science Communication
- \* Dan Monk: Director of the Gillian Dickinson Astro-Imaging Academy
- \* Patti Purcell: Office Manager and PA to the Board
- \* Heather Woodfine: Communications and Events Administrator
- \* Alison Booth: Finance Executive
- \* Nazanin Jahanshahi: Astronomer
- \* Natasha Lund: Astronomer and Arts Lead
- \* Ellie MacDonald: Astronomer
- \* George Pattinson: Astronomer and Science Lead
- \* Liam Reid: Astronomer
- \* Adam Shore: Astronomer and Education Lead

Hayden and Jesse, who some of you may have met on your visits to the Observatory, haven't vanished entirely as they remain on our team as part-time astronomers (if you're interested in similar part-time work with our team, why not get in touch?).





## OBSERVATORY NEWS

We are excited to be working with our fellow observatories at Battlesteads, Stonehaugh and Twice-Brewed to create the Northumberland International Dark Skies Festival from February 12th-21st - a programme of free online events covering all things dark skies. It will include our latest arts and education project, 'Escape Velocity!', in which school children will be encouraged to use their mobile phones to take pictures of the Northumberland dark skies. Hopefully there may also be some live streaming of the Kielder night skies.

To find out more and book, visit: <https://www.northumberlandnationalpark.org.uk/northumberland-dark-skies-festival>

Have you listened to our podcasts yet? We now have four online for you at <https://podfollow.com/kielderobs/view>, including our latest, 'Our journey to Mars'. Definitely something to do during lockdown!

We are saying goodbye to our iconic T-shirt. The original design of the

Observatory by architect Charles Barclay has been with us for many years and we are moving on to our mission-patch-inspired range of clothing. So it's an end of line sale for the T-shirts - get them while you can!

We are also treating you to a temporary price drop on our fleeces, given the weather, and our winter posters are also discontinued and on sale at <https://kielderobservatory.org/giftshop>.



"At last I popped out above the tree tops to a wind swept hillside, it felt like the far side of nowhere. Kielder Observatory is stunning, a wooden ship sailing on the tree tops of the 150,000 acre forest. The views are even better."

Julia Barthram, ITV Tyne Tees



## OBSERVERS' SLOT

### The Effect of Focal Length on Imaging Orion



***M42 - from trustee Jürgen Schmoll. Self-made telescope, Newtonian 257/1140mm, Canon EOS 40D camera, 75 x 30 seconds.***

***"The rather old telescope got just upgraded with a drive system, but is quite aged. So the mirrors need recoating and the overall structure is tired and rusty. Still the instrument works well, even without a coma corrector on this occasion."***





## OBSERVERS' SLOT

Jürgen's photo reminded me that winter is the best time for taking images of Orion, and in particular the Orion Nebula, Messier 42. But what you get is very dependent on the focal length you are imaging at, so I thought I would have a look through my archives and compare what you might get at different focal lengths. Not everyone has a telescope they can photograph through,



***M42 at 2000mm focal length***

but a simple camera lens can still produce some stunning shots. All these photos were taken with a Canon 1000D camera, and show the complete image, which is some 3888 x 2592 pixels in size. This is an APS-C camera (as are many entry-level DSLRs), so if you have a so-called

full-frame camera then remember you would get a larger area of sky. The photos are all oriented with east-west horizontal.

We start at a mighty 2000mm focal length. This image was taken through a 10" f8 Ritchey-Chretien telescope (borrowed from Jürgen for the winter of 2016/7 as it happens). The camera pixels here only subtend 0.6 arcsec across on the sky, and this gives a great view of the central Trapezium stars of M42 (if your sky conditions allow it!). Even at this focal length you can still get most of M42 into the shot.



***M42 at 1200mm focal length***

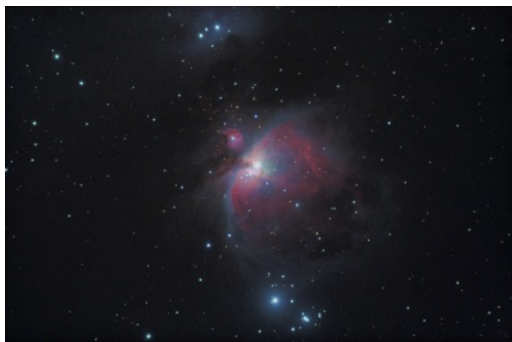
Next we move down to a mere 1200mm focal length. This was taken on a 12" f4

"A trip to Kielder Observatory is unforgettable. From the drive out to the remote location through glorious unspoilt countryside and up the winding track through beautiful pine forests to the hill top site above, you know you're in for a treat"



## OBSERVERS' SLOT

Newtonian telescope. I think this gives quite a pleasing view, capturing some of the wispy nature of the gas around the edge of the nebula.



***M42 at 660mm focal length***

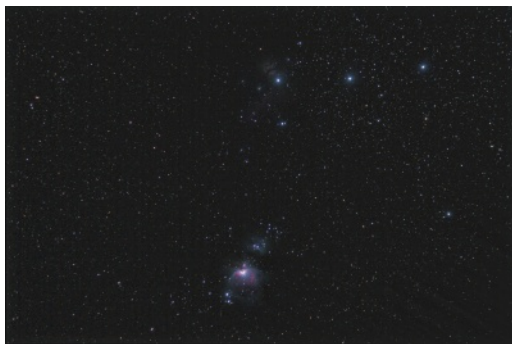
Moving down again, the next photo is at 660mm focal length. This was taken with a 4" f6.5 refractor. I think this a good focal length for imaging the whole of M42, and picks up Iota Orionis to the south and the 'Running Man Nebula', NGC1977, to the north.

The previous shots were all taken at prime focus, i.e. without the camera lens attached, using the telescope as a long telephoto lens. We now move away from the realm of the telescope to see what can be done with just a camera lens. This is something of a jump, as the longest focal length I can muster is 200mm! However, although a pleasing shot of the main nebula can be achieved with this length of



***M42 at 200mm focal length***

lens, it doesn't really bring in many of the other interesting objects in Orion. To do that we need to decrease our focal length even further.



***Orion at 130mm focal length***

By the time we reach 100mm (OK, 130mm in the example given) we can begin to encompass Orion's belt, with the famous Horsehead Nebula, and the Flame nebula, as well as M42. You will still need some sort of star tracker to get pictures like these, but there are now plenty of reasonably cheap trackers on the market.



## OBSERVERS' SLOT

If you want the familiar shape of the constellation of Orion in the shot then you need to go for a wider angle lens. The final two shots are at 35mm and 20mm focal length. These shorter focal lengths are



***Orion at 35mm focal length***

more forgiving, and you can probably get away without a tracker of any sort if you keep the individual exposures to a few seconds, and stack repeated shots to improve the noise levels.

My camera is an off-the-shelf model.

Sadly, camera manufacturers and Nature have conspired such that the red glow



***Orion at 20mm focal length***

from hydrogen gas, the main luminous component of many of the sky's finest nebula, is mostly filtered out by the glass in front of the camera sensor. However, all is not lost - there are people out there who will remove the glass or replace it with a more astro-friendly version. If you are feeling adventurous you can even replace it yourself - there are instructions on the web! Such modification will make a stunning difference on wide-field shots of Orion.

*Nigel Metcalfe*

### **Not been to Kielder Observatory yet?**

#### **Then why not book one of our events for you or your family?**

Advanced booking is essential. Weekend events can fill up several weeks in advance. Please book online at <https://www.kielderobservatory.org/our-events/>.

We can also be contacted at [admin@kielderobservatory.org](mailto:admin@kielderobservatory.org)

*We are currently taking bookings for March onwards in anticipation of lockdown being lifted.*



## SPACE SLOT

### And Now For Something Completely Different ... or Things to Do Under Lockdown

Readers will remember the 50th anniversary of the Apollo 11 Moon landing in 2019. It featured heavily in the newspapers and on TV, and we even had a special event at the Observatory on 20th July, the actual day of the anniversary. I remember it was a very clear night, and as well as observing both Saturn and Jupiter, I managed to take this photo of the Moon through the eyepiece of a 12" Dobsonian telescope. Well, it was actually taken by Dan Monk, but he was using my iPhone!

Inspired by these events, I decided to buy some model construction kits. As a boy I spent many a happy hour making kits of ships and planes, and I have fond memories of a Mercury capsule on top of its Atlas launch vehicle, complete with launch pad, a Gemini capsule with two opening doors (but no one inside) and an Apollo capsule.

So, flushed with enthusiasm, a year and a half ago I bought some kits: a Lunar Lander, an Apollo capsule, a Saturn V rocket and, just for good measure, a Space Shuttle with External Tank and Booster Rockets. The goods were duly delivered and, after admiring the boxes, I



put them in our junk room. Where they stayed for some time!

The arrival of lockdown last March seemed like a good opportunity to open the boxes, and since then I have been busy making models. Some have been easier than others to put together, but they have all provided a welcome activity to keep me occupied. Here I am going to show some of my models and compare then to the real thing, with just a few facts. Relax, this is not an article about Project Apollo!

Having said that, let's kick off with the Apollo Command and Service Module (CSM). The model below was great fun to make, partly because it is large scale;





## SPACE SLOT

it is the Revell 1:32 scale model. Revell have been making model kits like this for ages. My 1960s models were manufactured by them. My CSM, with some transparent panels, is shown below, together with the Apollo 14 CSM.



A number of CSMs were built for ground tests, and one was lost in the Apollo 1 launch pad fire. One of these non-flight CSMs is on display at the Smithsonian National Air and Space Museum in Washington DC as part of an Apollo Soyuz Test Project (ASTP) exhibit together with a Russian Soyuz capsule, and another is part of a similar display at the Academy of Science Museum in Moscow.

Nineteen CSMs were launched into space, of which nine went to the Moon and back, two carried crews into Earth orbit and four were used for unmanned test flights. A further three were used for the Skylab program in 1973/4, and the final manned flight was as part of ASTP in 1975. The last CSM constructed was intended to be the ASTP backup, but was not needed, and is now on display at the Kennedy Space Centre in Florida, USA. All the flown Apollo capsules are on display at various locations in the USA, apart from the Apollo 10 capsule which is at the Science Museum in London.

The LM on the left only has one Stars and Stripes flag; there should have been two! Things got better with more practice on later models. The real LM on the right is Challenger, from the Apollo 17 mission. NASA contracted the manufacturer,

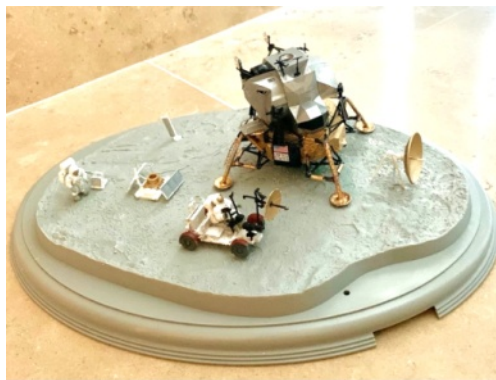
*The Lunar Module (LM) model is a slightly larger scale than the CSM (1:48). It was a little trickier to assemble, as it had a larger number of small parts. I also discovered that transferring the decals could be difficult.*





Grumman, to make 15 LMs. Ten were launched into space, of which six landed on the Moon. One is on display at the Smithsonian National Air and Space Museum in Washington DC, and another can be seen at the Kennedy Space Centre. What would have been the final three were not completed because of the cancellation of the Apollo 18, 19 and 20 missions.

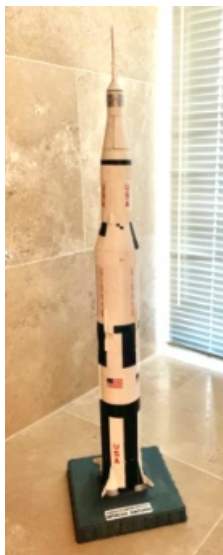
Being a glutton for punishment, I made another model of the LM on the Moon's surface, complete with astronauts, a Lunar Roving Vehicle, and a few surface experiment packages. This kit is made by



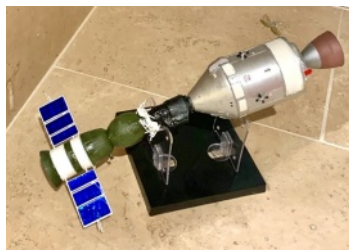
a Chinese company, Dragon, and is marketed as "Apollo 17 – the final J Mission".

Of course, if you are looking at the Apollo Project, you cannot ignore the launch vehicle, Saturn V, which is still the tallest, heaviest and most powerful rocket ever

made. The model below is made by Revell, but another version widely available is made by Airfix (who also make other space-themed model kits).

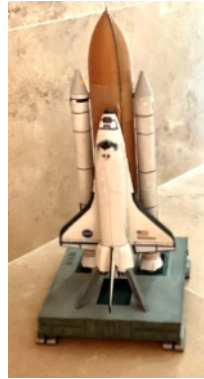


My final Apollo model (so far!) is the Apollo Soyuz Test Project, the joint US-Russian mission in 1975. Underneath the model below, another Dragon product, is the display at the Air and Space Museum, based on unused Apollo and Soyuz capsules.





*Moving forward a decade or so brings us to the Space Shuttle era. This was a bit of a tricky model to make, especially the Shuttle itself; I just couldn't get the cargo bay doors to fit. I'm still not sure if that was down to my fairly basic modelling skills or imperfections in the model parts.*



The final model I want to show is a little unusual; it is the Lunar Lander designed by Werner von Braun in 1952. Von Braun was the leader of the group that designed the Saturn V, but had been involved in rocket design since before the Second World War, in Germany. During the war he had led the team that developed the V2 rocket (but that is another story!) and at the end of the war was taken on by the American Army to develop its rocket program. He put forward many proposals for space rockets and vehicles, most of which never got much further than the drawing board, and his Lunar Lander, below, is one of these.

Von Braun's 1952 lunar lander design was an immense spacecraft, much larger than a Saturn V. Three spacecraft would be assembled in Earth orbit, and they would take a 50-crew expedition to the moon in 1977 for a six-week exploration. To call this extremely ambitious would be an understatement!

Finally, I referred at the beginning of this article to the 50th anniversary of the Apollo 11 landing in 2019. At the time of writing, we are almost at the 50th anniversary of the Apollo 14 landing, which took place on 5th February 1971. Doesn't time fly!

*Trevor Robinson  
Trustee & Treasurer*



Real photos courtesy of NASA, the National Air and Space Museum and the US Information Agency.



## NIGHT SKY

### FEBRUARY 2021 (times in GMT)

#### Lunar phases

Third quarter	04/2/2021	12:38
New moon	11/2/2021	14:08
First quarter	19/2/2021	13:49
Full moon	27/2/2021	03:09

#### PLANET SUMMARY

Mercury will be a very challenging object in the morning twilight. Venus is in conjunction with the Sun. Mars is an evening object visible from around 1900 until midnight. Jupiter and Saturn are in conjunction with the Sun. Uranus will be visible from around 1900 until midnight, not far away from Mars.

#### THE STARS AT 9PM

North – Cassiopeia and Cepheus are nicely placed with the two Bears. Cygnus and Hercules are low down.

East – Gemini is high up with Leo and Cancer nicely placed. Virgo is just beginning to rise.

South – Auriga is high up. Orion and Monoceros are nicely placed. Canis Major and Lepus are low down.

West – Taurus and Perseus are high up. Andromeda is nicely placed. Pisces and Pegasus are low down.

#### METEOR SHOWERS

There are no bright meteor showers in February.

#### COMETS

There are no bright comets brighter than 10th magnitude expected to be visible this month.

#### The Planets 15/2/2021

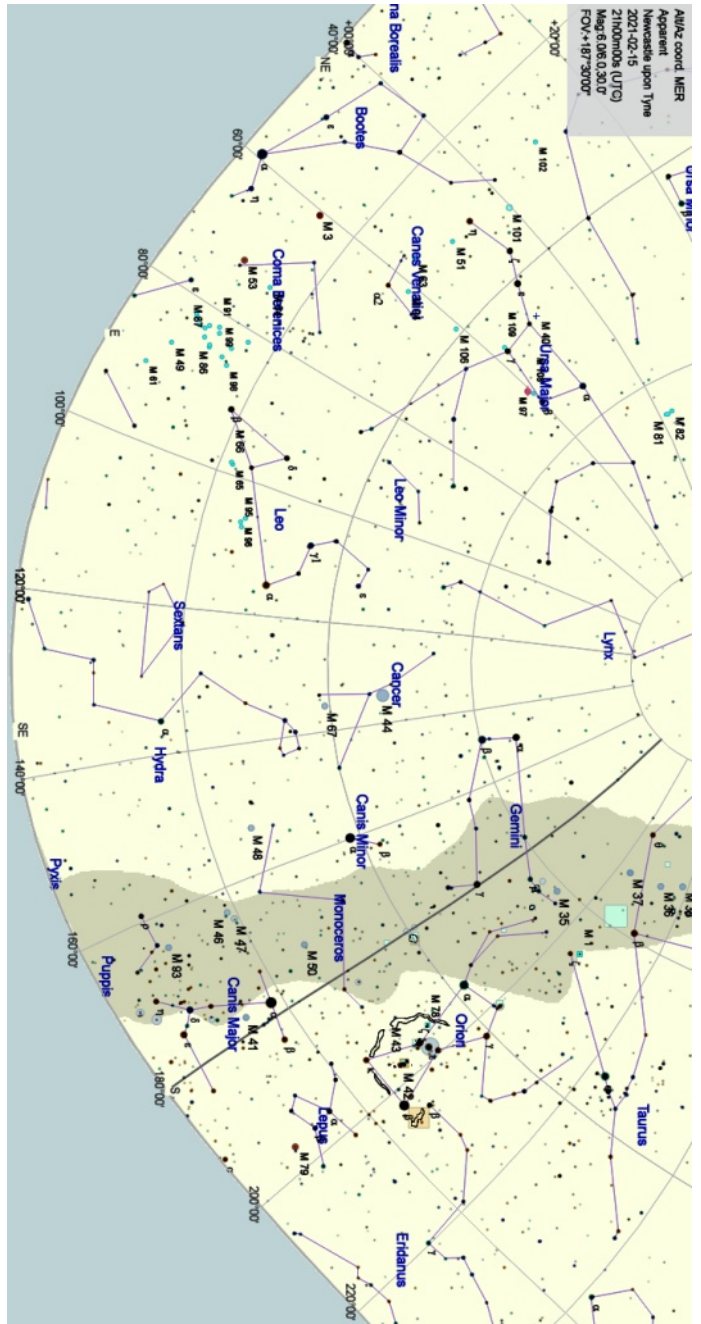
	Sun	Moon	Mercury	Venus	Mars	Jupiter	Saturn	Uranus
Rise	07:28	09:06	06:39	07:20	09:29	08:38	08:29	11:00
Set	17:12	21:21	16:05	16:03	01:39	16:51	16:32	01:50





## NIGHT SKY

The sky chart for  
Newcastle looking SE at  
9pm on 15/2/2021.





## NIGHT SKY

### MARCH 2021 (times in GMT)

#### Lunar phases

Third quarter	05/3/2021	19:32
New moon	13/3/2021	03:23
First quarter	21/3/2021	08:41
Full moon	28/3/2021	12:50

#### PLANET SUMMARY

Mercury and Venus are too close to the Sun to see this month. Mars is a morning object visible from 1930 until midnight. Jupiter and Saturn are not visible this month. Uranus is an evening object visible from 1930 until 2130.

#### THE STARS AT 10PM

North – The two Bears are high up. Cepheus and Draco are nicely placed. Cygnus, Lyra and Hercules are low down. East – Leo and Coma Berenices are nicely placed. Virgo is low down. You can also find Hydra, Crater and there is Corvus near the horizon. South – Virgo, Leo, Cancer and Gemini are nicely placed. Orion, Canis Major, Monoceros and Lepus are low down. West – Gemini, Auriga, Perseus, Orion

and Canis Major are nicely placed. Pisces is near the horizon.

#### METEOR SHOWERS

There are no major meteor showers in March.

#### COMETS

There are no comets brighter than 10th magnitude expected to be visible this month.

*Night Sky credits:*

*Data sourced from Cybersky 5,*

<https://www.timeanddate.com/moon/phases/>

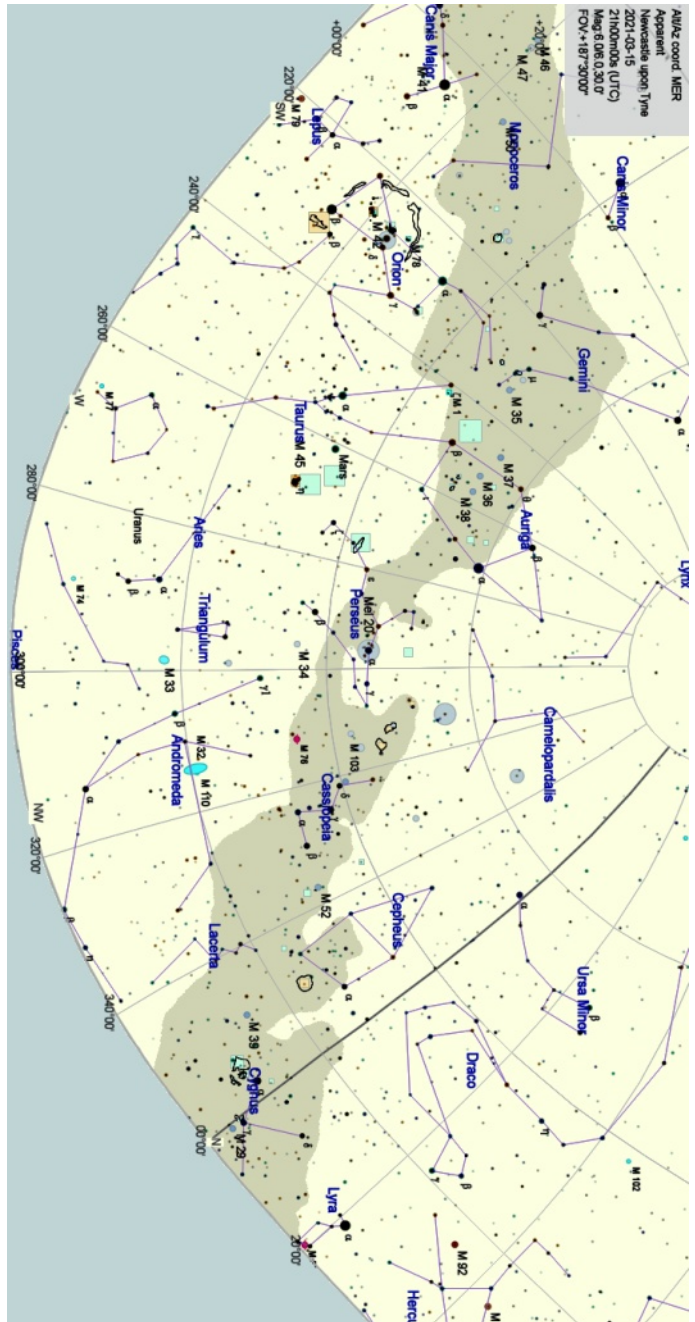
and <https://in-the-sky.org/>.

#### The Planets 15/3/2021

	Sun	Moon	Mercury	Venus	Mars	Jupiter	Saturn	Uranus
Rise	06:21	07:26	05:55	06:28	08:16	05:32	05:11	07:30
Set	18:09	20:15	15:23	17:42	01:25	14:33	13:35	22:22



This image is a vertical strip from a larger astronomical photograph. It depicts a vast field of stars against a dark, black background. The stars vary in brightness and color, with many appearing as small white or yellow dots, and some showing hints of red or blue. In the center of the strip, there is a faint, diffuse, and somewhat irregularly shaped region of light, which appears to be the core or a nebula of a distant galaxy. The overall texture is grainy, typical of deep space photography.





## NIGHT SKY

### APRIL 2021 (times in BST)

#### Lunar phases

Third quarter	04/4/2021	11:02
New moon	12/4/2021	03:30
First quarter	20/4/2021	08:58
Full moon	27/4/2021	07:41

#### PLANET SUMMARY

Mercury and Venus are in solar conjunction. Mars is visible from around 10pm until just after midnight. Jupiter and Saturn will make a nice bright pair visible low in the east before sunrise. Uranus will be a difficult object low in the west after sunset.

#### THE STARS AT 10PM

North – Perseus, Cepheus and Cassiopeia are nicely placed with the two Bears high up.

East – Draco, Bootes and Virgo are nicely placed. Lyra, Hercules and Serpens Caput are near the horizon.

South – Virgo, Leo, Cancer and Gemini are all nicely placed. Corvus, Crater, Sextans and Hydra are near the horizon.

West – Monoceros, Canis Minor, Gemini,

Auriga, Perseus and Cassiopeia are all nicely placed. Canis Major, Orion and Taurus are all near the horizon with Venus in Aries just setting.

#### METEOR SHOWERS

There are the April Lyrids – active between the 16th and 25th of April. There will be a first quarter Moon during this period so, once the Moon has set, there will be an excellent opportunity, with a radiant point near Vega, to see this shower which can give rise to around 10 to 20 shooting stars per hour. Originating from regular Comet C/1861 G1 Thatcher, there is always the chance of seeing a few fireballs from the larger particles shed by the comet, with occasional outbursts during some years.

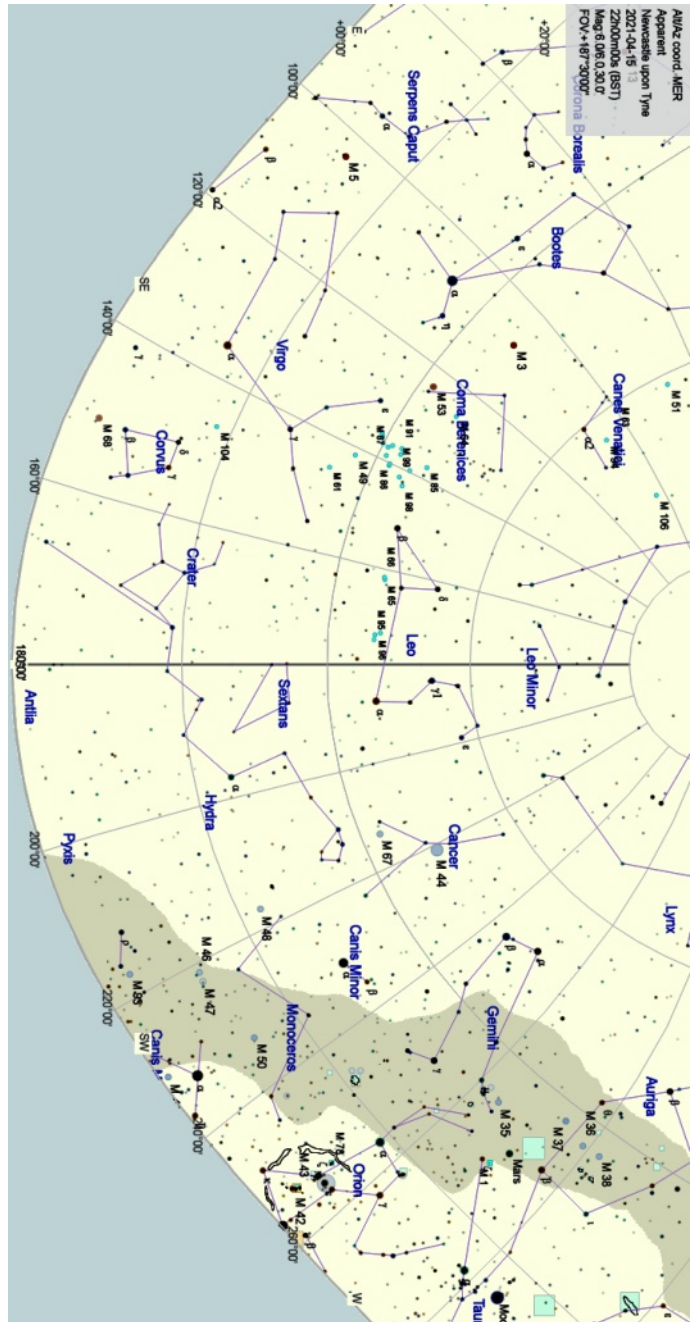
#### COMETS

There are no comets brighter than 10th magnitude expected to be visible this month.

#### The Planets 15/4/2021

	Sun	Moon	Mercury	Venus	Mars	Jupiter	Saturn	Uranus
Rise	06:03	07:27	06:05	06:18	07:27	04:41	04:15	06:31
Set	20:09	23:49	19:33	20:31	23:49	14:08	12:47	21:30







## SCIENCE SLOT

### Exotic Stars

Our Galaxy - the Milky Way – has about 250,000 million stars in it. Some galaxies [for example M87 in Virgo] have more than 4x as many stars [ $10^{12}$ ] in them.

Others, such as dwarf galaxies, have less than 1 ten-thousandth of that number [i.e. ~25 million stars] in them.

It has been known for about 110 years, since the advent of the Hertzsprung-Russell Diagram in 1910, that most of the stars in any one galaxy belong to one of about 11 main types [Google

"WOBAFGKMRNS"!]. There are, though, some stars that live and behave a bit on the wild side and can be described as somewhat 'exotic'. Even if – as seems likely – 99.9999% of all stars in a galaxy are considered 'normal', that still leaves the remaining 0.0001% - one star in a million – or to put it another way some 250,000 stars in the Milky Way, that are in some way 'unusual'. Even in dwarf galaxies that also means there are about 100 exotic stars lurking around often creating mayhem of some form to the other stars.

It is possible to classify some exotic stars into a few general groups of similar objects. These classifications are based on some simple descriptions:

a) That the star or stars move rapidly

through space relative to their [current] neighbours - so-called Hyper-velocity Stars

b) Symbiotic stars - so called because they existing in a small group of only 2 or 3 physically associated and interacting members

c) Stars that are reborn or suck the lifeblood out of other stars – such as Zombies, Weir-wolfs and similarly macabre sounding objects

Some of these stars have fascinating lives and lifestyles and a few of them can be located using amateur equipment, as they are found in our galaxy. So let's take a look at these groups in turn and check out where you can find them.

Firstly, Hyper-velocity stars - as this suggests, this type of star is moving through space relative to its near neighbours at an usually high velocity. Most stars move through the galaxy – even our Sun is steadily moving though the Milky Way. Our galaxy rotates at around 830,000 km/hour. But our Sun moves independently due to the influence of stars within about 100 ly of its location. In fact the Sun moves in a wave-like motion through the local area of our galaxy. About once every 40 million years



## SCIENCE SLOT

our Sun passes through the galactic plane ['up' and then 'down'] and scientists suggest that this may trigger instabilities in the Oort Cloud of Comets, around our Sun, triggering one or more to venture into the solar system. It is likely that many other stars in the Milky Way follow similar paths through the spiral arm in which they were born. Hyper-velocity stars, though, are very different. Astronomers are now piecing together the 'crime scenes' of the births of hyper-velocity stars.

The Sun will never become one - however it is possible that some time in the future it could interact with one. This is because HVSs are born in the complex fallout from the birth and also death of a multiple star system.

Scientists understand that about 50% or more of the stars in our galaxy exist in binary, triple, or even many as 6 or 7 multiple star systems. A good example is Epsilon Lyrae - a double-double star system where two sets of binary stars orbit the common centre between the sets.

There are many examples of a triple system where a single star orbits a binary pair. An even more extreme example is Castor, in Gemini. Here you have 3 sets of spectroscopic binaries all interacting together.

Hypervelocity stars are the result of a triple star system where two of the trio

gravitationally interact and cause the third star to be given a massive kick that flings this star completely out of the system. But not only gravity can set the star rolling, so to speak. For if the triple star system consists of two Sun-like stars and one much more massive star, then as the more massive component evolves the consequence of that evolution, which could be a Red Giant, a Supernova or a



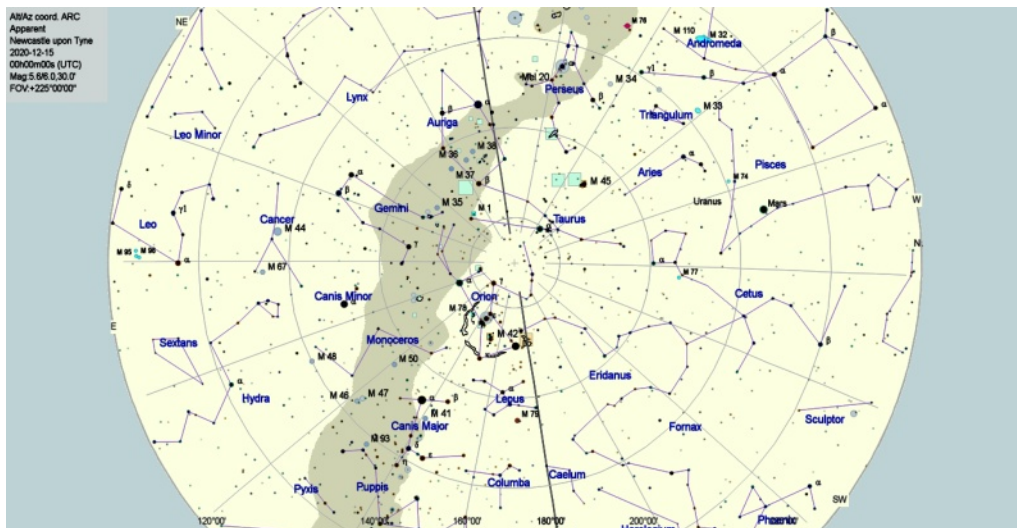
***AE Auriga and the Flaming Star nebula***

*Credit: Nigel Metcalfe*

Black Hole, is an instability in the system and the angular momentum is transferred to the unfortunate member of the trio



## SCIENCE SLOT



**Star chart showing the location of AE Aurigae in relation to MU Columbae and Iota Orionis.**

causing its velocity through space to increase by a factor of at least 2 orders of magnitude, from typically 10km/s to over 1000km/s .

For many years the astronomical community tried to reconcile the so-called 3-Body Problem. This had taxed even the finest of mathematicians for the past 240+ years. Brilliant mathematicians of the 18th Century such as Euler and LaGrange found that a system containing three stationary gravitational bodies was stable but could not find a solution for three moving bodies. Lagrange actually found a solution whereby a stationary body close to two other moving gravitational bodies was stable under specific circumstances -

and scientists use this to great effect when planning missions to 'park' a satellite so that it is gravitationally bound by the two objects, for example the SOHO mission to observe the Sun.

The three body problem was finally solved in a selection of systems, one of which is the Broucke–Henon–Hadjidemetriou family. In 1993 another solution was found - by Cris Moore - whereby a trio of objects move around a 3D figure-of-eight shaped orbit. Since 2013 a further 1000+ solutions to the three body problem have been discovered.

So, where can you find a hyper-velocity star?





## SCIENCE SLOT

a) AE Aurigae - a blue O-type star in the constellation of Auriga, the Charioteer. It shines at a typical magnitude of  $\sim 6.0$  with a slight variability. It is the star that generates the nebula IC405, also known as the Flaming Star Nebula, also catalogued as SH 2-229, or Caldwell 31 and is  $\sim 1300$  ly away from Earth (see [https://en.wikipedia.org/wiki/AE\\_Aurigae](https://en.wikipedia.org/wiki/AE_Aurigae)).

b) MU Collumbae - unfortunately this star is not visible from the UK as it is in the far south of the celestial sphere. This star is also  $\sim 1300$  ly away and is also an O-class star.

c) Iota Orionis - in the Trapezium Cluster [M42] in Orion. Iota Orionis is a binary star - a combination of an O9 and B8 giants and is visible to the naked eye. [mag 2.77]. It is  $\sim 2300$  ly away.

About 3 million years ago this trio of stars interacted resulting in Iota Orionis staying put and the other two stars were flung in diametrically opposite directions – and are still moving!.

See the attached star chart to show the location of AE Aurigae in relation to MU Collumbae and Iota Orionis

Secondly, Symbiotic stars. These are 2-star systems whereby a white dwarf - or similar compact object such as a Neutron Star or Black Hole - orbits, or is orbited by,

another star, which is typically a Red Giant or, in more extreme examples, a Blue Giant. The Red [or Blue] Giant loses material over time which accumulates in a disc around the compact object. As a result these objects are variable in brightness, often over a predictable period of time and with a predictable amplitude of the variation. White Dwarf/Red Giant types: these are classified by the 1st star of this type to be found as Z-Andromedae variables. These stars show regular blips in brightness whereby the accumulation of material onto the white dwarf results in the WD star going above the Chandrasekhar limit [ $\sim 1.6 M_{\odot}$ ] and the excess material - somewhere around  $0.1 M_{\odot}$  - undergoes a thermonuclear flash causing a short but sharp and typically 4-magnitude [i.e.  $\sim 40$ -fold] increase in brightness, which lasts only for about 1 hr or so before the system returns to normal. More details about Z.And. can be found at [https://www.aavso.org/vsots\\_zand](https://www.aavso.org/vsots_zand).

Thirdly, Zombies and Werewolf stars. Neutron Star or Black Hole and Red or Blue [Super]-giant type. Things happen a lot more violently with this type of system. The exact process depends on the mass and type of objects involved. Because of the higher gravity of both objects and the



## SCIENCE SLOT

much greater quantity of material being 'shared' the process can trigger either a supernova explosion in the RG/BG and copious quantities of X-ray emission from the compact object, or, if enough material is transferred quickly, both objects may be destroyed in a 'super'-supernova, which can generate gravitational waves.

Sometimes these processes are known as Black Widow Stars - where the lifeblood of the star-like object is completely annihilated because of the action of the compact sibling.

There are quite a few examples of each type:

a) Recurrent Novae – an example being RS Ophiuchi in the constellation of Ophiuchus the Serpent Bearer.

b) Dwarf Novae - in addition to Z.And. the following stars are of this type:

SU Ursa Majoris - here the system has 'super outbursts' much stronger than the average outburst.

SS Cygni – this system has two distinctive outburst patterns.

c) Luminous Red Novae - here two stars merge to form a deeply red (i.e. cool) object. V838 Monocerotis in Monoceros the Unicorn is a well known example. For more details of this system see [https://en.wikipedia.org/wiki/V838\\_Monocerotis](https://en.wikipedia.org/wiki/V838_Monocerotis)

d) Polars - here the interaction is between the rotation period of one component with the orbital period of the system caused by magnetic alignments. This results in material from the 'donor' star to be funnelled directly onto the acceptor star. Good examples are AM and DQ Herculis in Hercules the Hero. In AM Her the magnetic field is strong but it is much weaker in DQ Her. See this link for more details: [https://en.wikipedia.org/wiki/DQ\\_Herculis](https://en.wikipedia.org/wiki/DQ_Herculis) .

e) A related class is the VY Sculptoris class, in which the brightness decreases. A good example in the northern night sky is V751 Cygni in Cygnus the Swan. This is a highly luminous star that emits soft X-rays.

f) A more powerful example of this is AM Canum Venaticorum in Canes Venatici the Hunting Dogs. In this system there are two white dwarfs interacting and generating gravitational waves.

g) On a slightly less violent scale are SW Sextans in Sextans, the Sextant. In this system the stars are similar to Z.And. variables but there is less transfer of materials onto the accretion disc and as a result little or no outburst.

*Robert Williams*



## GALLERY

We would love to display your images here, whether they are taken up at Kielder or not. Please send them to

[admin@kielderobservatory.org](mailto:admin@kielderobservatory.org)

along with a brief description of how and when they were taken.



© KOAS

***The moon on Christmas Eve. Taken through one of our 80mm refracting telescopes using a planetary camera, this image is a stack of ~3000 frames.***



## GALLERY

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***The Great Conjunction of Jupiter and Saturn. Taken from Norfolk on December 19th with a Nikon D90 camera and 105mm f5.6 lens (1 sec exposure). Credit: Duncan Hale-Sutton***



## GALLERY



***Our star, the Sun, setting behind the Ribbleshead Viaduct in the Yorkshire Dales National Park. Credit: Kevan Hubbard.***

***By December 29th,  
when this shot from Co.  
Durham was taken,  
Jupiter and Saturn had  
started to move apart.  
1/4s exposure with a  
Panasonic TZ-18  
camera. Credit: Nigel  
Metcalf***







## GALLERY



*The Rosette nebula: 200/1000mm Newtonian, 40 x 3min with H-alpha modified Canon EOS 40D camera. No guiding, just tracked on an EQ6 pro mount. Credit: Jürgen Schmoll.*



© KOAS

*The night of December 21st/ 22nd was the peak of the Ursids Meteor Shower. Quite a few impressive fireballs were seen from the Observatory - this was probably the best one, it lit up the night sky! You can see a number of trail flares before the meteor terminates.*



## GALLERY



***The Moon over the mouth of the River Tees from Seaton Carew, Co. Durham.  
Credit: Kevan Hubbard.***



"Fantastic place, felt like being on another planet - so dark and high up! The staff were brilliant - so friendly and professional, and with an infectious enthusiasm. They really know their stuff!"

"Absolutely superb. I thought it would be enjoyable but this exceeded my expectations. I can't speak highly enough of the knowledgeable staff."

"Amazing location, excellent staff, really engaged with the children. Awesome!"

***Kielder Observatory - a beacon for dark skies***

<https://kielderobservatory.org>

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