NWASNEWS

Volume24, Issue 6

February 2019

Newsletter for the Wiltshire, Swindon, Beckington Astronomical Societies and Salisbury Plain Observing Group

COUNTING STARS

Well Peter Chappell has just got back from a trip to Iceland viewing the Aurora and the scenery of that beautiful, if snowy island. If the pictures seen on Facebook are anything to go by…

I am heading to northern Iceland to do the same sort of thing at the beginning of March so while Aurora are supposed to be better nearer the equinox there is no guarantee and the weather can change all that.

But it does mean I not going to able to produce a full newsletter for the next meeting, and certainly cant print anything to bring to the meeting either.

Just a word of warning…

The early part of March should also be the time of the moonless hunt for the Messier objects known as the Messier marathon. We have frequently managed to get close to a hundred objects through one night.

If anyone wants to set something up I suggest getting hold of Jonathan Gale (Tony Vale is in Spain).

On the 28th February we have an early evening commitment (around 6:30) at Westbury Leigh school. Help with some telescopes will be gratefully received.

We have a couple of other postponed school events that we may be called in to help, and I am booked for 2 weeks of talks and displays at Dunstable Downs near Luton with Dark Skies Wales.

One thing we can all get involved with is the Campaign for Rural England Dark Skies recording.

This means a star count for the visible stars within the boundaries of the four main stars of Orion. Make sure you go out beyond the belt to the straight lines between Bellatrix and Rigel and on the left Betelgeuse to Sai[ph. Aslo record your viewing location and any other factors that influence seeing (state off the Moon, any mist in the skies). Chrystal clear dark skies may yield over 30 stars. Last night with misty conditions getting in the way I managed between 19 and 21 stars at Knap Hill and down at Silbury Hill.

Clear Skies Andy

The sickle, or the head and front paw of Leo rising through the mist above Silbury Hill last night (4th Feb).

A patch of remaining snow can just be seen, Regulus is just visible above the Hill, lights from Marlborough put a glow in the sky to the east.

Lets hope the spring evening rising of Leo is a sign of warmer weather and clear skies to come.

Galaxy hunting season returns!

Andy Burns.

Nikon D850

35mm Nikkor, 30 seconds at f3.5.

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

Meetings 2018/2019Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

Date Speaker Title

2019

5 Feb Prof. David Southwood: Mars: Delirium, Delight & Disasters, some personal stories.

5 Mar Martin Griffiths: 'Universal Death' or How the Universe is trying to kill us.

2 Apr Chris Starr: A Most beautiful Moon – A History of Lunar Exploration.

7 May Mark Radice: Observing the Solar System.

4 Jun Jon Gale: Observing the Herschel 400.

Professor David Southwood

His CV is such a huge litany of fabulous high acheivemnet. It is fantastic that he has chosen to come back and speak to us.

PhD work 1966-1970 and post doctoral work in USA 1970-71.

My thesis, unusually for the time, concerned both theory and data analysis of low frequency waves in the earth's space environment. [The data came from the magnetometer on Explorer 33, a spacecraft that failed to achieve lunar orbit.] I was first to show that waves creating ULF (1-1000 mHz) signals on the ground were generated by the solar wind flowing past the magnetosphere (Kelvin-Helmholtz instability)

Lecturer, 1971-1981

Reader in Physics (and Head of Space Physics, from 1984), 1981-86

Professor of Physics (and Head of Space and Atmospheric Physics), 1986-94

Head of Blackett Laboratory, 1994-7

ESA (EO Strategy) 1997-2000

Regent's Professor, University of California, 2000

ISSI, 2000 (and prospects for Saturn system science)

I have been on committees in Britain (SERC/PPARC, NERC, Royal Society and others) and the USA (NASA and AGU), but also for the European Commission, Norwegian Research Council, Finnish Academy, and various universities/institutes from the University of Tokyo to the International Space Science Institute in Switzerland.Despite an avowed scepticism of committeedom, I have chaired a lot.

And so much more.

Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Keith Bruton Chair, keisana@tiscali.co.uk

Vice chair: Andy Burns and newsletter editor. Email anglesburns@hotmail.com

Bob Johnston (Treasurer) Debbie Croker (vice Treasurer)

Philip Proven (Hall coordinator) Dave Buckle (Teas)

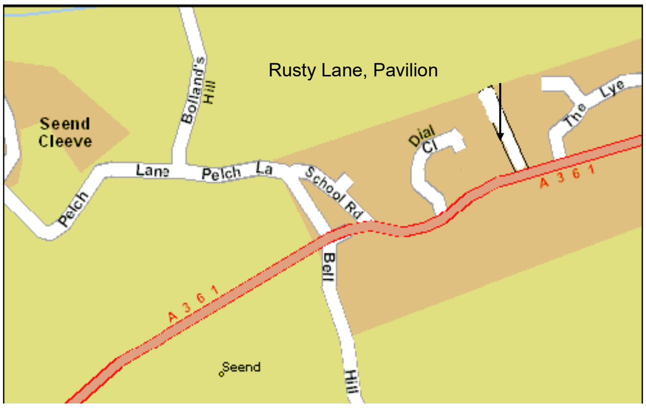
Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

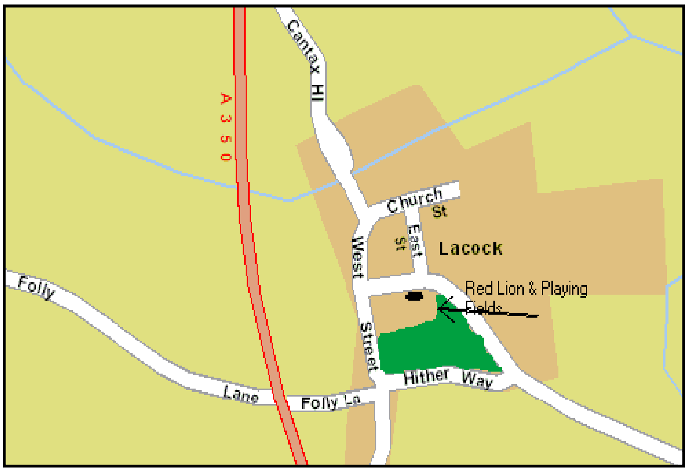
Observing Sessions coordinators: Jon Gale, Tony Vale

Web coordinator: Sam Franklin

Contact via the web site details.



Observing Sessions



The Wiltshire Astronomical Society's observing sessions are open, and we welcome visitors from other societies as well as members of the public to join us.

We will help you set up equipment (as often as you need this help), and let you test anything we have to help you in your choice of future astronomy purchases.

Please treat the lights and return to full working order before leaving. With enough care shown we may get the National Trust to do something with them!

PLEASE see our proposed changes to the observing sessions, contacting and other details. Back Page

Note this year we have moved away from the '4th Friday of the month' routine to get away from nights when the Moon is too bright to view other objects, so may be 1st Friday of month...

Swindon's own astronomy group

The club meets once a month at Liddington Hall, Church Road, Liddington, Swindon, SN4 0HB at 7.30pm. See programme below.

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.

When we use East Kennett, we meet at the public car park just below The Red Lion pub at Avebury; we usually hang on for 10 minutes and then move on to our viewing spot at East Kennett. Information about our evenings and viewing spots can be found here:

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

If you think you might be interested email the organiser Robin Wilkey (see website). 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!

Members of the Wiltshire Astronomical Society always welcome!

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.ht

Meeting Dates for 2019

Friday 18 January 2019
Programme: Ray Doran, Reaction Engines: SABRE: Unlocking the future of Hypersonic Flight and Space Access

Friday 15 February 2019
Programme: Graham Bryant: Astronomical Events that have effected Human History

Friday 15 March 2019
Programme: AGM plus Viv Williams: Astro Imaging - the Basics

Friday 12 April 2019

Programme: Dr. Sarah Bosman: Dark Matter the most distant Objects

Friday 17 May 2019

Programme: Mark Woodland FRAS: Exoplanents and the Charterhouse Exoplanet Project

Friday 21 June 2019
Programme: TBA

Website:

http://www.swindonstargazers.co

Chairman: Peter Struve

Tel No: 01793 481547
Email: peter.struve@sky.com
Address: 3 Monkton Close, Park South, Swindon, SN3 2EU

Secretary: Dr Bob Gatten (PhD)
Tel Number: 07913 335475

Email: bob.gatten@ntlworld.co.uk
Address: 17, Euclid Street,

Swindon, SN1 2JW

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.

15th February	*Journey to the Edge of the Solar System*	Chris Starr
15th March	*How Old Is It?*	Stephen Tonkin
26th April	*Observing and Sketching the Deep Sky*	Mark Radice
17th May	*The Herschel 400*	Jonathan Gale
21st June	Annual General Meeting *Member Talks*	

Some Favourite Lunar Detail Shots

Andy Burns, D7200 on Celestron 9.25" Schmidt Cassegrain telescope, processed from video and stacked using registax.

William Herschel crater (the small deep crater, with larger more shallow Ptolemaeus and Alphonsus. The top of Rupes rectus can be seen in the bottom Mare Nuibium.

The top of the Moon.
Mare Frigoris and the large Aristoteles crater above the Eudoxus crater.

The crater Goldschmidt is top left.

Below the Apennine mountains with the Hadley Rille region, with the large shallow Archimedes and deeper Aristillus and Autolycus.

The Night Sky Network program supports astronomy clubs across the USA dedicated to astronomy outreach. Visit nightsky.jpl.nasa.org to find local clubs, events, and more!

Hexagon at Night, Quartet in the Morning

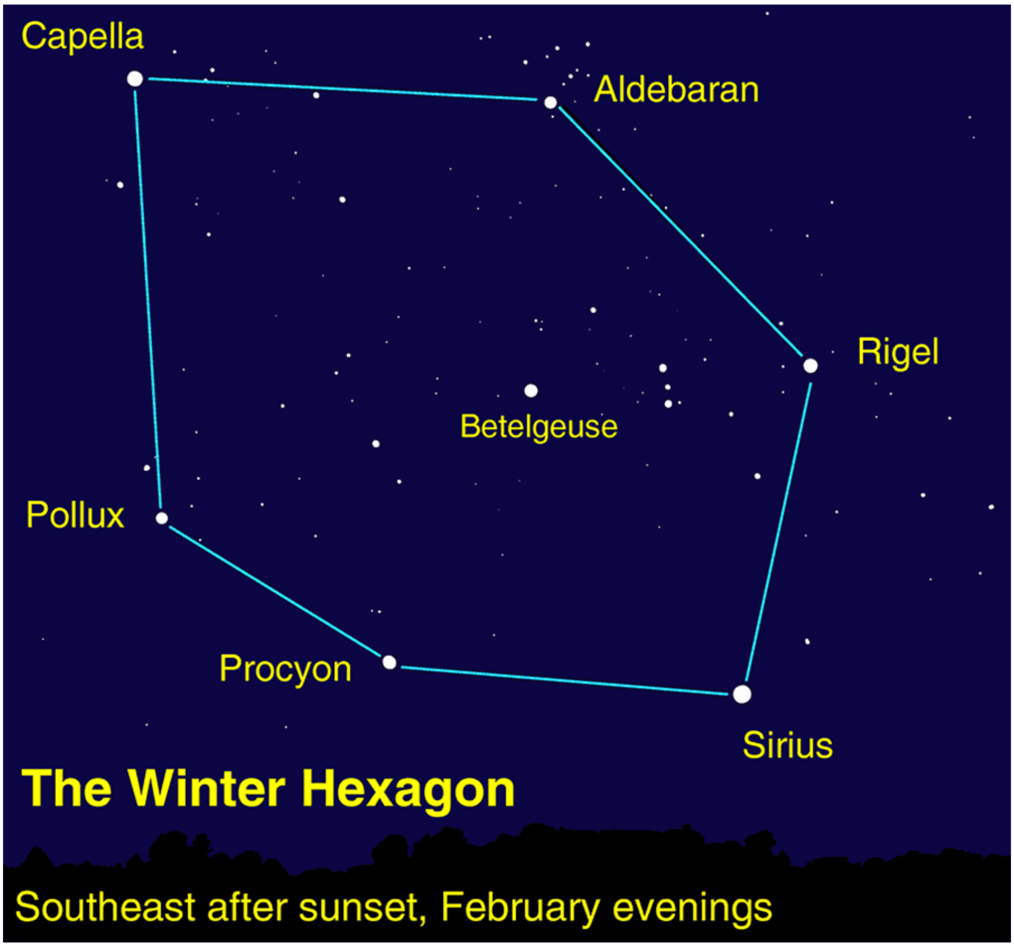
David Prosper

The stars that make up the **Winter Hexagon** asterism are some of the brightest in the night sky and February evenings are a great time to enjoy their sparkly splendor. The Winter Hexagon is so large in size that the six stars that make up its points are also the brightest members of six different constellations, making the Hexagon a great starting point for learning the winter sky. Find the Hexagon by looking southeast after sunset and finding the bright red star that forms the "left shoulder" of the constellation Orion: **Betelgeuse**. You can think of Betelgeuse as the center of a large irregular clock, with the Winter Hexagon stars as the clock's hour numbers. Move diagonally across Orion to spot its "right foot," the bright star **Rigel.** Now move clockwise from Rigel to the brightest star in the night sky: **Sirius** in Canis Major. Continue ticking along clockwise to **Procyon** in Canis Minor and then towards **Pollux,** the brighter of the Gemini twins. Keep moving around the circuit to find **Capella** in Auriga, and finish at orange **Aldebaran**, the "eye" of the V-shaped face of Taurus the Bull.

Two naked-eye planets are visible in the evening sky this month. As red **Mars** moves across Pisces, NASA's InSight Mission is readying its suite of geological instruments designed to study the Martian interior. InSight and the rest of humanity's robotic Martian emissaries will soon be joined by the Mars 2020 rover. The SUV-sized robot is slated to launch next year on a mission to study the possibility of past life on the red planet. A conjunction between Mars and **Uranus** on February 13 will be a treat for telescopic observers. Mars will pass a little over a degree away from Uranus and larger magnifications will allow comparisons between the small red disc of dusty Mars with the smaller and much more distant blue-green disc of ice giant Uranus.

Speedy **Mercury** has a good showing this month and makes its highest appearance in the evening on February 27; spot it above the western horizon at sunset. An unobstructed western view and binoculars will greatly help in catching Mercury against the glow of evening twilight.

The morning planets put on quite a show in February. Look for the bright planets **Venus**, **Jupiter**, and **Saturn** above the eastern horizon all month, at times forming a neat lineup. A crescent **Moon** makes a stunning addition on the mornings of February 1-2, and again on the 28th. Watch over the course of the month as Venus travels from its position above Jupiter to below dimmer Saturn. Venus and Saturn will be in close conjunction on the 18th; see if you can fit both planets into the same telescopic field of view. A telescope reveals the brilliant thin crescent phase of Venus waxing into a wide gibbous phase as the planet passes around the other side of our Sun. The Night Sky Network has a simple activity that helps explain the nature of both Venus and Mercury's phases at bit.ly/venusphases



Caption: The stars of the Winter Hexagon
Image created with help from Stellarium

MEMBERS VIEWING LOGS and IMAGES

February Star Count

From : allfassocs@fedastro.org.uk
Date : 13/01/2019 - 21:15 (GMT)
To : allfassocs@fedastro.org.uk
Subject : [Allfassocs] "Star Count 2019"

Dear FAS Member, This information from the website of the Campaign to Protect Rural England entitled "Star Count 2019" is a campaign to help map light pollution from 2 February to 23 February and requires your participation: https://www.cpre.org.uk/what-we-do/countryside/dark-skies/star-count-2019?utm_medium=email&utm_source=engagingnetworks&utm_campaign=campaigns-update-2019-jan&utm_content=Campaigns+Update+2019+Jan

We hope that this will be of interest to your members and ultimately will help the campaign for dark skies.

Regards, Richard Field

Only count the star WITHIN the 4 body stars, Betelgeuse, Bellatrix, Rigel and Saiph. Belt and sword stars count and outside the 'belted waist' out to the lines of the quadrant as shown.
Wait for a completely clear night (not like last night shown here) and as moonless as possible. Please note observing site latitude and longitude.

Good day to you Mr Burns,

Following on from my previous enquiries to you I can announce that Marlborough Town Council have resolved to look at a dark skies initiative in the town.

The Dark Skies working party has identified late October 2020 as the earliest & best opportunity to hold such a "Marlborough Dark Skies Festival"

Given that we've already floated the idea with a number of people, we'd now like to know what your availability would be & what sort of support, information, display, equipment or expertise you & your organisation could bring to such a festival?

Regards

Peter Cairns

Hi Andy, Keith, Peter and Tony

I thought I'd give you a quick update on the web/IT side of things ahead of tomorrow's meeting.

1. Website. I'm currently adding content, it won't be finished by tomorrow, but will be definitely done by March, if not much sooner.
2. Closed Facebook Group. Andy for the newsletter tomorrow, can you please include a link to the new "closed" facebook group for members and encourge them to sign up. This is the link https://www.facebook.com/groups/wiltshire.astro.society. As a reminder, this is a members-only group, that is voluntary. It should act as a forum, and a place where members can chat and post questions but is not public.
3. **Archive newsletters**. I'm doing a section on the website for archive meetings and newsletters. I reckon you've got a good back-catalogue of the PDF newsletters. I wonder how best for me to get access to them. I'll bring a USB drive tomorrow in case we have time.
4. **Images.** I think it would be really good if we can get some astro images from you or other members. Not too many as Facebook can serve this purpose for sharing member images. Let's chat tomorrow.
5. History of the society. I'm including a very short "about" section on the website. When was the society formed? Who were the founder members? If there's some short text that someone would like to contribute, that will be great.
6. Group Photo. I think it would be nice to have a group photo (voluntary participation of course!) to include on the site. We should attempt to look welcoming and not scary, ha ha!

I'm sure there are a few other things to ask. See you tomorrow.
Sam

Hi Andy,

Here are my submissions for the February WAS Newsletter.

Unfortunately, the Total Lunar Eclipse was a no show due to thick cloud. I did attempt to view it despite the weather forecast and the conditions. What I did notice, even with the cloud cover, was the change in luminosity as the time of total eclipse approached and went. It was really dark at totality.

To make up for the disappointment there were many early morning starts to catch the planets and Moon in the dawn sky in the last few days of January and beginning of February.

22/01/2019
Venus and Jupiter Conjunction with Antares reflected in Braydon Pond near Brinkworth.

Canon G16 at 28mm, F1.8, 13 sec, ISO 800
02/02/2019
Waning Crescent Moon (5.3% lit) and Saturn.

Saturn was a difficult spot due the low cloud on the horizon and the increase in the brightness of the sky as the Sun rose. Venus and Jupiter were visible as well so there was a good display of the crescent Moon and planets in the early dawn sky. Wide Angle and Close Up - Canon SX50HS, F8, 1.3 sec, ISO 80

Clear Skies,
John Dartnell

Some of my views of the early morning line up of the

Moon, Jupiter and Venus from, my home in the middle of Chippenham. Trees getting in the way as usual!
Below star trails on lunar eclipse morning. Andy

SPACE NEWS FOR FEBRUARY

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

Elon Musk's New Plan is to Get to the Moon as Fast as Possible

For Elon Musk and SpaceX, the company he founded to reignite space exploration, a great deal hinges on the creation of the *Starship*. This super-heavy launch vehicle, which was has evolved considerably in the past few years, will eventually replace the *Falcon 9* and *Falcon Heavy* as the mainstay of the SpaceX fleet. Once operational, it will also facilitate missions to the Moon and eventually Mars.

Once again, Elon Musk has used his social media platform of choice to share the latest details about the *Starship*'s progress. As he shared in a series of tweets, which began on Thursday, Jan. 31st, the company has commenced test-firing the Raptor engine at their Rocket Development and Test Facility in McGregor, Texas, and is pushing towards the *Starship's* first mission.

The Raptor is a staged-combustion reusable rocket engine powered by cryogenic liquid methane and liquid oxygen (LOX), rather than the kerosene and LOX combination (RP1) which powers the Merlin rockets used by the Falcon rocket family. Once complete, the *Starship* will have seven Raptor engines, each of which will provide twice as much thrust as the Merlin 1D used by the *Falcon 9.*

News of the engine's test-firing began with Musk posting two pictures of the Raptor engine along with the caption, "Preparing to fire the Starship Raptor engine." In addition to the pictures, Musk took the opportunity to share specifications that provided some clues as to what path the company is planning to take with the *Starship* in the near future.

For example, Musk indicated that the current version of the engine is simplified compared to later versions, and is tailor-made for speed:

"Initially making one 200 metric ton thrust engine common across ship & booster to reach the moon as fast as possible. Next versions will split to vacuum-optimized (380+ sec Isp) & sea-level thrust optimized (~250 ton)."

Here, Musk is alluding to the first crewed mission of the *Starship*, which is scheduled to take place in 2023. According to the plan that Musk announced back in September, this inaugural flight will see Japanese fashion designer and art curator Yusaku Maezawa and a group of artists being taken on a flight around the Moon.

This mission, the #dearmoon project, will be the first private lunar passenger flight in history and is intended to help fund the development of the *Starship*. The flight will last a full week and will involve the passengers using the journey to inspire their particular brand of artwork. By streamlining the development of the engine, Musk is indicating that he may be accelerating the timeline.

This update was followed on February 2nd with Musk tweeting a photo of himself standing by the engine and announcing that it had made it to the McGregor facility. On the following day, Musk posted two more tweets (shown above) of the Raptor engine being test-fired.

The two video segments show the engine igniting and achieving about three seconds of clean thrust before being shut off.

As you can see from the videos, the test was a dazzling display of both light and sound. Aside from the beautiful, multi-colored stream of fire that the engine produces, there is also the ear-shattering noise it makes (which sounds like a cannon firing repeatedly). Elon followed the video clips with a still shot of the engine firing with the caption, "First firing of Starship Raptor flight engine! So proud of great work by **@SpaceX** team!"

Other recent changes that were shared by Musk in recent weeks include the fact that the first stage of the launch system (the Super Heavy) could initially fly with less than 31 Raptor engines (as was originally proposed). The reasoning behind this, according to Musk, is for the company to cut their losses "in case it blows up".

Artist's impression of SpaceX's Starship deploying cargo to Low Earth Orbit (LEO). Credit: SpaceX

In addition to that, Musk also indicated that the *Starship*'s Reaction Control System (RCS) thrusters will have a simplified design. When asked if he was still planning on using methalox fuel to power them, he tweeted: "Cold gas thrusters only. Will use body flaps & main engines for landing orientation, so won't need high thrust reaction control. Simplifies things considerably."

All of this suggests that Musk is looking to cut costs and push ahead on production. It also raises the question of whether or not this has anything to do with the recent announcement that SpaceX will be laying off almost ten percent of its employees, while Tesla will similarly be laying off seven percent of its workforce.

Musk attributed the latter to the steady growth of the company's workforce, which has led to the unwanted duplication of some positions. In the case of SpaceX, however, Musk claimed that the layoffs were caused by the company's "absolutely insane" projects, specifically Starlink (the SpaceX initiative for providing high-speed global internet access via satellite) and the *Starship*.

As such, it makes sense that some trimming and expediting is seen as necessary as far as the development of the *Starship* is concerned. These latest updates also come shortly after Musk revealed that the ship's hull design had changed. This was apparent when the miniature version – the "Starship Alpha" – was photographed being assembled over the holidays.

Artist's impression of what the completed Starship Alpha will look like. Credit: SpaceX

Thanks to multiple shutterbugs who kept an eye on the South Texas Launch Site, it became apparent that the *Starship* – like it's prototype – would be constructed out of stainless steel rather than carbon composites (as had originally been proposed). Musk confirmed this shortly thereafter, and reiterated it once again on Jan. 31st, tweeting:

"To be clear, I'm confident that a stainless steel ship will be lighter than advanced aluminum or carbon fiber, because of strength to weight vs temperature & reduced need for heat shielding."

As always, Musk is keeping the public engaged on the progress of his "insane projects". And while there might be some bumps along the way, Musk is nothing if not tenaciously-driven. He's also no stranger to financial hiccups and setbacks, but has always managed to deliver in the end. And where the *Starship* is concerned, he's hardly alone in wanting to see it succeed.

SpaceX Starhopper Damaged in High Winds

Elon Musk indicates that the SpaceX Starhopper has been damaged after being toppled in 50 mile-per-hour winds. This will take a few weeks to repair.

Elon Musk had mentioned in a tweet on January 5, 2019, that unexpected issues could delay the Starhopper by 4 weeks. This turned out to be an accurate prediction of bad weather causing damage and delays.

Aiming for 4 weeks, which probably means 8 weeks, due to unforeseen issues— Elon Musk (@elonmusk) January 5, 2019

The wind damage came after several weeks of rapid progress on the SpaceX Starhopper and the conversion of the Super Heavy Starship to use stainless steel instead of carbon fiber.

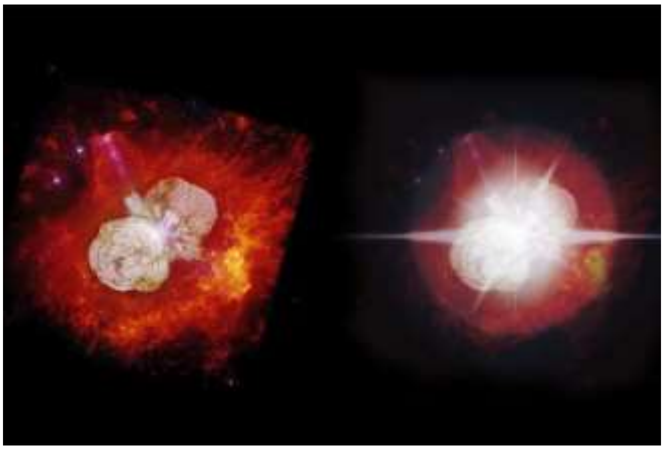
Elon Musk explained in a Popular Mechanics interview that 300 series of stainless steel alloy can handle higher temperatures than carbon fiber or aluminum. Carbon fiber can theoretically take higher temperatures but in practice, the resin has problems after exposure to prolonged temperatures over 300 degrees Fahrenheit.

Eta Carinae is Getting Brighter Because a Dust Cloud was Blocking our View

In addition to being one of the most beautiful and frequently photographed objects in the night sky, Eta Carinae also has also had the honor of being one of the sky's most luminous stars for over a century and a half. In addition, it has been a scientific curiosity since its giant ejected nebula (Homunculus) contains information about its parent star.

It is therefore sad news that within a decade or so, we will no longer be able to see the Homunculus nebula clearly. That was the conclusion reached in a new study by an international team of researchers. According to their findings, the nebula will be obscured by the growing brightness of Eta Carinae itself, which will be ten times brighter by about 2036.

Astronomers became aware of Eta Carinae in 1847, when the giant eruption that ejected its nebula also made it the second-brightest star in the sky after Sirius. At the time, the star was visible even in broad daylight, which made it easily distinguishable from other, similarly unstable stars called Luminous Blue Variables (LBVs) whose nebulae are not so clearly visible.



The star Eta Carinae, as it appears today, and within 10 years from now. Credit: University of Montreal

The new study, which recently appeared in the *Monthly Notices of the Royal Astronomical Society* (MNRAS), was led by Augusto Damineli of the University of Sao Paulo's Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG) and included researchers from the NASA Goddard Space Flight Center, the Max Planck Institute for Radio Astronomy, and multiple institutes and universities.

According to their study, Eta Carinae's brightness is likely caused by the dissipation of a dust cloud positioned in front of it (as seen from Earth). This contradicts previously-held notions that the brightness is intrinsic to the star itself. In fact, they claim that this cloud is responsible for shrouding the star and its winds, which obscures much of the light coming from it towards Earth.

The surrounding Homunculus is not affected by this cloud, however, since it is over 200 times larger. But by 2032 (plus or minus four years), the dusty cloud will have dissipated and the brightness of the central star will begin to obscure the Homunculus nebula. In other words, Eta Carinae will appear brighter and the nebula itself will no longer be visible.

While this certainly sounds like bad news, the team emphasizes that there is an upside to this. For one, the increased visibility of the star will allow for deeper study of Eta Carinae itself, which will settle some long-standing questions. For instance, astronomers have puzzled over whether Eta Carinae is in fact one star or a binary system.

As Anthony Moffat, a professor of astrophysics at the University of Montreal and a co-author on the study, explained in a UdeM press release:

"There have been a number of recent revelations about this unique object in the sky, but this is among the most important. It may finally allow us to probe the true nature of the central engine and show that it is a close binary system of two very massive interacting stars."

"There have been a number of recent revelations about this unique object in the sky, but this is among the most important. It may finally allow us to probe the true nature of the central engine and show that it is a close binary system of two very massive interacting stars."

To paraphrase Heraclitus, "The only constant is change". In a Universe where everything is in flux, change can provide new and exciting opportunities for research. And with next-generation telescopes coming online soon, Eta Carinae could prove to be a very interesting subject of study.

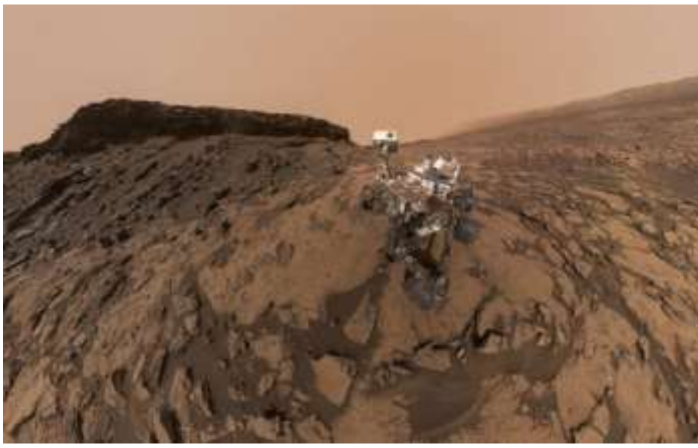
Further Reading: University of Montreal

Oumuamua Could be the Debris Cloud of a Disintegrated Interstellar Comet

Since it was first detected hurling through our Solar System, the interstellar object known as 'Oumuamua has been a source of immense scientific interest. Aside from being extrasolar in origin, the fact that it has managed to defy classification time and again has led to some pretty interesting theories. While some have suggested that it is a comet or an asteroid, there has even been the suggestion that it might be an interstellar spacecraft.

However, a recent study may offer a synthesis to all the conflicting data and finally reveal the true nature of 'Oumuamua. The study comes from famed astronomer Dr. Zdenek Sekanina of the NASA Jet Propulsion Laboratory, who suggests that 'Oumuamua is the remnant of an interstellar comet that shattered before making its closest pass to the Sun (perihelion), leaving behind a cigar-shaped rocky fragment.

NASA used Curiosity's Sensors to Measure the Gravity of a Mountain on Mars



Some very clever people have figured out how to use MSL Curiosity's navigation sensors to measure the gravity of a Martian mountain. What they've found contradicts previous thinking about Aeolis Mons, aka Mt. Sharp. Aeolis Mons is a mountain in the center of Gale Crater, Curiosity's landing site in 2012.

Gale Crater is a huge impact crater that's 154 km (96 mi) in diameter and about 3.5 billion years old. In the center is Aeolis Mons, a mountain about 5.5 km (18,000 ft) high. Over an approximately 2 billion year period, sediments were deposited either by water, wind, or both, creating the mountain. Subsequent erosion reduced the mountain to its current form.

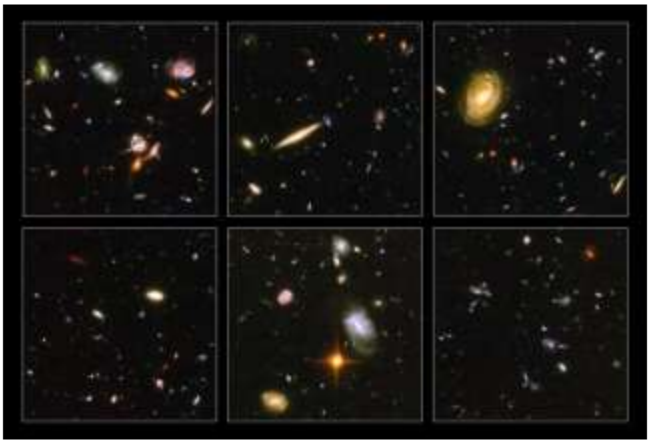
Now a new paper published in Science, based on gravity measurements from Curiosity, shows that Aeolis Mons' bedrock layers are not as dense as once thought.

Astronomers Process Hubble's Deepest Image to get Even More Data, and Show that Some Galaxies are Twice as big as Previously Believed

It allowed us to spot auroras on Saturn and planets orbiting distant suns. It permitted astronomers to see galaxies in the early stages of formation, and look back to some of the earliest periods in the Universe. It also measured the distances to Cepheid variable stars more accurately than ever before, which helped astrophysicists constrain how fast the Universe is expanding (the Hubble Constant).

It did all of this and more, which is why no space telescope is as recognized and revered as the *Hubble Space Telescope*. And while it's mission is currently scheduled to end in 2021, *Hubble* is still breaking new ground. Thanks to the efforts of a research team from the Instituto de Astrofísica de Canarias (IAC), *Hubble* recently obtained the deepest images of the Universe ever taken from space.

The study that describes the research team's work, titled “The missing light of the *Hubble* Ultra Deep Field“, recently appeared in the journal *Astronomy and Astrophysics.* For the sake of their study, the team used original *Hubble* images from the Hubble Ultra-Deep Field (HUDF) – the deepest view of the Universe ever taken, which was the result of hundreds of images being taken from over 230 hours worth of observations.



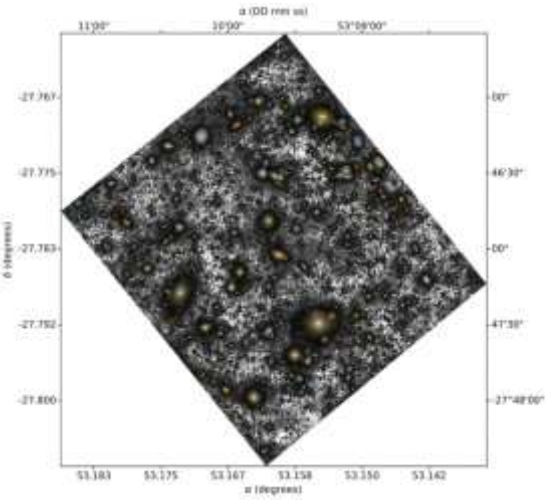
Images from the Hubble Ultra Deep Field (HUDF). Credit: NASA/ESA/S. Beckwith (STScI)/HUDF Team

The images were acquired with Hubble’s Wide Field Camera 3 (WFC3), which had been installed on *Hubble* in May of 2009. These images were then combined to reveal some of the earliest galaxies in the Universe. However, the method of combining images is not ideal when it comes to the detection of faint extended objects.

These include the arms of spiral galaxies and the disk of lenticular galaxies, where the concentrations of stars and gas is less dense than in the center. By improving the process of image combining, the research team was able to recover a large quantity of light from the HUDF, specifically in the outer zones of the largest galaxies. As Alejandro S. Borlaff, the lead researcher on the team, explained in a recent IAC press release:

“What we have done is to go back to the archive of the original images, directly as observed by the HST, and improve the process of combination, aiming at the best image quality not only for the more distant smaller galaxies but also for the extended regions of the largest galaxies.”

Processing these images to find the “missing light” was a major challenge for the researchers, since it required that the WFC3’s camera and telescope be tested and calibrated. But since they are both currently on board Hubble and in orbit, it was impossible to do this on the ground.



The first ABYSS HUDF mosaic. Credit: Borlaff (et al)/ ABYSS/IAC

To overcome this, the team launched the ABYSS HUDF Project, which was dedicated to the optimization of infrared and WFC3 data acquired by Hubble to preserve the properties of the low surface brightness regions. This consisted of analyzing several thousand images of different regions on the sky to improve the calibration of the orbiting telescope.

The process worked, leading to new mosaics that successfully recovered the low surface brightness structure removed on the previous HUDF images. This in turn revealed that the largest galaxies imaged in the HUDF were almost twice as large as previously measured.

As Borloff explained, this latest view of the Universe “has been possible thanks to a striking improvement in the techniques of image processing which has been achieved in recent years, a field in which the group working in the IAC is at the forefront”.

This new picture of the earliest period in the Universe could have significant implications for cosmology. Knowing that early galaxies were larger and more massive than previously thought is likely to revise some of our timelines, indicating that galaxy formation either began sooner or was more rapid than we thought.

And it demonstrates that after 30 years of service, Hubble is still capable of providing groundbreaking discoveries!

Further Reading: IAC, Astronomy and Astrophysics

Newborn Stars in the Orion Nebula Prevent Other Stars from Forming

The Orion Nebula is one of the most observed and photographed objects in the night sky. At a distance of 1350 light years away, it’s the closest active star-forming region to Earth.

This diffuse nebula is also known as M42, and has been studied intensely by astronomers for many years. From it, astronomers have learned a lot about star formation, planetary system formation, and other bedrock topics in astronomy and astrophysics. Now a new discovery has been made which goes against the grain of established theory: stellar winds from newly-formed massive stars may prevent other stars from forming in their vicinity. They also play a much larger role in star formation, and in galaxy evolution, than previously thought.

The Orion Nebula is pretty easy to see. If you can see the Orion constellation, then you're looking at the nebula without really trying. Depending on where you live, you can use binoculars or a small telescope to see it. Through a telescope, it looks like a grey, wispy, cloud.

The Orion Constellation. The Orion Nebula appears as a greyish smudge near the bottom middle of this image. Image Credit: By Skatebiker at English Wikipedia – Transferred from en.wikipedia to Commons by Sreejithk2000 using CommonsHelper., Public Domain, https://commons.wikimedia.org/w/index.php?curid=14969173

But more powerful instruments reveal all the complexity inside the nebula. It's a great example of a stellar nursery, a place where young stars are born in a cloud of gas called a molecular cloud. Around these young stars are young protoplanetary disks, places where planets like ours may be forming right now.

As these young stars are born, and burst into fusion, they expel a stellar wind. This new study shows that this stellar wind plays a larger role than previously thought.

The study is published in the journal Nature, and is led by Cornelia Pabst, a Ph.D. student at the University of Leiden in the Netherlands and the lead author on the paper. In the paper, the authors describe how newly-formed stars inhibit the formation of other stars in a process called "stellar feedback."

Current thinking says that supernovae can dominate the star-forming process. Massive supernova explosions send powerful shock waves through molecular clouds, and this creates dense concentrations of gas which then go on to form stars. While that remains true, it looks like stellar feedback from new stars may shape the process, too.

The research is based on the work of NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA.) SOFIA is a flying observatory in a customized Boeing 747. SOFIA has a German instrument onboard called GREAT, or German Receiver for Astronomy at Terahertz Frequencies.

The stunning, shaped clouds of gas in the Orion Nebula make it beautiful, but also make it difficult to see inside of. This image of the Orion Nebula was captured by the Hubble Telescope. Image: NASA, ESA, M. Robberto (STScI/ESA) and The Hubble Space Telescope Orion Treasury Project Team

The Orion Nebula is an object of great astronomical beauty, but that beauty is what makes it hard to see into. Those clouds of gas that look so ephemeral and beautiful do weird things to light. GREAT allowed astronomers to look inside the Orion Nebula with increased clarity and to observe in detail the newly-formed star Theta1 Orionis C (01 Ori C).

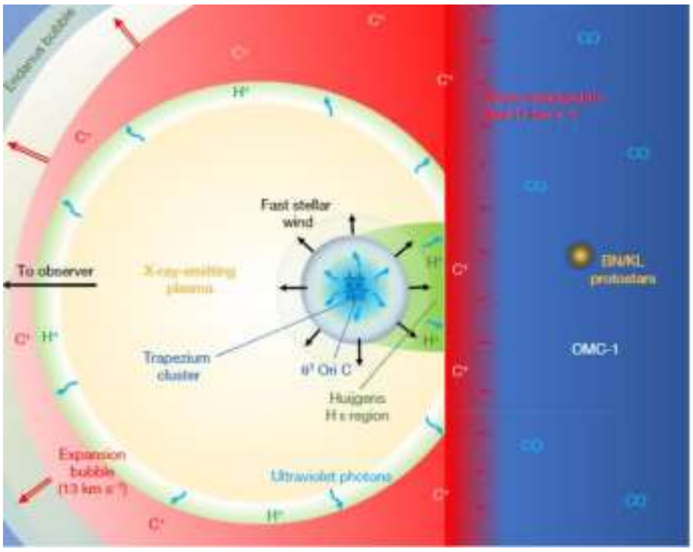
What they found is that the stellar wind from 01 Ori C is carving a bubble around itself, essentially blowing all the gas away from itself, preventing any new stars from forming.

"Astronomers use GREAT like a police officer uses a radar gun."

"The wind is responsible for blowing an enormous bubble around the central stars," explained Pabst. "It disrupts the natal cloud and prevents the birth of new stars."

Because SOFIA does its science from altitude, it flies above 99% of the water vapour in Earth's atmosphere. That, combined with the sensitivity of the GREAT instrument, makes it a powerful fool for peering at 01 Ori C. The team behind the paper combined GREAT data with data from the Herschel and Spitzer space observatories to get their results.

They were able to determine the velocity of the gas creating the bubble and to track its growth and origin. "Astronomers use GREAT like a police officer uses a radar gun," explained Alexander Tielens, an astronomer at Leiden Observatory and a senior scientist on the paper. "The radar bounces off your car, and the signal tells the officer if you're speeding."



This graphic from the study helps explain the findings. 01 Ori C is a member of the Trapezium Cluster. The black arrows represent the fast stellar wind expelled from the star. The yellow represents the plasma bubble, which is gas swept up by the stellar wind and creating what they call the Veil bubble, in red. Note that the bubble is not expanding in all directions equally. The blue OMC-1 area is dense gas in side the Orion Molecular Core, too dense to be shaped by the stellar wind from the young star. Image Credit: Pabst et. al., 2019.

The process is called "stellar feedback" because of the way the bubble interacts with the gas around it. As the image above shows, the wind (black arrows) leaves the star in all directions. But when it hits the dense OMC-1 region, on the right of the image, there is pushback from other young stars, labelled BN/KL in the graphic. This creates the vertical column of red-grey arrows, which represents the combined bubbles from 01 Ori C's and the BN/KL bubbles.

As these stellar winds feed back on each other, they shape the interstellar medium (ISM) and any molecular clouds in the vicinity. This creates localized areas that either encourage or discourage more star formation.

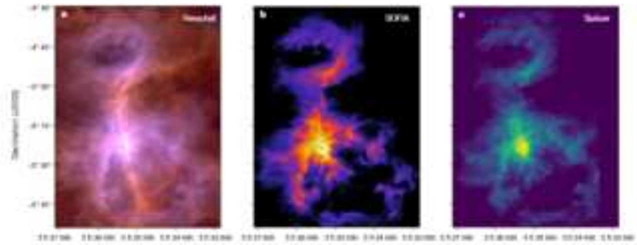
"Stellar winds from O-type massive stars are very effective at disrupting molecular cores and star formation."

From the Conclusion of the paper "Disruption of the Orion molecular core 1 by wind from the massive star ?[1] Orionis C."

The bubble itself is huge. It's a 4 parsec diameter half shell. Inside that area, no star formation is possible because all the gas has been forced out. But on the edge of that bubble, gas is more dense. In those denser regions, star formation is more likely. It's similar to the way that shock-waves from a supernova create areas of dense gas, which leads to increased star formation.

The powerful wind from the newly formed star at the heart of the Orion Nebula is creating the bubble (black) and preventing new stars from forming in its neighborhood. At the same time, the wind is pushing molecular gas (color) to the edges, creating a dense shell around the bubble where future generations of stars can form. Credits: NASA/SOFIA/Pabst et. al

01 Orionis C's bubble is inside a much larger bubble called the Orion-Eridanus Superbubble, made of overlapping supernova remnants. Eventually, the small bubble will erupt and vent its gas into the superbubble. In some millions of years, another supernova will explode and carry the material from 01 Orionis C's bubble into the wall of the superbubble. That wall of gas that makes up the edges of the superbubble will be come more dense, and likely lead to more star formation. So while it may look like the supernova played a more direct role in star formation, the bubble from the young star will already have played its role.



The study combined data from SOFIA, the Spitzer Space Telescope, and the Herschel Space Observatory. Image: Pabst et. al., 2019.

As the conclusion of the paper says, "Stellar winds from O-type massive stars are very effective at disrupting molecular cores and star formation. Because energy input from stellar wind is dominated by the most massive stars in a cluster whereas that from supernovae is dominated by the more numerous B-type stars, the predominance of the disruption caused by stellar winds has a direct effect on cosmological simulations."

This is only one example of the stellar feedback process. As the paper says, "Here we have analysed one specific case of the interaction of a wind from a massive star with its environment; whether our conclusions apply more generally still needs to be assessed."

Sources:

NASA Press Release: Lifting the Veil on Star Formation in the Orion Nebula

Research Paper: Disruption of the Orion molecular core 1 by wind from the massive star ?^{1} Orionis C

SOFIA

When Does the Sun Rise… Really?

It's strange but true. We may not fully understand one of the simplest metrics in observational astronomy: just what time does the Sun rise… really?

It's something so basic that we rarely thing about it. Every morning, the sunrise races at us from the east at up to (if you're on the equator) over 1,000 miles per hour (1,600 kph), and will do so for tens of thousands of mornings throughout our lifetimes. If there's one thing you think you could count on, it's the morning sunrise.

Now, a Michigan Tech analysis by the U.S. Naval Observatory's Teresa Wilson suggests that traditional methods and almanacs may put the quoted sunrise and sunset time off by as much as 5 minutes. Wilson announced the results of the fascinating study at the January 8th meeting of the American Astronomical Society in Seattle.

The problem is one of refraction. If we lived on an airless word, the calculated and observed moment of sunrise would be easy… but as air-breathing mammals, we'd have other problems to contend with. Air bends light, meaning we see the Sun slightly offset from its true position on the horizon due to the atmosphere. Along with the Moon, the Sun is one of the few celestial objects that is large and close enough to appear as more than a point of light to the naked eye. Also, like the Moon, the Sun's apparent diameter is about half a degree across, meaning you could line the local horizon with 720 Suns end to end, or 180 Suns from horizon to zenith. This size also changes very slightly from perihelion in January to aphelion in July, as the Sun seems to grow then shrink from a value of 31.6′ 32.7′ arc minutes.

Most calculations assume local sunrise and sunset time as when the centre of the Sun's disk clears the horizon. Of course, your actual horizon is probably cluttered with foreground objects that the Sun needs to clear, unless you live on a remote mountaintop or are lucky enough to observe sunrise and sunset from the beach.

Most standard sunrise calculations assume a refraction angle of 34′ arcminutes, a little larger than the apparent diameter of the Sun. Wilson notes in the study that this value is cited as far back as 1865, and its use may go all the way back to that 17th century master of optics, Isaac Newton. However, this value is an approximation, and does not account for local meteorological conditions. Air behaves very differently, say, on a still January morning over the Great Lakes versus a hot dusty July morning off the west coast of Africa. Yet, simply using a standard value assumes the true conditions at these disparately different sites are the same.

Wilson's study looked at historic records of 514 sunsets and 251 sunrises from 30 separate geographic locations. Most of these (about 600) came along with weather data for the site, which Wilson then fed into three separate refraction models.

Wilson found that while sunrise and sunset varied by season, wintertime predictions tended to run late, while summer predictions ran early. Viewing sunrise over water seemed to magnify the effect, though taking into account the observer's altitude did dampen down the discrepancy.

Sunrise over Jimena de la Frontera, Spain. Dave Dickinson

Moreover, modelling the complex effect of the weather in the troposphere didn't make the discrepancy go away. Wilson found that using the current 34′ standard, we can't predict the actual sunrise time to better than within 2 minutes.

Why does it matter? Wilson notes that one minute of error measuring sunrise at sea using celestial navigation can lead to up to 15 nautical miles of error. This is crucial, as the U.S. Navy has resumed teaching cadets old-school celestial navigation, in the event a cyber attack blinds GPS capability. Also, for now, our time is set to astronomical time, though there has been calls to move away from this standard and abolish the deletion and insertion of leap seconds starting in 2023. I think the really fascinating story here, though, is the fact that the science surrounding this basic facet of astronomy is something that really anyone could have done, had they simply thought to do it.

The solution? Perhaps smart forecasts can work to account for local atmospheric conditions, delivering to observers a better sunrise and sunset prediction.

…and the Sun will continue to rise and set, every day.

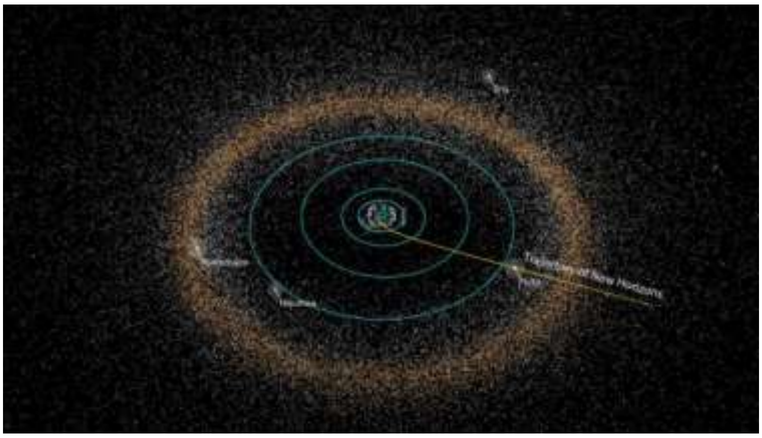
One of the Oldest Earth Rocks Turned up on the Moon, of all Places

According the Giant Impact Hypothesis, the Earth-Moon system was created roughly 4.5 billion years ago when a Mars-sized object collided with Earth. This impact led to the release of massive amounts of material

that eventually coalesced to form the Earth and Moon. Over time, the Moon gradually migrated away from Earth and assumed its current orbit.
Since then, there have been regular exchanges between the Earth and the Moon due to impacts on their surfaces. According to a recent study, an impact that took place during the Hadean Eon (roughly 4 billion years ago) may have been responsible for sending the Earth's oldest sample of rock to the Moon, where it was retrieved by the *Apollo 14* astronauts.

Tiny Object Found at the Edge of the Solar System for the First Time. A Kuiper Belt Object that's Only 2.6 km Across

The Kuiper Belt, or the Edgeworth-Kuiper Belt, is home to ancient rocks. Kuiper Belt Objects, or KBOs, are remnants of the early planet-formation days of our Solar System. Small KBOs, in the 1 km. diameter range, have been theorized about for decades, but nobody's every found one. Until now.
Planets form when bits of dust conglomerate into rocks, which conglomerate into boulders, which conglomerate into larger and larger objects. In our inner Solar System, we can see many of these larger rocks, or asteroids. We can study them, but they're not the same as the distant, ancient KBOs. Asteroids in our neighbourhood have been changed by exposure to solar radiation, by collisions, and by interacting with the gravity of the planets.
But KBOs are more pristine. They're a truer representation of the state of things in the early Solar System. That's why finally confirming the existence of one is creating so much interest.



The Kuiper Belt was named in honor of Dutch-American astronomer Gerard Kuiper, who postulated a reservoir of icy bodies beyond Neptune. The first Kuiper Belt object was discovered in 1992. We now know of more than a thousand objects there, and it's estimated it's home to more than 100,000 asteroids and comets there over 62 miles (100 km) across. Credit: JHUAPL

Scientists have predicted the existence of KBOs between 1 km and several km diameter. But they're so far away, so tiny, and so incredibly dim that there's just no way a telescope can spot one. But a research team led by Ko Arimatsu at the National Astronomical Observatory of Japan found a way to detect them: occultation.
In the same way that we can detect exoplanets around distant stars by watching for dips in starlight, Arimatsu and his team reasoned, we can watch distant stars and look for dips caused by a KBO in our Solar System. They started the OASES (Organized Auto-telescopes for Serendipitous Event Survey) project to do it.

"This is a real victory for little projects."
Ko Arimatsu, National Astronomical Observatory of Japan

They placed two small (28 cm) telescopes on the roof of the Miyako open-air school on Miyako Island, Miyakojima-shi, Okinawa Prefecture, Japan, and monitored approximately 2000 stars for a total of 60 hours. When they analyzed the 60 hours of data, the team discovered a star appearing to dim as it is occulted by a 1.3 km radius Edgeworth-Kuiper Belt Object. Their work indicates that kilometer-sized Edgeworth-Kuiper Belt Objects are more numerous than previously thought. It also supports planetary formation models where planetesimals first grow slowly into kilometer sized objects before runaway growth causes them to merge into planets.
In a press release, Arimatsu explains: "This is a real victory for little projects. Our team had less than 0.3% of the budget of large international projects. We didn't even have enough money to build a second dome to protect our second telescope! Yet we still managed to make a discovery that is impossible for the big projects. Now that we know our system works, we will investigate the Edgeworth-Kuiper Belt in more detail. We also have our sights set on the still undiscovered Oort Cloud out beyond that."
More detections will confirm the team's findings, and when they do, it will fill in an observational gap in our understanding of planet formation. As the team says in their paper, "If this is a true KBO detection, this implies that planetesimals before their runaway growth phase grew into kilometre-sized objects in the primordial outer Solar System and remain as a major population in the present-day Kuiper belt."

Sources:

Press Release: Missing link in planet evolution found
Research Paper: A kilometre-sized Kuiper belt object discovered by stellar occultation using amateur telescopes

Without the Impact that Formed the Moon, We Might Not Have Life on Earth

The Earth wasn't formed containing the necessary chemicals for life to begin. One well-supported theory, called the "late veneer theory", suggests that the volatile chemicals needed for life arrived long after the Earth formed, brought here by meteorites. But a new study challenges the late veneer theory.
Evidence shows that the Moon was created when a Mars-sized planet named Theia collided with the Earth. The impact created a debris ring out of which the Moon formed. Now, this new study says that same impact may have delivered the necessary chemicals for life to the young Earth.

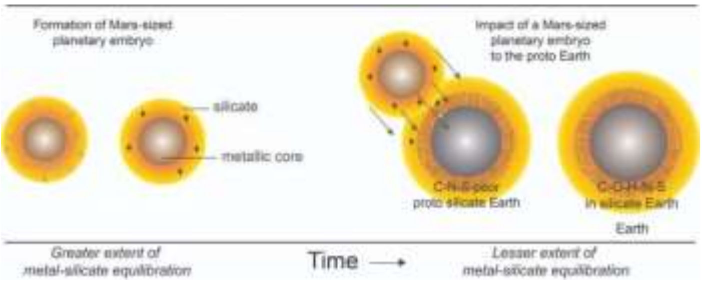
"Ours is the first scenario that can explain the timing and delivery <of volatiles> in a way that is consistent with all of the geochemical evidence."
Co-author Rajdeep Dasgupta, Department of Earth, Environmental and Planetary Sciences, Rice University.

The impact between Earth and Theia occurred about 4.4 billion years ago, very early in Earth's life. That's when the Earth most likely received most of its carbon, nitrogen, and other volatile chemicals necessary for life to exist. The new study is from Rice University and is published in the journal Science Advances.

Scientists have studied primitive meteorites from the early Earth and the other rocky planets in the inner Solar System. They've found that the ancient meteorites are depleted of volatile chemicals necessary for life. That begged the question, where did Earth's volatile chemicals come from?
"From the study of primitive meteorites, scientists have long known that Earth and other rocky planets in the inner solar system are volatile-depleted," said study co-author Rajdeep Dasgupta. "But the timing and mechanism of volatile delivery has been hotly debated. Ours is the first scenario that can explain the timing and delivery in a way that is consistent with all of the geochemical evidence."
According to the team behind the study, the impacting planet had a sulfur-rich core, while its mantle and crust contained volatiles. When it collided with the Earth, it injected the chemicals necessary for life, like nitrogen, carbon, hydrogen and sulfur, into the Earth's crust. The collision also ejected massive amounts of material into space, which coalesced into the Moon.

"What we found is that all the evidence … are consistent with a moon-forming impact involving a volatile-bearing, Mars-sized planet with a sulfur-rich core."
Damanveer Grewal, study lead author, grad student, Rice University.

The team behind this study performed experiments in a lab that mimics the high-pressure and high-temperature conditions found when a planet's core is formed. The experiments helped test their theory that says volatiles came to Earth as a result of a collision with a planet with a sulfur-rich core.
The sulfur content of the donor planet's core matters because of the puzzling array of experimental evidence about the carbon, nitrogen and sulfur that exist in all parts of the Earth other than the core. "The core doesn't interact with the rest of Earth, but everything above it, the mantle, the crust, the hydrosphere and the atmosphere, are all connected,"
study lead author and graduate student Damanveer Grewal said. "Material cycles between them."
They tested the idea with a hypothesized Earth core containing varying levels of sulfur. They wanted to know if a high-sulfur core excluded carbon, nitrogen or both. Overall, they found that the greater the sulfur content of the core, the less likely it is that it will contain volatiles. At least in Earth's case.



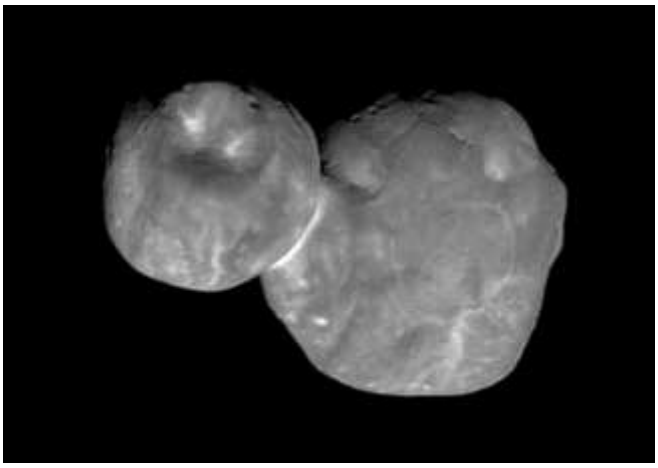
A schematic depicting the formation of a Mars-sized planet (left) and its differentiation into a body with a metallic core and an overlying silicate reservoir. The sulfur-rich core expels carbon, producing silicate with a high carbon to nitrogen ratio. The moon-forming collision of such a planet with the growing Earth (right) can explain Earth's abundance of both water and major life-essential elements like carbon, nitrogen and sulfur, as well as the geochemical similarity between Earth and the moon. (Image courtesy of Rajdeep Dasgupta)
Nitrogen was largely unaffected," Grewal said. "It remained soluble in the alloys relative to silicates, and only began to be excluded from the core under the highest sulfur concentration."
Using the results of these experiments, they ran over a billion simulations to find out how Earth could have gained its volatile chemicals. "What we found is that all the evidence — isotopic signatures, the carbon-nitrogen ratio and the overall amounts of carbon, nitrogen and sulfur in the bulk silicate Earth — are consistent with a moon-forming impact involving a volatile-bearing, Mars-sized planet with a sulfur-rich core," Grewal said.
The implications of this study are about more than just Earth. They also tell us something about how life may come to be on other rocky planets in other solar systems.
"This study suggests that a rocky, Earth-like planet gets more chances to acquire life-essential elements if it forms and grows from giant impacts with planets that have sampled different building blocks, perhaps from different parts of a protoplanetary disk," Dasgupta said.
"This removes some boundary conditions," Dasgupta said. "It shows that life-essential volatiles can arrive at the surface layers of a planet, even if they were produced on planetary bodies that underwent core formation under very different conditions."
Dasgupta said it does not appear that Earth's bulk silicate, on its own, could have attained the life-essential volatile budgets that produced our biosphere, atmosphere and hydrosphere. "That means we can broaden our search for pathways that lead to volatile elements coming together on a planet to support life as we know it."
The team's work is part of the CLEVER Planets (Cycles of Life-Essential Volatile Elements on Rocky) Planets program.
Sources:

Press Release: Planetary collision that formed the moon made life possible on Earth
Research Paper: Delivery of carbon, nitrogen, and sulfur to the silicate Earth by a giant impact
Universe Today: A Cataclysmic Collision Formed the Moon, but Killed Theia

Here it is, the high resolution photo of MU69 We've all been waiting for.

On December 31st, 2018, NASA's *New Horizons* mission made history by being the first spacecraft to rendezvous with a Kuiper Belt Object (KBO) named Ultima Thule (2014 MU69). This came roughly two and a half years after *New Horizons* became the first mission in history to conduct a flyby of Pluto. Much like the encounter with Pluto, the probe's rendezvous with Ultima Thule led to a truly stunning encounter image.

And now, thanks to a team of researchers from the John Hopkins University Applied Physics Lab (JHUAPL), this image has been enhanced to provide a more detailed and high-resolution look at Ultima Thule and its surface features. Thanks to these efforts, scientists may be able to learn more about the history of this object and how it was formed, which could tell us a great deal about the early days of the Solar System.



The original image was obtained by the wide-angle Multicolor Visible Imaging Camera (MVIC) – one of two components making up the New Horizons' Ralph telescope – on Jan. 1st, 2019, when the spacecraft was 6,700 km (4,200 mi) from Ultima Thule. The image had a resolution of 135 meters (440 feet) per pixel when it was stored and then transmitted back to Earth as part of the spacecraft's data package (on Jan. 18th – 19th).
The image was then subjected to a process known as deconvolution, where images are sharpened to enhance fine detail (which also amplifies the graininess of images when viewed at high contrast). The resulting deconvoluted image reveals new topographic details along the terminator (day/night boundary) near the top, thanks to the oblique lighting pattern.
As Alan Stern, the Principal Investigator of the *New Horizons* mission at the Southwest Research Institute (SwRI), explained in a recent JHUAPL press statement:
"This new image is starting to reveal differences in the geologic character of the two lobes of Ultima Thule, and is presenting us with new mysteries as well. Over the next month there will be better color and better resolution images that we hope will help unravel the many mysteries of Ultima Thule."
The details which are more apparent in this enhanced photo include numerous small pits that are up to about 700 meters (2300 feet) in diameter. The large feature on the smaller of the two lobes – which measures 7 km (4 mi) in diameter – also appears to be a deep depression. Both lobes also show many intriguing light and dark patterns, not to mention the bright "collar" where the two lobes are connected.
At the moment, it is unclear how these features and patterns formed, but there are several possibilities which could reveal a lot about the object's history. For instance, the deep depressions could be impact craters resulting from collisions that happened over the course of the object's 4.45 billion year lifespan. Or they could be the result of other processes, such as internal collapse or the venting of volatile materials early in its history.
Further studies of these features could reveal clues about how Ultima Thule was assembled during the formation of the Solar System, ca. 4.5 billion years ago. At present, *New Horizons* is approximately 6.64 billion km (4.13 billion mi) from Earth and moving towards the edge of the Solar System at more than 50,700 km (31,500 mi) per hour.
Barring additional extensions, the *New Horizons* mission is scheduled to run until 2021. In that time, it is hoped that the mission will be able to rendezvous with and study additional Kuiper Belt Objects (KBOs), which will reveal more about the earliest history of our Solar System.
Further Reading: JHUAPL

InSight lander completes seismometer deployment on Mars

NASA's InSight lander has placed a protective enclosure over a French-developed seismometer designed to detect tremors on Mars, completing the deployment of the first of two science instruments delivered to the Red Planet in November.
Using its nearly 8-foot-long (2.4-meter) robotic arm, InSight followed commands beamed up from Earth to cover the seismometer package with a dome-shaped wind and thermal shield Saturday.
The milestone follows weeks of leveling and cable adjustments since InSight's robot arm picked up the seismometer itself from the lander's deck and placed it on a rock-free portion of the Martian surface that was within reach of the stationary lander.
The shield will ensure winds and temperature swings do not affect the sensors inside the seismometer instrument. Without the added protection, winds could add "noise" to the instrument's measurements, making it harder to discern when it registers a quake on Mars, scientists said.
Ringed with a thermal barrier and chain mail around the bottom, the wind and thermal shield will also moderate temperatures inside the instrument. Scientists were concerned warming and cooling trends might expand and contract metal springs and other parts inside the instrument, according to NASA.
"Temperature is one of our biggest bugaboos," **said** Bruce Banerdt of NASA's Jet Propulsion Laboratory in Pasadena, California, principal investigator for the InSight mission. "Think of the shield as putting a cozy over your food on a table. It keeps SEIS from warming up too much during the day or cooling off too much at night. In general, we want to keep the temperature as steady as possible."

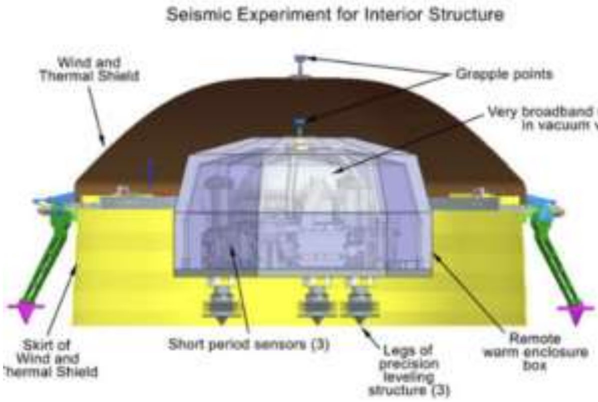


Diagram of InSight's seismometer package. Credit: NASA/JPL-Caltech
Temperatures measured by InSight since its Nov. 26 landing on Mars fluctuate by about 170 degrees Fahrenheit, or 94 degrees Celsius, over the course of a Martian day, or sol, NASA said in a statement.
InSight braked to a rocket-assisted landing at Elysium Planitia, a broad equatorial plain.
The seismometer instrument was provided by the French space agency, CNES, and its development was led by the Institut de Physique du Globe de Paris. JPL built the wind and thermal shield, and leads the overall InSight mission.
The seismometer package was designed with several layers of insulation against temperature changes on

Mars. When some parts inside expand and contract, others are designed to do so in the opposite direction to counteract the effects of the changes, according to NASA. The seismic sensors themselves are encased within a vacuum-sealed titanium sphere, which is then overlaid with a hexagonal copper container with honeycomb cells that trap air and keep it from moving.

“Mars provides an excellent gas for this insulation: Its thin atmosphere is primarily composed of carbon dioxide, which at low pressure is especially slow to conduct heat,” NASA said in a statement.

The instrument contains three sets of seismic sensors at its core, which was placed on the surface Dec. 19.

Scientists will also monitor weather conditions, including winds and temperatures, with a meteorological station carried aboard inSight. The weather information can be applied to seismic measurements to filter out data that might have been corrupted by environmental conditions.

Next up for InSight will be the deployment of the mission’s other main instrument: the Heat Flow and Physical Properties Package, or HP3.

HP3 was developed by DLR, the German space agency, and is scheduled to be transferred from InSight’s instrument deck to the Martian surface with the robot arm next week.

The heat probe consists of a mechanized mole that will dig into the Martian crust to a depth of up to 16 feet, or 5 meters, deeper than any previous Mars mission has reached. The mole is expected to take around six weeks to reach that depth with roughly 10,000 individual mechanical hammer blows, accounting for several planned pauses to allow the instrument to record thermal conductivity measurements.

The underground probe will measure the heat coming from Mars’s interior, providing information for scientists to study the planet’s internal structure.

Combining the heat probe and the seismic results — which will also tell scientists about layers inside Mars — Banerdt’s team seeks to examine how the rocky planets formed in the ancient solar system, providing a comparison for what geologists already know about Earth.

The procedures to place the instruments on the Martian surface represent a first in the exploration of Mars. While previous NASA missions have used rovers to drive around the Red Planet, none before InSight have physically placed payloads into permanent positions directly on the surface.

The seismometer and heat probe will transmit their readings back to InSight through umbilical cables. The lander will then beam the data back to Earth through communications relay orbiters flying overhead.

“I liken it to … playing that “Claw” game at a carnival, but you’re doing it with a really, really valuable prize, and you’re doing it blindfolded, where you can only take occasional pictures, and then you’re doing it via remote control on another planet,” said Elizabeth Barrett, InSight instrument operations lead at JPL, describing the carefully-choreographed procedure to move the instruments to the Martian surface.

“It takes a little bit longer,” she said. “You need take more pauses to make sure you actually have the grapple of the payload before you lift it up, and it’s actually on the ground before you let it go.”

Engineers created a mock-up of the lander, the instruments and the surrounding environment in a lab at JPL to simulate the instrument deployment procedures before executing them on Mars.

“Sensitive is really an understatement,” Banerdt said of the seismometer. “It’s an exquisitely sensitive device for measuring the motion of the ground. And when we talk about motion, we’re talking about vibrations that have an amplitude comparable to the size of an atom.

“These are waves that were generated, maybe, by a marsquake on the other side of the planet, have traveled all the way through the planet, getting their waveform modified as they go through the planet and picking up information about the deep interior structure, and then we are able to pick it up when it comes back up to the surface under the seismometer,” Banerdt said before InSight’s launch last May.

The seismic sensors aboard InSight evolved from mission concepts in the 1990s and 2000s that would have dispatched multiple small probes to Mars, creating a global geophysical network. InSight will give scientists just one seismic station, but experts have developed techniques to glean information about the interior of Mars, even with a single seismometer.

Researchers have attempted seismic detections on Mars before, but seismometers on NASA’s Viking landers in the 1970s provided inconclusive results. The instruments were mounted the decks of the landers, making them susceptible from interference from spacecraft vibrations and winds.

That’s where the wind and thermal enclosure deployed Saturday comes in.

“Not only do you have to have a very sensitive device for measuring those motions but you have to protect it from everything else that might affect it,” Banerdt said. “We have several different layers of protection, it’s sort of like a Russian doll.”

Once the instruments are deployed and operational, the InSight science mission is planned to last one Martian year, or roughly two Earth years.

FORUM FEEDBACK

One of the questions at the forum was about the celestial sphere, but until the evening I was unsure of what aspect of the celestial sphere was being needed.

The user of the telescope used positional information from a magazine and wanted to be able to translate this to a pointing position for the scope.

The celestial sphere coordinates are a way of projecting the stellar objects onto an imaginary sphere that has declination (from the north pole) running from 90degrees down to the equator) degrees and then it goes into minus numbers to the southern celestial pole (-90 º).

So a star like Vega has and latitude and longitude like we do on a map of the earth. Declination +38º48' 6.2"RA (right ascension from the 0 point in the first point of Aries) is then measured in hours (15 degree divisions) and minutes so 18h 37m 34.29s.

If we know the object is near this star we can set the telescope looking at Vega, and use protectors to offset from this position (for example M57 the ring nebula has Dec +33º03'12", RA 18h 54m 18sec). From this we can calculate M57 is 5º45'3" below Vega, and looking at the RA (remember x15 to convert degrees) 17m16sec to the right of Vega. 17m 16sec is around 0.288 of an hour, x 15 degrees or 4.3degrees. So offsetting from Vega 4.3degrees to the left and 5.57 degrees below will give you M57 near the centre of your field of view.

SETTING CIRCLES

Good setting circles on the telescope mount is a way of using the mount to find the position of an object from a known star.

Briefly:
Calibrating Your Telescope's Manual Setting Circles

- Polar align your telescope.
- Set up Dec setting circles and right ascensior
- Swing the telescope over and center a bright find the star both in the sky and on a star atl and Declination (DEC).
- Adjust your setting circles to match the RA a coordinates and names of bright stars.)

Using Your Telescope's Setting Circles

- To find a new object with your telescope, fin Nebula, M57) in a star atlas or online.
- Without touching or rotating the setting circle nates line up with the arrows on the RA and t

The object should be pretty close in the field of a WIDE angle eyepiece (low power). I usually have to spend a few minutes hunting around in a spiral pattern for it though.
Using an equatorial mount equipped with setting circles, you can "dial in" any object that you want to observe.

Detailed Explanation:
Celestial Coordinates and Manual Telescope Setting Circles
To help you better understand the celestial coordinate system and setting circles, let's walk through an example with pictures and illustrations. We'll start with an example of an alt-azimuth mount and transform it into an equatorial mount and then move on to actual pictures of manual setting circles and what they would look like when pointed at certain objects.

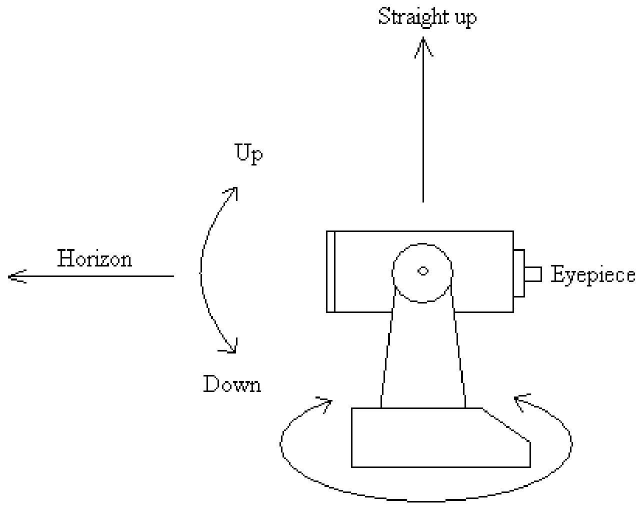


Fig. 1

An equatorial mount is not as complicated as it seems or looks. Think of the most basic type of mount, an alt-azimuth mount. This is shown in the image above, labeled Fig. 1. This particular design is a Schmidt-Cassegrain telescope (SCT) on a fork mount. We are seeing it from the side, as it points to the left. The telescope can be moved up and down, and left and right to point at objects. Imagine that the telescope is parallel to the ground, basically pointing at something on the far horizon. Mentally spin the telescope, left or right, 360 degrees. Now

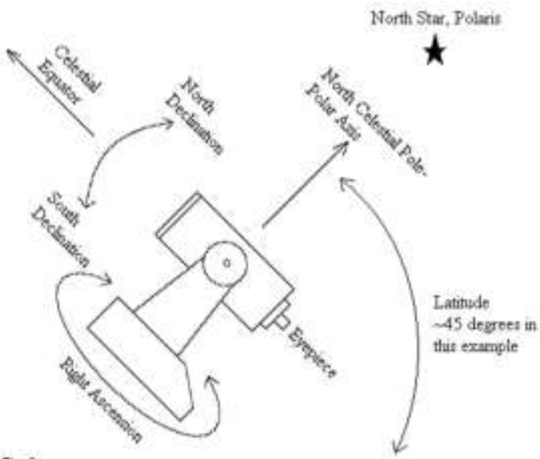


Fig. 2

should be abl
Right Ascensio
tar maps, cele

think of an axis line going from the middle of the mount, straight up into the sky. The left and right motion of the scope pivots, or rotates around this vertical axis. Got it visualized?

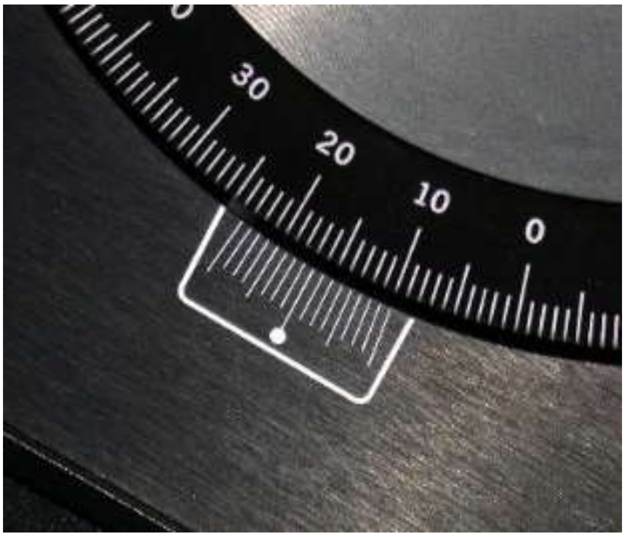
Now hold onto your hats for this next one. Imagine tilting the entire mount until the vertical rotational axis for left and right directions, is pointing at the North Star, Polaris (we would really point at the north celestial pole, but Polaris is close enough). See Fig. 2 above. This axis is now referred to as the 'polar axis' of the mount. The telescope still moves up and down, and left and right relative to its mount, but now the entire thing is tilted toward the North Star. This magically transforms the mount into an equatorial mount. Now moving the telescope "left and right" is moving it in right ascension (RA). If you move it "up and down" it is moving in declination (DEC). The mount's polar axis is aligned with the Earth's polar axis. It is now 'polar aligned'.
If the telescope was pointed at the horizon when you "tilted" it over, the scope now points to some point along the celestial equator and at zero degrees declination. The only other thing to remember is that as you move toward the east, the right ascension numbers increase (until you hit 24, in which case you're back to your starting point of zero hour again, i.e. you've done a "360", a loop). So, if an object was defined as having a Right Ascension of 2h 30m and a Declination of 15deg 10m N, you would start at the zero hour of right ascension on the celestial equator and move east until you reach the 2 hour, 30 minute mark. Then, since the declination is North (if it had been marked S or with a negative, it would be south), you move up (north) from the celestial equator until you reach the 15 degree, 10 minute mark. There you will find the object.

Now let's go through the exercise of actually locating an object using mechanical setting circles. Let's assume we have already set up our telescope and have it polar aligned. We have aligned the right ascension rotational axis, which is the polar axis, with the north celestial pole...you know, the tilt.
We first need to calibrate the setting circles. Actually, we only need to calibrate the right ascension circle because the declination dial doesn't move. To visualize this, imagine you are standing facing due south with your finger pointed at the sky at about the 15 degrees north declination mark. Imagine you stand that way all night long. You will always be pointing at 15 degrees north declination, but as the earth turns and the sky slides by, the right ascension you are pointing at will be constantly changing. If you happened to be initially pointing at 4hr 30m right ascension, two hours later you will be pointing at 6hr 30m right ascension. Unless of course you move your finger to keep it pointing at the original spot, which is exactly what the clock-drive does on your mount. Since declination does not change, the clock-drive only needs to rotate the telescope about the polar axis, in right ascension toward the west, at the speed of one complete rotation every 24 hours. This precise speed will keep an object centered in the telescope. So, you really only need to calibrate the right ascension setting circle.
The most common way of doing this is to point to a known object and rotate the right ascension setting circle dial until it matches the coordinates of this object. I keep a list of bright stars handy, along with their coordinates, for this purpose.
The bright star Sirius's coordinates are approximately 6h 45m right ascension, and -16d 43m declination. I always round the seconds off to the nearest minute. To calibrate the setting circles, we would point the telescope at Sirius then rotate the right ascension dial until it reads 6h 45m. Let's assume the telescope is now pointed at the star Sirius.

Sirius RA coordinates

This is an image of my right ascension setting circle. It has been rotated so that the pointer is pointing to the right ascension coordinates of Sirius, 6h 45m RA. On my system, this is read on the outside ring of the dial. The inside or interior numbers are used if the observer is in the southern hemisphere. If I ever get confused, I just push my scope to the east and note which set of numbers has increasing values of RA.

Sirius DEC coordinates

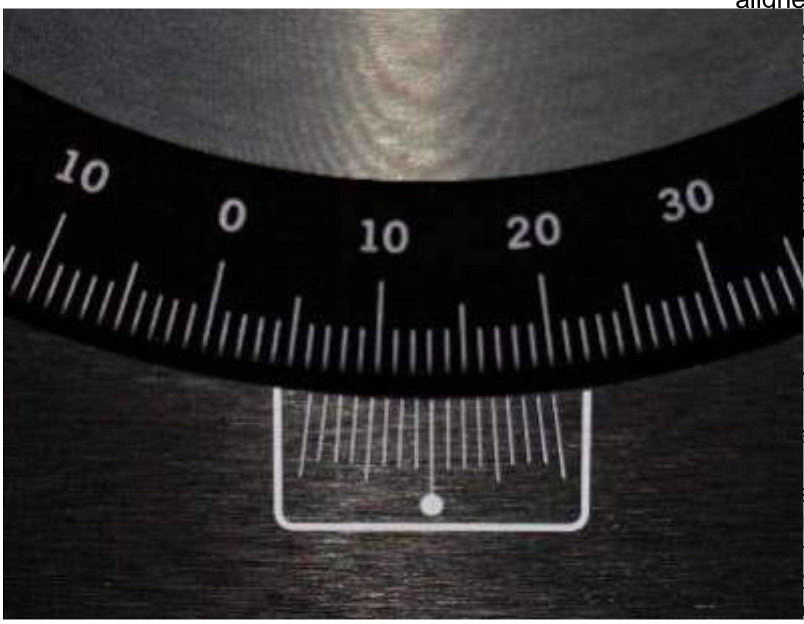


This is an image of my declination setting circle. By default, since the actual dial doesn't move, it will be pointing at the declination coordinates of Sirius, -16d 43m DEC. Notice the negative sign in Sirius' declination? That means it is ***below the celestial equator*** which is a southern declination. Visualize the constellation of Orion. Remember that the celestial equator runs through the belt. Where is Sirius? It's down and to the left of Orion, which means it has to have a southerly, or negative declination since it below the celestial equator.

Now that the setting circles (really only the right ascension circle) are calibrated, the mount can be used to find an object.

Let's imagine that we want to find the galaxy M65, located in the constellation of Leo. Using software, books, or whatever, we find that M65's coordinates are **11h 19m RA and +13deg 5m DEC**. It's now a simple matter of just moving the telescope until the pointers are pointing at these readings on the setting circles.

M65 DEC coordinates



This image shows the declination dial once the telescope has been moved so that the pointer is aligned with the declination coordinates of M65, +. Since the dial is only in 1 degree increments, I basically interpolate where the 5m point is.

If we did everything correctly, we should be able to look through the eyepiece of the telescope and see the galaxy M65. And if the telescope has a clock-drive, the galaxy should stay in the field of view as long as we want to observe it. When we want to observe another object, we just move the telescope until the pointers are pointing at the listed coordinates for the new object.

Some Considerations and Pitfalls

What if the object is not in the eyepiece when you take a look? We'll assume that given the type of telescope and the sky conditions, it should be visible. There are a number of reasons why it might not be in the eyepiece. First of all, you could have made a mistake. You might have transposed a couple of numbers, or moved north when you should have moved south. Did you calibrate on the right star? Are you sure you have the right coordinates? Are you using the correct, northern hemisphere right ascension dial? Assuming you have the right numbers, just take your time and dial in one coordinate at a time. I usually start by reading then dialing in the right ascension. Then I go back and read the declination, and dial it in.

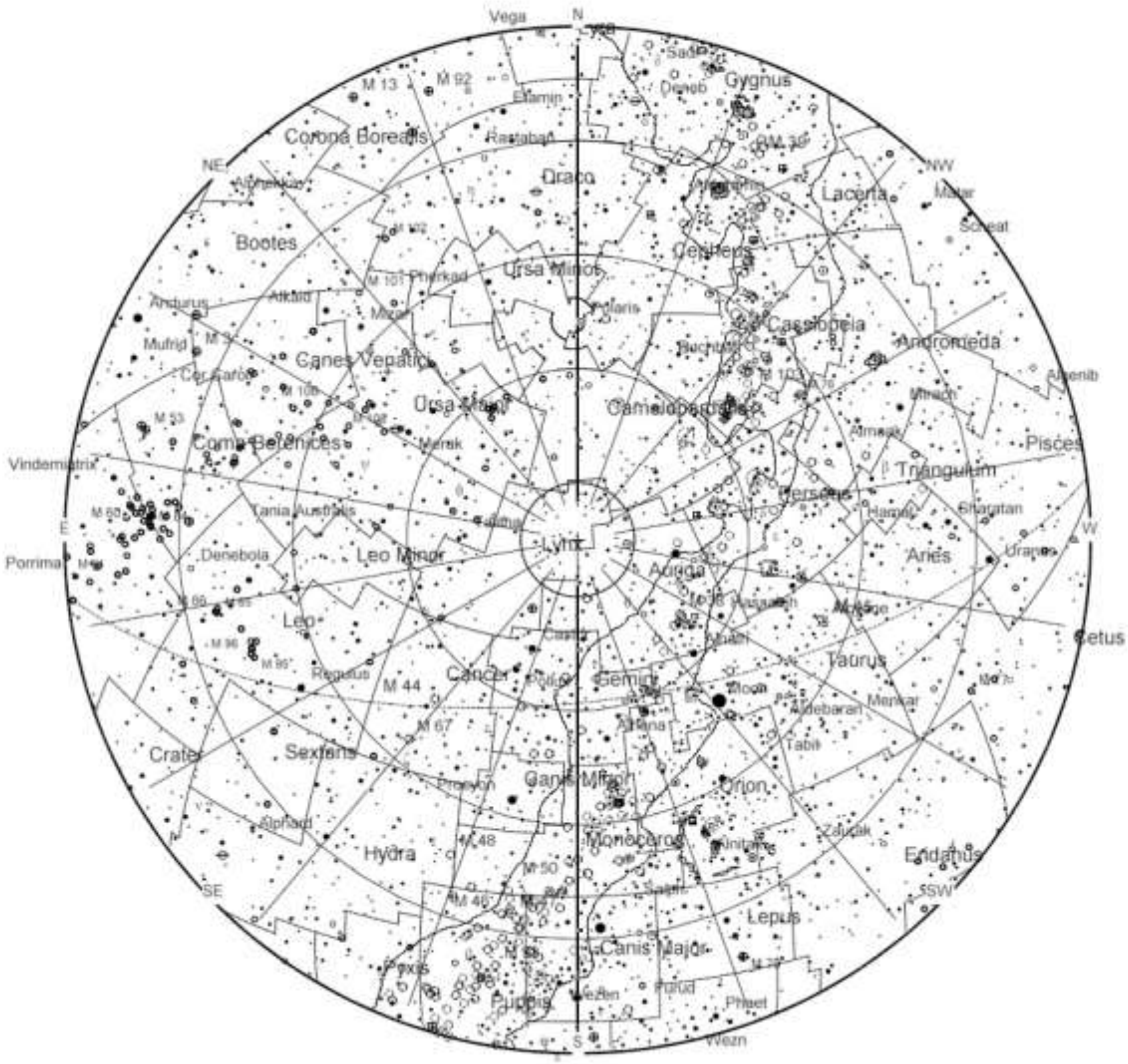
What if you have all the right numbers, and did everything by the book, but still can't see the object? Some mounts are more accurate than others. For example, my declination circle is only divided by whole degrees. That means I have to guess and estimate at where the minute markings are. This naturally introduces some error. Most of the time, if I'm careful the object is there when I take the first look. If not, it's usually within an eyepiece field of view away, so I just pan a little bit in declination, followed by right ascension. Use a low power eyepiece so that you have the widest possible field of view. And of course, if your polar alignment is way off, that will affect your accuracy as well. Also, although you shouldn't have to worry with calibrating the declination circle, sometimes it is a little off when it comes from the factory.

One way to determine if your declination circle is aligned properly is to move the telescope until it reads
grees north. In the case of my telescope, that
s the tube will be parallel with the forks. If I have
ject centered in the telescope's field of view, like a
nd spin the telescope about the polar axis (i.e. in
ovement), that object should stay in the center. If
sn't, then the telescope is not really pointing ex-
t 90 degrees. To correct this, you would move
elescope in declination until the object finally
in the middle of the field of view during a spin.
you would adjust your declination circle until it
90 degrees. This should be a one time proce-
I haven't adjusted my declination circle since I
y did it a few years ago..
if you found the fist object okay, but when you
ed to go for a second one, you missed? Assuming
iss is not because of a mistake or inadequately
ated setting circles, it could be related to the type
unt and how the clock-drive functions. If your
t does not have a clock-drive, that means that it
t track to keep the object within the telescope's
f view. You'll have to move the telescope every now and then in right ascension (toward the west) to keep the object within the field of view. For every minute that goes by after initially pointing at the object,

your right ascension circle will be a minute in error. So if you observe an object for 20 minutes, your right ascension setting circle will be off by 20 minutes. Before going on to another object, you have to recalibrate the setting circle. Just move the right ascension dial back to read the coordinates of the object you are viewing before moving to the next object. Even if you have a clock-drive on your mount, you may still have to perform this procedure. My SCT mount actually moves the right ascension dial as it moves the telescope so once I have made the initial calibration, I don't have to readjust it. Although I have noticed that sometimes during the night it will get a little off and I'll have to sync it up again. And if I just can't figure out why I can't find an object, I'll start over with pointing at a known star and making sure the right ascension setting circle is properly calibrated.

Conclusion

Some mounts have better setting circles than others. I have found the ones on my SCT to be quite accurate. But with most people buying electronic GOTO telescopes today, they don't have much use for mechanical setting circles. Those that don't have GOTO scopes seem to rely more on star hopping as a method for finding objects. But setting circles can have their place. They are generally quicker than star hopping when going to a target that isn't sufficiently surrounded by bright stars. They are also helpful in crowded areas like the galaxy clusters in Virgo and Coma Bernices, where star hopping is more confusing because of the sheer number of galaxies. Then there's the satisfaction of using them. For me, finding objects with setting circles is the most efficient use of my time when observing. What ever your reason for considering the use of setting circles and celestial coordinates, I hope this article helped in some way.

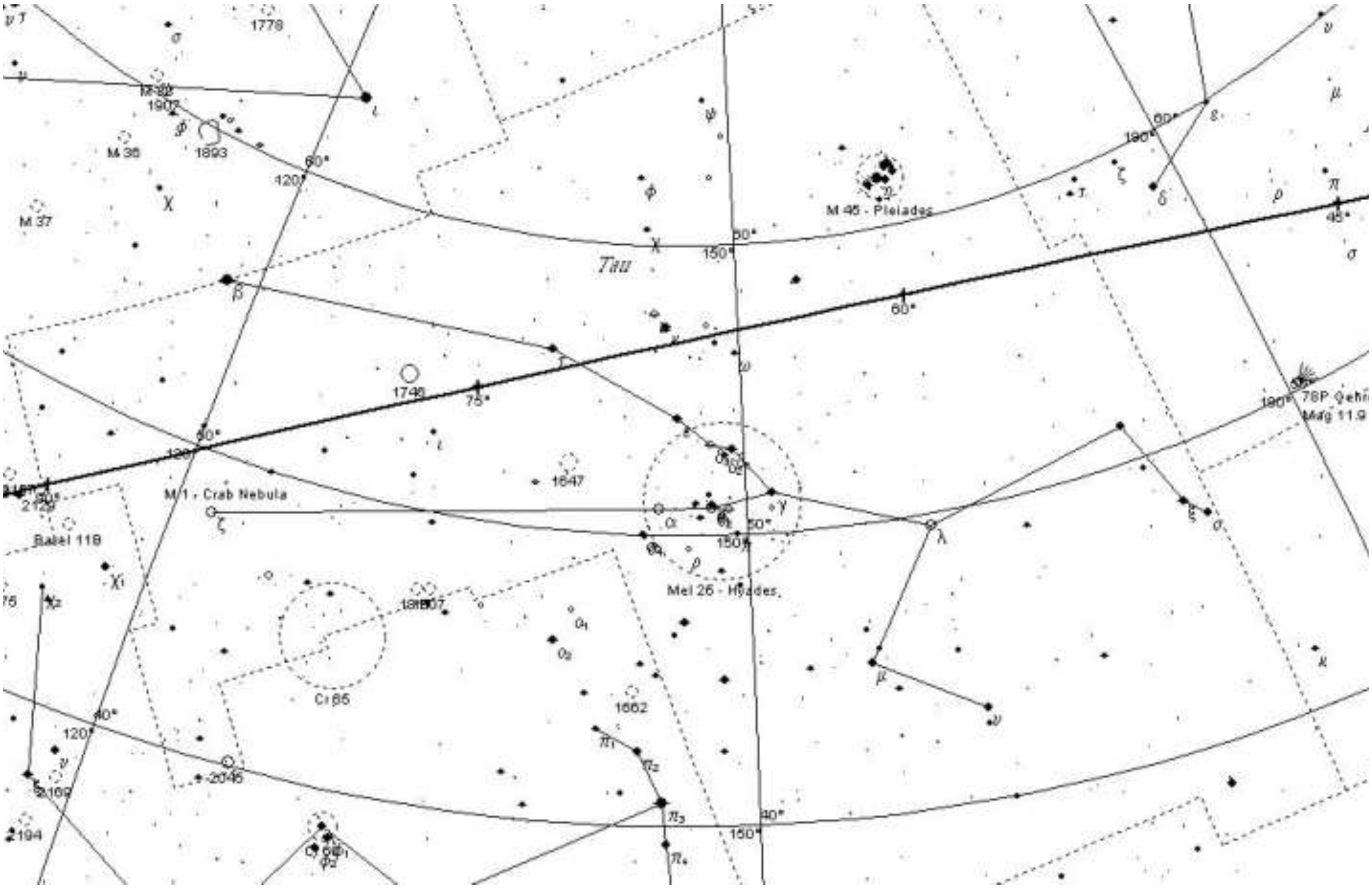


February 4 - **New Moon.** The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 21:03 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

February 19 - **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 15:53 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 second of three supermoons for 2019. The Moon will be at its closest approach to the Earth and may look slightly larger and brighter than usual.

February 27 - **Mercury at Greatest Eastern Elongation.** The planet Mercury reaches greatest eastern elongation of 18.1 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.

CONSTELLATIONS OF THE MONTH: TAURUS



The ancient zodiacal constellation of Taurus was one of Ptolemy's original 48 constellations and remains today as part of the official 88 modern constellations recognized by the IAU. It is perhaps one of the oldest constellations of all and may have even been recognized prehistorically. Taurus spreads over 797 square degrees of sky and contains 7 main stars in its asterism with 130 Bayer Flamsteed designated stars located within its confines. It is bordered by the constellations of Auriga, Perseus, Aries, Cetus, Eridanus, Orion and Gemini. Taurus is visible to all observers located at latitudes between +90Â° and ? 65Â° and is best seen at culmination during the month of January.

There is one major annual meteor shower associated with the constellation of Taurus, the annual Taurids, which peak on or about November 5 of each year and have a duration period of about 45 days. The maximum fall rate for this meteor shower is about 10 meteors per hour average, with many bright fireballs often occuring when the parent comet – Encke – has passed near perihelion. Look for the radiant, or point of origin, to be near the Pleiades.

Taurus is considered by some to be one of the oldest recognized constellations known, and may have even been depicted with the Pleiades in cave paints dating back to 13,000 BC. According to Greek myth, Taurus was the god Zeus, transformed into a bull in order to woo princess Europa, and perhaps could represent one of the Cretean Bull of Herculean fame. The ancient Egyptians also worshiped a bull-god for which this constellation might represent, just as the Arabs also considered it to be bovine by nature. The Hyades cluster was meant to represent the sisters of Hyas, a great hunter, placed in the sky to honor their mourning for the loss of their brother – just as the Pleiades represent the seven sisters of Greek mythology – as well as many other things in many other cultural beliefs. The Persians called this group of stars "Taura", just as the Arabs referred to it as "Al Thaur". No matter what way you want to look at it, this handsome collection of stars contains many fine deep sky objects to pique your interest!

Let's begin our binocular and telescope tour of Taurus with its brightest star- Alpha – the "a" symbol on our map. Known to the Arabs as Al Dabaran, or "the Follower," Alpha Tauri got its name because it appears to follow the Pleiades across the sky. In Latin it was called Stella Dominatrix, yet the Olde English knew it as Oculus Tauri, or very literally the "eye of Taurus." No matter which source of ancient astronomical lore we explore, there are references to Aldebaran.

As the 13th brightest star in the sky, it almost appears from Earth to be a member of the V-shaped Hyades star cluster, but this association is merely coincidental, since it is about twice as close to us as the cluster is. In reality, Aldebaran is on the small end as far as K5 stars go, and like many other orange giants, it could possibly be a variable. Aldebaran is also known to have five close companions, but they are faint and very difficult to observe with backyard equipment. At a distance of approximately 68 light-years, Alpha is "only" about 40 times larger than our own Sun and approximately 125 times brighter. To try to grasp such a size, think of it as being about the same size as Earth's orbit! Because of its position along the ecliptic, Aldebaran is one of the very few stars of first magnitude that can be occulted by the Moon.

Now, head off to Beta Tauri – the "B" symbol on our chart. Located 131 light years from our solar system, El Nath, or Gamma Aurigae, is a main sequence star about to evolve into a peculiar giant star – one high in manganese content, but low in calcium and magnesium. While you won't find anything else spectacular about El Nath, there is a good reason to remember its position – it, too, get frequently occulted by the Moon. Such occultations occur when the moon's ascending node is near the vernal equinox. Most occultations are visible only in parts of the Southern Hemisphere, because the star lies at the northern edge of the lunar occultation zone and occasionally it may be occulted as far north as southern California.

Now, turn your binoculars or small telescopes towards Omicron – the "o". Omicron is sometimes called Atirsagne, meaning the "Verdant One", but there's nothing green about this 212 light year distant yellow G-type giant star, only that it has a great optical companion! Be sure to take a look at Kappa Tau, too… the "k". Kappa is also a visual double star – but a whole lot more. Located 153 light years from Earth, this Hyades cluster member is dominated by white A-type subgiant star K1 and white A-type main sequence dwarf star, K2. They are 5.8 arcminutes, or at least a quarter light year apart. Between the two bright stars is a binary star made up of two 9th magnitude stars, Kappa Tauri C and Kappa Tauri D, which are 5.3 arcseconds from each other and 183 arcseconds from K1 Tau. Two more 12th magnitude companions fill out the star system, Kappa Tauri E, which is 136 arcseconds from K1 Tau, and Kappa Tauri F, 340 arcseconds away from K2 Tau. Still more? Then have a look at 37 Tauri, an orange giant star with a faint optical companion star… or 10 Tauri! 10 Tauri is only 45 light years away, and while it just slightly larger and brighter than our Sun, its almost the same age. It is believed to be a spectroscopic binary star, but you'll easily see it's optical companion. What's more, thanks to noticing a huge amount of infrared radiation being produced by 10, we know it also has a dusty debris disk surrounding it!

Now, let's have a go at variable stars – starting with Lambda, the upside down "Y" on our map. Al Thaur is in reality a binary star system as well as being an eclipsing variable star. The primary is a blue-white B-type main sequence dwarf star located about 370 light years away. However, located at a distance of 0.1 AU away from it is a white A-type subgiant star, too… and a third player even further away. Watch over a period of 3.95 days as first one, then the other passes in front of the primary star, dimming it by almost a full stellar magnitude! Don't forget to check out HU Tauri, too. It is also an eclipsing binary star that drops by a magnitude every 2.6 days!

Ready to take a look at Messier 45? Visible to the unaided eye, small binoculars and every telescope, the Pleiades bright components will resolve easily to any instrument and is simply stunning. The recognition of the Pleiades dates back to antiquity and they're known by many names in many cultures. The Greeks and Romans referred to them as the "Starry Seven," the "Net of Stars," "The Seven Virgins," "The Daughters of Pleione" and even "The Children of Atlas." The Egyptians referred to them as "The Stars of Athyr," the Germans as "Siebengestiren" (the Seven Stars), the Russians as "Baba" after Baba Yaga, the witch who flew through the skies on her fiery broom. The Japanese call them "Subaru," Norsemen saw them as packs of dogs and the Tongans as "Matarii" (the Little Eyes). American Indians viewed the Pleiades as seven maidens placed high upon a tower to protect them from the claws of giant bears, and even Tolkien immortalized the stargroup in The Hobbit as "Remmirath." The Pleiades have even been mentioned in the Bible! So, you see, no matter where we look in our "starry" history, this cluster of seven bright stars has been part of it.

The date of the Pleiades culmination (its highest point in the sky) has been celebrated through its rich history by being marked with various festivals and ancient rites â€" but there is one particular rite that really fits this occasion! What could be spookier on this date than to imagine a bunch of Druids celebrating the Pleiades' midnight "high" with Black Sabbath? This night of "unholy revelry" is still observed in the modern world as "All Hallows Eve" or more commonly as "Halloween." Although the actual date of the Pleiades' midnight culmination is now on November 21 instead of October 31. Thanks to its nebulous regions M45 looks wonderfully like a "ghost" haunting the starry skies. Binoculars give an incredible view of the entire region, revealing far more stars than are visible with the naked eye. Small telescopes at lowest power will enjoy M45's rich, icy-blue stars and fog-like nebulae. Larger telescopes and higher power reveal many pairs of double stars buried within its silver folds. No matter what you chose, the Pleiades definitely rocks!

Our next most famous Messier catalog object in Taurus is M1 – the "Crab Nebula". Although M1 was discovered by John Bevis in 1731, it became the first object on Charles Messier's astronomical list. He rediscovered M1 while searching for the expected return of Halley's Comet in late August 1758 and these "comet confusions" prompted Messier to start cataloging. It wasn't until Lord Rosse gathered enough light from M1 in the mid-1840's that the faint filamentary structure was noted (although he may not have given the Crab Nebula its name). To have a look for yourself, locate Zeta Tauri and look about a finger-width northwest. You won't see the "Crab legs" in small scopes – but there's much more to learn about this famous "supernova remnant". Factually, we know the "Crab Nebula" to be the remains of an exploded star recorded by the Chinese in 1054. We know it to be a rapid expanding cloud of gas moving outward at a rate of 1,000 km

per second, just as we understand there is a pulsar in the center. We also know it as first recorded by John Bevis in 1758, and then later cataloged as the beginning Messier object – penned by Charles himself some 27 years later to avoid confusion while searching for comets. We see it revealed beautifully in timed exposure photographs, its glory captured forever through the eye of the camera â€" but have you ever really taken the time to truly study the M1? Then you just may surprise yourselfâ€¦ In a small telescope, the "Crab Nebula" might seem to be a disappointment – but do not just glance at it and move on. There is a very strange quality to the light which reaches your eye, even though at first it may just appear as a vague, misty patch. To small aperture and well-adjusted eyes, the M1 will appear to have "living" qualities – a sense of movement in something that should be motionless. This aroused my curiosity to study and by using a 12.5″ scope, the reasons become very clear to me as the full dimensions of the M1 "came to light".

ISS PASSES For February /March2019 From Heavens Above website maintained by Chris Peat

Date	Brightness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
05 Feb	-3.7	17:43:32	10°	W	17:46:50	79°	SSW	17:50:09	10°	ESE
05 Feb	-2.1	19:20:15	10°	W	19:23:07	27°	SSW	19:23:30	27°	SSW
06 Feb	-2.6	18:28:45	10°	W	18:31:52	39°	SSW	18:34:35	13°	SE
07 Feb	-3.1	17:37:18	10°	W	17:40:33	55°	SSW	17:43:48	10°	ESE
07 Feb	-1.0	19:14:33	10°	WSW	19:16:35	15°	SW	19:18:34	10°	S
08 Feb	-1.5	18:22:43	10°	W	18:25:24	23°	SW	18:28:05	10°	SSE
10 Feb	-0.7	18:17:15	10°	WSW	18:18:45	13°	SW	18:20:15	10°	SSW
24 Feb	-1.2	06:16:11	10°	S	06:18:34	19°	SE	06:20:58	10°	E
25 Feb	-0.9	05:25:49	10°	SSE	05:27:13	12°	SE	05:28:37	10°	ESE
26 Feb	-2.2	06:08:39	10°	SW	06:11:37	33°	SSE	06:14:36	10°	E
27 Feb	-1.7	05:18:04	13°	SSW	05:20:09	22°	SE	05:22:46	10°	E
28 Feb	-1.2	04:28:42	15°	SE	04:28:43	15°	SE	04:30:40	10°	ESE
28 Feb	-3.2	06:01:31	10°	WSW	06:04:44	54°	SSE	06:07:56	10°	E
01 Mar	-2.8	05:11:56	27°	SSW	05:13:09	38°	SSE	05:16:14	10°	E
02 Mar	-1.8	04:22:22	24°	SE	04:22:22	24°	SE	04:24:26	10°	E
02 Mar	-3.8	05:55:04	14°	WSW	05:57:52	78°	SSE	06:01:09	10°	E
03 Mar	-3.6	05:05:26	44°	SW	05:06:13	61°	SSE	05:09:28	10°	E
04 Mar	-2.0	04:15:44	30°	ESE	04:15:44	30°	ESE	04:17:44	10°	E
04 Mar	-3.8	05:48:26	15°	W	05:51:00	87°	N	05:54:18	10°	E
05 Mar	-3.9	04:58:42	56°	WSW	04:59:17	84°	S	05:02:35	10°	E
06 Mar	-2.1	04:08:56	32°	E	04:08:56	32°	E	04:10:52	10°	E
06 Mar	-3.8	05:41:37	16°	W	05:44:08	86°	N	05:47:25	10°	E
07 Mar	-3.9	04:51:50	60°	W	04:52:22	85°	N	04:55:40	10°	E
08 Mar	-2.0	04:02:03	31°	E	04:02:03	31°	E	04:03:54	10°	E
08 Mar	-3.9	05:34:44	17°	W	05:37:10	80°	SSW	05:40:27	10°	ESE
09 Mar	-3.9	04:44:57	64°	W	04:45:25	88°	N	04:48:42	10°	E
10 Mar	-1.9	03:55:11	29°	E	03:55:11	29°	E	03:56:55	10°	E
10 Mar	-3.6	05:27:53	18°	W	05:30:06	56°	SSW	05:33:20	10°	ESE
11 Mar	-4.0	04:38:09	70°	SW	04:38:22	74°	SSW	04:41:39	10°	ESE
12 Mar	-1.6	03:48:28	23°	E	03:48:28	23°	E	03:49:52	10°	E
12 Mar	-3.0	05:21:10	20°	W	05:22:55	34°	SSW	05:25:56	10°	SE
13 Mar	-3.4	04:31:34	47°	S	04:31:34	47°	S	04:34:24	10°	SE
14 Mar	-1.1	03:42:03	15°	ESE	03:42:03	15°	ESE	03:42:43	10°	ESE
14 Mar	-2.3	05:14:45	18°	WSW	05:15:34	20°	SW	05:18:03	10°	SSE
15 Mar	-2.0	04:25:23	20°	SSE	04:25:23	20°	SSE	04:26:50	10°	SSE
16 Mar	-1.4	05:08:54	10°	SSW	05:08:54	10°	SSW	05:08:58	10°	SSW

END IMAGES, OBSERVING AND OUTREACH

The Lunar Eclipse of the 21st January. It was due to be poor weather, but it actually cleared in the late evening and hopes were high. I was very ill at the time, so awake most of the night. Set up to image the eclipse from the umbral shadow (darkening across the Moon), and shooting every four minutes from then. But the weather decided to close in with just over half the Moon in shadow.

I have stacked images from the series but it was never going to be brilliant.

D810a Nikon DSLR on Televue 127 refractor, mounted on the Avalon mount in my dome.

Andy Burns

Wiltshire Astronomical Society	**Observing Sessions 2018 – 2019**	
Date	**Moon Phase (%)**	**Moonrise**
2019		
22nd February	Waning Gibbous (84%)	9.31 pm
29th March	Waning Crescent (32%)	After midnight
26th April	Waning Gibbous (58%)	After midnight
24th May	Waning gibbous (75%)	After midnight

OUTREACH

To be arranged Great Wishford School, nr Wilton. Viewing evening

Kings Lodge Year 1/2s Moon talk and viewing from 7pm To be re arranged due to heating problem

February 28th Westbury Leigh Primary School, afternoon talk and viewing evening. Volunteers needed from 5:30pm

July 4th-5th Nibley Music Festival