NWASNEWS

Volume24, Issue 1

September 2018

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

Patches of Sky

I hope you all had a good warm and productive summer viewing the night skies from wherever you may have holidayed. Sometimes just the warmth of the evening can cause you to stand outside just a little longer. Perhaps the (sandstorm swept) Mars at close opposition pulled you outside, or was it the clouded out lunar eclipse. The lure of catching the summer meteor showers (Kappa Capricornids or the Perseids) could have been that pull.

Early June and July the Space Station, maybe Noctilucent clouds kept you up.

What ever it was the background views of the summer Milky Way would have eventually caught your eye. Maybe not the red clouds of emission gases that festoon the Milky Way band (you would need to be photographing the sky to see these in normal telescopes/binoculars/naked eyes), but the bright cloud like appearance of the stars in the galactic plain of our own galaxy, the Milky Way.

As it gets darker keep looking (end of June it sometimes never gets dark enough from high latitudes-I should know, I was blown of the Isle of Skye by a sudden hurricane). The darkness reveals large black patches within the starry glow of the Milky Way. These can be huge, stretching over 25 degrees through the plane (Cygnus Rift), sometimes smaller black patches in binoculars giving 'relief' to the background stars.

What are these dark areas? Are the confined to the Milky Way? I hope to explore these evening with my talk. Andrew Loundes was unfortunately indisposed but will be coming back soon.

Something that has been exercising the minds of some of our committee has been how much we needed to do to comply with regulations around data held on behalf of you the members. We are in a funny legal position as a Society, but it has many advantages (especially with public liability insurance and accountancy auditing demands). It also means the GDPR requirements or NOT targeted at a group like ours, but we have to make you aware of the situation.

The treasurer, who also acts as membership recording holds details provided by members, address, phone number and email where provided. He also records annual membership payment and weekly attendance (fire regs mean we have to sign in). But these records are kept separate to any other use/computer. To become a member you are tacitly permitting this data to be held. No bank or other sensitive data is recorded.

To contact you and others who are 'associated' with the society we use two email lists, kept separately and they do not even have full names, just the email name. But we ask you to affirm agreement to be on these lists.

Clear Skies Andy

Images of Mars was at opposition. A panorama of Mars with Saturn and Antares taken at Braydon Pond. The red planet and a red star both glowing in the sky. The panorama is a composite of three images stitched with Microsoft ICE.
John Dartnell

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

.4 Sep Andy Burns: Cataloguing the Heavens. Part 1: The stuff we don't see, the Dark Nebulae
2 Oct Mary McIntyre: Creating Stunning Star Trails.
6 Nov Pete Williamson: The Sun & How it Works.
4 Dec Dr Elizabeth Pearson: A very brief History of Rovers & Landers.
2019
15 Jan Open Forum/Beginners Meet.
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.

After being bought the book 'Astronomy' by Patrick Moore in 1961, when I was around 8, astronomy was something that always fascinating. When I was 13, a neighbour brought home a small and basic (by modern standards) refractor and showed us the rings of Saturn, my first look through a telescope. What a turn on to astronomy this was.

Education, work and family commitments put paid to any more than armchair astronomy until I bought my first telescope 6" TAL2 in 1992. Things then galloped along. Mirror grinding (I'm glad telescopes are now cheap enough to buy!), eclipse chasing – 6 for 6 seen so far lead to a regular slot on local BBC radio, and 14 years of weekly broadcasts followed. Both recent transits of Venus covered, the last from Venus point in Tahiti 2012.

I joined the fledgling Wiltshire AS in 1992, became Vice Chair and now Chair 2006 to 2018 then vice chair. Edit 24pp newsletter each month. (Now in the 24th year).

Distance learning university courses (a Central Lancashire and University of Glamorgan) to strengthen my background knowledge lead to annual imaging trips for University of Glamorgan students to Portugal. This led to an opportunity to transfer to Spain and set up, equip and Co-direct of the Griffon Educational Observatory in Andalucia.

In 2005 I sold my business and retired to spend more time doing astronomy, and had my arm pulled off to join the Herschel Museum in Bath, where I was a financer, committee member and education astronomer. The privilege of working in such a historical environment rubbed off, and access to books and papers has helped the background knowledge on this amazing family. I now give talks on the Herschels world wide – USA 2008 (to the Astronomical League of America congress) and the Johannesburg and Cape Town observatories 2009, and an invite to the astronomy league of America in 2017. And many other topics, particularly related to managing expectations for budding astronomers of all levels.

Was privileged to be given the Sky at Night Achievement in Amateur Astronomy Award in 2010 for 'outstanding contributions to advancement and promotion of astronomy'.

Worked with the STFC in promoting astronomy in schools, and established background enrichment programmes within schools prior to them taking on GCSE astronomy, and outreach to primary schools and many other groups. Lots of time working with Dark Sky Wales.

Currently working with a film director on 'Darkness, hence tonight's talk.

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)

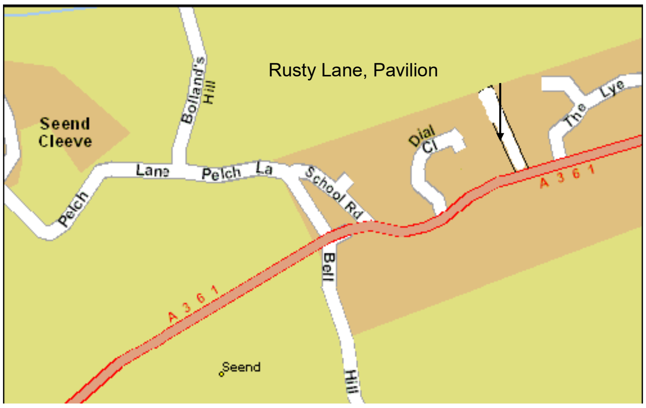
Philip Proven (Hall coordinator) Dave Buckle (Teas)

Peter Chappell (Speaker secretary)

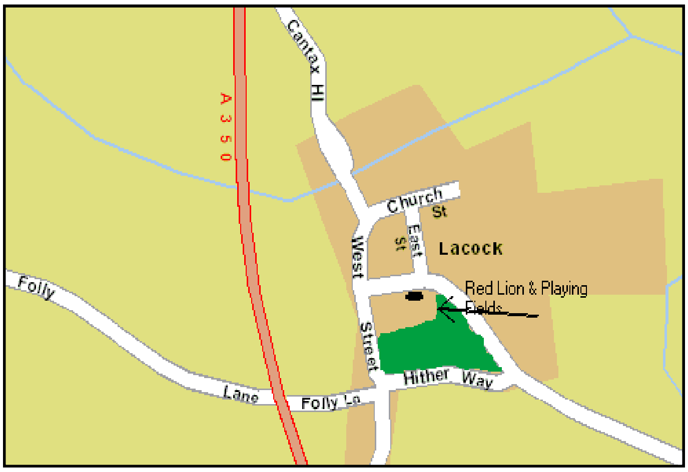
Nick Howes (Technical Guru)

Observing Sessions coordinators: Jon Gale, Tony Vale

Contact via the web site details. This is to protect individuals from unsolicited mailings.



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

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.

Pete, our chairman, recovering well

Our chairman, Peter Struve who had suffered another stroke, is now recovering quite well and attended our last club meeting.

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 2018

Friday 21 September 2018
Programme: Dr. Chris Pearson: Galaxy Formation and Evolution

Friday 19 October 2018
Programme: Dr. Michael McEllin - Radio Telescopes: How they work and what they can do

Friday 16 November 2018
Programme: Dr. Rhodri Evans - Astronomy from a Boeing 747

Friday 21 December 2018
Programme: Christmas Social

Meeting Dates for 2019

Friday 18 January 2019
Programme: TBA

Friday 15 February 2019
Programme: TBA

Friday 15 March 2019
Programme: AGM plus talk

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.com
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

Steve Hill-----------Chairman- 01761 435663

John Ball-----------Vice Chairman- 01373 830419

………….john@abbeylands1.freeserve.co.uk

Sandy Whitton---- Secretary-07974-841239

…………………..sandy.whitton@blueyonder.co.uk

Jacky Collenette---Treasurer… collenettejacqueline@yahoo.co.uk

Mike Witt---------- Membership-……… mjwitt@blueyonder.co.uk.

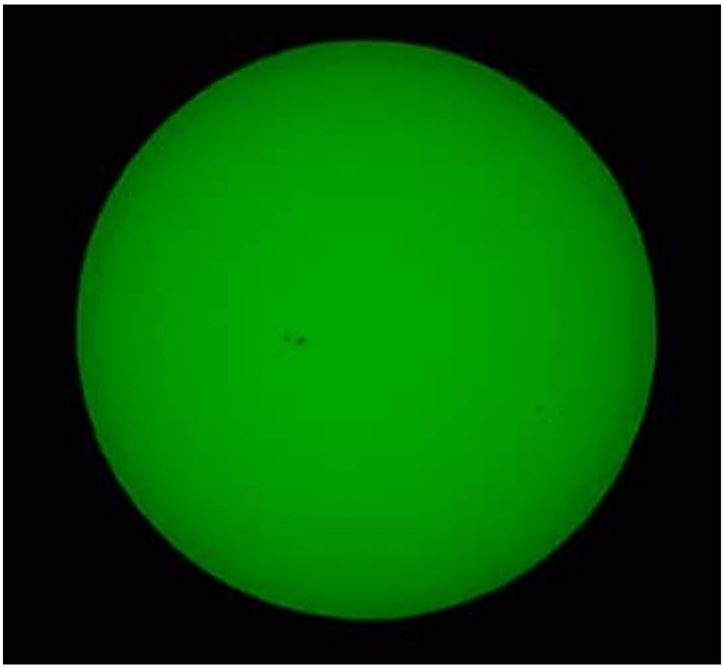
John Dolton------ Committee…. member@jdolton.freeserve.co.uk

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.



The Sun this summer was very quiet, the sunspots across the centre here imaged in June, using a Herschel Wedge on a small refractor.

Andy Burns.

SEPTEMBER COMET

Every season, there are something like a dozen comets visible throughout the night. Most are faint, usually around magnitude 11–13, and require larger amateur instruments to see.

This time around, we have a wonderful exception — 21P/Giacobini-Zinner.

With an orbital period of 6.6 years, it's a regular visitor to our planet's night skies. G-Z's making a favorable approach at this apparition, passing just 58.6 million kilometers over the tops of our heads on September 10–11, the same date it reaches perihelion. That's just a few million kilometers shy of Mars's close brush with Earth this past July.

Fortuitously, 21P/G-Z is passing through the winter Milky Way and will make scenic pit stops near several bright, well-known star clusters. Watch for it to pass close to M37 on the night of September 9th and directly across M35 in Gemini on the morning of September 15th for the Americas.

The M35 crossing will be amazing to watch for several reasons. The comet enters the outskirts of the cluster around 7:30 UT (2:30 a.m. CDT) and exits about 11:30 UT (6:30 a.m.). Traveling at an apparent speed of 4.4′ per hour, anyone with a small telescope can watch it slowly slide across this famous Messier object as the wee hours tick by. With 120 stars brighter than magnitude 13 it's quite possible that 21P/G-Z's false nucleus — the bright condensation near the coma's center — will occult one or more of them along the way. The binocular view should be unique with the rich cluster appearing to sprout a tail!

A Trip Through the Milky Way

By Jane Houston Jones and Jessica Stoller-Conrad

Feeling like you missed out on planning a last vacation of summer? Don't worry—you can still take a late summertime road trip along the Milky Way!

The waning days of summer are upon us, and that means the Sun is setting earlier now. These earlier sunsets reveal a starry sky bisected by the Milky Way. Want to see this view of our home galaxy? Head out to your favorite dark sky getaway or to the darkest city park or urban open space you can find.

While you're out there waiting for a peek at the Milky Way, you'll also have a great view of the planets in our solar system. Keep an eye out right after sunset and you can catch a look at Venus. If you have binoculars or a telescope, you'll see Venus's phase change dramatically during September—from nearly half phase to a larger, thinner crescent.

Jupiter, Saturn and reddish Mars are next in the sky, as they continue their brilliant appearances this month. To see them, look southwest after sunset. If you're in a dark sky and you look above and below Saturn, you can't miss the summer Milky Way spanning the sky from southwest to northeast.

You can also use the summer constellations to help you trace a path across the Milky Way. For example, there's Sagittarius, where stars and some brighter clumps appear as steam from a teapot. Then there is Aquila, where the Eagle's bright Star Altair combined with Cygnus's Deneb and Lyra's Vega mark what's called the "summer triangle." The familiar W-shaped constellation Cassiopeia completes the constellation trail through the summer Milky Way. Binoculars will reveal double stars, clusters and nebulae all along the Milky Way.

Between Sept. 12 and 20, watch the Moon pass from near Venus, above Jupiter, to the left of Saturn and finally above Mars!

This month, both Neptune and brighter Uranus can also be spotted with some help from a telescope. To see them, look in the southeastern sky at 1 a.m. or later. If you stay awake, you can also find Mercury just above Earth's eastern horizon shortly before sunrise. Use the Moon as a guide on Sept. 7 and 8.

Although there are no major meteor showers in September, cometary dust appears in another late summer sight, the morning zodiacal light. Zodiacal light looks like a cone of soft light in the night sky. It is produced when sunlight is scattered by dust in our solar system. Try looking for it in the east right before sunrise on the moonless mornings of Sept. 8 through Sept 23.

You can catch up on all of NASA's current—and future—missions at www.nasa.gov

Caption: This illustration shows how the summer constellations trace a path across the Milky Way. To get the best views, head out to the darkest sky you can find. Credit: NASA/JPL-Caltech

MEMBERS VIEWING LOGS and IMAGES

Viewing Log for 4th of August

I got an e mail alert from a member of the Salisbury Plain Observing Group (SPOG) about a planned viewing session at Casterley Camp on the edge of the Plain not far from the village of Upavon. That day I was coming back from a weekend on the Gower Peninsula and might not be back in time, all subject to traffic as on the way down it took us over three hours to do a two hour trip! As it was the trip back was non eventful and we got back in plenty of time for me to have some food, get the astronomy equipment in the car and be at the viewing site by 21:15. As it was, I was the first to arrive followed by the other two about 20 minutes later.

This was my first viewing session since mid-April, would I remember how to set up my equipment or not? As usual I was using my eight inch (203 mm) Meade GOTO LX 90 telescope with the 10 mm Pentax XW attached, giving me about 143 times magnification. As darkness fell I could make out four planets on show starting with Venus in the west followed by Jupiter in the south and Saturn and Mars rising in the south east. First target had to be Venus as it was now below 10 ° from the horizon, Casterley Camp gives you good all round views, and if the wind is blowing it can get quite cold as there is little protection from the wind? I could make out about a half phase for Venus and nothing else, well too low for any viewing really? Next target and Jupiter was about 25 ° up, so should get to see something with the king of the planets? Europa was out to the west of the planet and Io, Ganymede and Callisto on the other side, Great Red Spot was not on view so I did not stop long on this planet. Third planet to view was Saturn with the rings well open at the moment could not make out the Cassini gap (major gap in the ring system) but found Titan very easy. Final target was Mars shining very brightly in the sky, only the Sun, Moon and Venus were brighter in the sky at that time! Unfortunately there was a dust storm covering the whole planet so I could not make out any detail at all, even using various filters? Another Peter had a six inch Starwave refractor with him that night as was trying to locate comet P21/Giacobini-Zinner which he finally found, with it around mag 8 it was very easy to overlook and miss it completely? As I write this log it is currently mag 7.8 and sits between the constellations of Auriga and Perseus, it might even become a naked eye visible comet during September?

Now I had done the Solar System, it was time to have a look around the sky, first target was Messier (M) 82 in Ursa Major, just wanted to make sure my telescope was slewing to targets I selected as Venus and Mars was slightly out of the eye piece but well in the finder scope. M 82 was in my view but not dead centre but that would be okay. Currently I am trying to finish the Caldwell (C) list from the UK, I think you can see about 68 objects out of the 110 objects on this list? First target was C 35 in Coma Berenices, this Elliptical Galaxy was no more than a faint fuzzy blob (FFB) to look at, the sky in that direction was not totally dark, so might give a better view later on? C 45 was an even harder target to locate, this Spiral Galaxy (my least favourite deep sky object to look at!) in Bootes was only found using adverted vision? C 57, a Barred Irregular Galaxy (bit of a mouthful!) in Sagittarius was a FFB to look at. Best surprise was the last object I looked at in C 68; this Reflection/Emission Nebula was quite bright to view even with a Dec of – 36.57 °, about 2 ° above the horizon? I could see the horizon thru my finder scope so I knew the object would not stay long above the horizon? That was all of the objects I viewed tonight, I was also trying out a new lens which I had recently purchased, a 10 – 22 mm Canon lens. This I attached to my Canon 60Da camera which is mainly for taking pictures of the night sky as the IR filter has been removed, this helps anything in the red zone. I have attached a picture I took that night.

With the Moon due up not long after mid night I called it a day as I still had a 45 minutes trip back to Swindon and unload all of my gear. Normally I have leave all of the used equipment out overnight in the lounge so any dew on the equipment can dry off. This night there was no dew at all, even on the cars so that was one job I would not have to do J. So at 00:20, I said good bye to the Peter and Patrick and went home, got back 10 minutes quicker than the trip down to CC.

Clear skies for the coming season.

Peter

Viewing Log for 7th of August

Had not done a viewing session in nearly four month and now I was doing another only three days after my Casterley Camp session J.

This time I was meeting up with Jon Gale at my usual site of Uffcott not far off the A 4361, south of Swindon. As usual, I was using my Meade LX90 GOTO telescope but this time using the 14 mm Pentax XW eye piece. I had all of my equipment set up and ready by 21:48, not long after this Jon turned up, he was using a five inch refractor on a manual EQ 4 mount? With cloud in the sky we would not be able to see anything we wished, so it was a case of any clear patches we would have a go and see what we could pick out. My first target was Jupiter but this time I could not make out any Moons, thin cloud had blocked the light out from them? Off to Saturn, this was fine to look at, rings well on display and the large moon Titan going around this planet also could be made out. Overhead now and a look at Messier (M) 57, the Ring Nebula, it has been a while since I looked at this Planetary Nebula? Off to Sadr (the central star in the Cygnus cross) and nearby is M 29, a nice Open Cluster which is easy to make out. Jon suggested the Veil Nebula at the lower wing of the Swan, with my telescope I could not make out any part of this object; I was probably looking thru it, too high magnification? Could be seen easy with Jon's equipment. Time for another Planetary and the best in M 27, the Dumbbell Nebula in Vulpecula. Another of Jon's suggestion was NGC 6934, a Globular Cluster in Delphinus; this is a constellation that I very rarely look at! Final object as by now the cloud cover was getting to 100 % was also in Delphinus and NGC 6905, the Blue Flash Nebula, this is also a Planetary Nebula but could not make anything out AND not blue? Maybe on a clear night I might see some blue or is that just hoping?

We stayed around for another 20 minutes but the sky was not playing so we went to white light and packed up the equipment, it was 23:21! During that time we had a good chat about various things which did not include astronomy at times.

Hopefully next session the skies will behave?

Peter

Hi Andy,

Sent you some bits for mag but it bounced back, too big a file? So I am sending again but smaller this time.

In picture (IMG 4783) are two bright meteor trails plus four fainter ones, not sure if they will show up that well? Also Mars lower left and Saturn lower centre sitting in the Milky Way plus a few Messier objects.

Tech details: Canon 60 Da DSLR camera attached to 10 – 22 mm Canon lens set at 17 mm, shutter speed of 15 seconds, an ISO of 5000 and aperture of 5.6, lens focused manually by me.

Other pictures and tech details to follow.

Peter

Second picture (IMG 4773) shows Milky Way with Jupiter lower right, Saturn in the middle and Mars lower left, the Coathanger can just be seen top of the picture about a third of the way from left edge.

Tech details: same as before but shutter speed of 25 seconds and lens set at 10 mm.
Third picture (IMG4820) was taken at WAS Perseid meteor watch at Lacock, tech details as before but ISO set at 2500.

Hi Andy,

Here are my submissions for the September WAS Newsletter.

After front cover… second shot, showing Mars was bright enough to create reflection in the lake.

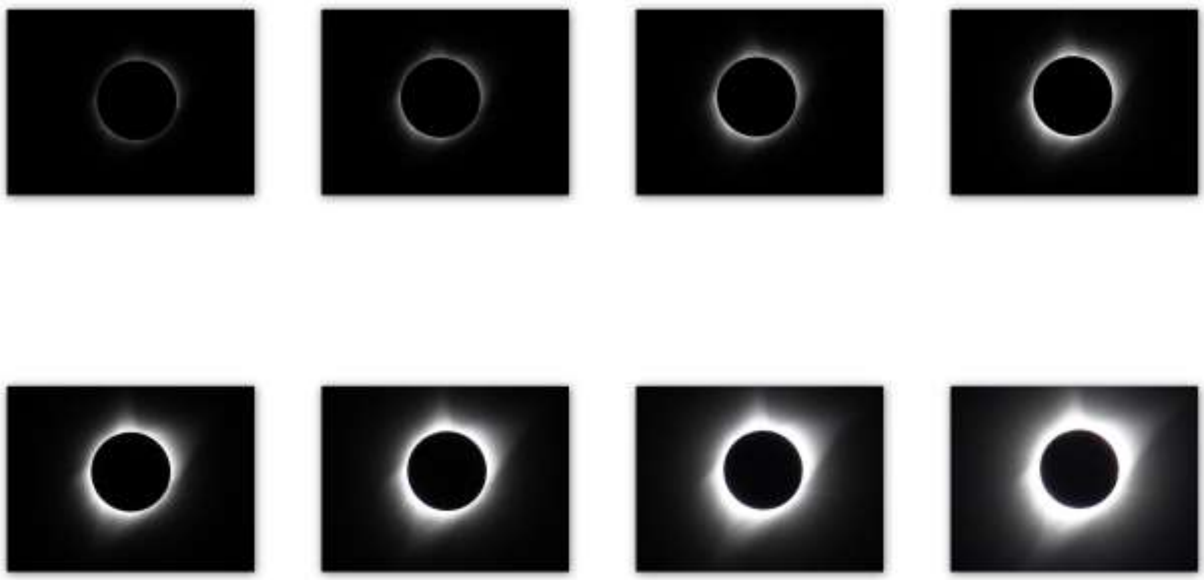
Camera and settings - Canon G16, 28mm, Star Mode, F1.8, ISO 800, 15 sec.

Also, I am following the series of articles in Astronomy Now by Nik Szymanek on solar image processing to combine my Total Solar Eclipse images from the USA on 21st August 2017. As I don't have Photoshop I have been translating the process steps to GIMP 2.10 actions. As ever, the process in the article seems quite straightforward. However, in practice, it is anything but!

So far I have combined the eight images attached and have prominence's with the corona out to a Solar diameter . The images were taken with a Canon SX50HS at 1200mm equivalent focal at F8, ISO 100 with a range in exposures of 1/500 to 1/4 sec. All controlled by a CHDK script running in the camera. This image is the best so far but I am still working on understanding the process.

TSE Wyoming

8 images, August 2017



Clear Skies,

John Dartnell

SPACE NEWS FOR JUNE

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

TELESCOPE PIERCES INTO ONE OF THE BIGGEST NEBULAE IN THE MILKY WAY TO REVEAL ITS NEWLY FORMING (AND NEARLY DYING) STARS

Article written: 31 Aug , 2018

by Matt Williams

Located about 7500 light-years from Earth, in the constellation of Carina, lies a star-forming region known as the Carina Nebula. This dynamic, evolving cloud of interstellar gas and dust measures about 300 light-years in diameter and is one of the Milky Way's largest star-forming regions. It is also an exercise in contrasts, consisting of bright regions of gas illuminated by intense stellar radiation and dark pillars of dust that obscure star formation.

While thousands of pictures have been taken of this scenic nebula, scientists have often wondered what is taking place within the darker regions of this stellar nursery. Thanks to the Visible and Infrared Survey Telescope for Astronomy (VISTA) at the Paranal Observatory in Chile, a team of astronomers was recently able to take detailed images of the nebula that pierced the dark veil of dust and showed what was taking place inside.

Thanks to its large mirror, wide field of view, and extremely sensitive detectors, VISTA is the world's largest infrared telescope and is allowing astronomers to study objects in our Universe that would not otherwise be visible. Using the VISTA telescope, astronomers at the European Southern Observatory (ESO) were able to learn things about the Carina Nebula that would not be possible using conventional (visible light) instruments.

This allowed the team to peer through the patches of hot, bright gas and obscuring dark dust that make up the nebula to see both newborn stars and those that were nearing the end of their life-cycle. Thanks to the images captured by VISTA, the team was also able to see a number of newly-formed stars that appeared to be locked in a battle with their obscuring dust clouds.

These dust clouds are the very stellar nurseries from which the new stars formed. Once formed, these new stars produce high-energy radiation and stellar winds that evaporate and disperse the dust clouds, making the nebula's new stars more visible. Eta Carinae, a massive binary system that is the most energetic star system in this region, was also captured in the image.

It appears amidst the bright cluster that sits above the dark V-shape formed by dust clouds (at the center/upper-right area of the image). Directly to the right is the Keyhole Nebula – a small, dense cloud of cold molecules and gas that hosts several massive stars. Much like Eta Carinae, these massive stars have changed dramatically in terms of their luminosity and appearance over time.

In 1837, Eta Carinae erupted dramatically and became the brightest object in the night sky. According to recent research, this was the result of a third stellar companion being consumed, causing a massive release of energy and the formation of a binary system. Since then, the system has faded considerably as it draws closer to the end of its life-cycle, though it remains one of the most massive and luminous star systems in the Milky Way Galaxy.

This is just one of many revealing images taken in recent years by VISTA of the Carina. Back in 2014, the telescope was able to pinpoint the location of five million individual sources of infrared light in the nebula, which corresponded to the locations of new stars. Like the most recent survey, the images that resulted revealed the extent of the Carina Nebula's vast stellar breeding ground.

Thanks to next-generation instruments and telescopes, astronomers are able to see more of our Universe than every before. And these views are providing insight into how stars and galaxies form and evolve, and how the large-scale structure of the Universe came to be. In time, our instruments may reach the point where they are able to study the most obscure corners of the cosmos, which will have dramatic implications for cosmological theories.

And be sure to enjoy this ESOcast video about the Carina Nebula, courtesy of the European Southern Observatory:

ANOTHER JUNO FLYBY, ANOTHER AMAZING SEQUENCE OF IMAGES OF JUPITER

Article written: 30 Aug , 2018
Updated: 30 Aug , 2018

by Matt Williams

In July of 2016, the *Juno* spacecraft established orbit around Jupiter, becoming the first spacecraft since the *Galileo* probe to study the planet directly. Since that time, the probe has been sending back vital information about Jupiter's atmosphere, magnetic field and weather patterns. With every passing orbit – known as perijoves, which take place every 53 days – the probe has revealed more exciting things about this gas giant.

In addition, each perijove has been an opportunity for *Juno* to snap pictures with its JunoCam. With the help of the public, these pictures have been processed and turned into stunning color-enhanced images. The latest image to be released, which was processed by citizen scientists Gerald Eichstädt and Seán Doran, provides a beautiful time-lapse sequence of atmospheric features in Jupiter's northern hemisphere.

The atmospheric features highlighted in this image (from left to right) include the N5-AWO, the Little Red Spot, and the

North North Temperate Band. Credit: NASA/JPL-Caltech/ SwRI/MSSS/Gerald Eichstäd/Seán Doran

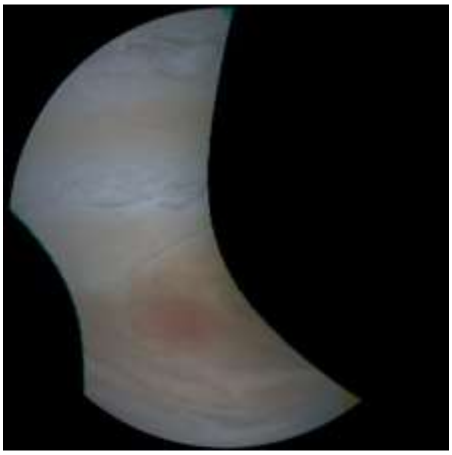
The images were taken (from left to right) between 12:54 a.m. and 1:11 a.m. EDT on July 16th (9:54 p.m. and 10:11 p.m. PDT on July 15th) during the spacecraft's 14th perijove maneuver. At the time, Juno was passing over Jupiter's northern hemisphere, where its altitude ranged from about 25,300 to 6,200 km (15,700 to 3,900 mil) above the planet's cloud tops.

Among them are the anticyclonic white oval (called N5-AWO), which can be seen at center left of the first image at far left and appears slightly higher in the second and third images. Then there is the Little Red Spot, a massive counterclockwise rotating storm that appears as a white oval in the gas giant's southern hemisphere. The miniature version of Jupiter's Great Red Spot, this feature is apparent at the bottom of the second and third images.

Raw image taken by the JunoCam during Perijove 14 of Jupiter's northern hemisphere, showing N5-AWO in the upper left corner. Credit: NASA/SwRI/MSSS

Last, but not least, there is the North North Temperate Belt, a predominantly cyclonic feature that rotates in the same direction as the planet. This Belt appears as a reddish-orange band and is most prominently displayed in the fourth and fifth images.

Like all JunoCam raw pictures, the series of photos that went into making this image product are available for the public to peruse and process at the Southwest Research Institute's (SwRI) JunoCam page.

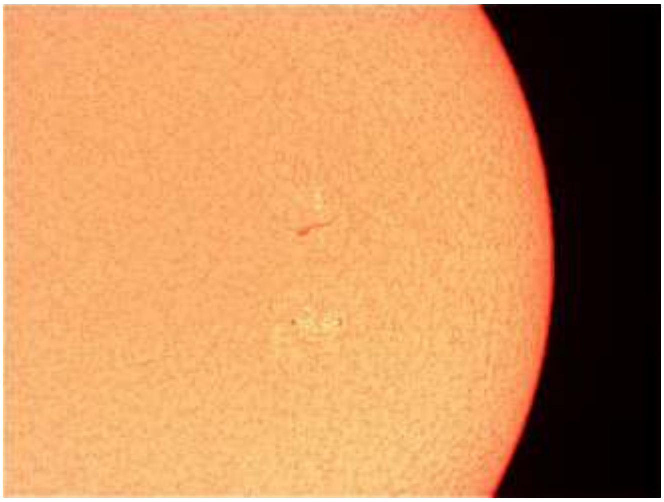


Raw image of Jupiter's North North Temperate Band, acquired by the JunoCam during perijove 14. Credit: NASA/ SwRI/MSSS

ARE WE WITNESSING THE START OF SOLAR CYCLE 25?

Article written: 29 Aug , 2018

by David Dickinson



A precursor to the start of Solar Cycle 25? The Sun in hydrogen alpha from August 25th, 2018, showing enigmatic sunspot AR 2720. Image credit and copyright: Damien Weatherly.

What's up with the Sun? As we've said previous, what the Sun *isn't* doing is the big news of 2018 in solar astronomy. Now, the Sun sent us another curveball this past weekend, with the strange tale of growing sunspot AR 2720.

We're currently headed towards a solar minimum, forecasted to arrive in 2019 as the Sun switches over from Solar Cycle 24 to Solar Cycle 25. The Sun goes through 11-year cycles, during which solar activity increases and ebbs in a somewhat predictable fashion. Tracking this activity goes all the way back to the start of the first solar cycle in 1755. Today, simple sketching and counting of sunspot numbers has given way to ground and space-based operations that monitor the Sun around the clock.

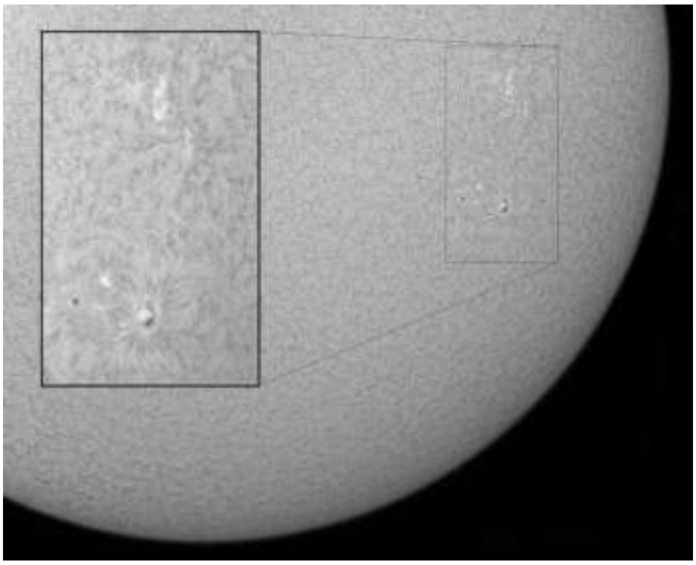
As a technology dependent society, it's important to know what the Sun is doing. Solar flares can spell a bad day for GPS, satellites, and astronauts currently in space. Even airline crew and passengers get a markedly higher dose of radiation during solar storms, especially during polar-crossing, trans-oceanic flights. And an event such as the 1859 Carrington Super-flare would wreak havoc today.

As it comes to a close, Solar Cycle 24 is now the most scrutinized period in solar astronomy… but it has been anything but normal. First, the transition period from Solar Cycle 24 to Solar Cycle 25 was deep and profound, the deepest in over a century. 2008 featured 268 spotless days, and when Cycle 24 finally arrived it was sputtering and lackluster at best, only producing a few notable sunspots.

Now, the transition from cycle 24 to 25 is on track to top that, with 132 spotless days on the Earthward face of Sol already as of August 29th or 55% of the time, leaving some solar astronomers to propose that if the trend continues, Solar Cycle #25 may be missing in action all together…

Or will it?

The growth of active sunspot region AR 2720 defied the overall trend for 2018 before it rotated around the solar limb and out of view, begging the question: has solar cycle #25 arrived? As a huge ball of gas, the Sun does not rotate uniformly, but instead, spins on its axis once every 34 days near its poles, and 25 days near the solar equator.

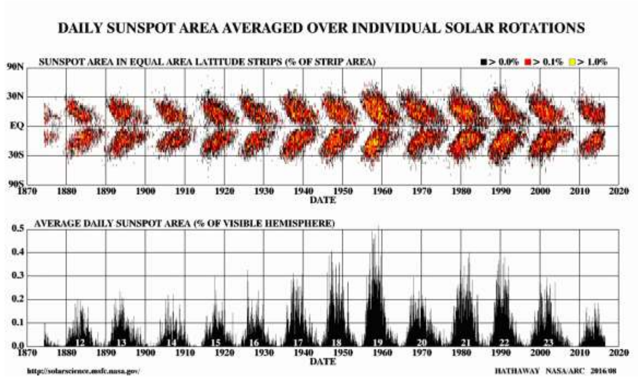


The swirling spicules of sunspot active region 2720, perhaps a harbinger of the new solar cycle. Image credit and copyright: Joseph Brimacombe. (note: Mr Brimacombe is located in Australia; in this image, AR 2720 is on the bottom!)

But how do we know that a new solar cycle has arrived, and that a given sunspot is a member?

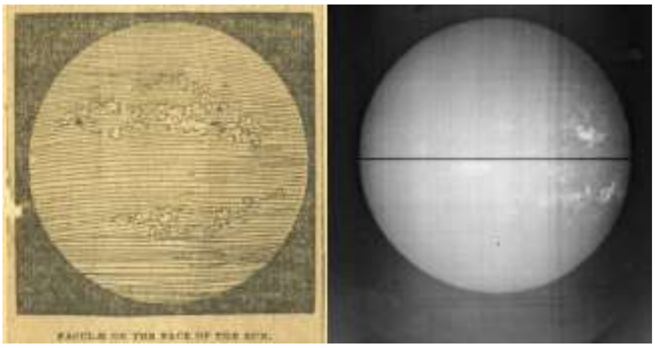
Two factors come into play with identifying that a new solar cycle is indeed underway: the appearance of new sunspots at relatively high solar latitudes, and the reversal of the Sun's magnetic field.

The first factor can be seen observationally in white light over the span of a solar cycle, and was first identified by Richard Carrington in 1861 and later refined by Gustav Spörer, in a law that now bears his name. Chart out the appearance of sunspots over time by latitude, Spörer noticed, and you get a tidy 'butterfly graph' depicting the 11-year solar cycle from minimum to maximum.



An updated 'butterfly graph' of successive solar cycles long term, depicting Sporer's Law. Credit: NASA/MSFC/Solar Physics division.

The second piece of the puzzle had to wait for the arrival of 20th century technology for astronomers to uncover it. It was known throughout the 19th century that there was a magnetic component to the Sun, as displayed by the electromagnetic havoc and enhanced auroral activity that solar storms could induce on Earth. In 1908, George Ellery Hale—a pioneer in American astronomy—used the newly installed 60-foot solar tower telescope at the Mount Wilson Observatory to note that spicule swirls around sunspot pairs rotated in opposite directions, much like metal fibers on a sheet of paper in the presence of a magnetic field in high school science class.



Early faculae sketches and images by George Hale from 1892, done from Hale's Kenwood Observatory in Chicago. Credit: Carnegie Astronomy.

Hale used the 9-meter Littrow spectrograph attached to the solar tower telescope to exploit what's known as the Zeeman effect—where a sunspot spectrum shows either a split or a broadening, evidence of its polarity—to deduce the magnetic field of the given spot. Hale showed that the Sun actually reverses its robust magnetic field every solar cycle, and the reversal period of 22 years whereas the same hemisphere returns to the same cycle is known as the Hale Cycle.

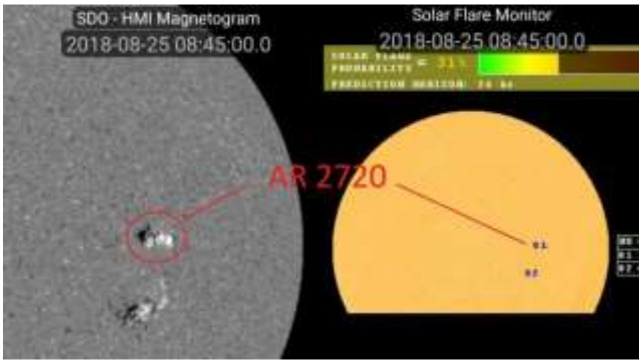
Hale's historic image showing the opposing vortices around two sunspots from 1908 (left) and the modern 150-foot solar tower at Mount Wilson today (right). Credit: Public Domain/ Davefoc/Wikimedia Commons

Likewise, sunspot pairs in the northern or southern hemisphere of the Sun show up as reversed in opposition to each other on magnetograms, showing spatial movement of the magnetic fields within the sunspot group, with one dark segment (south polarity, moving inward) and one bright segment (north polarity, moving outward). Remember that swirling action that Hale noted? Well, looking at the magnetogram of a given sunspot, you see either the bright spot leading or trailing the group versus solar rotation, and this flips when the Sun's poles reverse every solar cycle.

Horace Babcock built and installed the first true magnetogram imager on the 150-foot solar telescope on 1957, allowing him to take the first true magnetogram TV image of the Sun, which took the device about an hour to produce.

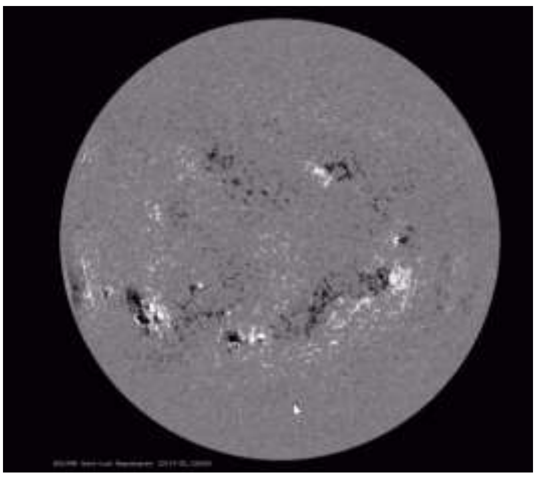
Babock's first solar 'image' with his TV magnetogram. Credit: NASA/Babock/Mt Wilson

Today, you can see the very latest magnetogram image of the Sun with the flick of a smartphone, courtesy of the Solar Heliospheric Observatory (SOHO) and NASA's Space Weather App.



The strange case of sunspot AR2720. Credit: NASA Space Weather App

Which brings us back to the curious case of sunspot active region 2720. It was indeed showing a bright leading edge matching its southern counterpart (such mixing isn't uncommon around the time the solar cycle flips) a strike in the 'for' category, but its latitude is still pretty low, a strike against. Another anomalous spot seen this past April also seems to have belonged to the next solar cycle.



A solar magnetogram, showing active bright and dark regions in opposing hemispheres. Credit: NASA/MSFC

One thing is for certain: the Sun is a fascinating subject of study, and will continue to surprise. Keep those solar filters handy, watch those magnetograms online, and we'll see what AR 2720 does when it comes back 'round the solar limb in about 12 days.

(Our thanks to astronomer Karl Battams at the U.S. Naval Research Laboratory helping us explain the process of identifying a sunspot's solar cycle membership!)

THE SUN IS ACTUALLY ONE OF THE MOST DIFFICULT PLACES TO REACH IN THE SOLAR SYSTEM. HERE'S HOW THE PARKER SOLAR PROBE WILL DO IT

Article written: 13 Aug , 2018
Updated: 14 Aug , 2018

by Matt Williams

When it comes to exploring our Solar System, there are few missions more ambitious than those that seek to study the Sun. While NASA and other space agencies have been observing the Sun for decades, the majority of these missions were conducted in orbit around Earth. To date, the closest any probes have gotten to the Sun were the *Helios 1* and *2* probes, which studied the Sun during the 1970s from inside Mercury's orbit at perihelion.

NASA intends to change all that with the Parker Solar Probe, the space probe that recently launched from Cape Canaveral, which will revolutionize our understanding of the Sun by entering it's atmosphere (aka. the corona). Over the next seven years, the probe will use Venus' gravity to conduct a series of slingshots that will gradually bring it closer the Sun than any mission in the history of spaceflight!

The spacecraft lifted off at 3:31 a.m. EDT on Sunday August 12th, from Space Launch Complex-37 at Cape Canaveral Air Force Station atop a United Launch Alliance Delta IV Heavy rocket. At 5:33 a.m., the mission operations manager reported that the spacecraft was healthy and operating normally. Over the course of the next week, it will begin deploying its instruments in preparation for its science mission.

Once inside the Sun's corona, the Parker Solar Probe will employ an advanced suite of instruments to revolutionize our understanding of the Sun's atmosphere and the origin and evolution of solar wind. These and other findings will allow researchers and astronomers to improve their ability to forecast space weather events (such as solar flares), which can cause harm to astronauts and orbiting missions, disrupt radio communications and damage power grids.

As Thomas Zurbuchen, the associate administrator of NASA's Science Mission Directorate, said in a recent NASA press release:

"This mission truly marks humanity's first visit to a star that will have implications not just here on Earth, but how we better understand our universe. We've accomplished something that decades ago, lived solely in the realm of science fiction."

The Parker Probes mission certainly comes with its share of challenges. In addition to the incredible heat it will have to endure, there is also the challenge of simply getting there. This is due to Earth's orbital velocity, which travels around the Sun at a speed of 30 km/s (18.64 mps) – or about 108,000 km/h (67,000 mph). Cancelling out this velocity and traveling towards the Sun would take 55 times as much energy as it would for a craft to travel to Mars.

To address this challenge, the Parker Probe has been launched by a very powerful rocket – the ULA Delta IV, which is capable of generating 9,700 kN of thrust. In addition, it will be relying on a series of gravity assists (aka. gravitational slingshots) with Venus. These will consist of the probe conducting flybys of the Sun, then circling around Venus to get a boost in speed from the force of the planet's gravity, and then slingshoting around the Sun again.

The launch of the Parker Solar Probe atop a ULA Delta IV Heavy rocket from Cape Canaveral Air Force Station on August 12th, 2018. Credit: Glenn Davis

Over the course of its seven-year mission, the probe will conduct seven gravity-assists with Venus and will make 24 passes of the Sun, gradually tightening its orbit in the process. Eventually, it will reach a distance of roughly 6 million km (3.8 million mi) from the Sun and fly through it's atmosphere (aka. corona), effectively getting more than seven times closer than any spacecraft in history. In addition, the probe will be traveling at speeds of roughly 692,000 km/h (430,000 mph), which will set the record for the fastest-moving spacecraft in history.

During the first week of its journey, the spacecraft will deploy its high-gain antenna and magnetometer boom, which houses the three instruments it will use to study the Sun's magnetic field. It will also perform the first of a two-part deployment of its five electric field antennas (aka. the FIELDS instrument suite), which will measure the properties of solar wind and help make a three-dimensional picture of the Sun's electric fields.

Other instruments aboard the spacecraft include the Wide-Field Imager for Parker Solar Probe (WISPR), the spacecraft's only imaging instrument. This instrument will take pictures of the large-scale structure of the corona and solar wind before the spacecraft flies through it, capturing such phenomena as coronal mass ejections (CMEs), jets, and other ejecta from the Sun.

There's also the Solar Wind Electrons Alphas and Protons (SWEAP) investigation instrument, which consists of two other instruments – the Solar Probe Cup (SPC) and the Solar Probe Analyzers (SPAN). These will count the most abundant particles in the solar wind – electrons, protons and helium ions – and measure their velocity, density, temperature, and other properties to improve our understanding of solar wind and coronal plasma.

Then there's the Integrated Science Investigation of the Sun (ISOIS), which relies on the EPI-Lo and EPI-Hi instruments – Energetic Particle Instruments (EPI). Using these two instruments, ISOIS will measure electrons, protons and ions across a wide range of energies to gain a better understanding of where these particles come from, how they became accelerated, and how they move throughout the Solar System.

In addition to being the first spacecraft to explore the Sun's corona, the Parker Solar Probe is the first spacecraft named after a living scientist – Eugene Parker, the physicist who first theorized the existence of the solar wind in 1958. As Nicola Fox, the probe's project scientist at the JHUAPL, indicated:

"Exploring the Sun's corona with a spacecraft has been one of the hardest challenges for space exploration. We're finally going to be able to answer questions about the corona and solar wind raised by Gene Parker in 1958 – using a spacecraft that bears his name – and I can't wait to find out what discoveries we make. The science will be remarkable."

Dr. Parker was on hand to witness the early morning launch of the spacecraft. In addition to its advanced suite of scientific instruments, the probe also carries a plaque dedicating the mission to Parker. This plaque, which was attached in May, includes a quote from the renowned physicist – "Let's see what lies ahead" – and a memory card containing more than 1.1 million names submitted by the public to travel with the spacecraft to the Sun.

Instrument testing will begin in early September and last approximately four weeks, after which the Parker Solar Probe can begin science operations. On September 28th, it will conduct its first flyby of Venus and perform its first gravity assist with the planet by early October. This will cause the spacecraft to assume a 180-day orbit of the Sun, which will bring it to a distance of about 24 million km (15 million mi).

In the end, the Parker Solar Probe will attempt to answer several long-standing mysteries about the Sun. For instance, why is the Sun's corona 300 times hotter than the Sun's surface, what drives the supersonic solar wind that permeates the entire Solar System, and what accelerates solar energetic particles – which can reach speeds of up to half the speed of light – away from the Sun?

Close up photo of the ULA Delta IV Heavy rocket's engines as it launches from Cape Canaveral Air Force Station. Credit: Glenn Davis

For sixty years, scientists have pondered these questions, but were unable to answer them since no spacecraft was capable of penetrating the Sun's corona. Thanks to advances in thermal engineering, the Parker Solar Probe is the first spacecraft that will be able to "touch" the face of the Sun and reveal its secrets. By December, the craft will transmit its first science observations back to Earth.

As Andy Driesman, the project manager of the Parker Probe mission at the Johns Hopkins University Applied Physics Laboratory (JHUAPL), expressed:

"Today's launch was the culmination of six decades of scientific study and millions of hours of effort. Now, Parker Solar Probe is operating normally and on its way to begin a seven-year mission of extreme science."

Understanding the dynamics of the Sun is intrinsic to understanding the history of the Solar System and the emergence of life itself. But until now, no mission has been able to get close enough to the Sun to address its greatest mysteries. By the time the Parker Solar Probe's mission is complete, scientists expect to have learned a great deal about the phenomena that can give rise to life, and disrupt it!

True color image of a storm front located near Utopia Planitia, near the northern polar ice cap of Mars. Credit: Credits: ESA/DLR/FU Berlin

Astronomy

THIS STUNNING PHOTO SHOWS THE MARTIAN DUST STORM AS IT WAS JUST GETTING GOING

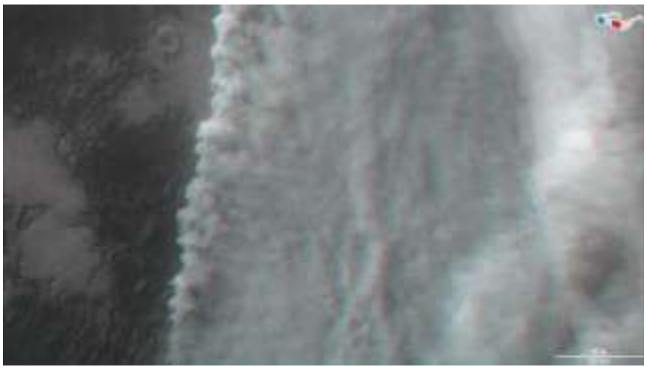
Article written: 22 Jul , 2018

by Matt Williams

The weather patterns on Mars are rather fascinating, owing to their particular similarities and differences with those of Earth. For one, the Red Planet experiences dust storms that are not dissimilar to storms that happen regularly here on Earth. Due to the lower atmospheric pressure, these storms are much less powerful than hurricanes on Earth, but can grow so large that they cover half the planet.

Recently, the ESA's *Mars Express* orbiter captured images of the towering cloud front of a dust storm located close to Mars' northern polar region. This storm, which began in April 2018, took place in the region known as Utopia Planitia, close to the ice cap at the Martian North Pole. It is one of several that have been observed on Mars in recent months, one which is the most severe to take place in years.

The images (shown above and below) were created using data acquired by the *Mars Express*' High Resolution Stereo Camera (HRSC). The camera system is operated by the German Aerospace Center (DLR), and managed to capture images of this storm front – which would prove to be the harbinger of the Martian storm season – on April 3rd, 2018, during its 18,039th orbit of Mars.



Anaglyph 3D image of the dust storm front forming above the subpolar plains in northern Mars. Credit: Credits: ESA/DLR/FU Berlin

This storm was one of several small-scale dust storms that have been observed in recent months on Mars. A much larger storm emerged further southwest in the Arabia Terra region, which began in May of 2018 and developed into a planet-wide dust storm within several weeks.

Dust storms occur on Mars when the southern hemisphere experiences summer, which coincides with the planet being closer to the Sun in its elliptical orbit. Due to increased temperatures, dust particles are lifted higher into the atmosphere, creating more wind. The resulting wind kicks up yet more dust, creating a feedback loop that NASA scientists are still trying to understand.

Since the southern polar region is pointed towards the Sun in the summer, carbon dioxide frozen in the polar cap evaporates. This has the effect of thickening the atmosphere and increases surface pressure, which enhances the storms by helping to suspend dust particles in the air. Though they are common and can begin suddenly, Martian dust storms typically stay localized and last only a few weeks.

While local and regional dust storms are frequent, only a few of them develop into global phenomena. These storms only occur every three to four Martian years (the equivalent of approximately 6 to 8 Earth years) and can persist for several months. Such storms have been viewed many times in the past by missions like *Mariner* 9 (1971), *Viking* I (1971) and the *Mars Global Surveyor* (2001).

This global map of Mars shows a growing dust storm as of June 6, 2018. The map was produced by the Mars Color Imager (MARCI) camera on NASA's Mars Reconnaissance Orbiter spacecraft. The blue dot indicates the approximate location of Opportunity. Image Credit: NASA/JPL-Caltech/MSSS

In 2007, a large storm covered the planet and darkened the skies over where the Opportunity rover was stationed – which led to two weeks of minimal operations and no communications. The most recent storm, which began back in May, has been less intense, but managed to create a state of perpetual night over *Opportunity's* location in Perseverance Valley.

As a result, the *Opportunity* team placed the rover into hibernation mode and shut down communications in June 2018. Meanwhile, NASA's *Curiosity* rover continues to explore the surface of Mars, thanks to its radioisotope thermoelectric generator (RTG), which does not rely on solar panels. By autumn, scientists expect the dust storm will weaken significantly, and are confident *Opportunity* will survive.

According to NASA, the dust storm will also not affect the landing of the *InSight* Lander, which is scheduled to take place on November 26th, 2018. In the meantime, this storm is being monitored by all five active ESA and NASA spacecraft around Mars, which includes the 2001 Mars Odyssey, the Mars Reconnaissance Orbiter, the Mars Atmosphere and Volatile EvolutioN (MAVEN), the Mars Express, and the Exomars Trace Gas Orbiter.

Understanding how global storms form and evolve on Mars will be critical for future solar-powered missions. It will also come in handy when crewed missions are conducted to the planet, not to mention space tourism and colonization!

Interstellar Medium (ISM) Overview

The Interstellar Medium. One tends to think of outer space as consisting of stars separated by great distances with a vacuum between them. While it is true that space is mostly empty, there are regions that contain considerable amounts of material. This is relative of course. By earthly standards such regions would still constitute a pretty good vacuum. The Interstellar Medium consists of all the materials that fill the space between the stars, which is mainly gas (99%) and a small amount of dust (1%). In total, about 15% of the visible matter in the Milky Way is composed of interstellar gas and dust.

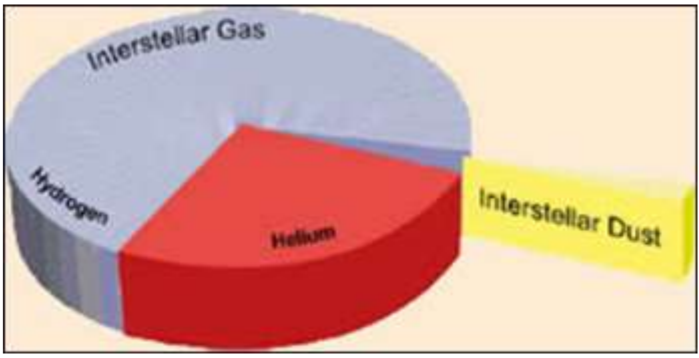
Observe the Bow Shock Nebula to the left. **Nebula** is a Latin word for cloud and "nebula" is used as a generic term for regions of intense interstellar gas and/or dust clouds.

The typical gas density in space is one atom per cubic centimeter (cc). The best man-made vacuum is about a 10^12 atoms per cubic centimeter. A cubic centimeter of air in a normal room has about 10^19 atoms in it. The interstellar medium is not uniform in density. Although on average its density is one atom per cc, a nebula can have densities up to a million atoms per cc.

Interstellar gas is composed of either molecules or atoms of gasses with hydrogen and helium being the most abundant. Carbon monoxide, oxygen and nitrogen are other forms of interstellar gas, but in much, much smaller quantities. Dust is composed of little bits of solid matter. Dust is very small, on the order of microns (10^-6 meters). Dust is mainly made of compounds of carbon and silicon in various forms and out of various forms of ice such as water, carbon dioxide, and ammonia (graphite grains, silicate grains, etc.). Temperatures have to be pretty low to have ice particles - 100 K and below. Other kinds of dust can exist at higher temperatures, but if temperatures gets too high, all the different kinds of dust are decimated. The interstellar composition, structure, etc. of dust particles remains an area of some uncertainty in astro-physics.

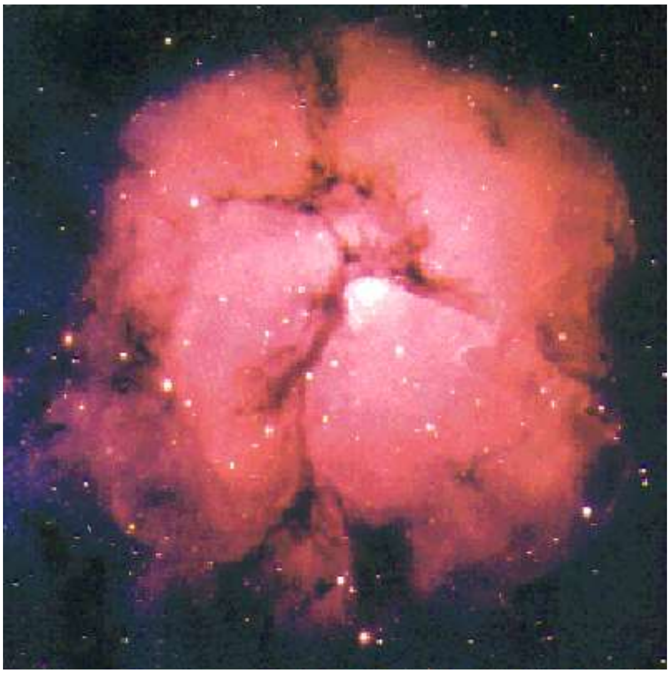
The interstellar medium can be divided into three different categories dependent on their individual temperatures: cold (10 to 99 Kelvin), warm (100 to 1,000's K) and hot (millions K). The colder a cloud of gas, the more of its output emission is in the long wavelengths; radio and microwave. Hot regions of interstellar gas are bright in their own material optical emissions. Note also that the various temperatures determine the type of matter that will exist. Cold temperatures are suitable to the formation of molecules. Warmer temperatures will find only atoms, such as neutral hydrogen. Under higher temperatures, atoms become ionized. The coldest regions of space are the dark nebula.

Interstellar Gas



About 75% of the Interstellar Medium is in the form of hydrogen with about 24% helium. The interstellar gas consists partly of neutral atoms and molecules, as well as charged particles such as ions and electrons. The gas is extremely dilute with an average density of 1 atom per cubic centimeter (cc). (For comparison, the air we breathe has a density of approximately 3 x 10^19 molecules per cc.) Even though the interstellar gas is very dilute, the total amount of matter adds up because of the vast distances between the stars.

Interstellar gas is typically found in one of two different formulations:



The power to keep an emission nebula glowing is provided by hot, high energy stars in the interior of the nebula, specifically class O (letter O) and class B1 stars, the hottest star categories. The ionization of hydrogen and helium requires high energy ultraviolet photons such as those that are emitted from these types of stars.

The cold clouds of neutral or molecular hydrogen are the birthplace of new stars as they become gravitationally unstable and collapse. The neutral and molecular forms emit radiation in the radio band of the electro-magnetic spectrum.

Ionized hydrogen is produced when large amounts of ultraviolet radiation are released by hot newly-formed stars. This radiation ionizes the surrounding clouds of gas. Visible light is emitted when electrons recombine with the ionized hydrogen, which is seen as beautiful red colors of "emission nebula".

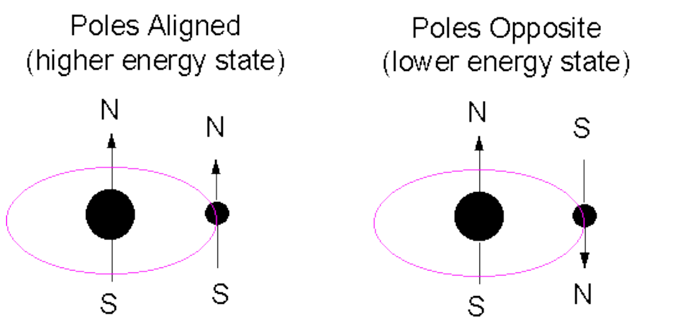
See the Trifid Nebula (M20) image to the left. The red light comes from hydrogen emission, excited by the ultraviolet radiation from hot stars embedded in the nebula. The dark regions criss-crossing the nebula are obscuring dust.

Emission nebula are also known as H II (H-two) regions. The explanation of this nomenclature is: The H means Hydrogen and the Roman numeral II means that the hydrogen is ionized (its electron has been stripped off by high energy photons). H I (H-one) is neutral hydrogen meaning that it still has its electron. He II would be singly ionized helium, and He III would be doubly (fully) ionized helium.

Astronomers had predicted that molecular oxygen would be the third most common interstellar molecule, after molecular hydrogen (H II) and carbon monoxide (CO). But the experimental evidence found that the oxygen molecule is much rarer than theory predicts. For example, hydrogen molecules in the Orion Nebula outnumber oxygen molecules a million to one. To explain this scarcity, astronomers recently proposed that oxygen atoms might bind tightly to dust particles that are found in most outer space clouds.

To see how readily oxygen atoms can escape, scientists heated two types of solids that make up interstellar dust grains - water ice and silicate. They found that the binding energy of oxygen is more than twice what had been previously estimated - 0.14 electron volts for water ice and 0.16 electron volts for silicate. These binding energies are high enough to keep oxygen atoms stuck to stardust. But when the oxygen atoms stay stuck to the dust grains, hydrogen atoms combine with the oxygen to create water ice (H_2O) instead. The water can then become part of asteroids, comets, and planets, setting the stage for the creation of life.

Neutral Hydrogen Emits Some Radiation!



A 21-cm photon is emitted when poles go from being aligned to opposite (a spin flip).

The Milky Way Galaxy is filled with a very diffuse distribution of neutral hydrogen gas. The interstellar medium is far too cool to excite the higher energy states of hydrogen, but there is a feature at the 21 centimeter (cm) wavelength in the radio frequency. 21-cm photons are produced by the spinning magnetic fields of the hydrogen atom's nuclear proton and orbiting electron.

Because the proton and electron are spinning distributions of electric charge they create minute magnetic fields which interact, creating a small energy difference between the state in which the poles are aligned versus counter-aligned. See the diagram to the left. This energy difference corresponds to the energy of radio waves at 21-centimeters.

Every once in a while (about once per 500 years) hydrogen atoms will collide, exciting an atom into the higher energy spin-aligned configuration. It will take as long as 30 million years for the atom to jump back to the lower energy state via a "spin-flip" emitting a 21 cm radio emission. The neutral hydrogen atom is distributed in clumpy fashion with cool, denser regions that astronomers call "clouds" but which are more like filaments. These regions have a typical temperature of about 100K and a density between 10 to 100 atoms per cubic centimeter (atom/cc). Surrounding the clouds is a warmer lower density medium with about 0.1 atom/cc and temperature (T) about 1000 K. On the other hand, there are billions and billions of hydrogen atoms in a typical cloud of gas. The result is that 21 cm radiation is a strong measure of the amount of hydrogen gas in various parts of the Milky Way.

Interstellar Dust

Interstellar dust is not like the dust that you might find under your refrigerator. It is made of very different materials. Interstellar dust particles are extremely small, just a fraction of a micron across, which happens to be approximately the wavelength of blue light waves. The particles are irregularly shaped, and are composed of silicates, carbon, ice, and/or iron compounds.

When light from other stars passes through the dust, a few things can happen. If the dust is thick enough, the light will be completely blocked, leading to dark areas. These dark clouds are known as dark nebulae. See the famous Pillars Of Creation nebula to the left.

Light passing through a dust cloud may not be completely blocked, although all wavelengths of light passing through will be dimmed somewhat. This phenomenon is known as "extinction". Extinction is caused by light being scattered off of dust particles out of our line of sight, preventing the light from reaching us. The amount that the light is dimmed depends upon a few factors, including the thickness and density of the dust cloud, as well as the wavelength (color) of the incoming light.

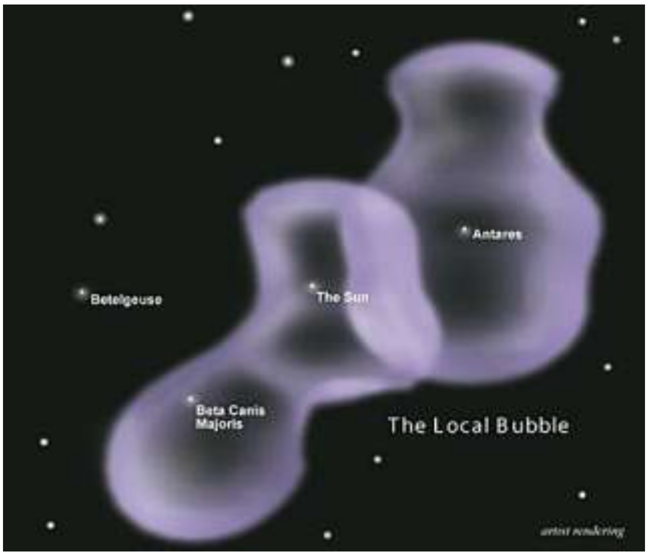
Because of the size of the dust particles, scattering of blue light is favored. Therefore, less of the blue light reaches us, which means that the light that reaches us is more red than it would have been without the interstellar dust. This effect is known as reddening. (Note that this is not the same thing as redshift.)

This process is similar to that make our sun so red at sunset.
Although solid objects, dust grains are not immune to collisions. Collisions with high speed gas particles, UV photons and other grains will breakdown dust grains. For this reason, dust is only found in the cores of dark nebula where they are shielded from destructive effects.
Dust grains serve as sites for the formation of molecules and organic compounds. Their cold surfaces act as catalysts by allowing atoms to stick to cold grains so that there is enough time for a second atom to land, interact, and form a molecule. Collections of dust and molecular gases are called "molecular clouds".
Some dark nebula are are visible because an "emission nebula" lies behind them. These normally dark nebula are brightly illuminated from behind, such as the Horse Head Nebula shown at the left. This illumination happens often because the gas that is associated with the dark nebula can also be heated by nearby young stars causing it to glow as an emission nebula. (The Horse Head Nebula is also shown in infrared by the Hubble Telescope in the top banner above.)
The Horse Head Nebula is several tens of parsecs across and would envelop the whole local neighbourhood of stars around our solar system. Stars seen in the image are foreground stars since the nebula is opaque.

Molecular Clouds

A molecular cloud is an accumulation of interstellar gas and dust. These clouds have very low temperatures of just 10 to 30 Kelvin and therefore the hydrogen is primarily composed of molecular hydrogen (H II). Compared to the ionized hydrogen in other areas of the interstellar medium, less than 1% of all hydrogen in the Milky Way is bound in molecular clouds. Pictured at the left is the famous Carina Nebula.
The size of these molecular clouds can vary from a few light years up to 600 light years and their total mass can reach several million solar masses. Molecular clouds with dimensions of more than about 15 light years are called Giant Molecular Clouds (GMCs).
Molecular clouds are so important because they are the raw material of stars and planets. A dark nebula is a very dense part of a bigger molecular cloud. These are the regions where new stars form.
These dense regions can only occur if the temperatures are very low, otherwise the thermal pressure of the gas leads to an expansion of the dark nebula and no new stars would be able to form. Molecular clouds consist mainly of hydrogen and dust particles which is all you need to form a new solar system.
Hundreds of different types of molecules have been detected in these clouds, among them water, ammonia, ethyl alcohol and even sugar and amino acids like glycine, the basic modules of life. More than 70 amino acids can be traced in meteorites. Meteorites represent the original composition of the molecular cloud that our solar system was formed out of. In most cases the basic meteorite structure has not changed much since the very first days of our solar system about 4.5 billion years ago.
These clouds do not last for a very long time. After new stars are born, their solar winds blow away the remaining cloud gas and dust. Only a fraction (about 10%) of the original material of the molecular cloud gets locked up in stars and planets. The rest of the material (90%) will be blown away into the interstellar medium and one day will be "recycled" into other molecular clouds. If one considers that for stars like our sun, approximately 50% of the hydrogen will also be returned to the interstellar medium. A total recycling rate of about 95% is achieved. In this sense, the universe is extremely efficient.

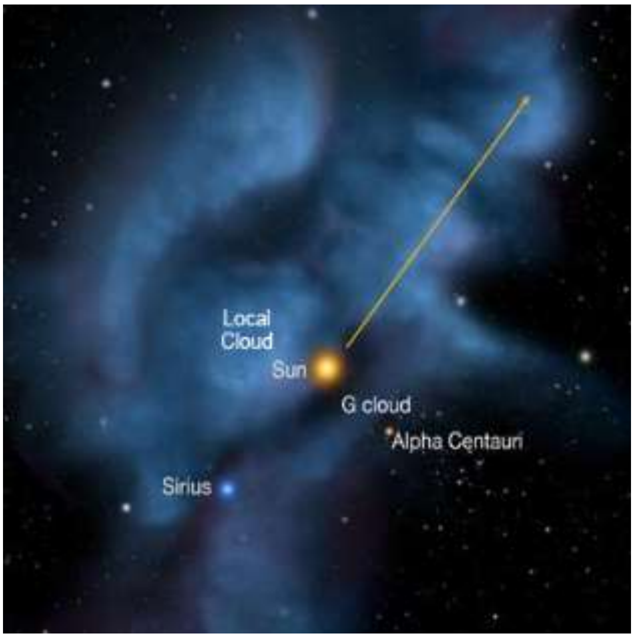
The Local Bubble



Decades of mapping the regional sky in soft x-rays had revealed a local glow, known as "**The Local Bubble**". The Local Bubble was discovered in the 1970s and 1980s. The Local Bubble is somewhat peanut-shaped, about 300 light years long, and filled with almost nothing. See the NASA artist's conception to the left.
Gas inside the bubble is very thin, approximately 0.001 particles per cubic centimeter, and very hot - roughly a million degrees. This is a a sharp departure from ordinary interstellar density and temperature. Evidence suggests that our solar system is moving through a region of space that may have been blasted totally clear by several supernova explosions during the past 20 million years. For more info about the Lo-

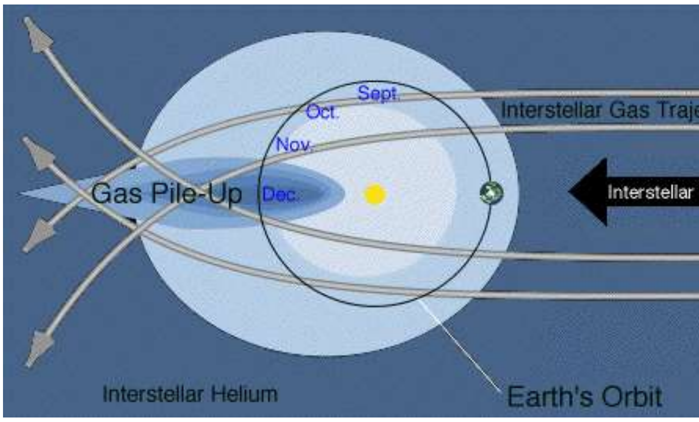
cal Bubble, see The Cosmic X-Ray Background section.
However within the last decade, some scientists have been challenging the supernova interpretation, suggesting that much, if not all, of the soft x-ray background is instead a result of "charge exchange" with the solar wind. (See the Charge Exchange section.)
To find out, an international team of researchers led by NASA developed an x-ray detector that could distinguish between the two possibilities.
On December 12, 2012, a NASA rocket, with the x-ray detector equipment aboard, reached a peak altitude of 160 miles and spent a grand total of five minutes above the earth's atmosphere. That was all the time it needed to measure the amount of "charge exchange" from the solar wind. The results clearly indicate that about 40 percent of the soft x-ray background originates from within the solar system. The 60 percent balance comes from the Local Bubble of hot gases, from the relics of ancient supernova explosions outside of our solar system, and possibly other interstellar sources.

The Local Cloud

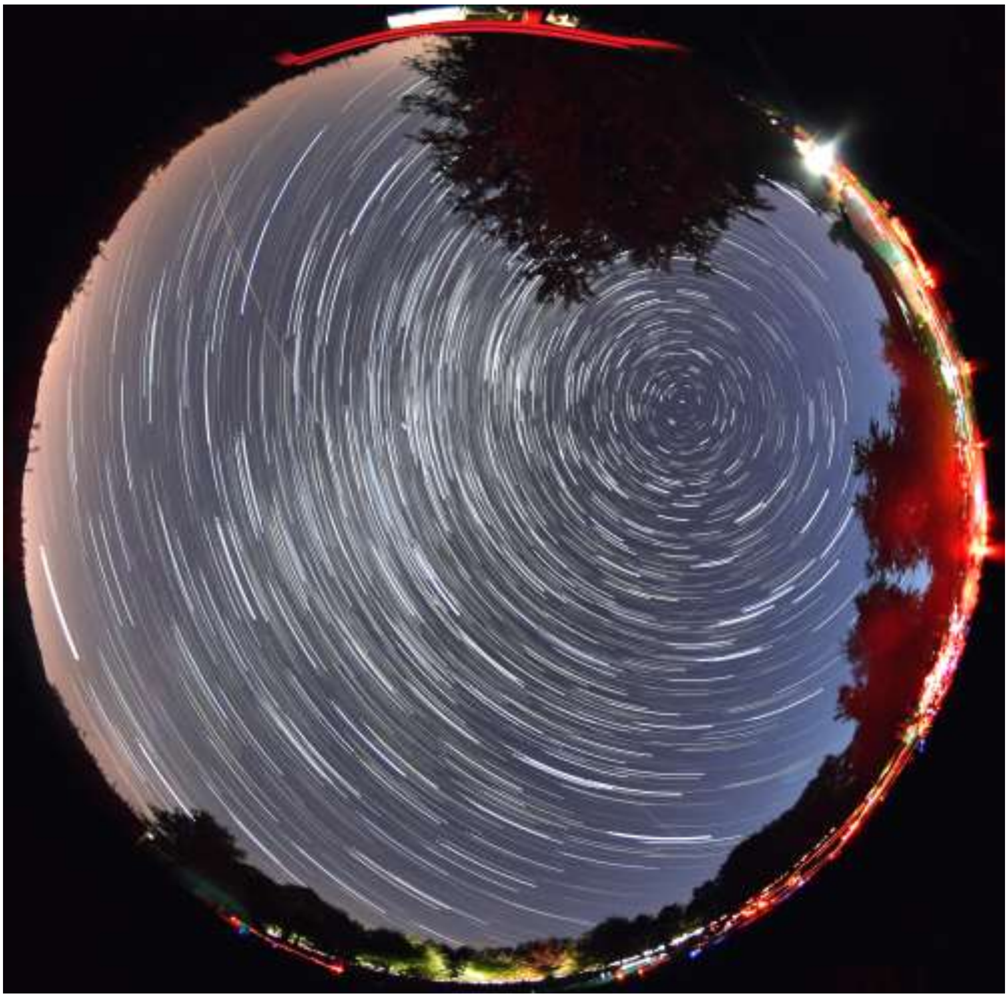


Our sun and the solar system are currently moving through a nearby cloud of interstellar gas called the "**Local Cloud**" which is also immersed in the "Local Bubble". See the NASA artist's illustration to the left. The Local Cloud is approximately 60 light years in diameter with our sun being approximately 4 light years from an edge. It contains a wispy mixture of hydrogen and helium atoms. The Local Cloud, features a density of 0.1 particles per cubic centimeter, and a temperature of about 6000 K,
Our sun and solar system are moving through the Local Cloud with a speed of about 50,000 miles per hour (23 km/sec.). As a result of our traveling motion, an interstellar wind of the same speed is blowing through our planetary system. This is similar to the wind one feels while driving a car with the top down. The observed temperature and density of the Local Cloud do not provide enough pressure to resist the crushing action of the hot gas from the Local Bubble. So how has the Local Cloud survived?
Voyager data showed that the Local Cloud is much more strongly magnetized than anyone had suspected - between 4 and 5 microgauss. This fairly strong magnetic field provides the extra pressure required to resist destruction from the Local Bubble. The Local Cloud is held at bay just beyond the edge of the solar system by the sun's magnetic field, the Heliosphere, which is inflated by the solar wind into a magnetic bubble more than 6 billion miles (10 billion km) wide.
The Heliosphere acts as a shield that protects the inner solar system from most outer space cosmic rays and interstellar clouds and bubbles. Also the Magnetosphere (the comet-like magnetic sphere around the earth) prevents highly charged fast-moving particles (mostly electrons and protons), propelled by the Solar Wind, Clouds and Bubbles, from hitting the earth. The Magnetosphere also does a good job of protecting us from Geo-Magnetic Storms from the sun.

The Gas Pile Up



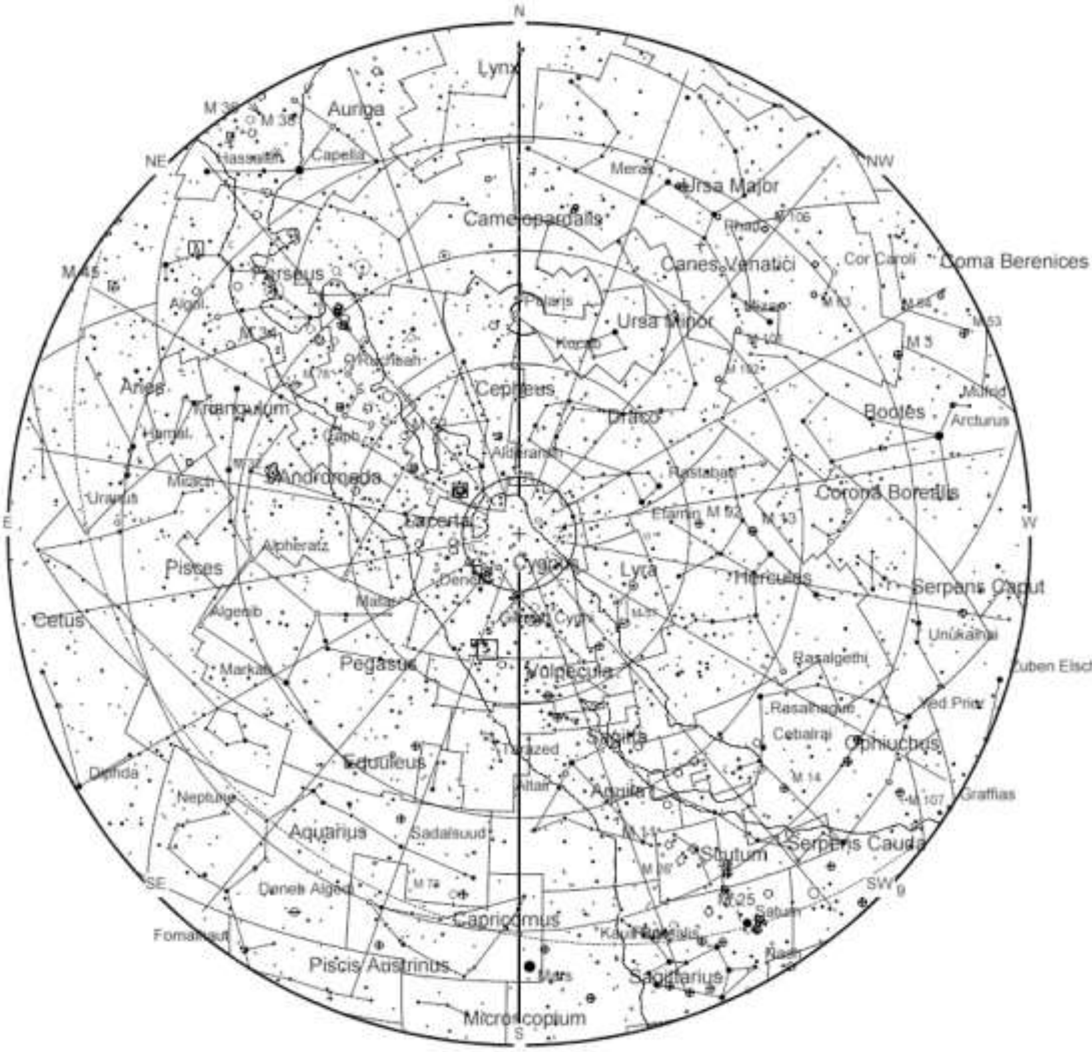
In the illustration to the left, note the interstellar **Gas Pile-Up** "downwind" due to the sun's gravity focusing the interstellar wind. As the earth revolves around the sun in the course of a year, satellites (most recently IBEX) have detected a gas pile up which peaks in the month of December as shown by a darker blue in the diagram. Satellites can determine the density of the medium by sampling how much neutral helium gas is found on any given day. It is heaviest in December and lightest in June when the earth is "upwind" of the Pile Up.
The sun sends out a solar wind in all directions, with speeds of 670,000 to 2,237,000 miles per hour (300 to 1000 km/sec). As mentioned in the section above, the interstellar wind is moving at a rather slow 50,000 miles an hour (23 km/sec.). One would think the gale force solar wind would just wipe out the interstellar wind. But that is not the case.
Typically, there is 0.1 atoms in each cubic centimeter of interstellar wind, and 10 ions in each cubic centimeter of solar wind (versus surface air which contains 3 x 10^19 molecules per cc). This means there is a great deal of dead space between the very tiny particles and collisions are rare. On average an interstellar gas atom can travel 100 times the distance between the sun and the earth before it is hit by a solar wind particle. The particles mostly just flow through each other without many collisions.



Some shots from the summer. All sky star trail from Brecon,

and the Moon Roll up Silbury hill from last week.

WHATS UP, SEPTEMBER 2018



September 7 - **Neptune at Opposition.** The blue giant planet will be at its closest approach to Earth and its face will be fully illuminated by the Sun. It will be brighter than any other time of the year and will be visible all night long. This is the best time to view and photograph Neptune. Due to its extreme distance from Earth, it will only appear as a tiny blue dot in all but the most powerful telescopes.

September 9 - **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 18:01 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.

September 23 - **September Equinox.** The September equinox occurs at 01:54 UTC. The Sun will shine directly on the equator and there will be nearly equal amounts of day and night throughout the world. This is also the first day of fall (autumnal equinox) in the Northern Hemisphere and the first day of spring (vernal equinox) in the Southern Hemisphere.

September 25 - **Full Moon.** 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 02:53 UTC. This full moon was known by early Native American tribes as the Full Corn Moon because the corn is harvested around this time of year. This moon is also known as the Harvest Moon. The Harvest Moon is the full moon that occurs closest to the September equinox each year.

NOTE Top left in Auriga is the Comet 21P.

It's a give and take month for Venus: Late this month, the planet reaches the pinnacle of brilliance for its current evening apparition . . . but all September long Venus is gradually dropping lower in the southwest twilight sky.

Meanwhile, Jupiter can be seen well to the upper left of Venus; they slowly get approach each other as September progresses, but before they can get strikingly close, Venus rapidly pulls away to the west late in the month. Dusk is the best time to look for Saturn in the south-southwest, while the much brighter Mars is over in the south-southeast.

Mars rivals Jupiter in brightness at the start of the month and Sirius, the brightest star until nearly the end of the month, but as it continues to pull away from the Earth its brightness is more than halved during September. As for Mercury, our only morning planet, you might catch a glimpse of it low in the east-northeast at dawn during September's first week.

Visible low in the east-southeastern sky before dawn on the morning of Thursday, September 6, Mercury will sit only a finger's width to the left of the bright naked-eye star Regulus in Leo. Both the planet and the star will appear together within the field of view of a small telescope at low magnification (orange circle).

Mercury is visible fairly low in the dawn sky, but only during the first week of September. Sept. 1 is the most interesting day to look for the -1.2 magnitude world for this morning it rises about an hour before the sun, and binoculars can show the 1st magnitude star Regulus little more than 1-degree to its right. From there it moves eastward very rapidly – true to its name for the fleet-footed messenger god – and falls back into the sun's glare sometime after Sept. 10. On Sept. 20, Mercury moves behind the sun, passing through superior conjunction. Low in the west-southwestern sky after sunset on the evening of Saturday, September 1, the bright planet Venus will be situated only a finger's width to the lower left of the bright naked-eye star Spica in Virgo. The pair of objects will be visible in binoculars and will fit together in the field of a small telescope at low magnification (orange circle).

Venus sets 1 3/4 hours after the sun as September starts and only 1 hour after as the month ends. Even worse, with respect to the sun, Venus's path makes a very shallow angle to the horizon for those living near latitude 40 degrees north. Sharp-eyed observers who can glimpse the planet's pinpoint gleam around the time of sunset will find it in the west-southwest only about 16-degrees high on Sept. 1 and 9-degrees on Sept. 30.

Looking low near the southwest horizon an hour after sunset on Sept. 1, observers can enjoy spotting the 1st-magnitude star Spica only about 1.4-degrees to the upper left of Venus. The gap between the two grows by 1-degree per day after that. This dazzling planet reaches its greatest brilliancy (magnitude -4.8) on Sept. 21, when telescopes show the planet presenting its "greatest illuminated extent" (321 square arc seconds of sunlit surface). Unfortunately for observers at mid-northern latitudes, this display occurs lower in the dusk sky than at any other time in Venus's 8-year cycle of recurring appearances.

Telescopes show Venus's crescent lengthening and thinning throughout the month, but observers at mid-northern latitudes will find Venus's image to be blurred by turbulence low in the sky. For the best telescopic views, try to catch Venus immediately after sunset – or even in late afternoon, if you can find a building or hill to block the sun from view. This equinox marks the beginning of autumn in the Northern Hemisphere and spring in the Southern.

After dark on the evening of Wednesday, September 19, look for the waxing gibbous moon sitting 4.5 finger widths above bright reddish Mars. The pair of objects will fit into the same binocular field of view (orange circle). They will cross the sky together until they set after 2 a.m. local time.

Mars is well placed in the evening sky for observation, crossing the meridian 2 to 3 hours after sunset; a reddish-orange light low in Capricornus. Having resumed eastward motion against the stars, it races fast enough ahead of the sun along the ecliptic to remain in the evening sky all fall, winter and spring.

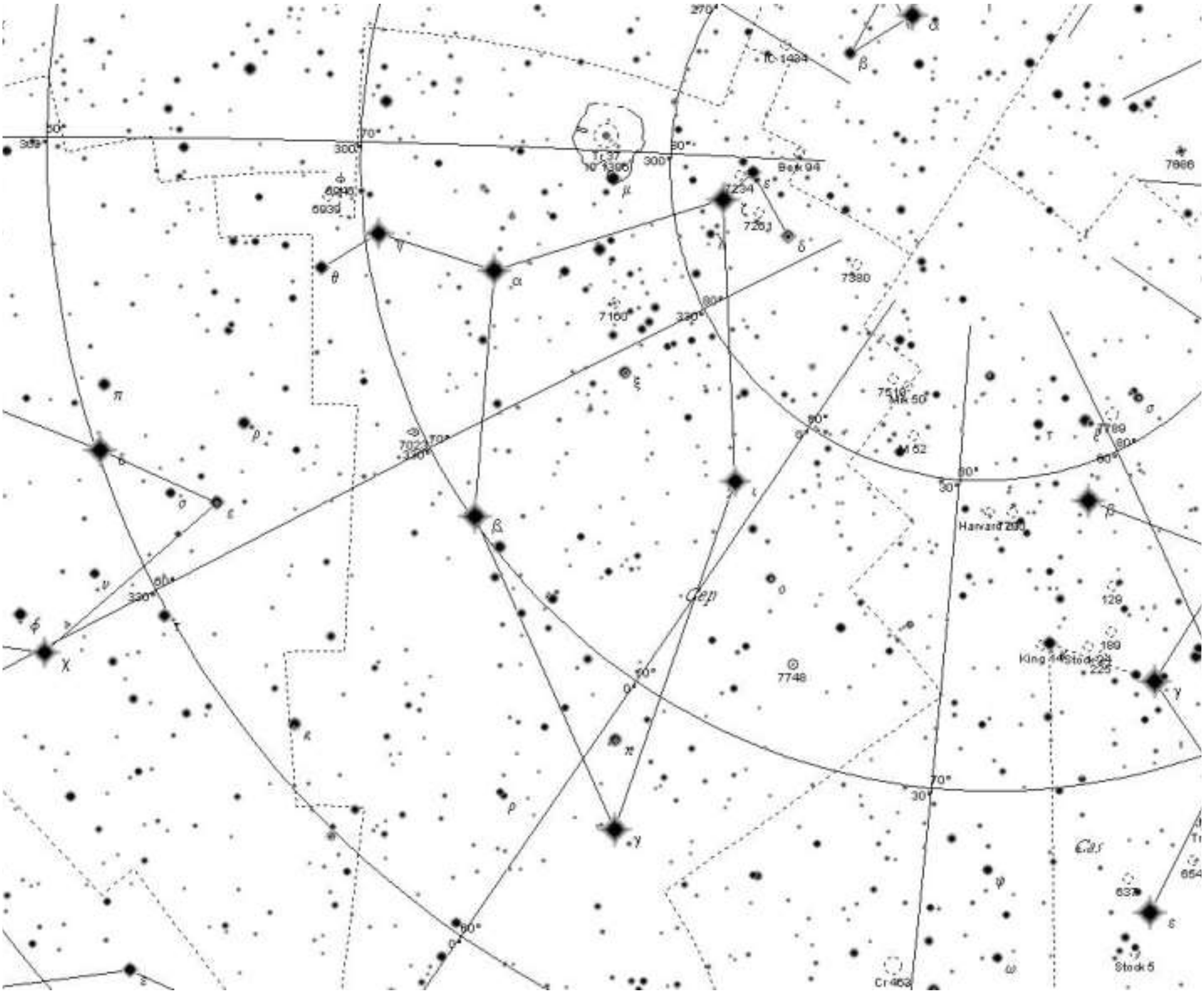
However, Mars is rapidly fading and its telescopic disk is shrinking as Earth pulls ahead of it in their respective orbits. As Mars' distance from the Earth increases from 42 to 55 million miles (68 to 88 million km) this month, the planet fades from magnitude -2.1 to -1.3, while its telescopic disk decreases in size by nearly 24-percent. A gibbous moon can be found well to the upper right of Mars on the evening of Sept. 19. The available time for observing Jupiter will shorten considerably during September. The very bright planet (visual magnitude -1.85) will be positioned low in the southwestern evening sky all month. It will move eastward through the stars of central Libra, pulling away from the nearby bright double star Zubenelgenubi. Jupiter will set at around 10:30 p.m. local time on September 1 and at 8:47 p.m., shortly after local twilight, at month's end. As Jupiter and the summer stars are carried west by Earth's orbital motion, Jupiter will move towards Venus; but that planet's westward passage towards the sun will prevent a close meeting of the pair of bright planets. On the evening of Thursday, September 13, the young crescent moon will be situated 4 finger widths to the upper right of Jupiter. That pairing, when combined with Venus below them, will make a lovely wide field photo opportunity.

Jupiter at magnitude -1.9 is rather low but still very obvious in the southwest sky as dusk begins to fade.

During this month, the king of the planets pulls noticeably away from the wide double star Alpha (α) Librae, Zubenelgenubi. They're a couple of degrees apart on the 1st, but by Sept. 30 the gap between them has widened to 7-degrees. Also by month's end, Jupiter is little more than 12-degrees high at mid-twilight for viewers around 40-degrees north latitude and sets less than two hours after the sun. Atmospheric turbulence will compromise telescopic views. The 4.5-day-old crescent moon is passing well to the upper right of Jupiter on the evening of Sept. 13. After dark on the evening of Monday, September 17, look for the first quarter moon sitting 4 finger widths to the upper left of medium-bright yellowish Saturn. The pair of objects will fit into the same binocular field of view (orange circle). They will cross the sky together until they set after midnight local time.

Saturn shines in the south-southwest as twilight fades. It is a steady yellow light about 23-degrees to the upper left of Antares, which is redder, fainter and twinkles. Later in the evening Saturn loses altitude as the wheeling of the sky carries it down to the southwest. In a telescope, Saturn's rings are still tilted wide open – 26.6-degrees to our line of sight – so much so they hide the planet's south pole. The waxing gibbous moon, 60-percent illuminated can be found to the upper left of Saturn on the evening of Sept. 17.

CONSTELLATIONS OF THE MONTH: CEPHEUS



The Cepheus Constellation

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

One of these is the northern constellation of Cepheus, named after the mythological king of Ethiopia. Today, it is one of the 88 modern constellations recognized by the IAU, and is bordered by the constellations of Camelopardalis, Cassiopeia, Cygnus, Draco, Lacerta, and Ursa Minor.

Name and Meaning:

In Greek mythology, Cepheus represents the mythical king of Aethiopia – and husband to the vain queen Cassiopeia. This also makes him the father of the lovely Andromeda, and a member of the entire sky saga which involves jealous gods and mortal boasts. According to this myth, Zeus placed Cepheus in the sky after his tragic death, which resulted from a jealous lovers' spat.

Cepheus as depicted in Urania's Mirror, a set of constellation cards published in London c. 1825. Credit: Library of Congress/Sidney Hall

It began when Cepheus' wife – Cassiopeia – boasted that she was more beautiful than the Nereids (the sea nymphs), which angered the nymphs and Poseidon, god of the sea. Poseidon sent a sea monster, represented by the constellation Cetus, to ravage Cepheus' land. To avoid catastrophe, Cepheus tried to sacrifice his daughter Andromeda to Cetus; but she was saved by the hero Perseus, who also slew the monster.

The two were to be married, but this created conflict since Andromeda had already been promised to Cepheus brother, Phineus. A fight ensued, and Perseus was forced to brandish the head of Medusa to defeat his enemies, which caused Cepheus and Cassiopeia (who did not look away in time) to turn to stone. Perhaps his part in the whole drama is why his crown only appears to be seen in the fainter stars when he's upside down?

History of Observation:

As one of the 48 fabled constellations from Greek mythology, Cepheus was included by Ptolemy in his 2nd century tract, *The Almagest*. In 1922, it was included in the 88 modern constellations recognized by the International Astronomical Union (IAU).

Notable Features:

Bordered by Cygnus, Lacerta and Cassiopeia, it contains only one bright star, but seven major stars and 43 which have Bayer/Flamsteed designations. It's brightest star, Alpha Cephei, is a white class A star, which is located about 48 light years away. Its traditional name (Alderamin) is derived from the Arabic "*al-dira al-yamin*", which means "the right arm".

This Hubble image shows RS Puppis, a type of variable star known as a Cepheid variable. Credit: NASA/ESA/ STScI/AURA/H. Bond/STScI/Penn State University

Next is Beta Cephei, a triple star systems that is approximately 690 light years from Earth. The star's traditional name, Alfirk, is derived from the Arabic "*al-firqah"* ("the flock"). The brightest component in this system, Alfirk A, is a blue giant star (B2IIIev), which indicates that it is a variable star. In fact, this star is a prototype for Beta Cephei variables – main sequence stars that show variations in brightness as a result of pulsations of their surfaces.

Then there's Delta Cephei, which is located approximately 891 light years from the Solar System. This star also serves as a prototype for Cepheid variables, where pulsations on its surface are directly linked to changes in luminosity. The brighter component of the binary is classified as a yellow-white F-class supergiant, while its companion is believed to be a B-class star.

Gamma Cephei is another binary star in Cepheus, which is located approximately 45 light years away. The star's traditional name is Alrai (Er Rai or Errai), which is derived from the Arabic *ar-r?'?*, which means "the shepherd." Gamma Cephei is an orange subgiant (K1III-IV) that can be seen by the naked eye, and its companion has about 0.409 solar masses and is thought to be an M4 class red dwarf.

Cepheus is also home to many notable Deep Sky Objects. For example, there's NGC 6946, which is sometimes called the Fireworks Galaxy because of its supernovae rate and high volume of star formation. This intermediate spiral galaxy is located approximately 22 million light years distant. The galaxy was discovered by William Herschel in September 1798, and nine supernovae have been observed in it over the last century.

The Fireworks Galaxy (NGC 6946). Credit: Simon Driver (University of St. Andrews)

Next up is the Wizard Nebula (NGC 7380), an open star cluster that was discovered by Caroline Herschel in 1787. The cluster is embedded in a nebula that is about 110 light years in size and roughly 7,000 light years from our Solar System. It is also a relatively young open cluster, as its stars are estimated to be less than 500 million years old.

Then there's the Iris Nebula (NGC 7023), a reflection nebula with an apparent magnitude of 6.8 that is approximately 1,300 light years distant. The object is so-named because it is actually a star cluster embedded inside a nebula. The nebula is lit by the star SAO 19158 and it lies close to two relatively bright stars – T Cephei, which is a Mira type variable, and Beta Cephei.

Discovered by Sir William Herschel on October 18, 1794, Herschel made the correct assumption of, "A star of 7th magnitude. Affected with nebulosity which more than fills the field. It seems to extend to at least a degree all around: (fainter) stars such as 9th or 10th magnitude, of which there are many, are perfectly free from this appearance."

So where did the confusion come in? It happened in 1931 when Per Collinder decided to list the stars around it as a star cluster Collinder 429. Then along came Mr. van den Berg, and the little nebula became known as van den Berg 139. Then the whole group became known as Caldwell 4! So what's right and what isn't?

The Wizard Nebula (NGC 738). Credit: NASA/JPL-Caltech/ WISE Team

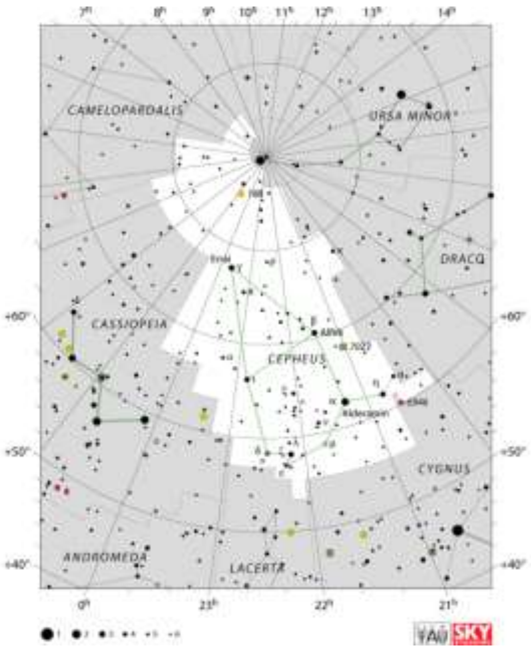
According to Brent Archinal, "I was surprised to find NGC 7023 listed in my catalog as a star cluster. I assumed immediately the Caldwell Catalog was in error, but further checking showed I was wrong! The Caldwell Catalog may be the only modern catalog to get the type correctly!"

Finding Cepheus:

Cepheus is a circumpolar constellation of the northern hemisphere and is easily seen at visible at latitudes between +90° and -10° and best seen during culmination during the month of November. For the unaided eye observer, start first with Cepheus' brightest star – Alpha. It's name is Alderamin and it's going through stellar evolution – moving off the main sequence into a subgiant, and on its way to becoming a red giant as its hydrogen supply depletes.

What's very cool is Alderamin is located near the precessional path traced across the celestial sphere by the Earth's north pole. That means that periodically this star comes within 3° of being a pole star! Keeping that in mind, head off for Gamma Cephei. Guess what? Due to the precession of the equinoxes, Errai will become our northern pole star around 3000 AD and will make its closest approach around 4000 AD. (Don't wait up, though… It will be late).

However, you can stay up late enough with a telescope or binoculars to have a closer look at Errai, because its an orange subgiant binary star that's also about to go off the main sequence and its accompanied by a red dwarf star. What's so special about that? Well, maybe because a planet has been discovered floating around there, too!



The location of the northern Cepheus constellation. Credit: IAU/ Sky & Telescope magazine (Roger Sinnott & Rick Fienberg)

Now let's have some fun with a Cepheid variable star that changes enough in about 5 days to make watching it fun! You'll find Delta on the map as the figure 8 symbol and in the sky you'll find it 891 light-years away. Delta Cephei is binary star system and the prototype of the Cepheid variable stars – the closest of its type to the Sun.

This star pulses every 5.36634 days, causing its stellar magnitude to vary from 3.6 to 4.3. But that's not all! Its spectral type varies, too – going from F5 to G3. Try watching it over a period of several nights. Its rise to brightness is much faster than its decline! With a telescope, you will be able to see a companion star separated from Delta Cephei by 41 arc seconds.

Are you ready to examine two red supergiant stars? If you live in a dark sky area, you can see these unaided, but they are much nicer in binoculars. The first is Mu Cephei – aka. Herschel's Garnet Star. In his 1783 notes, Sir William Herschel wrote: "a very fine deep garnet colour, such as the periodical star omicron ceti" and the name stuck when Giuseppe Piazzi included the description in his catalog.

Now compare it to VV Cephi, right smack in the middle of the map. VV is absolutely a supergiant star, and it is of the largest stars known. In fact, VV Cephei is believed to be the third largest star in the entire Milky Way Galaxy! VV Cephei is 275,000-575,000 times more luminous than the Sun and is approximately 1,600–1,900 times the Sun's diameter.

Artist's impression of VV Cep A, created using Celestia, with Mu Cephei (Garnet Star) in the background. Credit: Wikipedia Commons/Rackshea

If placed in our solar system, the binary system would extend past the orbit of Jupiter and approach that of Saturn. Some 3,000 light years away from Earth, matter continuously flows off this bad boy and into its blue companion. Stellar wind flows off the system at a velocity of approximately 25 kilometers per second. And some body's Roche lobe gets filled!

For some rich field telescope and binocular fun from a dark sky site, try your luck with IC1396. This 3 degree field of nebulosity can even be seen unaided at times! Inside you'll find an open star cluster (hence the designation) and photographically the whole area is criss-crossed with dark nebulae.

For a telescope challenge, see if you can locate both Spiral galaxy NGC 6946 – aka. the Fireworks Nebula – and galactic cluster NGC 6939 about 2 degrees southwest of Eta Cepheus. About 40 arc minutes northwest of NGC 6946 – is about 8th magnitude, well compressed and contains about 80 stars.

More? Then try NGC 7023 – The Iris Nebula. This faint nebula can be achieved in dark skies with a 114-150mm telescope, but larger aperture will help reveal more subtle details since it has a lower surface brightness. Take the time at lower power to reveal the dark dust "lacuna" around it reported so many years ago, and to enjoy the true beauty of this Caldwell gem.

The Iris Nebula (NGC 7023). Credit: Hewholooks

Still more? Then head off with your telescope for IC1470 – but take your CCD camera. IC1470 is a compact H II region excited by a single O7 star associated with an extensive molecular cloud in the Perseus arm!

Yes, Cepheus has plenty of viewing opportunities for the amateur astronomer. And for thousands of years, it has proven to be a source of fascination for scholars and astronomers.

We have written many interesting articles about the constellation here at Universe Today. Here is What Are The Constellations?, What Is The Zodiac?, and Zodiac Signs And Their Dates.

Be sure to check out The Messier Catalog while you're at it!

For more information, check out the IAUs list of Constellations, and the Students for the Exploration and Development of Space page on Canes Venatici and Constellation Families.

ISS PASSES For September 2018 From Heavens Above website maintained by Chris Peat

Date	Brightness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
04 Sep	-1.2	03:52:41	13°	SE	03:52:41	13°	SE	03:53:50	10°	ESE
04 Sep	-3.4	05:25:21	14°	SW	05:27:59	51°	SSE	05:31:11	10°	E
05 Sep	-2.9	04:35:23	32°	S	04:36:01	36°	SSE	04:39:04	10°	E
06 Sep	-1.6	03:45:23	19°	ESE	03:45:23	19°	ESE	03:46:51	10°	E
06 Sep	-3.8	05:18:03	19°	WSW	05:20:17	76°	SSE	05:23:33	10°	E
07 Sep	-3.7	04:28:01	56°	S	04:28:14	58°	SSE	04:31:29	10°	E
08 Sep	-1.6	03:37:58	22°	E	03:37:58	22°	E	03:39:20	10°	E
08 Sep	-3.9	05:10:38	22°	W	05:12:35	88°	NNW	05:15:53	10°	E
09 Sep	-3.9	04:20:35	80°	SE	04:20:35	80°	SE	04:23:47	10°	E
09 Sep	-3.8	05:53:43	10°	W	05:57:00	88°	S	06:00:17	10°	E
10 Sep	-1.3	03:30:32	20°	E	03:30:32	20°	E	03:31:39	10°	E
10 Sep	-3.9	05:03:12	26°	W	05:04:52	85°	N	05:08:10	10°	E
11 Sep	-3.5	04:13:11	63°	ENE	04:13:11	63°	ENE	04:16:00	10°	E
11 Sep	-3.8	05:45:57	10°	W	05:49:14	68°	SSW	05:52:29	10°	ESE
12 Sep	-0.9	03:23:13	15°	E	03:23:13	15°	E	03:23:51	10°	E
12 Sep	-3.9	04:55:54	36°	W	04:57:06	84°	S	05:00:22	10°	ESE
13 Sep	-2.6	04:06:00	40°	E	04:06:00	40°	E	04:08:13	10°	E
13 Sep	-3.4	05:38:41	14°	W	05:41:19	44°	SSW	05:44:27	10°	SE
14 Sep	-3.9	04:48:54	57°	SW	04:49:13	61°	SSW	04:52:27	10°	ESE
15 Sep	-1.5	03:59:15	19°	ESE	03:59:15	19°	ESE	04:00:20	10°	ESE
15 Sep	-2.7	05:31:56	20°	WSW	05:33:16	26°	SSW	05:36:04	10°	SSE
16 Sep	-2.4	04:42:28	26°	SSE	04:42:28	26°	SSE	04:44:17	10°	SE
17 Sep	-1.7	05:25:56	14°	SSW	05:25:56	14°	SSW	05:27:02	10°	S
22 Sep	-1.6	20:56:48	10°	SSW	20:57:42	15°	S	20:57:42	15°	S
23 Sep	-2.0	20:05:22	10°	S	20:07:23	15°	SE	20:08:03	15°	SE
23 Sep	-1.2	21:40:08	10°	WSW	21:40:44	14°	SW	21:40:44	14°	SW
24 Sep	-3.1	20:48:03	10°	SW	20:50:53	38°	SSE	20:50:53	38°	SSE
25 Sep	-2.6	19:56:08	10°	SSW	19:58:58	27°	SSE	20:00:52	16°	E
25 Sep	-2.0	21:31:52	10°	WSW	21:33:32	27°	WSW	21:33:32	27°	WSW
26 Sep	-3.8	20:39:37	10°	WSW	20:42:52	61°	SSE	20:43:24	51°	ESE
26 Sep	-0.4	22:16:01	10°	W	22:16:03	10°	W	22:16:03	10°	W
27 Sep	-3.3	19:47:26	10°	SW	19:50:35	44°	SSE	19:53:10	14°	E
27 Sep	-2.5	21:23:39	10°	W	21:25:49	38°	W	21:25:49	38°	W
28 Sep	-3.9	20:31:18	10°	WSW	20:34:36	84°	SSE	20:35:31	45°	E
28 Sep	-0.6	22:07:48	10°	W	22:08:09	12°	W	22:08:09	12°	W
29 Sep	-3.7	19:38:59	10°	WSW	19:42:15	68°	SSE	19:45:09	13°	E
29 Sep	-2.7	21:15:25	10°	W	21:17:48	44°	W	21:17:48	44°	W
30 Sep	-3.9	20:23:02	10°	W	20:26:20	85°	N	20:27:24	40°	E
30 Sep	-0.7	21:59:32	10°	W	22:00:02	14°	W	22:00:02	14°	W
01 Oct	-3.8	19:30:37	10°	W	19:33:56	88°	SSE	19:36:58	12°	E
01 Oct	-2.9	21:07:08	10°	W	21:09:36	47°	W	21:09:36	47°	W
02 Oct	-3.9	20:14:43	10°	W	20:18:02	87°	N	20:19:10	38°	E
02 Oct	-0.7	21:51:14	10°	W	21:51:48	14°	W	21:51:48	14°	W
03 Oct	-3.8	19:22:17	10°	W	19:25:36	84°	N	19:28:43	11°	E
03 Oct	-2.9	20:58:47	10°	W	21:01:21	46°	WSW	21:01:21	46°	WSW
04 Oct	-3.8	20:06:21	10°	W	20:09:39	77°	SSW	20:10:55	34°	ESE

END IMAGES, OBSERVING AND OUTREACH

All sky Milky Way from Alton Barnes car park between the 2 highest hills in Wiltshire.

Perseid meteor streaking down.

8mm Sigma fisheye on Nikon D800, 30 seconds.

Wiltshire Astronomical Society	Observing Sessions 2018 – 2019	
Date	**Moon Phase (%)**	**Moonrise**
2018		
28th September	Waning Gibbous (85%)	8.47 pm
2nd November	Waning Crescent (25%)	After midnight
30th November	Waning Crescent (39%)	After midnight
28th December (6.30pm start)	Last Quarter (54%)	11.35 pm
2019		
21st January	Total Lunar Eclipse	Starts 03:30 am
25th January	Waning Gibbous (70%)	10.36 pm
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

Saturday 8th September Meade School Trowbridge Morning and afternoon.

Friday 9th November. Great Wishford School, nr Wilton. Afternoon and possible evening.