NWASNEWS

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September 2019

Newsletter for the Wiltshire, Swindon, Beckington Astronomical Societies

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Welcome to the New Season

Wow, just had to change the Volume number at the top of this issue of the newsletter, and it is the quarter of century, 25 years of writing and producing the newsletter.

When it started it was printed on litho machines, then as my company went digital I was producing on a huge docutech machine, and I could 'test' stitching and folding applications built into the machine so I could sell the application to our publishers as an add on service (useful for academic and symposium publishers to provide author hand outs). I even dabbled with digital stochastic screening which was a world first at the time. The joys of owning these big toys as a director…

Then with the fateful news of my wife's terminal cancer coinciding with the sale of the business I took the opportunity to take an early retirement and set up an observatory in Spain and take the out reach to schools in school hours. Plus many other roles within astronomy. Despite severe bursitis and growing arthritis I have kept the newsletter going. I hope it is appreciated by the members, the full versions are on the internet and I print out the 4pp meeting newsletter on a home laser printer (probably works out to 2p per page printed). Over the 24 full years I have put around 5,000 pages, and prime writing over 1,000 pages.

As this has been about the passage of time here is the Segway to our speaker for tonight, Steve Tonkin who will be looking at the formation of calendars and other aspects of time.

We also have the small matter of our AGM to discuss. Hopefully nothing onerous, all current committee members have agreed to stand apart from one of our two observing evening co-ordinaters, Tony Vale.

A copy of the accounts should be available at the meeting, I have cleared with the committee a spend of £229 for a new projector with the latest connections for HDMI and higher resolution, bright projection and zoom range...

Clear skies

Andy Burns.

We had a couple of members travel out to Argentina and Chile for the total solar eclipse in the crisp skies of the Andes.
Here is an image from Peter Chappell.
3rd Contact: f6.3, ISO 3200, shutter speed (S/S) 1/160 of a second at 400 mm.

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

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

Meetings 2018/2019Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

NEW SEASON 2019/2020

3rd Sep: Steve Tonkin, Time & Calendar + AGM
1st Oct: TBC (awaiting come back e mail from possible speaker)
5th Nov: Andrew Lound:, Uranus – George's planet
3rd Dec: Dr Dirk Froebrich, Making stars & planets – The Hoys=Caps Citizen Science Project.

Steve Tonkin

The Astronomical Unit exists to make reliable astronomical information available to all. I do this through providing free information on this web site and undertaking outreach activities, including Star-tales (astronomy-based storytelling for children and adults), giving Astronomical Talks and running Astronomy Courses in the local community. These outreach activities are run both independently and in association with local astronomical societies, the National Trust, BBC Stargazing Live, local community groups, schools, colleges and adult learning centres.

I also run a companion website, The Binocular Sky, specifically for Astronomy with Binoculars.

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)

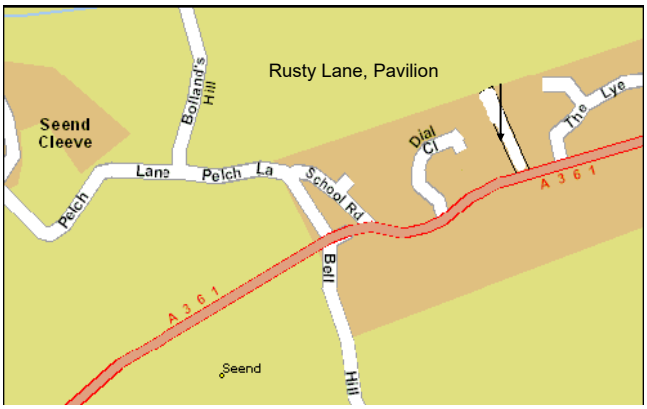
Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

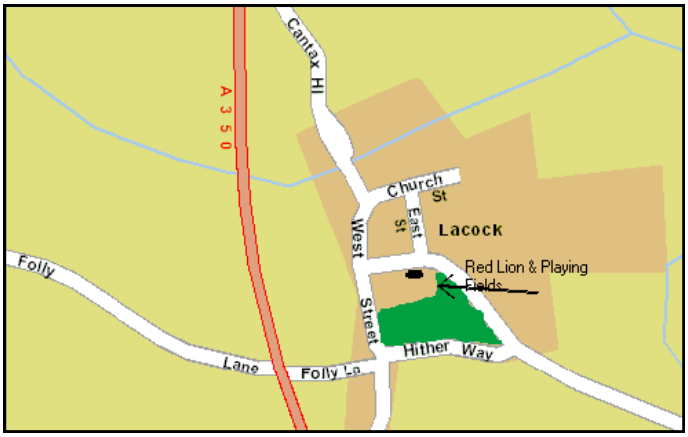
Observing Sessions coordinators: Jon Gale,

Web coordinator: Sam Franklin

Contact via the web site details.



Observing Sessions



The Wiltshire Astronomical Society's observing sessions are open, and we welcome visitors from other societies as well as members of the public to join us.
We will help you set up equipment (as often as you need this help), and let you test anything we have to help you in your choice of future astronomy purchases.
Please treat the lights and return to full working order before leaving. With enough care shown we may get the National Trust to do something with them!

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

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

Swindon's own astronomy group

September Meeting: Dr Lilian Hobbs

She is a Product Manager for the Oracle Corporation and astronomy is a hobby. She is a keen observer and astrophotographer.

She has been interested in Astronomy for many years. Her first telescope was purchased from Dixons and served her very well. Since then she has purchased several telescopes and currently likes Meade, Takahashi & TMB Telescopes.

The Meade ETX/EC-90, is ideal for travelling and she has taken hers on several business trips which enabled her to see the transit of Mercury.

Ad-hoc viewing sessions

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

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

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

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

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

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

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

Enjoy astronomy at it's best!

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

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

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

Meeting Dates for 2019

Friday 20 September 2019
Programme: Dr. Lilian Hobbs: How Astronomy Has Changed

Friday 18 October 2019

Programme: Robert Slack: The Grand Tour

Friday 15 November 2019
Programme: TBA

Friday 13 December 2019
Programme: TBA

Meeting Dates for 2020
Friday 7 January
Programme: Chris Starr FRAS MBIS:. Introduction to the Night Sky for Beginners

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

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

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

Website:

http://www.swindonstargazers.com

Chairman: Robin Wilkey

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

Secretary: Hilary Wilkey

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

BECKINGTON ASTRONOMICAL SOCIETY

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

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

Our Committee for 2016/2017 is

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

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

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

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

Post Code for Sat Nav is BA11 6TB.

Our start time is 7.30pm.

STAR QUEST ASTRONOMY CLUB

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

What Powers a Spacecraft?

The Short Answer:

A spacecraft generally gets its energy from at least one of three power sources: the Sun, batteries or unstable atoms. To choose the best type of power for a spacecraft, engineers consider where it is traveling, what it plans to do there and how long it will need to work.

Spacecraft have instruments that help them take pictures and collect information in space. But they need electricity to power those instruments and send the information back to Earth. Where does the power come from?

The answer is that it depends on the mission. To choose the best power system for a spacecraft, engineers have to think about several things. Some factors they consider are: where the spacecraft is traveling, what it plans to do there and how long it will need to work.

One source of power is the Sun.

Energy from the Sun (solar power)

Solar power is energy from the Sun. Spacecraft that orbit Earth, called satellites, are close enough to the Sun that they can often use solar power. These spacecraft have solar panels which convert the Sun's energy into electricity.

The electricity from the solar panels charges a battery in the spacecraft. These batteries can power the spacecraft even when it moves out of direct sunlight.

Solar energy has also been used to power spacecraft on Mars. NASA's Mars Exploration Rovers, Spirit and Opportunity, and Mars' Phoenix lander all used power from solar panels and so does the InSight lander. Spacecraft traveling far away from the Sun have very large solar panels to get the electricity they need. For example, NASA's Juno spacecraft uses solar power all the way out at Jupiter, where it orbits the planet. Each of Juno's three solar arrays is 30 feet (9 meters) long!

NASA's Juno spacecraft is powered by very large solar arrays. It began orbiting Jupiter in 2016. Credit: NASA/JPL-Caltech

However, solar power doesn't work for all spacecraft. One reason is that as spacecraft travel farther from the Sun, solar power becomes less efficient. Solar-powered explorers may also be limited by a planet's weather and seasons, and harsh radiation (a type of energy). And they might not be able to explore dark, dusty environments, such as caves on the Moon.

When solar power won't work, spacecraft have to get their power another way. So, scientists developed other ways that these spacecraft can get power. One way is to simply use batteries that can store power for a spacecraft to use later.

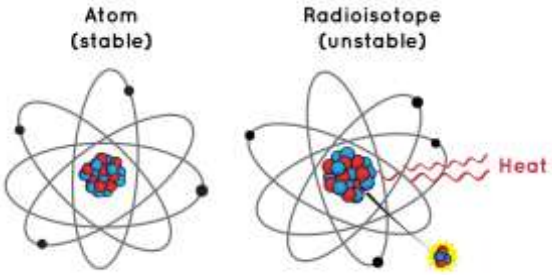
Energy from batteries

Sometimes, missions are designed to last a short amount of time. For example, the Huygens probe that landed on Saturn's large moon Titan was only meant to work for a few hours. So a battery provided enough power for the lander to do its job.

Spacecraft batteries are designed to be tough. They need to work in extreme environments in space and on the surfaces of other worlds. The batteries also need to be recharged many times. Over time, NASA scientists have invented ways to improve these batteries. Now they can store more energy in smaller sizes and last longer.

Energy from atoms

An **atom** is a tiny building block of matter. Almost everything we know in the universe is made up of atoms. Atoms have to store a lot of energy to hold themselves together. But, some atoms—called **radioisotopes**—are unstable and begin to fall apart. As the atoms fall apart, they release energy as heat.



An unstable atom is called a radioisotope. When these unstable atoms fall apart, they release energy as heat. Credit: NASA/JPL-Caltech

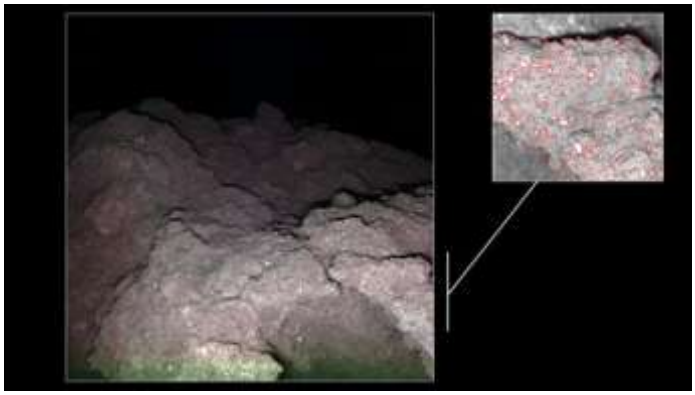
A **radioisotope power system** uses the temperature difference between the heat from the unstable atoms and the cold of space to produce electricity. NASA has used this type of system to power many missions. For example, it has powered missions to Saturn, Pluto and even spacecraft that have traveled to interstellar space. This type of power system also provides the energy for the Curiosity rover on Mars.

Radioisotope systems produce power for a very long time, even in harsh environments. In fact, NASA's two Voyager spacecraft use this type of power. They have traveled farther than any other human-made object and are still sending back information after more than 40 years in space!

SPACE NEWS FOR SUMMER 2019

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

Asteroid Ryugu is a “Fragile Rubble Pile”



When Japan’s Hayabusa 2 spacecraft arrived at asteroid Ryugu in June 2018, it carried four small rovers with it. Hayabusa 2 is primarily a sample-return mission, but JAXA (Japan Aerospace Exploration Agency) sent rovers along to explore the asteroid’s surface and learn as much as they could from their visit. There’s also no guarantee that the sample return will be successful.

They chose Ryugu because the asteroid is classified as a primitive carbonaceous asteroid. This type of asteroid is a desirable target because it represents the primordial matter that formed the bodies in our Solar System. It’s also pretty close to Earth.

The sample from Ryugu, which will make it to Earth in December 2020, is the big science prize from this mission. Analyzing it in Earth-based laboratories will tell us a lot more than spacecraft instruments can. But the rovers that landed on Ryugu’s surface have already revealed a lot about Ryugu.

Mars 2020 Rover Gets its Helicopter Sidekick

Work on the Mars 2020 Rover is heating up as the July/August 2020 launch date approaches. Mission engineers just attached the Mars Helicopter to the belly of the rover, where it will make the journey to Mars. Both the solar-powered helicopter and the Mars Helicopter Delivery System are now attached to the rover.

NASA’s Mars Helicopter will be the first aircraft to fly on another planet. The small rotor-craft only weighs 1.8 kg (4 lbs.) and is made of lightweight materials like carbon fiber and aluminum. It’s largely a technology demonstration mission, and is important to NASA. The overall mission for the Mars 2020 rover won’t depend on the helicopter, but NASA hopes to learn a lot about how to proceed with aircraft on future missions by putting the Mars helicopter through its paces on Mars.

Upgraded ISS Now Has a 600 Megabit per Second Internet Connection

In the digital age, connectivity and bandwidth are important, even if you’re in Low Earth Orbit (LEO). And when you’re performing research and experiments that could help pave the way for future missions to the Moon, to Mars, and other deep-space destinations, it’s especially important. Hence why NASA recently upgraded the ISS’ connection, effectively doubling the rate at which it can send and receive data.

ExoMars Parachute Test Fails, for the Second Time

Next year, the European Space Agency (ESA) will be sending the *ExoMars 2020* mission to the Red Planet. This mission consists of an ESA-built rover (*Rosalind Franklin*) and a Russian-led surface science platform (*Kazachok*) that will study the Martian environment in order to characterize its surface, atmosphere, and determine whether or not life could have once existed on the planet.

In preparation for this mission, engineers are putting the rover and lander through their paces. This includes the ongoing development of the mission’s parachute system, which is currently in troubleshooting after a failed deployment test earlier this month. These efforts are taking place at the Swedish Space Corporation testing site in Esrange, and involve the largest parachute ever used by a mission to Mars.

When it Comes to Gamma Radiation, the Moon is Actually Brighter Than the Sun

The eerie, hellish glow coming from the Moon may

seem unreal in this image, since it's invisible to our eyes. But instruments that detect gamma rays tell us it's real. More than just a grainy, red picture, it's a vivid reminder that there's more going on than meets human eyes. It's also a reminder that any humans that visit the Moon need to be protected from this high-energy radiation.

From Cosmic Rays to Gamma Rays

NASA's Fermi Gamma-Ray Space Telescope captured these images of the Moon's gamma rays. In this part of the electromagnetic spectrum, the Moon is actually brighter than the Sun. That's because the Sun produces most of its energy in other parts of the spectrum, though it does emit some gamma rays, especially during solar flares.

Most gamma rays in our Solar System come from distant sources like quasars and active galactic nuclei (AGN.) The Moon is an indirect source of gamma radiation, and produces gamma rays through its interaction with cosmic rays.

Cosmic rays are a type of high-energy radiation that for the most part is produced outside our Solar System. They're produced by things like supernovae and active galactic nuclei. When cosmic rays strike matter, like the surface of the Moon in this instance, they create gamma rays.

An artist's concept of an active galactic nuclei hosting an energetic blazar. Active galacitc nuclei are one source of cosmic rays. When those rays strike the Moon, gamma rays are created. Credit: NASA/Goddard Space Flight Center Conceptual Image Lab.

Two scientists at Italy's National Institute of Nuclear Physics, Mario Nicola Mazziotta and Francesco Loparco, have been studying the Moon's gamma radiation as a means to understand cosmic rays. Cosmic rays are fast-moving particles, and they gain their acceleration from their sources, like the aforementioned supernovae and AGN.

"Cosmic rays are mostly protons accelerated by some of the most energetic phenomena in the universe, like the blast waves of exploding stars and jets produced when matter falls into black holes," explained Mazziotta in a NASA press release.

The particles that make up cosmic rays are electrically charged. When they strike a magnetic field, like the Earth's magnetosphere, they're mostly deflected. But the Moon lacks a magnetic field. As a result, even the weakest cosmic rays strike the Moon's surface directly, and that produces gamma rays. The Moon actually absorbs most of the gamma rays it creates, but some escape out into space.

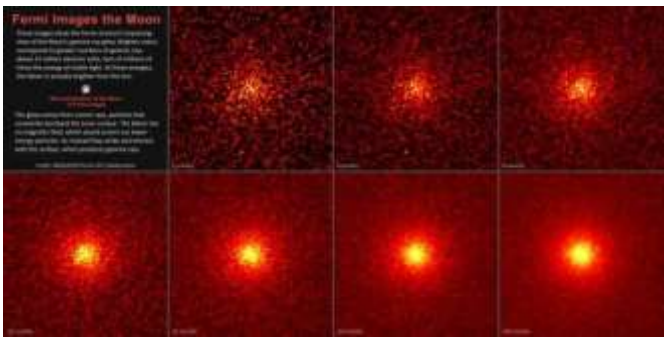
And the Fermi Telescope can see them, turning the Moon into a kind of inadvertent particle detector.

The Fermi Gamma-Ray Space Telescope (FGRST) has been at work for 11 years now. Mazziotta and Loparco have studied images of the Moon from the length of the telescope's mission, and over that time, the view has improved.

"… the Moon would never go through its monthly cycle of phases and would always look full."

Francesco Loparco, Italy's National Institute of Nuclear Physics.

The strength of the Moon's gamma rays is not always consistent. It varies over time. Mazziotta and Loparco gathered together data of the Moon's gamma rays that exceeded 31 million electron volts, which is 10 million times more powerful than visible light, and organized them over time. That resulted in the following image, which shows the view improving over time.



These images show the steadily improving view of the Moon's gamma-ray glow from NASA's Fermi Gamma-ray Space Telescope. Each 5-by-5-degree image is centered on the Moon and shows gamma rays with energies above 31 million electron volts, or tens of millions of times that of visible light. At these energies, the Moon is actually brighter than the Sun. Brighter colors indicate greater numbers of gamma rays. This image sequence shows how longer exposure, ranging from two to 128 months (10.7 years), improved the view.

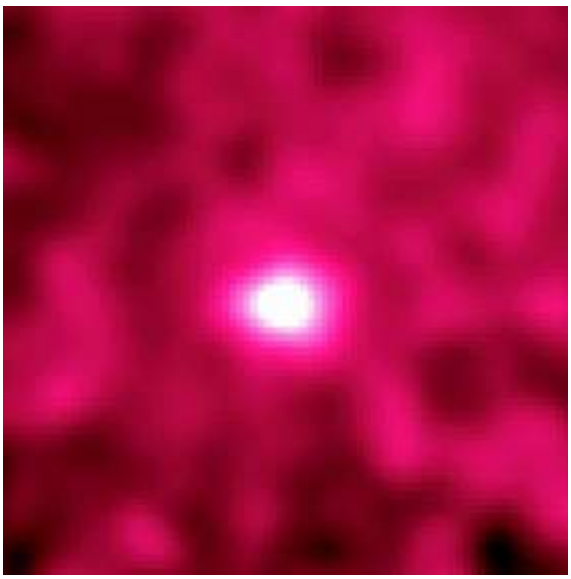
Credit: NASA/DOE/Fermi LAT Collaboration

"Seen at these energies, the Moon would never go through its monthly cycle of phases and would always look full," said Loparco.

The fact that the Moon emits these gamma rays is cautionary. NASA's Artemis Program will see more astronauts on the Moon for potentially longer periods of time than other Moon missions. They'll have to be protected from both the cosmic rays that strike the Moon, and the Moon's gamma rays that result.

A Complex Interaction

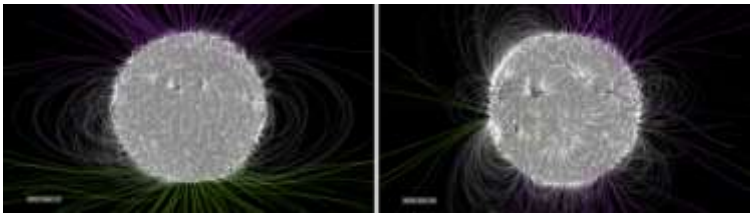
The interplay between cosmic rays, gamma rays, the Moon and the Sun can be complex. Gamma rays can have different energy levels. For instance, these FGRST images only capture gamma rays that exceeded 31 million electron volts (MeV) by a certain amount. But gamma rays can be far more energetic than that, and can be in the billions or even trillions of MeVs.



The Fermi Gamma-Ray Space Observatory is not the only observatory to see the Moon's gamma radiation. The Compton Gamma Ray Observatory captured this image of the Moon's gamma rays. Image Credit: By D. J. Thompson, D. L. Bertsch (NASA/GSFC), D. J. Morris (UNH), R. Mukherjee (NASA/GSFC/USRA) – ur=http://heasarc.gsfc.nasa.gov/docs/cgro/epo/news/gammoon.html., Public Domain, https://commons.wikimedia.org/w/index.php?curid=19838942

Since the electrical charge of cosmic rays means they can be deflected by magnetic fields, and the Sun has a powerful magnetic field, only the most powerful ones can strike the Sun. In turn, these powerful cosmic rays strike the dense part of the Sun's atmosphere and create very powerful gamma rays. So the Sun is actually brighter in gamma rays above 1 billion electron volts than the Moon is.

The Sun's 11-year cycle also affects the cosmic rays that strike the Moon, and the gamma rays that result. During that cycle, the Sun experiences variations in its magnetic field. As a result, sometimes more cosmic rays strike the Moon than other times. This variability in cosmic rays striking the lunar surface creates a variability in lunar gamma rays. According to Fermi data, it can vary by 20%.



The Sun's magnetic field varies in both strength and complexity during its 11-year cycle. This comparison shows the relative complexity of the solar magnetic field between January 2011 (left) and July 2014. In January 2011, three years after solar minimum, the field is still relatively simple, with open field lines concentrated near the poles. At solar maximum, in July 2014, the structure is much more complex, with closed and open field lines poking out all over.

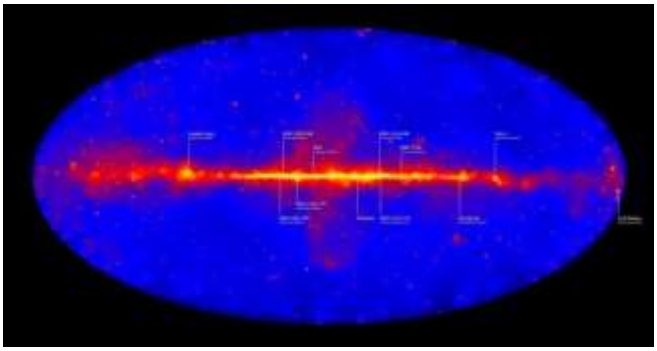
Gamma rays coming from the Moon, and the cosmic rays that cause them, both pose a threat to astronauts because both are ionizing radiation with great penetrating power. It takes a lot of shielding to prevent them from striking astronauts. Materials with high atomic numbers are effective shields. Lead (atomic number 82) is a good shield because it's also very dense.

For lower energy gamma rays, the risk to astronauts is due to exposure over time. Think of an x-ray technician vs. an x-ray patient. A patient's lifetime exposure to x-rays is not very high, so a patient accepts the risk. For the technician however, things are different. They're exposed each work day, so they leave the room and are shielded from the x-rays by materials like lead.

It's similar for astronauts. The more time they spend on the Moon in a gamma ray/cosmic ray environment, the more they need to limit their exposure. Not only by shielding, but by timing.

Trying to Understand the Moon's Radiation Environment

This Fermi Gamma-Ray Space Telescope data is helping scientists understand the gamma ray/cosmic ray risk on the Moon. If there are times when the Moon emits 20% less gamma radiation because of the Sun's 11-year cycle, then it may be sensible to make use of that time.



If we saw the sky in gamma rays, the same way the Fermi Space Telescope does, it would be unrecognizable. This image was constructed from six years of Fermi observations. It shows the entire sky at energies between 50 billion (GeV) and 2 trillion electron volts (TeV). The bright band in the middle is the central plane of the Milky Way. Some of the brightest sources are pulsar wind nebulae and supernova remnants within our galaxy, as well as distant galaxies called blazars powered by supermassive black holes. Labels show the highest-energy sources, all located within our galaxy and emitting gamma rays exceeding 1 TeV. Image Credit: ***NASA/DOE/Fermi LAT Collaboration***

Exposure to radiation is one of the main barriers to space travel and long-term space missions. Earth's magnetosphere and atmosphere are both radiation shields. But even in Low-Earth Orbit, astronauts risk exposure to greater radiation.

If we're going to have a human presence on the Moon, it's imperative that we understand the radiation environment there. NASA has been looking into the lunar radiation environment as far back as 2005 in anticipation of a human outpost on the Moon. When they launched the Lunar Reconnaissance Orbiter (LRO) in 2009, it contained an instrument called the Cosmic Ray Telescope for the Effects of Radiation (CRaTER).

CRaTER's job is to characterize the Moon's radiation environment and the biological impact it will have on astronauts. It uses plastics to mimic human tissue and placed them behind different shielding materials. At the time, Harlan Spence, the Principal Investigator CRaTER said, "Not only will we measure the radiation, we will use plastics that mimic human tissue to look at how these highly energetic particles penetrate and interact with the human body."

The Fermi images of the Moon's gamma rays are another piece of the radiation puzzle. And that's a puzzle

that has to be solved before there's a realistic hope of a long-term lunar base, or crewed missions to Mars.

Milky Way's Black Hole Just Flared, Growing 75 Times as Bright for a Few Hours

Even though the black hole at the center of the Milky Way is a monster, it's still rather quiet. Called Sagittarius A*, it's about 4.6 million times more massive than our Sun. Usually, it's a brooding behemoth. But scientists observing Sgr. A* with the Keck Telescope just watched as its brightness bloomed to over 75 times normal for a few hours.

The flaring is not visible in optical light. It's all happening in the near-infrared, the portion of the infrared spectrum closest to optical light. Astronomers have been watching Sgr. A* for 20 years, and though the black hole does have some variability in its output, this 75 times normal flaring event is like nothing astronomers have observed before. This peak was over twice as bright as the previous peak flux level.

These results are being reported in the Astrophysical Journal Letters in a paper titled "Unprecedented variability of Sgr A* in NIR", and is available at the pre-press site arXiv.org. The lead author is Tuan Do, an astronomer at UCLA.

The Moon is Older Than Scientists Thought

The most comprehensive and widely-held theory of how the Moon formed is called the 'giant impact hypothesis.' That hypothesis shows that about 150 million years after the Solar System formed, a roughly Mars-sized planet named Theia collided with Earth. Though the timeline is hotly-debated in the scientific community, we know that this collision melted Theia and some of Earth, and that molten rock orbited around Earth until it coalesced into the Moon.

But now a new study, though not contradicting the giant impact hypothesis, is suggesting a different timeline, and an older Moon.

New research from scientists at the University of Cologne's Institute of Geology and Mineralogy suggests that the Moon is older than the giant impact hypothesis says it is. Their research is based on chemical analyses of Apollo lunar samples and it shows that the Moon formed only 50 million years after the Solar System, rather than 150 million years. This ages the Moon by 100 million years.

This is important work because understanding the age of the Moon helps us understand the age of the Earth. And this type of study can only be done with Moon rocks because they're largely unchanged since the time of formation. Earthly rocks have been subjected to geological processes for billions of years and don't provide the same type of pristine record of formation that Moon rocks do.

"The Moon thus provides a unique opportunity to study planetary evolution."

Dr. Peter Sprung, Co-Author, University of Cologne

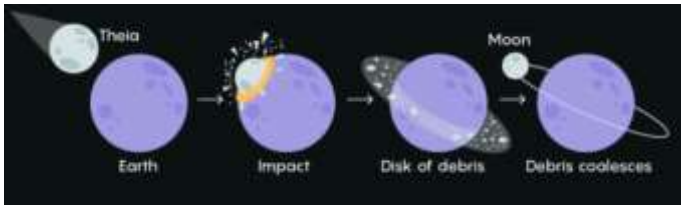
The study is titled "Early Moon formation inferred from hafnium-tungsten systematics," and is published in Nature Geoscience.

The evidence stems from the relationships between two rare elements: halfnium (Hf) and tungsten (W; it used to be known as wolfram.) It's focused on the amounts of the different chemical elements that are in rocks of different ages.

Hafnium is a shiny, corrosion-resistant metal. Image Credit: By Deglr6328 at the English language Wikipedia, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=6875345

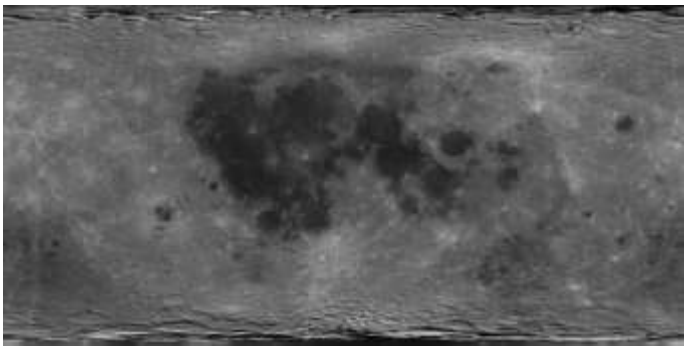
"By comparing the relative amounts of different elements in rocks that formed at different times, it is possible to learn how each sample is related to the lunar interior and the solidification of the magma ocean," said Dr. Raul Fonseca, from the University of Cologne. Together with his colleague, and co-author of the study Dr. Felipe Leitzke, they do laboratory experiments to study the geological processes that occurred in the Moon's interior.

After Theia struck Earth and created a swirling cloud of magma, that magma cooled and formed the Moon. After the collision, the newly-born Moon was covered in magma. As the magma cooled, it formed different types of rocks. Those rocks contain a record of that cooling scientists are trying to recover. "These rocks recorded information about the formation of the Moon, and can still be found today on the lunar surface," says Dr. Maxwell Thiemens, former University of Cologne researcher and lead author of the study.



A simple illustration showing how the Moon formed. Image Credit: By Citronade – Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=72720188

There are black regions on the surface of the Moon called mares, which means 'seas' in latin. They're large formations of basaltic, igneous rock. The scientists behind the study used the relationship between uranium, halfnium, and tungsten to understand the melting that created the Moon's mares. Because of the precision of their measurements, they identified distinct trends among the different suites of rocks.



A cylindrical projection of the Moon showing the black lunar mares. Image Credit: By Image processing by the U.S. Geological Survey in Flagstaff, Arizona. – direct source found on here, Public Domain, https://commons.wikimedia.org/w/index.php?curid=1889962

Halfnium and tungsten provide scientists with a natural clock contained in the rock itself, because over time the hafnium-182 isotope decays into tungsten 182. But that decay didn't go on for ever; it only lasted for the first 70 million years of the Solar System's life. The team compared the Apollo samples with their laboratory experiments and found that the Moon already started solidifying as early as 50 million years after solar system formed.

Tungsten has the highest melting point of any metal, and is used in lots of alloys. Image Credit: By Alchemist-hp (www.pse-mendelejew.de) – Self-photographed, CC BY-SA 2.0 de, https://commons.wikimedia.org/w/index.php?curid=4282516

"This age information means that any giant impact had to occur before that time, which answers a fiercely debated question among the scientific community regarding when the Moon formed," adds Professor Dr. Carsten Münker from the UoC's Institute of Geology and Mineralogy, senior author of the study.

This image shows what the collision between Earth and Theia might have looked like. Image: Hagai Perets

Dr. Peter Sprung, co-author of the study, adds: "Such observations are not possible on Earth anymore, as our planet has been geologically active over time. The Moon thus provides a unique opportunity to study planetary evolution."

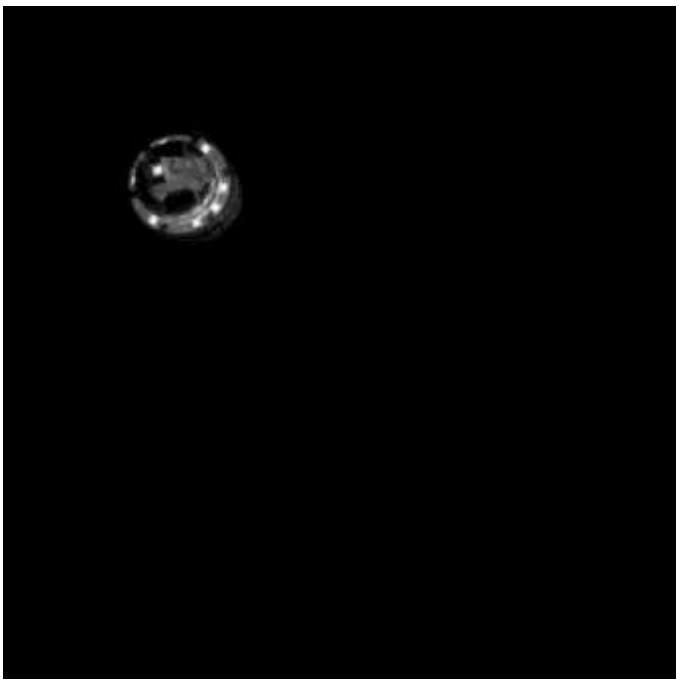
It's amazing that the rocks collected during Apollo 11 fifty years ago are still yielding evidence like this. The team's extremely precise measurements are based on inductively coupled plasma mass spectrometry, something that wasn't possible in Apollo's time. The astronauts that collected the samples couldn't have known this, but those rocks are still teaching us not only about the Moon, but about the age of the Earth itself.

Hayabusa 2 is the First Spacecraft to Sample the Inside of an Asteroid

Japan's Hayabusa 2 spacecraft is now the first spacecraft to retrieve a subsurface sample from an asteroid. On July 11th, the spacecraft touched down for a second time on asteroid 162173 Ryugu. This time, the probe retrieved a sample from a crater it excavated with its impactor.

The subsurface sampling operation is a complex mission. Hayabusa 2 first had to find a good location for the sampling site. That's not straight-forward on a rocky, bumpy body like Ryugu. Once it selected the location for the sampling, it then launched its Small Carry-on Impactor (SCI). The SCI is a 2.5 kg (5.5 lb) piece of copper propelled by an explosive charge.

But the SCI wasn't fired. Not yet. It remained above the asteroid, slowly lowering itself and waiting for the command to ignite its explosive charge and launch its copper projectile into the surface.



The SCI above Ryugu after being deployed by Hayabusa 2. It didn't fire its projectile into the asteroid until the spacecraft had travelled to a safe distance away from any debris. Image: JAXA

When Hayabusa 2 launched the SCI, it also left a camera behind at the impactor site. That camera is called the DCAM3, or Deployable Camera 3, and its job was to observe and map out the impact site. Then Hayabusa 2 made a two week journey 100 km away from Ryugu, to protect itself from debris from the impactor.

Once Hayabusa 2 was at a safe distance, the SCI was fired into the surface of Ryugu, excavating a pit. The DCAM3 was there to observe it, while Hayabusa 2 waited safely out of sight.

DCAM 3 captured this image of the SCI impact on 5 April 2019. The impact debris is a small spray of dust against the black of space, near the top-right limb of the asteroid. Image Credit: JAXA

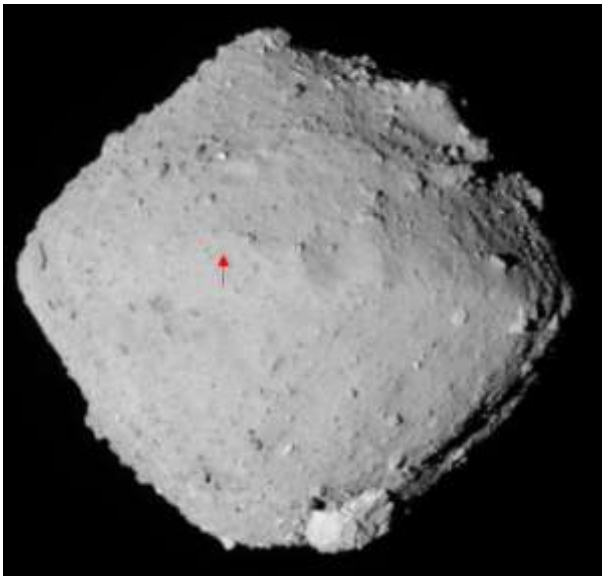
Hayabusa 2 waited for the debris to settle until the danger had passed, then it returned to the impact site. On July 11th, at about 1:05 UTC, the spacecraft descended towards Ryugu and retrieved a sub-surface sample.

And that's how the Japanese spacecraft reached another milestone.

What's the Big Deal About a Sub-Surface Sample?

Asteroids like Ryugu are almost like time capsules from the very early days of the Solar System, waiting for us to open them.

They're made of the same primordial material that the rocky planets like Earth are made from. But there's a difference between the surface samples and subsurface samples. The subsurface material is in a pristine state.



Asteroid Ryugu, as imaged by the Hayabusa2 spacecraft. The red dot marks the sampling location. Image Credit: JAXA/Hayabusa2

Surface material is subject to space weathering from the Sun. Over the billions of years since the Solar System formed, that material has changed. It's still scientifically interesting, but the material underneath it has never seen the Sun. Scientists want to get their hands on it and get it into labs to analyze it, and to hopefully shed some light on the origins of Earth and other rocky bodies.

When Will We Get The Samples?

Hayabusa 2's science phase will end in December 2019. At that point, with samples encased in protective canisters, the spacecraft will fire up its ion engines and head for Earth. When it approaches Earth, it will launch its sample return canister (SRC) towards Earth, and parachutes will slow its descent to the surface. From there, it'll be collected.

Celebratory V for Victory sings from the crew at JAXA's mission control room. Image Credit: JAXA

JAXA says that the samples should arrive on Earth in December 2020. The samples will go to JAXA's Extraterrestrial Sample Curation Center, and scientists can request portions of the sample for study.

After some time has passed, we can expect scientists to publish a bunch of new papers based on the Ryugu samples, both surface and subsurface.

Sending Hayabusa 2 On Its Way

Only the Sample Return Capsule will be returned to Earth in December 2020. Hayabusa 2 won't be done at that point. It should still have about 30 kg of zenon propellant for its ion engines, and JAXA intends to send Hayabasa 2 to another asteroid. Asteroid 2001 WR1 is a prime candidate for Hayabusa 2, but it won't land or retrieve any samples from that asteroid. The mission would be a fly-by to see what can be learned about the asteroid, and that would happen in 2023.

Hayabusa 2 is the successor to Hayabusa, JAXA's first asteroid sample-return mission. Hayabusa visited asteroid Itokawa in September 2005 and in June 2010 it returned tiny samples of dust grains from the asteroid to Earth. Those samples showed that Itokawa contains abundant amounts of water very similar to the water in Earth's oceans.

Artist concept of the Hayabusa spacecraft, which visited asteroid Itokawa in 2005 and returned samples to Earth in 2010. Credit: JAXA

That result only adds to the intrigue and anticipation around Hayabusa 2's sample return. The key, overarching question behind asteroid sample-return missions centers on Earth. Mainly, what role did asteroids and comets play in Earth's history? How did they deliver water, and possibly the chemical building blocks for life, to the young Earth? Hayabusa 2, and its successor Hayabusa, are not the only asteroid sample return missions. NASA's Osiris-REx mission is at asteroid Bennu right now, and should return a sample in 2023. It'll be interesting to see what we learn from these complex missions, and how it will shape our understanding of Earth and how it came to be the living planet it is.

E Mails Viewings Logs and Images from Members.

Hi Andy,

Some viewing logs and pictures for the mag.

Tech details:

3rd Contact: f6.3, ISO 3200, shutter speed (S/S) 1/160 of a second at 400 mm. On front page.

Wide field view of eclipse: f3.5, ISO 3200, S/S 1/25 of a second at 18 mm.

Both pictures taken with a Canon 70 D camera and Tamron 18 – 400 mm zoom lens.

Jupiter (IMG 5319a): f5.6, ISO 2500, 25 second S/S

at 17 mm.
Coal Sack and Crux (IMG 5334a): f5.6, ISO 2500, 25 second S/S at 17 mm.
South celestial pole (IMG 5331a): f4.5, ISO 200, 894 second S/S at 14 mm.
Closer view of Coal Sack and Crux (IMG 5320a): f4.5, ISO 2000, 31 second S/S at 22 mm.

Four pictures taken with a Canon 60 Da camera and a Canon 10 – 22 zoom lens .

Regards

Peter
{Some of the pictures are too dark for print..

Hi Andy,
Here are my submissions for the WAS September Newsletter. There are so many events since the last newsletter – brilliant Summer Solstice at Stonehenge, Total Solar Eclipse, Partial Lunar Eclipse, Perseid Meteors and so on. Here is a selection from my images:

2019 Total Solar Eclipse - Bella Vista, San Juan, Argentina

Wide angle - Canon 1200D, Samyang 8mm Fisheye (effective focal length 13mm), ISO 400, F8, 1.3 sec, Exposure bias minus 1.3 stops. Post processed in Affinity Photo.

Chromosphere and Prominences
Canon SX50HS Lens Approx 900mm ISO 100
12 images blended in Affinity Photo
1 at F5.6 exposure 1 sec
11 at F8 at following exposures 1 sec, 0.5, 0.25, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000

Diamond Ring/Baileys Beads

Canon SX50HS Lens Approx 900mm ISO 100 F8, 1/1600

The highlight was the Total Solar Eclipse with llamas in the adjoining field and views of the Andes. Even more incredible was sitting in the coach on the way back to our hotel and seeing the detail of the Milky Way thru the coach windows!
I have started to use image photo processing software called Affinity Photo from Serif. It is priced in the £40 - £50 range depending if there is a sale on or not. This is for a single device licence and is available for Windows, Mac and iPad. The Solar Eclipse chromosphere image was blended using the software. From my experience so far I would rate it as comparable to Photoshop. It is layer based and has a raw developer as well. The raw developer is better than Canon Digital Photo Professional (DPP) as it can also process raw images from my older Canon cameras. Otherwise I have to keep different versions of DPP for each generation of cameras.
Clear Skies,
John Dartnell

Viewing logs from Peter Chappell

Viewing Log for 1st July

While on my trip to Argentina/Chile for the total solar eclipse in early July, I only really had one time that I managed to get my telescope out for viewing the night sky and the conditions were not that good!

We were staying at the Del Bono Hotel in San Juan about two hours west of Buenos Aires for a couple of nights. After we had finished our evening meal and before we hit the wine (yes, I did drink some of the local red wine it tasted very nice!) we noticed the sky was clear and thought about getting the telescope out and try and do some viewing. Trouble was everywhere we went there was some lighting, the best place we found was near the swimming pool, as this is the middle of winter it was empty and probably doing its annual maintenance. Of course, to us Brits it did not feel like winter as we did the viewing in shorts and t shirts! We would never get good night vision due to the surrounding light, so all we could really look at would be the brighter objects in the sky?

My usual solar eclipse equipment for my travels is a William Optics 80 mm refractor on a Porta Mount I tripod, I also had a 8 mm Televue Ethos eye piece with me on top of the 7 – 21 mm zoom eye piece that stays with the telescope normally. We saw a bright star low down near the horizon (later found out it was Canopus), this star was jumping around all over the eye piece, and the light rays are going thru a lot of atmosphere. I guessed the star was not more than 5 ° above the horizon, not the best of conditions for viewing. First real targets of the evening for me and the few other people who joined me was Jupiter followed by Saturn, both of these planets I could make out even though they seemed upside down and I could not recognise some star patterns? Crux, the Southern Cross could be made out near a Palm Tree, had a look at the four main stars that make up the cross, namely Acrux, GA crux, Delta and Beta Crux. I knew the Jewel Box cluster was slightly to the east of the cross, using my 'Sky & Telescope' pocket atlas that I brought out me I guessed where the cluster should be? So with a bit of slewing with the tripod controls I finally managed to see it, I know why John Herschel called it the 'Jewel Box', an outstanding cluster to look at? Rigel Kent, lead star in the constellation of Centaurus and the third brightest star in the night sky (after Sirius and Canopus), I managed to spilt this triple star (you can only see two of the stars as Proxima Centauri is a 12th magnitude star and I did not have the equipment with me to see it!), one of the friends I made (he is with the West of London Astronomy Society) knows the sky well and was surprised about this spilt I managed to pull off?

After about 90 minutes of viewing we decided to call it an evening and return to the bar and have a glass of wine, or two for the rest of the evening and talk about the upcoming total solar eclipse?

Clear skies.

Peter Chappell

Viewing Log for 24th of August

Mark Radice of Salisbury Plain Observing Group (SPOG) arranged a viewing session at Casterley Camp just above Upavon. If the skies were clear I had planned to go out and do my first viewing session of the new season, normally I would travel to Uffcott and view from there but as other people would be attending Mark's session I thought I would join them? Going to Upavon is about a 40 minute drive for me and probably the longest I would go for a session?

My first port of call was Hackpen Hill and get the sunset before heading off to Casterley. When I arrived at Hackpen I noticed the horizon to the west had a lot of cloud around and it did not look good for later on! I managed to get some pictures of the brief sunset (later posted onto my Facebook page) before carrying on my journey.

When I arrived at Casterley Camp at 21:07 there was already four cars parked up and equipment being set up even though the conditions did not look that great? Mark introduce me to a member from Andover and one from Basingstoke as well as seeing another Peter from SPOG. As usual I would be using my trusted Meade LX90 GOTO telescope using a Pentax 14 mm eye piece. To start with I could not do any set ups as Polaris was hiding behind a bank of cloud, it stayed like this for a good 30 minutes, so in the mean time I went first to Jupiter followed by Saturn and looked at the two gas giants moving the scope manually to keep the planets in view. Finally the clouds broke a bit and I could find Polaris, so after doing my set up I had the scope ready at 21:56! While slewing to my first target I had a power failure, eh what……? Looking down at my tripod I noticed the power wire had caught on one of the legs not the first time this has happened to me), after freeing the wire I noticed the plug connection seemed a bit loose? Doing another set up I had the same failure, loss of power, beep, beep and another beep from me L. I manage to get some insulation tape from one of the new person's I met a bit earlier on. This made the plug a bit better, so I had to be very careful while slewing the telescope in case the power went again. This time I revisited Jupiter and Saturn and had a good look at

them, being low on the south western horizon did not help much? With Cygnus high overhead I thought I would look at some Planetary Nebula (PN), starting with M27, the Dumbbell Nebula. I could make the outline of this PN out but not much more? Not long after this the Army decided to play war games and light up the sky with flares and the odd red tracer from machine gun fire (there must be a firing range nearby, close to us was a red flag flying?). Onto my next target and the Ring Nebula (M57), could make this out fairly well even with the Army filling the sky with up to four flares at a time! While in the area I hunted down M56 a Globular Cluster that I do not normally look at, this look very good to view, maybe I should come back to this one on another night when

it is a fairly dark sky? Then I had another power failure with the wire, so at 22:56 I called it a night as the Army did not seem to be stopping anytime soon and I was not going to do another set up. Apart from that cloud had nor covered a good deal of the sky!

Spoke to the other astronomers for a while before packing up my equipment, I noticed there was not any dew on either my equipment or my car, which would save me a job when I got home! I finally got home around 00:05 and left most of my equipment at the bottom of the stairs which I would sort out the following morning as I did not have the wife staying in the house that night (she was visiting her mother in Yorkshire).

I have since ordered a replacement jack (packet of 10) and now just waiting for the order to arrive and then hopefully I can sort out the power lead and get the telescope working again. I still have to sort out the GPS problem from early in the summer, probably do that at the same time?

Clear skies for the new season.

Peter Chappell

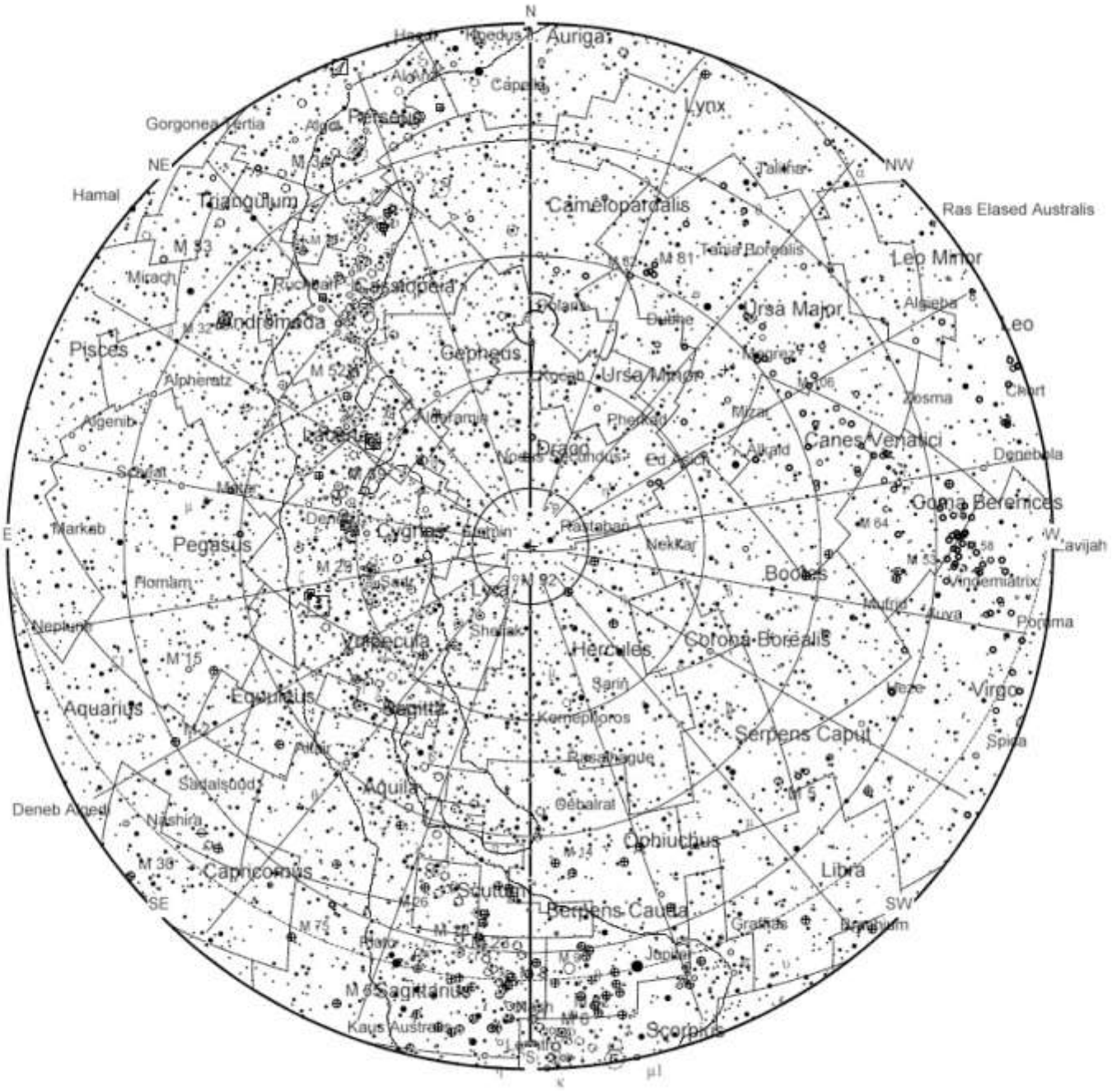
Just a few of my images from the summer months:

Noctilucent clouds from June…

The rising lunar eclipse on 16th July.

The Milky Way from the Dorset coast. A mist layer has bloated Jupiter right and Saturn left.

Lots of dark nebulae clouds seen.



Spot the Stars of the Summer Triangle

David Prosper

September skies are a showcase for the **Summer Triangle**, its three stars gleaming directly overhead after sunset. The **equinox** ushers in the official change of seasons on September 23. **Jupiter** and **Saturn** maintain their vigil over the southern horizon, but set earlier each evening, while the terrestrial planets remain hidden.

The bright three points of the **Summer Triangle** are among the first stars you can see after sunset: Deneb, Vega, and Altair. The Summer Triangle is called an **asterism**, as it's not an official constellation, but still a striking group of stars. However, the Triangle is the key to spotting multiple constellations! Its three stars are themselves the brightest in their respective constellations: Deneb, in Cygnus the Swan; Vega, in Lyra the Harp; and Altair, in Aquila the Eagle. That alone would be impressive, but the Summer Triangle also contains two small constellations inside its lines, Vulpecula the Fox and Sagitta the Arrow. There is even another small constellation just outside its borders: diminutive Delphinus the Dolphin. The Summer Triangle is huge!

The **equinox** occurs on September 23, officially ushering in autumn for folks in the Northern Hemisphere and bringing with it longer nights and shorter days, a change many stargazers appreciate. Right before sunrise on the 23rd, look for Deneb - the Summer Triangle's last visible point - flickering right above the western horizon, almost as if saying goodbye to summer.

The Summer Triangle region is home to many important astronomical discoveries. Cygnus X-1, the first confirmed black hole, was initially detected here by x-ray equipment on board a sounding rocket launched in 1964. NASA's Kepler Mission, which revolutionized our understanding of exoplanets, discovered thousands of planet candidates within its initial field of view in Cygnus. The Dumbbell Nebula (M27), the first planetary nebula discovered, was spotted by Charles Messier in the diminutive constellation Vulpecula way back in 1764!

Planet watchers can easily find **Jupiter** and **Saturn** shining in the south after sunset, with Jupiter to the right and brighter than Saturn. At the beginning of September, Jupiter sets shortly after midnight, with Saturn following a couple of hours later, around 2:00am. By month's end the gas giant duo are setting noticeably earlier: Jupiter sets right before 10:30pm, with Saturn following just after midnight. Thankfully for planet watchers, earlier fall sunsets help these giant worlds remain in view for a bit longer. The terrestrial planets, Mars, Venus, and Mercury, remain hidden in the Sun's glare for the entire month.

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•**September 9** - **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 14** - **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 04:34 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.

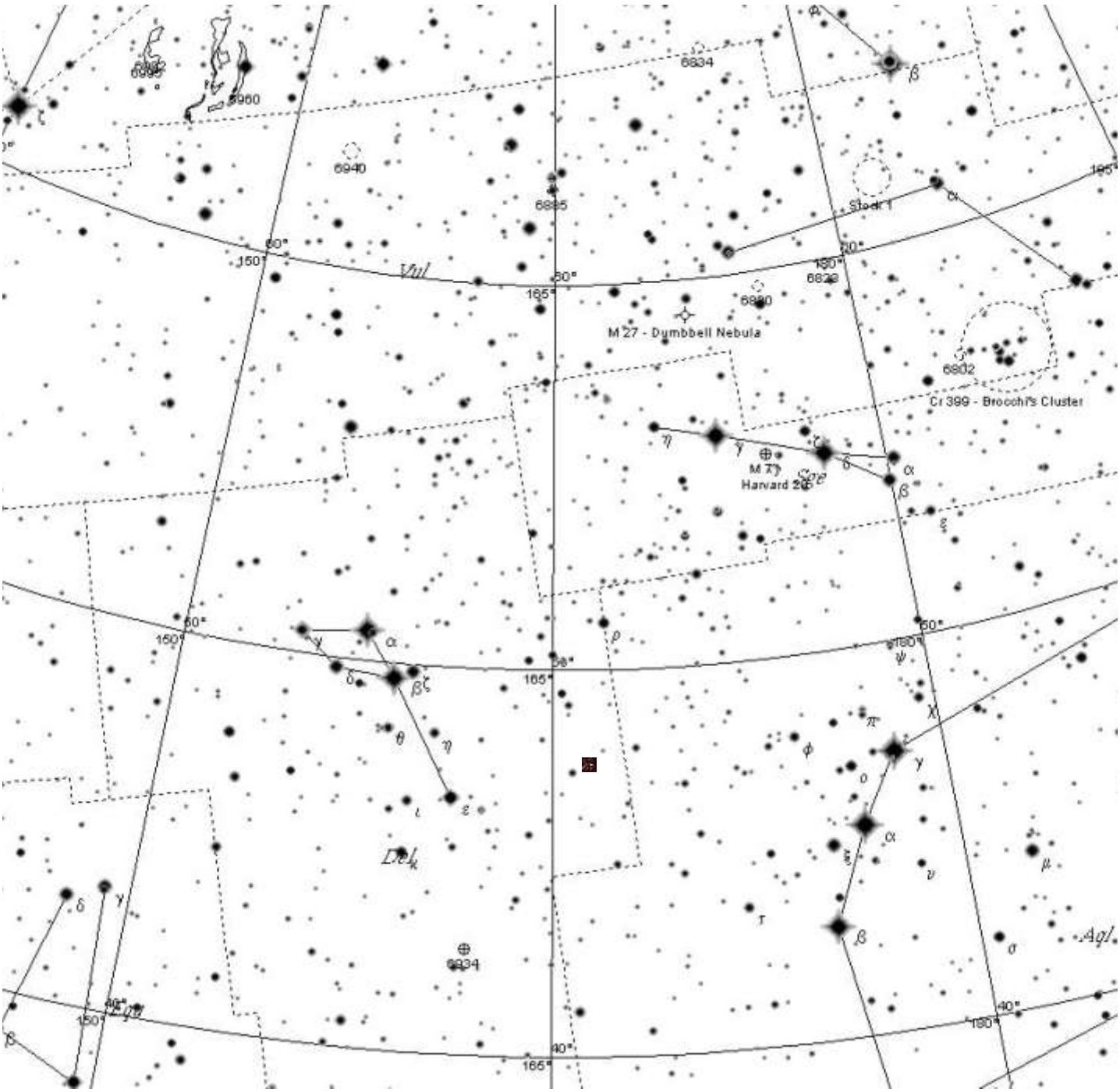
•

•**September 23** - **September Equinox.** The September equinox occurs at 07:50 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 28** - **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 18:26 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.

CONSTELLATIONS OF THE MONTH: Delphinus, Sagitta, Vulpecula



***Vulpecula**, the Fox,* is one of Johannes Hevelius' constellations, introduced in his posthumously published star catalogue of 1690. (See "Lacerta" for comments on Hevelius.) The asterism resembles more a flying gull seen face on.

The constellation was originally called *Vulpecula cum Anser*, The Fox and Goose. This is a rather faint constellation, with most stars of the fourth and fifth magnitude. There is only one Bayer star.

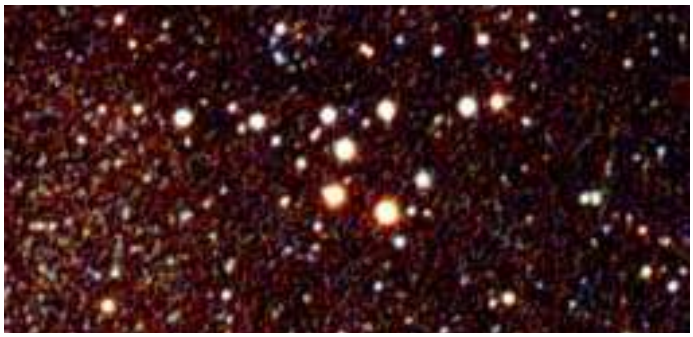
Vulpecula has several objects of interest: a fine binary, a couple of variables, and even a Messier object.

Double stars:

Alpha Vulpeculae may be only optical (observers differ on this point).

AB: 4.6, 6.0; PA 28º, separation 13.7".

16 Vulpeculae is a close binary with nearly equal components: 5.9, 6.3; PA 115º, separation 0.8".



Struve 2525 is a fine binary with orbit of 990 years; the 2000 values are: 8.5, 8.7; PA 291º, 2.1". The binary lies between beta Cygni and 3 Vulpeculae.

Variable stars:

R Vulpeculae is a Mira type variable with range of 7.4 to 13.7 every 137 days.

T Vulpeculae is a Cepheid: 5.4 to 6.1 every 4.43 days.

Deep Sky Objects:

M27 (NGC 6853), "The Dumbbell Nebula" is a noted planetary nebula, large, bright, and oddly shaped (thus its name). It glows with a faintly green colour.

The nebula is found midway between 12 Vul and 17 Vul and about half a degree to the south. (14 Vul is in the same field, just to the NNW).

NGC 6940 is an open cluster of about a hundred stars, found just midway between 23 Vul and 32 Vul, and a half degree to the north.

Sagitta, "The Arrow", while small and insignificant, is a constellation known to the Greeks. Some references believe that Sagittarius, the Archer, shot the arrow (apparently without a known target); others talk about Cupid, and Heracles, and Apollo. The point is, there isn't any established myth associated with Sagitta.

The constellation has a number of interesting items, including several multiple binary systems and a Messier object.

The Bayer stars range from 3.5 to 6.5. Note that the brightest star here is gamma Sagittae.

Double stars:

Zeta Sge (Struve 2585) is a close binary with 22.78 year orbit; it's also a multiple system:

AB (1962 values): 5.5, 6.5; PA 180º, separation 0.2"

C: 9; PA 311º, separation 8.4"
D: 11; PA 247º, separation 75".

Theta Sge (Struve 2637) is also a multiple system:

AB: 6.5, 8.5; PA 325º, separation 12"
C: 7, PA 223º, separation 84".

Variable stars:

S Sagittae is a fairly bright Cepheid, ranging from 5.5 to 6.2 every 8.38 days.

To locate S Sge, drop three degrees south of gamma Sge. The bright star here is 11 Sge. S Sge is in the same field, just to the west-southwest.

U Sagittae is a well-known Algol-type eclipsing variable, suitable or small telescope or binoculars.

Use the nearby star just to the NE (*Struve 2504*, visual magnitude 7.9) as a comparison; U Sge is slightly brighter than this star at its regular brightness, then dips far below (to about 9.2) every 3d9h8m5s as the larger companion completely eclipses the primary. This lasts for about 1h40m, then the star rapidly regains its brightest magnitude.

U Sagittae is five degrees west of alpha Sge, and 1.75 degrees to the north. It forms an equilateral triangle with two brighter stars, 1 Vulpeculae and 4 Vulpeculae. (Note: on Tirion's *Sky Atlas*, U Sge appears to have the label "OU" due to the size of the star itself.)

Deep Sky Objects:

M71 (NGC 6838) is classified as a globular cluster, but it looks much more like an open cluster. It's found just between delta and gamma Sagittae and slightly south.

Delphinus, "The Dolphin", is an ancient constellation located just west of Pegasus.

Some references name a certain "Arion" as the inspiration for the constellation.

There were two Arions in antiquity. One was a (mythic?) poet who may have lived in the eighth century BC. This Arion, travelling from Sicily to Corinth, was thrown overboard by the ship's crew, eager for the valuables he was carrying. A dolphin is said to have rescued the poet. But this dolphin probably isn't the constellation's origin.

The second Arion was a son of Poseidon and Demeter, and was in fact a horse (like his half-brother Pegasus). Instead of hooves, he had feet on his right side. And, unlike most horses, he could talk. But this Arion also has nothing to do with the constellation.

It is most likely however that the constellation is associated with Poseidon. It was probably his way of thanking one of his messengers for a job well done.

As God of the Sea, Poseidon had fifty sea-nymphs at his court. These were all born of Nereus and known therefore as the Nereids.

While Poseidon had many casual love affairs, when he set out to find a wife he was concerned that she be accustomed to life in the sea. His first choice was Thetis, one of the fifty Nereids. But he learned that any son born of Thetis would grow to become greater than his father. Clearly Poseidon couldn't accept that prophecy.

As a side note, Thetis married Peleus, a mortal, and they had a famous son named Achilles. Thetis dipped Achilles in the river Styx to make him invulnerable to his enemies. As most people now know, since his mother grasped him by the heels, they were the only part of Achilles which was vulnerable. Wouldn't you know, the day would come when he'd get a poisoned arrow in his heel and die from it?

Poseidon's next choice in marriage was a sister of Thetis, called Amphitrite. But when Poseidon pressed Amphitrite to marry him, she was quite disgusted by the thought and fled to the far-off Atlas Mountains. Poseidon sent a number of messengers to persuade her to return, as his wife, to his underwater realm.

The messenger who succeeded in this task was the dolphin Delphinus. Amphitrite was so beguiled by Delphinus' pleadings she relented and returned to Poseidon and became the Queen of the Sea. They had many children.

Delphinus was later put in the heavens as a constellation by a grateful Poseidon.

The asterism is rather curious, for its four main stars form a rectangle called "Job's Coffin". This is probably a hang-over from the time Delphinus was interpreted as a whale, as in Chapter 41 of *Job* where God challenged Job: "Canst thou draw out leviathan with a hook?" However there is no reference to Job being swallowed by a whale, as happened with Jonah, so the name Job's Coffin remains a bit of a mystery.

The constellation's Bayer stars are not complete, and are mostly in the fourth and fifth magnitude range.

Double stars:

Delphinus has several fine binaries, a Mira-type variable, and a very remote globular cluster.

Beta Delphini is a very close visual binary with orbit of 26.7 years. Epoch 2000 values: 4.0, 4.9; PA 343º, separation 0.5".

Gamma^{1} and *gamma*^{2} *Del* form a fine binary with (perhaps) subtle colour change (observers argue over this; some find them both yellow, others that the companion is greenish or bluish): 4.5, 5.5; PA 268º, 9.6"

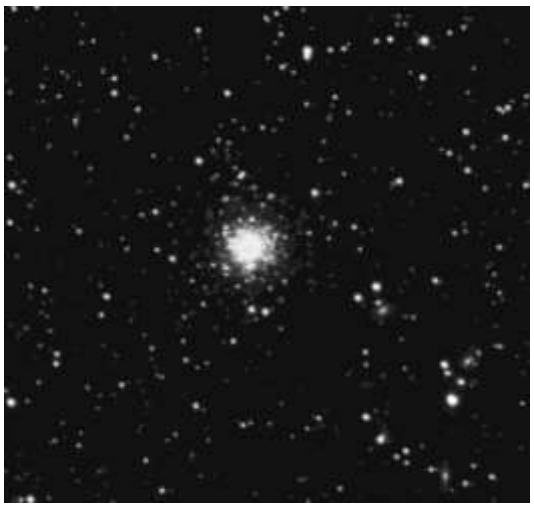
Struve 2725 is a wonderful sight in the same field as gamma Del (to the SW): 7.3, 8.0; PA 9º, separation 5.7".

Variable stars:

R Delphini is a Mira-type variable with a period of 285.07 days and a range of 7.6-13.8. In the year 2000 the maximum should occur near the end of August.

Deep Sky Objects:

NGC 7006 is a very remote globular cluster, perhaps as far as 200,000 light years away. Because of its distance it is extremely difficult to resolve. It is located fifteen arc minutes due east of gamma Delphini



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

Date	Brightness (mag)	Start			Highest point			End		
		Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
03 Sep	-3.1	04:34:21	35°	SSW	04:35:10	43°	SSE	04:38:23	10°	E
04 Sep	-2.1	03:47:32	26°	ESE	03:47:32	26°	ESE	03:49:33	10°	E
04 Sep	-3.8	05:20:24	16°	WSW	05:23:02	84°	SSE	05:26:23	10°	E
05 Sep	-3.8	04:33:33	49°	SW	04:34:17	71°	SSE	04:37:37	10°	E
06 Sep	-2.4	03:46:41	34°	E	03:46:41	34°	E	03:48:50	10°	E
06 Sep	-3.8	05:19:34	15°	W	05:22:14	85°	N	05:25:36	10°	E
07 Sep	-0.7	02:59:50	11°	E	02:59:50	11°	E	03:00:01	10°	E
07 Sep	-3.9	04:32:43	52°	W	04:33:26	88°	NNW	04:36:48	10°	E
08 Sep	-2.4	03:45:53	36°	E	03:45:53	36°	E	03:48:00	10°	E
08 Sep	-3.8	05:18:45	15°	W	05:21:24	88°	S	05:24:46	10°	E
09 Sep	-0.6	02:59:05	11°	E	02:59:05	11°	E	02:59:11	10°	E
09 Sep	-3.9	04:31:58	56°	W	04:32:35	86°	N	04:35:57	10°	E
10 Sep	-2.1	03:45:13	31°	E	03:45:13	31°	E	03:47:07	10°	E
10 Sep	-3.8	05:18:07	18°	W	05:20:28	64°	SSW	05:23:47	10°	ESE
11 Sep	-4.0	04:31:28	74°	WSW	04:31:40	79°	SSW	04:35:01	10°	ESE
12 Sep	-1.5	03:44:56	21°	E	03:44:56	21°	E	03:46:11	10°	E
12 Sep	-3.2	05:17:50	23°	W	05:19:23	37°	SSW	05:22:31	10°	SE
13 Sep	-3.0	04:31:29	39°	SSE	04:31:29	39°	SSE	04:33:53	10°	SE
13 Sep	-1.8	06:04:57	10°	WSW	06:06:47	14°	SW	06:08:37	10°	S
14 Sep	-2.3	05:18:15	20°	SSW	05:18:15	20°	SSW	05:20:40	10°	SSE
15 Sep	-1.0	04:32:21	10°	SSE	04:32:21	10°	SSE	04:32:21	10°	SSE
19 Sep	-1.4	21:09:21	10°	SSW	21:09:52	13°	SSW	21:09:52	13°	SSW
20 Sep	-2.1	20:21:08	10°	S	20:23:19	17°	SE	20:23:32	16°	SE
20 Sep	-0.9	21:56:17	10°	WSW	21:56:27	11°	WSW	21:56:27	11°	WSW
21 Sep	-2.9	21:07:31	10°	SW	21:09:53	35°	SSW	21:09:53	35°	SSW
22 Sep	-2.9	20:18:51	10°	SW	20:21:49	31°	SSE	20:23:09	22°	ESE
22 Sep	-1.3	21:54:58	10°	WSW	21:56:02	19°	WSW	21:56:02	19°	WSW
23 Sep	-3.8	21:06:03	10°	WSW	21:09:10	68°	SSW	21:09:10	68°	SSW
24 Sep	-3.6	20:17:10	10°	WSW	20:20:25	55°	SSE	20:22:11	24°	E
24 Sep	-1.4	21:53:45	10°	W	21:55:03	22°	W	21:55:03	22°	W
25 Sep	-3.1	19:28:22	10°	SW	19:31:31	40°	SSE	19:34:39	10°	E
25 Sep	-3.9	21:04:45	10°	W	21:08:00	85°	W	21:08:00	85°	W
26 Sep	-3.9	20:15:45	10°	WSW	20:19:05	81°	S	20:20:53	25°	E
26 Sep	-1.3	21:52:29	10°	W	21:53:45	21°	W	21:53:45	21°	W
27 Sep	-3.7	19:26:47	10°	WSW	19:30:05	67°	SSE	19:33:24	10°	E
27 Sep	-3.7	21:03:27	10°	W	21:06:35	76°	WNW	21:06:35	76°	WNW
28 Sep	-3.8	20:14:25	10°	W	20:17:45	85°	N	20:19:24	28°	E
28 Sep	-1.1	21:51:09	10°	W	21:52:15	19°	W	21:52:15	19°	W
29 Sep	-3.8	19:25:23	10°	W	19:28:43	90°	S	19:32:03	10°	E
29 Sep	-3.5	21:02:07	10°	W	21:05:02	65°	WSW	21:05:02	65°	WSW
30 Sep	-3.9	20:13:04	10°	W	20:16:24	90°	NE	20:17:50	32°	E
30 Sep	-0.9	21:49:50	10°	W	21:50:41	16°	W	21:50:41	16°	W
01 Oct	-3.8	19:24:00	10°	W	19:27:21	85°	N	19:30:37	10°	E
01 Oct	-3.0	21:00:44	10°	W	21:03:28	46°	WSW	21:03:28	46°	WSW
02 Oct	-3.7	20:11:39	10°	W	20:14:57	68°	SSW	20:16:17	33°	ESE
02 Oct	-0.7	21:48:42	10°	W	21:49:08	12°	W	21:49:08	12°	W

END IMAGES, OBSERVING AND OUTREACH

The partial lunar eclipse of 16th July was hindered on the rising by a very thick mist layer towards the eastern horizon.

The top image is the partially covered Moon above Stonehenge by Pete Glastonbury.

The lower shot is by John Dartnell also at Barbury Castle.

Lunar Partial Eclipse (Barbury Castle)
Close Up
Canon SX50HS, 1800mm (50x Optical and 25 x Digital), ISO 125, F8, 1/4 sec.

Wiltshire Astronomical Society	Observing Sessions 2018 – 2019	And 2019-2020
Date	**Moon Phase (%)**	**Moonrise**
2019		
27th Sept		
25th October		
22nd December		

OUTREACH

Evenings now too light for school link ins.

July 4th-5th Nibley Music Festival

October 4th/11th Queen's Crescent School Astronomy Evening. Help required please. Possible viewing, but meteors, rocket models, books and equipment on show while I give some talks.

How about a Milky Way photo session? End of July will be ideal. Site to be arranged.