NWASNEWS

Volume22, Issue 7

March 2017

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

Wiltshire Society Page	**2**
Swindon Stargazers	**3**
Beckington	4
Space Place Prepare for USA eclipse.	5
Binocular views March	5-6
Dark Matter may be found Colliding galaxies Cracksin Mars poles Planetary foundation missing link Elon Musk tourists to Moon Trump asks NASA for same 8 or 110 planets? 7 earth size planets found	7-21
IViewing logs, travel notes	22-24
What's Up March 2017	25
Constellation of the Month Cepheus	26-29
Herschel dance in Bath.	30
Space Station Timings	31
IMAGES, VIEWING SESSIONS and OUTREACH	32

Space race hotting up

With Elon Musk bristling with confidence as his solar tiles business kicks off to work with his batteries, his cars going well, and the Falcon 9 launch successfully takes off and lands after problems in September, he did refire a used launch stage. Suddenly he is announcing trips around the Moon for paying tourists.

Blue Origins are also feeling brave and feel they can run deliveries to the Moon.

Galactic X from Virgin are retesting successfully after the disaster in 2015.

With India interested in going back to the Moon and China also looking at Mars it is not surprising that Donald Trump can see some glory coming his way, and he has asked NASA to put astronauts on the proposed Moon launch in 2019.

Interesting times indeed.

Dark matter astronomy has taken a lurch forward with research coming in to take

shape following gravitation wave discoveries last year.

The calls for Pluto to be renamed a planet took a bit of a hit when some researchers say the rules changing the dwarf planet status may mean adding another 102 planets to the list. That is going to make on heck of a memory to name those!

Exo planets took another huge boost with a 7 earth sized planetary system being discovered around a small red star. It may have three planets in the 'goldilocks' zone for liquid water to exist BUT there are many more variables that need sorting, and questions need to answered.

Planets revolving round a star I hear you gasp in disbelief! Yes. Movements of the planets suggest that is the case.

Luckily we have Steve Tonkin here tonight as our speaker to put this more earthly findings and theories to the test of history. His talk 'And Yet It Moves' is a view from the Greeks to the Renaissance men in the quest to answer the movements of the wanderers and place then around our own star rather than the Earth.

Such heracy. As long as we don't have to move the stone at Stonehenge. Interest to see the royal astronomical society has taken a view on the building of a tunnel near the site. Isn't it enough we've got to move them when the clocks go forward later this month.

Clear Skies

Andy

M41. The large open cluster in Canis Major sits just below Sirius.
The diameter of the cluster is between 25 and 26 light years. It is estimated to be 190 million years old
Up to 100 star exist in this cluster, about 2,300 light years away.

Wiltshire Society Page

Wiltshire Astronomical Society
Web site: www.wasnet.org.uk
Meetings 2015/2016Season.
NEW VENUE the Pavilion, Rusty Lane, Seend
Meet 7.30 for 8.00pm start
2016

7 Mar	Steve Tonkin, And yet it Moves!
4 Apr	Dr Chris North, Telescopes through the Ages
2 May	Martin Griffiths, Planetary Nebulae Marathon
6 Jun	Mark Radice, Observing from the Caribbean + AGM

Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Andy Burns (Chairman, and Editor) Tel: 01249 654541, email: anglesburns@hotmail.com

Vice chair: Keith Bruton

Bob Johnston (Treasurer)

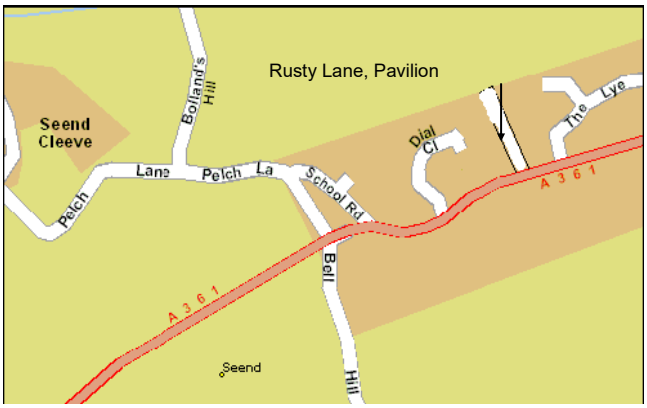
Philip Proven (Hall coordinator)

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.

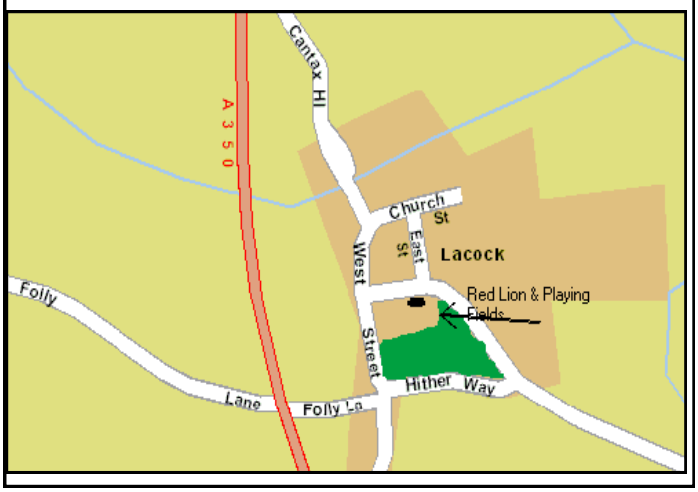


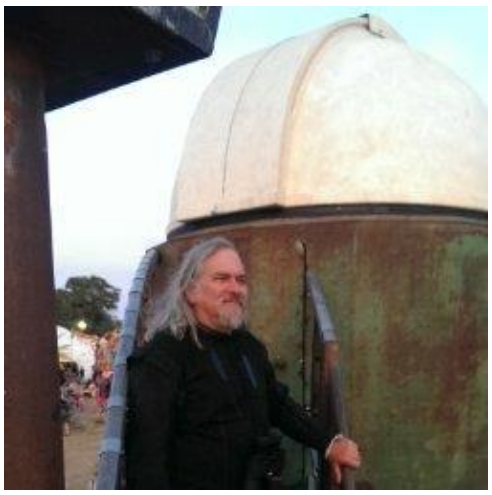
Observing Sessions

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





Steve Tonkin is an astronomy author who is engaged in astronomy education and outreach to people of all ages, via visits, talks, STEM ambassadorship, running astronomy classes, and provision of practical resource material on the internet.

And Yet It Moves

According to legend, Galileo famously muttered, "Eppur si muove!" (And yet, it moves!) There was, however, no direct evidence of this until almost a century after his death. This talk traces the story of heliocentricity, which begins in ancient Greece and ends with the third Astronomer Royal, James Bradley, who made a chance discovery whilst trying to determine stellar distances .

Please also see my companion website for general astronomy, including courses and online tutorials, **The Astronomical Unit**.

Swindon Stargazers

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.

This Month

This month we are holding our AGM and following the meeting our secretary, Bob Gatten will be giving a talk on using remote telescopes.

All welcome!

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.htm

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!

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 2017:

Friday 17 March 2017

Programme: AGM plus Dr Bob Gatten - Using the Faulkes Telescope Project's remote telescopes, results so far

Friday 24 April 2017

Programme: Dr Pauline Norris - The Ancient Egyptians and their Astronomy

Friday 19 May 2017

Programme: Martin Griffiths - Contact with extraterrestrials, how will it affect us

Friday 16 June 2017

Programme: Paul Roche - Robotic Astronomy

---------SUMMER BREAK--------

Friday 15 September 2017

Programme: Prof. Richard Harrison MBE BSc Phs FRAS FinstP - Space Weather

Friday 20 October 2017

Programme: Steve Tonkin - Binocular Astronomy

Friday 17 November 2017

Programme: Mike Leggett: Exploration of Mars

Friday 15 December 2017

Programme: Christmas Social

Website:

http://www.swindonstargazers.com

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

Solar Eclipse Provides Coronal Glimpse

By Marcus Woo

On August 21, 2017, North Americans will enjoy a rare treat: The first total solar eclipse visible from the continent since 1979. The sky will darken and the temperature will drop, in one of the most dramatic cosmic events on Earth. It could be a once-in-a-lifetime show indeed. But it will also be an opportunity to do some science.

Only during an eclipse, when the moon blocks the light from the sun's surface, does the sun's corona fully reveal itself. The corona is the hot and wispy atmosphere of the sun, extending far beyond the solar disk. But it's relatively dim, merely as bright as the full moon at night. The glaring sun, about a million times brighter, renders the corona invisible.

"The beauty of eclipse observations is that they are, at present, the only opportunity where one can observe the corona [in visible light] starting from the solar surface out to several solar radii," says Shadia Habbal, an astronomer at the University of Hawaii. To study the corona, she's traveled the world having experienced 14 total eclipses (she missed only five due to weather). This summer, she and her team will set up identical imaging systems and spectrometers at five locations along the path of totality, collecting data that's normally impossible to get.

Ground-based coronagraphs, instruments designed to study the corona by blocking the sun, can't view the full extent of the corona. Solar space-based telescopes don't have the spectrographs needed to measure how the temperatures vary throughout the corona. These temperature variations show how the sun's chemical composition is distributed—crucial information for solving one of long-standing mysteries about the corona: how it gets so hot.

While the sun's surface is ~9980 Farenheit (~5800 Kelvin), the corona can reach several millions of degrees Farenheit. Researchers have proposed many explanations involving magneto-acoustic waves and the dissipation of magnetic fields, but none can account for the wide-ranging temperature distribution in the corona, Habbal says.

You too can contribute to science through one of several citizen science projects. For example, you can also help study the corona through the Citizen CATE experiment; help produce a high definition, time-expanded video of the eclipse; use your ham radio to probe how an eclipse affects the propagation of radio waves in the ionosphere; or even observe how wildlife responds to such a unique event.

Otherwise, Habbal still encourages everyone to experience the eclipse. Never look directly at the sun, of course (find more safety guidelines here: https://eclipse2017.nasa.gov/safety). But during the approximately 2.5 minutes of totality, you may remove your safety glasses and watch the eclipse directly—only then can you see the glorious corona. So enjoy the show. The next one visible from North America won't be until 2024.

For more information about the upcoming eclipse, please see:

NASA Eclipse citizen science page

https://eclipse2017.nasa.gov/citizen-science

NASA Eclipse safety guidelines

https://eclipse2017.nasa.gov/safety

Want to teach kids about eclipses? Go to the NASA Space Place and see our article on solar and lunar eclipses! http://spaceplace.nasa.gov/eclipses/

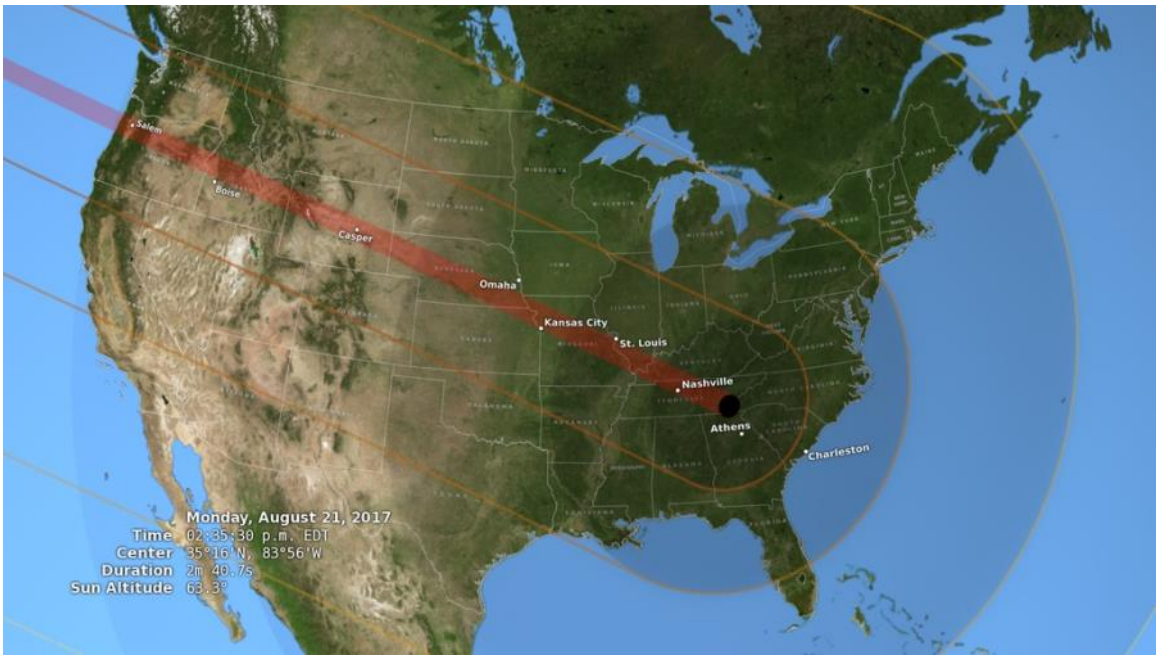


Illustration showing the United States during the total solar eclipse of August 21, 2017, with the umbra (black oval), penumbra (concentric shaded ovals), and path of totality (red) through or very near several major cities. Credit: Goddard Science Visualization Studio, NASA

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.

Programme details for 2016/2017

2016

Mar 17th: The Sun…….. Ron Westmaas

Apr 21st: Observing the Solar System……. Mark Radice

May 19th: Imaging Colloquium `Open discussion bring your kit along`…… Steve Hill.

All are welcome to come along for a chat from beginners to experts.

The Binocular Observer -

Targets for March 2017 Jonathan Gale

March brings us to galaxy season and, whilst many are beyond the range of binoculars, we can scan around the sky and find some of the brighter ones, plus some open clusters and a globular cluster or two.

As mentioned last month, 10 x 50 or 15 x 70 binoculars are my favourites, and I have seen these objects in one or both of my pairs. Maps will be provided so onto the list …

Open Clusters

M44 - The Beehive (Cancer)

An easy one to start the month with, M44 or the Beehive. Cancer is a notoriously dim constellation, but M44 is one of the delights within it. You can pick it out naked eye from a dark site, but turn a small pair of binoculars towards it and the 10 brightest stars pop out at magnitude 7 easily. M44 is set in a rather barren area of the sky so appears all the more impressive with so stellar competitors.

To find it, first try naked eye, just looking half way between Gemini and Leo and see if you can spot a faint path between the two constellations. When you have it, just point your binoculars and see what shapes you can trace.

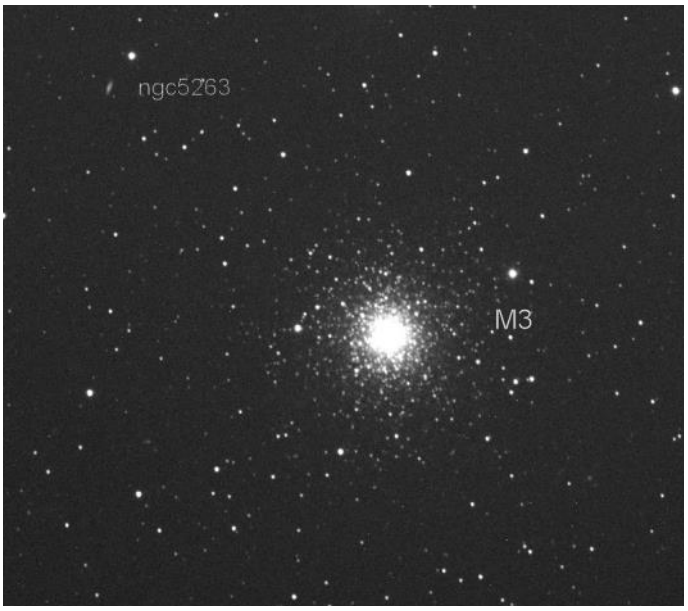
M67 (Cancer)

M67 is a very pleasing cluster in its own right, but so very often overshadowed by M44. This cluster comprises some 500 stars and is amongst the oldest open clusters. To locate it is quite easy as it sits below M44; identify the two brighter stars above and below M44 and draw an imaginary line downwards; follow this line to M67.

Globular Clusters

M3 (Canes Venatici)

M3 is amongst the loveliest globular clusters in the sky and fairly easy to find as well. Whilst it is not an easy naked eye target (not to me anyway!), it is found by following the handle of the Plough down to Arcturus. From there draw an imaginary line to a star known as Cor Caroli, the brighter of the two stars in Canes Venatici. M3 lies a little below half way between the two. The cluster appears as a noticeably fuzzy



blob in your binoculars, so use this opportunity to get used to locating it and then turn your telescope onto it if you have one.

M5 (Serpens Caput)

Around Hercules, we have Serpens Caput with the third brightest globular cluster M5. At around 165 light years in diameter M5 is one of the largest and oldest on the sky. Using 10 x 5 binoculars the cluster appears as a conspicuous little blob of light with a bright nucleus. To locate the cluster takes a little work; begin by locating the bowl shape of Corona Borealis and the keystone of Hercules. Beneath the bowl is a triangle of stars which represents the head of Serpens - follow the body down and you come to a straight portion of the body and M5 lies to the west of this portion.

Galaxies

M101 (Ursa Major)

M101 is thought to be one of the harder galaxies to find as its light is so spread out. It is a face on spiral galaxy which lies to the left side of a line drawn from Alkaid to Mizar. As it is so spread out, it may be tricky to find under urban conditions, so you may well need a trip to a dark site. Looking south east, locate the Plough and draw the line between Alkaid to Mizar. Now aim your binoculars roughly halfway up this line and follow a ragged trail of 5th magnitude stars heading eastwards and look for a small round faint patch of light. Whilst M101 may not look excitingly bright, remember that this little smudge of light is the combined light of several hundred billion suns, separated and faded by a distance of 22 million light years.

M51 (Canes Venatici)

M51 is an amazing site in a telescope, but an equally good galaxy to begin your star hoping skills with. Although it sits in the constellation of Canes Venatici, it is a straightforward star hop from Alkaid in Ursa Major as it sits within the boundaries of a small triangle just over the border. I start from Alkaid and imagine a line at right angles to the one made earlier to locate M101. Extending this line to Cor Caroli, I spot this small triangle a short distance along the line and then look for a small faint smudge which is M51. The nice point of this star hop is that whatever the orientation of the Plough, you can rely on this method to get to M51.

M81 / 82 (Ursa Major)

The most popular pair of galaxies in the northern sky has to be M's 81 and 82. Lying some 12,000,000 light years away a darkish site is best to spot them in 10 x 50 binoculars. To find them, locate the stars Phad and Dubhe

and imagine a line connecting them together. Now extend this from Dubhe for the same distance as from Phad. Slowly scan around the area and you may be able to spot 2 small faint patches of light! In a small telescope, M81 shows up as the larger fuzzy patch, with M82 appearing thinner as it is an edge on galaxy; just imagine two fried eggs clapped back to back and we are looking along the edge!

Asterisms

Engagement Ring (Ursa Minor)

Polaris, the North Star, has a very "engaging" asterism association - the Engagement Ring. Polaris shines like a diamond atop a loop of 9th magnitude stars. Just point your binoculars towards Polaris and enjoy the view!

Napoleon's Hat (Bootes)

This may be a telescopic object, but if you have larger binoculars and keen eyes give it try. Napoleon's Hat lies fairly close to Arcturus and looks exactly as it sounds. It also has been called a humped back caterpillar!

So, a few objects to get you out under the night sky if this poor weather ever clears. I'll pop some finder maps as soon as I can in the observing section on the website - hopefully we'll get some clear sky before the next planed Lacock session.

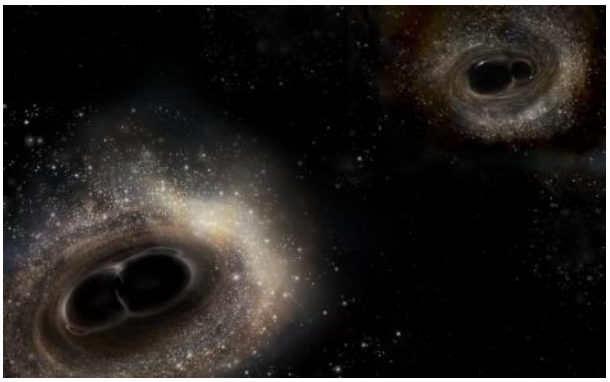
Jonathan Gale

SPACE NEWS

Towards A New Understanding Of Dark Matter

Published: 6 Mar , 2017

by Evan Gough



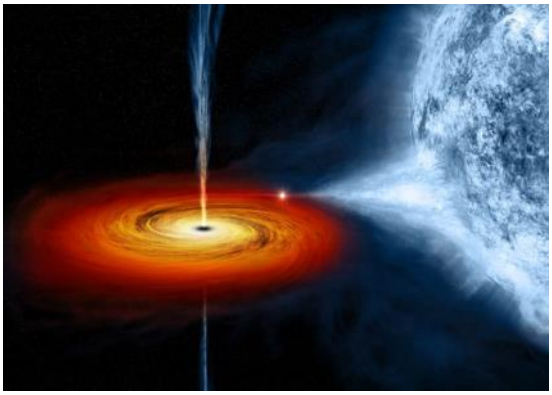
In February 2016, LIGO detected gravity waves for the first time. As this artist's illustration depicts, the gravitational waves were created by merging black holes. But were they stellar black holes, or so-called Primordial Black Holes, which could account for the dark matter in the Universe? Credit: LIGO/A. Simonnet.

Dark matter remains largely mysterious, but astrophysicists keep trying to crack open that mystery. Last year's discovery of gravity waves by the Laser Interferometer Gravitational Wave Observatory (LIGO) may have opened up a new window into the dark matter mystery. Enter what are known as 'primordial black holes.'

Theorists have predicted the existence of particles called Weakly Interacting Massive Particles (WIMPS). These WIMPs could be what dark matter is made of. But the problem is, there's no experimental evidence to back it up. The mystery of dark matter is still an open case file.

When LIGO detected gravitational waves last year, it renewed interest in another theory attempting to explain dark matter. That theory says that dark matter could actually be in the form of Primordial Black Holes (PBHs), not the aforementioned WIMPS.

Primordial black holes are different than the black holes you're probably thinking of. Those are called stellar black holes, and they form when a large enough star collapses in on itself at the end of its life. The size of these stellar black holes is limited by the size and evolution of the stars that they form from.

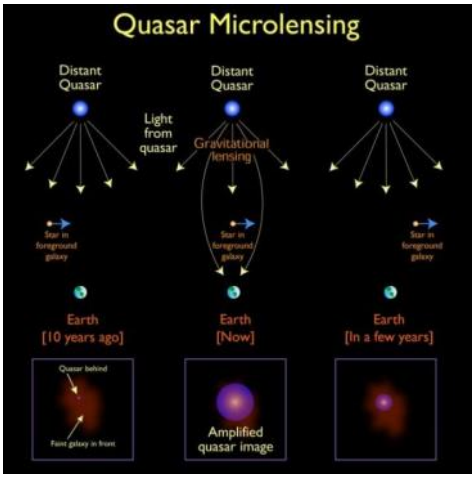


This artist's drawing shows a stellar black hole as it pulls matter from a blue star beside it. Could the stellar black hole's cousin, the primordial black hole, account for the dark matter in our Universe?
Credits: NASA/CXC/M.Weiss

Unlike stellar black holes, primordial black holes originated in high density fluctuations of matter during the first moments of the Universe. They can be much larger, or smaller, than stellar black holes. PBHs could be as small as asteroids or as large as 30 solar masses, even larger. They could also be more abundant, because they don't require a large mass star to form.

When two of these PBHs larger than about 30 solar masses merge together, they would create the gravitational waves detected by LIGO. The theory says that these primordial black holes would be found in the halos of galaxies.

If there are enough of these intermediate sized PBHs in galactic halos, they would have an effect on light from distant quasars as it passes through the halo. This effect is called 'micro-lensing'. The micro-lensing would concentrate the light and make the quasars appear brighter.



A depiction of quasar microlensing. The microlensing object in the foreground galaxy could be a star (as depicted), a primordial black hole, or any other compact object. Credit: NASA/Jason Cowan (Astronomy Technology Center).

The effect of this micro-lensing would be stronger the more mass a PBH has, or the more abundant the PBHs are in the galactic halo. We can't see the black holes themselves, of course, but we can see the increased brightness of the quasars.

Working with this assumption, a team of astronomers at the Instituto de Astrofísica de Canarias examined the micro-lensing effect on quasars to estimate the numbers of primordial black holes of intermediate mass in galaxies.

"The black holes whose merging was detected by LIGO were probably formed by the collapse of stars, and were not primordial black holes." -Evencio Mediavilla

The study looked at 24 quasars that are gravitationally lensed, and the results show that it is normal stars like our Sun that cause the micro-lensing effect on distant quasars. That rules out the existence of a large population of PBHs in the galactic halo. "This study implies "says Evencio Mediavilla, "that it is not at all probable that black holes with masses between 10 and 100 times the mass of the Sun make up a significant fraction of the dark matter". For that reason the black holes whose merging was detected by LIGO were probably formed by the collapse of stars, and were not primordial black holes".

Depending on you perspective, that either answers some of our questions about dark matter, or only deepens the mystery.

We may have to wait a long time before we know exactly what dark matter is. But the new telescopes being built around the world, like the European Extremely Large Tele-

scope, the Giant Magellan Telescope, and the Large Synoptic Survey Telescope, promise to deepen our understanding of how dark matter behaves, and how it shapes the Universe.

It's only a matter of time before the mystery of dark matter is solved.

When Galaxies Collide, Stars Suffer the Consequences

Article Updated: 2 Mar , 2017

by Matt Williams

Depiction of the tidal disruption event in F01004-2237. The release of gravitational energy as the debris of the star is accreted by the black hole leads to a flare in the optical light of the galaxy. Credit and copyright: Mark Garlick

When galaxies collide, the result is nothing short of spectacular. While this type of event only takes place once every few billion years (and takes millions of years to complete), it is actually pretty common from a cosmological perspective. And interestingly enough, one of the most impressive consequences – stars being ripped apart by supermassive black holes (SMBHs) – is quite common as well.

This process is known in the scientific community as stellar cannibalism, or Tidal Disruption Events (TDEs). Until recently, astronomers believed that these sorts of events were very rare. But according to a pioneering study conducted by leading scientists from the University of Sheffield, it is actually 100 times more likely than astronomers previously suspected.

TDEs were first proposed in 1975 as an inevitable consequence of black holes being present at the center of galaxies. When a star passes close enough to be subject to the tidal forces of a SMBH it undergoes what is known as "spaghetification", where material is slowly pulled away and forms string-like shapes around the black hole. The process causes dramatic flare ups that can be billions of times brighter than all the stars in the galaxy combined.

Since the gravitational force of black holes is so strong that even light cannot escape their surfaces (thus making them invisible to conventional instruments), TDEs can be used to locate SMBHs at the center of galaxies and study how they accrete matter. Previously, astronomers have relied on large-area surveys to determine the rate at which TDEs happen, and concluded that they occur at a rate of once every 10,000 to 100,000 years per galaxy.

However, using the William Herschel Telescope at the Roque de los Muchachos Observatory on the island of La Palma, the team of scientists – who hail from Sheffield's Department of Physics and Astronomy – conducted a survey of 15 ultra-luminous infrared galaxies that were undergoing galactic collisions. When comparing information on one galaxy that had been observed twice over a ten year period, they noticed that a TDE was taking place.

Their findings were detailed in a study titled "A tidal disruption event in the nearby ultra-luminous infrared galaxy F01004-2237", which appeared recently in the journal *Nature: Astronomy*. As Dr James Mullaney, a Lecturer in Astronomy at Sheffield and a co-author of the study, said in a University press release:

"Each of these 15 galaxies is undergoing a 'cosmic collision' with a neighboring galaxy. Our surprising findings show that the rate of TDEs dramatically increases when galaxies collide. This is likely due to the fact that the collisions lead to large numbers of stars being formed close to the central supermassive black holes in the two galaxies as they merge together."

The William Herschel Telescope, part of the Isaac Newton group of telescopes, located in the Canary Islands. Credit: ing.iac.es

The Sheffield team first observed these 15 colliding galaxies in 2005 during a previous survey. However, when they observed them again in 2015, they noticed that one of the galaxies in the sample – F01004-2237 – appeared to have undergone some changes. The team them consulted data from the Hubble Space Telescope and the Catalina Sky Survey – which monitors the brightness of astronomical objects (particularly NEOs) over time.

What they found was that the brightness of F01004-2237 – which is about 1.7 billion light years from Earth – had changed dramatically. Ordinarily, such flare ups would be attributed to a supernova or matter being accreted onto an SMBH at the center (aka. an active galactic nucleus). However, the nature of this flare up (which showed unusually strong and broad helium emission lines in its post-flare spectrum) was more consistent with a TDE.

The appearance of such an event had been detected during a repeat spectroscopic observations of a sample of 15 galaxies over a period of just 10 years suggested that the rate at which TDEs happen was far higher than previously thought – and by a factor of 100 no less. As Clive Tadhunter, a Professor of Astrophysics at the University of Sheffield and lead author of the study, said:

"Based on our results for F01004-2237, we expect that TDE events will become common in our own Milky Way galaxy when it eventually merges with the neighboring Andromeda galaxy in about 5 billion years. Looking towards the center of the Milky Way at the time of the merger we'd see a flare approximately every 10 to 100 years. The flares would be visible to the naked eye and appear much brighter than any other star or planet in the night sky."

Artist's impression depicts a rapidly spinning supermassive black hole surrounded by an accretion disc. Credit: ESA/Hubble, ESO, M. Kornmesse

In the meantime, we can expect that TDEs are likely to be noticed in other galaxies within our own lifetimes. The last time such an event was witnessed directly was back in 2015, when the All-Sky Automated Survey for Supernovae (aka. ASAS-SN, or Assassin) detected a superlimunous event four billion light years away – which follow-up investigations revealed was a star being swallowed by a spinning SMBH.

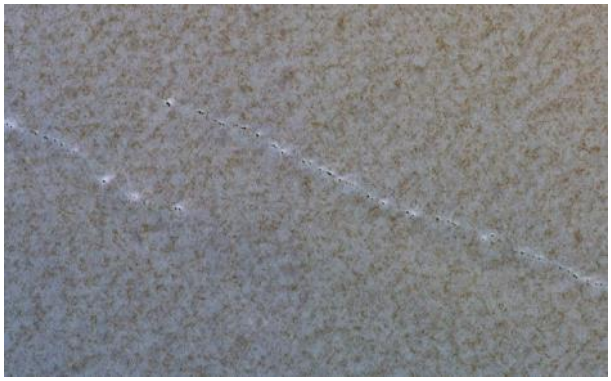
Naturally, news of this was met with a fair degree of excitement from the astronomical community, since it was such a rare event. But if the results of this study are any indication, astronomers should be noticing plenty more stars being slowly ripped apart in the not-too-distant future.

With improvements in instrumentation, and next-generation instruments like the James Webb Telescope being deployed in the coming years, these rare and extremely picturesque events may prove to be a more common experience.

Some Active Process is Cracking Open These Faults on Mars. But What is it?

Article Updated: 2 Mar , 2017

by Matt Williams



A 2008 image showing a portion of the North Polar layered deposits with lines of very small pits. Credit: NASA/JPL/University of Arizona

Mars has many characteristics that put one in mind of Earth. Consider its polar ice caps, which are quite similar to the ones in the Arctic and Antarctic circle. But upon closer examination, Mars' icy polar regions have numerous features that hint at some unusual processes. Consider the northern polar ice cap, which consists predominantly of frozen water ice, but also a seasonal veneer of frozen carbon dioxide ("dry ice").

Here, ice is arranged in multicolored layers that are due to seasonal change and weather patterns. And as images taken by the Mars Global Surveyor and the Mars Reconnaissance Orbiter (MRO) have shown, the region is also covered in lines of small pits that measure about 1 meter (3.28 feet) in diameter. While these features have been known to scientists for some time, the process behind them remains something of a mystery.

Layered features around found both in the northern and southern polar regions of Mars, and are the result of seasonal melting and the deposition of ice and dust (from Martian dust storms). Both polar caps also show grooves which appear to be influenced by the amount of dust deposited. The more dust there is, the darker the surface of the grooved feature, which affects the level of seasonal melting that takes place.

HiRISE image showing the layered appearance of Mars' northern polar region. Credit: NASA/JPL/University of Arizona

These layered deposits measure around 3-kilometer thick and about 1000 kilometers across. And in many locations, erosion and melting has created scarps and troughs that expose the layering (shown above). However, as NASA's Mars Global Surveyor revealed through a series of high-resolution images, the northern polar cap also has plenty of pits, cracks, small bumps and knobs that give it a strange, textured look.

These featured have also been imaged in detail by the High Resolution Imaging Science Experiment (HiRISE) instrument aboard the MRO. In 2008, it snapped the image shown at top, which illustrates how the layered features in the northern polar region also have lines of small pits cutting across them. Such small pits should be quickly filled in by seasonal ice and dust, so their existence has been something of a mystery.

What this process could be has been the preoccupation of researchers like Doctor Chris Okubo and Professor Alfred McEwen. In addition to being a planetary geologist from the Lunar and Planetary Laboratory (LPL) at Arizona State University, Prof. McEwen is the Principal Investigator of the High Resolution Imaging Science Experiment (HiRISE).

Dr. Chris Okubo, meanwhile, is a planetary engineer with the LPL who has spent some time examining Mars' northern polar region, seeking to determine what geological process could account for them. Over time, he also noted that the pits appeared to be enlarging. As he explained to Universe Today via email:

"I monitored some of these pits during northern summer of Mars year 31 (2011-2012). The pits appeared to enlarge over time, starting from depressions roughly centered on the pits observed in in 2008. My interpretation is that these pits are depressions within the residual cap that formed through collapse above a fault or fracture. The pits are buried by seasonal ice in the winter, which then sublimates in the spring/summer leading to an apparent widening and exposure of the pits until they are reburied by seasonal ice in the subsequent winter."

HiRISE being prepared before it is shipped for attachment to the spacecraft. Credit: NASA/JPL

Since the MRO reached Mars in 2006, the LPL has been responsible for processing and interpreting images sent back by its HiRISE instrument. As for these pits, the theory that they are the result of faults pulling apart the icy layers is the most currently-favored one. Naturally, it will have to be tested as more data comes, in showing how seasonal changes play out in Mars' northern polar region.

"I plan to re-monitor the same pits I looked at in MY31 during this upcoming northern summer to see if this pattern has changed substantially," said Okubo. "Re-imaging these after several Mars years may also reveal changes to the size/distribution of the pits within the residual cap – if such changes are observed, then that would suggest that the underlying fractures are active."

One thing is clear though; the layered appearance of Mars polar ice caps and its strange surface features are just another indication of the dynamic processes taking place on Mars. In addition to seasonal change, these interesting features are thought to be related to changes in Mars' obliquity and axial tilt. Just one more way in which Mars and Earth are similar!

Finally, the Missing Link in Planetary Formation!

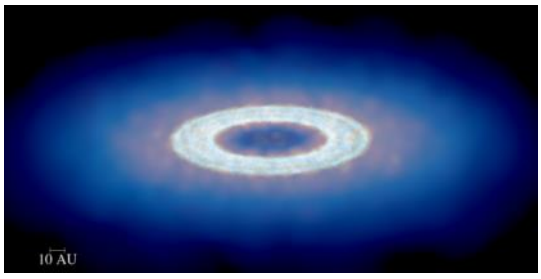
Article Updated: 28 Feb , 2017

by Matt Williams

The theory of how planets form has been something of an enduring mystery for scientists. While astronomers have a pretty good understanding of where planetary systems comes from – i.e. protoplanetary disks of dust and gas around new stars (aka. "Nebular Theory") – a complete understanding of how these discs eventually become objects large enough to collapse under their own gravity has remained elusive.

But thanks to a new study by a team of researchers from France, Australia and the UK, it seems that the missing piece of the puzzle may finally have been found. Using a series of simulations, these researchers have shown how "dust traps" – i.e. regions where pebble-sized fragments could collect and stick together – are common enough to allow for the formation of planetesimals.

Their study, titled "Self-Induced Dust Traps: Overcoming Planet Formation Barriers", appeared recently in the *Monthly Notices of the Royal Astronomical Society.* Led by Dr. Jean-Francois Gonzalez – of the Lyon Astrophysics Research Center (CRAL) in France – the team examined the troublesome middle-stage of planetary formation that has plagued scientists.



An image of a protoplanetary disk, made using results from the new model, after the formation of a spontaneous dust trap, visible as a bright dust ring. Gas is depicted in blue and dust in red. Credit: Jean-Francois Gonzalez.

Until recently, the process by which protoplanetary disks of dust and gas aggregate to form peddle-sized objects, and the process by which planetesimals (objects that are one hundred meters or more in diameter) form planetary cores, have been well understood. But the process that bridges these two – where pebbles come together to form planetesimals – has remained unknown.

Part of the problem has been the fact that the Solar System, which has been our only frame of reference for centuries, formed billions of years ago. But thanks to recent discoveries (3453 confirmed exoplanets and counting), astronomers have had lots of opportunities to study other systems that are in various stages of formation. As Dr. Gonzalez explained in a Royal Astronomical Society press release:

"Until now we have struggled to explain how pebbles can come together to form planets, and yet we've now discovered huge numbers of planets in orbit around other stars. That set us thinking about how to solve this mystery."

In the past, astronomers believed that "dust traps" – which are integral to planet formation – could only exist within certain environments. In these high-pressure regions, large grains of dust are slowed down to the point where they are able to come together. These regions are extremely important since they counteract the two main obstacles to planetary formation, which are drag and high-speed collisions.

Artist's impression of the planets in our solar system, along with the Sun (at bottom). Credit: NASA

Drag is caused by the effect gas has on dust grains, which causes them to slow down and eventually drift into the central star (where they are consumed). As for high-speed collisions, this is what causes large pebbles to smash into each other and break apart, thus reversing the aggregation process. Dust traps are therefore needed to ensure that dust grains are slowed down just enough so that they won't annihilate each other when they collide.

To see just how common these dust traps were, Dr. Gonzalez and his colleagues conducted a series of computer simulations that took into account how dust in a protoplanetary disk could exert drag on the gas component – a process known as "aerodynamic drag back-reaction". Whereas gas typically has an arresting influence on dust particles, in particularly dusty rings, the opposite can be true.

This effect has been largely ignored by astronomers up until recently, since its generally quite negligible. But as the team noted, it is an important factor in protoplanetary disks, which are known for being incredibly dusty environments. In this scenario, the effect of back-reaction is to slow inward-moving dust grains and push gas outwards where it forms high-pressure regions – i.e. "dust traps".

Once they accounted for these effects, their simulations showed how planets form in three basic stages. In the first stage, dust grains grow in size and move inwards towards the central star. In the second, the now pebble-sized larger grains accumulate and slow down. In the third and final stage, the gas is pushed outwards by the back-reaction, creating the dust trap regions where it accumulates.

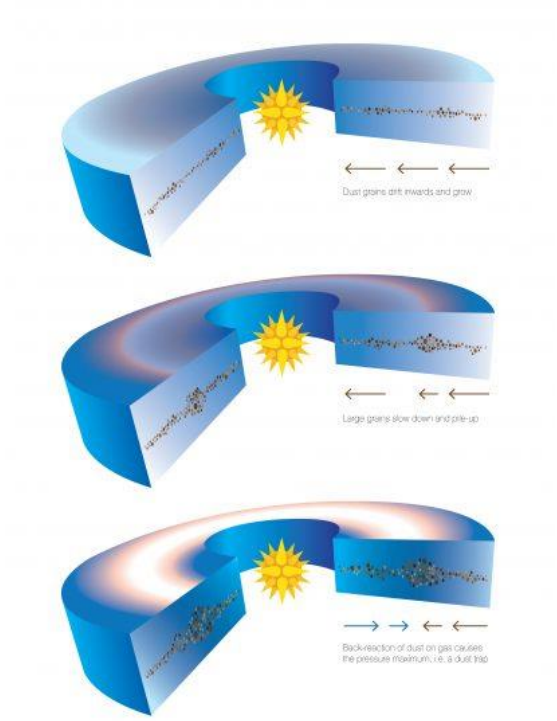


Illustration showing the stages of the formation mechanism for dust traps. Credit: © Volker Schurbert.

These traps then allow the pebbles to aggregate to form planetesimals, and eventually planet-sized worlds. With this model, astronomers now have a solid idea of how planetary formation goes from dusty disks to planetesimals coming together. In addition to resolving a key question as to how the Solar System came to be, this sort of research could prove vital in the study of exoplanets.

Ground-based and space-based observatories have already noted the presence of dark and bright rings that are forming in protoplanetary disks around distant stars – which are believed to be dust traps. These systems could provide astronomers with a chance to test this new model, as they watch planets slowly come together. As Dr. Gonzalez indicated:

"We were thrilled to discover that, with the right ingredients in place, dust traps can form spontaneously, in a wide range of environments. This is a simple and robust solution to a long standing problem in planet formation."

Elon Musk Announces Daring SpaceX Dragon Flight Beyond Moon with 2 Private Astronauts in 2018

Article Updated: 28 Feb , 2017

by Ken Kremer

SpaceX CEO Elon Musk announced plans on Feb. 27, 2017 to launch a commercial crew SpaceX Dragon to beyond the Moon and back with two private astronauts in 2018 using a SpaceX Falcon Heavy launching from the Kennedy Space Center. Credit: SpaceX

KENNEDY SPACE CENTER, FL – Elon Musk, billionaire founder and CEO of SpaceX, announced today (27 Feb) a daring plan to launch a commercial manned journey "to beyond the Moon and back" in 2018 flying aboard an advanced crewed Dragon spacecraft paid for by two private astronauts – at a media telecon.

Note: Check back again for updated details on this breaking news story.

"This is an exciting thing! We have been approached to do a crewed mission to beyond the Moon by some private individuals," Musk announced at the hastily arranged media telecon just concluded this afternoon which Universe Today was invited to participate in.

The private two person crew would fly aboard a human rated Dragon on a long looping trajectory around the moon and far beyond on an ambitious mission lasting roughly eight days and that could blastoff by late 2018 – if all goes well with rocket and spacecraft currently under development, but not yet flown.

"This would do a long leap around the moon," Musk said. "We're working out the exact parameters, but this would be approximately a week long mission – and it would skim the surface of the moon, go quite a bit farther out into deep space, and then loop back to Earth. I'm guessing probably distance wise, maybe 300,000 or 400,000 miles."

The private duo would fly on a 'free return' trajectory around the Moon – but not land on the Moon like NASA did in the 1960s and 1970s.

But they would venture further out into deep space than any humans have ever been before.

No human has traveled beyond low Earth orbit in more than four decades since Apollo 17 – NASA's final lunar landing mission in December 1972, and commanded by recently deceased astronaut Gene Cernan.

"Like the Apollo astronauts before them, these individuals will travel into space carrying the hopes and dreams of all humankind, driven by the universal human spirit of exploration," says SpaceX.

Musk said the private crew of two would launch on a Dragon 2 crew spacecraft atop a SpaceX Falcon Heavy booster from historic pad 39A at the Kennedy Space Center in Florida – the same pad that just reopened for business last week with the successful launch of a cargo Dragon to the International Space Station (ISS) for NASA on the CRS-10 mission.

"They are two paying customers," Musk elaborated. "They're very serious about it."

"But nobody from Hollywood."

"They will fly using a Dragon 2 and Falcon Heavy next year in 2018."

"The lunar orbit mission would launch about 6 months after the [first] NASA crew to the space station on Falcon 9/Dragon 2," Musk told Universe Today.

Musk noted they had put down "a significant deposit" and will undergo extensive flight training.

He declined to state the cost – but just mentioned it would be more than the cost of a Dragon seat for a flight to the space station, which is about $58 million.

The Falcon Heavy, once operational, will be the most powerful rocket in the world. Credit: SpaceX

SpaceX is currently developing the commercial crew Dragon spacecraft for missions to transport astronauts to low Earth orbit (LEO) and the International Space Station (ISS) under a NASA funded a $2.6 billion public/private contract. Boeing was also awarded a $4.2 Billion commercial crew contract by NASA to build the crewed CST-100 Starliner for ISS missions.

The company is developing the triple barreled Falcon Heavy with its own funds – which is derived from the single barreled Falcon 9 rocket funded by NASA.

But neither the Dragon 2 nor the Falcon Heavy have yet launched to space and their respective maiden missions haven been postponed multiple time for several years – due to a combination of funding and technical issues.

So alot has to go right for this private Moonshot mission to actually lift off by the end of next year.

NASA is developing the new SLS heavy lift booster and Orion capsule for deep space missions to the Moon, Asteroids and Mars.

The inaugural uncrewed SLS/Orion launch is slated for late 2018. But NASA just announced the agency has started a feasibility study to examine launching a crew on the first Orion dubbed Exploration Mission-1 (EM-1) on a revamped mission in 2019 rather than 2021 on EM-2.

Thus the potential exists that SpaceX could beat NASA back to the Moon with humans.

I asked Musk to describe the sequence of launches leading up to the private Moonshot and whether a crewed Dragon 2 would launch initially to the ISS.

Musk replied that SpaceX hopes to launch the first uncrewed Dragon 2 test flight to the ISS by the end of this year on the firm's Falcon 9 rocket – almost identical to the rocket that just launched on Feb. 19 from pad 39A.

That would be followed by crewed launch to the ISS around mid-2018 and the private Moonshot by the end of 2018.

"The timeline is we expect to launch a human rated Dragon 2 on Falcon 9 by the end of this year, but without people on board just for the test flight to the space station," Musk told Universe Today.

"Then about 6 months later we would fly with a NASA crew to the space station on Falcon 9/Dragon 2."

"And then about 6 months after that, assuming the schedule holds by end of next year, is when we would do the lunar orbit mission."

I asked Musk about whether any heat shield modifications to Dragon 2 were required?

"The heat shield is quite massively over designed," Musk told me during the telecom.

"It's actually designed for multiple Earth orbit reentry missions – so that we can actually do up to 10 reentry missions with the same heat shield."

"That means it can actually do at least 1 lunar orbit reentry velocity missions, and conceivably maybe 2."

"So we do not expect any redesign of the heat shield."

The reentry velocity and heat generated from a lunar mission is far higher than from a low Earth orbit mission to the space station.

Nevertheless the flight is not without risk.

The Dragon 2 craft will need some upgrades. For example "a deep space communications system" with have to be installed for longer trips, said Musk.

Dragon currently is only equipped for shorter Earth orbiting missions.

The flight must also be approved by the FAA before its allowed to blastoff – as is the case with all commercial launches like the Feb. 19 Falcon 9/Cargo Dragon mission for NASA.

SpaceX founder and CEO Elon Musk. Credit: Ken Kremer/ kenkremer.com

Musk declined to identify the two individuals or their genders but did say they know one another.

They must pass health and training tests.

"We expect to conduct health and fitness tests, as well as begin initial training later this year,' noted SpaceX.

The flight itself would be very autonomous. The private passengers will train for emergencies but would not be responsible for piloting Dragon.

Historic maiden blastoff of SpaceX Falcon 9 rocket from Launch Complex 39A at the Kennedy Space Center) at 9:38 a.m. EDT on Feb 19, 2017, on Dragon CRS-10 resupply mission to the International Space Station (ISS) for NASA. Credit: Ken Kremer/kenkremer.com

Musk said he would give top priority to NASA astronauts for the Moonshot mission if the agency wanted to procure the seats ahead of the private passengers.

He noted that SpaceX would have the capability to launch one or 2 private moonshots per year.

“I think this should be a really exciting mission that gets the world really excited about sending people into deep space again. I think it should be super inspirational,” Musk said.

Stay tuned here for Ken’s continuing Earth and Planetary science and human spaceflight news.

Ken Kremer

SpaceX Falcon 9 rocket launches from pad 39A at the Kennedy Space Center on Feb 19, 2017 for NASA on the Dragon CRS-10 delivery mission to the International Space Station (ISS). Credit: Julian Leek

SpaceX Falcon 9 rocket goes vertical at night atop Launch Complex 39A at the Kennedy Space Center on 19 Feb 2017 as seen after midnight from the pad perimeter. This is the first rocket rolled out to launch from pad 39A since the retirement of NASA’s Space Shuttles in July 2011. Liftoff of the CRS-10 mission slated for 19 Feb 2017. Credit: Ken Kremer/ Kenkremer.com

An artist’s illustration of the Falcon Heavy rocket. Image: SpaceX

NASA Studies Whether to Add Crew to 1st SLS Megarocket Moon Launch in 2019

Article Updated: 26 Feb , 2017

by Ken Kremer

NASA’s Space Launch System rocket will be the most powerful rocket in the world and, with the agency’s Orion spacecraft, will launch America into a new era of exploration to destinations beyond Earth’s orbit. Their first integrated mission is planned as uncrewed, but NASA now is assessing the feasibility of adding crew. Credits: NASA/MSFC

KENNEDY SPACE CENTER, FL – At the request of the new Trump Administration, NASA has initiated a month long study to determine the feasibility of converting the first integrated unmanned launch of the agency’s new Space Launch System (SLS) megarocket and Orion capsule into a crewed mission that would propel two astronauts to the Moon and back by 2019 – 50 years after the first human lunar landing.

Top NASA officials outlined the details of the study at a hastily arranged media teleconference briefing on Friday, Feb 24. It will examine the feasibility of what it would take to add a crew of 2 astronauts to significantly modified maiden SLS/ Orion mission hardware and whether a launch could be accomplished technically and safely by the end of 2019.

On Feb. 15, Acting Administrator Robert Lightfoot announced that he had asked Bill Gerstenmaier, associate administrator for NASA’s Human Exploration and Operations Mission Directorate in Washington, to start detailed studies of what it would take to host astronauts inside the Orion capsule on what the agency calls Exploration Mission-1, or EM-1.

Gerstenmaier, joined by Bill Hill, deputy associate administrator for Exploration Systems Development in Washington, at the briefing said a team was quickly assembled and the study is already underway.

They expect the study to be completed in early spring, possibly by late March and it will focus on assessing the possibilities – but not making a conclusion on whether to actually

implement changes to the current uncrewed EM-1 flight profile targeted for blastoff later in 2018.

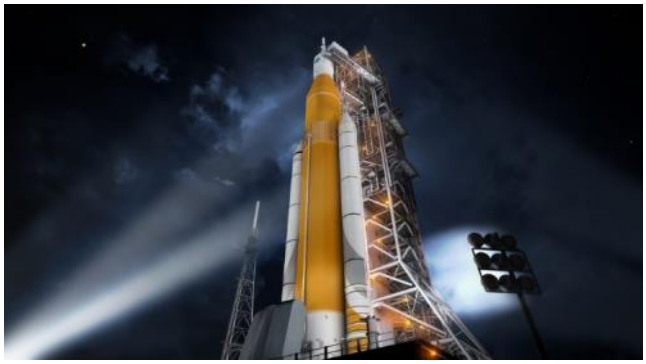
“I want to stress to you this is a feasibility study. So when we get done with this we won’t come out with a hard recommendation, one way or the other,” Gerstenmaier stated.

“We’re going to talk about essentially the advantages and disadvantages of adding crew to EM-1.”

“We were given this task a week ago, appointed a team and have held one telecon.”

“Our priority is to ensure the safe and effective execution of all our planned exploration missions with the Orion spacecraft and Space Launch System rocket,” said Gerstenmaier.

“This is an assessment and not a decision as the primary mission for EM-1 remains an uncrewed flight test.”



Artist concept of the SLS Block 1 configuration on the Mobile Launcher at KSC. Credit: NASA/MSFC

Gerstenmaier further stipulated that the study should focus on determining if a crewed EM-1 could liftoff by the end of 2019. The study team includes one astronaut.

If a change resulted in a maiden SLS/Orion launch date stretching beyond 2019 it has little value – and NASA is best to stick to the current EM-1 flight plan.

The first SLS/Orion crewed flight is slated for Exploration Mission-2 (EM-2) launching in 2021.

“I felt that if we went much beyond 2019, then we might as well fly EM-2 and actually do the plan we’re on,” Gerstenmaier said.

NASA’s current plans call for the unmanned blastoff of Orion EM-1 on the SLS-1 rocket later next year on its first test flight on a 3 week long mission to a distant lunar retrograde orbit. It is slated to occur roughly in the September to November timeframe from Launch Complex 39B at the Kennedy Space Center.

Lightfoot initially revealed the study in a speech to the Space Launch System/Orion Suppliers Conference in Washington, D.C. and an agency wide memo circulated to NASA employees on Feb. 15 – as I reported here.

The Orion EM-1 capsule is currently being manufactured at the Neil Armstrong Operations and Checkout Building at the Kennedy Space Center by prime contractor Lockheed Martin.

Orion crew module pressure vessel for NASA’s Exploration Mission-1 (EM-1) is unveiled for the first time on Feb. 3, 2016 after arrival at the agency’s Kennedy Space Center (KSC) in Florida. It is secured for processing in a test stand called the birdcage in the high bay inside the Neil Armstrong Operations and Checkout (O&C) Building at KSC. Launch to the Moon is slated in 2018 atop the SLS rocket. Credit: Ken Kremer/ kenkremer.com

To launch astronauts, Orion EM-1 would require very significant upgrades since it will not have the life support systems, display panels, abort systems and more needed to safely support humans on board.

“We know there are certain systems that needed to be added to EM-1 to add crew,” Gerstenmaier elaborated. “So we have a good, crisp list of all the things we would physically have to change from a hardware standpoint.

In fact since EM-1 assembly is already well underway, some hardware already installed would have to be pulled out in order to allow access behind to add the life support hardware and other systems, Hill explained.

The EM-1 pressure shell arrived last February as I witnessed and reported here.

Thus adding crew at this latter date in the manufacturing cycle is no easy task and would absolutely require additional time and additional funding to the NASA budget – which as everyone knows is difficult in these tough fiscal times.

“Then we asked the team to take a look at what additional tests would be needed to add crew, what the additional risk would be, and then we also wanted the teams to talk about the benefits of having crew on the first flight,” Gerstenmaier explained.

“It’s going to take a significant amount of money, and money that will be required fairly quickly to implement what we need to do,” Hill stated. “So it’s a question of how we refine the funding levels and the phasing of the funding for the next three years and see where it comes out.”

Hill also stated that NASA would maintain the Interim Cryogenic Propulsion stage for the first flight, and not switch to the more advanced and powerful Exploration Upper Stage (EUS) planned for first use on EM-2.

Furthermore NASA would move up the AA-2 ascent abort test for Orion to take place before crewed EM-1 mission.

Components of the SLS-1 rocket are being manufactured at NASA’s Michoud Assembly Facility and elsewhere around the country by numerous suppliers.

Michoud is building the huge fuel liquid oxygen/liquid hydrogen SLS core stage fuel tank, derived from the Space Shuttle External Tank (ET) – as I detailed here.

The liquid hydrogen tank qualification test article for NASA's new Space Launch System (SLS) heavy lift rocket lies horizontally after final welding was completed at NASA's Michoud Assembly Facility in New Orleans in July 2016. Credit: Ken Kremer/kenkremer.com

Gerstenmaier noted that Michoud did suffer some damage during the recent tornado strike which will necessitate several months worth of repairs.

The newly assembled first liquid hydrogen tank, also called the qualification test article, for NASA's new Space Launch System (SLS) heavy lift rocket lies horizontally beside the Vertical Assembly Center robotic weld machine (blue) on July 22, 2016. It was lifted out of the welder (top) after final welding was just completed at NASA's Michoud Assembly Facility in New Orleans. Credit: Ken Kremer/kenkremer.com

The 2018 launch of NASA's Orion on the unpiloted EM-1 mission counts as the first joint flight of SLS and Orion, and the first flight of a human rated spacecraft to deep space since the Apollo Moon landing era ended more than 4 decades ago.

SLS is the most powerful booster the world has even seen – even more powerful than NASA's Saturn V moon landing rocket of the 1960s and 1970s.

For SLS-1 the mammoth booster will launch in its initial 70-metric-ton (77-ton) Block 1 configuration with a liftoff thrust of 8.4 million pounds.

If NASA can pull off a 2019 EM-1 human launch it will coincide with the 50th anniversary of Apollo 11 – NASA's first lunar landing mission manned by Neil Armstrong and Buzz Aldrin, along with Michael Collins.

If crew are added to EM-1 it would essentially adopt the mission profile currently planned for Orion EM-2.

"If the agency decides to put crew on the first flight, the mission profile for Exploration Mission-2 would likely replace it, which is an approximately eight-day mission with a multi-translunar injection with a free return trajectory," said NASA. It would be similar to Apollo 8 and Apollo 13.

This artist concept depicts the Space Launch System rocket rolling out of the Vehicle Assembly Building at NASA's Kennedy Space Center. SLS will be the most powerful rocket ever built and will launch the agency's Orion spacecraft into a new era of exploration to destinations beyond low-Earth orbit. Credits: NASA/Marshall Space Flight Center

Orion is designed to send astronauts deeper into space than ever before, including missions to the Moon, asteroids and the Red Planet.

NASA is developing SLS and Orion for sending humans on a 'Journey to Mars' in the 2030s.

They are but the first hardware elements required to carry out such an ambitious initiative.

Looking up from beneath the enlarged exhaust hole of the Mobile Launcher to the 380 foot-tall tower astronauts will ascend as their gateway for missions to the Moon, Asteroids and Mars. The ML will support NASA's Space Launch System (SLS) and Orion spacecraft during Exploration Mission-1

at NASA's Kennedy Space Center in Florida. Credit: Ken Kremer/kenkremer.com

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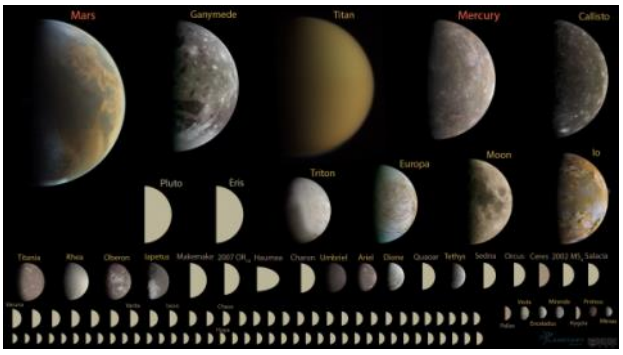
Ken Kremer

An artist's interpretation of NASA's Space Launch System Block 1 configuration with an Orion vehicle. Image: NASA

Sad About Pluto? How about 110 Planets in the Solar System Instead?

21 Feb , 2017 by Matt Williams



A new geophysical definition has been proposed by a team of planetary scientists, one which would result in a Solar System of 110 planets.

In 2006, during their 26th General Assembly, the International Astronomical Union (IAU) adopted a formal definition of the term "planet". This was done in the hopes of dispelling ambiguity over which bodies should be designated as "planets", an issue that had plagued astronomers ever since they discovered objects beyond the orbit of Neptune that were comparable in size to Pluto.

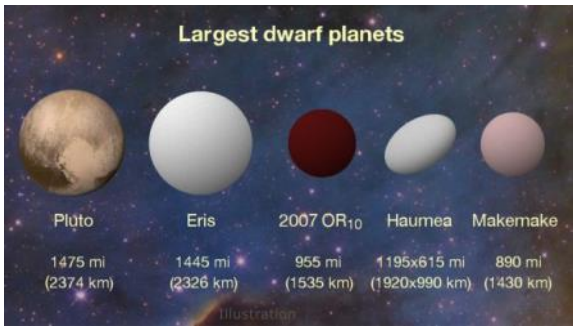
Needless to say, the definition they adopted resulted in fair degree of controversy from the astronomical community. For this reason, a team of planetary scientists – which includes famed "Pluto defender" Alan Stern – have come together to propose a new meaning for the term "planet". Based on their geophysical definition, the term would apply to over 100 bodies in the Solar System, including the Moon itself.

The current IAU definition (known as Resolution 5A) states that a planet is defined based on the following criteria:

"(1) A "planet" is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and (c) has cleared the neighbourhood around its orbit.

(2) A "dwarf planet" is a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape , (c) has not cleared the neighbourhood around its orbit, and (d) is not a satellite.

(3) All other objects , except satellites, orbiting the Sun shall be referred to collectively as "Small Solar-System Bodies"



The dwarf planets of the Solar System, arranged according to size. Credit: Konkoly Observatory/András Pál, Hungarian Astronomical Association/Iván Éder, NASA/JHUAPL/SwRI

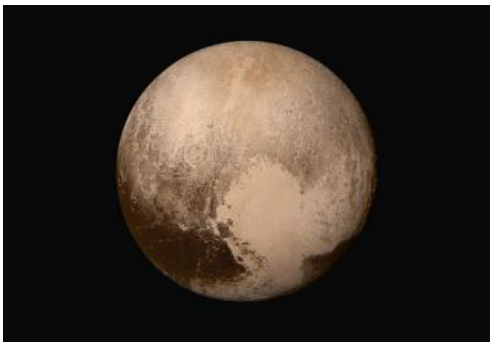
Because of these qualifiers, Pluto was no longer considered a planet, and became known alternately as a "dwarf planet", Plutiod, Plutino, Trans-Neptunian Object (TNO), or Kuiper Belt Object (KBO). In addition, bodies like Ceres, and newly discovered TNOs like Eris, Haumea, Makemake and the like, were also designated as "dwarf planets". Naturally, this definition did not sit right with some, not the least of which are planetary geologists.

Led by Kirby Runyon – a final year PhD student from the Department of Earth and Planetary Sciences at Johns Hopkins University – this team includes scientists from the Southwest Research Institute (SwRI) in Boulder, Colorado; the National Optical Astronomy Observatory in Tuscon, Arizona; the Lowell Observatory in Flagstaff, Arizona; and the Department of Physics and Astronomy at George Mason University.

Their study – titled "A Geophysical Planet Definition", which was recently made available on the Universities Space Research Association (USRA) website – addresses what the team sees as a need for a new definition that takes into account a planet's geophysical properties. In other words, they believe a planet should be so-designated based on its intrinsic properties, rather than its orbital or extrinsic properties.

From this more basic set of parameters, Runyon and his colleagues have suggested the following definition:

"A planet is a sub-stellar mass body that has never undergone nuclear fusion and that has sufficient self-gravitation to assume a spheroidal shape adequately described by a triaxial ellipsoid regardless of its orbital parameters."



The most iconic image from the New Horizon's July 2015 flyby, showing Pluto's 'heart.' Credit: NASA/JHUAPL/SwRI.

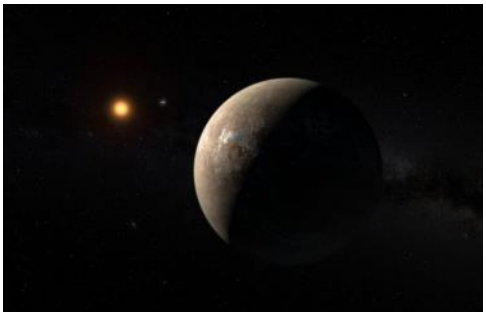
As Runyon told Universe Today in a phone interview, this definition is an attempt to establish something that is useful for all those involved in the study of planetary science, which has always included geologists:

"The IAU definition is useful to planetary astronomers concerned with the orbital properties of bodies in the Solar System, and may capture the essence of what a 'planet' is to them. The definition is not useful to planetary geologists. I study landscapes and how landscapes evolve. It also kind of irked me that the IAU took upon itself to define something that geologists use too.

"The way our brain has evolved, we make sense of the universe by classifying things. Nature exists in a continuum, not in discrete boxes. Nevertheless, we as humans need to classify things in order to bring order out of chaos. Having a definition of the word planet that expresses what we think a planet ought to be, is concordant with this desire to bring order out of chaos and understand the universe."

The new definition also attempts to tackle many of the more sticky aspects of the definition adopted by the IAU. For example, it addresses the issue of whether or not a body orbits the Sun – which does apply to those found orbiting other stars (i.e. exoplanets). In addition, in accordance with this definition, rogue planets that have been ejected from their solar systems are technically not planets as well.

And then there's the troublesome issue of "neighborhood clearance". As has been emphasized by many who reject the IAU's definition, planets like Earth do not satisfy this qualification since new small bodies are constantly injected into planet-crossing orbits – i..e Near-Earth Objects (NEOs). On top of that, this proposed definition seeks to resolve what is arguably one of the most regrettable aspects of the IAU's 2006 resolution.



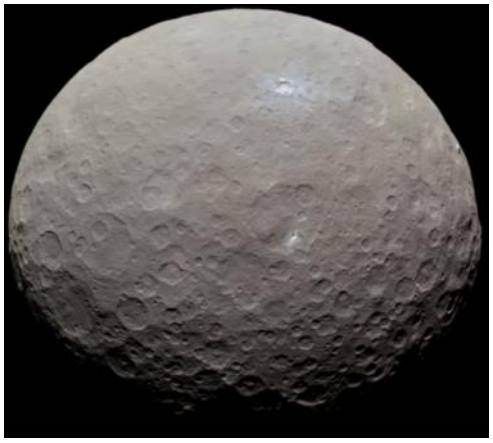
Artist's impression of the planet Proxima b orbiting the red dwarf star Proxima Centauri, the closest star to the Solar System. Credit: ESO/M. Kornmesser

"The largest motivation for me personally is: every time I talk about this to the general public, the very next thing people talk about is 'Pluto is not a planet anymore'," said Runyon. "People's interest in a body seems tied to whether or not it has the name 'planet' labelled on it. I want to set straight in the mind of the public what a planet is. The IAU definition doesn't jive with my intuition and I find it doesn't jive with other people's intuition."

The study was prepared for the upcoming 48th Lunar and Planetary Science Conference. This annual conference – which will be taking place this year from March 20th-24th at the Universities Space Research Association in Houston, Texas – will involve specialists from all over the worlds coming together to share the latest research findings in planetary science.

Here, Runyon and his colleagues hope to present it as part of the Education and Public Engagement Event. It is his hope that through an oversized poster, which is a common education tool at Lunar and Planetary Science Conference, they can show how this new definition will facilitate the study of the Solar System's many bodies in a way that is more intuitive and inclusive.

"We have chosen to post this in a section of the conference dedicated to education," he said. "Specifically, I want to influence elementary school teachers, grades K-6, on the definitions that they can teach their students. This is not the first time someone has proposed a definition other than the one proposed by the IAU. But few people have talked about education. They talk among their peers and little progress is made. I wanted to post this in a section to reach teachers."



In accordance with the definition proposed by Runyon, bodies like Ceres and even the moon would be considered "planets". Credit: NASA/ JPL/Planetary Society/Justin Cowart

Naturally, there are those who would raise concerns about how this definition could lead to too many planets. If intrinsic property of hydrostatic equilibrium is the only real qualifier, then large bodies like Ganymede, Europa, and the Moon would also be considered planets. Given that this definition would result in a Solar System with 110 "planets", one has to wonder if perhaps it is too inclusive. However, Runyon is not concerned by these numbers.

"Fifty states is a lot to memorize, 88 constellations is a lot to memorize," he said. "How many stars are in the sky? Why do we need a memorable number? How does that play into the definition? If you understand the periodic table to be organized based on the number of protons, you don't need to memorize all the atomic elements. There's no logic to the IAU definition when they throw around the argument that there are too many planets in the Solar System."

Since its publication, Runyon has also been asked many times if he intends to submit this proposal to the IAU for official sanction. To this, Runyon has replied simply:

"No. Because the assumption there is that the IAU has a corner on the market on what a definition is. We in the planetary science field don't need the IAU definition. The definition of words is based partly on how they are used. If [the geophysical definition] is the definition that people use and what teachers teach, it will become the de facto definition, regardless of how the IAU votes in Prague."

Regardless of where people fall on the IAU's definition of planet (or the one proposed by Runyon and his colleagues) it is clear that the debate is far from over. Prior to 2006, there was no working definition of the term planet; and new astronomical bodies are being discovered all the time that put our notions of what constitutes a planet to the test. In the end, it is the process of discovery which drives classification schemes, and not the other way around.

Commercial Space, Dragon, Earth, Earth Observation, Falcon 9, International Space Station, Kennedy Space Center, Launches, NASA, Space Exploration, Space Exploration Technologies, Space Flight, Space Station, SpaceX, Vehicle Assembly Building (VAB)

Spectacular SpaceX Space Station Launch and 1st Stage Landing – Photo/Video Gallery

21 Feb , 2017 by Ken Kremer

KENNEDY SPACE CENTER, FL – Sunday's inaugural blastoff of a commercial SpaceX Falcon 9 rocket from historic pad 39A at NASA's Kennedy Space Center on Feb. 19 proved to be space spectacular like none other along the Florida Space Coast, that will help path the path for eventual human journeys to the Red Planet. UPDATE: more imagery added.

Huge News, Seven Earth-Sized Worlds Orbiting a Red Dwarf, Three in the Habitable Zone

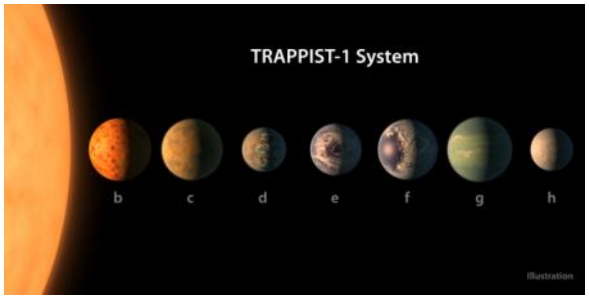
Article Updated: 27 Feb , 2017

by Matt Williams

In what is surely the biggest news since the hunt for exoplanets began, NASA announced today the discovery of a system of seven exoplanets orbiting the nearby star of TRAPPIST-1. Discovered by a team of astronomers using data from the TRAPPIST telescope in Chile and the Spitzer Space Telescope, this find is especially exciting since all of these planets are believed to be Earth-sized and terrestrial (i.e. rocky).

But most exciting of all is the fact that three of these rocky exoplanets orbit within the star's habitable zone (aka. "Goldilocks Zone"). This means, in effect, that these planets are capable of having liquid water on their surfaces and could therefore support life. As far as extra-solar planet discoveries go, this is without precedent, and the discovery heralds a new age in the search for life beyond our Solar System.

The team behind the discovery was led by Michael Gillon, an astronomer from the University of Liege in Belgium. Using the The Transiting Planets and Planetesimals Small Telescope (TRAPPIST) telescope at the European Southern Observatory's (ESO) La Silla Observatory in Chile, he and his colleagues first noticed the presence of three planets in the TRAPPIST-1 system in May of 2016.



Artist's concept showing what each of the TRAPPIST-1 planets may look like, based on available data about their sizes, masses and orbital distances. Credits: NASA/JPL-Caltech

The team made their observations of this star system – which is located about 39 light years from Earth in the direction of the Aquarius constellation – from September to December 2015. This discovery was immediately followed-up using several ground-based telescopes, which included including the ESO's Very Large Telescope, and the Spitzer Space Telescope.

Data from these surveys confirmed the existence of two of these planets, and revealed five more – making this the largest find around a single star in exoplanet-hunting history. Relying on the Spitzer data, Dr. Gillon and his team were also able to obtain precise information on the planets using the transit method. By measuring the periodic dips in TRAPPIST-1's luminosity (from the planet's passing in front of it), they were able to measure their sizes, masses and densities.

This is especially important when studying exoplanets. Not only does it allow scientists to make accurate assessments of a planet's composition (i.e. whether or not its rocky, icy, or gaseous), it is key in determining whether or not a planet could be habitable. It was also the first time in which accurate constraints were placed upon the masses and radii of exoplanets using this method.

A follow-up survey was then mounted with NASA's Hubble Space Telescope to study the three innermost planets and look for signs of hydrogen and helium – the chemical signatures that would indicate if the planets were gas giants. Hubble detected no evidence of hydrogen and helium atmospheres, which only strengthened the case for these planets being rocky in nature.

Another exciting aspect of all this is that these seven exoplanets – which are some of the best candidates for habitability – are near enough to Earth to be studies closely. As Michael Gillon, lead author of the paper and the principal investigator of the TRAPPIST exoplanet survey at the University of Liege, said in a NASA press release:

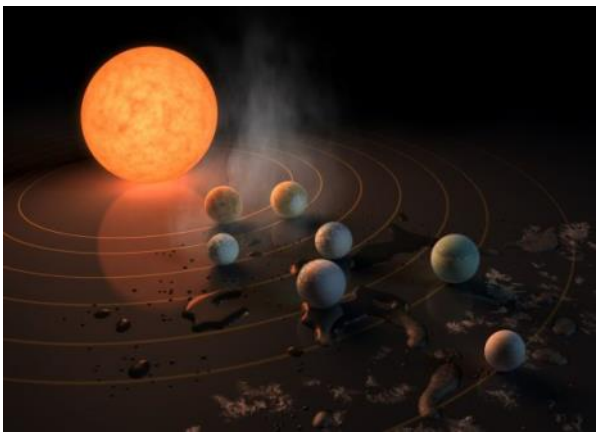
"The seven wonders of TRAPPIST-1 are the first Earth-size planets that have been found orbiting this kind of star. It is

also the best target yet for studying the atmospheres of potentially habitable, Earth-size worlds."

Nikole Lewis, the co-leader of the Hubble study and an astronomer at the Space Telescope Science Institute, was also on hand at the NASA press briefing where the findings were announced. There, she shared information that was obtained by the Hubble Space Telescope. And as she explained, of the three worlds that are in the habitable zone – TRAPPIST-1e, f, and g – all experience conditions that are very similar to what we experience here on Earth.

TRAPPIST-1e is the innermost of the three exoplanets. It is very close in size to Earth, and receives about the same amount of light as Earth does – which means temperatures are likely to be very close to Earth's as well. TRAPPIST-1f, meanwhile, is a potentially-water rich world that is also likely to be the same size as Earth. It has a 9-day orbit, and receives about the same amount of sunlight as Mars.

The outermost of the habitable zone planets is Trappist 1g. With a radius that is 13% larger than that of Earth, it is the largest planet in the system, and receives about the same amount of light as a body positioned between Mars and the Asteroid Belt would. Between these three exoplanets, and the four others in the system, astronomers now have a multiple candidates within the same star system to study what potentially-habitable worlds might look like.



Artist's concept of the TRAPPIST-1 star system, an ultra-cool dwarf that has seven Earth-size planets orbiting it. Credits: NASA/JPL-Caltech

During the course of the NASA press briefing, Dr. Gillon stressed why the discovery of this system is a major boon for astronomers and planetary scientists. Not only is this the first time that so many exoplanets have been discovered around the same star, but the fact that it is a red dwarf – a class of small, cooler, dimmer stars – is especially encouraging.

Compared to other classes, red dwarfs (aka. M-class stars) are the most frequent type of star in the Universe – making up an estimated 70% of stars in our galaxy alone. On top of that, the TRAPPIST-1 system is rather unique. As Gillon explained, the planets are in close enough proximity that they gravitationally interact with one another. Their proximity would also make for some excellent viewing opportunities for a person standing on the surface of one of them.

"The planets are close enough to each other," he said, "that if you were on the surface of one, you would have a wonderful view of the others. You would see them not as we see Venus or Mars from Earth (as bright stars), but as we see the Moon. They would be as large or larger than the Moon."

In the coming weeks and months, NASA plans to follow-up on this system of planets even more. At the moment, the Kepler space telescope is studying the system, conducting measurements of minuscule changes in the star's brightness due to transiting planets. Operating as the K2 mission, the spacecraft's observations will allow astronomers to refine the properties of the known planets, as well as search for additional planets in the system.

In the meantime, Dr. Gillon and his team will be using ground-based telescopes to search 1000 of the nearest ultra-cool dwarf stars to see if they too have multi-planet systems. Nikole Lewis indicated that Hubble will be conducting further observations of TRAPPIST-1 in order to obtain information about the planets' atmospheres.

These studies will determine what gases make up the atmospheres, but will also be looking for tell-tale signs of those that indicate the presence of organic life – i.e. methane, ozone, oxygen, etc.

"The TRAPPIST-1 system provides one of the best opportunities in the next decade to study the atmospheres around Earth-size planets," she said. "Not only will these studies let us know if any of these planets have the kind of atmospheres that are conducive to life, they will also tell us much about the formation and evolution processes of the surface – which are also key factors in determining habitability."

The Spitzer Space Telescope will also be trained on this system in order to obtain follow-up information on the planets' atmospheres. Besides looking for biological indicators (such as oxygen gas, ozone and methane), it will also be trying to determine the greenhouse gas content of the atmospheres – which will help put further constrains on the surface temperatures of the planets.

On top of that, next-generation missions – like the James Webb Telescope – are expected to play a vital role in learning more about this system. As Sara Seager – a professor of planetary science and physics at MIT – explained in the course of the briefing, the discovery of a system with multiple potentially-habitable planets was a giant, accelerated leap forward in the hunt for life beyond our Solar System.

Artist's impression of the view from one of the exoplanets discovered around the red dwarf star TRAPPIST-1. Credit: ESO/M. Kornmesser.

"Goldilocks has several sisters," as she put it. "An amazing system like this one lets us know there are many more life-bearing worlds out there. This star system is a veritable laboratory for studying stars orbiting very cool, very dim stars. We get to test many theories about these worlds, being tidally-locked and amount of radiation coming from host star."

Thomas Zurbuchen – the associate administrator of NASA's Science Mission Directorate – was also on hand at the briefing. In addition to expressing how this was a first for NASA

and exoplanet-hunters everywhere, he also expressed how exciting it was in the context of searching for life beyond our Solar System:

"This discovery could be a significant piece in the puzzle of finding habitable environments, places that are conducive to life. Answering the question 'are we alone' is a top science priority and finding so many planets like these for the first time in the habitable zone is a remarkable step forward toward that goal."

7 Questions For 7 New Planets

Published: 1 Mar , 2017

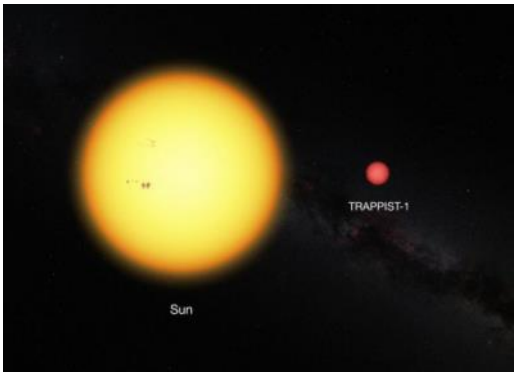
by Evan Gough

NASA's announcement last week of 7 new exoplanets is still causing great excitement. Any time you discover 7 "Earth-like" planets around a distant star, with 3 of them "potentially" in the habitable zone, it's a big deal. But now that we're over some of our initial excitement, let's look at some of the questions that need to be answered before we can all get excited again.

What About That Star?

The star that the planets orbit, called Trappist-1, is a Red Dwarf star, much dimmer and cooler than our Sun. The three potentially habitable planets—TRAPPIST-1e, f, and g— get about the same amount of energy as Earth and Mars do from the Sun, because they're so close to it. Red Dwarfs are very long-lasting stars, and their lifetimes are measured in the trillions of years, rather than billions of years, like our Sun is.

But Red Dwarfs themselves can have some unusual properties that are problematic when it comes to supporting life on nearby planets.



This illustration shows TRAPPIST-1 in relation to our Sun. Image: By ESO – http://www.eso.org/public/images/eso1615e/, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=48532941

Red Dwarfs can be covered in starspots, or what we call sunspots when they appear on our Sun. On our Sun, they don't have much affect on the amount of energy received by the Earth. But on a Red Dwarf, they can reduce the energy output by up to 40%. And this can go on for months at a time.

Other Red Dwarfs can emit powerful flares of energy, causing the star to double in brightness in mere minutes. Some Red Dwarfs constantly emit these flares, along with powerful magnetic fields.

Part of the excitement surrounding the Trappist planets is that they show multiple rocky planets in orbit around a Red Dwarf. And Red Dwarfs are the most common type of star in the Milky Way. So, the potential for life-supporting, rocky planets just grew in a huge way.

But we don't know yet how the starspots and flaring of Red Dwarfs will affect the potential habitability of planets orbiting them. It could very well render them uninhabitable.

Will Tidal Locking Affect the Planets' Habitability?

The planets orbiting Trappist-1 are very likely tidally locked to their star. This means that they don't rotate, like Earth and the rest of the planets in our Solar System. This has huge implications for the potential habitability of these planets. With one side of the planet getting all the energy from the star, and the other side in perpetual darkness, these planets would be nothing like Earth.

Tidal locking is not rare. For example, Pluto and its moon Charon (above) are tidally locked to each other, as are the Earth and the Moon. But can life appear and survive on a planet tidally locked to its star? Credit: NASA/JHUAPL/SwRI

One side would be constantly roasted by the star, while the other would be frigid. It's possible that some of these planets could have atmospheres. Depending on the type of atmosphere, the extreme temperature effects of tidal locking could be mitigated. But we just don't know if or what type of atmosphere any of the planets have. Yet.

So, Do They Have Atmospheres?

We just don't know yet. But we do have some constraints on what any atmospheres might be.

Preliminary data from the Hubble Space Telescope suggests that TRAPPIST 1b and 1c don't have extended gas envelopes. All that really tells us is that they aren't gaseous planets. In any case, those two planets are outside of the habitable zone. What we really need to know is if TRAPPIST 1e, 1f, and 1g have atmospheres. We also need to know if they have greenhouse gases in their atmospheres. Greenhouse gases could help make tidally locked planets hospitable to life.

On a tidally locked planet, the termination line between the sunlit side and the dark side is considered the most likely place for life to develop. The presence of greenhouse gases could expand the habitable band of the termination line and make more of the dark side warmer.

We won't know much about any greenhouse gases in the atmospheres of these planets until the James Webb Space Telescope (JWST) and the European Extremely Large Telescope (EELT) are operating. Those two 'scopes will be able to analyze the atmospheres for greenhouse gases. They might

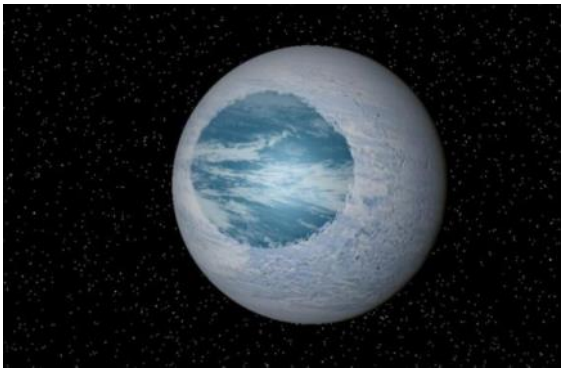
also be able to detect biosignatures like ozone and methane in the atmospheres.

We'll have to wait a while for that though. The JWST doesn't launch until October 2018, and the EELT won't see first light until 2024.

Do They Have Liquid Water?

We don't know for sure if life requires liquid water. We only know that's true on Earth. Until we find life somewhere else, we have to be guided by what we know of life on Earth. So we always start with liquid water.

A study published in 2016 looked at planets orbiting ultracool dwarfs like TRAPPIST-1. They determined that TRAPPIST 1b and 1c could have lost as much as 15 Earth oceans of water during the early hot phase of their solar system. TRAPPIST 1d might have lost as much as 1 Earth ocean of water. If they had any water initially, that is. But the study also shows that they may have retained some of that water. It's not clear if the three habitable planets in the TRAPPIST system suffered the same loss of initial water. But if they did, they could have retained a similar amount of water.



Artist's impression of an "eyeball" planet, a water world where the sun-facing side is able to maintain a liquid-water ocean. Credit and Copyright: eburacum45/ DeviantArt

There are still a lot of questions here. The word "habitable" only means that they are receiving enough energy from their star to keep water in liquid form. Since the planets are tidally locked, any water they did retain could be frozen on the planets' dark side. To find out for sure, we'll have to point other instruments at them.

Are Their Orbits Stable?

Planets require stable orbits over a biologically significant period of time in order for life to develop. Conditions that change too rapidly make it impossible for life to survive and adapt. A planet needs a stable amount of solar radiation, and a stable temperature, to support life. If the solar radiation, and the planet's temperature, fluctuates too rapidly or too much due to orbital instability, then life would not be able to adapt to those changes.

Right now, there's no indication that the orbits of the TRAPPIST 1 planets are unstable. But we are still in the preliminary stage of investigation. We need a longer sampling of their orbits to know for sure.

Pelted by Interlopers?

Our Solar System is a relatively placid place when it comes to meteors and asteroids. But it wasn't always that way. Evidence from lunar rock samples show that it may have suffered through a period called the "Late Heavy Bombardment." During this time, the inner Solar System was like a shooting gallery, with Earth, Venus, Mercury, Mars, and our Moon being struck continuously by asteroids.

The cause of this period of Bombardment, so the theory goes, was the migration of the giant planets through the solar system. Their gravity would have dislodged asteroids from the asteroid belt and the Kuiper Belt, and sent them into the path of the inner, terrestrial planets.

We know that Earth has been hit by meteorites multiple times, and that at least one of those times, a mass extinction was the result.

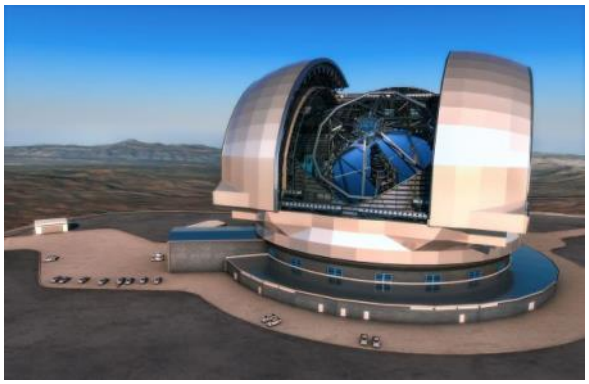
The TRAPPIST 1 system has no giant planets. But we don't know if it has an asteroid belt, a Kuiper Belt, or any other organized, stable body of asteroids. It may be populated by asteroids and comets that are unstable. Perhaps the planets in the habitable zone are subjected to regular asteroid strikes which wipes out any life that gets started there. Admittedly, this is purely speculative, but so are a lot of other things about the TRAPPIST 1 system.

How Will We Find Out More?

We need more powerful telescopes to probe exoplanets like those in the TRAPPIST 1 system. It's the only way to learn more about them. Sending some kind of probe to a solar system 40 light years away is something that might not happen for generations, if ever.

Luckily, more powerful telescopes are on the way. The James Webb Space Telescope should be in operation by April of 2019, and one of its objectives is to study exoplanets. It will tell us a lot more about the atmospheres of distant exoplanets, and whether or not they can support life.

Other telescopes, like the Giant Magellan Telescope (GMT) and the European Extremely Large Telescope (E-ELT), have the potential to capture images of large exoplanets, and possibly even Earth-sized exoplanets like the ones in the TRAPPIST system. These telescopes will see their first light within ten years.



This artist's impression shows the European Extremely Large Telescope (E-ELT) in its enclosure. The E-ELT will be a 39-metre aperture optical and infrared telescope. ESO/L. Calçada

What these questions show is that we can't get ahead of ourselves. Yes, it's exciting that the TRAPPIST planets have been discovered. It's exciting that there are multiple terrestrial worlds there, and that 3 of them appear to be in the habitable zone.

It's exciting that a Red Dwarf star—the most common type of star in our neighborhood—has been found with multiple rocky planets in the habitable zone. Maybe we'll find a bunch more of them, and the prospect of finding life somewhere else will grow.

But it's also possible that Earth, with all of its life supporting and sustaining characteristics, is an extremely unlikely occurrence. Special, rare, and unrepeatable..

MEMBERS VIEWING LOGS and IMAGES

Log February 2017

As a follow up to the YZ Cnc campaign which I described in the January Log, I have included an email to the BAAVSS alert group from Professor Christian Knigge, the Southampton University project leader:

Hi all,

Thanks so much for the hard work in covering this outburst -- the ground-based data we are getting from the amateur community look fantastic. Chandra did trigger near the peak, and those observations are in the bag. It would be great if the dense monitoring could continue at least until the decline is completely over and the system is fully back in quiescence again, just to give us a really clean view of what this outburst was like.

I'll let you know once I have preliminary results from the Chandra observation -- as you may recall, the main goal here is to see if we can detect the soft X-rays that we think should be coming from the boundary layer between the disk and the white dwarf during an outburst.

A detection would mean that YZ Cnc might be a great target for the bigger program I am hoping to kickstart, in which we'd cover a full outburst with everything from radio to X-rays (including UV, soft X-rays, hard X-rays, ground-based optical and IR, photometry, spectroscopy, all at high time resolution). A non-detection would mean I have to find a different target, but would still be scientifically interesting.

Thanks again for your crucial help!

Cheers,

Christian

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Professor Christian Knigge
Physics & Astronomy
University of Southampton
Southampton SO17 1BJ
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Just 45 observations this month bringing the total to 1181. GK Persei has been well placed for observation from my observing site for the last few months but is steadily disappearing over the roof of the house next door as each night goes by. I managed 4obseervations of it this month but that may be all until later in the year. GK Persei is perhaps better known as Nova Persei and was discovered by Thomas Anderson of Edinburgh on the evening of 21st February 1901 when he noticed a 3rd magnitude star in Perseus as he was walking home. A photograph of the star had been taken by Pickering's team at Harvard just two days before showing a magnitude 13 star in that position. This meant that the brightness had increased by 10 magnitudes (a 10,000 times increase in brightness) in no more than two days. It continued to increase in brightness over the next few days, reaching magnitude 0.2 before starting a decline which reduced it to magnitude 13 after around 11 years. From 1966 onwards it has been showing behaviour typical of a dwarf nova and fluctuates by about 3 magnitudes every 3 years or so. It is now thought that Cataclysmic variables, including dwarf novae accrete hydrogen which is transferred from their red dwarf secondaries via an accretion disk. After a period of a few thousand years to a few tens of thousands of years the hydrogen undergoes a thermonuclear explosion such as the outburst of GK Persei in 1901.
In 1978 GK Persei was found to be an X ray source which is a characteristic of a class of dwarf novae with strong magnetic fields. In the case of GK Persei, the field is strong enough to draw plasma from the inner regions of the accretion disc down onto the surface of the white dwarf – an Intermediate Polar. The magnetic field strength is between 1 and 10 million Gauss. For Comparison, the Earth's magnetic field is just about 1 Gauss. (Polars, such as AM Herculis, have even stronger magnetic fields, between 10 to 100 million Gauss, which is so strong that no accretion disc forms at all, instead material is drawn straight from the red dwarf onto the surface of the white dwarf).

Tony Vale

Viewing Log for 18th of February

Hilary Wilkey from Swindon Stargazers had asked me about going out viewing at Uffcott during spring before the skies become too light to view. We had been talking about this for about five weeks before we both had a free night and the sky was clear J. With my job as a driver it was quite normal for me to be working evening taking people from Heathrow Airport to their homes or dropping them off at the office to collect their cars!

So late afternoon I rung Hilary and she was happy to meet me at Uffcott from about 19:00 onwards. When I arrived at the layby there was a white van already parked up which seemed abandoned as there seemed to be nobody around it? I had my Meade LX90 GOTO telescope set up and running by 19:15 when Hilary got to the viewing site, while I was doing my set ups she brought her tripod out and tried to set it up when it fell over! Having a look at the tripod we noticed one of the legs was very loose, on closer inspection we found the attachment bolt was missing! As our night vision had not really kicked in we switched our lights to white so we if we could found the missing nut and bolt. After a couple of minutes I found the bolt but no sign of the nut, Hilary then informed me she had noticed a nut on the kitchen table at home and not thought more about it, hopefully that is the missing part? So with Hilary out of action for viewing I said she could view with me. My plan I decided I would change the format so Hilary would get something out of the evening as well.

First of all I wanted to take some pictures of the planets on view in the western horizon: started with Venus, noticed the crescent stage was becoming more evident (hopefully our speaker for this evening will mention the changing phases of Venus during his talk tonight?), followed on with Mars (not showing any real details apart being red to look at) and finally Uranus (which is Hilary's favourite planet to look at), hopefully these pictures will be in this month's magazine? After removing the camera I went back to these planets again so Hilary could have a decent look as well instead of viewing them thru the Live View on the back of the camera. So what to look? Cannot go wrong with looking at Messier (M) objects really? First object was M42 (probably the best deep sky object to view in the winter evenings?) and M43 in Orion, both looking fine to view. I thought I would try different objects to look at, so with this in mind I went for the only Supernova remnant in his list, namely M1 in Taurus which exploded in 1054 and was visible in daylight for quite a while afterwards. For Globular Clusters (G C) M79 is a bit of an odd ball as it is in an area of sky with no other G C's on view, this fuzzy object sits in Lepus just below Orion. Open Clusters (O C) are my favourite deep sky object to look at, so we went about four degrees below Sirius (brightest star in the night sky) and located M41, while in the area we went off and found O C's M46 and M47 to the east and slightly above Sirius. Both of these objects

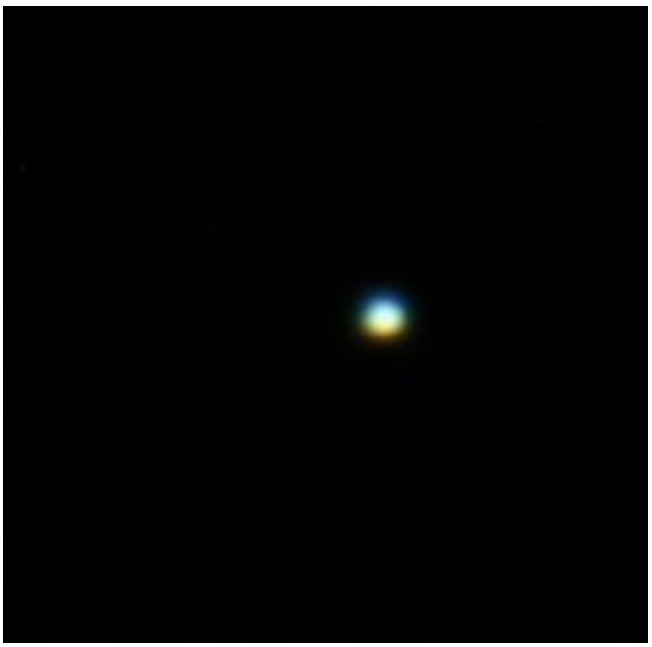
are not often looked at by me so it made a nice change to view them both. Another over looked O C was M50 in Monoceros (only Messier object in this constellation, just like M79 in Lepus). To find M50 draw a line from Sirius and Procyon and about a third of the way from Sirius you will locate M50? Off to find a galaxy now and M82 in Ursa Major, one of the better galaxies to look at as most of them (to me) are either faint fuzzies or very faint fuzzies! Final object of the evening was M97, a Planetary Nebula AKA the Owl Nebula just sitting below the pan of the Plough asterism, M97 is also the nemesis of Peter Chappell as told by Jon Gale as it was an object I could never locate even using GOTO equipment, sometimes it would not give itself up!

By now it was 20:55 and Hilary was starting to get cold so we decided to pack up and go home, as for the van parked up? Well someone was inside as we heard movement, as they did not disturb us we would not disturb them; they were probably glad that we moved on if they were trying to get some sleep?

Clear skies.

Peter Chappell

Mars



Uranus

And Venus, imaged by Peter Chappell.

Hi Andy,

Please find attached my submissions for the WAS newsletter for March 2017.

These images were taken on 4th February 2017 at the Teide National Park between 20:00 and 22:00 approx. There was a half Moon which was so bright it was casting shadows. Even so, the number of stars visible in the clear sky was over-whelming.

As Cassiopeia was the constellation of the month here is an image of Cassiopeia above the Roque Cinchado, one of the Roques de Garcia in the Teide National Park. In the back-

ground is Teide. To the left of Cinchado is a flare and I think it is Andromeda making an entrance at top left corner. The image was taken with a Canon G16 at 28mm, F1.8, ISO 800, 13 Sec.

The second image is a 60 minute startrail above Teide. It is a stack of 60 images taken with a Canon G16 at 28mm, F1.8, ISO 800, 13 Sec.

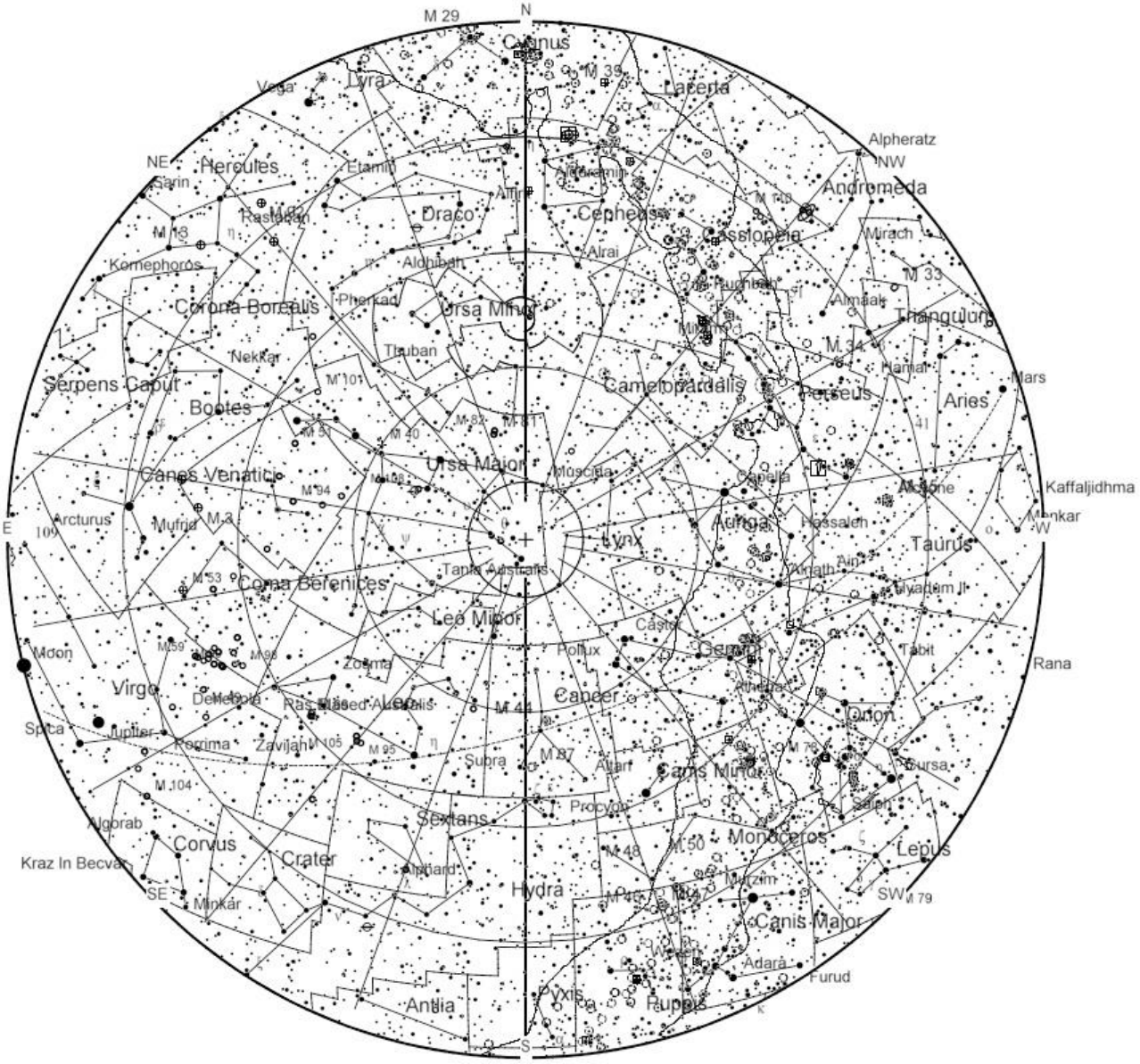
Regards,

John Dartnell

Below and right, Venus and the Moon taken on the 10th February, using televue 127 telescope and Nikon D7200 with 2x Barlow.

Andy Burns

WHATS UP, March 2017



March 12 - **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 14:54 UTC. This full moon was known by early Native American tribes as the Full Worm Moon because this was the time of year when the ground would begin to soften and the earthworms would reappear. This moon has also been known as the Full Crow Moon, the Full Crust Moon, the Full Sap Moon, and the Lenten Moon.

March 20 - **March Equinox.** The March equinox occurs at 10:29 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 spring (vernal equinox) in the Northern Hemisphere and the first day of fall (autumnal equinox) in the Southern Hemisphere.

March 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 02:58 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.

April 1 - **Mercury at Greatest Eastern Elongation.** The planet Mercury reaches greatest eastern elongation of 19 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the evening sky. Look for the planet low in the western sky just after sunset.

March is also a great time for the Messier marathon, with the Sun in a part of the sky where few of the deep sky objects are located, but the best time is also full Moon.

So why not search for the Messier object that matches your age this birthday, or even last birthday. Some fun with binoculars at least.

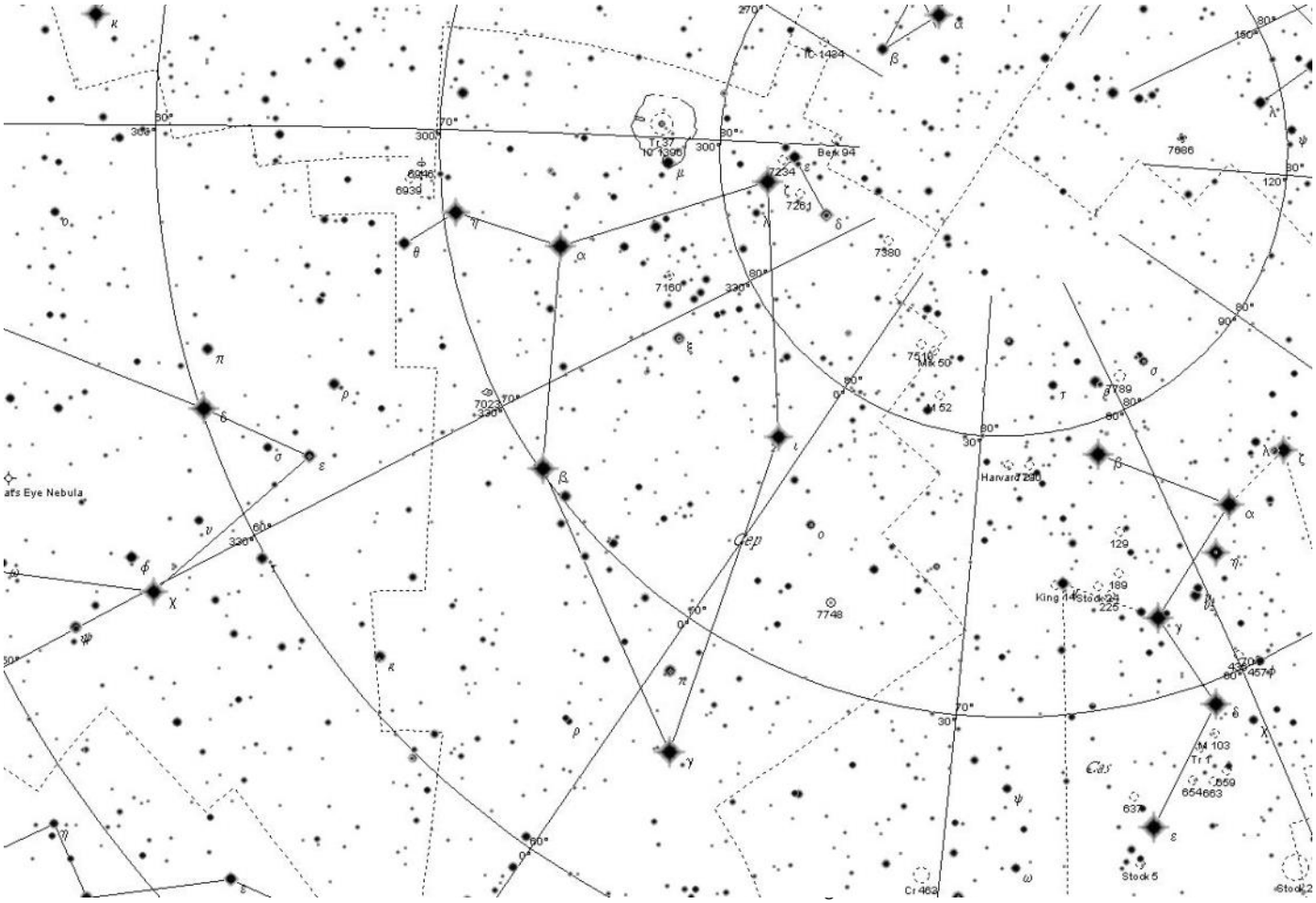
See Jonathan Gale's Binocular views for March in the main newsletter.

Another very hard to hunt thing occurs on the 25th March (try days before and days after if you are unsure of solar safety). Venus will be 8º above the Sun on its inferior pass, so can be seen as a morning object and an evening object on the same day. BUT PLEASE BE CAREFUL.

Clear skies

Andy

CONSTELLATIONS OF THE MONTH: Cepheus

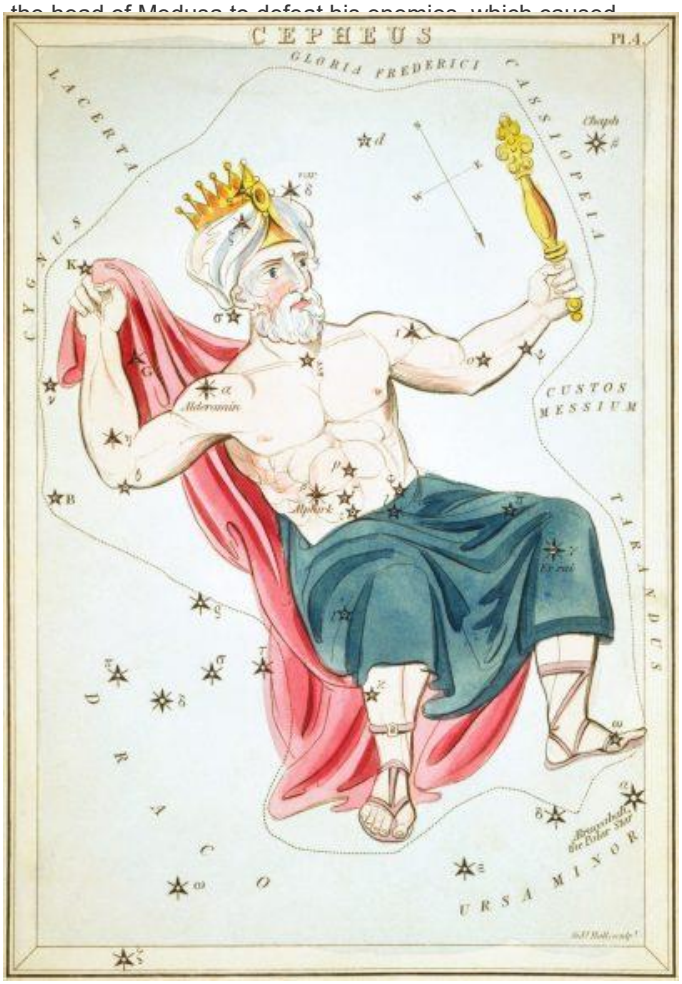


Transit Date of principal star:
11 August

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 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.

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:

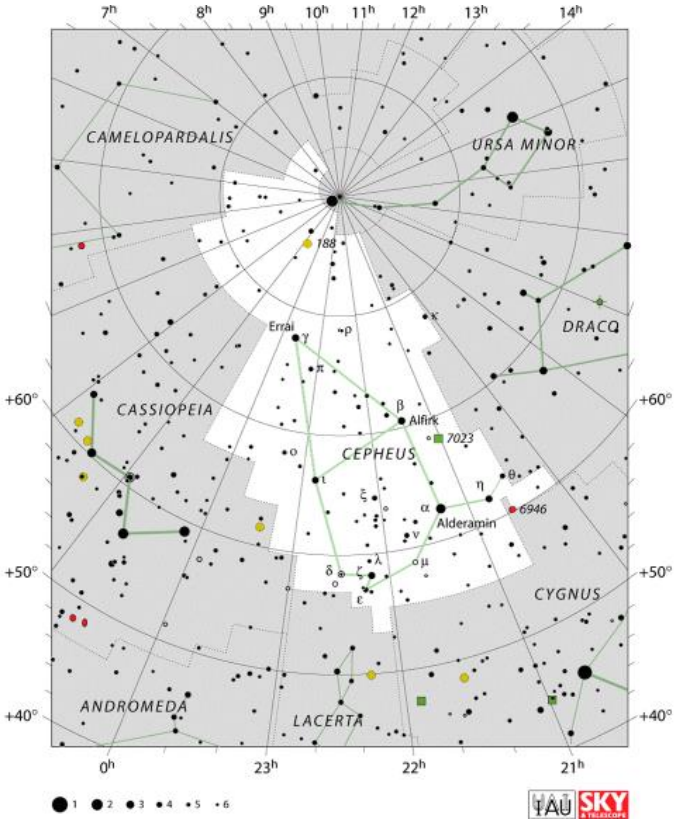
Cepheus is a circumpolar constellation of the northern hemisphere and is easily seen at visible at latitudes between +90° and -10° and best seen during culmination during the month of November. For the unaided eye observer, start first with Cepheus' brightest star – Alpha. It's name is Alderamin and 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.

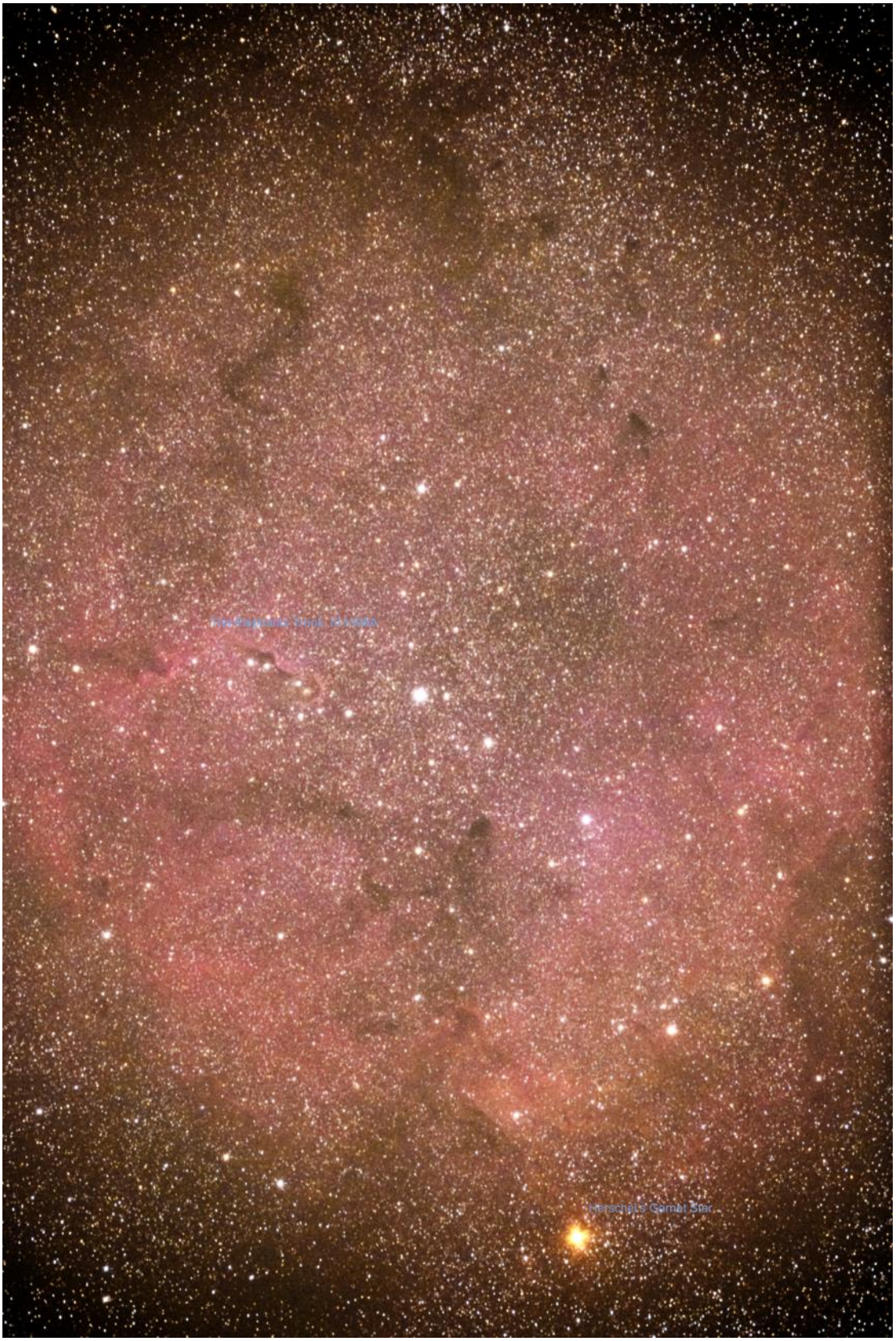
For a telescope challenge, see if you can locate both Spiral galaxy NGC 6946 – aka. the Fireworks Nebula – and galactic cluster NGC 6939 about 2 degrees southwest of Eta Cepheus. About 40 arc minutes northwest of NGC 6946 – is about 8th magnitude, well compressed and contains about 80 stars.

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.

Upcoming Astronomy Events.

Dear Herschellians,

This is to let you know about the dance work 'Lina' which is to be performed this week:

Dates and Times:	Thu, Mar 9, 2017 19:30 Fri, Mar 10, 2017 19:30
Place:	The Mission Theatre, 32 Corn Street Bath BA1 1UF
Tickets:	£8 (£6 concs) from the Bath Box Office 01225 463362

Presented by **Forged Line Dance Company**

Lina explores the lives and obsessions of brother and sister William and Caroline Herschel. Both talented musicians and celebrated astronomers, they studied the universe and mapped the stars from their garden in 18th Century Bath.

A new dance work from Bath-based company Forged Line, *Lina* delves into a caring yet complex relationship, where family ties are tested by individual ambition. Music merges into science, art becomes mathematics, and a brother and sister, far from home, change how we see the universe forever.

This intimate and emotionally charged duet is inspired by themes of creativity, invention and frustration that shaped the siblings' extraordinary story. Featuring music composed by William Herschel.

Supported by Herschel Museum of Astronomy and the William Herschel Society.

Kind regards,

Tony Symes

ISS PASSES For January to Mid Feb 2017 From Heavens Above website maintained by Chris Peat

Date	Brightness	Start	Highest point		End					
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
06 Mar	-1.7	05:21:22	12°	SSW	05:23:57	29°	SSE	05:26:53	10°	E
07 Mar	-1.2	04:31:22	19°	SSE	04:31:53	20°	SE	04:34:22	10°	E
07 Mar	-3.0	06:04:40	10°	WSW	06:07:58	65°	SSE	06:11:15	10°	E
08 Mar	-0.1	03:41:16	10°	ESE	03:41:16	10°	ESE	03:41:25	10°	ESE
08 Mar	-2.6	05:13:56	22°	SW	05:15:47	48°	SSE	05:18:59	10°	E
09 Mar	-2.0	04:23:45	33°	SE	04:23:45	33°	SE	04:26:38	10°	E
09 Mar	-3.3	05:56:35	10°	W	05:59:54	86°	S	06:03:14	10°	E
10 Mar	-0.3	03:33:31	14°	E	03:33:31	14°	E	03:34:10	10°	E
10 Mar	-3.2	05:06:10	30°	WSW	05:07:38	72°	SSE	05:10:57	10°	E
11 Mar	-2.6	04:15:53	48°	ESE	04:15:53	48°	ESE	04:18:38	10°	E
11 Mar	-3.3	05:48:31	10°	W	05:51:50	85°	N	05:55:09	10°	E
12 Mar	-0.3	03:25:33	15°	E	03:25:33	15°	E	03:26:17	10°	E
12 Mar	-3.4	04:58:12	34°	W	04:59:31	90°	E	05:02:50	10°	E
13 Mar	-2.7	04:07:50	54°	E	04:07:50	54°	E	04:10:31	10°	E
13 Mar	-3.3	05:40:29	11°	W	05:43:42	89°	NNW	05:47:02	10°	E
14 Mar	-0.3	03:17:28	15°	E	03:17:28	15°	E	03:18:11	10°	E
14 Mar	-3.4	04:50:07	35°	W	04:51:22	85°	N	04:54:41	10°	E
15 Mar	-2.5	03:59:44	51°	E	03:59:44	51°	E	04:02:20	10°	E
15 Mar	-3.3	05:32:23	11°	W	05:35:30	73°	SSW	05:38:48	10°	ESE
16 Mar	-0.2	03:09:23	14°	E	03:09:23	14°	E	03:09:58	10°	E
16 Mar	-3.4	04:42:01	38°	W	04:43:10	87°	S	04:46:28	10°	E
17 Mar	-2.3	03:51:41	45°	E	03:51:41	45°	E	03:54:06	10°	E
17 Mar	-2.9	05:24:19	12°	W	05:27:11	49°	SSW	05:30:24	10°	SE
18 Mar	-0.1	03:01:22	12°	E	03:01:22	12°	E	03:01:43	10°	E
18 Mar	-3.3	04:34:01	44°	W	04:34:52	67°	SSW	04:38:09	10°	ESE
19 Mar	-1.9	03:43:47	34°	ESE	03:43:47	34°	ESE	03:45:49	10°	ESE
19 Mar	-2.3	05:16:26	14°	W	05:18:44	30°	SSW	05:21:41	10°	SSE
20 Mar	-3.0	04:26:17	43°	SW	04:26:27	44°	SSW	04:29:37	10°	SE
21 Mar	-1.1	03:36:15	20°	ESE	03:36:15	20°	ESE	03:37:22	10°	ESE
21 Mar	-1.6	05:08:55	15°	WSW	05:10:07	18°	SW	05:12:26	10°	S
22 Mar	-1.7	04:19:02	21°	S	04:19:02	21°	S	04:20:44	10°	SSE
27 Mar	-1.0	20:49:31	10°	SSE	20:49:54	11°	SSE	20:49:54	11°	SSE
28 Mar	-1.7	21:31:32	10°	SW	21:33:10	23°	SSW	21:33:10	23°	SSW
29 Mar	-2.0	20:39:32	10°	SSW	20:42:10	23°	SE	20:43:29	18°	ESE
29 Mar	-1.1	22:15:01	10°	WSW	22:16:10	20°	WSW	22:16:10	20°	WSW
30 Mar	-3.2	21:22:36	10°	WSW	21:25:47	54°	SSE	21:26:14	48°	SE
31 Mar	-2.7	20:30:17	10°	SW	20:33:20	38°	SSE	20:36:09	12°	E
31 Mar	-2.5	22:06:21	10°	W	22:08:47	47°	W	22:08:47	47°	W
01 Apr	-3.4	21:13:49	10°	WSW	21:17:05	77°	SSE	21:18:33	30°	E
01 Apr	-0.7	22:50:17	10°	W	22:51:12	18°	W	22:51:12	18°	W
02 Apr	-3.2	20:21:19	10°	WSW	20:24:32	59°	SSE	20:27:47	10°	E
02 Apr	-3.3	21:57:41	10°	W	22:00:50	80°	WNW	22:00:50	80°	WNW
03 Apr	-3.4	21:05:06	10°	W	21:08:22	87°	NNW	21:10:24	22°	E
03 Apr	-1.2	22:41:34	10°	W	22:43:03	24°	W	22:43:03	24°	W
04 Apr	-3.5	21:48:58	10°	W	21:52:15	88°	S	21:52:32	73°	ESE
05 Apr	-3.3	20:56:21	10°	W	20:59:38	85°	N	21:02:00	17°	E
05 Apr	-1.6	22:32:50	10°	W	22:34:38	28°	W	22:34:38	28°	W
06 Apr	-3.3	21:40:11	10°	W	21:43:27	68°	SSW	21:44:04	51°	SE
07 Apr	-3.4	20:47:33	10°	W	20:50:49	84°	SSW	20:53:30	15°	ESE
07 Apr	-1.6	22:24:08	10°	W	22:26:07	26°	WSW	22:26:07	26°	WSW

END IMAGES, OBSERVING AND OUTREACH

The two pictures above and right show the importance of making 'flat white' images through the imaging train used to take images through a telescope.

The California nebula in Perseus is a large object and fills the full telescope view in the 5" refractor used. It is almost like the old comment, if lens are round why are film and digital camera chips rectangular. The trade of is a dimming in running in from the corners called vignette. When you use in daylight or bright objects these tend not to show, but long exposures with subsequent pushing and pulling in photoshop levels give very pronounced darkening.

Using a white sheet/handkerchief to cover the whole objective lens take a picture of a white sky (or white screen on iPad) and push the levels a similar amount and extract as a layer and merge. With tweaking, practice and iterations the above result can be achieved from the same photograph.

Andy Burns

Date	Moon Phase	Observing Topic
2017		
Friday 24th March	Waning crescent (sets around 2pm)	Deep Sky
Friday 28th April	Waxing crescent (sets 11pm)	Deep Sky & Lunar targets
Friday 26th May	Waxing crescent (sets around 10pm)	Deep Sky & Lunar targets

OUTREACH ACTIVITIES

Still awaiting clear Thursday to tie in with Chippenham Scouts.

Paragon School, Bath Changed to May daytime meeting

March 18th. Bath Does Science, Victoria Park. Do you want to set up solar viewing?