NWASNEWS

Volume24, Issue 4

December 2018

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

SEASONS GREETINGS

What a busy month for space (rather than astronomy).

From getting astronauts back into space onto the ISS yesterday, also launching a cluster of 68 microsatellites using a 3rd use Falcon 9 rocket. Plus a probe/landing arriving at Bennu asteroid, a near Earth threatening lump of rock that my get pushed into a more threatening orbit by the thrust build up of the solar energy creating the Yarkovsky thrust effect.

After taking measurements it will also try a grap a sample of the asteroid and return it to Earth.

This follows the Huyabasi probe from Japan that landed on December 3rd.

Then we have another landing rover at Mars, this time one that will explore deep below the surface of Mars. It should go well, it has plenty of power, in the first week it doubled the previous highest daily power gain from its solar panels.

Back at home on Earth we are being visited by a comet that orbits the Sun every 46 years, but on this pass it will come as close as 2 million miles, one of the top 10 close passes. But there is little danger from this comet, only having a core of around 1km diameter. Even if it hit the earth it will probably burn up before impact.

But it should just reach naked eye visibility as it rises from Cetus, up past the Pleiades and onto Auriga with a close encounter with Capella on Christmas day.

Speaking of Christmas, on Christmas morning you may catch Santa returning home alongside the ISS as it passes Venus at 6:45 on the 25th.

We will have a weather dependant early start viewing session on the 28th starting at 6:30pm. We have been very lucky with observing session weather in this season with some viewing available each time.

Our next meeting session is the Q and A forum, that many people find helpful, but to make best use of this session we need to be able to prepare answers and equipment to help. I have already had one request to go into celestial coordinates and how to use them. I have been using them to find the comet Wirtanen and find the comet to image it, so Celestial coordinates are very useful indeed.

Please pass on questions or email

anglesburns@hotmail.com.

We also have three potential viewing sessions at schools in January and February. Please, if you say you are available I need to rely on those volunteers because schools have to make arrangements for out of school hours from the numbers I have to help.

Clear Skies Andy

The 'Christmas Comet' or 46P Wirtanen is rising through the skies this month and will be as high as Capella on Christmas day, and should be naked eye by then.

It is a tiny comet, a mere 1km across so does not have a lot of material to make a huge coma or tail. The 3.7 magnitude peak is spread over an area the size of the Moon, and it will pass around 2 million miles from the Earth, making it among the top 10 closest comets.

Here, low in Cetus taken last night (3rd December) from home observatory, Nikon D810A, 60seconds, ISO1600 with 2x convertor on Televue 127 refractor.

Minimum magnitude on picture 14.5.

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

Meetings 2018/2019Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

Date	Speaker	Title
4 Dec	Dr Elizabeth Pearson:	A very brief History of Rovers & Landers.
2019		
15 Jan	Open Forum/Beginners Meet.	
5 Feb	Prof. David Southwood:	Mars: Delirium, Delight & Disasters, some personal stories.
5 Mar	Martin Griffiths:	'Universal Death' or How the Universe is trying to kill us.
2 Apr	Chris Starr:	A Most beautiful Moon – A History of Lunar Exploration.
7 May	Mark Radice:	Observing the Solar System.
4 Jun	Jon Gale:	Observing the Herschel 400.

Elizabeth Pearson; space journalist, astrophysicist and board game enthusiast.

I'm currently working as the News Editor of BBC Sky at Night Magazine where I regularly write about all things space. I am also available for talks and freelance writing.

She will be talking about 'A very brief History of Rovers & Landers', very appropriate after a very busy two weeks with landers at Mars and Bennau asteroid taking the headlines.

Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Keith Bruton Chair, keisana@tiscali.co.uk

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

Bob Johnston (Treasurer) Debbie Croker (vice Treasurer)

Philip Proven (Hall coordinator) Dave Buckle (Teas)

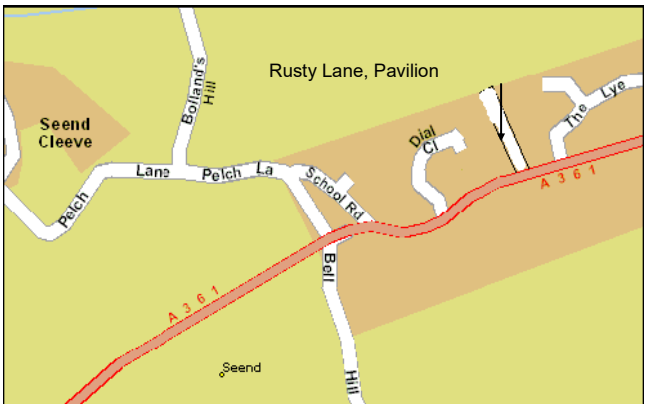
Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

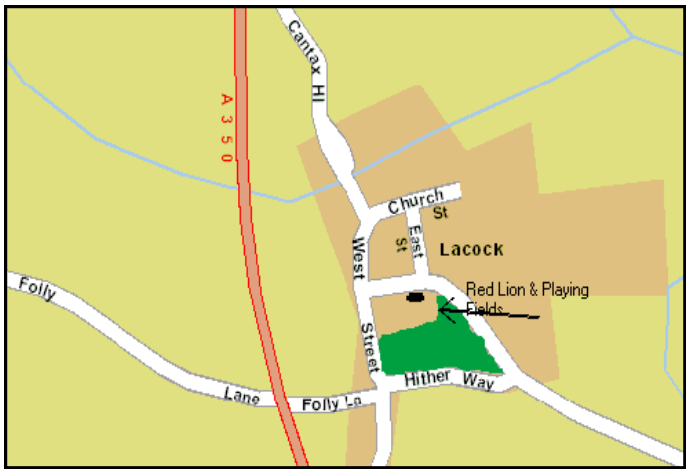
Observing Sessions coordinators: Jon Gale, Tony Vale

Web coordinmator: Sam Franklin

Contact via the web site details.



Observing Sessions



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

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

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

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

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

Swindon 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.

Stargazing Season

We have quite a few observers at Swindon Stargazers so we are very much looking forward to the winter season.

Ad-hoc viewing sessions

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

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

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

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

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

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

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

Enjoy astronomy at it's best!

Members of the Wiltshire Astronomical Society always welcome!

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

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

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

Meeting Dates for 2018

Friday 14 December 2018
Programme: Christmas Social at the Bakers Arms, Badbury

Meeting Dates for 2019

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

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

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

Friday 12 April 2019

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

Friday 17 May 2019

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

Friday 21 June 2019
Programme: TBA

Website:

http://www.swindonstargazers.co

Chairman: Peter Struve

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BECKINGTON ASTRONOMICAL SOCIETY

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

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

Our Committee for 2016/2017 is

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

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

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

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

Post Code for Sat Nav is BA11 6TB.

Our start time is 7.30pm.

7th December	Social Evening + bring and tell	
18th January	*The Mathematical Universe*	Steve Hill
15th February	*Journey to the Edge of the Solar System*	Chris Starr
15th March	*How Old Is It?*	Stephen Tonkin
26th April	*Observing and Sketching the Deep Sky*	Mark Radice
17th May	*The Herschel 400*	Jonathan Gale
21st June	Annual General Meeting *Member Talks*	

Herschel Society

Next lecture at Bath University

Wednesday 21st November – Caroline Herschel Prize Lecture. Bath University.

NASA Night Sky Notes: Observe Apollo 8's Lunar Milestones
By David Prosper

December marks the 50th anniversary of NASA's Apollo 8 mission, when humans first orbited the Moon in a triumph of human engineering. The mission may be most famous for "Earthrise," the iconic photograph of Earth suspended over the rugged lunar surface. "Earthrise" inspired the imaginations of people around the world and remains one of the most famous photos ever taken. This month also brings a great potential display of the Geminids and a close approach by Comet 46P/Wirtanen

You can take note of Apollo 8's mission milestones while observing the Moon this month. Watch the nearly full Moon rise just before sunset on December 21, exactly 50 years after Apollo 8 launched; it will be near the bright orange star Aldebaran in Taurus. The following evenings watch it pass over the top of Orion and on through Gemini; on those days five decades earlier, astronauts Frank Borman, Jim Lovell, and Bill Anders sped towards the Moon in their fully crewed command module. Notice how the Moon rises later each evening, and how its phase wanes from full on Dec 22 to gibbous through the rest of the week. Can you imagine what phase Earth would appear as if you were standing on the Moon, looking back? The three brave astronauts spent 20 sleepless hours in orbit around the Moon, starting on Dec 24, 1968. During those ten orbits they became the first humans to see with their own eyes both the far side of the Moon and an Earthrise! The crew telecast a holiday message on December 25 to a record number of Earthbound viewers as they orbited over the lifeless lunar terrain; "Good night, good luck, a merry Christmas and God bless all of you - all of you on the good Earth." 50 years later, spot the Moon on these holiday evenings as it travels through Cancer and Leo. Just two days later the astronauts splashed down into the Pacific Ocean after achieving all the mission's test objectives, paving the way for another giant leap in space exploration the following year.

The Geminids, an excellent annual meteor shower, peaks the evening of December 13 through the morning of the 14th. They get their chance to truly shine after a waxing crescent Moon sets around 10:30 pm on the 13th. Expert Geminid observers can spot around 100 meteors per hour under ideal conditions. You'll spot quite a few meteors by avoiding bad weather and light pollution if you can, and of course make sure to bundle up and take frequent warming breaks. The Geminids have an unusual origin compared to most meteor showers, which generally spring from icy comets. The tiny particles Earth passes through these evenings come from a strange "rock comet" named asteroid 3200 Phaethon. This dusty asteroid experiences faint outbursts of fine particles of rock instead of ice.

You can also look for comet 46P/Wirtanen while you're out meteor watching. Its closest approach to Earth brings it within 7.1 million miles of us on December 16. That's 30 times the average Earth-Moon distance! While passing near enough to rank as the 10th closest cometary approach in modern times, there is no danger of this object striking our planet. Cometary brightness is hard to predict, and while there is a chance comet 46P/Wirtanen may flare up to naked eye visibility, it will likely remain visible only via binoculars or telescopes. You'll be able to see for yourself how much 46P/Wirtanen actually brightens. Some of the best nights to hunt for it will be December 15 and 16 as it passes between two prominent star clusters in Taurus: the Pleiades and the V-shaped Hyades. Happy hunting!

Catch up on all of NASA's past, current, and future missions at nasa.gov

Earthrise, 1968. Note the phase of Earth as seen from the Moon. Nearside lunar observers see Earth go through a complete set of phases. However, only orbiting astronauts witness Earthrises; for stationary lunar observers, Earth barely moves at all. Why is that?

Credit: Bill Anders/NASA

MEMBERS VIEWING LOGS and IMAGES

Viewing Log for 30th of November

My only real chance of getting out during November for a viewing session was at the monthly WAS session at Lacock! It has been that poor for weather or the only good clear times were around a full Moon which unless it is a lunar eclipse (next one in this country is on the 27th of January 2019) is not really a good time to go out and do any deep sky viewing!

So with this in mind and knowing they could be a good chance for cloud cover at Lacock I packed my gear up and took the 35 minute trip to the sight. By the time I had arrived and set up my Meade LX90 GOTO telescope at 20:35 there was seven other people there which on recent numbers are pretty reasonable? Same old faces but nice to be able to catch up with them anyway.

I could see a band of cloud coming in from the west so my time might be limited by this, as Mars was clear I set off to find this planet. Last month I was having trouble with finding planets (including the Moon) in the eye piece when I slewed to them (no trouble with stars or deep sky stuff), this time Mars was in the field of view, not centre but good enough to find and if required centre. I found this strange as setting up my telescope uses a GPS fix, no input from me apart from levelling the scope and centring the stars when requested. As usual I could not make out any detail on the surface of Mars probably low in the sky and the conditions were not that great? Off to Uranus and Neptune the two ice giants of the Solar System; I think I found them, if so they were not great to look at? After the Solar System objects it might be a case of hunting for deep sky items as by now the cloud cover had come across our area! I could make out Auriga clearly so I had a look at the Open Clusters of Messier (M) 36, 37 & 38. M 36 was sparse to look at, M 37 was no better than okay and I could make out M 38 thru thin cloud? A small gap on the eastern horizon saw Orion razing so I had a look at M 42 which even at this lower height was a delight to view, never really get fed up looking at this object. Around to Ursa Major and M 81 and 82, two bright galaxies above the Plough blade part of the asterism and slightly to the east. While here I thought I would have a look at probably the most dull and not looked at Messier object, namely M 40 a double star of magnitudes 9.65 & 10.1, this is also known as Winnecke 4. By now the cloud cover was nearly complete so I headed back to Mars for one final look before stopping L.

Every other person had now packed up and some had gone when I called it a day at 21:22, it was a bit disappointing session but at least I did get out for a while, hopefully this month will not be that bad as there is a comet raising near Orion which should get to naked eye vision very soon?

Let's hope for some clear skies when the full Moon is not around?

Peter Chappell

M42 and Messier 35 from last night while looking for comets. Andy Burns

SPACE NEWS FOR DECEMBER

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

SpaceX launches swarm of satellites, re-flies rocket for third time

December 3, 2018 Stephen Clark

A Falcon 9 rocket lifts off Monday at 10:34 a.m. PST (1:34 p.m. EST; 1834 GMT) from Space Launch Complex 4-East at Vandenberg Air Force Base, California. Credit: SpaceX

Setting new commercial launch and satellite industry records, a SpaceX Falcon 9 rocket propelled by a first stage booster launched and recovered two times before soared into a clear morning sky over California's Central Coast on Monday with 64 small satellites, then returned to a pinpoint landing on a vessel parked offshore in the Pacific Ocean, potentially to be flown again.

The first stage of the Falcon 9 rocket launched Monday became the first commercial booster to accomplish three flights hauling satellites toward orbit, pushing SpaceX closer to its goal of re-flying boosters 10 times without maintenance or refurbishment between missions. Elon Musk, SpaceX's billionaire founder and chief executive, considers that goal central to the company's mission of reducing the cost of space transportation, enabling exploration — and ultimately settlements — on Mars.

Going into Monday's launch, SpaceX had re-launched one of its Falcon 9 boosters 17 times, including a pair of modified first stages used on the inaugural flight of company's Falcon Heavy rocket in February. But none of the boosters had launched more than twice before Monday's re-flight of a first stage that debuted May 11 with a launch from the Kennedy Space Center in Florida, landed on a drone ship in the Atlantic Ocean, then lifted off again Aug. 7 from Cape Canaveral Air Force Station and touched down again on the drone ship.

SpaceX transported the rocket by road from Florida to Vandenberg Air Force Base, California, for final launch preps to blast off for.a third time.

The 229-foot-tall (70-meter), two-stage Falcon 9 rocket — its booster stage covered in soot and scorch marks from two fiery trips to the edge of space and back — ignited its nine Merlin main engines and lifted off from Vandenberg Air Force Base at 10:34:05 a.m. PST (1:34:05 p.m. EST; 1834:05 GMT) Monday.

The launcher tilted toward the south, riding 1.7 million pounds of thrust into a cloudless late autumn sky at the military-run spaceport around 140 miles (225 kilometers) northwest of Los Angeles.

The first stage shut down its engines less than two-and-a-half minutes into the mission after accelerating the rocket to a velocity of more than 3,600 mph (about 5,900 kilometers per hour), and pneumatic pushers separated the booster from the Falcon 9's second stage, which SpaceX builds new for each mission.

While the upper stage's single Merlin engine ignited for a roughly seven-and-a-half minute firing to place the mission's payloads into orbit, the first stage fired a subset of its engines for boost-back and entry burns to aim the descending rocket for SpaceX's drone ship "Just Read the Instructions" positioned around 30 miles (50 kilometers) off the coast of Vandenberg in the Pacific Ocean.

The Falcon 9 rocket's first stage descends back to Earth as its engines fire for the entry burn before landing on SpaceX's drone ship in the Pacific Ocean on Monday. Credit: SpaceX

Long-range tracking cameras at Vandenberg captured spectacular views of the rocket coming back to Earth, then lighting its center engine and extending four landing legs before nailing a landing on the drone ship — all within view of spectators on the coast, thanks to an unusually clear morning at the military base.

SpaceX's rocket landing drone ships are typically parked hundreds of miles offshore, but the company's California-based rocket recovery vessel held position much closer to shore Monday.

Meanwhile, the Falcon 9's second stage continued firing until T+plus 10 minutes to reach a targeted orbit around 357 miles (575 kilometers) above Earth, flying on a north-to-south path inclined 97.8 degrees to the equator.

During the second stage burn, the Falcon 9 jettisoned its clamshell-like nose shroud, which covered the mission's 64 small satellite payloads during the first few minutes of the flight. After falling away from the rocket, the two halves of the fairing unfurled parafoils to slow their fall back to Earth, where a SpaceX-leased fast-moving boat named "Mr. Steven" tried to catch the shroud with a giant net.

The fairing catch attempt Monday was the first in more than four months by SpaceX, but Mr. Steven missed the fairing halves, despite the installation of a bigger net earlier this year, and several apparent practice runs in recent weeks using test hardware dropped from a helicopter.

Musk tweeted after Monday's launch that the fairing halves will be retrieved from the sea, dried and used again.

But it's not clear how easy it will be to refurbish fairings after dropping into salt water. The method of catching the fairings using a net was intended to keep the shrouds away from the corrosive effects of sea water, a problem that lengthens the time needed for SpaceX to refurbish Dragon cargo capsules for reuse after splashing down in the ocean.

Earlier this year, Musk said the fairing costs around $6 million, representing about 10 percent of the total cost of a Falcon 9 launch. Approximately 60 percent of the marginal cost of a Falcon 9 launch comes from the first stage, 20 percent from the second stage, and around 10 percent from the processing, testing and assembly of a rocket for flight, according to Musk.

SpaceX has offered discounts from the Falcon 9's advertised

selling price of $62 million for customers willing to place their satellites on a reused rocket, or as SpaceX likes to say, a flight -proven booster. Musk said in May that SpaceX then charged around $50 million for flights using a previously-flown first stage, and he expected a “steady reduction in prices” as the company gains experience with reusing rockets, and as SpaceX pays off what Musk has said was a billion-dollar investment in the capability to recover and re-fly boosters.

SpaceX cargo launch slips a day after rodent experiment snag

December 4, 2018

NASA has announced a one-day delay in SpaceX’s next cargo launch until Wednesday to allow time for ground teams to replace moldy food bars meant for 40 mice heading for the International Space Station as part of a biological research experiment, denying the launch company a chance at two Falcon 9 missions on back-to-back days.

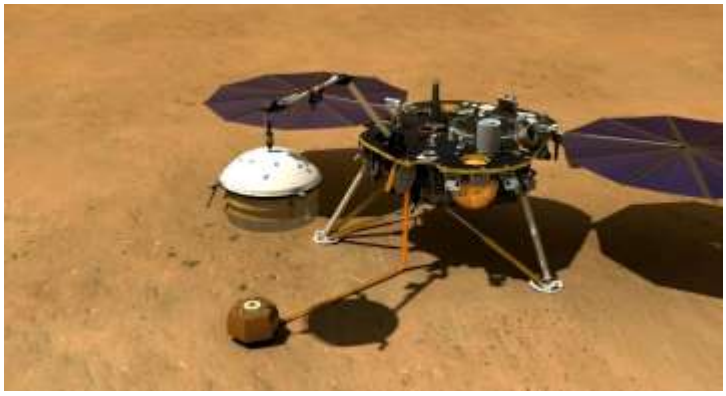
Soyuz crew enjoys problem-free launch, docks with space station

December 3, 2018

A Soyuz FG rocket thundered to life and shot into orbit smoothly Monday carrying three crew members on a six-hour flight to the International Space Station. The problem-free ascent came less than two months after an Oct. 11 launch abort that forced a different crew to carry out safe-but-scary emergency landing.

What's Next for NASA's New Mars Lander?

By Mike Wall, Space.com Senior Writer | November 27, 2018 06:57am ET



In this artist's illustration, NASA’s InSight Mars lander uses its robotic arm to cover the already-deployed seismometer instrument with a wind and thermal shield. InSight landed on the Red Planet on Nov. 26, 2018.
Credit: Lockheed Martin

PASADENA, Calif. — NASA's InSight lander has made it to Mars, but it'll be a while before the robot is ready to start its science work.

InSight arrived at its new home yesterday afternoon (Nov. 26), acing a touchdown on an equatorial plane called Elysium Planitia. The lander will begin probing the Red Planet's interior in unprecedented detail — a few months from now.

It'll take that long for InSight to deploy and calibrate its two main science instruments, a burrowing heat probe and a suite of super-sensitive seismometers. This gear must be placed on the Martian surface by the lander's robotic arm, and InSight team members want to make sure they get this crucial step — which no other Mars robot

So, the researchers will spend the next few weeks studying InSight's landing site carefully, deciding on the best deployment area. Then they'll practice deployment using a testbed lander here at NASA's Jet Propulsion Laboratory (JPL), which manages InSight's mission.

Next Up

Quality

This work will include "terraforming" the testbed to resemble InSight's actual environs on the Red Planet, mission instrument operations lead Elizabeth Barrett of JPL said yesterday during a post-landing news conference here. Barrett likened deployment to a very difficult and high-stakes version of an arcade claw-machine game.

"It makes it a little bit longer — you need to take more pauses, to make sure you actually have the grapple on the payload before you lift it up, and it's actually on the ground before you let it go," Barrett said.

InSight's arm will actually perform three such placements, because it will drop a shield over the seismometer suite to insulate the instrument from wind and temperature swings, which could interfere with data collection and interpretation.

It'll take two to three months to finish the deployments, Barrett said, "and then another couple of months" before InSight's ready to begin its Mars science campaign in earnest. The additional time will be needed for the heat probe to hammer itself up to 16 feet (5 meters) below the surface, and to calibrate both instruments properly.

When they're up and running, the seismometers will be on the lookout for "marsquakes" caused by internal Martian rumblings and meteorite strikes. The heat probe, meanwhile, will gauge heat flow at different depths. InSight team members will also learn about the Martian core by measuring the slight wobbles in the planet's axial tilt — data they'll gather by precisely tracking InSight's position over time.

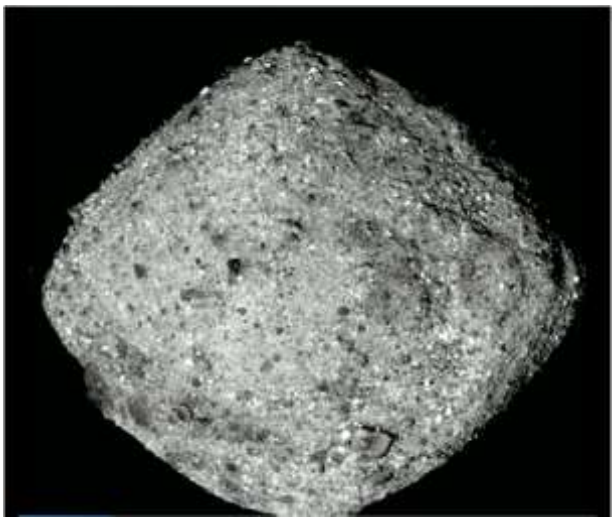
Together, these observations will reveal a great deal about Mars' internal structure and composition, which in turn will shed considerable light on how rocky planets in general form and evolve, mission team members have said.

InSight has already beamed home a bit of information, including a dust-speckled photo of its immediate surround-

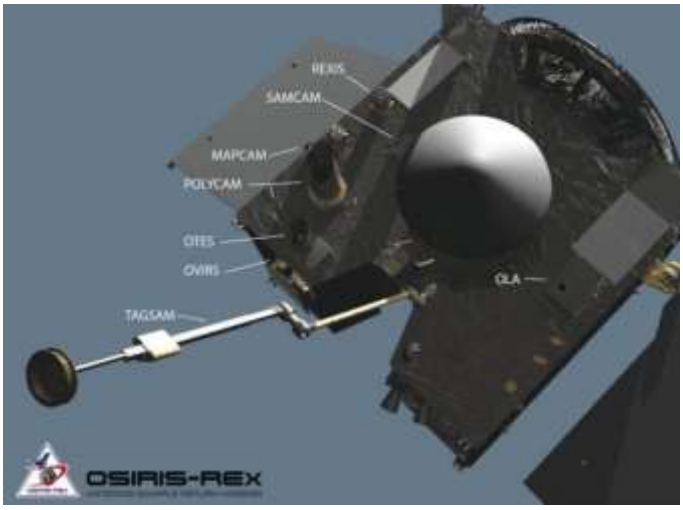
ings. And this little taste — the stationary lander's first image from Mars — bodes well for future data collection, Barrett and other team members said: The area appears to be relatively flat and sandy, without lots of big rocks or other impediments to deployment.
"We were all certain that that first image would help us determine how difficult a job we would have in placing the instruments," Barrett said. "And I'm very happy that it looks like we'll be able to do it quite easily — we hope."
"InSight" is short for "Interior Exploration using Seismic Investigations, Geodesy and Heat Transport." The lander's surface mission is scheduled to run for one Mars year, which is nearly two Earth years. It'll probably take the lander about that long to gather enough data to address its main mission goals, team members have said.
Mike Wall's book about the search for alien life, "Out There" (Grand Central Publishing, 2018; illustrated by Karl Tate) is out now. Follow him on Twitter @michaeldwall. Follow us @Spacedotcom or Facebook. Originally published on Space.com.

OSIRIS-REx has Finally Caught up with Asteroid Bennu.

Let the Analysis and Sample Collection Commence!
NASA's OSIRIS-REx spacecraft has reached its destination and is now in orbit around asteroid Bennu. The spacecraft travelled for over two years and covered more than 2 billion kms. It will spend a year in orbit, surveying the surface of the Potentially Hazardous Object (PHO) before settling on a location for the key phase of its mission: a sample return to Earth.



OSIRIS-Rex (Origins, Spectral Interpretation, Resource Identification, Security, Regolith Explorer), if successful, will be the first US spacecraft to return an asteroid sample to Earth. The $800 million mission was launched in September of 2016, and if all goes according to plan, it will return a sample to Earth in September, 2023. The sample will be small—only 60 grams, or 2.1 oz.—but that's enough material to meet the missions goals.
Below is a series of images taken by OSIRIS-REx at a distance of about 80 km (50 mi.) The images constitute one full revolution of the asteroid.
Why Did NASA Send OSIRIS-REx to Bennu?
NASA targeted Bennu for its sample mission for a number of reasons. First of all, Bennu is old, really old. Scientists think it might be older than the Solar System itself, which is about 4.6 billion years ago. At that age, it holds clues to how the Solar System formed, clues that aren't available here on Earth because of Earth's geological activity and living processes.
Bennu is also close to Earth. So close that it's considered a Potentially Hazardous Object (PHO), an object with an orbit that brings it close to Earth, and that's large enough to do serious damage if it struck. (Relax. They don't think it will.) Its closest approach to Earth is every six years and it orbits the Sun on the same plane as Earth. Its proximity to us made it a prime target for OSIRIS-REx.
For a sample-return mission, the asteroid has to be the right size. Too small, around 200 meters or less in diameter, and it spins so fast you can't land on it. The rapid rotation also sends small rocks on the asteroid's surface flying into space, meaning there's nothing there for the spacecraft to collect. Bennu's almost 500 meters in diameter, and rotates only once every 4.3 hours. It's easier to land on, and once on the surface, there will be plenty of material to sample.
Asteroids may have played a role in the origins of life here on Earth by delivering organic molecules to our planet in its early days. Astronomers have studied Bennu intensely from a distance, and they know that it's a carbonaceous, or carbon-rich, asteroid. Carbon is the key to the organic molecules needed for life, so finding organic molecules on a sample from Bennu would help to answer a big question about the origin of life.
There are a host of other reasons that NASA chose Bennu, and you can read about them all here.
Below is a gif of the spacecraft's approach to Bennu, from a distance of 2.2 million km (1.4 million miles) to 65 km (40 miles.)
How Will OSIRIS-REx Return a Sample to Earth?
OSIRIS-REx is in no hurry. It will spend a year studying Bennu from orbit. It has a nice suite of instruments to do its work. It has three different cameras, a laser altimeter which will allow it to map the surface of the asteroid in exquisite detail, to help choose a landing site. It has three spectrometers: a visible and infrared one, a thermal spectrometer, and an X-ray spectrometer.



OSIRIS-REx and its instruments. Image: NASA/University of Arizona
Lots of spacecraft have cameras and spectrometers, and laser altimeters are becoming more common, but the main focus of OSIRIS-REx is sample-return. To do that it has a specialized piece of equipment called TAGSAM, or Touch-And-Go Sample Acquisition Mechanism. TAGSAM is the heart of the spacecraft's mission. It consists of a sampling head and an arm that is 3.35-meter (11 ft) long. The sample-return will work like this:
OSIRIS-REx will slowly approach Bennu, at a speed of only 0.2 meters per second.
The spacecraft will land on the asteroid within 25 meters of its selected landing spot
The cameras will begin recording the sampling site and its surroundings.
The sampling arm will contact the surface of Bennu for five seconds.
It will release a blast of liquid nitrogen which will stir up dust.
The dust will be captured in the sampler head.
The sampler head is stored in the Sample-Return Capsule (SRC) and OSIRIS-REx will return to Earth.
The SRC will separate from the spacecraft and enter Earth's atmosphere, to be collected at the Utah Test and Training Range.
This summary might make the mission sound simple, but of course its not. A lot has to go right for NASA to get its sample

back to Earth. But NASA are the experts when it comes to landing spacecraft on other bodies, as the recent successful landing of the INSIGHT lander on Mars shows us.
Let's hope NASA gets it right again, because that small sample, between 60 and 2000 grams in weight, could provide some big answers to some big questions.
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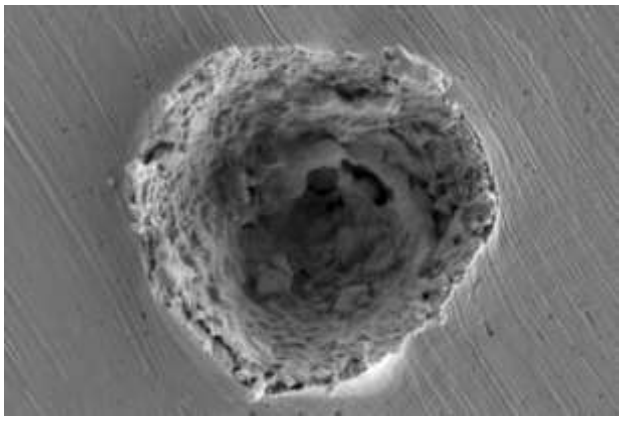
Micrometeorite Damage Under the Microscope



If there's one thing that decades of operating in Low Earth Orbit (LEO) has taught us, it is that space is full of hazards. In addition to solar flares and cosmic radiation, one of the greatest dangers comes from space debris. While the largest bits of junk (which measure more than 10 cm in diameter) are certainly a threat, the real concern is the more than 166 million objects that range in size from 1 mm to 1 cm in diameter.
While tiny, these bits of junk can reach speeds of up to 56,000 km/h (34,800 mph) and are impossible to track using current methods. Because of their speed, what happens at the moment of impact has never been clearly understood. However, a research team from MIT recently conducted the first detailed high-speed imaging and analysis of the microparticle impact process, which will come in handy when developing space debris mitigation strategies.

SpaceX's next launch to have thousands of worms on board
Antonia Jaramillo

© Provided by Gannett Co., Inc. MELBOURNE, Fla. – When SpaceX's Falcon 9 rocket blasts off from Cape Canaveral on Tuesday for the International Space Station, it will be carrying some unusual passengers – actually, 36,000 of them.
Worms. Wriggling, slimy worms in plastic bags. If you're curious why NASA, let alone the three astronauts on board the station, would want to fly bags of worms into orbit, it turns out worms are more like people than you might think. How they react in space could be key to figuring out ways to keep humans healthy on long space trips to Mars and beyond.
Spaceflight poses many hazards to people, one of the most prevalent being muscle weakening. In fact, astronauts in space for six months or longer can lose up to 40 percent of their muscle mass.
Download the all-new Microsoft News app to receive up-to-the minute news from the world's best sources – available now on iOS and Android
Worms too have muscles, and scientists from around the world want to see what happens to them in orbit. Scientists from Exeter, Nottingham and Lancaster universities partnered with the United Kingdom Space Agency and other teams around the world to work on the Molecular Muscle Experiment. Countries represented by other teams include the U.S., Japan, South Korea and Greece.

© stockcam Earth worms with earth "(Worms) are genetically very similar to people," Tim Etheridge, principal investigator on the project and senior lecturer at the University of Exeter, said.
"Their muscles look very similar. They're structured almost identically; their molecular makeup and the way they metabolize is similar with people."
The worms are practical, too: Since they're only about 0.04 inches in length, they don't take up much space, they grow quickly and astronauts aboard the ISS don't have to become involved in the experiment (something they might be very y about).
36,000 microscopic worms of the *Caenorhabditis elegans* ies will not only help scientists figure out the reasons for cle loss in space, but they might also provide clues for ments for earthbound diseases such as muscular dystro- and diabetes.
Falcon 9 launch at Cape Canaveral Air Force Station is duled for 1:38 p.m. EST Tuesday.
gh scientists still don't understand the causes behind e muscle loss, some believe it's similar to the aging pro- of humans on Earth.
ve age, our muscles get smaller, they get weaker," Ether- said. "These are all the same changes that occur in as- uts, but just on a much shorter time frame,"
s where the worms come in.
Video: How do astronauts play tennis on the ISS? (Seeker)
C. elegans were chosen as the ideal test subject because

they are the first multicellular critter to have had their whole genome sequenced, which is the process of determining the complete genetic makeup of an organism.
"They're just a really, really strong model for space biology in particular," Etheridge said.
Though *C. elegans* have already been used in other NASA experiments to study spaceflight muscle loss, this will be the first time scientists will target specific genes to try to prevent muscle loss, Nate Szewcyzk, professor of space biology at the University of Nottingham, said.
Scientists will try to promote mutations in the worms or target specific molecules in their bodies either through genetic manipulation or via drugs to figure out what might hinder muscle loss.
"The novel thing about this (experiment) is we're going to target those genes that change reproducibly in space and see whether stopping those from happening make muscle healthier," Etheridge said.
The worms will be refrigerated throughout the launch in plastic bags along with liquid bacterial food. The cold will put them in a state of hibernation for the journey. Once on board the ISS, astronauts will place them in an incubator to wake them up.
Since the worms grow quickly, the project will only last about six days.
Gallery: Here's what Nasa and the night sky have in store for 2019 (Business Insider)

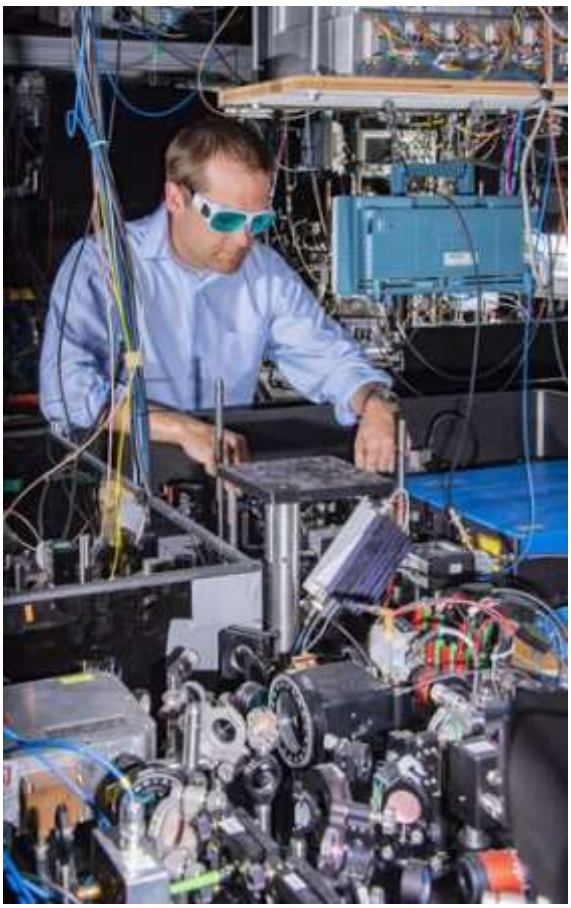
The worms will produce their own offspring on board and the offspring will mature and reproduce as well. Though 36,000 worms are being flown initially, scientists expect the number to rise to about 3 million by the time the experiment is over.
Once those last baby worms are adults, they will be frozen for the return trip back to Earth where they will be sent to labs around the world for further analysis, Etheridge said.
The UK team will focus on studying the molecular and genetic changes in the worms to see if they look healthier than the worms in a control group that had no interventions.
Teams will look at the effect of genes thought to be important for regulating exercise responses as well as genes associated with nerve cell health, Szewczyk said. Testing will last approximately six to 12 months.
The project's cost was about $2.5 million, according to Libby Jackson, a program manager with the UK Space Agency.

A New Atomic Clock has been Built that Would be off by Less than a Second Since the Big Bang

Physicists have developed an atomic clock so accurate that it would be off by less than a single second in 14 billion years. That kind of accuracy and precision makes it more than just a timepiece. It's a powerful scientific instrument that could measure gravitational waves, take the measure of the Earth's gravitational shape, and maybe even detect dark matter.
How did they do it?
The "Royal Flush" of Clock Performance
Physicists at the National Institute of Standards and Technology say their new atomic clock is based on the rare-earth element ytterbium. They use a grid of laser beams called an optical lattice to trap 1000 ytterbium atoms. The atoms naturally "tick" by switching between two energy levels. That action is called atomic electron transition, and it takes nanoseconds to occur. Each time they tick, or change energy levels, the electrons emit microwave energy, which can be detected. The NIST physicists built two of these ytterbium clocks, and by comparing them, they have achieved record-breaking performance.

This record-breaking performance is measured in three ways:
Systematic uncertainty: This is how well the clock represents the natural vibrations of the ytterbium atoms. The ytterbium clock was off by only one billionth of one billionth.
Stability: This is how much the frequency of the clock changes in a specified time. In this case, they measured their ytterbium clock and it changed by only 0.00000000000000000032) over a day.
Reproducibility: This measures how closely two ytterbium clocks tick at the same frequency. In 10 comparisons between the pair of clocks, the difference was again less than one billionth of a billionth.
"Systematic uncertainty, stability, and reproducibility can be considered the 'royal flush' of performance for these clocks," project leader Andrew Ludlow said in a press release. "The agreement of the two clocks at this unprecedented level, which we call reproducibility, is perhaps the single most important result, because it essentially requires and substantiates the other two results."

Atomic clocks have been in use for decades. This image shows banks of atomic clocks at the US Naval Observatory, used to define the time standard for the US Dept. of Defense. Image: By US Naval Observatory – http://tycho.usno.navy.mil/gif/clockvaults.jpg, Public Domain, https://commons.wikimedia.org/w/index.php?curid=5538835
Clocks, Gravity, and Relativity
Einstein showed us that time passes differently depending on the gravity you're subject too. The ticking of the atoms in an atomic clock is slowed down when observed in stronger gravity. On the top of Mt. Everest, for example, time moves more quickly than at the bottom of the Mariana Trench. That's because, here on Earth, the force of gravity is concentrated at the center of the planet. The further you are away from the center, the less gravity there is. The effect is not great, perhaps only millionths of a second. But it's there. That seems counter-intuitive somehow, but that's what Einstein showed, and he's been proven correct.
The exceptional thing about this new atomic clock is that it's demonstrated reproducibility means the clock's error is below our ability to detect the gravitational effect on time here on Earth.



Physicists at the National Institute of Standards and Technology (NIST) have developed an atomic clock based on the element ytterbium that has broken performance benchmarks for atomic clocks. Physicist Andrew Ludlow pictured. Image Credit: Burrus/ NIST

NIST physicist Andrew Ludlow explains it like this: "… the demonstrated reproducibility shows that the clocks' total error drops below our general ability to account for gravity's effect on time here on Earth. Hence, as we envision clocks like these being used around the country or world, their relative performance would be, for the first time, limited by Earth's gravitational effects."

The physicists say that now that we have a clock that's accuracy is greater than the gravitational effect on time, we can use the clock to measure Earth's gravitational shape. The usual way of measuring the Earth's gravitational shape is by measuring its tides. Tidal gauges placed around the world are used, but their accuracy is only with several centimeters. The new clocks could bring that accuracy down to less than a single centimeter.

In fact, these ytterbium clocks can be used to measure much more than Earth's gravitational shape. They can be used to measure space-time itself, and to detect gravitational waves from the early universe. It's possible that they could even measure dark matter. At this level of accuracy and precision, this instrument is much more than just a clock.

A Portable, Game-Changing Atomic Clock

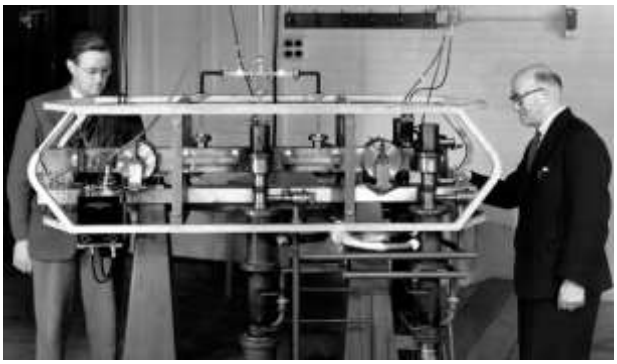
It's not only gravity that can effect a clock like the ytterbium clock. Other environmental effects can disrupt the device's accuracy. They must be kept cooled and they must be isolated from any stray electrical fields. The new clocks are shielded from electrical and heat effects so that they can be accounted and corrected for. With improvements like electrical and thermal shielding, the physicists are building portable ytterbium clocks that can be transported to different labs to measure and compare other clocks. They could also be moved to other locations to study relativistic geodesy techniques. This would be a game-changer, because currently, our best atomic clocks are room-sized, so-called "fountain-clocks" which use the caesium atom to define the second.

But that could all be about to change with the new clocks.

Goodbye Caesium, Hello Ytterbium

Previous atomic clocks are based on the element caesium, which up to now provided the most accurate timekeeping available. The vibration of the caesium atom has been used since the 1960s to define the duration of a single second in the International System of Units (ISU). But with the development of the ytterbium clock, caesium's time might be up.

The first caesium clock was built in 1955, and since then it's been the gold standard. The official definition of the second, if you're interested, has been in use since 1967. It says: "The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium 133 atom." Then in 1997 they clarified it to mean the caesium had to be at 0 Kelvin.



The world's first caesium atomic clock was built at the UK National Physical Laboratory in 1955. Since then, it has been used to define the length of a second. Image: By National Physical Laboratory – http://www.npl.co.uk/upload/img/essen-experiment_1.jpg, Public Domain, https://commons.wikimedia.org/w/index.php?curid=5543813

Other atomic clocks have been built using rubidium, which can be made portable. They're not as accurate as caesium, but they're good enough for applications like GPS, mobile phone base stations, and for controlling the frequency of television stations. But with the development of the new atomic clock using the ytterbium atom, we may have the best of both worlds: unprecedented scientific accuracy, and portability.

The new ytterbium atomic clock is a leading candidate to redefine the definition of how ling one second is. That's because it meets the accuracy threshold defined by the International System of Units. That body said that any new definition would require a 100-fold improvement in validated accuracy over the cesium clocks currently used to define the second.

We used to define time by the rotation of the Earth, but we've come a long way since then. An atomic clock using the tick-rate of a rare-earth element to measure the gravitational shape of the Earth, gravitational waves from the early Universe, and maybe even dark matter is something no historical human could have ever imaged when they stuck a stick in the ground to make a sun dial.

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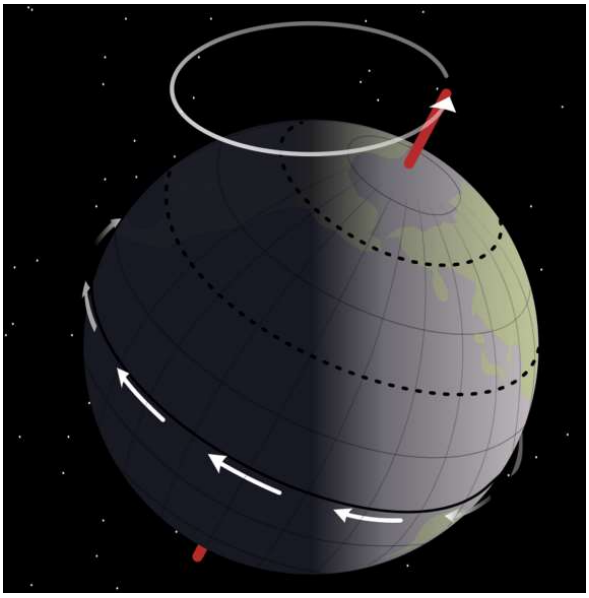
Prehistoric Cave Paintings Show That Ancient People Had Pretty Advanced Knowledge of Astronomy

Astronomy is one of humanity's oldest obsessions, reaching back all the way to prehistoric times. Long before the Scientific Revolution taught us that the Sun is at the center of the Solar System, or modern astronomy revealed the true extend of our galaxy and the Universe, ancient peoples were looking up at the night sky and finding patterns in the stars.

For some time, scholars believed that an understanding of complex astronomical phenomena (like the precession of the equinoxes) did not predate the ancient Greeks. However, researchers from the Universities of Edinburgh and Kent

recently revealed findings that show how ancient cave paintings that date back to 40,000 years ago may in fact be astronomical calendars that monitored the equinoxes and kept track of major events.

The team's study, "*Decoding European Palaeolithic Art: Extremely Ancient knowledge of Precession of the Equinoxes*", recently appeared in the *Athens Journal of History.* The study team included Martin B. Sweatman (an associate professor at the University of Edinburgh's School of Engineering) and Alistair Coombs – a researcher and PhD candidate with the Department of Religious Studies at the University of Kent.



Precession of the Equinoxes. Image credit: NASA

Together, Sweatman and Coombs studied the details of Paleolithic and Neolithic art featuring animal symbols at sites located in Turkey, Spain, France and Germany. What they found was that all of these sites used the same method of date-keeping, even though the artwork was created by people living tens of thousands of kilometers and years apart.

According to the team's analysis, the cave paintings were not simply depictions of wild animals (as previously thought) but instead represented star constellations in the night sky. These paintings were apparently used to represent dates and mark major astronomical events like comet strikes. In this sense, they demonstrate that ancient humans kept track of time by monitoring the precession of the equinoxes.

This refers to the phenomena where the constellations appear to slowly shift in the sky in a cycle that spans a period of roughly 25,920 years. This is the result of axial precession: a slow, continuous change in the orientation of an astronomical body's rotational axis. To an Earth-bound observer, the equinoxes appeared to move westward along the ecliptic relative to the background stars and in the opposite direction of the Sun.

As Dr. Martin Sweatman, a professor with the University of Edinburgh's School of Engineering, explained in a recent UofE press release:

"Early cave art shows that people had advanced knowledge of the night sky within the last ice age. Intellectually, they were hardly any different to us today. These findings support a theory of multiple comet impacts over the course of human development, and will probably revolutionize how prehistoric populations are seen."

Göbekli Tepe, structures A-D of the site, located in southern Turkey. Credit: Wikipedia Commons/Teomancimit

Their analysis including a clarification of earlier findings from stone carvings at Gobekli Tepe. Located in modern day Turkey, this site is dated to ca. 10,950 BCE, making it the oldest known temple site in the world. In a previous study conducted by Sweatman and Dimitrios Tsikritsis (a Doctor of Philosophy at the University of Edinburgh), they interpreted this site as a memorial to a devastating comet strike around 11,000 BCE.

This strike is thought to have initiated a mini ice-age known as the Younger Dryas period, which began abruptly about 12,500 years ago and ended just as abruptly 1200 years later. By examining the pictograms and animal reliefs on the site's many standing pillars (using the planetarium program Stellarium 0.15), they concluded that the images bore a resemblance to constellations that would have been visible in 10,950 BCE.

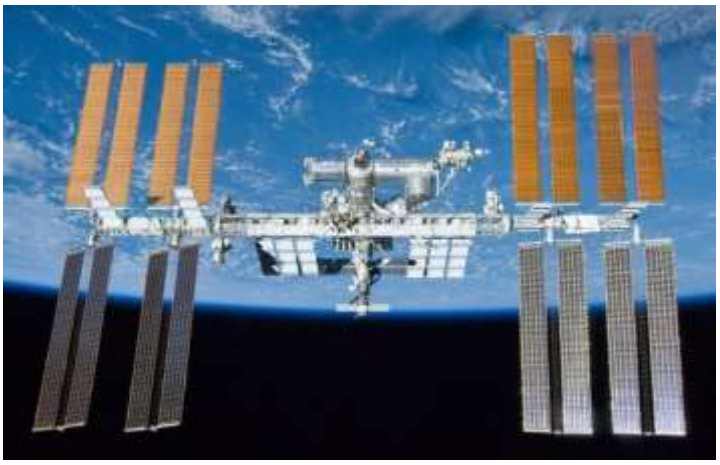
For this study, the team compared artwork in various locations with the positions of stars in ancient times, which they simulated using Stellarium 0.18. From this, they were able to decode what is perhaps the the best known example of ancient artwork – the Lascaux Shaft Scene, which is part of a series of cave paintings located in the Lascaux caves in southwestern France.

These paintings, which feature a dying man and several animals, may be an astronomical record of another comet strike that took place around 15,200 BCE. In addition, they found that the world's oldest sculpture, the Lion-Man of Hohlenstein-Stadel cave (which is located in southern Germany) appeared to conform to this ancient time-keeping system. This sculpture is dated to 38,000 BCE, making it the earliest piece of evidence of prehistoric astronomy.

Aurochs' heads found within one of the shrine rooms at Catalhöyük. Credit: Verity Cridland/Wikipedia Commons

Another site they considered was Catalhöyük, an ancient settlement in modern-day Turkey that existed from approxi-

mately 7500 BCE to 5700 BCE. Within the excavated shrine rooms, their are carvings of animals (auroch heads, ram heads, a bear symbol and the pouncing lion/leopard) that are similar to reliefs found at Gobekli Tepe and are believed to represent the constellations of Capricornus, Aries, Ursa and Cancer.
What this reveals is that as early as 40,000 years ago, humans may have been keeping track of time based on how the position of the stars slowly changed over the course of thousands of years. The commonalities found between sites would also seem to indicate that these traditions survived the passage of time and were carried from place to place by prehistoric humans as they migrated.
In essence, ancient people may have had a far greater understanding of astronomy than previously thought. This could have drastic implications when it comes to our understanding of prehistoric human migration, since this knowledge could have aided navigation of the open seas. It could also help anthropologists further refine their theories of when migrations occurred.
This, along with many findings over the past century across multiple disciplines, appears to be telling us that our ancient ancestors were far more knowledgeable than we gave them credit for. And by learning more about them, we might even be able to learn something about ourselves.
Further Reading: University of Edinburgh, Athens Journal of History
Antibiotic Resistant Bacteria has been Found on the Space Station's Toilet



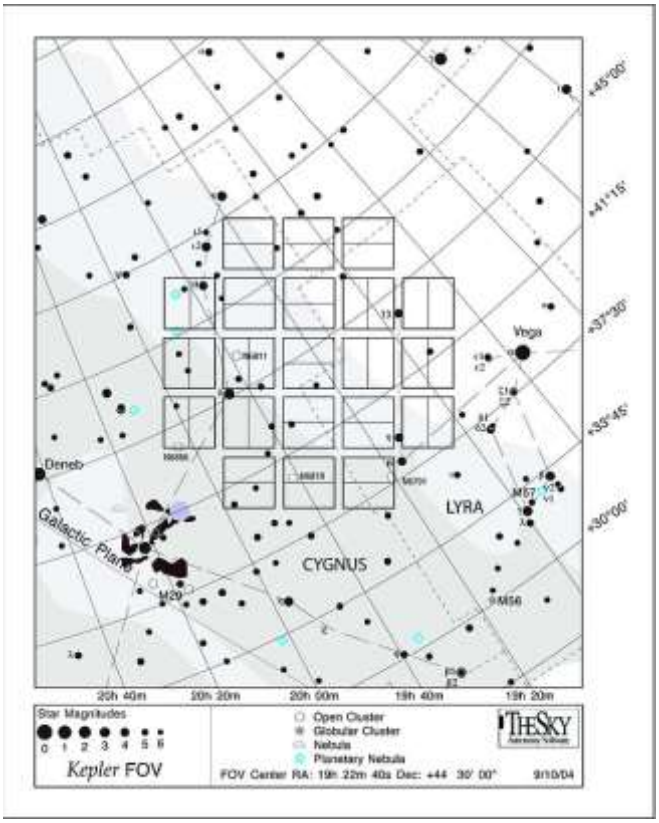
NASA keeps a close eye on the bacteria inhabiting the International Space Station with a program called the Microbial Observatory (M.O.) The ISS is home to a variety of microbes, some of which pose a threat to the health of astronauts. As part of their monitoring, the M.O. has discovered antibiotic resistant bacteria on the toilet seat on the ISS.
There Could be Hundreds of Interstellar Asteroids and Comets in the Solar System Right Now That we Could Study

On October 19th, 2017, the first interstellar object – named 1I/2017 U1 (aka. 'Oumuamua) – to be observed in our Solar System was detected. In the months that followed, multiple follow-up observations were conducted to gather more data on its composition, shape, and possible origins. Rather than dispel the mystery surrounding the true nature of 'Oumuamua – is a comet or an asteroid? – these efforts have only managed to deepen it.
In a recent study, Harvard Professor Abraham Loeb and Shmuel Bialy – a postdoctoral researcher from the Smithsonian Center for Astrophysics (CfA) – addressed this mystery by suggesting that 'Oumuamua may be an extra-terrestrial solar sail. Building on this, Loeb and Amir Siraj (a Harvard undergraduate student) conducted a new study that indicated that hundreds of "'Oumuamua-like" objects could be detectable in our Solar System.

NOVEMBER 29, 2018 BY EVAN GOUGH

Now that TESS is Operational, Astronomers Estimate it'll Find 14,000 Planets. 10 Could Be Earthlike Worlds in a Sun-like Star's Habitable Zone
How many exoplanets are there? Not that long ago, we didn't know if there were any. Then we detected a few around pulsars. Then the Kepler spacecraft was launched and it discovered a couple thousand more. Now NASA's TESS (Transiting Exoplanet Survey Satellite) is operational, and a new study predicts its findings.

The Kepler findings gave us a better idea of the types and numbers of planets in other solar systems. But Kepler had its limitations and its own sampling bias due to its measurement methods. Kepler also only focused on one small area of the sky, comprising about 0.25% of the sky. It's possible, but not necessarily likely, that the small part of the sky Kepler focused on is not representative of a larger sample.
TESS is much different than Kepler, especially in the area of the sky it covers. It will perform an all-sky survey, rather than a survey focused on a small portion of the sky. NASA's new planet-hunter will also focus on the brightest stars. That's because its primary science objective is to find planets larger than Neptune that are orbiting bright stars. The stars need to be bright so that follow-up spectroscopic observations can determine planet masses and atmospheric compositions.



Kepler's field of view encompassed only 0.25% of the sky. TESS will look at almost the entire sky. Image: NASA/Ames/JPL-Caltech, Image credit: Software Bisque
Even though we don't have a consensus on how common exoplanets are in terms of their size and orbital periods, Kep-

ler showed us that exoplanets are common. Most stars have them. But many of the exoplanets that Kepler found are extremely distant, from hundreds to thousands of parsecs away. So detailed follow-up observations are difficult to impossible. Since Tess is focusing on closer, brighter stars closer to Earth, making follow-up observations with other 'scopes easier, its results should be more representative and more accurate in determining exoplanet populations.

So, What Can We Expect From TESS?

A new study from Thomas Barclay, NASA Goddard Space Flight Center, Joshua Pepper, University of Maryland, and Elisa Quintana, Lehigh University, has predicted TESS's results. Their paper was published in The Astrophysical Journal. The three researchers used what we know about the stellar population and what we know about exoplanet populations, combined with TESS's observation modes, to come up with their estimates.

There are three factors in their simulation:

A simulation of the stellar population that TESS will observe.

A representative sample of planets orbiting those stars.

A prediction of how many of those planets TESS will detect.

Their estimates are called a "yield simulation" and it's not the first one that astronomers have come up with. But before we get to the numbers, a question: Why do we need to know beforehand what TESS will find?

This is TESS's First Light image. On the left is the star R Doradus, and on the right is the Large Magellanic Cloud. Image: By NASA/MIT/TESS

The answer to that is to get a head-start on what a follow-up observation program might look like. Astronomers like to plan ahead, since observing resources are so dear. They don't want to wait until all the results from TESS are in before they think about the next steps. Or maybe they're just excited like kids in a candy story. A bit of both, probably.

The Yield Simulation: 14,000 exoplanets and 10 that could be Earth-like

Barclay, Pepper, and Quintana ran their simulation 300 times to come up with their predicted yield. There's a lot of detail in their results related to the type of star the planets orbit, the different observation mode used to detect which planets, and how it all relates to follow-up observations. But in a more brief form, here's what the three researchers think TESS will find during its planned two-year mission:

14,000 total exoplanets

2100 of them will be smaller than 4 Earth radius (4R), 280 of those smaller than 2R

70 habitable planets orbiting red dwarf stars, 9 of them smaller than 2R

10 Earth-like worlds less than 2R which could be in the habitable zone of a star like our Sun

That's a pretty exciting haul. 14,000 exoplanets, of which 10 could be Earth-like worlds in the habitable zone of a star like the Sun. It doesn't mean that's what TESS will find, but it should be a good approximation, and an intriguing one. Especially since, unlike Kepler, TESS's exoplanets are prime targets for further observation and characterization.

Most exoplanets orbit red dwarf stars because they're the most plentiful stars. This is an artist's illustration of what the TRAPPIST-1 system might look like from a vantage point near planet TRAPPIST-1f (at right). Credits: NASA/JPL-Caltech

This isn't the first yield simulation for TESS. But this one is done with real rather than simulated stellar population, so it should be more accurate. Another yield simulation from 2015 can be viewed here, and one from 2017 here.

The simulation yields show us that we're likely to find Earth-like planets in habitable zones. Most of them will be orbiting red dwarfs, but a small number should be around Sun-like stars. This is what everybody wants to know.

But maybe more importantly, these simulations show us that TESS will meet its mission goal: to detect an abundance of planets smaller than Neptune that can be examined in follow up studies to determine their masses and atmospheric makeups.

In both cases, TESS is on track to deliver some solid results.

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Research Paper: Planet Detection Simulations for Several Possible TESS Extended Missions

NASA TESS Science Support Center

NASA Kepler Mission Overview

Wikipedia Entry: TESS

NASA's InSight Lander on Mars Just Set a Solar Power Record!

By Sarah Lewin, Space.com Associate Editor | December 2, 2018 02:00pm ET

NASA's InSight lander, which touched down on Mars Nov. 26 and successfully extended its large solar arrays hours later, is already setting records.

During its full first day on the Red Planet, the solar-powered lander generated more electrical power in one day than any previous Mars vehicle has, mission team members said.

It is great to get our first 'off-world record' on our very first full day on Mars," Tom Hoffman, InSight project manager at NASA's Jet Propulsion Laboratory (JPL) in California, said in a statement. [NASA's InSight Mars Lander: Amazing Landing Day Photos!]

"But even better than the achievement of generating more electricity than any mission before us is what it represents for performing our upcoming engineering tasks," Hoffman added. "The 4,588 watt-hours we produced during sol 1 means we currently have more than enough juice to perform these tasks and move forward with our science mission."

NASA’s InSight lander flipped open the lens cover on its Instrument Context Camera (ICC) on Nov. 30, 2018, and captured this view of Mars. Located below InSight’s deck, the ICC has a fisheye view, creating a curved horizon. Some clumps of dust are still visible on the camera’s lens. One of the spacecraft’s footpads can be seen in the lower right corner. The seismometer’s tether box is in the upper left corner.
Credit: NASA/JPL-Caltech
The 4,588 watt-hours InSight generated on its first sol, or Martian day, from solar power is well over the 2,806 watt-hours generated in a day by NASA's Curiosity rover, which runs on a nuclear system called a radioisotope thermoelectric generator. Coming in third was the solar-powered Phoenix lander, which generated around 1,800 watt-hours in a day, according to NASA officials.

After sending back its first photo of the landing site and extending its two solar arrays, each of which is about 7 feet in diameter (2.2 meters), InSight got to work photographing its environment and unlatching its robotic arm, which it will eventually use to deploy seismometers and a heat probe to learn about Mars' interior. And mission team members are busy inspecting the images they've received so far to learn more about InSight's landing site, a lava plain called Elysium Planitia. They've found that the spacecraft is tilted by about 4 degrees, according to the statement, in a shallow impact crater filled with dust and sand. (This is no big deal; the lander can operate at up to a 15-degree tilt.) A steep slope could have hurt the spacecraft's ability to get enough power from its solar arrays, and landing near rocks could have kept the spacecraft from easily opening both arrays, the researchers said. "The science team had been hoping to land in a sandy area with few rocks since we chose the landing site, so we couldn't be happier," Hoffman said in the statement. "There are no landing pads or runways on Mars, so coming down in an area that is basically a large sandbox without any large rocks should make instrument deployment easier and provide a great place for our mole to start burrowing."

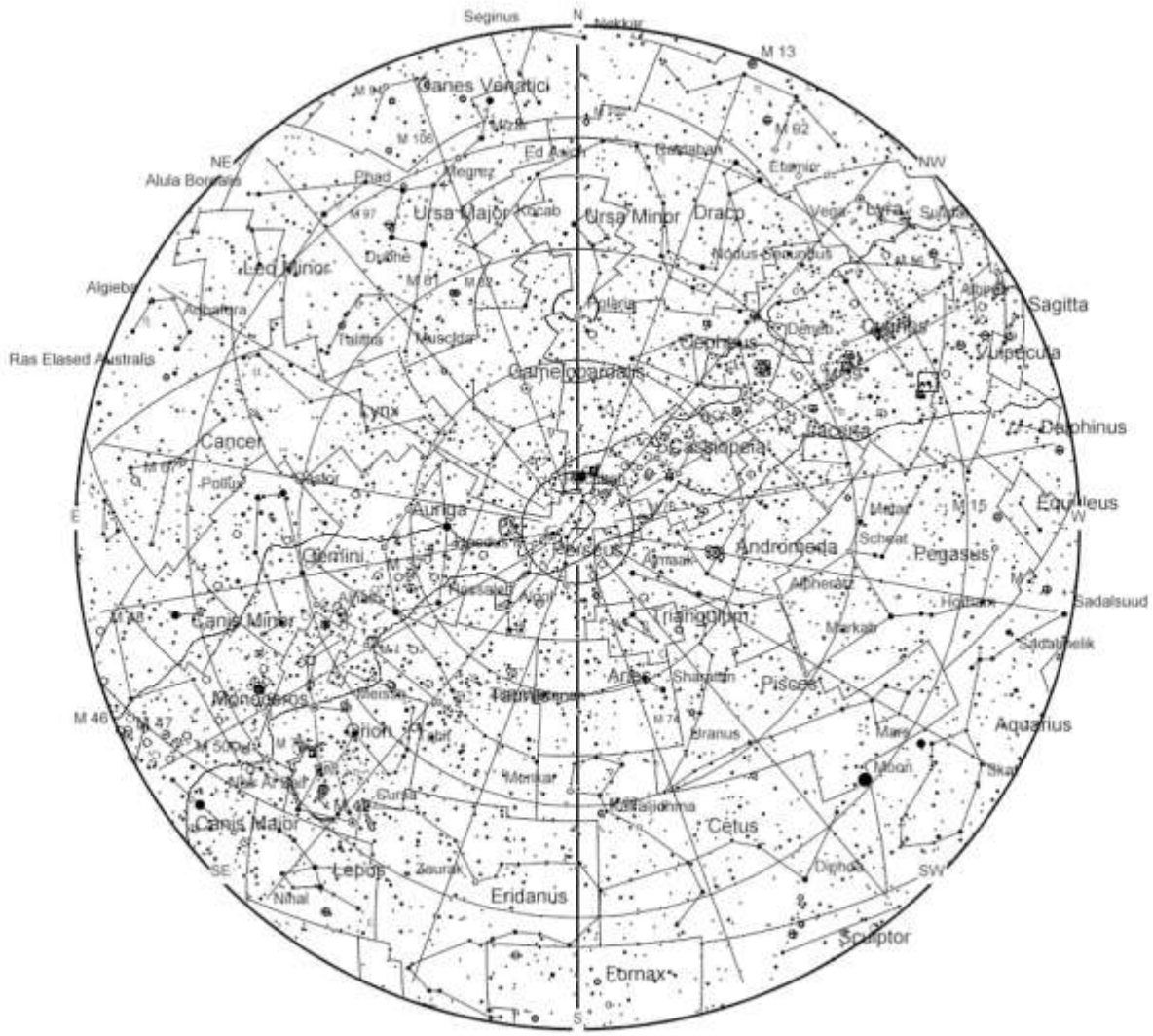
So far, the team thinks the immediate area has few rocks, but higher-resolution images coming later on will give a more conclusive view of the surroundings. The team will use those views to plan out exactly how the spacecraft will place its instruments with its mechanical arm.
"We are looking forward to higher-definition pictures to confirm this preliminary assessment," InSight principal investigator Bruce Banerdt, also at JPL, said in the statement. "If these few images — with resolution-reducing dust covers on — are accurate, it bodes well for both instrument deployment and the mole penetration of our subsurface heat-flow experiment." (According to NASA, the spacecraft got its first view of Mars with a lens cover off Nov. 30.)
The $850 million InSight mission is scheduled to run for one Mars year, or nearly two Earth years. The data gathered by the lander will help mission team members map out the Red Planet's interior structure in unprecedented detail, NASA officials have said. This information should, in turn, reveal key insights about the formation of rocky planets in general.
Email Sarah Lewin at slewin@space.com or follow her @SarahExplains. Follow us on Twitter @Spacedotcom and on Facebook. Originally published on Space.com.

Space station passing over Wiltshire last night (3rd December) at 17:43. The Soyez transport with 3 cosmonauts had just arrived at the ISS.

Andy Burns

20mm lens, 7 pictures put together using Startrails.

WHATS UP, DECEMBER 2018



December 7 - **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 07:20 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.

December 13, 14 - **Geminids Meteor Shower.** The Geminids is the king of the meteor showers. It is considered by many to be the best shower in the heavens, producing up to 120 multicolored meteors per hour at its peak. It is produced by debris left behind by an asteroid known as 3200 Phaethon, which was discovered in 1982. The shower runs annually from December 7-17. It peaks this year on the night of the 13th and morning of the 14th. The first quarter moon will set shortly after midnight leaving dark skies for what should be an excellent early morning show. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Gemini, but can appear anywhere in the sky.

December 15 - **Mercury at Greatest Western Elongation.** The planet Mercury reaches greatest western elongation of 21.3 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 morning sky. Look for the planet low in the eastern sky just before sunrise.

December 21 - **December Solstice.** The December solstice occurs at 22:23 UTC. The South Pole of the earth will be tilted toward the Sun, which will have reached its southernmost position in the sky and will be directly over the Tropic of Capricorn at 23.44 degrees south latitude. This is the first day of winter (winter solstice) in the Northern Hemisphere and the first day of summer (summer solstice) in the Southern Hemisphere.

December 22 - **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 17:49 UTC. This full moon was known by early Native American tribes as the Full Cold Moon because this is the time of year when the cold winter air settles in and the nights become long and dark. This moon has also been known as the Full Long Nights Moon and the Moon Before Yule.

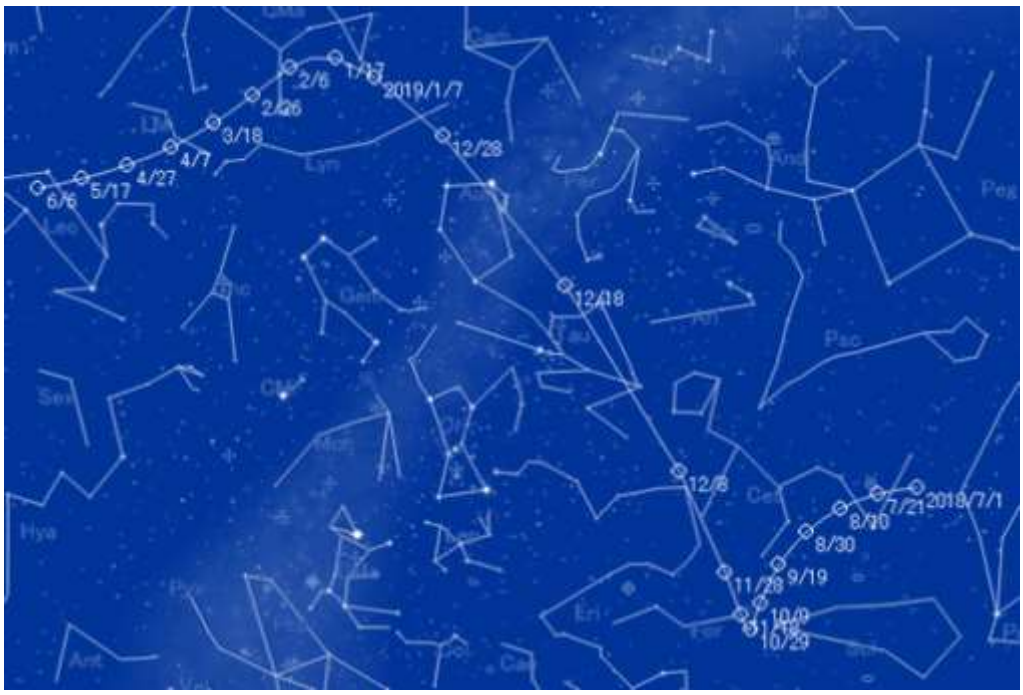
December 21, 22 - **Ursids Meteor Shower.** The Ursids is a minor meteor shower producing about 5-10 meteors per hour. It is produced by dust grains left behind by comet Tuttle, which was first discovered in 1790. The shower runs annually from December 17-25. It peaks this year on the the night of the 21st and morning of the 22nd. This year the glare from the full moon will hide all but the brightest meteors. If you are extremely patient, you might still be able to catch a few good ones. Best viewing will be just after midnight from a dark location far away from city lights. Meteors will radiate from the constellation Ursa Minor, but can appear anywhere in the sky.

January 21 - **Full Moon, Supermoon.** The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. This phase occurs

at 05:16 UTC. This full moon was known by early Native American tribes as the Full Wolf Moon because this was the time of year when hungry wolf packs howled outside their camps. This moon has also been know as the Old Moon and the Moon After Yule. This is also the first of three supermoons for 2019. The Moon will be at its closest approach to the Earth and may look slightly larger and brighter than usual.

January 22 - **Conjunction of Venus and Jupiter.** A conjunction of Venus and Jupiter will be visible on January 22. The two bright planets will be visible within 2.4 degrees of each other in the early morning sky. Look for this impressive sight in the east just before sunrise.

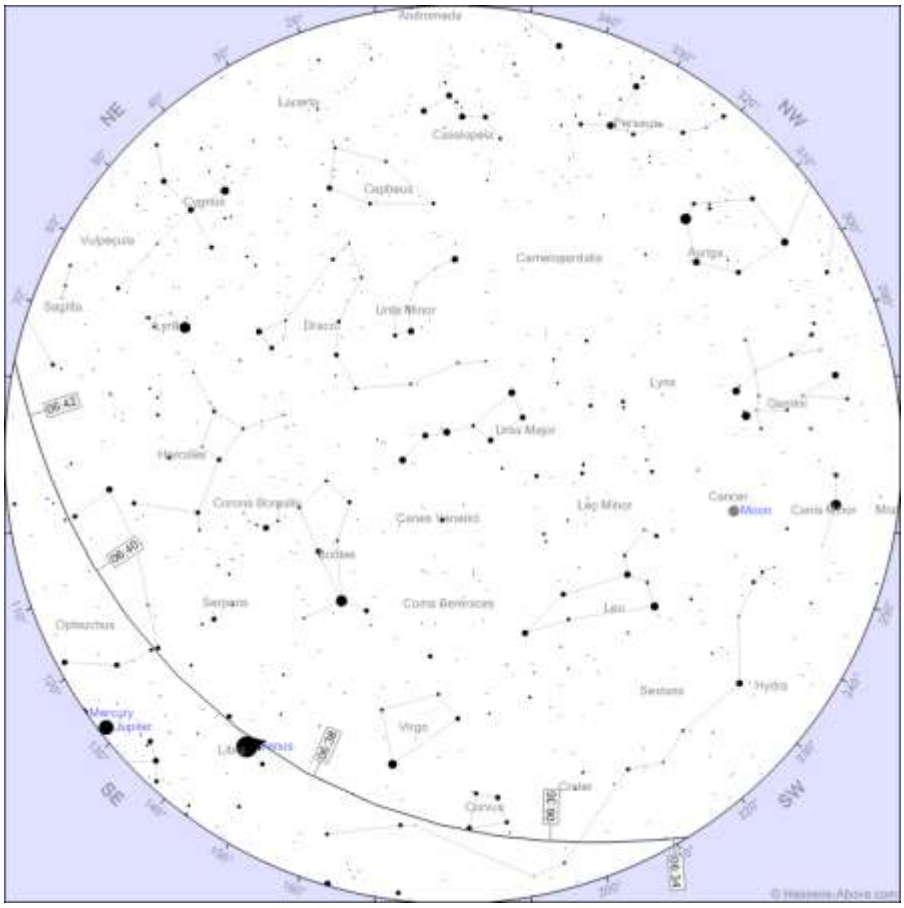
January 21 - **Total Lunar Eclipse.** A total lunar eclipse occurs when the Moon passes completely through the Earth's dark shadow, or umbra. During this type of eclipse, the Moon will gradually get darker and then take on a rusty or blood red color. The eclipse will be visible throughout most of North America, South America, the eastern Pacific Ocean, western Atlantic Ocean, extreme western Europe, and extreme western Africa.



A COMET AS BIG AS THE FULL MOON:

On Dec. 12th, Comet 46P/Wirtanen will approach Earth less than 1.5 million km away–making it one of the 10 closest-approaching comets of the Space Age. It's a small comet, with a nucleus barely 1 km wide, but such proximity makes even a small things appear large. The comet's gaseous atmosphere is now as wide as a full Moon. Mike Broussard of Perry, Louisiana, photographed the comet on Dec. 2nd and inserted the Moon for scale:

"The comet still has a couple of weeks before closest approach and it is already as big as a full Moon," says Broussard, who could see the comet with his naked eye--"just barely using averted vision and only when it was in the darkest section of the sky," he adds.

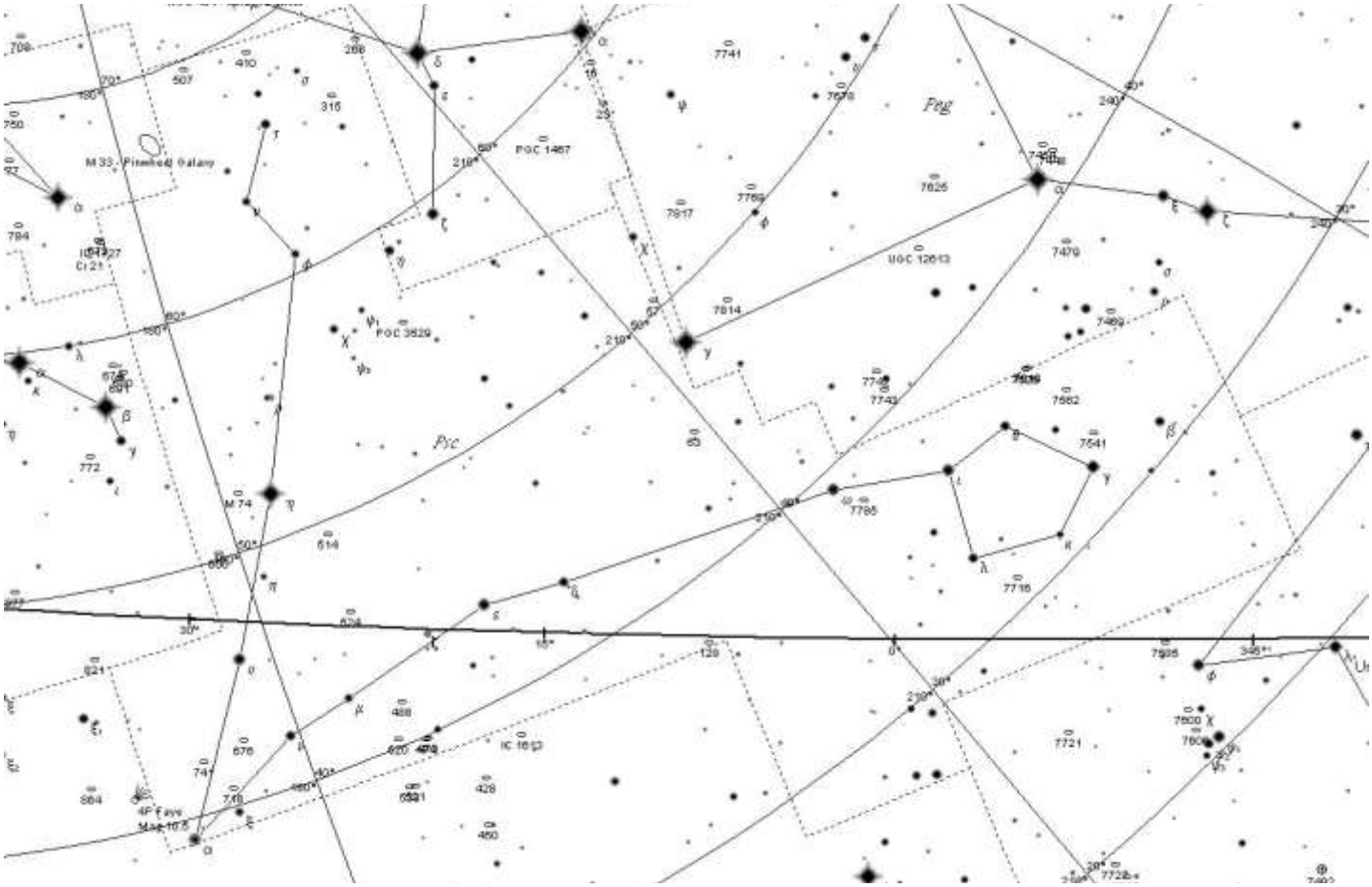


WATCH FATHER CHRISTMAS ON HIS WAY HOME CHRISTMAS MORNING.

PASSING VENUS.

06:35:56am…

CONSTELLATIONS OF THE MONTH: Pisces



Transit Date of principal star:
22 October

Pisces is an ancient constellation derived, some say, from the story of the terrible Greek god Typhon.

(This is not the Chinese word for "big wind", which - in English - is of course spelled "typhoon". The French, however, spell this word "typhon", which adds to the confusion. It is possible that the Chinese borrowed the word from the Greek. The modern Greek equivalent is spelled "tau upsilon phi omega nu" and means "cyclone".)

Typhon was born from Gaia (Mother Earth) and Tartarus. This was Gaia's youngest offspring, but by far the deadliest and the largest monster ever conceived.

Its thighs were gigantic coiled serpents; its arms could spread across the heavens, and its head (in the shape of an ass's head) touched the stars. When it took flight, its wings blotted out the sun, and when it opened its mouth, out came burning boulders.

Typhon was so frightful even the gods of Olympus refused to fight, fleeing instead to Egypt when Typhon attacked their mountain home. Each god disguised itself into an animal: Zeus transformed himself into a ram, Dionysus a goat, and so on. Aphrodite and Eros both disguised themselves as fish and swam up the Nile to escape the monster.

Typhon was eventually defeated, due in large part to the brave and level-headed Athene, who convinced Zeus to take up his thunderbolts and make battle. Typhon actually captured Zeus and placed him in a cave, but Hermes and Pan were able to free him.

To make a long story short, Zeus then took the battle to Typhon, chasing him to Sicily. There Zeus threw Mount Aetna at the monster, finally subduing it. But under the earth, the buried monster still spews up fire and boulders every so often.

While the myth eventually moved to Italy, there were origins from the ancient Hittite culture, as well as the volcanic eruptions along the Aegean archipelago.

As for Aphrodite and Eros, who escaped the monster's wrath, these two were given their fish-like images in the heavens, thus commemorating the time Typhon nearly overran Olympus. Later cultures equated the two fish with the Biblical story of the miracle of the fishes and the loaves.

The sun passes through the southeast corner of Pisces; in fact the vernal equinox now lies in Pisces.

Pisces is depicted as two fish connected by their tails at the star *alpha Piscium*. Indeed, alpha's name, "Al Rischa", means "the cord".

The constellation is rather faint; Pisces' stars are generally fourth magnitude. There are a few fine binaries, an interesting variable, and one Messier object: a splendid face-on spiral, which unfortunately is quite faint and rather a challenge for smaller telescopes.

Double stars:

Alpha Piscium (Struve 202) has an orbit of 933 years (considerably more than the 720 years previously thought): 4.3, 5.2; currently PA 223 degrees, separation 1.6".

Zeta Piscium (Struve 100) is a fine binary: 5.6, 6.5; 63 degrees, 23" separation.

Eta Piscium is a difficult binary to resolve: 3.5, 11; 36 degrees, 1" separation.

Psi[1] Piscium (Struve 88): 5.3, 5.5; 160 degrees, 30" separation.

Struve 61 (65 Piscium) is a splendid binary of equal stars: 6.3, 6.3; 297 degrees, 4.4" separation.

The binary is found just on the border with Andromeda. The easiest way to find it is to start from zeta Andromedae, then move north 3 degrees and east half a degree.

Variable stars:

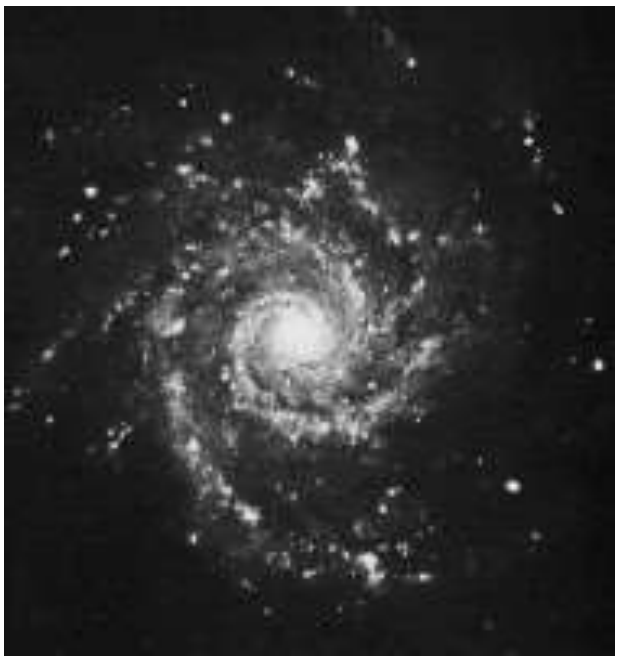
Kappa Psc is an alpha CV variable: 4.87-4.95.

TX Psc (19 Psc) is an interesting irregular, a deep red star that changes only slightly (about 5.0 to 5.5, although some references say from 5.5 to 6.0). Its main attraction is in the exceptionally deep redness of the star.

The star is found between iota and lambda, north two degrees from lambda and one degree east. Or you might find it easier by first starting at gamma Psc and moving seven degrees east. (Burnham, p. 1475, has a finder's chart.)

Deep Sky Objects:

The best deep sky object in Pisces is M74, the only Messier in the constellation.



M74 (NGC 628) is a spiral galaxy seen face on. It's about 22 million light years away, and one of the faintest Messiers. The larger the scope, the better. Long exposure photographs show two or three loosely-wound spirals `spinning' out from a small bright nucleus.

The galaxy is found 1.5 degrees ENE of eta Piscium.

Plenty of other galaxies abound bit they are all over 100 million light years distant, because Pisces lies around the nominal boundary of the ngc catalogue east/west datum point it has low ngc numbers and some up around the 7790 range that are the end of the ngc catalogue designated by Drayer in 1892.

NGC 57

NGC488

NGC524

NGC676

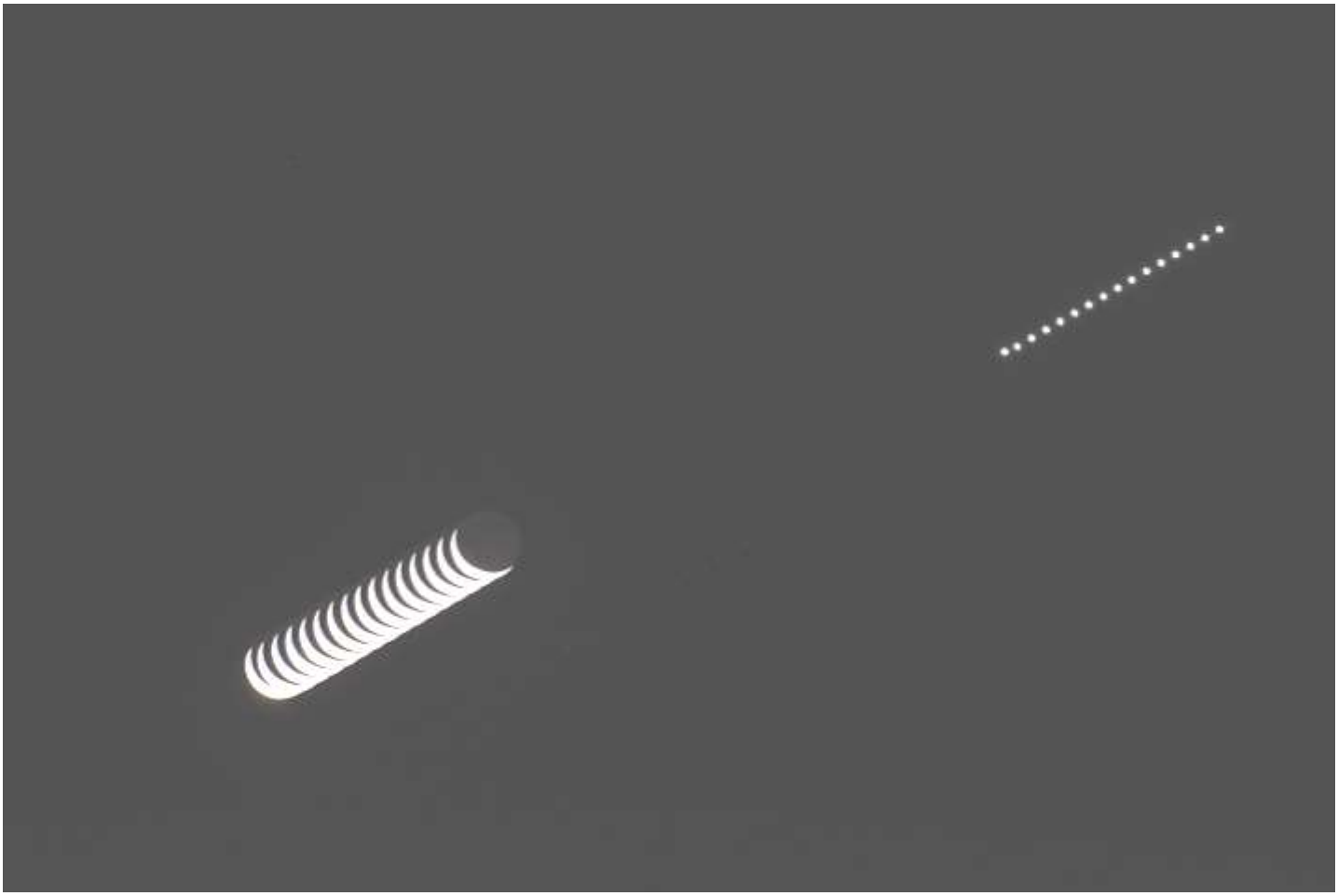
NGC7542

NGC7785

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

Date	Brightness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
02 Dec	-3.5	16:58:51	10°	WSW	17:02:04	58°	SSE	17:04:56	13°	E
02 Dec	-2.7	18:35:15	10°	W	18:37:35	43°	W	18:37:35	43°	W
03 Dec	-3.9	17:43:05	10°	W	17:46:22	88°	N	17:47:29	38°	E
03 Dec	-0.6	19:19:36	10°	W	19:20:09	14°	W	19:20:09	14°	W
04 Dec	-3.8	16:50:54	10°	WSW	16:54:11	82°	SSE	16:57:23	10°	E
04 Dec	-3.2	18:27:25	10°	W	18:30:03	54°	W	18:30:03	54°	W
05 Dec	-3.9	17:35:13	10°	W	17:38:30	85°	N	17:39:58	30°	E
05 Dec	-0.8	19:11:44	10°	W	19:12:38	17°	W	19:12:38	17°	W
06 Dec	-3.8	16:43:01	10°	W	16:46:17	86°	N	16:49:34	10°	E
06 Dec	-3.6	18:19:31	10°	W	18:22:35	65°	SW	18:22:35	65°	SW
07 Dec	-3.8	17:27:18	10°	W	17:30:35	83°	SSW	17:32:36	21°	ESE
07 Dec	-1.1	19:03:55	10°	W	19:05:17	20°	WSW	19:05:17	20°	WSW
08 Dec	-3.8	16:35:04	10°	W	16:38:21	87°	N	16:41:38	10°	E
08 Dec	-2.9	18:11:35	10°	W	18:14:43	44°	SSW	18:15:23	38°	S
09 Dec	-3.4	17:19:20	10°	W	17:22:33	61°	SSW	17:25:36	11°	ESE
09 Dec	-1.2	18:56:19	10°	W	18:58:17	17°	SW	18:58:17	17°	SW
10 Dec	-1.8	18:03:45	10°	W	18:06:33	26°	SSW	18:08:42	14°	SSE
11 Dec	-2.4	17:11:21	10°	W	17:14:26	38°	SSW	17:17:29	10°	SE
12 Dec	-0.8	17:56:14	10°	WSW	17:58:12	15°	SW	18:00:10	10°	S
13 Dec	-1.2	17:03:29	10°	W	17:06:08	23°	SW	17:08:47	10°	SSE
15 Dec	-0.4	16:56:07	10°	WSW	16:57:41	13°	SW	16:59:14	10°	SSW
23 Dec	-0.3	06:46:09	10°	SSE	06:47:10	11°	SE	06:48:12	10°	ESE
24 Dec	-1.7	07:27:47	10°	SSW	07:30:42	30°	SSE	07:33:38	10°	E
25 Dec	-1.1	06:35:57	10°	SSW	06:38:27	20°	SE	06:40:57	10°	E
26 Dec	-0.8	05:44:37	10°	S	05:46:14	13°	SE	05:47:52	10°	ESE
26 Dec	-2.8	07:18:57	10°	SW	07:22:08	49°	SSE	07:25:20	10°	E
27 Dec	-2.2	06:26:45	10°	SW	06:29:46	34°	SSE	06:32:48	10°	E
28 Dec	-1.7	05:36:49	22°	SSE	05:37:28	23°	SE	05:40:08	10°	E
28 Dec	-3.6	07:10:19	10°	WSW	07:13:36	73°	SSE	07:16:53	10°	E
29 Dec	-0.3	04:46:53	11°	ESE	04:46:53	11°	ESE	04:47:12	10°	ESE
29 Dec	-3.2	06:19:32	25°	SW	06:21:09	55°	SSE	06:24:23	10°	E
30 Dec	-2.2	05:29:26	34°	ESE	05:29:26	34°	ESE	05:31:50	10°	E
30 Dec	-3.9	07:02:05	12°	W	07:05:03	89°	NW	07:08:22	10°	E
31 Dec	-3.8	06:11:51	51°	WSW	06:12:33	78°	S	06:15:51	10°	E
01 Jan	-1.8	05:21:31	29°	E	05:21:31	29°	E	05:23:20	10°	E
01 Jan	-3.9	06:54:10	18°	W	06:56:31	85°	N	06:59:49	10°	E
02 Jan	-4.0	06:03:46	78°	W	06:03:57	87°	N	06:07:15	10°	E
03 Jan	-1.4	05:13:19	23°	E	05:13:19	23°	E	05:14:42	10°	E
03 Jan	-3.9	06:45:58	23°	W	06:47:54	87°	S	06:51:11	10°	E
04 Jan	-3.8	05:55:29	80°	ENE	05:55:29	80°	ENE	05:58:37	10°	E
04 Jan	-3.2	07:28:31	10°	W	07:31:43	49°	SSW	07:34:54	10°	SE
05 Jan	-1.0	05:04:59	19°	E	05:04:59	19°	E	05:06:02	10°	E
05 Jan	-3.7	06:37:37	27°	W	06:39:12	67°	SSW	06:42:28	10°	ESE
06 Jan	-3.4	05:47:07	62°	ESE	05:47:07	62°	ESE	05:49:55	10°	ESE
06 Jan	-2.5	07:19:56	10°	W	07:22:52	30°	SSW	07:25:46	10°	SSE
07 Jan	-0.7	04:56:37	16°	E	04:56:37	16°	E	04:57:20	10°	E
07 Jan	-3.2	06:29:15	30°	WSW	06:30:23	43°	SSW	06:33:31	10°	SE

END IMAGES, OBSERVING AND OUTREACH



The Moon and Venus this morning 4th December, 17 consecutive images at 35 seconds apart. 180mm lens on Nikon D7200, merged using Startrails.
Andy Burns

Wiltshire Astronomical Society	Observing Sessions 2018 – 2019	
Date	**Moon Phase (%)**	**Moonrise**
2018		
28th December (6.30pm start)	Last Quarter (54%)	11.35 pm
2019		
21st January	Total Lunar Eclipse	Starts 03:30 am
25th January	Waning Gibbous (70%)	10.36 pm
22nd February	Waning Gibbous (84%)	9.31 pm
29th March	Waning Crescent (32%)	After midnight
26th April	Waning Gibbous (58%)	After midnight
24th May	Waning gibbous (75%)	After midnight

OUTREACH

To be arranged Great Wishford School, nr Wilton. Viewing evening
January 17th Kings Lodge Year 1/2s Moon talk and viewing from 5pm
February tba Westbury Primary School, afternoon talk and viewing evening