NWASNEWS

Volume26 Issue 6

FEBRUARY 2021

Newsletter for the Wiltshire, Swindon, Beckington, Bath Astronomical Societies

Rocky times ahead for government investment

Space budgets are under pressure with a lot of scientific emphasis being pushed towards medicines and pinched to pay some of the bills for Covid or even Brexit.

We will see quite a large change in emphasis from the USA and its NASA funding now there has been a government change. We will have to wait and see, but we can expect a more introverted view coming from the government, less hostile we hope, but also searching for private funding.

This will affect the future missions but hopefully the current Mars probe and helicopter mission should be unaffected after it lands this month. And the frequently delayed James Webb Telescope should still launch later in October, They have been unfolding the solar panels last week.

India have announced their 10 year space plan and they are hoping to join the club of launching their own astronauts from India.

I was talking with our speaker on Monday afternoon and we both see delays in manned mission to the Moon , perhaps the race with Chine being the only boost. But with privateers coming to the fore (Virgin now launching satellites from aircraft joining the band of sky fillers, one can only wonder about the future risks with cluttered skies.

Meeting Night 2nd February Waiting Room will be open from 19:45

Andy Burns is inviting you to a scheduled Zoom meeting.

Topic: Wiltshire AS Zoom Meeting

Time: Feb 2, 2021 07:45 PM London

Join Zoom Meeting

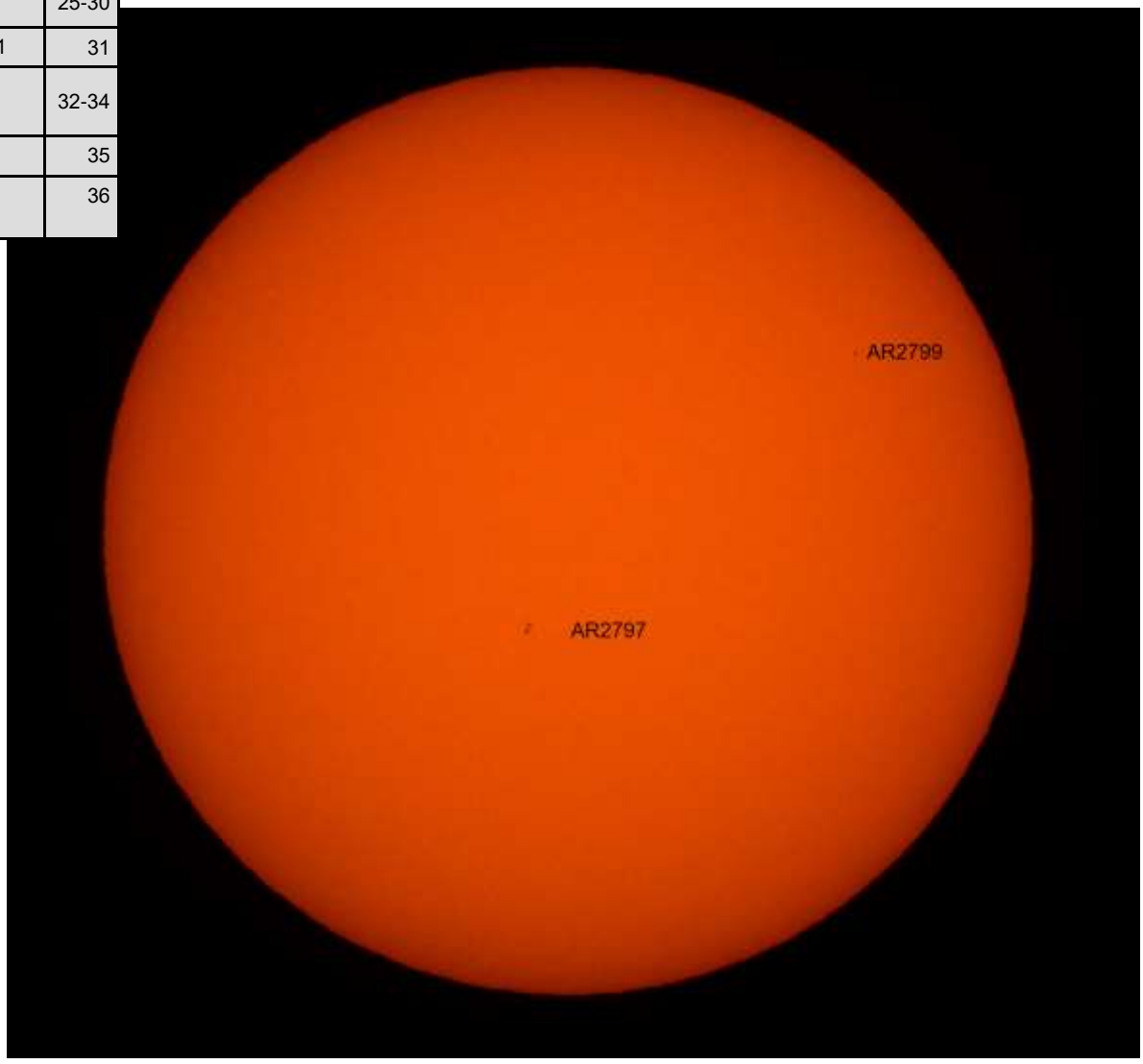
https://us02web.zoom.us/j/85100981193?pwd=ZGZtclRJZUZvM3VTamtnS3hxTWVhZz09

Meeting ID: 851 0098 1193

Passcode: 627310

Clear skies

Andy



The Sun using a thousand oaks filter on Coolpix 1000 camera at zoom set around 1000mm. Sunspots revealed in two active areas. Until late March the Sun doesn't rise above the house from my observatory, so I can use this white light filter from anywhere.

The much vaunted Sun reawakening is still not very active, the largest Sunspot active area is a double spot, each being the diameter of the Earth, but this is small compared to the monsters seen in 2002.

Andy

Wiltshire Society Page

Wiltshire Astronomical Society
Web site: www.wasnet.org.uk
Facebook members page: https://www.facebook.com/groups/wiltshire.astro.society/
Meetings 2020/2021.
During COVID19 ZOOM meetingd

HALL VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

SEASON 2020/21
2021
2 Feb Prof David Southwood/ Moon and Mars the next Giant Leap.
2 Mar Pete Williamson/The moon & Moons of the Solar System.
6 Apr Prof Mike Edmunds/The Clockwork universe.
4 May TBC
1 Jun Robert Harvey/Understanding the Universe.

Thank you Peter and those that have helped get a list together in the circumstances.

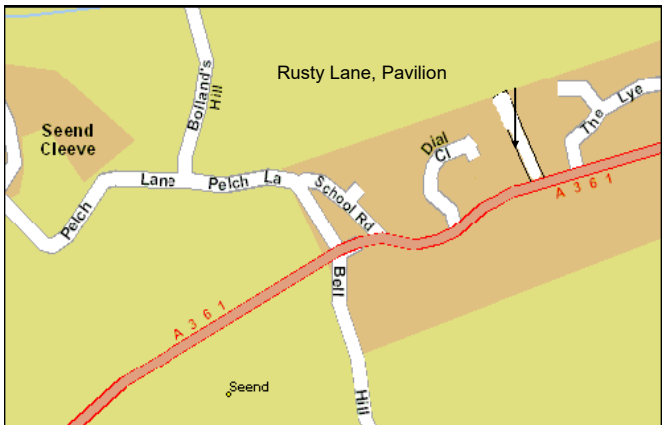
Professor David Siuthwood. CBE is a British space scientist who holds the post of Senior Research Investigator at Imperial College London. He was the President of the Royal Astronomical Society from 2012–2014, and earlier served as the Director of Science and Robotic Exploration at the European Space Agency (2001–2011). Southwood's research interests have been in solar–terrestrial physics and planetary science, particularly magnetospheres. He built the magnetic field instrument for the Cassini Saturn orbiter.

David will be giving us a talk on the next steps for missions looking towards the Moon or Mars, or even linking the progress with halfway stations in space or on the Moon.

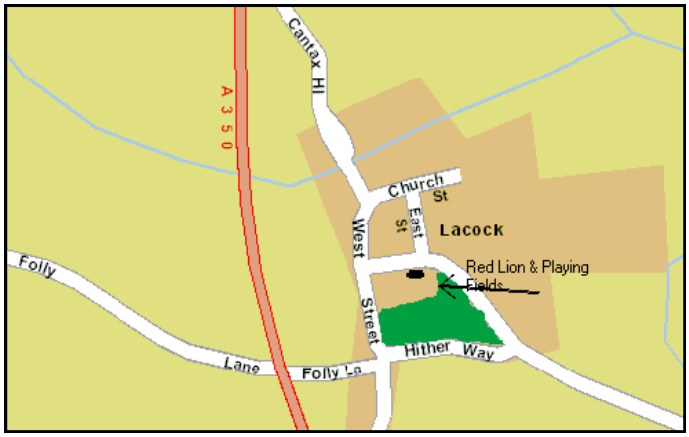
Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Andy Burns Chair, anglesburns@hotmail.com
Andy Burns Outreach and newsletter editor.
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: Chris Brooks, Jon Gale,
Web coordinator: Sam Franklin
Contact via the web site details.



Observing Sessions see back page



Swindon Stargazers

Swindon's own astronomy group

Due to the current crisis our meetings, like many other physical meetings have been suspended and replaced with Zoom meetings.

Next Zoom Meeting: Prof Rene Breton

Rene is Professor of Astrophysics at the University of Manchester.

He was born and raised in Quebec City, Canada. He is a Reader at the Jodrell Bank Centre for Astrophysics

He is a multi-wavelength astrophysicist but likes to think of himself as an observer/applied theorist as a lot of his work lies at the frontier between observational science and theory.

After receiving a generous grant in 2016, his current research is on a project called 'Fundamental Physics Using Black Widow, Redback and Transitional Pulsar Binaries'.

His presenration will be 'Comsmic Fireworks'

Ad-hoc viewing sessions postponed

All ad-hoc meetings are currently cancelled until further notice.

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

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

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

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

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

For insurance reasons you need to be a club member to take part. If you think you might be interested email the organiser Robin Wilkey (see below). With this you will then be emailed regarding the event, whether it is going ahead or whether it will be cancelled because of cloud etc.

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

Enjoy astronomy at it's best!

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

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

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

Meeting Dates for 2021

Friday 19 February Zoom meeting
Programme: Prof Rene Breton: Cosmic Fireworks

Friday 19 March Zoom meeting
Programme: AGM, Speaker: Viv Williams 'A Guide to Amateur Telescope Mounts and how to set up'

Friday 16 April 2021 19.30 Meeting or Zoom

Programme: Mike Foulkes: Herschel's Planet
Friday 21 May Meeting or Zoom

Programme: Gary Poyner: Variable Stars and the Double Cluster

Friday 18 June 19.30 Meeting or Zoom

Programme: Graham Bryant: Pluto: from Myth to a Voyage of Discovery

July & August - No Meetings

Website:
http://www.swindonstargazers.com

Chairman: Robin Wilkey

Tel No: 07808 775630
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Address: 61 Northern Road
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Secretary: Hilary Wilkey

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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

STAR QUEST ASTRONOMY CLUB

This young astronomy club meets at the

Sutton Veny Village Hall.

Second Thursday of the Month.

Meet at Sutton Veey near Warminster.

BATH ASTRONOMERS

Bath Astronomers are holding webinar sessions linking in with Stargazers web sight.

Feb24

Talk by Nora Eisner, Planet Hunters TESS: discovering exoplanets using citizen science

24 Feb - Zoom

Wednesday 24th February – Monthly meeting. This month's talk will be given by Nora Eisner, Department of Physics, University of Oxford. She is a PhD student at the University of Oxford where her research focuses on citizen-powered exoplanet discoveries using NASA's TESS (Transiting Exoplanet Survey Satellite) data. She is working under the supervision of Professor Chris Lintott and Professor Suzanne Aigrain. The talk is entitled "Planet Hunters TESS: discovering exoplanets using citizen science". Nora's research focuses on citizen-powered exoplanet discoveries using TESS data via Planet Hunters TESS. As the leader of this exciting project she collates the returns from the citizen science campaigns, analyse them, and follows-up on the most promising detections using ground based facilities. The analysis of the extremely large time-series data sets has a strong emphasis on applying various statistical processes, as well as using machine learning in order detect exciting new planet systems that were missed by the main pipelines and other teams of professional astronomers. Abstract: Since the first unambiguous discovery of an exoplanet in 1995, over 4,000 more have been confirmed, and studies of their characteristics have unveiled an extremely wide range of planetary properties in terms of their mass, size, system architecture and orbital periods. While dedicated planet detection algorithms are able to identify the vast majority of planets in data obtained with spaced satellites, they miss certain types of planets that are key to the further development of our understanding of how these systems form and evolve. In this talk, I will discuss how we can harness the power of citizen science, and in particular Planet Hunters TESS, to find these more elusive planets with the help of tens of thousands of volunteers. I will present some of our exciting findings, including both planets and exotic stellar systems, and show that human classification still plays a vital role in a world that is becoming increasingly automated. Bath Astronomers monthly meeting for all members and new comers to meet up, enjoy perhaps a new topic and a cup of tea and a biscuit. Held on the last Wednesday of every month online or at the Herschel Museum of Astronomy, 19 New King Street.

Mar31

Talk by Dr Julian Onions - Aperture Fever

31 Mar - Online

Wednesday 31st March – Monthly meeting. Topic: Aperture Fever - does my mirror look big in this? After a very brief review of how telescopes work, we look at some of the existing telescopes, both visible and other wavebands, and consider why they are so big, what they can and can't see and what the telescopes planned for the next few years will deliver.

Talk by Mary McIntyre

28 Apr - Zoom

Wednesday 28th April – Monthly meeting. This month's talk will be given by Mary McIntyre. Mary is a well renown astro artist and astrophotographer. The format is open and comprises an update for the month and a talk on an astronomy topic within the reach of amateurs.

May26

Talk by Pete Williamson FRAS

26 May - Herschel Museum of Astronomy

Wednesday 26th May – Monthly meeting. Topic: From Herschel to Hawkwind

Jun30

Talk by Chris Starr, Cassini and Saturn

30 Jun - Herschel Museum of Astronomy

Wednesday 30th June – Monthly meet

SPACE NEWS FEBRUARY 21

Moon or Mars - NASA's next logical step?

The second and final qualification motor (QM-2) test for NASA's Space Launch System's (SLS) booster took place in June at Orbital ATK Propulsion Systems test facilities in Utah.

Allyson ReneauIntern at International and Interagency Relations Office,

On 20 July 1969, astronauts Neil Armstrong and Buzz Aldrin stepped onto the Moon and accomplished one of the greatest achievements in the history of humankind. Subsequent missions to explore the lunar surface continued, with astronaut Gene Cernan leaving the last footprint on the Moon in December 1972. Since then, there have been more than 100 US Space Shuttle missions and a continuous human presence in space on the International Space Station (ISS). These are significant accomplishments as far as human spaceflight is concerned, but we have been trapped in the repetitive cycle of low Earth orbit for more than 40 years. If we are to explore this Solar System, we must exit from this pattern.

Exploration has inspired mankind throughout history, and is one of the characteristics of a progressing society. When a nation explores the unknown, it leads to innovation, discovery and, ultimately, prosperity. In addition, it fosters national prestige and inspires citizens, both old and young, to pursue excellence.

So what really is the next logical step for NASA? Is it to return to the Moon, or press forward to Mars? With shrinking space budgets, a lack of political will, and shortages of technological and medical knowledge, the compass points to NASA going back to the Moon. NASA is at a critical juncture. The decisions made by the next President and the US Congress will determine the future of human exploration in our Solar System for decades to come.

Our Moon has certainly helped define life on Earth. As well as scientific value, it offers the possibility of rich, raw resources that could benefit life on Earth. Mars maybe the horizon goal - but there is a hefty price tag and a unique set of problems that must be solved for a successful crewed mission to Mars and back.

Chalk and cheese

A journey to the Moon takes approximately three days, a distance of 239,000 miles, and humans can relatively easily 'come and go' due to its proximity to Earth. It has one-sixth of the Earth's gravity (not ideal for sustaining the bones and muscles of the human body), has no atmosphere or weather, and affords no protection from cosmic radiation. Day and night cycles equal about 14 Earth days and lunar explorers will encounter extremely high temperatures during the Moon 'day' (250F) and very frigid temperatures (-380F) during a Moon 'night'.

Moon dust, called regolith, will also be a serious hazard for astronauts and their equipment.

The Moon does, however, promise large amounts of natural ice at its frozen polar regions and, because it is only three days away, rescue and a quick return is feasible in an emergency.

Mars, on the other hand, is at least eight months away, at a distance of approximately 46 million miles, and only then when the Earth and Mars have an aligned orbit. Any crew arriving at the red planet would likely need to stay there for up to a year until Earth and Mars are lined up in orbit again - and certainly there is no chance for a quick rescue operation from home.

Saturn V launch in July 1969 of the first Apollo lunar landing mission. The large version of NASA's new heavy lift SLS rocket will be 40 feet taller than a Saturn V, coming in at about 400 feet.

Mars has about 38 per cent of Earth's gravity, which is better physiologically for humans than the Moon. It has an atmosphere of carbon dioxide and a more Earth-equivalent day and night cycle (a Martian day is 24 hours and 39 minutes). Daytime temperatures can reach around 80F but drop to as low as minus 200F at the poles. Mars also has a type of water-ice, which might be a source of rocket fuel, and there is a possibility that the Martian soil could be modified to grow food. But, as on the Moon, dust would be a problem.

Initially, it appears Mars might be a more 'people-friendly' planet. Its great distance, however, remains a deal breaker

Initially, it appears Mars might be a more 'people-friendly' planet and desirable location. Its great distance, however, remains a deal breaker. This challenge alone generates such

problems as psychological stress, bone loss and muscle atrophy, and exposure to cancer-causing galactic radiation.

Any human-rated entry, descent and landing (EDL) system must be capable of delivering at least 10 times the mass and volume of current robots exploring Mars - achieving this is both costly and fraught with challenges. Technical and political obstacles aside, humans travelling to Mars will need food, water, protective shelter, medical supplies, entertainment, friendship, and a return ticket back to Earth. This is a unique set of problems to solve.

Psychological effects

Separation, long term isolation and the dynamics of living in close quarters for extended periods of time is one of the big challenges. The Apollo lunar missions lasted about a week or more, the crews could still catch sight of the Earth, and they knew they were only three days away. Although a typical stint on the ISS is about six months, astronauts in Earth orbit can still peek from the window and see their familiar home planet - and know they are but a stone's throw from a safe return. Things would be very different on a trip to Mars with a round trip taking anything between two and three years. The crew would witness Earth becoming a small dot of light against a starry background.

Fundamentally, humankind is not going to Mars just to plant a flag on the surface and collect a few samples. In preparation for the psychological isolation of a surface mission lasting up to 18 months, Russia, ESA and China conducted 'The Mars 500' experiment from 2007 to 2011. This study simulated a 520-day round trip to Mars, where volunteers lived and worked in a mock mission environment, generating useful data on the psychological and social effects on people placed in a long-term and cramped living situation. Communication with the outside world had a realistic time delay of twenty-five minutes and there was only a limited supply of food and other consumables. Overall there were no reports of conflicts and difficulties encountered were solved together as a team. Cultural and language differences did not create significant problems but the effects of cosmic radiation and weightlessness could obviously not be factored into such an experiment.

NASA astronaut Tracy Caldwell Dyson, Expedition 24 flight engineer, contemplates Earth through a Cupola window of the International Space Station, in a self-portrait photo using natural light.

Physiological effects

The ISS continues to provide a useful testing platform for understanding some of the adverse effects that living and working in space has on the human body. But undertaking a trip to Mars will be very different because of exposure to cosmic radiation. Whereas an astronaut on the ISS encounters about 20 times the amount of radiation compared to Earth, a journey to the red planet increases radiation more than 300 times greater than normal exposure on Earth.

Using data gathered from radiation detectors carried by the Curiosity rover en route to Mars, scientists have estimated the instance of cancer would increase by five per cent, which is higher than NASA's tolerances for an astronaut.

Technological challenges

The lunar environment could be a good location for a technical proving ground, validating deep space technologies while remaining in close proximity to Earth. NASA has identified a list of technologies it deems essential for a journey to Mars which include - ground operations, a heavy-launch vehicle, crew capsule, a deep-space transit vehicle with high -efficiency in-space propulsion and power, protection from radiation, optical communication, and deep-space navigation and rendezvous.

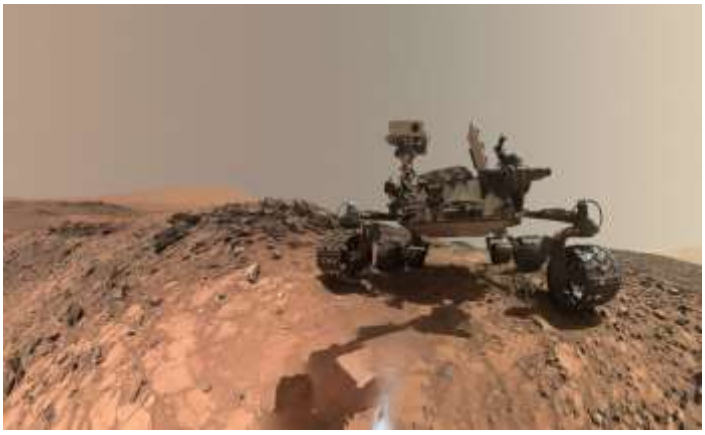
Decisions made by the next President and the US Congress will determine the future of human exploration in our Solar System for decades to come

Surface power generators will be essential for energy and astronauts will need long duration habitation modules which include life-support systems, radiation safety, protection from the environment, and medical facilities. In contrast, the ISS is Earth-reliant and dependent on re-supply flights. For a Mars mission of two years or more, astronauts will have to be both self-sufficient and Earth-independent.

In situ resource utilisation is required development, as well as comfortable EVA spacesuits, and sustainable food and water systems. Also necessary are mobile exploration vehicles and ascent propulsion for the return to Earth. Of course, this does not encompass all of the necessary technologies, but these will have to be created, matured and perfected over time.

Harrison 'Jack' Schmitt was the first trained scientist to walk on the Moon. During the Apollo 17 mission he collected evidence of lunar volcanic activity.

Lunar exploration in the coming years will be essential preparation for long journeys across our Solar System, developing and demonstrating capabilities that are independent of Earth. Returning to the Moon will, therefore, be a cornerstone of future deep-space human exploration.



This low-angle self-portrait of NASA's Curiosity Mars rover shows the vehicle at the site from which it reached down to drill into a rock target called 'Buckskin' on lower Mount Sharp. The 'selfie' combines several component images taken by Curiosity's Mars Hand Lens Imager (MAHLI). For scale, the rover's wheels are 50 cm in diameter and about 40 cm wide.

International perspective

Using data from radiation detectors carried by Curiosity, scientists have estimated the instance of cancer could increase by five per cent, which is higher than NASA tolerances for an astronaut

The International Space Station is a tribute to the ingenuity of humankind along with the shared cooperation of many countries - a crowning triumph in the arena of worldwide collaboration. With over 80 countries involved, the ISS has celebrated 16 consecutive years in low Earth orbit. Significant scientific breakthroughs are already transforming how human beings live on Earth, as well as facilitating ground-breaking research on the effects of microgravity on the human body over long periods of time.

As the technological revolution accelerates, many countries are partnering to use a variety of technologies and we must find a way to continue the pattern set by the ISS to guarantee that competition does not overshadow international cooperation.

A US perspective

In spite of seemingly urgent priorities, daily pressures and challenges that face every nation on Earth, the United States must remain committed to human space exploration.

Space inspires our children, fuels invention and innovation, and provides tangible benefits. It improves health, security, clean energy, technology and our overall quality of life.

In the future, NASA human exploration missions must remain independent of the start-stop cycle of the US, or any government's, shifting political allegiances. In the US we have witnessed many times the start of a bold space programme, only to find Republicans cancelling Democrat initiatives, and Democrats cancelling Republican initiatives. In 2017, the incoming US President will have to take into account the geopolitical and fiscal situations, set up a winning formula, and then passionately communicate this to NASA and the American people.

Dr David Kendall, former executive of the Canadian Space Agency (CSA), was appointed in June 2016 to chair the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS) for two years.

David Kendall, director general of the Canadian Space Agency (CSA), and chairman of the United Nations Committee on the Peaceful Uses of Outer Space (UN COPOUS), believes there would be great interest if NASA were to invite partners to join a Moon exploration programme.

"I even think China would be open to this. People need inspiration and I believe people still see that in space exploration. The next step will be the Moon - it is the most conservative step beyond LEO that makes sense. But it has to be sold right, and right now the United States doesn't have the leadership in place to make it happen."

Future US space policy

The ISS continues to provide a platform for understanding some of the adverse effects that living and working in space has on the human body

NASA should set up a step-by-step logical schedule of progressive and realistic goals. Each milestone must be interesting to the public, even while NASA incrementally builds its space-faring capabilities. Realisable, short-term space goals will build long-term and enduring space policy - and lasting credibility with US taxpayers, Congress, and international partners. The Moon also represents an affordable and sustainable destination that can remain stable over several US administrations.

Astronauts Tim Peake (left) and Tim Kopra at work on the International Space Station.

The sustainable path to deep space, human exploration depends on a strategy where stakeholders from government, industry, international partners and the public are committed to the programme's success. The power of partnership will maintain ambitious human exploration plans through its ups and downs as proven by the collaboration of many nations and private companies invested in the achievements of the ISS. Missions to the Moon, Mars or beyond should not be any different.

Allyson Reneau *is a recipient of an MA in International Relations from Harvard University and is an aspiring space professional. She works as an intern in the Office of International and Interagency Relations at NASA, headquarters in Washington DC. The article is drawn from her master's thesis, which received highest honours, and does not reflect official views of NASA.*

ASA is looking at commercial options to launch its Europa Clipper

An artist's rendering showing NASA's Europa Clipper spacecraft, which is aiming for launch readiness by 2024 and could now make its way to the icy-world by way of a commercial launch vehicle instead of the SLS. Image: NASA

by Kerry Hebden

NASA has issued a request for information (RFI) for a commercial rocket provider to launch the Europa Clipper, the agency's long awaited orbiter that will search for signs of life on Jupiter ice-covered moon Europa; a move that signals NASA has overcome a long-standing requirement by US Congress which would have placed lengthy delays on the project's launch.

Originally scheduled for liftoff in 2023, a date which has now slipped to 2024, US Congress had previously mandated by law that Europa Clipper's orbiter and a follow-up lander mission had to be launched on NASA's huge,
but problematic Space Launch Systems (SLS) rocket.

However, development on the SLS is behind schedule and when it is finally ready to fly, NASA plans on using the first three SLS rockets produced for its Artemis lunar programme.

As such, an SLS will not be available for the Clipper Orbiter launch until 2025 at the earliest.

With the completion of the Orbiter itself expected in 2023 according to a US Government Accountability Office (GAO) report published in April 2020, this would mean the Clipper would have to be held in storage for at least 18 months, probably longer.

Although this might not seem such a problematic requirement, the cost of storing a Class A payload, a mission-type that the space agency reserves for its highest priority and most expensive missions, is not cheap.

Figures published both in the same GAO document and a NASA Office of Inspector general report indicate that costs involved in the Clipper's storage amount to an estimated $3 to $5 million per month – a substantial figure which includes fees of $1 million for physical storage; $129 million for workforce and potential staff requirements; $96 million for mission system impact and a change in cruise time to Europa from 2.4 to 3 years.

Funds to the tune of $250 million in reserves were added to the project by NASA last year, to address these storage and related personnel costs, says the report.

A launch using the SLS would have an advantage in that the Europa Clipper could be sent directly to Europa, whereas a later launch window using a commercial launch vehicle would require Mars and Earth gravity assists therefore extending the flight time of the Clipper.

But, says NASA's inspector general, the agency could save nearly $1 billion if Congress gives it the ability to choose the best launch vehicle for the mission.

"Our May 2019 report highlighted three main differences between launching the Europa mission on an SLS versus a commercial rocket: cost, transit time to Europa, and availability for a 2023 launch. The SLS is the most expensive launch vehicle option by a factor of three," notes Paul K. Martin, Inspector General on the OIG report.

The much needed flexibility NASA needed in order to use vehicles other than its own to loft Europa Clipper into space, has now appeared in the form of revised wording used in a recent spending bill, which specified that SLS should still be used but only "if available"; a term not seen in past bills.

Taking full advantage of this change in language, the agency is now seeking information about commercial launchers that would be available for a 21-day launch window that runs from 10-24 October, 2024.

"NASA/Kennedy Space Center (KSC) is hereby soliciting information from potential sources in anticipation of a full and open competition for the acquisition of launch services of the Europa Clipper mission," says the request for information. "The launch vehicle shall deliver a minimum 6065 kg Europa Clipper spacecraft (SC) with Mars-Earth-Gravity-Assist (MEGA) trajectory characteristics as follows: C3 value of 41.69km2/sec2 and a DLA range of 30-32 degrees," it adds.

The RFI is required by law set out by Congress, which specifies that a competitive bid process for the Clipper launch must take place.

With such a heavy payload, at present, there are only a couple of commercial options on the table; a SpaceX Falcon Heavy in its completely expendable configuration, and a ULA Delta IV Heavy.

This latter alternative is somewhat doubtful as a possible contender because ULA are planning to phase out their Delta IV rocket in the next couple of years.

As it is also unlikely that NASA will consider rockets not in service at the moment, and that the agency would like to "begin the procurement process in the next few months", it would seem there is not a lot of competition in the running at this current time.

Axiom Space unveils crew for first private ISS mission

The Axiom Mission 1 crew, from left to right, Michael López-Alegría, Mark Pathy, Larry Connor, and Eytan Stibbe. Image: Axiom Space

by Kerry Hebden

Axiom Space has announced that as early as next year, a private crew, led by former NASA astronaut Michael López-Alegría could make history by becoming members of the first commercial crew to visit the International Space Station (ISS).

Joining López-Alegría are real estate investor Larry Connor, Canadian investor Mark Pathy and former Israeli Air Force pilot and philanthropist, Eytan Stibbe.

López-Alegría, who now works for Axiom, heads the Ax-1 mission as Commander, while Connor will be the mission's pilot, making him the first private pilot on an orbital spaceflight. Both Pathy and Stibbe have been assigned as mission specialists.

The team are expected to stay at the ISS for eight days and will use SpaceX's Crew Dragon spacecraft "Resilience" for the mission.

The trip, slated to launch no earlier than January 2022, is estimated to cost $55 million per person by industry sources. Axiom however have not disclosed the prices the three commercial astronauts paid to join the mission.

"Axiom provides missions to Earth's orbit because the dawn of true private spaceflight is the next line of moments. Only into the expanse outside our atmosphere can the species step out of the cradle," say Axiom in a statement Tuesday. "And it all begins with this multinational crew. This groundbreaking mission."

As groundbreaking the mission might be, many have pointed out the apparent lack of diversity amongst the four selected crew members.

"These may be great people going to space; but an older, non-diverse, affluent crew will reinforce the narrative of space as a plaything for rich elites. This matters… Commercial space needs to be for all," writes Eric Berger, Senior Space Editor at Art Technica, via Twitter.

Addressing the issue of why some might criticise private spaceflight as only for the ultra rich, Axiom's VP López-Alegría said in an interview with CNBC; "It's not a very democratic demographic right now because of the cost of the flights, but we fully anticipate that the costs will start coming down. At some point we'll be able to offer these to the man-on-the-street. It's going to be a while but that's the goal, and you have to start somewhere."

The crew are also keen to emphasise that as each member will be participating in various research and philanthropic projects during their stay aboard the ISS, their mission is one of work and not play and as such the trip does fall into the category of space tourism.

"We absolutely do not believe that we're space tourists," Connor told CNBC.

The Ax-1 crew has yet to begin its formal training, but the team have seen the spacecraft and tried on spacesuits at SpaceX's headquarters in Los Angeles, Connor said.

Once training does get underway, Connor, who turns 71 this year, will receive additional guidance on the operations of the spacecraft to support López-Alegría, who has already flown to space in four previous NASA missions.

John Shoffner, a commercial astronaut from Tennessee, will train as a backup, while former NASA astronaut Peggy Whitson will back up López-Alegría.

"Not the first time I have backed up @CommanderMLA! The next best thing to flying in space is training for it! Looking forward to the commercial evolution @Axiom_Space," Whitson recently Tweeted.

Ax-1 is the first of Axiom Space's "precursor" private astronaut missions to the ISS – subject to approval from NASA and its international partners, say the Houston based firm.

Although Ax-1 is not yet an official mission, Axiom Space and NASA are working together on the final approvals of a formal Basic Ordering Agreement (BOA) to enable private astronaut missions.

Axiom, in conjunction with NASA, have already stated they would like to offer at least two private and public flights to the ISS each year and the Ax-1 mission is seen as an important first step in that direction.

"We sought to put together a crew for this historic mission that had demonstrated a lifelong commitment to improving the lives of the people on Earth, and I'm glad to say we've done that with this group," Axiom Space President & CEO Michael Suffredini said. "This is just the first of several Axiom Space crews whose private missions to the International Space Station will truly inaugurate an expansive future for humans in space – and make a meaningful difference in the world when they return home."

The space start-up firm's ultimate aim however is build and launch its own space station which it would make available to the international community. Axiom has plans to first add modules to the current international space station, that upon its retirement would see Axiom's own segments set free to then orbit independently around Earth.

Russia develops instrument to search for precious metals on the Moon and Mars

An artist's depiction of a lunar lander in Russia's second-generation Luna program - the type that might house the new device created by Russian scientists which can search for precious metals. Image: Roscosmos

by Kerry Hebden

Scientists at the Space Research Institute of the Russian Academy of Sciences have created a device for searching for precious metals on the Moon and Mars, that could be incorporated into either a future Russian lunar lander or be offered to other foreign landing vehicles and rovers.

The device is a prototype and has been in development for three years, says Igor Mitrofanov, head of the nuclear planetology department of the Space Research Institute, in news reported by Russian news site RIA Novosti.

"It is best suited for a lunar rover. Along the route we will be able to determine the elemental composition of the surface in a strip about 30 centimetres wide," Mitrofanov said.

The unnamed device works by reading the energy spectra of particles that have emitted gamma radiation, with an board gamma-ray detector.

It will achieve this by first recording both the "flight" of a high-energy cosmic-ray particle, and then the gamma-photon that is emitted from the element when struck by the cosmic-ray, Mitrofanov explained.

The device is also able to distinguish between false positive signals, such as those emitted by a lunar lander, and a genuine signal from a metal-bearing lunar rock.

"We can use these observations to determine the elemental composition of matter with high accuracy. This is the idea of the device," Mitrofanov said.

Once on the surface the device will be used to search for rare earth metals such as gold, silver and platinum, at depths of several tens of centimetres to a metre.

The speed of element determination will presumably depend on the rover it is attached to. According to RIA Novosti when used on the Lunokhod, it will need to stop and stand in place for an hour or two in order to collect statistics of counts from gamma rays.

“Lunokhod-Geolog”, could be referring to Luna-27. Also called the Luna-Resurs lander, Luna-27 is a planned lunar lander mission by Roscosmos in collaboration with the European Space Agency (ESA).

The two space agency’s have recently teamed up to work on three Luna missions, two landers and one orbiter.

Luna-27, which could reach the lunar surface by 2024/2025, is being designed not just to inspect the terrain, but also to prospect it for resources such as lunar water ice in permanently shadowed regions of the Moon.

This will be a big step up from Russia’s first series of robotic lunar rovers, Lunokhod 1 and Lunokhod 2, that were first sent to the Moon in 1970.

Lunokhod 1 (which means "Moonwalker 1” in Russian) become the first roving remote-controlled robot to land on an extraterrestrial body when it landed on the lunar surface over 50 years ago.

Although only designed for a lifetime of three lunar days (approximately three Earth months), Lunokhod 1 operated on the lunar surface for eleven lunar days (321 Earth days) and traversed a total distance of 10.54 kilometres.

Its counterpart, Lunokhod 2, touched down on the lunar surface in 1973 and operated for about four months.

However, before the Luna-27 mission gets underway, Russia plans on kickstarting its new moon ambitions with Luna-25.

Luna-25 is set to demonstrate the landing technology for future missions and it will target the Boguslavsky crater near to the lunar south pole. Its flight is slated to leave from the Vostochny Cosmodrome, possibly in October 2021.

Rover missions are just the start of Russia’s new moon directive and crewed missions to the lunar surface are planned for the end of the decade.

According to Russian state media news site Radio Sputnik, Dmitry Rogozin, head of Roscosmos, announced that “a spacecraft carrying cosmonauts will fly around the moon in 2028, and their landing on the lunar surface in 2030.”

Previous statements from Russia had suggested that the 2028 launch would be carried out using a Yenisei super-heavy rocket, designed specifically for ferrying cosmonauts to the Moon.

However, the Space Council of the Russian Academy of Sciences (RAS) has recently recommended postponing the creation of Yenisei for a later date when breakthrough and economically viable technologies become available, says RIA Novosti.

Instead, several of the countries Angara-A5V carrier rockets will now be used. Manufacturing of the hydrogen stages of the A5V will start at the countries Khrunichev Center in 2024.

Commissioning of the facility, which includes the construction of two new buildings, is expected in the fourth quarter of 2023.

“This will make it possible "to create the production capacities necessary for the production of final products - the Angara-A5V launch vehicles and upper stages (Breeze-M or a heavy-class oxygen-hydrogen unit) - up to 10 products per year,” notes RIA Novosti.

Meanwhile the Russian Space Agency is busy ploughing billions of rubles into the development of the Oryol spacecraft; a crucial element of Russia's plans to land cosmonauts on the Moon.

Formerly named Federatsiya (Federation), the Oryol spacecraft (which means “Eagle”) has been in development for 10 years.

Last month, Energiya, the crafts contractors, asked Roscosmos for an additional 18 billion rubles (about $261 million) for the project.

Roscosmos chief Rogozin later clarified that part of the money was necessary to build the necessary infrastructure at Russia's Vostochny Cosmodrome.

Speaking at a press conference at the Cosmodrome just over a month ago, Rogozin said the first test launch of the new generation Oryol spacecraft is slated for August or September 2023.

If everything goes to plan, the Oryol will begin crewed test flights to the International Space Station starting in 2025.

India lays out its space plans for the next 10 years

India's GSLV MK III launch vehicle (pictured here) will be used to launch the country's Gaganyaan mission into space. Image: ISRO

by Kerry Hebden

In a New Year message from the Indian Space Research Organisation (ISRO), its Chairman, K Sivan, has laid out the country’s space plans for the next decade. A number of projects will be focused on, including the development of a heavy lift launch vehicle, advanced green and electric propulsion, a reusable launch vehicle as well as advanced space science missions, say ISRO.

With the expansion of the space sector, the work of ISRO is going to increase with major attention on innovation and development over the next 10 years, said the statement issued on ISRO’s website.

To foster the growth of the India’s space sector, Kivan said every centre of ISRO has been directed to work out a decadal plan, to consider the expanded capabilities required in the short term as well as the long term.

Highlights of the plan include a continuance of the country’s Vikram Sarabhai Space Center (VSSC) to carry forward its “competence in launch vehicle development towards heavy lift capabilities, achieving partial and full reusability”, along with a focus on scramjet engine research.

The Liquid Propulsion Systems Center (LPSC) is to play a role in developing a high thrust semicryogenic propulsion capability, which is expected to boost the country’s geosynchronous transfer orbit (GTO) payload capability to almost 5.5 tonnes.

In addition, the LPSC will also advance development on on liquid oxygen (LOX)/Methane propulsion, Green and electric propulsion.

NASA also uses liquid oxygen as an oxidiser in its RS-25 main engines that power its huge Space Launch System (SLS) rocket.

ISRO's research and development Inertial System's Unit (IISU) has been asked to scale up its capabilities to support the space science & exploration missions in the next decade, while its ISTRAC and Master Control Facility (MCF) will upgrade the ground systems to meet the future requirements including that of human space flight.

The ISRO Telemetry Tracking and Command Network (ISTRAC) was India's nerve centre for the country's first interplanetary mission, the Mars Orbiter Mission (MOM) or Mangalyaan.

Its Satish Dhawan Space Centre (SDSC) has also been tasked with scaling up its launch infrastructure to support human spaceflight.

The Centre, which has two launch pads and is located on the East Coast of the country, far from populated areas, could soon be lined up to support & facilitate the launching of private space transportation systems in the country.

Last year, the Indian government announced it was opening up its space agency facilities to allow private firms and startups to build satellites and rockets to help combat the crippling financial effects of the coronavirus pandemic.

As part of the deal, an independent nodal agency known as the Indian National Space Promotion & Authorization Center (IN-SPACe) would be formed, to support private entrepreneurs who had come forward to develop end-to-end launch vehicles and satellites, ISRO said.

"We want to help Indian startups that are doing pioneering work," Finance Minister Nirmala Sitharaman said at the time, although the move was seen by some critics as the start of the end of ISRO as a pioneering agency.

As the various facets of ISRO start to make head way on their aims for the next decade, the country has a number of up and coming missions to achieve first, such as Chandrayaan-3, the first solar mission, Aditya-L1 and the first uncrewed flight under the Gaganyaan Programme.

The Gaganyaan Programme, will receive "a lion's share of ISRO's technology development & advanced R & D activities," to help sustain human spaceflight activities in the long term, Kivan said in the New Years message.

This would be a boost from last year when the Times of India reported that the programme had only received around 30 percent of much needed funds to facilitate the mission.

Gaganyaan is designed to send three crew members into space for five to seven days in a small spacecraft, approximately 3 meters by 3.4 metres (10 feet by 11 feet) in diameter.

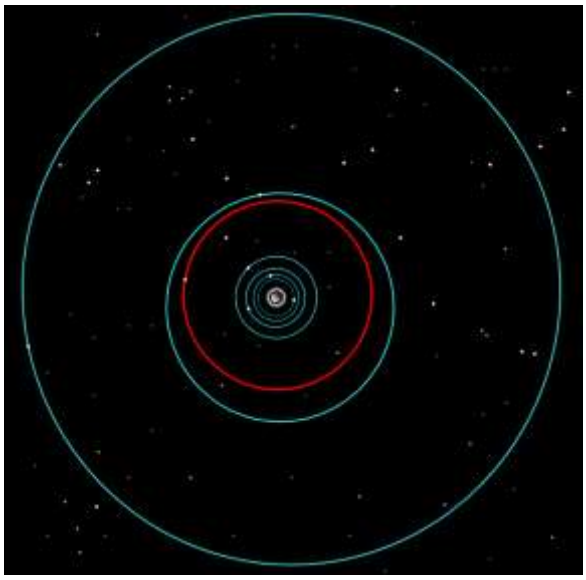
If successful, it would mean India is only the fourth country to fly its own astronauts in a spacecraft after the United States, the Soviet Union (now Russia) and China.

Saturn Got Its Tilt From Its Moons

One of the fundamental tenets of physics is that two objects, now matter how different their size, exert a force on each other. In most cases the size makes a big difference, with the larger objects enacting a much greater force on the smaller one.

However, over long periods of time, even much smaller objects can have an effect on the larger object in the pair. Recently a team of researchers from CNRS, the Sorbonne, and the University of Pisa have found an example of the smaller object, or in this case group of objects, having an outsized impact on the larger one. They have discovered that Saturn's moons actually caused its famous tilt.

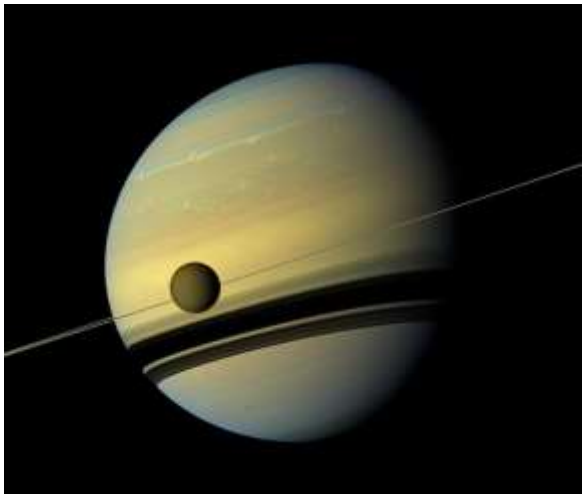
Saturn, the second largest planet in the solar system, has a total of 82 discovered moons. Though that is a lot of moons, over 96% of the mass in orbit around the planet exists in one moon in particular: Titan. The other six "ellipsoidal" moons make up almost another 4% of the mass. However, Saturn itself masses over 4000x all of its moons combined.



A top-down image of the orbits of some of Saturn's larger moons, with Titan in red. The moons outside its orbit are (from the outside to the inside) Iapetus and Hyperion; those inside are Rhea, Dione, Tethys, Enceladus, and Mimas. Image Credit: By !Original: Rubble pileVector: Mysid. – Own work based on: Titan's orbit.jpg., CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=4819125

Recently scientists have begun taking a closer look at Saturn's moons, in part because of their potential as harbors of life as well as them being targets of some upcoming missions. During this closer look, they realized that the moons were moving away from their parent planet at a much faster rate than previously thought. When they recalculated some models using this increased speed, they realized that Saturn's tilt can be almost entirely explained by the gravitational effects of its moons.

About one billion years ago, the ring planet's moons forced it into a resonance state with themselves which continues to this day. That resonance, along with a slight disruption by Neptune as it moved through the early solar system, resulted in the 27° incline we can see on the planet today.



Saturn, with its noticeable axial tilt, and its largest moon, Titan.
Credit: Credit: NASA / JPL-Caltech / Space Science Institute

Even more interestingly, it seems this axial tilting will continue for some time yet. By the authors' calculations, it could more than double over the next few billion years.

Saturn is not the only gas giant in the solar system to get the same push from its moons. Jupiter is currently in the process of being tilted by its moons, with some help from Uranus along the way. Five billion years from now, the biggest planet in the solar system is expected to have an axial tilt 10x what it is today (3°), making it even more angled than Saturn is currently.

Unfortunately no one alive today will be around to witness that. But the fact that models can tell us that is what will happen is always impressive. So is a small force maintained over a long period of time.

Low-Cost Approach to Scanning Historic Glass Plates gives an Astronomical Surprise

A new process highlights an innovative way to get old glass plates online… and turned up a potential extra-galactic discovery over a century old.

You never know what new discoveries might be hiding in old astronomical observations. For almost a hundred years starting in the late 19th century, emulsion-coated dry glass plate photography was the standard of choice used by large astronomical observatories and surveys for documenting and imaging the sky. These large enormous glass plate collections are still out there around the world, filed away in observatory libraries and university archives. Now, a new project shows how we might bring the stories told on these old plates back to light.

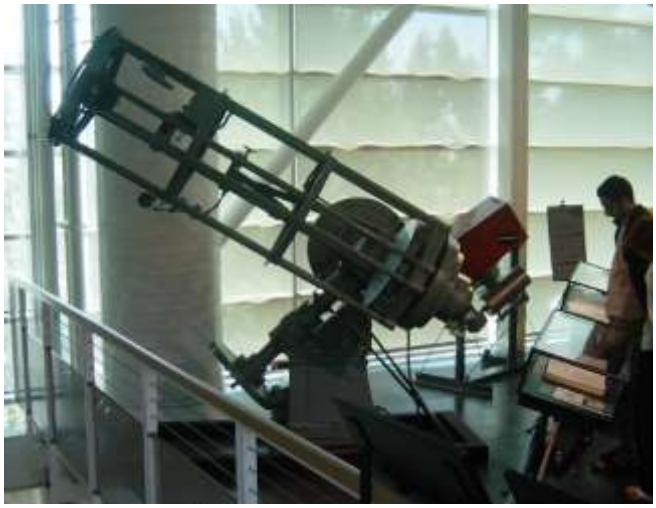
More than an estimated 2.4 million glass plates are out there in collections in North America alone. These were taken starting in the 1890s right up until the 1970s, when CCD (Charged Couple Device) detectors started to come online for astronomy. Of these, only an estimated 400,000 plates have been digitized to research quality, most notably by the DASCH (the Digital Access to the Sky Century at Harvard) and the international APPLAUSE (The Archives of Photographic Plates for Astronomical USE) projects.

A team from the University of Chicago Department of Astronomy and Astrophysics, and the Kavali Institute for Cosmological Astrophysics wondered if there might be an easier way to bring these old plates into the modern digital era.

"The plate scanning process is actually quite simple," Will Cerny (University of Chicago) told *Universe Today*. "After we select a plate, we make sure the surface is clean so that dust particles don't get mistaken for stars in the final image. Then, we set our scanner to the highest quality we can and produce an image file. In effect, we are considering the scanner to be a scientific instrument: for each small piece of information on the plate, we get a digital rendition of the amount of light transmitted through the photograph. From there, we upload the resulting file to a website which maps the celestial coordinates onto the image, which also creates a file in a standardized format for astronomical analysis."

The team turned to a nearby source, the Yerkes Observatory. For the study, the Yerkes Plate Digitization Team wanted a plate ideal for calibrating both stellar brightness and the sky background, covering a swath of sky located away from the galactic plane. The team also wanted plates taken under excellent sky conditions, with long exposures depicting a good variety of galactic in extra-galactic objects in order to gauge limiting magnitude.

Located on the shores of Lake Geneva in southern Wisconsin and built by American astronomer and telescope maker George Ellery Hale in 1897, Yerkes Observatory also houses a collection of 150,000-200,000 glass plates. Though Yerkes is home to the Great 40" telescope—the largest operational refractor in the world—most of the plates in the collection were taken using the 24-inch Ritchey reflector at Yerkes starting in 1901 or at the McDonald Observatory in western Texas.



The 24-inch Ritchey refractor, now on display at the Smithsonian. Wikimedia Commons/Public Domain.

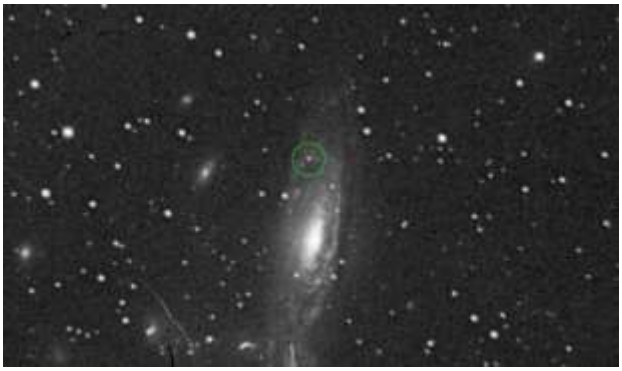
The era and utilization of glass plates for astrophotography was often tedious and cumbersome. Often, astronomers had to custom-shape the plates to fit specific cameras by hand using diamond cutters. What then followed was often a cold dark night at the eyepiece following a guide star, while the necessary exposures were made. These resulting plates, however, serve as a chronicle of the sky spanning nearly a century.

The Great 40-inch refractor at Yerkes Observatory. Credit: Dave Dickinson.

Interpreting the magnitude scale on the scans and calibrating the plates for factors such as sky glow, surface brightness and saturation (artifacts often introduced by the photographic and scanning process) yield a limiting magnitude of +19, and the scanning process obtained a precision of better than a tenth of a magnitude in brightness. For context, a large backyard telescope can typically see down to about magnitude +14 on a clear night with good seeing, and modern ground all-sky surveys such as PanSTARRS-1 have a limiting magnitude of about 10,000 times fainter, at around magnitude +24.

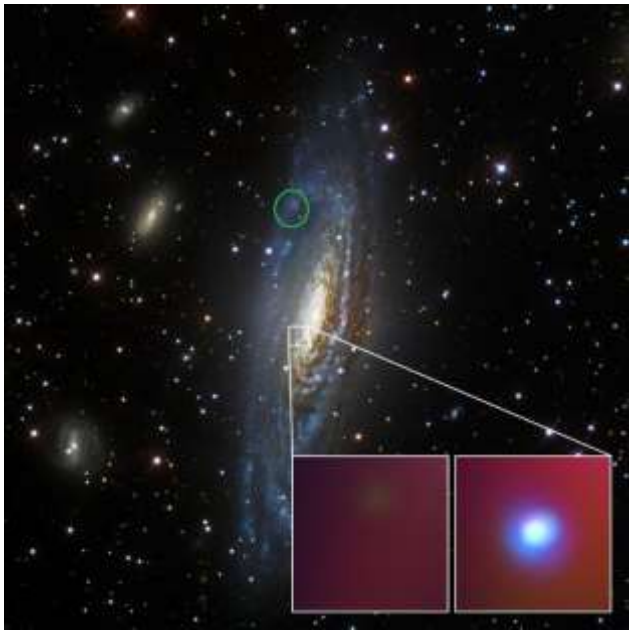
“The simplicity of the process makes it possible to digitize a large number of plates in a relatively small amount of time,” says Cerny. “It also has the benefit of not requiring a custom scanner, making it accessible to teams without the wherewithal to design or purchase one. Custom scanners are prohibitively expensive. If our methods can be generalized, then photographic plate collections from multiple observatories could be rendered available for use in scientific research.”

In the end, the team selected about 50 plates that met the criterion for the study. The team used a commercially available Epson Expression 12000XL graphic arts scanner, greatly speeding up and streamlining the process. Files were initially scanned as positive .TIFF files (with black stars on a white background) then saved as FITS files, a format familiar to many modern astrophotographers. The targeted scan area resulted in a field of view 1.5 degrees wide, about three times the diameter of a full Moon. Amazingly, one of the very first plates scanned by the team (Ry60) taken in 1903 centered on the +10th magnitude galaxy NGC 7331 located 45 million light-years distant in the constellation Pegasus also turned up a surprise visitor: a guest ‘star’ or possible supernova, not visible in SDSS (Sloan Digital Sky Survey) comparison images. If confirmed, this would be the fourth known supernova observed in this galaxy.



The 1903 plate (negative, with bright stars on a black background) showing the previously unnoticed supernova (circled). Credit: W. Cerny/Yerkes Plate Digitization Team.

“Our team had actually scanned a number of plates before settling on this particular plate (Ry60) for our paper… however, we had absolutely no idea at first that this plate was hiding this candidate supernova!” says Cerny. “We were going through the image of the galaxy on the plate as part of our analysis, which involved comparing the plate with a modern image of the same field of sky. At one point, we blinked (rapidly alternated) between the two pictures, and noticed what appeared to be a star present on the plate image.” The team also eliminated other potential false positives—such as an asteroid, dust fleck or a galactic classical nova—before measuring the object’s brightness, consistent with a distant supernova.



A modern optical and x-ray image of NGC 7331, showing a supernova from 2014 (inset) and the region of the 1903 supernova (green circle). Credit: NASA/CXC/CIERA/R. Margutti.

New Mysteries on Old Glass Plates

What good are old glass plate images of the sky? Well, several recent studies have turned to the record documenting the sky back over a century ago. When astronomers noticed an anomalous dimming seen in Tabby’s Star KIC 8462852, they looked at old glass plates of the same region to show that the strange star is actually *fading* over longer time scales. Another study looked at the nearby white dwarf named Van Maanen’s Star and demonstrated that astronomers had potentially documented evidence for exoplanets waaaay back in 1917… had they known to look for it.

A 1903 Ritchey series plate depicting the Andromeda Galaxy (Messier 31). Note that when this was taken, it would have been

referred to as the 'Andromeda Nebula' (!) Credit: W. Cerny/ Yerkes Plate Digitization Team.

In addition to looking at the variability of stars over long periods of time, old plates open up the possibility of looking at stellar astrometry or the position and movement of stars via proper motion over a century-plus long baseline. The team used measurements from the European Space Agency's Gaia mission for comparison in the study to demonstrate this very technique. Gaia released its DR2 (Data Release 2) catalog with over 1.6 billion stellar position measurements in 2018, and just recently went public with EDR3 (Early Data Release 3) on December 3, 2020, with the full release set for late 2021.

A scan from the 1903 Ritchey series of plates, centered on the Veil Nebula. The scan is light-to-dark inverted. Credit: W. Cerny/Yerkes Plate Digitization Team.

In the end, the team and the study demonstrated a low-cost but effective technique to easily scan astronomical glass plates for research level quality, using off-the-shelf commercially available equipment. The team also has long-term plans to make Yerkes plate scans and logbooks available online to the public via the University of Chicago Library website.

It's definitely worth the effort to preserve those glass plate images of yore. Who knows what other astronomical discoveries are waiting to see the light of day.

What Did The Solar System Look Like Before All The Planets Migrated?

Early planetary migration in the solar system has been long established, and there are myriad theories that have been put forward to explain where the planets were coming from. Theories such as the Grand Tack Hypothesis an the Nice Model show how important that migration is to the current state of our solar system. Now, a team from Lawrence Livermore National Laboratory (LLNL) has come up with a novel way of trying to understand planetary migration patterns: by looking at meteorite compositions.

The researchers, led by postdoc Jan Render, had three key realizations. First, that almost all the meteorites that have fallen to Earth originated from the asteroid belt. Second, that the asteroid belt is known to have formed by sweeping material up from all over the solar system. And third, and perhaps most importantly, that they could analyze the isotopic signatures in meteorites to help determine where a given asteroid had formed in the solar system.

UT Video describing the forces that stopped the asteroid belt from becoming a planet.

With that knowledge, they could then extrapolate out to other asteroids of the same type. There are approximately 100 different types of asteroids, with different isotopic signatures, in the asteroid belt. The team used a technique to measure the nucleosynthetic isotope signatures of several samples of basaltic achondrites, a type of stony meteorite.

They were looking for concentrates of neodymium (Nd) and zirconium (Zr), which were lacking in some types of presolar material. This meant that understanding the amount of Nd and Zr in a specific type of asteroid will allow them to understand where in the pre-sun solar system that type of asteroid was formed.

Examples of basaltic meteorites that came from the moon. Credit: NASA / JSC and R. Korotev

Tying their terrestrial results back to the asteroids in the asteroid belt, and then to other models of how the different parts of the asteroid belt ended up where they were, and which planet they were closest to, allowed to researchers to create a completed map of the early solar system with models of how each of the planets moved into their current positions.

There is yet more data to collect regarding these planetary migrations. Using meteorites that have actually landed on Earth is a novel, and hopefully inspirational, way to make the best use of all of the data available. Maybe there are even more insights into the original of the solar system hidden away close by.

Galileo's Probe Discovered a Mystery at Jupiter, Juno Finally Helped Solve it

In 1995, NASA's Galileo mission dropped a probe into the atmosphere of Jupiter and found it to be far drier than expected. In 2020, NASA's follow-up mission Juno explained the mystery: it involves mushballs.

When NASA's Galileo probe reported that the upper reaches of Jupiter's atmosphere just north of its equator were drier than expected, planetary scientists at the time just chalked it up to bad luck. They had thought that perhaps while the general region is dominated by moist, cooler air, the probe just happened to fall into a hot spot that was drier than normal.

But nobody likes a coincidence, especially scientists, and 25 years later, they found the real reason.

It turns out that the region just north of Jupiter's equator is overall much drier than you might expect based on atmospheric modeling that we had performed so far. But that atmospheric modeling neglected one key ingredient that was only discovered recently with the Juno mission: mushballs.

The Juno probe discovered that in areas where shallow lightning can occur in the atmosphere, ammonia can combine with water, binding together into a mushier version of hail. As these balls sink, they accumulate more ammonia and water, pulling it down into the depths of the atmosphere.

“High up in the atmosphere, where shallow lightning is seen, water and ammonia are combined and become invisible to Juno’s microwave instrument. This is where a special kind of hailstone that we call ‘mushballs’ are forming,” related Tristan Guillot, Juno co-investigator at the Université Côte d’Azur in Nice, France.

“These mushballs get heavy and fall deep into the atmosphere, creating a large region that is depleted of both ammonia and water.”

Juno has found an abundance of shallow lightning and the associated mushballs in the latitude band just north of the equator, exactly where Galileo dropped its atmospheric probe. And so that probe didn’t just get unlucky, it found the first signs of a much more complex and intricate atmospheric pattern than we had ever realized.

One of the Oldest Stars in the Galaxy has a Planet. Rocky Planets Were Forming at Nearly the Beginning of the Universe

Would it be surprising to find a rocky planet that dates back to the very early Universe? It should be. The early Universe lacked the heavier elements necessary to form rocky planets.

But astronomers have found one, right here in the Milky Way.

After the Big Bang, the Universe consisted of nothing but light elements like hydrogen and helium, with a little lithium. Rocky planets require heavier elements like carbon, oxygen, and iron, which astronomers call metals. Those heavier elements can only be formed in the hearts of stars. And the first stars didn’t form until about 200 million years after the Big Bang.

Any extremely ancient planets, formed not long after the Universe began, should be gaseous, not rocky. There wasn’t enough time for stars to seed the Universe with heavy elements for rocky planets. Or was there?

The planet in question orbits the star known as TOI 561. TOI stands for TESS Object of Interest, meaning it was spotted with NASA’s TESS (Transiting Exoplanet Survey Satellite). TOI 561 is one of the oldest stars in the Milky Way; about 10 billion years old.

TESS found the planet, and a team of researchers used follow-up observations with the Keck Telescope to learn more about it. They presented their findings at the January 2021 meeting of the American Astronomical Society. They also published their findings in a paper titled “The TESS-Keck Survey. II. An Ultra-short-period Rocky Planet and Its Siblings Transiting the Galactic Thick-disk Star TOI-561.” It’s published in the Astronomical Journal and the lead author is Dr. Lauren Weiss, Beatrice Watson Parrent Postdoctoral Fellow at the Institute for Astronomy at the University of Hawaii.

TOI 561 is in rare company. It’s one of the stars in what’s called the galactic thick disk. The galactic thick disk is composed almost entirely of ancient stars, whose chemistry and motion are different from the thin disk. Thick disk stars, including TOI 561, have much lower metallicity than stars in the thin disk. So finding a rocky planet orbiting it is surprising.

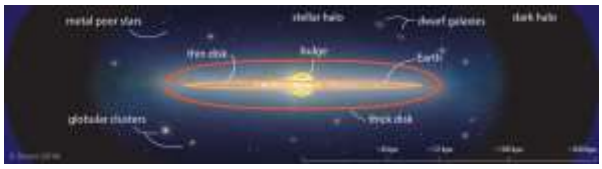
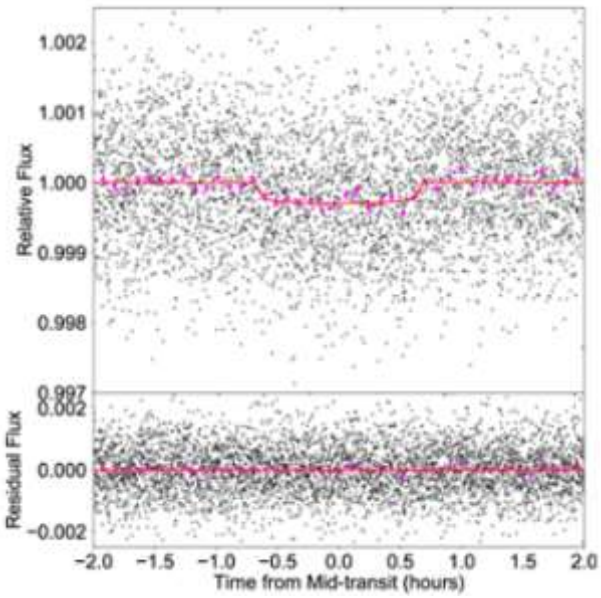


Illustration showing the structural components of the Milky Way Galaxy. The star TOI-561 is located in the thick disk (marked in red-orange), which contains a rare, older population of stars. While nearly all known planets are found within the thin disk (marked in orange), the newly-discovered rock-and-lava exoplanet orbiting TOI-561 is one of the first confirmed rocky planets orbiting a galactic thick disk star. *Credit: Kaley Brauer, MIT*

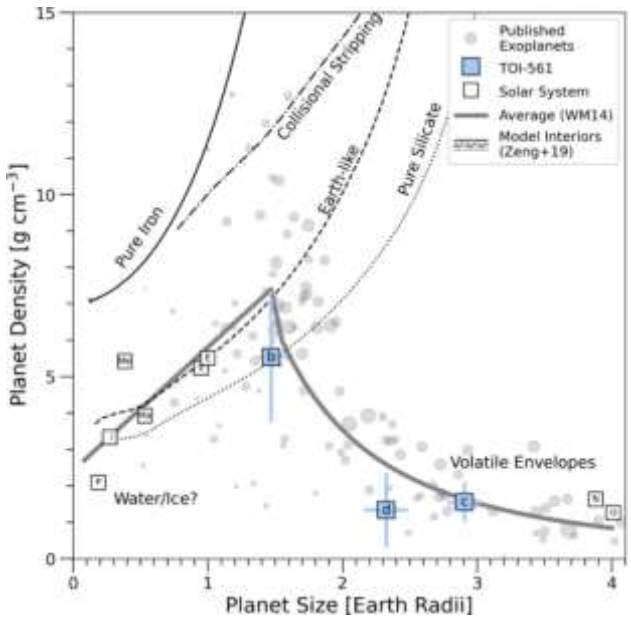
“The rocky planet orbiting TOI-561 is one of the oldest rocky planets yet discovered. Its existence shows that the universe has been forming rocky planets almost since its inception 14 billion years ago,” said lead author Weiss in a press release.

The planet, named TOI-561b, was discovered when it transited in front of its star. As its name says, TESS is designed to detect the dip in star light when a planet transits in front of a star in its field of view. Astronomers can gauge the planet’s size by measuring the drop in light, and in this case, it indicates that the planet is about 1.5 Earth radii.



Here’s what data on planetary transits looks like. It shows the measured dip in starlight when TOI 561b passes in front of its star from TESS’s perspective. Image Credit: Weiss et al, 2021

The team used the Keck Observatory for follow-up observations. The Keck has a special instrument called the High-Resolution Echelle Spectrometer (HIRES) to confirm the planet’s detection. HIRES allows astronomers to measure the wobble in the star caused by the planet’s gravitational tug. That measurement reveals the planet’s mass. In this case, the mass is large enough—three times greater than Earth’s—that TOI 561b has to be a dense rocky planet rather than a gaseous one. There are two other planets orbiting TOI-561, but they’re both gas planets.



This figure from the study shows planet bulk density vs. planet radius for small planets with measured radii and masses, based on results from the NASA Exoplanet Archive. TOI 561 b, c, and d are shown. Planets in our Solar System are shown for comparison. Image Credit: Weiss et al, 2021.

The origin of the old stars in the galactic thick disk is unclear. They could be the remnants of an ancient galaxy that was swallowed up by the Milky Way. Or they could be the first stars to form in the Milky Way. Or it could be something else. Nobody's certain.

As a planet orbiting an ancient, 10 billion-year-old star, it's been through a lot. The wandering motion of stars in the disk sometimes takes them above the galactic plane. An observer on TOI 561b would have been gifted some stunning views of the Milky Way's beautiful spiral structure. "I wonder what view of the night sky would have been accessible from the rocky planet during its history," said Weiss.

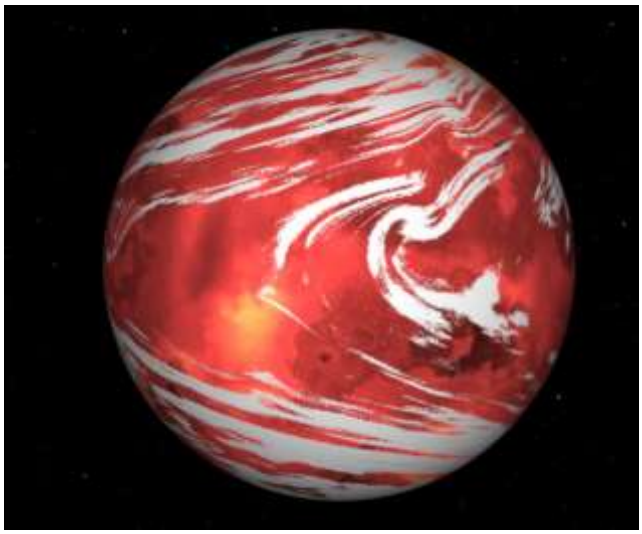
Artist's rendition of TOI-561, one of the oldest, most metal-poor planetary systems discovered yet in the Milky Way galaxy. This 10 billion-year-old system has a hot, rocky exoplanet (center) that's one and a half times the size of Earth as well as two gas planets (to the left of the rocky planet) that are about twice as large as Earth. Credit: W. M. Keck Observatory/Adam Makarenko

But there were likely no observers. Not now, anyway. Though the long history of the planet is unknown, it's too hot for life in the present-day. TOI 561b in an ultra-short period (USP) planet. It orbits TOI 561 twice each Earth day at a distance that keeps the surface at about 2000 degrees Kelvin (1721 C; 3140 F.) So while it is a rocky planet, that rock is likely magma on the surface.

What does this discovery mean? Well, it would be surprising if it was the only one. It's likely an indication that there's a whole population of ancient, rocky planets orbiting ancient stars.

In fact, TOI 561b isn't the first planet detected around a galactic thick disk star. The Kepler mission found five sub-Earth size planets orbiting the triple star system Kepler 444. Kepler 444 is estimated to be just over 11 billion years old, and its five planets are all rocky planets smaller than Venus. They're also very close to their star and are blisteringly hot.

There's also LHS 1815b. It's orbiting an M dwarf star in the thick disk and was discovered in early 2020. It's a rocky super-Earth and has a blistering surface temperature due to its proximity to its star.



An illustration of LHS 1815b, an ancient rocky exoplanet orbiting a star in the galactic thick disk. Image Credit: NASA

There's still some mystery in this discovery. Not so much over the planet itself, but the thick disk. There's disagreement and uncertainty on the nature of the galactic thick disk itself. Some astronomers think it doesn't even exist as a distinct structure. In 2012 a group of astronomers published a paper in the Astrophysical Journal titled "The Milky Way Has No Distinct Thick Disk." They argued that there is no distinct thick disk and say their data showed that "…the Milky Way has a continuous and monotonic distribution of disk thicknesses: there is no "thick disk" sensibly characterized as a distinct component."

Nobody's denying the existence of the ancient stars themselves or the ancient rocky planets orbiting them. But what the existence of those planets means for our understanding of the Universe is not clear yet.

Away From the Light Pollution of the Inner Solar System, New Horizons was Able to see how Dark the Universe Really is

Just how dark is the universe, anyway? It's a pretty hard thing to measure when we're sitting this close to the sun. But NASA's New Horizons probe is so far away that the images it

takes of the distant universe are able to deliver the most accurate measurement ever of the universe's diffuse background light.

The Cosmic Optical Background is the name that scientists give to the diffuse, general light given off by all the stars and galaxies through all of space and time in the universe combined. Like its cousin, the more well-known Cosmic Microwave Background, it's an important cosmological number, because it tells us about the contents of the universe. We can't hope to measure every single galaxy, no matter how far away or dim they are, with our telescopes, so by measuring all the light given by all the galaxies we can get a better handle on how dark the universe is.

"It's an important number to know – how many galaxies are there?" said Marc Postman of the Space Telescope Science Institute in Baltimore, Maryland, a lead author on a recent study answering that very question.

Unfortunately, measuring this background light isn't as easy as just taking a picture of space and hoping for the best.

We obviously can't do a very good job from the ground, because of all the sources of light pollution on the Earth. We also can't use the Hubble, because that telescope is too close to the sun. Tiny ice particles throughout the solar system reflect the sun's light in a phenomenon called Zodiacal light, which really mess up this kind of observation.

But NASA's New Horizons spacecraft, which recently sped by the Kuiper belt object Arrokoth, is far enough away that the zodiacal light is not a concern. Using released archived images from the probe's main camera, a team of researchers attempted a measurement of the background light of the cosmos, and came up with a number about twice as bright as expected.

To get this number the team first subtracted a few known sources of background light, like stars in the Milky Way reflecting off of the interstellar medium, and galaxies too dim and distant to be observed. But even after subtracting these there was still some leftover light.

Astronomers aren't sure what could cause that excess background light. It could be a number of dwarf galaxies near the Milky Way that we haven't observed yet. It could be more stars than expected scattered in the distant outskirts of galaxies. Or it could be more galaxies than expected appearing in the early universe, something that the James Webb Space Telescope will be able to answer.

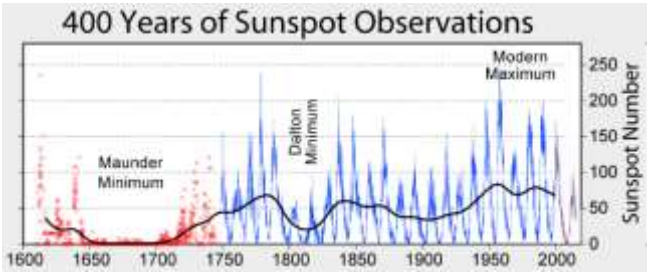
Tree Rings Reveal 1,000 Years of Solar Activity

The Sun has a lot of rhythm and goes through different cycles of activity. The most well-known cycle might be the Schwabe cycle, which has an 11-year cadence. But what about cycles with much longer time scales? How can scientists understand them?

As it turns out, the Sun has left some hidden clues in tree rings.

About 400 years ago, astronomers started watching the Sun with their newly-invented telescopes. They noticed sunspots coming and going and began to record their appearance and dissipation. They had no idea what they signified.

Those observations have taught us a lot about the Sun's activity. The more sunspots there are, the more there is going on inside the Sun. But there are other cycles of longer duration which have an effect on Earth and its climate. And a 400 yr record, though great in some respects, can't tell us much about the longer-term cycles.



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The 11-yr Schwabe cycle is itself part of these even longer cycles. A team of scientists wanted to reconstruct the Schwabe cycle back in time beyond 400 years to understand how it all fits together. To do so, they had to uncover clues left behind by the Sun inside trees. Those clues are in the form of radionuclides created by cosmic rays.

The team of researchers is led by Hans-Arno Synal and Lukas Wacker of the Laboratory of Ion Beam Physics at ETH Zurich. They traced the Schwabe cycle back as far as the year 969 by measuring radioactive carbon concentrations in tree rings. They published their results in a paper titled "Eleven-year solar cycles over the last millennium revealed by radiocarbon in tree rings." It's published in the journal Nature Geoscience.

The great thing about trees is they grow in an annual cycle. So each year, as they grow another ring, it's a snapshot of the Sun's output for that year. Piecing all those rings together gives an accurate picture of solar activity. In this study, the scientists looked at tree-ring archives from England and Switzerland.

The light and dark rings of a tree. The oldest rings are in the center, and the most recent ones are on the outside. Credit: Flickr Creative Commons user Amanda Tromley.

Each ring contains a tiny amount of radioactive carbon—as little as one atom of Carbon 14 per 1000 billion atoms. Since scientists know that C14's half-life is about 5700 years, they can calculate the concentration of C14 atoms in the atmosphere when each ring was grown.

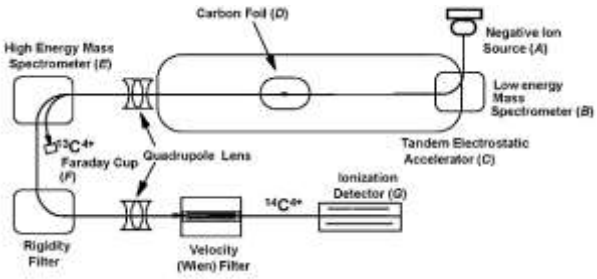
Here's where it gets even more fascinating: the radioactive carbon in the tree rings doesn't come from the Sun. It comes from cosmic rays that reach Earth from way outside our Solar System. But the Sun's magnetic field helps keeps those cosmic rays from reaching the Earth. The more powerful the Sun's magnetic field is, the fewer C14 isotopes reach Earth to be taken up by tree growth. So lower amounts of C14 in tree rings correlate with periods of greater solar activity.

But measuring these minuscule amounts of c14 isotopes in the tree rings is not easy, and neither is detecting differences from year-to-year. “The only measurements of that kind were made in the ’80s and ’90s,” says Lukas Wacker, “but only for the last 400 years and using the extremely laborious counting method.” The counting method used a Geiger counter to measure the decay event of each isotope. That method takes a lot of material and a lot of time.

The team came up with another method: accelerator mass spectrometry. This type of spectrometry was developed in the mid-twentieth century and is especially useful at detecting radioisotopes with long lives, like C14.

“Using modern accelerator mass spectrometry we were now able to measure the C14 concentration to within 0.1 percent in just a few hours with tree-ring samples that were a thousand times smaller”, said Ph.D. student Nicolas Brehm in a press release, who was responsible for those analyses.

The tree ring samples contain two types of carbon. Alongside the radioactive C14 isotope is C12, the most abundant of the two types of stable carbon isotope. An accelerator mass spectrometer accelerates both those isotopes before being sent through a magnetic field. The field directs one type of carbon one way and the other isotope in another direction due to their different masses. The results of that measurement are then analyzed statistically.



A simple schematic of an accelerator mass spectrometer. Due to their different weights, C13 and C14 are separated from each other and the C14 can be measured. Image Credit: By Hah; BioMed Central Ltd., CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=68194664

As a result, the team of scientists was able to reconstruct the record of the Sun’s activity all the way from the year 969 to 1933. Their reconstruction confirmed the Sun’s 11-year Schwabe cycle all the way back to 969 AD. It also showed that the amplitude of that cycle, or how much the solar activity goes up and down, is smaller during long-lasting solar minima.

Their reconstruction also confirmed something else. In 993, there was a pronounced solar proton event that created a peak in atmospheric C14. These events happen when protons emitted by the Sun are accelerated enough to penetrate the Earth’s magnetic field and cause ionization in the atmosphere. There’s been debate around the 993 event, but this work confirms its existence.

In fact, the results went further than confirming the event in the year 993. The researchers also found evidence of two more proton events: one in 1052 and one in 1279. This is the first time those events have been detected, and it might indicate that they happen more frequently than thought. This is very interesting since these events can pose a hazard to electronics on Earth and satellites.

Earth has some very long-lived trees. One of them, a bristlecone pine tree in California named Methuselah, is thought to be about 5,000 years old. But for this study, there was no need to disturb ancient living trees. Instead, the researchers examined ancient timbers used in buildings still standing, like the Abbey Church of St Alban, St Albans, Hertfordshire, UK. Its construction dates back to the eleventh century. The team examined 13 different timbers from 11 different buildings in the UK and Switzerland.

California’s Methuselah tree is nearly 5000 years old, and it contains a record of solar activity over its lifespan. For its own protection, its location is secret and there are no photos of it. This is a photo of another Bristlecone Pine tree. Image Credit: Wikimedia Commons

This type of analysis has the potential to teach us even more about the Sun. There are tree ring archives that go back 14,000 years in sub-fossilized wood, which is still rich in carbon. The researchers hope to use their method to measure the C14 concentrations in that wood, which will help them reconstruct solar activity back to the end of the last ice age.

Astronomers Confirm That Darksat is About Half as Bright as an Unpainted Starlink

Space-based internet service is poised to revolutionize the internet and bring high-speed connectivity to countless communities worldwide. Programs like SpaceX’s Starlink paint a picture of a bright future for the citizens of the world. Like many revolutionary technological advances, there is a dark side to Starlink.

The constellation of hundreds (and eventually thousands) of satellites reflect light back to the Earth, impinging on the darkness of the skies for professional astronomers and stargazers alike. Astronomers report images and data being disrupted by bright streaks left from the satellites passing through their observational fields of view. One potential solution to this issue is applying a dark coating to the reflective antennae on the satellites’ ground-facing side. In January of 2020, SpaceX launched the experimental DarkSat to test the effectiveness of such a coating. Astronomers around the world observed the new satellite. In December of 2020, a team from the National Astronomical Observatory of Japan (NAOJ) released a paper in *The Astrophysical Journal* showing detailed measurements of the efficacy of DarkSat.

So what were the results of the study? Is DarkSat an effective solution to the astronomical problem posed by Starlink? As is often the case in such studies, the answer is a little complicated.

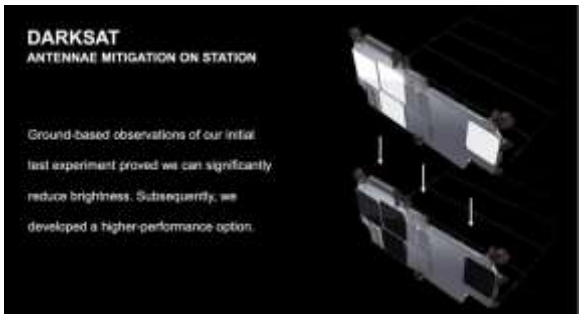
The 105 cm Murikabushi Telescope that was used to image Darksat. Credit: NAOJ

In a conversation with lead author Dr. Takashi Horiuchi of the Ishigakijima Astronomical Observatory/NAOJ, the results were illuminated. Dr. Horiuchi, an astronomer who spends most of his time observing quasars billions of light-years away, highlighted the fact that his study of the reflectivity of DarkSat was broken up into various wavelengths. In the visible portion of the electromagnetic spectrum, the DarkSat appears half as bright as uncoated Starlink satellites. The coating reduced the apparent magnitude of the satellite down to around a 7. This magnitude is just past the lower limit of brightness at which the naked eye can pick up an object in the night sky, but still far brighter than many astronomically significant targets. Dr. Horiuchi put it this way; “DarkSat is a magnitude of 7, but a typical quasar is a magnitude 18.” It is notable that in the magnitude scale, the higher the number, the *dimmer* the object. A magnitude 18 quasar is about 23,000 times fainter than a magnitude 7 DarkSat.

Dr. Takashi Horiuchi inset on a long exposure of the Ishigakijima Astronomical Observatory, part of the National Astronomical Observatory of Japan. Credit: NAOJ

Dr. Horiuchi continued to explain that the light energy absorbed by the coating is then converted to heat. All objects with a measurable temperature radiate in the infrared. Since the DarkSat is warmed by its coating more than a typical Starlink satellite, it follows that DarkSat radiates more in the infrared. Essentially, when viewed in IR, DarkSat is *brighter* than a typical Starlink.

Is the higher brightness in the infrared portion of the spectrum something that will impact astronomical observations? Professor Masatoshi Ohishi, Head of the Spectrum Management Office at NAOJ and another author of the paper, commented, “The higher level of infrared flux would have a negative impact on infrared observations.” Ohishi continued to explain that this is not a surprise and was precisely what was expected of the coating.



A demonstration of the dark coating on the reflective antennae of DarkSat. Credit: SpaceX

It seems clear that the DarkSat solution to Starlink satellite streaking interfering with astronomical observation is flawed at best. The good news for the astronomical community is that SpaceX has already implemented a new solution, VisorSats, which deploy panels, not unlike the sun visors used to keep parked cars cool in the summer. Even with his paper still hot off the presses, Dr. Horiuchi assured me that an in-depth study of the new VisorSats was in the works for his observatory in 2021. “ I would like to continue these observations…we think it’s important to continue to discuss this with the astronomical community of ground-based observations.”

Another positive aspect of the situation is a growing rapport between SpaceX and the astronomical community. Professor Ohishi commented on meetings he has had with SpaceX and spoke on the importance of programs like Starlink. “I would like to stress that we respect the technical advancement developed by SpaceX. Their project aims to make internet connections much better for all of the people in the world; this is very important. At the same time, we have to collaborate with

space x on how to keep our environment as clean or as quiet as possible."

Dr. Horiuchi reflected on the importance of dark skies and preserving the night sky for astronomers and regular folks alike. "Dark skies are beautiful and are a treasure to all of the people around the world." Thankfully, with SpaceX's continued dedication to addressing light pollution issues with the ever-growing Starlink constellation and with the tireless work of brilliant astronomers like Dr. Horiuchi, it seems likely that the regions of Earth that are lucky enough to have clear dark skies will still enjoy cosmic vistas for a long time to come.

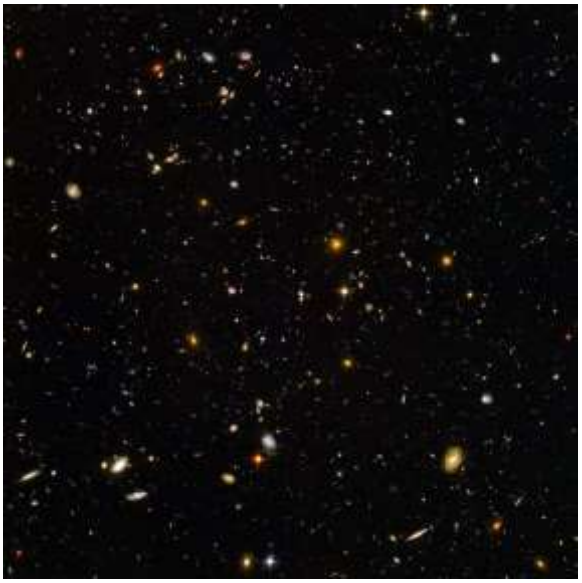
The Roman Space Telescope's Version of the Hubble Deep Field Will Cover a 100x Larger Area of the Sky

Remember the Hubble Deep Field? And its successor the Hubble Ultra Deep Field? We sure do here at Universe Today. How could we forget them?

Well, just as the Hubble Space Telescope has successors, so do two of its most famous images. And those successors will come from one of Hubble's successors, NASA's Roman Space Telescope.

The Hubble Deep Field and Ultra Deep Field showed a generation of people how expansive and wondrous the Universe is. They showed that even empty-looking patches of sky are, in fact, full of galaxies. All sizes, shapes, and ages of galaxies.

And the Roman Space Telescope—also called the Nancy Grace Roman Space Telescope—(and formerly called WFIRST), will trump those images with images of its own. And they could be equivalent to 100 Hubble Ultra-Deep Fields at once. Mind equals blown, as the kids say.



This is the original NASA release of the Hubble Ultra Deep Field. Among all the galaxies in the image are about 10,000 of the most distant galaxies. They're the smallest, reddest ones, and they existed not long after the Big Bang. Image Credit: By NASA and the European Space Agency. Edited by Noodle snacks – http://hubblesite.org/newscenter/archive/releases/2004/07/image/a/warn/, Public Domain, https://commons.wikimedia.org/w/index.php?curid=5276968

The Roman Space Telescope is scheduled to launch in 2025 on a five-year mission. It'll perform cutting-edge research into some of the compelling questions surrounding cosmology and exoplanets. To do that, it has some serious observing power.

Its primary mirror is 2.4 m (7 ft 10 in) in diameter, the same size as the Hubble's. But the Roman Telescope's first working name was WFIRST, which stands for Wide-Field Infrared Survey Telescope. The Wide-Field part of its name means it can image an area of the sky much wider than Hubble can. Up to 100 times wider or more.

Observing time with the Roman will be highly coveted. A large portion of that time will be taken up with wide surveys covering large swaths of the sky. But some of the time is up for grabs and will be made available to whoever puts together a great observing proposal. According to some in the astronomy community, a Roman Ultra Deep Field observation like the Hubble Ultra Deep Field should be a priority and could provide many benefits.

An illustration of how the Roman Ultra Deep Field would look compared to the Hubble's. Image Credit: NASA, ESA, and A. Koekemoer (STScI)
Acknowledgement: Digitized Sky Survey

Anton Koekemoer is a research astrophysicist with the Hubble Space Telescope at the Space Telescope Science Institute. He presented the idea for a Roman Ultra Deep Field at the 237th meeting of the American Astronomical Society. His idea currently has the support of astronomers from more than 30 institutions.

In a press release, Koekemoer spoke in favour of the project. "As a community science concept, there could be exciting science returns from ultra-deep field observations by Roman. We would like to engage the astronomical community to think about ways in which they could take advantage of Roman's capabilities," he said.

This is an image of the Andromeda galaxy. It's from one of the largest Hubble programs ever carried out, the Panchromatic Hubble Andromeda Treasury program. To get it, astronomers took 400 distinct pointings with Hubble (blue square) and connected them to build a wide-field mosaic. The image is now the gold standard for understanding the detailed makeup of galaxies like the Milky Way. The red outline shows the enormous footprint of Roman superimposed on this Hubble mosaic. It would take just two Roman pointings to cover the entire region explored by Hubble in this mosaic at the same depth and image clarity. Image Credit: NASA and STScI

Hubble used about one hundred hours of its highly-coveted observing time to gather its Ultra Deep Field. It would take about the same amount of time for the Roman Space Telescope to gather a similar image. But while Hubble's image contained thousands of galaxies, the Roman Telescope's would contain millions of them. Who can predict exactly what new science and discoveries would come from the effort?

In those millions of galaxies would be some of the oldest ones ever imaged. While the Hubble's deep image contained only a handful of those elusive targets, Roman's deep image could contain hundreds of them, possibly even thousands. That would be a huge boost to our study of the early Universe. It could allow astronomers to study how those ancient galaxies are grouped, how old they are, and how their stars formed.

This zoom-out video starts out with the Hubble Ultra Deep Field and zooms out to show the Roman Space Telescope's field of view.

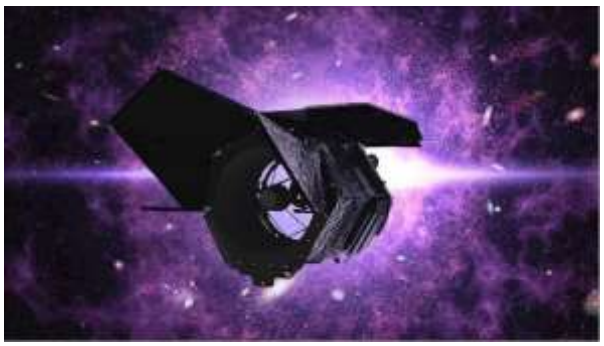
Not only that, but the Roman Telescope would work alongside other powerful telescopes, which can only provide another boost to our understanding.

"Roman would also yield powerful synergies with current and future telescopes on the ground and in space, including NASA's James Webb Space Telescope and others," said Koekemoer.

As telescopes become more and more powerful, they generate larger quantities of detailed data. But all of that data has to be handled properly, and there's simply too much of it for astronomers to manage by themselves. The Roman Space Telescope will generate an enormous amount of data, and scientists are developing ways to deal with it.

Most of that centers around machine learning and AI.

When another super-powerful telescope, the Vera C. Rubin Observatory, comes online sometime this year, it will generate an almost overwhelming amount of observational data. The scientific community has been preparing for that massive flow of data years in advance. The Rubin Observatory has specialized infrastructure to handle it all. Northwestern University even implemented a new program to educate up and coming young data scientists to deal with it.



An illustration of the Nancy Grace Roman Space Telescope. Image Credit: NASA

The Roman Space Telescope will rely on similar data-handling capabilities. It'll rely on machine learning to process the massive database it creates. When each image can contain information on millions of individual galaxies, we'll need elite computing power to help make sense of it all.

"The discovery potential enabled by the huge datasets from the Roman mission could lead to breakthroughs in our understanding of the universe, beyond what we might currently envision."

Anton Koekemoer, research astrophysicist, Hubble Space Telescope/Space Telescope Science Institute.

But of course, all that data isn't just a chore: it's an unprecedented opportunity. "You could explore completely new questions that you couldn't previously address," stated Koekemoer.

The flow of data will likely also generate some new questions that nobody anticipated. "The discovery potential enabled by the huge datasets from the Roman mission could lead to breakthroughs in our understanding of the universe, beyond what we might currently envision," Koekemoer added. "That could be Roman's lasting legacy for the scientific community: not only in answering the science questions we think we can address but also new questions that we have yet to think of."

The claims about the Roman's observing power may be actually understated. In effect, the Roman is like a combination of the Hubble Space Telescope and the Sloan Digital Sky Survey (SDSS). It can't do everything the Hubble does, particularly when it comes to UV observations. But for many of the observing programs it will undertake, the Roman is literally hundreds of times more powerful than the Hubble. And it's massive field of view puts it in league with the SDSS.

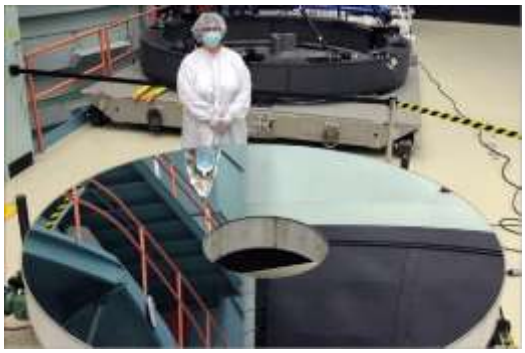
The synergy with other observatories can't really be overstated, either. Some very rare galaxies will be contained in the Roman's massive datasets. Once they're identified, they can be examined more closely with the James Webb Space Telescope and its powerful spectroscopy and IR capabilities.

The Roman Space Telescope will also test some of our most powerful and detailed simulations of the Universe. Astronomers and cosmologists have used supercomputers to create simulations of the Universe unfolding over time. Those data-based simulations show that between about 800 million and 1 billion years after the Big Bang, galaxies had started to group up as dark matter exerted its influence on them. That's when the large scale structure of the Universe started to take shape. The Roman will be able to look at large numbers of galaxies from that time and compare them to simulations.

The study of star formation is a research area that the Roman should be able to shed some light on, too. Cosmologists talk about the "Cosmic Dawn" and the "Cosmic Noon," which covers a span of time between about 500 million years and 3 billion years after the Big Bang. During that span, stars were being born at a ferocious pace, much faster than in our current time. Scientists also think that supermassive black holes (SMBHs) were most active during that time.

According to Sangeeta Malhotra of NASA Goddard Space Flight Center, who is also co-investigator on the Roman science investigation teams, Roman's wide field of view will be a huge boost to studying these eras.

"Because Roman's field of view is so large, it will be game changing. We would be able to sample not just one environment in a narrow field of view, but instead a variety of environments captured by Roman's wide-eyed view. This will give us a better sense of where and when star formation was happening." Malhotra said.



The Roman's primary mirror is made by the L3Harris company. In this image, Bonnie Patterson of L3Harris stands with the completed primary mirror for the Nancy Grace Roman Space Telescope (photo credit: L3Harris)

Rates of star formation in different regions hold lots of information for astronomers, and this is another area that the Roman will excel in. "Population experts might ask, what differences are there between people who live in big cities, versus those in suburbia, or rural areas? Similarly, as astronomers we can ask, do the most active star-forming galaxies live in very clustered regions, or just at the edges of clusters, or do they live in isolation?" Malhotra said.

The Roman Space Telescope will also boost exoplanet research. Its powerful coronagraph will allow it to image giant exoplanets and give us some unprecedented high-resolution views of them. It'll be able to examine protoplanetary disks in the same way and will help us understand if there are other Solar Systems like ours and how common or rare they are.

The Roman will join the JWST as our premier space telescopes. It's also part of a whole group of telescopes and observatories coming online in the next few years that together promise to advance astronomy in ways we can't be sure of yet. This group includes the Giant Magellan Telescope, the Thirty Meter Telescope, the European Extremely Large Telescope, and others.

The Roman Space Telescope is set to advance our understanding of the Universe along a lot of detailed, reasearch-driven pathways. That's important and exciting. But for many people, it's the Ultra Deep Field images that may be the most compelling. Images like that can become part of our social narrative, and can affect the way even non-scientists think of Earth, humanity, and the Universe. Just look at the effect that the Hubble images have had on an entire generation of people.

In some ways, these deep, wide images of the cosmos may be more important than all the purely scientific advances.

The Nancy Grace Roman Space Telescope is scheduled to launch sometime in 2025 if all goes well. After launch, it'll be placed into a halo orbit at the Sun-Earth L2 point. It'll spend five years there, maybe more, observing in both optical and near-infrared.

Size of Andromeda Galaxy Reassessed.

Our Milky Way and the Andromeda galaxy—two giant galaxies in our local patch of the universe—are heading for an immense collision with each other in only a few billion years' time. So which will dominate in this intergalactic tussle?

Our recent work has turned up an interesting result on measuring the mass of the Andromeda galaxy, which at a distance of only 2 million light years is our cosmic next-door neighbour.

Both Andromeda and the Milky Way appear to have about the same total mass, about 800 billion times that of our sun, suggesting that the result of this intergalactic gravitational battle may actually be a tie.

Big brother, little brother?

The Andromeda and the Milky Way galaxies are very similar, giant spirals containing hundreds of billions of individual stars. But astronomers have struggled to work out which of these two galaxies is the most massive.

And knowing the masses of the two giant galaxies will help to reveal the details of our ultimate fate.

The answer to this question is vitally important if we are to understand the dynamic history of all nearby galaxies, both large and small, as the gravitational field of the most massive will command the action.

Until now, astronomers have been unable to pin down the galactic masses, with a lack of data and complex calculations yielding very uncertain answers.

At times it seemed that our own Milky Way was more massive; at others it appeared that Andromeda was the local Goliath.

In our Milky Way, where we can get the best observational data, there has been a growing consensus among astronomers as to its mass. For Andromeda, where observations are more difficult, astronomers have still struggled to measure an accurate mass.

Our new work takes a new approach to measuring the mass of the Andromeda galaxy.

How to measure a galaxy?

Simply counting the number of stars in any galaxy, and adding their individual masses, won't give you its total mass. Not even close. The mass of a galaxy is dominated by its dark side, an immense amount of matter that is unseen by telescopes.

The light side of a galaxy, the glowing stars and gas that we can see, accounts for only a couple of tens of percent of the total mass. The rest, the significant majority, is this elusive dark matter that dominates all of the mass in the universe.

But it is the gravitational pull of this dark matter that holds the stars in their orbits, meaning we can measure its presence.

American astronomer Vera Rubin figured out more than half a century ago that there is much more to the Andromeda galaxy than simply the stars we can see.

As dark matter holds stars in their orbits, we can use their motions to measure the overall mass of the Andromeda galaxy, including the unseen dark matter. This is what we did in our new work, but with a twist.

The key concept is escape velocity, or how fast you have to be moving to break free from the gravitational pull of a massive object.

We figured that if we can trace out the escape velocity for stars within the massive gravitational halo of Andromeda, we can work out its gravitational pull, and the mass that is ultimately responsible.

While the calculation was complicated, the result was unequivocal: previous estimates had overstated the total mass of Andromeda. It and the Milky Way are equals in the local universe.

Geraint Lewis, is professor of astrophysics at the University of Sydney. Prajwal Kafle is a postdoctoral research associate at the University of Western Australia.

E Mails Viewings Logs and Images from Members.

Viewing Log for 21st of January

Now that we are back in Lockdown 1.3 viewing at my usual place of Uffcott is not possible? In the front garden I have a street light right beside the drive entrance BUT it has not been working for a while and as the sky was clear, I thought I would try from there. I also have another two street lights a bit further away, so doing deep sky objects might be a real challenge if not impossible to view? Also there was an 8.64 day old lit Moon or 59.2 % phase, so I had another light source to deal with!

Setting up the Meade LX 90 GOTO telescope was rather easy this time, all I had to do is carry the bits out to the front garden and set the telescope up instead of loading the car and going from there. Everything was ready by 20:38 with a temperature of 2.4 °C and no wind I should have no trouble with the weather?

As usual I would be using my Pentax XW 14 mm eye piece giving a magnification of around 143? First object was Mars, this time the planet was in the field of view of the eye piece (it is quite normal for some reason the planet I wish to view is not in the eye piece but visible in the finder scope?), I could make out some marking on the planet? On to Uranus, this planet was not in the eye piece but I could make it out in the finder scope, so some movement and I could bag the seventh planet from the Sun, as usual all I could make out was the colour of the planet and nothing else, Neptune was now too low to view from my house?

What to look at tonight, I could do the usual Messier (M) objects but for a change I thought I would follow the observing list from the WAS magazine managed by Chris and Jon. I started with the November list (in Taurus) and M 45, the Pleiades or Seven Sisters to name a few, this open cluster (O C) has been called. Looking thru the eye piece I was actually looking thru this O C, best seen with the finder scope as it is quite a large object in the sky? Nice and bright was the view with the finder scope. Next was M 1, the only Supernova object of this famous list, I could just make it out, very dim indeed? As for NGC 1514, a planetary nebula (P N) no way, so I knew I could not see items with a magnitude of around 11? So I went to the December list (Gemini) and M 35, this is a large and loose O C to look at. NGC 2158, a small O C which looked fairly loose? NGC 2392 aka Caldwell (C) 39, aka the Eskimo nebula is a small P N which had a bright centre. NGC 2420 is a small and faint O C. Not far away is NGC 2129, another O C which is small and loose but has three fairly bright stars within the cluster? As for NGC 2266, could not make out at all! Onto January's list (Auriga) and the three O C's that Messier added to his list and M 36, a large and loose O C. While viewing this O C a dim satellite went thru my field of view, I waited for a while to see if another went thru but none did so I guess it was not any Starlink satellites? M 37, probably the best of the three (in my view) is a large and dense O C. Finally we have M 38, a large and loose O C which has three arms of stars within it? It is not often I look at the I C list of objects but I C 405 called for a visit, it is aka C 31, this diffused nebula was a point of light for me, as for IC 410, no way could I make it out? Onto Astronomy Now magazine list for January and hunting down nebulae. NGC 2359 in Canis Major was the first object aka Thor's Helmet, I could not make it out at all probably too low in the sky at that time and I also had to deal with street lights in the area? NGC 2440 was not better for me, this P N was hiding behind a house! Same answer for NGC 1977 as Thor's Helmet could not see it at all! NGC 1788 was washed out. Gave up doing the rest of the list, so I thought I would try brighter objects, even the star Sirius (brightest in the night sky) failed as street light was coming into the dew shield area of the telescope. This meant I had to view higher in the sky? Started with M 46 an often overlooked O C for me? This O C was large, loose and dim to look at, M 47 (right next door) was a large and sparse O C to look at. M 50 is a medium sized O C to look at and was also fairly sparse. On to an old favourite and M 42, even with street light and a half phased Moon it was still good to look at, for a changed I tried a UHC filter on the nebula. The four stars that make up the trapezium in the centre were dimmer but the nebula cloud was clearer? Left the UHC in for M 78, but as usual I could only make out the two main stars of this emission nebula? The Flame nebula (NGC 2024) at the eastern end of the belt stars in Orion was a faint blob to look at? What next if I would be viewing from my front garden for the next few months? Quick look at Cancer and I could make out M 67, this O C was sparse and dim to look at.

Around 23:00 and a temperature of 1.3 °C I had a power failure with the telescope. I knocked the power supply cable near the connection point on the control panel been out for the best part of two and a half hours so I called it a night. Plus points for viewing at home: you can go inside for a hot drink or a toilet break if you need one, setting up and taking down the equipment is just one job to do. Minus points: night glow and street lights are against you and normally there is more traffic around the place?

Hope Lockdown 1.3 is lifted soon as I would like to get out to a dark sky area soon?

Peter Chappell

PS. About a week after doing the viewing session I noticed a van fixing the street light in the front garden, it seems like a neighbour had put a report in about the light not working. Bastard!

As I had a lot of free time last week I thought I would go thru all of my filters and eye pieces and give the glass a good clean. Most of the glass on the eye pieces had a film of muck over them which would not help my general viewing? About 90 minutes later all of the filters and eye pieces have been cleaned so hopefully the next time I go

out I might see a bit more? Will report back in my next viewing log which will probably be from the back garden instead?
Peter Chappell

Hi Andy,
I hope you are well.
Here are my submissions for the WAS February 2021 Newsletter.
21/01/2021
Orion and Orion Star Trail

Orion -

Canon G16 (Star Mode), 28mm, ISO 800, F1.8, 15 sec

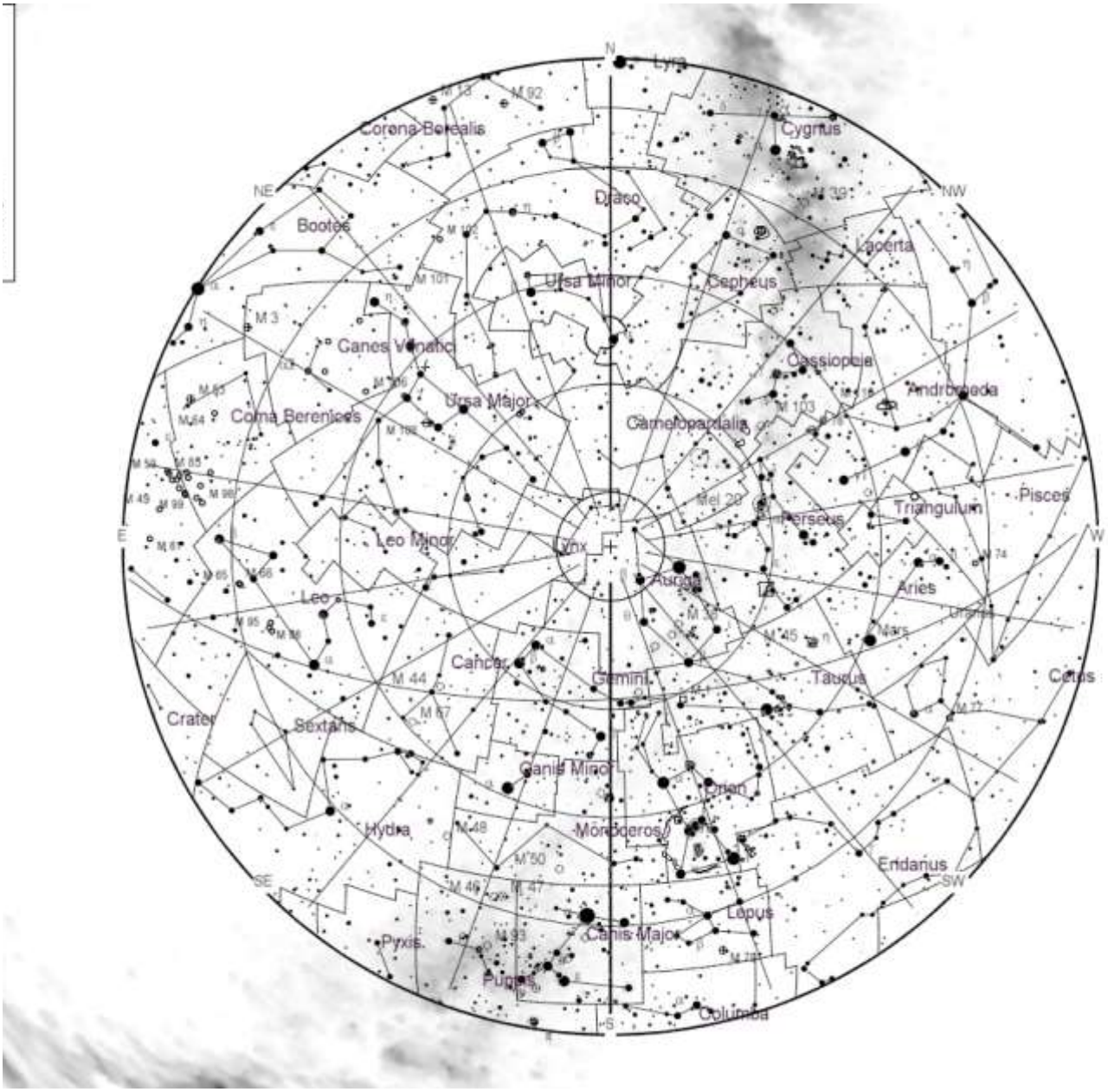
Orion Star Trail – 120 exposures - Canon G16 (Star Trail Mode), 28mm, ISO 400, F1.8, 30 sec

Post processed in Affinity Photo.
23/01/2021
77% Waxing Gibbous Moon

Also visible the clair-obscur effect of the Jewelled Handle as the peaks of the Montes Jura semi-circular mountain range catch the Sun's light at the terminator.

Canon SX50HS 1200mm, ISO 80, F8, 1/125 sec 100 raw images converted to tiff in Canon DPP, cropped and centred in Pipp, stacked in Autostakkert, wavelet in Registax 6 and post processed in Affinity Photo.
Clear Skies,
John Dartnell

WHATS UP, FEBRUARY 2021



February 6th Saturn 0.4 degrees north of **Venus**

February 10th Jupiter 4degrees north of **Moon**

February 11 - **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 19:08 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

February 11 Jupiter 0.4 degrees north of **Venus**

February 12 Mercury joins **Venus** and **Jupiter**

February 18 Mars 4.5degrees above the **Moon**

February 27 - **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 08:19 UTC. This full moon was known by early Native American tribes as the Snow Moon because the heaviest snows usually fell during this time of the year. Since hunting is difficult, this moon has also been known by some tribes as the Hunger Moon, since the harsh weather made hunting difficult.

Binocular users should enjoy the Pleiades and Beehive clusters through the evening.

Observing Notes - February 2021

The Winter Hexagon

While the winter started back in December 2020, February is probably the coldest part of the year and if it's going to snow at all in my part of Wiltshire (Chippenham) it will most likely snow during this month.

As I get older, I dislike the cold even more. Having no permanent observatory, I hate having to strip down my kit at the end of a really frosty observing session when the metal work is so cold your gloves stick to it. The pathway to and from my observing position in the garden is also fraught with dangers such a slippery decking, steps, a small low tree, a number of very thorny rose bushes and even a pond to fall in to (been close a couple of times).

A result of this means that this month, I often restrict myself to binocular viewing only and capturing the very few (if the last month is anything to go by) clear nights we get between the bright moon, to view objects. It also means being able to pop in and out during the night to warm up.

I have only two pairs of binoculars, a pair of 10x50's which are the largest pair I can hand hold for a time before my arms give up on me.

My other pair are 16x80's which I have no hope of holding for more than a few seconds and still struggle to keep the view stead. To ease my observing with these, I have an Orion Paragon support on to which I can mount them which enables me to point them in any direction and keeps them still enough to make out some of the fainter objects.

I also have a good quality reclining garden chair which enables me to use the smaller binoculars comfortably (almost) horizontal and at the same time keeping my feet off the cold frosty ground. I have even been known to take an old blanket out with me to really spoil myself.

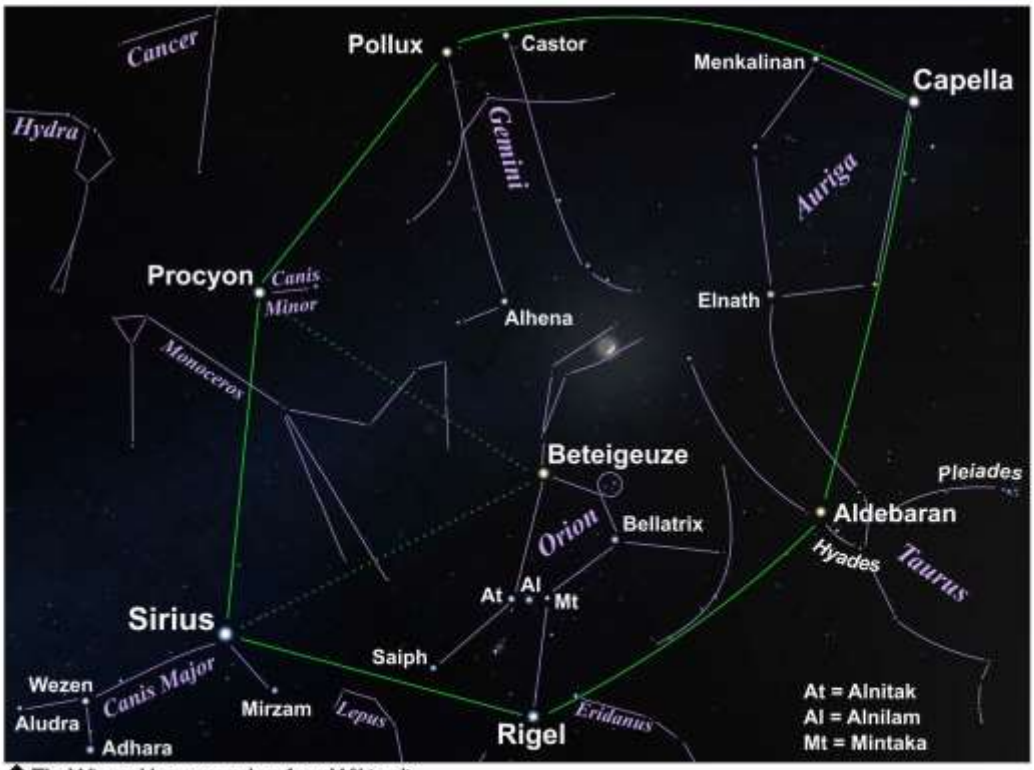
This month most of the planets are past their recent best so we are somewhat limited in our observing to star formations and what is referred to as deep sky objects.

In this observing session, we will be looking at binocular and smaller telescope objects in an area of sky sometimes referred to as the Winter Hexagon (or Circle).

What and Where is the Winter Hexagon?

The Winter Hexagon contains of some of the brightest stars in the Northern hemisphere's winter sky and is what we refer to as an asterism, or prominent group of stars that form a pattern and often has a separate name as it does here.

The Hexagon lies due south at 20:00 in mid-February and to located it, first find the easily recognisable constellation of Orion which is



▲ The Winter Hexagon : taken from Wikipedia

identified by the three stars in it belt. Now look for the bright bluish star at lower right. This is the star Rigel and marks the southwest corner of the Winter hexagon and the first of the six first magnitude stars.

Rigel is the brightest star in Orion and the seventh brightest star in the night sky but is designate β (beta) suggesting it is the second star of Orion. However, it often outshines its bright orange neighbour Betelgeuse (α Orionis) as we saw last year when there was a lot of talk about it going supernova. Alas, this did not happen, and Betelgeuse has settled down a bit.

If we follow a line along the stars of Orion's Belt and extend it upward to find Aldebaran, the ruddy eye in the constellation Taurus the Bull. Aldebaran is as first magnitude star, the second star in the Hexagon, the brightest star in Taurus and fourteenth brightest star in the sky.

We discussed the constellation of Taurus in our November Observation Notes where we found the Hyades and the Pleiades open clusters so worth taking another look.

As we continue upward in an anti-clockwise direction, we find the next first magnitude star, Capella, the brightest star in the constellation of Auriga. This star marks the northernmost point of the Winter Hexagon and is the sixth brightest star in the heavens. There are a few deep sky objects to be found in Auriga, and again these can be found in last month's January observing notes should you want to catch a few this time around.

As we continue in the anti-clockwise direction and start to come back down the hexagon, we come across into two bright stars marking the heads of the twins in the constellation of Gemini. For the hexagon the star Pollux, forms the fourth corner in the hexagon, being slightly brighter than its "twin," Castor and is the sky's 17th brightest star (and Castor is 24th). Objects to see in constellation of Gemini were discussed in our December 2020 observing notes.

Our penultimate stop around the Winter Hexagon is the bright star below the twins, Procyon. Another first magnitude star, Procyon is the brightest in the constellation of Canis Minor, and one of only two named stars in the constellation. Although a relatively minor constellation, Procyon is the seventh brightest star in the sky.

We come down to the final and southernmost star and completing the Winter Hexagon. Sirius is the brightest star not only in the Winter Hexagon but also in the entire night sky (not forgetting the sun isn't in the night sky of course). Only the moon and some planets can outshine Sirius.

To find the Winter Triangle, take the last two stars, Sirius in Canis Major and Procyon in Canis Minor, then head toward the centre of the Hexagon to find reddish Betelgeuse, shoulder star in Orion, to make the third corner of the triangle. Betelgeuse is the 10th brightest star in the sky and second brightest star in Orion.

A number of deep sky objects can be found inside the Winter Hexagon including nebulae, such as the Orion and Rosette Nebulae, and star clusters such as the interestingly named Salt and Pepper cluster as well as M38, the Starfish cluster.

The Hexagon's Deep Sky Objects

The Winter Hexagon contains many of the season's finest deep-sky targets including the Orion Nebula while a will reveal M36, M37, and M38; the lovely trio of Messier open clusters nestled within Auriga's pentagon.

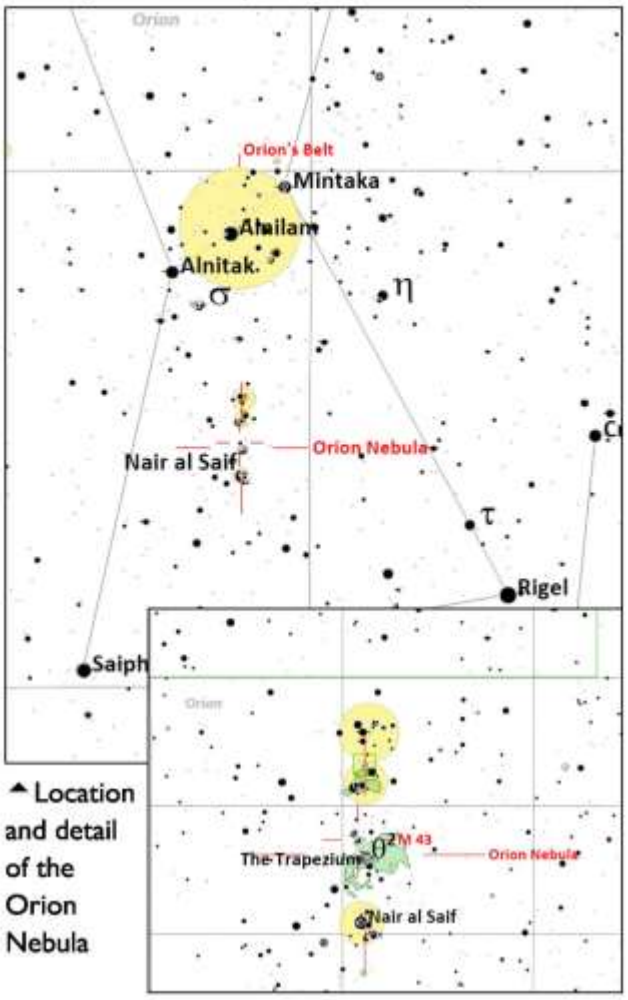
The Orion Molecular Cloud Complex

The Orion Molecular Cloud Complex is a large group of bright nebulae, dark clouds, and young stars located in the constellation of Orion around 1500 or so light-years away, and spreads hundreds of light-years across.

Several parts of the nebula can be observed through binoculars and small telescopes, with some parts even visible to the naked eye.

The Great Orion Nebula

M42, the Great Nebula, and the middle star in Orion's sword is probably the biggest and best treat in the night sky. When I saw this bright fuzzy blob in my first pair of binoculars I was overwhelmed with excitement. I remember just standing there under what was the most



▲ Location and detail of the Orion Nebula

beautifully dark skies that spread out overlooking south Wiltshire. Initially I could see blueish cloud but the longer I stared the more I saw. Even in relatively modern town skies it's possible to tease out some of the brighter nebulas.

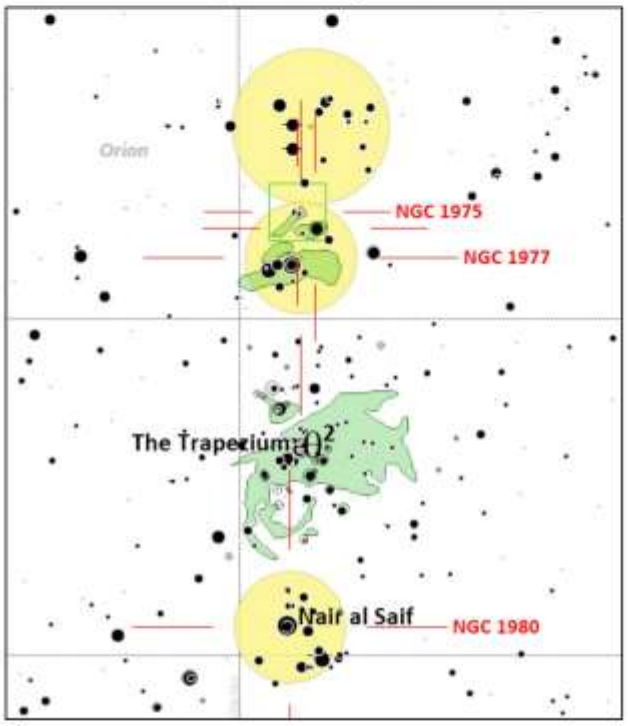
De Mairan's Nebula

Messier 43 (M43), also known as De Mairan's Nebula, is a star-forming region located in the constellation Orion. M43 has an apparent magnitude of 9.0. In 10×50 binoculars, the nebula appears like an elongated patch with a bright centre and the central star can easily be seen. The dark lane that separates M43 from M42 is revealed in small telescopes.

M42 and the connected M43 benefit greatly from mounted binoculars. Even in small binoculars, the detail becomes more apparent, especially if you use averted vision. Give it time: the longer you look, the more you see of the nebulosity and the cluster of stars whose light it reflects. Larger binoculars with higher magnification should be able to make out the Trapezium (θ Orionis) into separate stars.

Orion's Star Clusters

Binoculars will show also that the other two "stars" of the sword are clusters. The northern one still has some reflection nebulosity (NGC 1973, 1975, & 1977) that may hint of its presence on dark, transparent nights, while the older southern cluster (NGC 1980) has none at all.

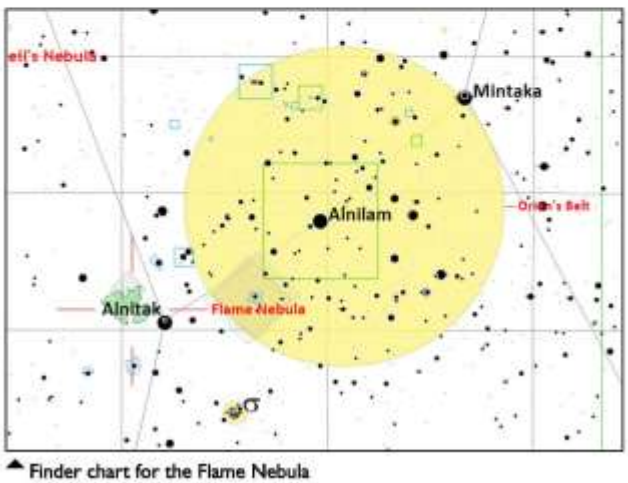


▲ NGCs 1975, 1977 and 1980

The Flame Nebula (NGC 2024)

The Flame Nebula needs very dark skies, low magnification and larger aperture binoculars to see it well if at all so this is this months challenge.

Using a 6-inch reflector and making sure you

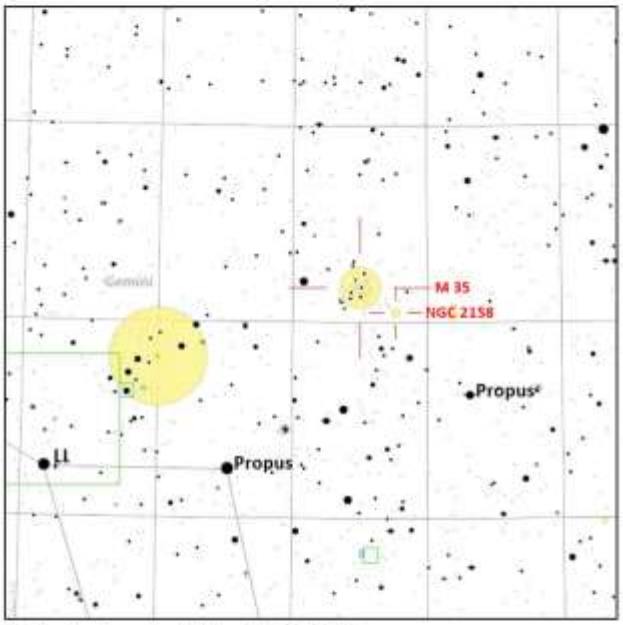


▲ Finder chart for the Flame Nebula

keep nearby star, Alnitak out of the field of view as this will improve contrast. You should then be able to see its mottled fan shape. As a bonus, the reflection nebula NGC 2023 lies nearby.

The Gemini Clusters

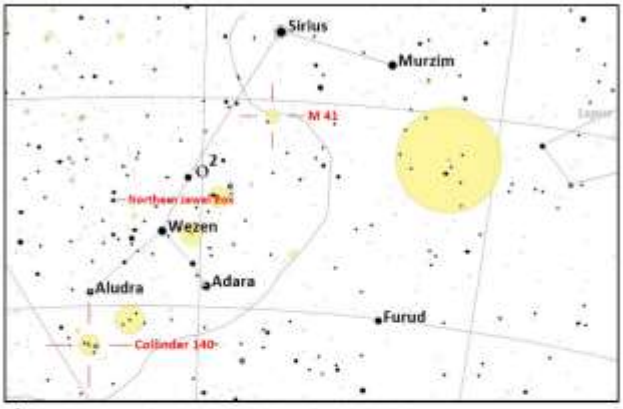
Among the many deep-sky objects worth looking for in the Hexagon, M35 has to be on your target list. This fifth magnitude and naked eye (in good seeing) object is easy to find, located just above the westernmost foot of the Twins.



▲ Finder chart for M35 and MGC 2158

Tripod-mounted 10×50 binoculars are steady and powerful enough to show a few individual stars in the cluster but comes into its own in a telescope, which has the ability to resolve many

▲ M35 in Gemini



▲ Finder chart for M41 & Collinder (Cr) 140

more. The cluster is reasonably close and so presents a large apparent diameter of some 28 arc minutes - almost exactly the same as that of the full Moon!

If you're up for another bit of a challenge, see if you can spot M35's neighbour, the 8.6-magnitude cluster NGC 2158. It's a tough spot in binoculars, but a small scope in dark skies can bring this open cluster alive.

The Big Dog Clusters

Use Sirius for the starting point for the bright open cluster, M41 which is located just 4° south of the star. In normal magnification binoculars you

▲ M41 in Can is Major

should see both Sirius and M41 in the same field of view and an easy find for this 4.5-magnitude open cluster. The cluster is a great sight and its brightest members even show up under the glow

of suburban light pollution. Better conditions will reveal a smattering of stars.

M41 is the only Messier object in the constellation but south of the rear legs of the Big Dog are a nice pair of open clusters with the Collinder catalogue identifiers.

Aim at 2.4-magnitude Eta (η) Canis Majoris then move the star to the northeast edge of the field and the clusters should come into view from the bottom right. Cr132 is the most open with 10 or so stars easily resolved even in small binoculars and could overlook it if you didn't know it was there.

Nearby Cr140 is more attractive even in smaller binoculars with the brighter stars arranged in the shape of the Greek letter Lambda (λ) shape and worth a peak.

Solar System Objects

The February night skies are relatively quite for objects to see solar system-wise.

There are no significant meteor shows this month.

The Moon is waning and is at last quarter on the 4th and New on the 11th of the month, so viewing deep sky objects is best around the earlier month. The rising lunar 'X' & 'V' will be visible at 08:00 on Saturday 19th February but will be quite a challenge to see as the sun rises.

Also around the 18th and 19th, the Moon and Mars will be a mere 3.5 degrees apart and observable through binoculars.

Mercury is poorly placed in the night sky, retuning as a morning planet after the 9th, where it will still be difficult to see but will be close to Jupiter and Saturn for a time.

Venus is poorly placed in the night sky this month but will be half a degree from Jupiter on the 11th.

Mars is still observable in the Western skies but getting dimmer as it gets smaller throughout this month. It will be 3 degrees from the Pleiades at the end of the month.

Jupiter and Saturn and Mercury rise together one hour before the sun in the morning skies at the end of the month.

Uranus sits close to Mars but is losing height by the day in the Western skies. Worth looking for it near the crescent moon on the 17th February. Neptune is in the evening twilight and becomes unobservable at the end of this month.

Something Else To Do In February - Star Count 2021

Don't forget this year's Star Count is between the 6th and 14th of this month.

It's an opportunity to help identify where best to enjoy dark skies. By adding to a nationwide map of where light pollution is most serious, CPRE can work with local councils and others to decide what to do to improve it.

Go to the following link to find out more and join in the fun, even under lockdown!

https://www.cpre.org.uk/what-we-care-about/nature-and-landscapes/dark-skies/star-count-2021/

Let's hope the weather improves this month and we are out of lockdown soon.

Happy observing

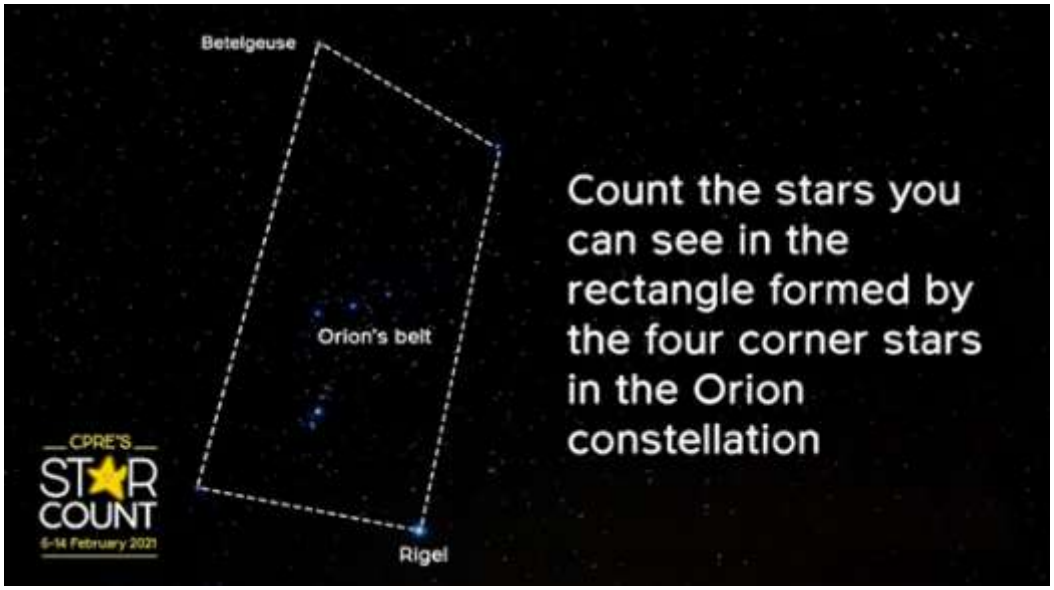
Chris Brooks
Jonathan Gale
WAS Observing Team

Look to the skies and count what you can see as part of our annual Star Count *Abigail Oliver / CPRE*

Each year, CPRE asks the nation to help measure light pollution in their area by getting starry-eyed with us and counting visible stars. Ready to help out and have fun?

We think that dark and starry skies are a special part of our countryside. Nothing beats looking upwards to see velvety blackness, with twinkling constellations as far as the eye can see.

Our buildings and streetlights emit light, though, and this can affect our view of truly dark skies. We want to make sure that we can all enjoy starlit nights, and we need your help in measuring what effect light is having on our views of the galaxy.



What is Star Count?

The best way to see how many stars we can all see in the sky is… to count them! So we're asking people from all across the country to become citizen scientists and look heavenwards from home for one night. Join in by choosing a clear night between 6-14 February 2021, looking up at the constellation of Orion and letting us know how many stars you can spot.

This year we're asking everyone to take part from home. You can stargaze from your garden, balcony, doorstep or even bedroom window.

Don't worry: we'll give plenty of support on how to do this. Once you've done your star-spotting, we'll share a form with you where you can quickly and easily send us your count – and then we get busy with our number-crunching.

Your results from Star Count will help us make a map of where star-spotters are enjoying deep, dark skies. By showing on a map where light pollution is most serious, we can work with local councils and others to decide what to do about it. You can see the 2020 results, and the map of what we discovered, here.

Star Count is supported by the British Astronomical Association.

How to take part in Star Count

Here are our top tips for a brilliant Star Count evening:

Make a note of the dates, 6-14 February 2021, and keep an eye on the weather forecasts as the week approaches. Remember: safety and health are the most important things, so stay at home for your star counting this year.

Try to pick a clear night for your count, with no haze or clouds, then wait until after 7pm so that the sky is really dark. Turn off all the lights in your house, too, to make it easier to see the stars.

Looking south into the night sky, find the Orion constellation, with its four corners and 'belt'.

Take a few moments to let your eyes adjust, then count the number of stars you can see within the rectangle formed by the four corner stars. You can count the three stars in the middle – the belt – but not the corner stars.

Make a note of the number of stars seen with the naked eye (not with telescopes or binoculars) and then submit your count on our website.

Share your experiences (and any photos) with others on social media using #StarCount

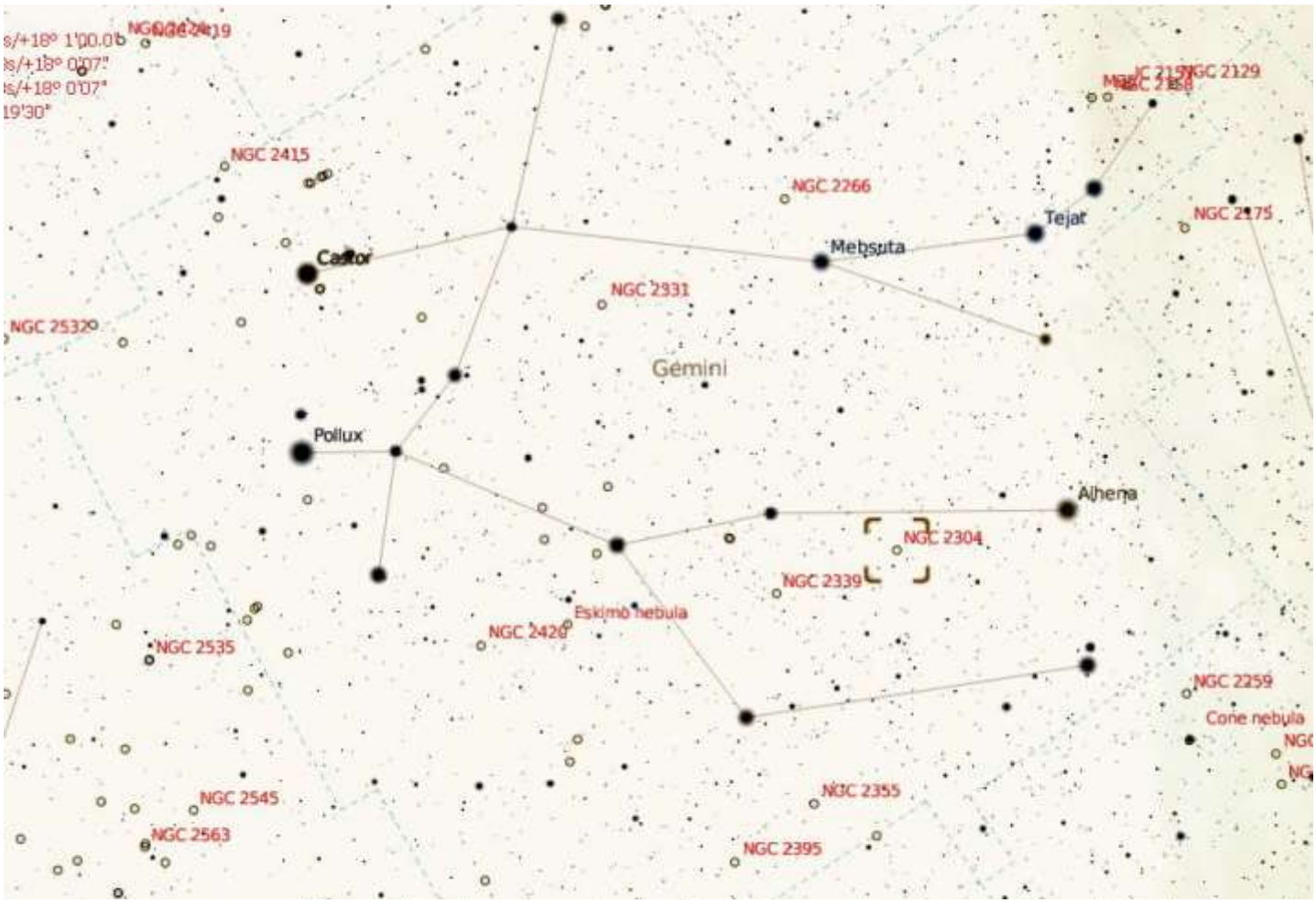
And don't forget to check back here to see the national results and how your area compares to the rest of the country.

Get ready to count!

Remember, you can do your 2021 Star Count on any night between 6-14 February. Pop the dates in your diary now!

Sign up now to be kept informed and for more information about the 2021 Star Count, including top tips for the best times to see Orion and more information about why we care so much about our magical dark sky views.

CONSTELLATIONS OF THE MONTH: GEMINI



In mythology, Gemini is associated with the myth of Castor and Polydeuces. The two brothers Castor and Pollux were twins, of course and no one could tell them apart. According to legend, they joined Jason's expedition aboard the Argo to the Black Sea in search of the Golden Fleece. When the Argo stopped at the entrance to the King Amycus' realm, the king challenged them to a boxing match – mainly because no one ever survived. The brothers were known to be fit and ready, so Pollux was the first Argonaut to take on the challenge. As soon as he got a clear shot, Pollux drove his fist into Amycus' temple, crushing his skull and ended the battle. However, the tale ends rather sadly. Their final adventure took them to lands of Arcadia with two cousins (ex-Argonauts) to raid cattle. When their ill-gotten booty was divided, the cousins took the loot and ran. Of course, Castor and Pollux followed, taking a shortcut to wait. Unfortunately, a cousin discovered Castor first shot him. When Pollux avenged his brother, the other cousin knocked him unconscious with a rock and went in for the kill. Luckily, Zeus was watching and ended the ordeal with a thunderbolt. When Pollux regained consciousness and realized Castor was join, he begged Zeus to remove his immortality. Zeus granted his wish and placed the twins in the sky to remind us of all of brotherly love.

Gemini is a constellation of the zodiac, positioned on the ecliptic plane between Taurus to the west and Cancer to the east. Only its Alpha and Beta stars – Castor and Pollux – are easy to recognize. They represent the "Twins". Gemini is one of the original 48 constellations charted by Ptolemy and has endured to become a part of the 88 modern constellations recognized by the International Astronomical Union. It covers approximately 54 square degrees of sky and contains 17 main stars in the asterism, with 80 stars possessing Bayer/Flamsteed designations. Gemini is bordered by the constellations of Lynx, Auriga, Taurus, Orion, Monoceros, Canis Minor and Cancer. It can be viewed by all observers located at latitudes between +90° and ? 60° and is best seen at culmination during the month of February.

There are two annual meteor showers associated with the constellation of Gemini. The first peaks on or around the date of March 22, and are referred to as the March Geminids. This meteor shower was first discovered in 1973 and then confirmed in 1975. The average fall rate is generally about 40 per

hour, but the meteoroid stream is unstudied and it may vary. These appear to be very slow meteors, entering our atmosphere unhurriedly and leaving lasting trails.

The second meteor shower associated with Gemini are the Geminids themselves, which peak on or near the date of December 14th, with activity beginning up to two weeks prior and last several days beyond the date. The Geminids are one of the most hauntingly beautiful and mysterious displays of celestial fireworks all year – first noted in 1862 by Robert P. Greg in England, and B. V. Marsh and Prof. Alex C. Twining of the United States in independent studies. The annual appearance of the Geminid stream was weak initially, producing no more than a few per hour, but it has grown in intensity during the last century and a half. By 1877, astronomers had realized

this was a new annual shower – producing about 14 meteors per hour. At the turn of the last century, the rate had increased to over 20; and by the 1930s, up to 70 per hour. Only ten years ago observers recorded an outstanding 110 per hour during a moonless night…
So why are the Geminids such a mystery? Most meteor showers are historic – documented and recorded for hundreds of years – and we know them as originating with cometary debris. But when astronomers began looking for the Geminids' parent comet, they found none. It wasn't until October 11, 1983 that Simon Green and John K. Davies, using data from NASA's Infrared Astronomical Satellite, detected an object (confirmed the next night by Charles Kowal) that matched the orbit of the Geminid meteoroid stream. But this was no comet, it was an asteroid – in fact, a 14th magnitude asteroid which is passing Earth tonight from a distance of less than 18 million kilometres! Now considered a Potential Hazardous Asteroid (PHA), 3200 Phaeton comes within 3.2 million kilometres of Earth's orbit about every 17 months. Originally designated as 1983 TB, but later renamed 3200 Phaethon, this apparently rocky solar system member has a highly elliptical orbit that places it within 0.15 AU of the Sun during every solar system tour. But asteroids can't fragment like a comet – or can they? The original hypothesis was that since Phaethon's orbit passes through the asteroid belt, it may have collided with one or more asteroids, creating rocky debris. This sounded good, but the more we studied the more we realized the meteoroid "path" occurred when Phaethon neared the Sun. So now our asteroid is behaving like a comet, yet it doesn't develop a tail.
So what exactly is this "thing?" Well, we do know that 5.1 kilometre diameter Phaethon orbits like a comet, yet has the spectral signature of an asteroid. By studying photographs of the meteor showers, scientists have determined that the meteors are denser than cometary material, yet not as dense as asteroid fragments. This leads them to believe Phaethon is probably an extinct comet which has gathered a thick layer of interplanetary dust during its travels, yet retains the ice-like nucleus. Until we are able to take physical samples of this "mystery," we may never fully understand what Phaethon is, but we can fully appreciate the annual display it produces!
Thanks to the wide path of the stream, folks the world over get an opportunity to enjoy the show of the Geminids. The traditional peak time is the night of the 13th into the morning of the 14th of December – as soon as the constellation of Gemini appears, around mid-evening. The radiant for the shower is near the bright star Castor, but meteors can originate from many points in the sky. From around 2 AM tonight until dawn (when our local sky window is aimed directly into the stream) it is possible to see about one "shooting star" every 30 seconds. The most successful of observing nights are ones where you are comfortable, so be sure to use a reclining chair or pad on the ground while looking up… And dress warmly! Please get away from light sources when possible – it will triple the amount of meteors you see.

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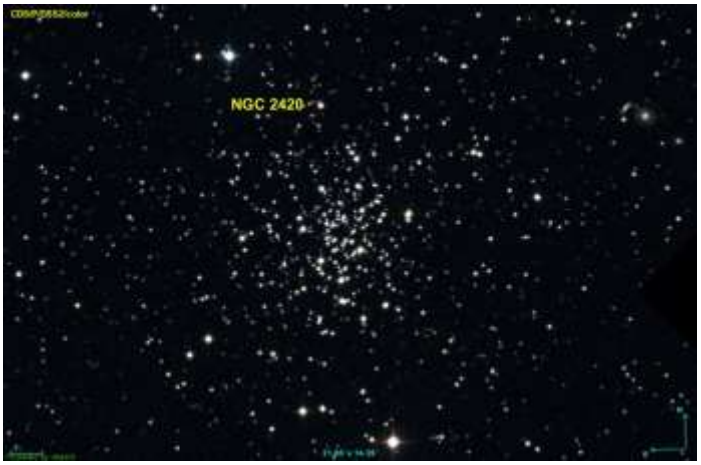
For binocular observers, Gemini has a wealth of treasures. But to find things, you've got to know your way around! Let's start first with Alpha Geminorum – the "a" symbol on our map. This is Castor. Although it might look like just a single star in binoculars, it's really quite an outstanding triple star system in a telescope. Here you will find two similar magnitude stars separated by just a few seconds of arc – and both of these stars are binary stars, too! The faint, distant orange star, Castor C, is also double star, consisting of nearly identical, low-mass M stars – red dwarfs – and either one, or both of these are flare stars. Pretty remarkable, huh?
Now, go look at brighter Beta Geminorum, the "B" symbol on our map. Pollux is the 17th brightest star in the sky, and this orange giant star is unusual, too. Here we have an X-ray emitter. Pollux has a hot, outer, magnetically supported corona perhaps similar to that surrounding our Sun. But that's not all. Beta Geminorum has an orbiting planet! That's right. A planet that's nearly 3 times the size of Jupiter and orbits its sun about the same distance as Mars orbits ours. So, if we were there, how big would orange giant Pollux look in the sky? Try almost 6 times larger, and belting out 16 times more radiation. Sunblock 6000 anyone?
Our next target is Delta Geminorum – the "8" shape on our map. Delta goes by the traditional name of Wasat, which means middle. Thankfully, that's right about where it's positioned! Wasat is positioned very close to the ecliptic plane, so it is an important star to remember since it often gets occulted by the Moon. But that's not all. Wasat is also a terrific double star, too. Take out the telescope and have a look at this soft white star with the disparate orange companion. It's a tasty treat!
Now head further down the line for Gamma Geminorum – the "Y" shape on our map. It's name is Almeisan and it is about 150 light years away from Earth. A binary star? You bet. The major star is a spectroscopic binary, but look for a faint optical companion, too. Hop across the constellation to Theta Geminorum, the "n" shape. Often called Nageba, this 200 light year distant Class A3 star is also a binary that can be split with a telescope. Look for components of magnitudes 3.60 and 5.18, separated by 2.9 arcseconds.
Last on our list of stars is Epsilon Geminorum, the backward "3". It's name is Mebsuta and it is about 900 light years away from our solar system. Mebsuta is a supergiant star of spectral class G5, and compared to our Sun, it's 150 times larger. Like Delta on the other side of Gemini, Epsilon is also very near the ecliptic plane and can also be occulted by the Moon or planets. Be sure to also keep an eye on Zeta Geminorum, too! It is a cepheid variable star, with very nice magnitude changes from 3.62 to 4.18 every 10.15 days. Quite worth following!

Before you put away your binoculars, travel back to Theta and make the starhop to magnificent Messier 35. Also listed as NGC 2168, the awesome open star cluster was discovered by Philippe Loys de Chéseaux in 1745 and independently discovered by John Bevis before 1750. Progressively larger optics will reveal more and more stars… several hundred stars in an area about the size of the full moon. Perhaps 100 million years old, this collection of stellar gems contains several yellow and orange giant stars to delight the eye – but large telescopes will see something else. Located about 15 arc minutes southwest of M35 is another galactic cluster – NGC 2158. At low magnification, it will appear almost like a faint globular cluster – and with good reason. NGC 2158 is over 10 times older and over five times more remote than M35! About 50 arc minutes west from M35, faint, loose open cluster IC 2157 can also be found. For those with ultra-wide field eyepieces, you can often showcase

all three objects in the same field of view!
For the telescope, there's no place like NGC 2392 (RA 7:29; Dec 20:55) about 4 degrees east/southeast of Wasat. Better known as the "Eskimo Nebula", this planetary nebula has a bright central region and the surrounding dim ring structure. Be sure to up the magnification in even a small

telescope on this one. This stellar relic was first spied by William Herschel in 1787 and is a bubble of material being blown into space by the central star's intense "wind" of high -speed material. Try adding a nebula filter to bring out different and subtle details!
Head now for NGC 2266 (RA 06 43.2 Dec +26 58). This open cluster is probably a billion years old – nearly all of its

members evolved to the red giant star phase. From its position high above the galactic plane, low metallicity NGC 2266 has escaped the mixing of dusts and gases contained in the rest of the Milky Way and become the perfect laboratory for studying stellar evolution. Look for a relatively well compressed area of looping faint stars with a combined magnitude of near 10.
Care to try NGC 2420? You'll find it located at RA 07 38.5 Dec +21 34. This near 8th magnitude galactic star cluster is rich in solar type stars – another scientific playground for learning about the origins and evolution of the Milky Way. With nearly 1000 stars packed densely together in a small region, NGC 2420 originally belonged to another small galaxy that was cannibalized by our own. With an estimated age of 1.7 billion years old, it remains a curiosity be-



cause it is moving rapidly through space – and because it hasn't been tidally pulled apart by our galactic disc. Enjoy this unique view!
For the deep sky nebula enthusiast the IC443 lies just inside the right lowest star of Gemini, Propus.
IC 443 (also known as the **Jellyfish Nebula** and **Sharpless 248** (Sh2-248)) is a galactic supernova remnant (SNR) in the constellation Gemini. On the plane of the sky, it is located near the star Eta Geminorum. Its distance is roughly 5,000 light years from Earth.

(Andy Burns using Ha filter on D810a)

IC 443 may be the remains of a supernova that occurred 3,000 - 30,000 years ago. The same supernova event likely created the neutron star CXOU J061705.3+222127, the collapsed remnant of the stellar core. IC 443 is one of the best-studied cases of supernova remnants interacting with surrounding molecular clouds.
There are other star clusters to enjoy in the constellation of Gemini as well, so get a good star chart and enjoy your time with the "Twins"!

ISS PASSES For February/March 2021 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 Feb	-2.4	18:41:23	10°	W	18:44:32	36°	SSW	18:46:34	18°	SSE
03 Feb	-2.9	17:53:57	10°	W	17:57:14	49°	SSW	18:00:31	10°	SE
03 Feb	-0.9	19:31:46	10°	WSW	19:33:28	13°	SW	19:34:37	12°	SSW
04 Feb	-1.2	18:43:49	10°	W	18:46:17	19°	SW	18:48:45	10°	S
05 Feb	-1.6	17:56:10	10°	W	17:59:02	26°	SSW	18:01:56	10°	SSE
07 Feb	-0.6	17:59:00	10°	WSW	18:00:38	13°	SW	18:02:17	10°	SSW
21 Feb	-0.5	05:20:06	10°	SE	05:20:20	10°	SE	05:20:31	10°	SE
22 Feb	-2.0	06:05:58	10°	SSW	06:08:57	29°	SSE	06:11:57	10°	E
23 Feb	-1.6	05:19:24	13°	S	05:21:31	21°	SE	05:24:09	10°	E
24 Feb	-1.2	04:33:58	15°	SE	04:34:07	15°	SE	04:36:08	10°	ESE
24 Feb	-3.1	06:07:05	10°	WSW	06:10:23	54°	SSE	06:13:41	10°	E
25 Feb	-2.7	05:21:23	25°	SSW	05:22:51	40°	SSE	05:26:03	10°	E
26 Feb	-2.1	04:35:44	28°	SE	04:35:44	28°	SE	04:38:20	10°	E
26 Feb	-3.7	06:08:42	11°	WSW	06:11:54	82°	SSE	06:15:17	10°	E
27 Feb	-0.6	03:50:02	12°	E	03:50:02	12°	E	03:50:30	10°	E
27 Feb	-3.6	05:22:59	33°	WSW	05:24:17	68°	SSE	05:27:39	10°	E
28 Feb	-2.9	04:37:12	47°	ESE	04:37:12	47°	ESE	04:40:00	10°	E
28 Feb	-3.7	06:10:09	11°	W	06:13:26	85°	N	06:16:50	10°	E
01 Mar	-0.9	03:51:23	17°	E	03:51:23	17°	E	03:52:19	10°	E
01 Mar	-3.8	05:24:20	32°	W	05:25:47	89°	N	05:29:10	10°	E
02 Mar	-3.5	04:38:29	68°	E	04:38:29	68°	E	04:41:30	10°	E
02 Mar	-3.7	06:11:34	10°	W	06:14:57	88°	S	06:18:20	10°	E
03 Mar	-1.1	03:52:37	20°	E	03:52:37	20°	E	03:53:49	10°	E
03 Mar	-3.8	05:25:33	27°	W	05:27:16	86°	N	05:30:39	10°	E
04 Mar	-3.8	04:39:41	82°	NE	04:39:41	82°	NE	04:42:57	10°	E
05 Mar	-1.4	03:53:48	24°	E	03:53:48	24°	E	03:55:15	10°	E
05 Mar	-3.8	05:26:45	23°	W	05:28:42	77°	SSW	05:32:04	10°	ESE
06 Mar	-3.9	04:40:53	84°	W	04:41:00	88°	S	04:44:22	10°	E
07 Mar	-1.6	03:55:03	26°	E	03:55:03	26°	E	03:56:40	10°	E
07 Mar	-3.4	05:28:00	21°	W	05:29:59	48°	SSW	05:33:15	10°	SE
08 Mar	-3.8	04:42:13	63°	SSW	04:42:19	63°	SSW	04:45:39	10°	ESE
09 Mar	-1.7	03:56:30	24°	ESE	03:56:30	24°	ESE	03:57:59	10°	ESE
09 Mar	-2.5	05:29:28	18°	WSW	05:31:07	26°	SSW	05:33:59	10°	SSE
10 Mar	-2.9	04:43:50	35°	SSW	04:43:50	35°	SSW	04:46:37	10°	SE
11 Mar	-1.2	03:58:19	16°	SE	03:58:19	16°	SE	03:59:05	10°	SE
11 Mar	-1.7	05:31:18	13°	SW	05:32:01	13°	SW	05:33:42	10°	S
12 Mar	-1.6	04:45:56	15°	S	04:45:56	15°	S	04:46:56	10°	S

END IMAGES, OBSERVING AND OUTREACH

The star cluster ngc2244 lies inside the much larger Rosette nebular, ngc2237 which is very diffuse and frequently missed with narrow field of view, high magnification telescopes..
The whole nebular is twice the diameter of the Moon.
Other parts of the nebula have other ngc numbers given to them.
This picture was taken on 21st January with the gibbous Moon less than 45degrees away, but it was the only clear night I could get in the dome.
D810a Nikon, Lenhance filter, single 120 second exposure RAW stretched in Photoshop.
Andy Burns

Wiltshire Astronomical Society Observing Suggestions for February 2021 @ 20:00

We have updated the observation targets this month for those with binoculars or smaller wide field telescopes to have someth search for.

The WAS Observing Team will provide recommended observing sessions for you to do while under lockdown at home or as part of your ble. Please always follow the latest government guidelines if observing away from the home.

These observing recommendations will continue until we can start our group observing again.

Most target objects can be found around due South at about 20:00.

Where To Look This Month:
This month we take a look at the Winter Hexagon.

Just select 'What's Up' link below to get the PDF file.

OUTREACH

Zoom sessions and Google Classroom sessions have kept outreach going to schools. In January I did sessions at Stonar and Westbury Leigh. If anyone else has links to schools who might be interested in ‘in the classroom’ sessions ask them to get in touch with me via anglesburns@hotmail.com.