NWASNEWS

Volume23, Issue 8

April 2018

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

Going Down.

The heavenly palace has fallen. Tiangong 1 fell to earth about 1000 miles north of Tahiti in the centre of the Pacific, and despite all the hype (again) no one was injured, in fact no one saw it fall. It was never capable of falling north of 49 degrees so a bit of none news.

Also falling to Earth was the vanity crowd funded disco ball, 6 months ahead of schedule. Gravity eh? It sucks.

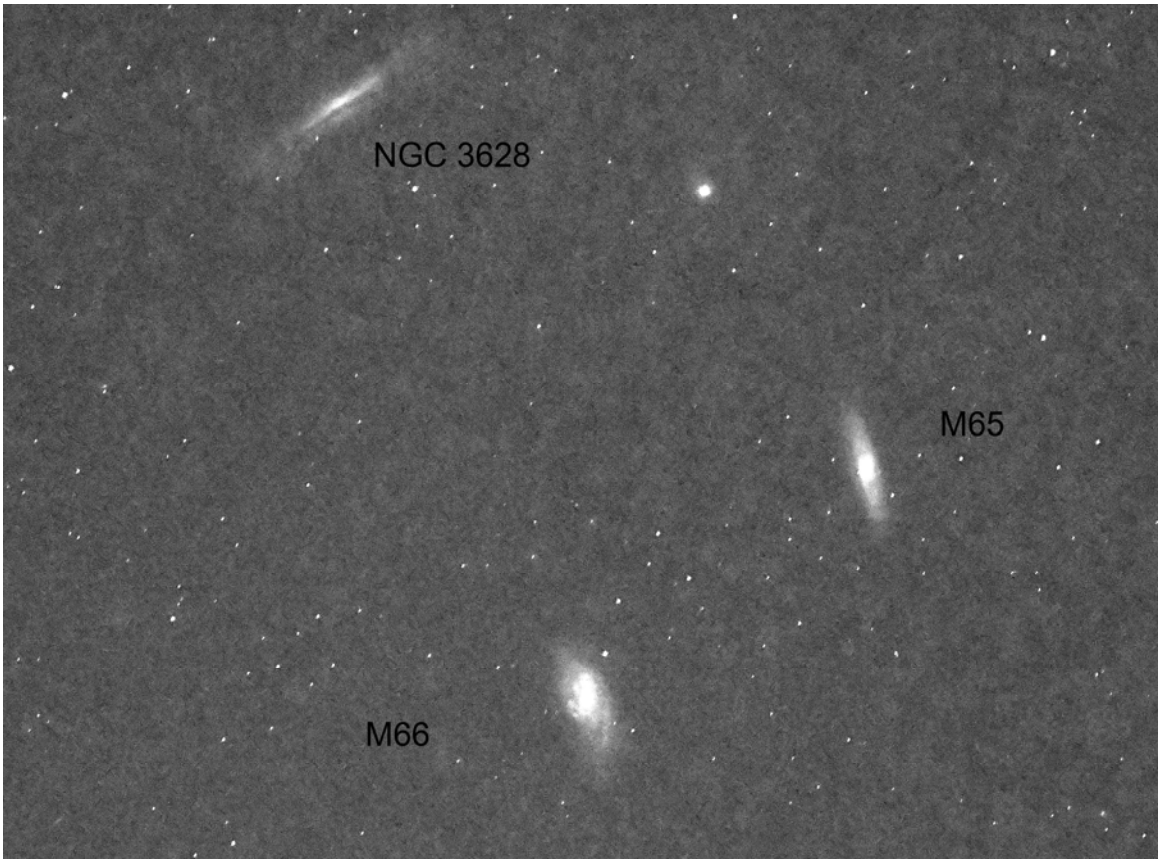
March brought sad news with the death of Stephen Hawking, one of the most highly regarded and best known physicists of the 20th century (and into this century). But he was more than this, he had a heart and a sense of humour. Stephen Hawking's final gift to the world: Legendary physicist brings his fans to tears as he pays for a massive Easter meal for fifty homeless people in Cambridge on the day of his funeral ...

Tonight's talk to the Wiltshire society is about one of the finest amateur astronomers from the United Kingdom in the 20th century. One of the first talks given to the Wiltshire society about George Alcock inspired me to get out there searching the skies with big binoculars for comets and supernova. Just managing to discover one of the latter…

George Eric Deacon Alcock,MBE was an English astronomer. He was one of the most successful visual discoverers of novae and comets. Initially, his interest in astronomy involved observation of meteors and meteor showers, but in 1953 he decided to start searching for comets and in 1955 began searching for novae. His technique was to memorize the patterns of thousands of stars, so that he would visually recognize any intruder.

Clear Skies

Andy



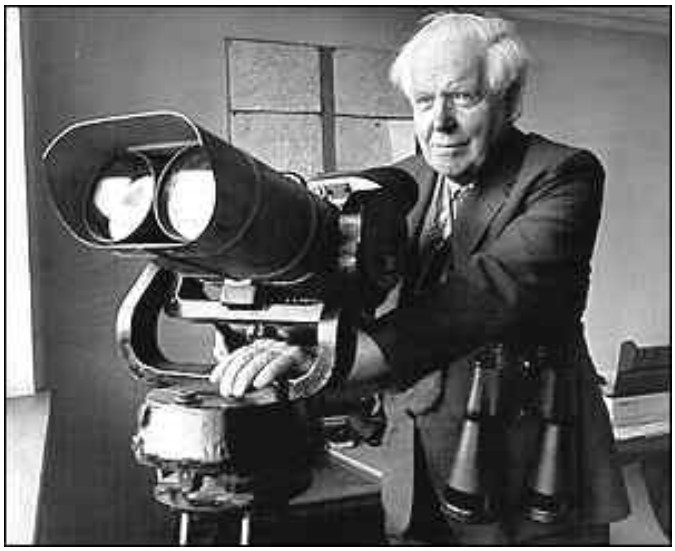
A temporary clear patch bit with sky haze on March 13th allowed me to image the Leo triplet using a D850 Nikon DSLR through the TMB102 refractor.

Wiltshire Society Page

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

Date	Speaker	Title
3rd Apr	Guy Hurst	George Alcock – The Life & Achievements of this Amazing Observer.
1st May	Paul Money	Triumphs of Voyager: Journey to Jupiter/Splendours of Saturn.
5th Jun	Martin Griffiths	Understanding Stars +AGM.

George Alcock MBE.



Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Keith Bruton Chair, keisana@tiscali.co.uk

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

Bob Johnston (Treasurer) Debbie Croker (vice Treasurer)

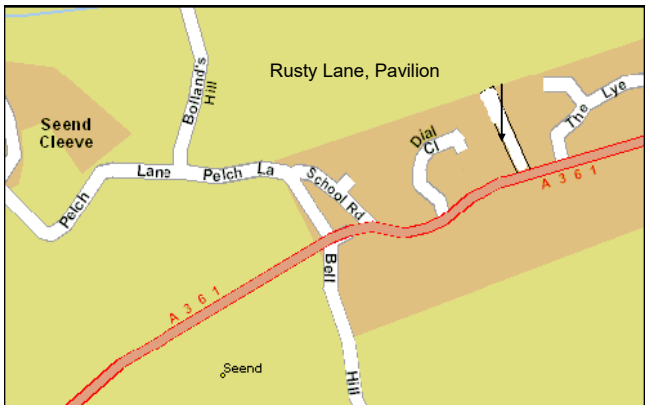
Philip Proven (Hall coordinator) Dave Buckle (Teas)

Peter Chappell (Speaker secretary)

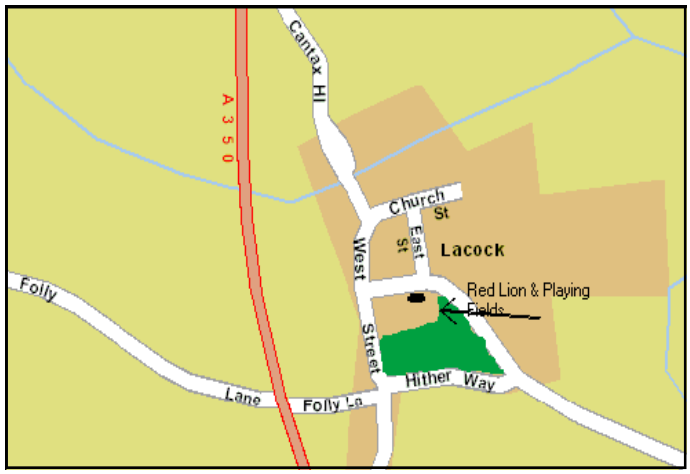
Nick Howes (Technical Guru)

Observing Sessions coordinators: Jon Gale, Tony Vale

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



Observing Sessions



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

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

Swindon Stargazers

Swindon's own astronomy group

The club meets once a month at Liddington Hall, Church Road, Liddington, Swindon, SN4 0HB at 7.30pm. See programme below.

Ad-hoc viewing sessions

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

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

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

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

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

If you think you might be interested email the organiser Robin Wilkey (see website). With this you will then be emailed regarding the event, whether it is going ahead or whether it will be cancelled because of cloud etc.
We are a small keen group and I would ask you to note that you DO NOT have to own a telescope to take part, just turn up and have a great evening looking through other people's scopes. We are out there to share an interest and the hobby. There's nothing better than practical astronomy in the great cold British winter! And hot drinks are often available, you can also bring your own.

Enjoy astronomy at it's best!

Members of the Wiltshire Astronomical Society always welcome!

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

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

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

Meeting Dates for 2018

Friday 20 April 2018
Programme: Stephen Tonkin - Age of the Universe

Friday 18 May 2018

Programme: Prof. Harrison - Space Weather

Friday 15 June 2018
Programme: Owen Brazell - Galaxy Clusters

Summer Break: No meetings in July and August

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

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

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

Friday 21 December 2018
Programme: Christmas Social

Website:

http://www.swindonstargazers.com

Chairman: Peter Struve

Tel No: 01793 481547
Email: peter.struve@sky.com
Address: 3 Monkton Close, Park South, Swindon, SN3 2EU

Secretary: Dr Bob Gatten (PhD)
Tel Number: 07913 335475
Email: bob.gatten@ntlworld.com
Address: 17, Euclid Street,

BECKINGTON ASTRONOMICAL SOCIETY

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

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

Our Committee for 2016/2017 is

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

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

…….john@abbeylands1.freeserve.co.uk

Sandy Whitton---- Secretary-07974-841239

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

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

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

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

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

Post Code for Sat Nav is BA11 6TB.

Our start time is 7.30pm.

20th April	*Building the World's Largest FM Radio Receiver to Learn about the First Galaxies*	Jonathan Pritchard
18th May	*The Dichotomy of Mars*	Mike Witt
15th June	Annual General Meeting *Member Talks*	

Dear Herschellians,

Venue: 7.30pm **Thursday** 5th April 2018 at the BRLSI

Title: Caroline Herschel and the nearly all male world of eighteenth century science

Speaker: Dr Emily Winterburn, former Curator of Astronomy at Royal Observatory Greenwich

Description:

Dr Emily Winterburn is an academic, author and former Curator of Astronomy at Royal Observatory Greenwich. Based on her book, she will consider Caroline Herschel and her various tactics for encouraging support for her work. Between 1788 and 1797 Caroline discovered comets, became the first woman to be published in the journal of the Royal Society and assisted her brother in his research. Women had tried to get their work heard before, indeed all over Europe there were women quietly working in science, more often than not silently, and unacknowledged for their male relatives, Caroline however was the first to get her voice truly heard. In this talk Dr Winterburn will focus on the beginning of her story, her very first, tentative steps into the world of scientific publication. Would she judge it well? Or fall to ridicule or condensation as so many of her predecessors had done?

Kind regards,

Tony Symes

Measuring the Movement of Water on Earth

By Teagan Wall

As far as we know, water is essential for every form of life. It's a simple molecule, and we know a lot about it. Water has two hydrogen atoms and one oxygen atom. It boils at 212° Fahrenheit (100° Celsius) and freezes at 32° Fahrenheit (0° Celsius). The Earth's surface is more than 70 percent covered in water.

On our planet, we find water at every stage: liquid, solid (ice), and gas (steam and vapor). Our bodies are mostly water. We use it to drink, bathe, clean, grow crops, make energy, and more. With everything it does, measuring where the water on Earth is, and how it moves, is no easy task.

The world's oceans, lakes, rivers and streams are water. However, there's also water frozen in the ice caps, glaciers, and icebergs. There's water held in the tiny spaces between rocks and soils deep underground. With so much water all over the planet—including some of it hidden where we can't see—NASA scientists have to get creative to study it all. One way that NASA will measure where all that water is and how it moves, is by launching a set of spacecraft this spring called GRACE-FO.

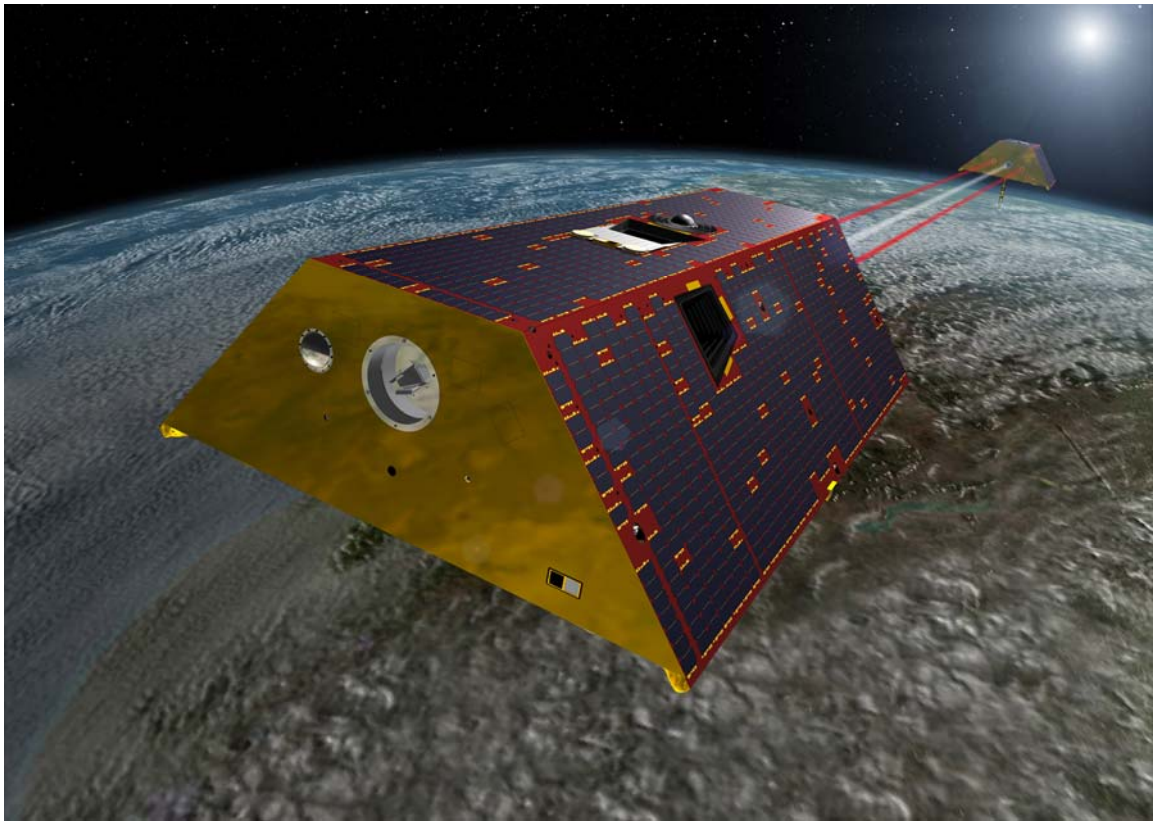
GRACE-FO stands for the "Gravity Recovery and Climate Experiment Follow-on." "Follow-on" means it's the second satellite mission like this—a follow-up to the original GRACE mission. GRACE-FO will use two satellites. One satellite will be about 137 miles (220 km) behind the other as they orbit the Earth. As the satellites move, the gravity of the Earth will pull on them.

Gravity isn't the same everywhere on Earth. Areas with more mass—like big mountains—have a stronger gravitational pull than areas with less mass. When the GRACE-FO satellites fly towards an area with stronger gravitational pull, the first satellite will be pulled a little faster. When the second GRACE-FO satellite reaches the stronger gravity area, it will be pulled faster, and catch up.

Scientists combine this distance between the two satellites with lots of other information to create a map of Earth's gravity field each month. The changes in that map will tell them how land and water move on our planet. For example, a melting glacier will have less water, and so less mass, as it melts. Less mass means less gravitational pull, so the GRACE-FO satellites will have less distance between them. That data can be used to help scientists figure out if the glacier is melting.

GRACE-FO will also be able to look at how Earth's overall weather changes from year to year. For example, the satellite can monitor certain regions to help us figure out how severe a drought is. These satellites will help us keep track of one of the most important things to all life on this planet: water.

You can learn more about our planet's most important molecule here: https://spaceplace.nasa.gov/water



An artist's rendering of the twin GRACE-FO spacecraft in orbit around Earth. Credit: NASA

MEMBERS VIEWING LOGS and IMAGES

Viewing Log for 13th of March

With it being less than a week away from the planned Messier marathon I thought I would go out and do some practising with my GOTO equipment before the actual night, might give me some idea of where some of the fuzzy blobs (FB) are in the night sky? Doing the marathon you are supposed to use none GOTO equipment as in Messiers day!

So Tuesday night was a clear evening and I was free as well, so I headed off to my usual viewing slot at Uffcott just off the A4361 south of Swindon. I was set up and ready to start viewing at 20:12 with my eight inch (203 mm) Meade LX90 using a Delos 17.3 mm eye piece. The temperature was about 3 °C with very little wind so it should be a good evening for viewing subject to cars going past my location? While I was setting up a black Labrador dog went walking past me, in the past Jon Gale and I have heard this dog go pass us!

Anyway on to the marathon and first on the list is M77 a spiral galaxy (SG) in Cetus, not the best of starts as it was hiding in a cloud bank which was hugging the western horizon! Better with the next object in M74 another SG which was hard to make out, this was more like a faint fuzzy blob (FFB)? The Triangulum galaxy (M33) looked like a FB to me, quite bright but has a large surface area! Finally got one which I could really make out in seeing the Andromeda galaxy, this looked nice to view? Not far away was M32, an Elliptical galaxy (EG) which is a satellite of M31, this galaxy had a bright core. Yet another satellite galaxy is M110, this EG was hard to find, another FFB! Had a slight stoppage as the black dog went past me at 20:29 in the other direction, maybe going home? Now onto my favourite Deep Sky object, Open clusters (OC) and M52 in Cassiopeia, this OC was faint to look at. M103, also in Cassiopeia is much smaller than M52 and fainter. The first of the four Planetary nebula (PN) in the list was M76, this also was a FB to view? M34 an OC looked like a three bladed propeller to look at? The next object you only really need your eyes as M45 is hard to miss (assuming you know where to look?), looking with my telescope all I needed was the finder. M79 a Globular cluster (GC) in Lepus was also hiding in the cloud bank which got M77 at the start! Time to bag two objects with one go as M43 is right next door (less than 0.2 arc minutes) to M42, the great nebula in Orion. The often overlooked object in this constellation is M78 just north and slightly east of the belt stars, this Diffuse nebula (DN) looks like two stars which we will come to later in this list! M1 which started this list is a Supernova remnant which could easy be confused with a comet, to me it was a grey blob? Now back to a bagful of OC's, starting with M35 (big and bright), M37 (dense), M36 (sparse), M38 (big & loose), M41 (very loose), M93 (an often over looked object?), M47 (very loose), M46 (big), if you are using binoculars you will get these two in the same field of view, M50 (very loose & sparse), M48 (very loose), M44 best viewed with finder and finally M67 (small). After all those OC's it was back to the faint fuzzies and start with M95 in Leo, this object looked like a FFB, M96 not far away was brighter of the two? While viewing M105 I noticed another object in the field of view (later on after consulting the Internet it was either NGC 3384 or 3389, I suspect it was NGC 3384 which is nearly two magnitudes brighter?). Another double grab was M65 and M66 (part of the Leo triplet) in the same field of view J, now it was time to head north and visit Ursa Major and start with M81, looked like an out of focus star? Its near neighbour in M82 is an edge on galaxy. Now onto my old nemesis and M97, this looked worse than M1 to look at! M108 & M109 I had to use averted vision to locate, both of these I would class as FFB's! If you remember earlier on I said M78 in Orion looked like two stars, well M40 IS two stars and nothing else, probably the least interesting object in his whole list? M106 was easy to see even though I would class it as a FB. M94 in Canes Venatici was another FB to look at, yet M63 looked misty to view? For a change M51, the Whirlpool galaxy looked nice to look at, normally when I view this object it looks faint, maybe seeing conditions tonight were better? M101 just north of the Plough handle can easy be missed even though it is big to look at. M102 some people say it should not be included in his list as it might have been mistaken for M101 in the past? Anyway, this Lenticular galaxy was a FB to look at. M53, a GC had a bright core. The Blackeye galaxy in M64 was a FB to view. M3 another GC was nice to look at, not far below the best GC in the northern sky in M13 (which I would not be viewing tonight!) Onto Virgo and the Realm of Galaxies and start with M98 and M99, both of these were very faint to find, could not make out M100. My final object for the evening was M87 a bright EG.

By now it was 22:06 and I still had to pack up all of my equipment and go home as I had work the following morning. While out for nearly two hours I managed to find 49 of the 52 objects I tried to find which is pretty good for me, if using a manual telescope that number would probably be down in the 20's as I do cannot locate faint fuzzies at all, eyes are not that good as they use to be?

Clear skies.

Peter Chappell

PS. Turns out the marathon got cancelled the following Saturday due to total cloud cover with the chance of snow during the night!

Below The Moon on 25th March, 8.6 day phase. Andy Burns, Nikon D7200.

Messier Marathon quiz (Answers back page) Thanks to Peter CHappell

As the marathon got cancelled due to the weather I thought I would do a quiz (just for fun), see how you get on with the questions? All answers come from 'The Ultimate Messier Object Log' which Andy Burns give me. Below are 11 questions, some are easy with some difficult to get? Enjoy!

1 Which constellation has the second most objects on his list?
A: Virgo.
B: Ophiuchus
C: Coma Berenices.

2 Which is the 2nd largest object (in area of sky)?
A: M42.
B: M45.
C: M44.

3 How many Supernova remnants are there on the list?
A: 0.
B: 1.
C: 2.

4 Which is the only object in Draco?
A: M100.
B: M101.
C: M102.

5 Which is the most southerly object?
A: M6.
B: M7.
C: M93.

6 Going other direction, which is most northerly?
A: M101.
B: M81.
C: M82.

7 Last object to view on conventional list?
A: M30.
B: M72.
C: M73.

8 Only IC object on list, all others are NGC?
A: M23.
B: M24.
C: M25.

9 Which two make up part of the Leo triplet?
A: M95 & M96.
B: M65 & M66.
C: M105 & M106.

10 How many objects were on Messier's final list (at his death)?
A: 101.
B: 103.
C: 110.

11 What is the most popular object in the list?
A: Globular Cluster.
B: Open Cluster.
C: Galaxy, not including Spirals.

SPACE NEWS FOR APRIL

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

Stephen Hawking 1942-2018

14 March 2018 Keith Cooper

Professor Stephen Hawking, who was probably the most renowned and recognisable scientist in the world, and famed for his work on black holes, has died aged 76.
Despite suffering from crippling motor neurone disease since being diagnosed at the age of 21, Professor Hawking was one of the most brilliant minds of modern times, as well as a best-selling author, most notably with his book A Brief History of Time.

Stephen Hawking pictured with Newton's own annotated copy Principia Mathematica as part of Cambridge University Library's 600th anniversary. Photo: Graham CopeKoga/ Cambridge University Library.
Hawking first came to prominence in the early 1970s, when a trip to Moscow to meet the eminent Soviet physicist Yakov Zel'dovich inspired him to question the assumption of whether black holes are truly black. Such was his genius that he would run complex equations through his mind, night after night, eventually leading him to the conclusion that black holes emit particles and, in the process, lose mass, shrink and ultimately disappear. It was an insight that would make his name immortal, but at first he didn't quite believe it himself. His equations showed that, quantum mechanically, black holes are able to radiate away mass in the form of virtual particles – particles that fizz in and out of existence thanks to tiny quantum fluctuations. At first he stayed silent about his discovery, but he was encouraged by the support of his former PhD supervisor, Dennis Sciama, who apparently had far more faith in Hawking's equations than Hawking himself did. Soon news of the breakthrough spread, though not everyone was as welcoming of the discovery as Sciama; some physicists were actively hostile to the idea. It took a few years for everyone to be convinced that the so-called 'Hawking radiation' was real. Today it is part of the furniture of black hole physics, and helped transform Stephen Hawking into a true celebrity of science.

Hawking radiation

It all comes down to the nature of the fabric of space–time. Quantum mechanics tells us that space–time is filled with quantum fields and that any given point in space has an associated energy, rendering space–time as a frothing foam of quantum energy. In his famous equation $E=mc^2$, Albert Einstein had shown that energy and mass are equivalent, while quantum mechanics is a probabilistic approach to understanding nature. The combination of the two means that the energy of any given point in space can experience a random fluctuation and transform itself into mass, in the guise of 'virtual' particles that 'borrow' energy from the Universe, surviving for just a fraction of a second before annihilating each other and disappearing from existence as they return their energy to the cosmos.

As one of physics' 'rock stars', Stephen Hawking's cosmic thoughts have changed how we think of black holes. Image: Max Alexander/ Starmus.
When virtual particles form just on the inside edge of a black hole's event horizon (the boundary beyond which not even light can escape), one of the particles moves deeper into the black hole while the other jumps across the event horizon thanks to another quantum mechanical process known as tunnelling. One of the early insights into quantum physics was that particles can also act as waves and have an associated wave-function that describes, among other things, the probabilities associated with their exact position. Some parts of a particle's wave-function have greater amplitudes, implying that the particle is more likely to be found over here, while other sections of the wave function have lower amplitudes, implying a lower probability that the particle is really over there. When virtual particles form just inside the event horizon there is a chance that one of the particles can appear on the other side of the event horizon – its wave-function has allowed it to tunnel through the barrier, and off it goes. Forever separated, the virtual particles cannot annihilate and so the escaping particle becomes a real particle, boosted in energy by the rotation of the black hole. Because the conservation of energy dictates that the virtual particle falling into the black hole must have 'negative' energy, the escaping particle must have positive energy, which it removes from the black hole. Since energy is equivalent to mass, the escaping particle is therefore also removing some of the black hole's mass. After a very, very long time (say, 10^{120} years) even the most massive black holes will shrink to nothing thanks to Hawking radiation.

The early years

Hawking's discovery had more than just cosmological relevance. It was a testament to his determination to succeed no matter the odds, given that in 1963, just after his 21st birthday, he'd been diagnosed with a form of motor neurone disease called amyotrophic lateral sclerosis, which results in the nerves that control the body's muscles shutting down, and

was given just two years to live. It is testament to his determination that he lived well into his 70s while remaining a prominent figure in science and the public consciousness.
Hawking once recalled that when he first visited the clinic where he was diagnosed, he shared a room with a boy suffering from leukaemia and realised that, no matter how bad his condition was, he was fortunate that it was not even worse and he still had something to live for. This sparked renewed enthusiasm in his university studies, while on the personal front he married his first wife, Jane Wilde, in 1965 (their romance is depicted in the 2014 film, 'Theory of Everything'). His illness failed to progress as quickly as doctors had pronounced and it soon became clear that his impending death was anything but. Although he was forced to abandon his crutches for a wheelchair in 1969, he was still able to take up a position as a visiting professor at the California Institute of Technology (Caltech) in 1970 and became known for his reckless driving of his wheelchair!
While in California the Hawking family would take in a grad student each year to help with both Stephen's work and his health care. It was during his five years at Caltech that Hawking met Kip Thorne, a theoretical physicist best known for his work on black holes, which in the public's eyes culminated in the 2014 film 'Interstellar'. Hawking and Thorne enjoyed a playful friendship over the years, frequently placing wagers with one another, or together versus other scientists, over whose theories were correct regarding various aspects of black holes. Often Hawking would be in agreement with the opposing bet but would still place the wager as an 'insurance policy', just in case he was wrong, with all manner of lighthearted prizes for the winner.

President Barack Obama talks with Stephen Hawking at the White House before a ceremony in 2009 to present him with the Presidential Medal of Freedom, the United States' highest civilian honour. Image: Pete Souza/ The White House.

Information Paradox

One of those wagers was as a direct consequence of Hawking radiation. Although it is not an official law of nature, it had been assumed that 'information' is a property that must be conserved and cannot be lost or destroyed (when we refer to information, we mean properties referring to a particle's specific state, such as its charge or quantum spin). It was not clear how Hawking radiation could contain any information pertaining to what has fallen into a black hole; that information seemingly had to stay in there. Yet when a black hole eventually evaporates by losing mass through Hawking radiation, what happens to the information that it contained?
The notion that information could disappear for good, erased from existence, was disquieting because it clashed with our quantum mechanical understanding of information. If information is lost, then the entropy within the black hole would increase, which the laws of thermodynamics say would cause the black holes to heat up to unfathomable temperatures. Nevertheless, Hawking's calculations convinced him that information was indeed lost from the Universe once it enters a black hole and the black hole evaporates, but not everyone agreed. By the turn of the millennium, the scientific consensus was against Hawking. Hence another wager – in 1997 Caltech's John Preskill bet Hawking and Kip Thorne that information was conserved and just seven years later, in a development that made the news headlines, Hawking conceded the bet (Thorne, though, is still holding out), buying Preskill a baseball encyclopaedia – from which information could easily be retrieved! – for winning the wager.
The favoured solution to the paradox rests on the idea that our Universe is holographic. What this means is that physics in a given number of dimensions corresponds to different physics operating in a higher number of dimensions. For example, String Theory (which posits that fundamental particles are made from tiny vibrating strings) predicts the existence of eleven dimensions, and in 1997 the Argentinian physicist Juan Maldacena proposed that the quantum field theory belonging to our four-dimensional (length, breadth, width and time) Universe, with the exception of gravity, corresponds to String Theory physics in five dimensions with gravity, as though our Universe were a projection of a four-dimensional boundary in multi-dimensional space, through which gravity leaks into our Universe (which would explain why gravity is so weak compared to the other fundamental forces of nature).
Gerard t'Hooft of Utrecht University in the Netherlands and Leonard Susskind of Stanford University suggested something similar for how black holes operate: that the physics of the three-dimensional volume within a black hole, where gravity plays a significant role, corresponds to the physics of a -dimensional horizon above the black hole that is described by equations that do not need to invoke gravity. This means that the information within the black hole could be encoded onto this two-dimensional surface.
From this point, there is a lot of conjecture as to how the information becomes encoded into virtual particles or otherwise escapes the black hole's evaporation. One of Hawking's last scientific papers on the subject, published in January 2016 and written with Harvard's Andrew Strominger and Cambridge's Malcolm Perry, suggests that when an object falls into a black hole it imprints its information on what they call 'soft particles', which are particles such as photons or gravitons that possess zero energy and which lurk on the black hole's two-dimensional event horizon.

The voice

Hawking returned to Cambridge in 1975 and four years later took up the chair of the Lucasian Professor of Mathematics at the university. He held this position, of which previous incumbents included such greats as Isaac Newton, Charles Babbage and Paul Dirac, for 30 years before the rules forced him to step down in 2009, after which he became the Director of Research at Cambridge's Department of Applied Mathematics and Theoretical Physics. During the intervening years he lost his voice for good following a bout of pneumonia in 1985 that resulted in a tracheotomy and subsequent around-the-clock care from nurses. Hawking subsequently adopted a synthesised voice provided by a program called 'The Equalizer', which was developed by a Californian software developer Walter Woltosz, whose mother-in-law also suffered from amyotrophic lateral sclerosis. It works by selecting words on a computer screen, arranging them into a sentence and then commanding the computer to speak the words. Initially Hawking was able to control The Equalizer with a hand-held device, but as his illness progressed he gradually lost the limited use he had in his hand. This forced him to control the device with an infrared sensor attached to his glasses that could detect movement in his cheek muscle, allowing him to painstakingly construct on the computer the words that were then spoken by the stilted, robotic voice that made Hawking instantly recognisable when he spoke in the media.

Stephen Hawking experiencing weightlessness in 2007. Image: Jim Campbell/Aero News Network.

His frequent appearances in the media ranged from guest-starring in 'Star Trek: The Next Generation' and 'The Simpsons' to presenting documentary series. He also voiced his opinion on many subjects, from climate change and politics to the future of humanity and the search for extraterrestrial intelligence. Hawking frequently stated his belief that the future of human civilisation resides in space, spreading amongst the planets and then the stars. To stay on Earth, he said, may doom humanity, whether it is through climate change or war or disease or something else that finally eradicates us.

A Brief History of Time

In 1988 Hawking published his best-selling book, *A Brief History of Time*, which has since gone on to sell over 10 million copies. It broached the topics that Hawking was most interested in – black holes, the General Theory of Relativity, quantum mechanics and the origin of the Universe. Although well-written, the topics it attempted to describe for general readers are immensely complex and, despite its tremendous sales success, it's often said that while most people began reading the book, few ever finished it.

Other books followed, including 2001's *The Universe in a Nutshell* and 2005's *A Briefer History of Time*, in an attempt to convey the ideas presented inside *A Brief History of Time* in a simpler way, but it was Hawking's first book that remained his best known tome. Within its pages, Hawking declared that science is all that will ever be needed to understand the Universe and that a complete, unified theory of physics will replace the notion of God. This was a view he continued to hold throughout his life. For Hawking, science was the beginning and the end.

Jupiter's Great Red Spot extending upward as it shrinks

14 March 2018 Astronomy Now

Jupiter's Great Red Spot with Earth superimposed at the same scale. The huge storm has been shrinking overall since continuous observations began in 1878, but a new NASA study shows it is moving faster and extending upward. Image: NASA

Though once big enough to swallow three Earths with room to spare, Jupiter's Great Red Spot has been shrinking for a century and a half. Nobody is sure how long the storm will continue to contract or whether it will disappear altogether.

A new study suggests that it hasn't all been downhill, though. The storm seems to have increased in area at least once along the way, and it's growing taller as it gets smaller.

"Storms are dynamic, and that's what we see with the Great Red Spot. It's constantly changing in size and shape, and its winds shift, as well," said Amy Simon, an expert in planetary atmospheres at NASA's Goddard Space Flight Centre in Greenbelt, Maryland, and lead author of the new paper, published in the Astronomical Journal.

Observations of Jupiter date back centuries, but the first confirmed sighting of the Great Red Spot was in 1831. (Researchers aren't certain whether earlier observers who saw a red spot on Jupiter were looking at the same storm.) Keen observers have long been able to measure the size and drift of the Great Red Spot by fitting their telescopes with an eyepiece scored with crosshairs. A continuous record of at least one observation of this kind per year dates back to 1878.

Simon and her colleagues drew on this rich archive of historical observations and combined them with data from NASA spacecraft, starting with the two Voyager missions in 1979. In particular, the group relied on a series of annual observations of Jupiter that team members have been conducting with NASA's Hubble Space Telescope as part of the Outer Planets Atmospheres Legacy, or OPAL, project. The OPAL team scientists are based at Goddard, the University of California at Berkeley, and NASA's Jet Propulsion Laboratory in Pasadena, California,

The team traced the evolution of the Great Red Spot, analysing its size, shape, colour and drift rate. They also looked at the storm's internal wind speeds, when that information was available from spacecraft.

The new findings indicate that the Great Red Spot recently started to drift westward faster than before. The storm always stays at the same latitude, held there by jet streams to the north and south, but it circles the globe in the opposite direction relative to the planet's eastward rotation. Historically, it's been assumed that this drift is more or less constant, but in recent observations, the team found the spot is zooming along much faster.

The study confirms that the storm has been decreasing in length overall since 1878 and is big enough to accommodate just over one Earth at this point. But the historical record indicates the area of the spot grew temporarily in the 1920s.

"There is evidence in the archived observations that the Great Red Spot has grown and shrunk over time," said co-author Reta Beebe, an emeritus professor at New Mexico State University in Las Cruces. "However, the storm is quite small now, and it's been a long time since it last grew."

Because the storm has been contracting, the researchers expected to find the already-powerful internal winds becoming even stronger, like an ice skater who spins faster as she pulls in her arms.

Instead of spinning faster, the storm appears to be forced to stretch up. It's almost like clay being shaped on a potter's wheel. As the wheel spins, an artist can transform a short, round lump into a tall, thin vase by pushing inward with his hands. The smaller he makes the base, the taller the vessel will grow.

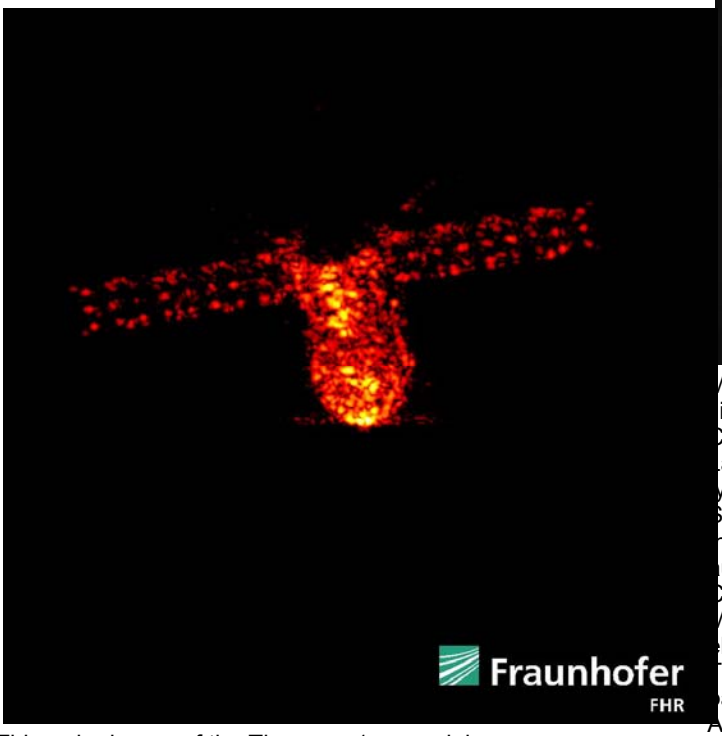
In the case of the Great Red Spot, the change in height is small relative to the area that the storm covers, but it's still noticeable.

The Great Red Spot's colour has been deepening, too, becoming intensely orange since 2014. Researchers aren't sure why that's happening, but it's possible that the chemicals which colour the storm are being carried higher into the atmosphere as the spot stretches up. At higher alti-

tudes, the chemicals would be subjected to more UV radiation and would take on a deeper colour.
In some ways, the mystery of the Great Red Spot only seems to deepen as the iconic storm contracts. Researchers don't know whether the spot will shrink a bit more and then stabilise, or break apart completely.
"If the trends we see in the Great Red Spot continue, the next five to 10 years could be very interesting from a dynamical point of view," said Goddard co-author Rick Cosentino. "We could see rapid changes in the storm's physical appearance and behaviour, and maybe the red spot will end up being not so great after all."

Chinese space lab burns up on re-entry over Pacific Ocean

April 2, 2018 Stephen Clark



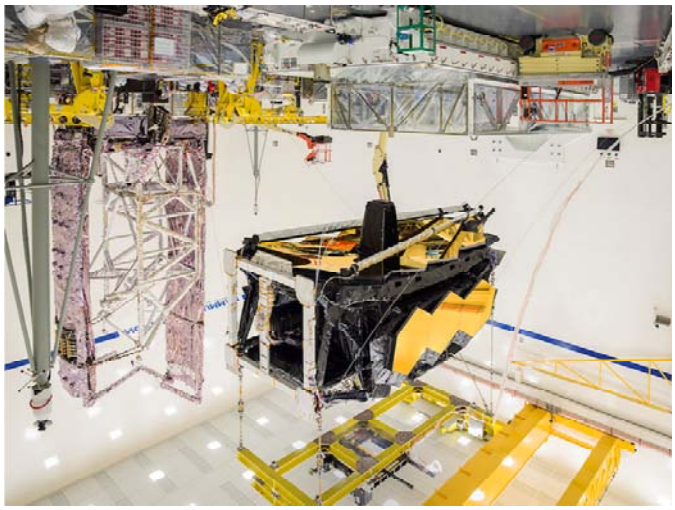
This radar image of the Tiangong 1 space lab was captured Sunday when the module was at an altitude of 100 miles (161 kilometers). Credit: Fraunhofer Institute for High Frequency Physics and Radar Technology (Fraunhofer FHR)
China's Tiangong 1 space lab, home to two astronaut crews in 2012 and 2013, fell back to Earth uncontrolled Sunday, likely burning up over the Pacific Ocean as satellite trackers monitored the module's gradual descent from orbit.
The bus-sized spacecraft re-entered Earth's atmosphere at approximately 8:16 p.m. EDT Sunday (0016 GMT Monday) over the southern Pacific Ocean, according to the U.S. military's Joint Force Space Component Command, which tracks objects orbiting Earth using a network of radars and optical sensors.
"One of our missions, which we remain focused on, is to monitor space and the tens of thousands of pieces of debris that congest it, while at the same time working with allies and partners to enhance spaceflight safety and increase transparency in the space domain," said Maj. Gen. Stephen Whiting, deputy commander of the Joint Force Space Component Command, and commander of the 14th Air Force.
The U.S. military publishes orbital parameters on all unclassified objects in its catalog, sharing the data with satellite operators and foreign governments to reduce the risk of collisions in space.
"All nations benefit from a safe, stable, sustainable, and secure space doman," Whiting said in a statement. "We're sharing information with space-faring nations to preserve the space domain for the future of mankind."
The China Manned Space Agency, which oversees the country's human spaceflight program, confirmed the Tiangong 1 spacecraft's re-entry in a brief statement early Monday. A control center in Beijing monitored the spacecraft's descent, and most of Tiangong 1 was expected to burn up during re-entry, Chinese officials said.
Tiangong 1's re-entry corridor was confined by its orbital ground track between 42.8 degrees north and south latitude, and the space lab could have come back to Earth anywhere along its orbit.

Members of the Shenzhou 9 crew — Liu Wang, Liu Yang and ing Haipeng — inside the Tiangong 1 space lab in 2012. Credit: China Manned Space Agency
Launched in September 2011, Tiangong 1 was the first prototype for a planned Chinese space station. Three visiting Shenzhou spaceships, one without a crew and then two with hree astronauts on-board, docked with Tiangong 1 to test out utomated and manually-controlled rendezvous procedures. Chinese engineers lost control of Tiangong 1's orbit in 2016. Measuring around 34.1 feet (10.4 meters) long with solar panels extending to a tip-to-tip span of 60 feet (18.4 meters), Tiangong 1 was larger than most defunct satellites that fall ack to Earth. But Tiangong 1 was not a record-holder.
A list of the most massive human-made space objects that have plunged back to Earth compiled by Jonathan McDowell, an astrophysicist who tracks space activities, registered Tiangong 1 as the 49th biggest spacecraft to re-enter uncontrolled.
The eight-ton Tiangong 1 would have been dwarfed by the space shuttle Columbia, which lost control during re-entry in 2003, killing seven astronauts and spreading debris across East Texas and Louisiana. NASA's Skylab space station had a mass of more than 80 tons (around 75 metric tons) when it came down over Australia in 1979.
More recently, large disused Russian rocket stages have come back to Earth, and the failed Phobos-Grunt Mars probe re-entered uncontrolled in 2012. All were more massive than Tiangong 1.
China launched an upgraded human-rated experiment lab, Tiangong 2, in September 2016. It hosted a two-person crew launched on the Shenzhou 11 spaceraft for a month-long expedition later that year.
The centerpiece of a larger Chinese orbital complex is scheduled to launch in 2020, a couple of years later than previously planned, according to Chinese state media.
The Tianhe 1 command module will launch on a Long March 5 rocket, China's most powerful launcher. The Long March 5 failed on its second test flight in 2017, and a third demonstration is scheduled for late this year before Chinese officials commit to putting more valuable payloads on the rocket, in-

cluding a lunar sample return probe, a Mars rover and pieces of the Chinese space station.

Webb telescope's launch delayed until 2020

28 March 2018 Stephen Clark



The James Webb Space Telescope's mirror and instrument section, known as the Optical Telescope element and Integrated Science (OTIS) module, is unpacked from its shipping container after arriving at Northrop Grumman's satellite factory in Redondo Beach, California, earlier this year. JWST's sunshield is visible at left. Credit: NASA/Chris Gunn

Blaming a slew of technical snags and "avoidable errors," NASA officials said Tuesday that the launch of the James Webb Space Telescope, already years behind schedule, will be delayed to 2020, potentially pushing the mission's development cost above an $8 billion cap mandated by Congress.

Problems encountered in recent months with the observatory's spacecraft bus, the section that will host the mission's expandable telescope after liftoff, prompted a review of the schedule engineers need to prepare it for liftoff.

"The project has achieved numerous successful milestones, and in fact, 100 percent of the observatory's flight hardware is now complete," said Robert Lightfoot, NASA's acting administrator. "However, work performance challenges that were brought to light have prompted us to take some action.

"We need to successfully integrate both halves of the observatory into the final flight configuration and complete some vital testing after an independent assessment of the remaining tasks," Lightfoot said Tuesday in a conference call with reporters. "Frankly, the tasks are taking longer to complete than we expected, which will result in a new target launch window, which we now expect to be approximately May of 2020."

NASA announced last September that JWST would miss its target launch date in October 2018, but managers still expected the observatory to be ready for liftoff between March and June of 2019. Officials on Tuesday said that was no longer possible.

All components of the observatory are in a clean room at Northrop Grumman's satellite factory in Redondo Beach, California, where technicians will connect JWST's spacecraft platform — still under construction — to the mission's telescope and science module, which arrived at the contractor's plant earlier this year following assembly at NASA's Goddard Space Flight Center in Maryland and a cryogenic vacuum test at the Johnson Space Center in Houston.

The telescope and instruments have passed their standalone tests, but the team in charge of building the spacecraft has run into problems, NASA officials said. A NASA review board determined earlier this month that the mission would likely not be ready to launch until 2020.

"More time is needed to test and integrate the highly complex sunshield and spacecraft section at Northrop Grumman," said Thomas Zurbuchen, associate administrator of NASA's science mission directorate. "That is taking longer to complete, and there are also a few mistakes that happened."

The flagship mission will be the most ambitious astronomical observatory ever launched, building on a quarter-century of discoveries made by NASA's famous Hubble Space Telescope. Originally proposed more than 20 years ago, the James Webb Space Telescope has been redesigned to expand its observing power and overcome numerous technical hurdles, ballooning costs from an original projection below $1 billion to more than $10 billion, a figure that includes planned launch and operations expenses, along with European and Canadian contributions.

The new observatory will be stationed nearly a million miles (1.5 million kilometers) from Earth, using a 21.3-foot (6.5-meter) mirror and four science instruments hidden behind a thermal sunshield to peer into the distant universe, studying the turbulent aftermath of the Big Bang, the formation of galaxies and the environments of planets around other stars.

The sunshield for James Webb Space Telescope is pictured in flight configuration after a deployment test last year. Credit: Northrop Grumman

Lightfoot said NASA has invested $7.3 billion to date in the James Webb Space Telescope, named for the NASA administrator who led the agency during the Space Race of the 1960s.

NASA remains committed to the observatory, but with the launch delay to 2020, the cost to develop the mission could rise above an $8 billion limit set by lawmakers. If that happens, the mission must be reviewed and reauthorized by Congress.

"The James Webb Space Telescope is our highest priority science project within NASA's science mission directorate," Lightfoot said. "It's really a tremendous feat of human engineering, and it's going to leave a legacy of exceptional science and technical innovations for decades. It's loaded with pioneering technology, and it's also the largest international space science project in U.S. history."

NASA officials did not provide a new cost estimate to finish development of the observatory. Agency leaders will submit a report to Congress by late June to inform lawmakers of the mission's updated schedule and budget.

"The moment we have any indication that a breach will happen, both in schedule and cost, we need to inform right away," Zurbuchen said. "The disadvantage of that kind of sudden action is that we have not fully done all our entire joint analysis of cost and schedule, and we actually, at this moment in time, don't really fully know what the exact cost will be of the entire completed and deployment spacecraft."

If NASA needs relatively little extra money to complete JWST, future expenditures planned for the observatory's post-launch operations could be applied to finish assembly and testing of the spacecraft on Earth, Zurbuchen said. If the budget ends up well above NASA's previous expectation, the impacts to the agency's other science missions could be more severe, assuming Congress gives the green light to proceed with the observatory's final testing and launch.

Zurbuchen and his deputy in NASA's science mission directorate, Dennis Andrucyk, said a series of problems beset the observatory's spacecraft module over the last year.

"There have been a couple of technical challenges … primar-

ily in the propulsion system, we've had a schedule delay due to a transducer that was incorrectly powered," Andrucyk said. "We needed to replace that. That resulted in a three-month hit. Incorrect solvent was run through prop system. As a result, we wound having to replace valves in that system, and a catalyst bed heater was accidentally overstressed (at the wrong voltage) and needed to be replaced."

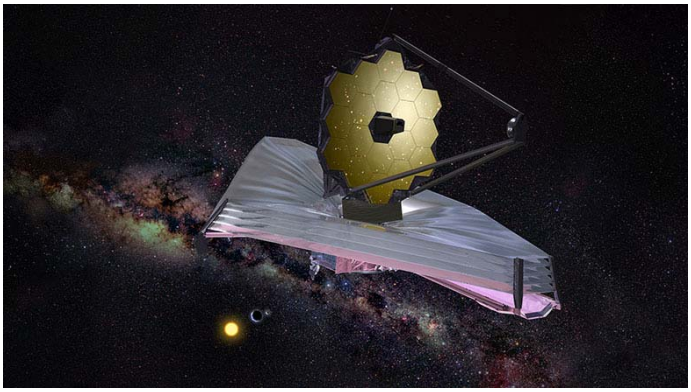
Andrucyk characterized the propulsion system issues as "avoidable errors."

"The sunshield complications also took a toll on the schedule," he said. "It's a very large five-layer membrane sysstem about the size of a tennis court, and during the deploy, fold and stow operations, the amount of time that we expected to perform those activities took longer than we expected. The first deploy we expected to be two weeks. It wound up being a month, and in the fold and stow, we expected it to be about a month, and it wound up being two months. We have two additional of those deploy, fold and stow operations to go."

Engineers discovered seven tears across five of the sunshield membranes, which will ensure the observatory's detectors and mirrors remain protected from heat and light from the sun, keeping parts of the spacecraft as cold as minus 370 degrees Fahrenheit, or minus 223 degrees Celsius. Internal coolers will chill some of the telescopes's sensors even colder.

"Also, the sunshield tensioning system, the cables that hold the sunshield membrane into its shape, developed too much slack during the deployment, creating a snagging hazard," Zurbuchen said. "So they had to redesign how the cables straddle certain parts of the boom so that wouldn't happen."

The sunshield tears have been repaired, officials said.



Artist's concept of the James Webb Space Telescope in its fully deployed configuration. Credit: NASA/Space Telescope Science Institute

Once the telescope and spacecraft sections are connected, ground crews at Northrop Grumman will again deploy the sunshield, along with the telescope's unfoldable wings and other structures, then put the entire observatory through electrical, vibration and acoustic tests. After those checks are complete, technicians will unfurl the full observatory once more before stowing it into launch configuration.

The testing is geared toward ensuring the mission's post-launch deployments go off without a hitch.

The sunshield and mirror will fold up origami-style to fit inside the envelope of the European Ariane 5 rocket that will launch JWST from French Guiana. The Ariane 5 launcher is one of the European Space Agency's major contributions to the mission, along with key instrument hardware.

Depending on how you count, JWST will have more than 300 deployments after it separates from from the upper stage of the Ariane 5 launcher. Counting steps in a similar way, the Curiosity Mars rover had around 70 deployments.

"Webb is really complex," Zurbuchen said. "Extensive and rigorous testing is necessary to ensure that we have a launch, deployment and checkout that succeeds with high confidence.

"Webb will journey to an orbit about a million miles from the Earth, four times farther than the moon," Zurbuchen said. "Simply put, we have one shot to get this right before going into space. You've heard this before, and it rings true for Webb, for us, really failure is not an option."

Andrucyk said NASA Headquarters will have more oversight over JWST in the future, including direct interaction with Northrop Grumman's president and chief operating officer.

NASA will also dispatch a project manager to Northrop Grumman's factory in Southern California on a permanent basis, along with additional NASA spacecraft integration and test experts during critical operations.

NASA will also have daily and weekly schedule reviews with Northrop Grumman, which will also revamp its management structure. Northrop Grumman is also making personnel changes and updating procedures.

Andrucyk said Tuesday at a meeting at the National Academies of Sciences that some of the recent JWST problems "were driven by poorly written procedures."

"Northrop Grumman remains steadfast in its commitment to NASA and ensuring successful integration, launch and deployment of the James Webb Space Telescope, the world's most advanced space telescope," Northrop Grumman said in a statement.

An independent review board chaired by Thomas Young, a space industry veteran who served as an executive at Lockheed Martin and as mission director of NASA's Viking Mars landers, will help the space agency confirm a new target launch date and cost figure for JWST.

NASA's standing review board estimated the mission could be ready for launch by April 30, 2020, at a 70 percent confidence level, Andrucyk said at the National Academies of Sciences' Space Science Week meeting Tuesday. That led the agency's leaders to announce the mission was likely off until May 2020.

For the record, Andrucyk said, NASA's standing review board — comprised of engineers and managers not part of the JWST program — concluded the mission could launch in January 2020 with 30 percent confidence.

"Today's announcement that the James Webb Space Telescope launch will slip again and likely go over the $8 billion development cost cap is disappointing and unacceptable," said Rep. Lamar Smith (R-Texas), chairman of the House Science Committee.

Smith added in a statement that the delays and cost overruns "undermine confidence in NASA and its prime contractor, Northrop Grumman."

"NASA must keep their promises to the American taxpayers," Smith said. "Every time a mission is delayed or goes over budget, it negatively affects other science missions. This includes delays, cancellations and de-scoping of other missions. Those effects ripple out within NASA and through the entire scientific community.

"The James Webb Space Telescope is a crucial project and an investment in our future," Smith concluded in his statement. "I expect it to be completed within the cap and launched as close to on schedule as possible so we can look forward to the incredible discoveries it will bring."

The observatory survived a brush with cancellation by lawmakers in 2011, who proposed zeroing the mission's budget.

An independent review in 2010 found that the mission needed more money to maintain a target launch date in 2015, and NASA and Congress eventually agreed to aim for JWST's launch in 2018, with additional funding to give managers a budget reserve to handle potential technical issues.

That funding reserve may prove insufficient, and officials admitted Tuesday that a 2018 launch was based on an optimistic schedule.

The Webb mission is set to become the most expensive robotic science mission ever launched. The observatory's primary mirror — which collects light from astronomical sources — is nearly three times the diameter of Hubble's, and no other observatory of JWST's size is planned for launch until at least the 2030s.

Webb will enable "science that will look at the universe in a way we have never seen it," Zurbuchen said.

With another announcement that Webb's costs are rising, some worry that the mission's budget will hamstring NASA's ability to secure approval for future flagship-class science missions. Zurbuchen said missions like JWST have strong

value, pushing frontiers in technology and scientific productivity that make future probes possible.
“One conclusion you could make is you shouldn’t do complex missions like this,” Zurbuchen said Tuesday afternoon at the National Academies of Sciences. “I will tell you that this would be a very grave and wrong assumption. At NASA, and together with our international partners, we should push the envelope.
“What we should do is not make stupid mistakes,” he said. ‘We should learn as we go, as fast as we can.”

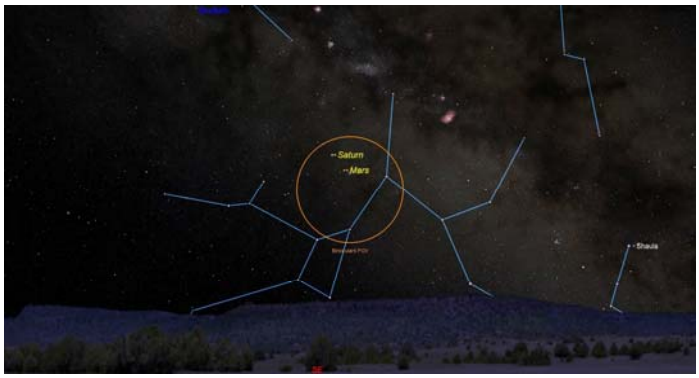
Brightest Planets in April's Night Sky: How to See them (and When)

By Joe Rao, Space.com Skywatching Columnist | April 2, 2018 07:00am ET

As April kicks off, be sure to check out the predawn south-southeast sky for a beautifully close and colorful pairing-off of Mars and Saturn. They'll be joined by the moon on the 7th and then grow noticeably farther apart as the month progresses. Venus slowly climbs higher in the western twilight sky during April, while Jupiter begins to call attention to itself to evening skywatchers as it rises progressively earlier each evening. Finally, Mercury, which enjoyed the company of Venus in March, sweeps into the morning skies of April, but is low and rather difficult to see even at its greatest elongation near month's end.
In our schedule, remember that when measuring the angular separation between two celestial objects, your clenched fist held at arm's length measures roughly 10 degrees. Here, we present a schedule below which provides some of the best planet viewing times as well directing you as to where to look to see them.

On Sunday, April 29, Mercury (orbit shown as a red curve) will reach its widest separation west of the Sun. Due to the shallow morning ecliptic (green line), this will be a very poor pre-dawn apparition for Northern Hemisphere skywatchers, but a very good one for those in the Southern Hemisphere.
Credit: Starry Night software
Mercury – is in inferior conjunction on April 1st, passing between the sun and the Earth. In the days that follow, the innermost planet is too faint to be glimpsed at dawn until mid-April. By April 29th, Mercury reaches greatest western elongation, 27 degrees from the sun. However, as viewed from mid-northern latitudes, this will be *the most unfavorable morning apparition* of 2018 because it will positioned well to the south of the sun. This shy planet shines at +0.5 magnitude and is only about 10° above the horizon at sunup and rises less than an hour before the Sun.

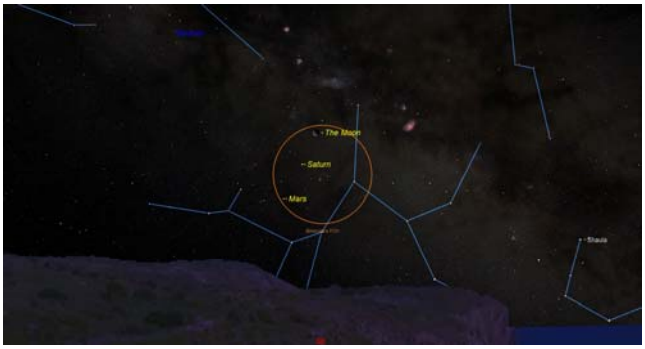
Low in the western sky for about 90 minutes after sunset on Tuesday, April 17, the very young crescent moon will be visible sitting six degrees to the lower left of bright Venus. The pair will fit within the field of view of binoculars (orange circle) and make a lovely photo opportunity.
Credit: Starry Night software
Venus – Earth's "sister planet" gets a little higher each week during April. It remains small and roundish in telescopes this month, but from early April until early September, Venus will be at least 10 degrees above the horizon 45 minutes after sunset (though never very high), and during that period we will see its disk grow and enter its crescent phase. On April 17th, soon after sunset, look low toward the west-northwest for a view of a slender 2-day old crescent Moon, just 5 percent illuminated. And situated about a half-dozen degrees to its upper right will be the steady, dazzling light of the planet Venus. On April 24th, wait at least an hour after sunset to see the Pleiades star cluster poised beautifully about 3½ degrees to the upper right of Venus (binoculars help). Aldebaran and the Hyades are somewhat farther to the upper left of Venus.



In the southern sky between 3:30 a.m. and dawn on the morning of Monday, April 2, the eastward orbital motion of the red planet Mars will bring it close to yellowish Saturn. With Mars slightly more than 1 degree below Saturn, the two planets will appear equal in brightness and fit together in the field of view of binoculars (orange circle) or a backyard telescope at low magnification. The teapot-shape constellation of Sagittarius will sit directly below the two planets.
Credit: Starry Night software
Mars – is rising earlier and growing brighter as Earth moves up on it from behind. In April, it rises at around 2:15 a.m. local daylight time at the start of the month; closer to 1:30 a.m. at the end. Mars moves along its orbit only 3½ miles per second slower than Earth, on the average. It always tries to outrun us, but we always catch up, placing Mars at opposition every 2.14 years on average. By the end of April, Mars will have closed to within 79 million miles (127 million km) of Earth and will have doubled in brightness to magnitude -0.4. And it will grow more than nine times brighter by the end of July! Early in April Mars will team up with Saturn and later the moon for an eye-catching show (See **Saturn** below for more details).

When the waning gibbous moon rises just before 11 p.m. local time on Monday evening, it will be positioned 4 degrees to the upper right of Jupiter in the constellation of Libra. The pair of naked eye objects will cross the sky together for the rest of the night, eventually moving to a point low in the southwestern pre-dawn sky on Tuesday morning.
Credit: Starry Night software
Jupiter – starts April rising about 90 minutes after the end of evening twilight, but it comes up earlier and earlier each week. As soon as it clears horizon obstructions in the east-southeast, it grabs the attention of any skywatcher. Telescopic views of Jupiter during April are best in the middle of the night, when the planet has gotten at least moderately high. On April 2nd, very late in the evening, look low toward

the east-southeast horizon about an hour before midnight and you'll see a waning gibbous Moon and 8 degrees directly below you'll find "Big Jupe." Through the remainder of the overnight hours of Apr. 2-3, the moon will appear to slowly approach Jupiter at roughly one moon width per hour. Then on April 30th, about an hour after sunset, look low to the east-southeast horizon for the rising of the moon, now one night past full. And about 5 degrees to its upper right, you'll again see Jupiter; the second time it has gotten together with our nearest neighbor this month.

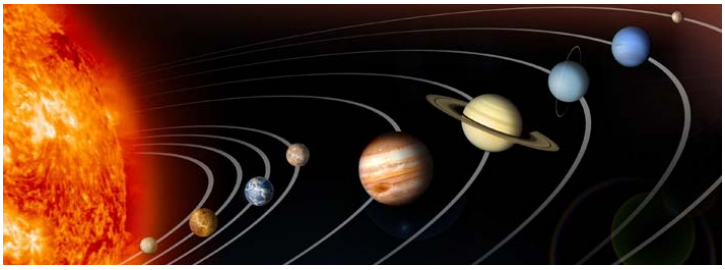


In the southeastern pre-dawn sky on Saturday, April 7, the last quarter moon will form a picturesque linear grouping with Mars and Saturn. Reddish Mars will sit about 5 degrees to the lower left of the moon, with yellowish Saturn roughly midway between them. The trio will appear low over the horizon after 3 a.m. local time. By dawn, they will be higher, and the moon will have shifted closer to Saturn. The trio will fit nicely into the field of view of binoculars, and make a nice photograph.
Credit: Starry Night software

Saturn — rises around 2:15 a.m. local daylight time in early April, and around 12:15 a.m. at month's end. Three hours later it is shining more than 20 degrees up in the southeast – providing an eerily beautiful end for a late-night telescopic observing session. Saturn's rings are still tilted enough this year (25.5 degrees at midmonth) to show above the planet's north pole and cover its south pole. Because Saturn is still two months away from opposition, it casts its shadow westward onto the rings. Check out the southeast sky a few hours before sunrise on April 2nd, as Mars slips 1.3 degrees to the south of Saturn. The two planets are all the more eye catching because they appear at practically the same in brightness (Mars is magnitude +0.3, while Saturn is just a trifle dimmer at +0.4), while also presenting a striking color contrast: Saturn is a baleful yellow, while Mars glows a fiery orange-red Both planets will be shining just to the upper left of the top of the lid of the Teapot in Sagittarius. On April 7th, although Mars and Saturn have noticeably separated since their pairing off five days ago, they are now joined this morning by the moon, just one day from its half or last quarter phase. The Mars-Saturn-Moon trio are arranged diagonally in that order, from lower left to upper right spanning 5 degrees. Mars and Saturn are separated by 3 degrees, while Saturn and the moon are separated by 2 degrees.

Gas Giants: Facts About the Outer Planets

By Elizabeth Howell, Space.com Contributor | March 29, 2018 10:00pm ET



The planets of the solar system as depicted by a NASA computer illustration. Orbits and sizes are not shown to scale.
Credit: NASA

A gas giant is a large planet composed mostly of gases, such as hydrogen and helium, with a relatively small rocky core. The gas giants of our solar system are Jupiter, Saturn, Uranus and Neptune. These four large planets, also called jovian planets after Jupiter, reside in the outer part of the solar system past the orbits of Mars and the asteroid belt. Jupiter and Saturn are substantially larger than Uranus and Neptune, and each pair of planets has a somewhat different composition.

Although there are only four large planets in our solar system, astronomers have discovered thousands outside of it, particularly using NASA's Kepler Space Telescope. These exoplanets (as they are called) are being examined to learn more about how our solar system came to be.

Basic facts

Jupiter is the largest planet in our solar system. It has a radius almost 11 times the size of Earth. It has 50 known moons and 17 waiting to be confirmed, according to NASA. The planet is mostly made of hydrogen and helium surrounding a dense core of rocks and ice, with most of its bulk likely made up of liquid metallic hydrogen, which creates a huge magnetic field. Jupiter is visible with the naked eye and was known by the ancients. Its atmosphere consists mostly of hydrogen, helium, ammonia and methane. [Related: Planet Jupiter: Facts About Its Size, Moons and Red Spot]

Saturn is about nine times Earth's radius and is characterized by large rings; how they formed is unknown. It has 53 known moons and nine more awaiting confirmation, according to NASA. Like Jupiter, it is mostly made up of hydrogen and helium that surround a dense core and was also tracked by ancient cultures. Its atmosphere is similar to Jupiter's. [Related: Planet Saturn: Facts About Saturn's Rings, Moons & Size]

Uranus has a radius about four times that of Earth's. It is the only planet tilted on its side, and it also rotates backward relative to every planet but Venus, implying a huge collision disrupted it long ago. The planet has 27 moons, and its atmosphere is made up of hydrogen, helium and methane, according to NASA. It was discovered by William Herschel in 1781. [Related: Planet Uranus: Facts About Its Name, Moons & Orbit]

Neptune also has a radius about four times that of Earth's. Like Uranus, its atmosphere is mostly made up of hydrogen, helium and methane. It has 13 confirmed moons and an additional one awaiting confirmation, according to NASA. It was discovered by several people in 1846. [Related: Planet Neptune: Facts About Its Orbit, Moons & Rings]

Super-Earths: Scientists have found a multitude of "super-Earths" (planets between the size of Earth and Neptune) in other solar systems. There are no known super-Earths in our own solar system, although some scientists speculate there may be a "Planet Nine" lurking in the outer reaches of our solar system. Scientists are studying this category of planets to learn whether super-Earths are more like small giant planets or big terrestrial planets.

Formation and similarities

Astronomers think the giants first formed as rocky and icy planets similar to terrestrial planets. However, the size of the cores allowed these planets (particularly Jupiter and Saturn) to grab hydrogen and helium out of the gas cloud from which the sun was condensing, before the sun formed and blew most of the gas away.

Since Uranus and Neptune are smaller and have bigger or-

bits, it was harder for them to collect hydrogen and helium as efficiently as Jupiter and Saturn. This likely explains why they are smaller than those two planets. On a percentage basis, their atmospheres are more "polluted" with heavier elements such as methane and ammonia because they are so much smaller.

Scientists have discovered thousands of exoplanets. Many of these happen to be "hot Jupiters," or massive gas giants that are extremely close to their parent stars. (Rocky worlds are more abundant in the universe, according to estimates from Kepler.) Scientists speculate that large planets may have moved back and forth in their orbits before settling into their current configuration. But how much they moved is still a subject of debate.

There are dozens of moons around the giant planets. Many formed at the same time as their parent planets, which is implied if the planets rotate in the same direction as the planet close to the equator (such as the huge Jovian moons Io, Europa, Ganymede and Callisto.) But there are exceptions.

One moon of Neptune, Triton, orbits the planet opposite to the direction Neptune spins — implying that Triton was captured, perhaps by Neptune's once larger atmosphere, as it passed by. And there are many tiny moons in the solar system that rotate far from the equator of their planets, implying that they were also snagged by the immense gravitational pull.

Current research

Jupiter: NASA's Juno spacecraft arrived at the planet in 2016 and has already made several discoveries. It studied the planet's rings, which is difficult to achieve since they are far subtler than Saturn's. Juno discovered that the particles influencing the auroras of Jupiter are different than those on Earth. It also revealed insights about the atmosphere, such as finding snow emanating from high-altitude clouds. Meanwhile, scientists using the Hubble Space Telescope have made detailed studies of Jupiter's Great Red Spot, watching it shrink and intensify in color.

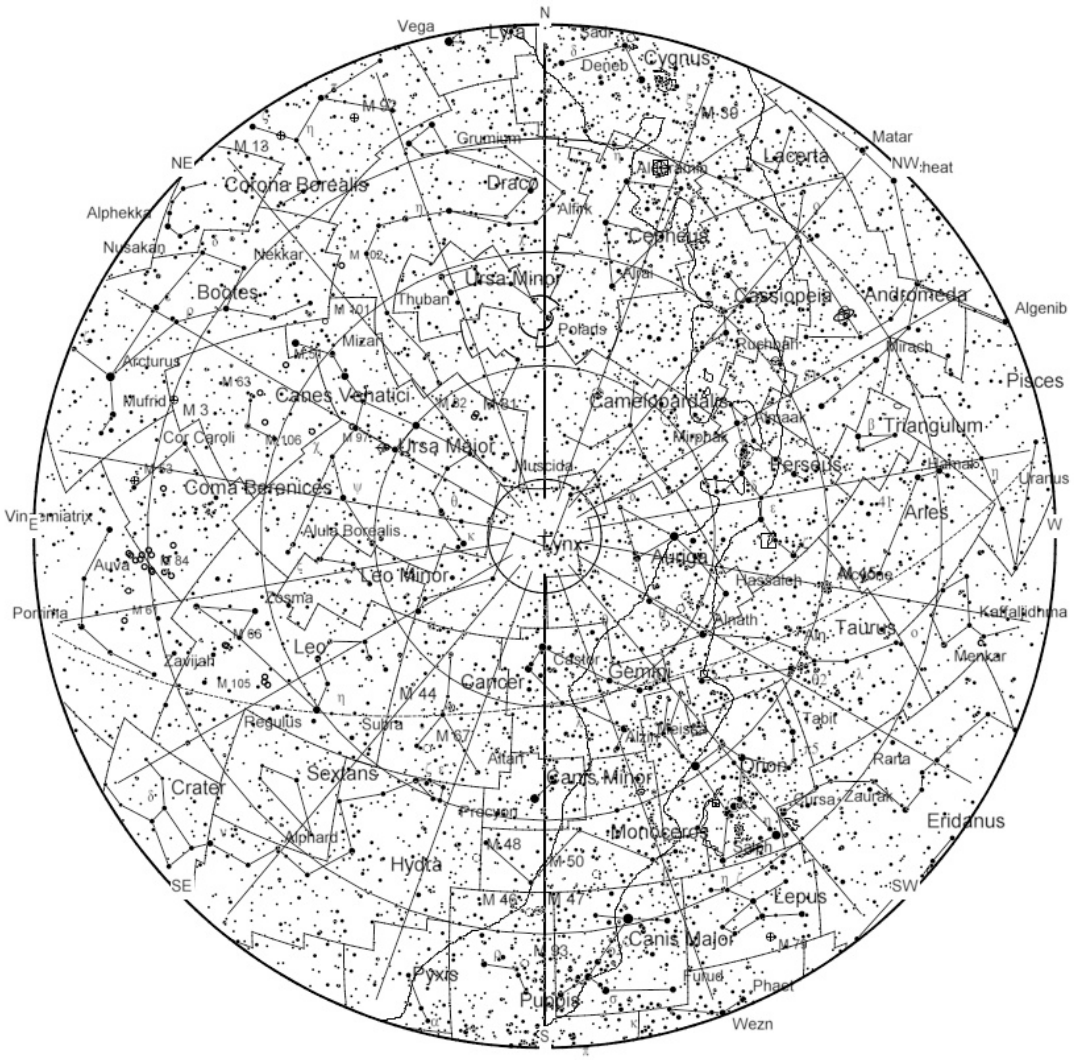
Saturn: The Cassini spacecraft wrapped up more than a dozen years of observation at Saturn in 2017. But the science Cassini performed is still very much in progress, as scientists analyze work from its many years at Saturn. In its latter months, the mission examined Saturn's gravity and magnetic fields, looked at the rings from a different angle than before, and plunged into the atmosphere deliberately (a move that will reveal more about the structure of the atmosphere.)

Uranus: The storms of Uranus are a frequent target for both professional telescopes and amateur astronomers, who monitor how they evolve and change over time. Scientists are also interested in learning about the structure of its rings, and what its atmosphere is made of. Uranus may also have several Trojan asteroids (asteroids in the same orbit as the planet); the first was found in 2013.

Neptune: Storms on Neptune are also a popular observing target, and in 2018 those observations again bore fruit; work from the Hubble Space Telescope showed that a long-standing storm is now shrinking. The researchers noted the storm is dissipating differently than what their models expected, which shows that our understanding of Neptune's atmosphere still requires refinement.

Exoplanets: Many ground telescopes search for exoplanets. There are also several active space missions performing exoplanet research, including Kepler, the Hubble Space Telescope and the Spitzer Space Telescope. A flurry of new missions is also planned: the NASA Transiting Exoplanet Survey Satellite (TESS) in 2018, the NASA James Webb Space Telescope in 2020, the European Space Agency's PLAnetary Transits and Oscillations of stars (PLATO) in 2026 and ESA's Atmospheric Remote-sensing Infrared Exoplanet Large-survey mission (Ariel) in 2028.

WHATS UP, APRIL 2018



April 16 - **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 01:58 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

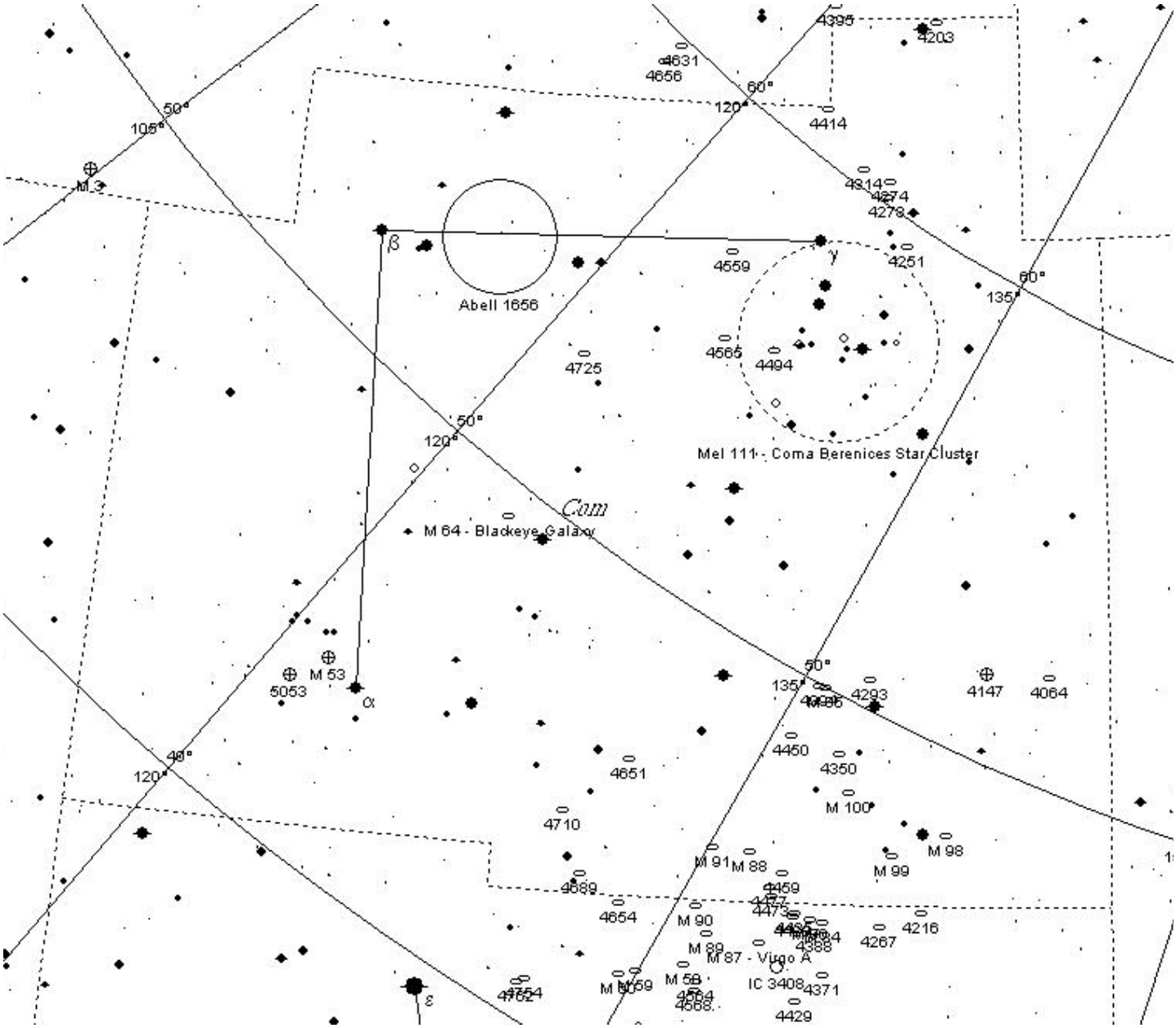
April 22, 23 - **Lyrids Meteor Shower.** The Lyrids is an average shower, usually producing about 20 meteors per hour at its peak. It is produced by dust particles left behind by comet C/1861 G1 Thatcher, which was discovered in 1861. The shower runs annually from April 16-25. It peaks this year on the night of the night of the 22nd and morning of the 23rd. These meteors can sometimes produce bright dust trails that last for several seconds. The first quarter moon will set shortly after midnight, leaving dark skies for the what could be a good show. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Lyra, but can appear anywhere in the sky.

April 29 - **Mercury at Greatest Western Elongation.** The planet Mercury reaches greatest western elongation of 27 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the morning sky. Look for the planet low in the eastern sky just before sunrise.

April 30 - **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 00:58 UTC. This full moon was known by early Native American tribes as the Full Pink Moon because it marked the appearance of the moss pink, or wild ground phlox, which is one of the first spring flowers. This moon has also been known as the Sprouting Grass Moon, the Growing Moon, and the Egg Moon. Many coastal tribes called it the Full Fish Moon because this was the time that the shad swam upstream to spawn.

Clear Skies
Andy

CONSTELLATIONS OF THE MONTH: Coma Berenices



Transit Date of principal star:
9 April

Coma Berenices refers to a classical story concerning the hair of Berenice, the wife of Ptolemy III of Egypt. While the story is an old one, the constellation is relatively new, being introduced by Tycho Brahe (1546-1601).

According to the story, Ptolemy had waged a long war on the Assyrians, since it was they who had killed his sister. As Ptolemy returned successfully from the war, his wife Berenice had her beautiful tresses ceremoniously clipped and given to Aphrodite, laid out on the temple altar.

As the evening's festivities continued, the shorn hair was discovered to be missing. The priests might be sacrificed, if the queen's hair couldn't be found. It was the astronomer Conon of Samos who came to their rescue - proclaiming that Aphrodite had accepted the gift of Berenice's hair, which now shown brightly in the heavens next to Leo.

The stars that form the constellation really aren't that remarkable to look at, only a handful of fourth-magnitude stars, including three Bayer stars. Yet there are several fine binaries, eight Messier objects and the Coma Star cluster, not included in Messier's list.

From *Denebola (beta Leonis)* draw a line to the bright star to the southeast, *Arcturus (alpha Bootis)*. Alpha Comae is found on this line at about the midpoint.

Now proceed north from *alpha Comae* to *beta Comae* and then west about the same distance to *gamma Comae*. These three stars form half of a nearly perfect square. They aren't very prominent, and you will have to have a nice dark night in order to study them.

Alpha Comae, sometimes called *Diadem*, has the same diameter as our Sun, and is 62 light years away with a luminosity of nearly three. It's a rapid motion binary (see below) and in the same field is the globular cluster M53 (see below).

Beta Comae is actually the brightest star in the constellation, and certainly the closest at 27 light years. It too has a diameter equal to the Sun.

Gamma Comae is an orange star about 260 light years away. It is in the same region as the well-known Coma Star Cluster, but isn't a member of that group.

Double stars in Coma Berenices:

Alpha Comae is a rapid binary of two equal stars (5.05, 5.08). The companion orbits every 25.87 years and is presently decreasing; the current (2000) separation is less than 0.05". The orbit is an unusual one, seen perfectly edge-on.

Zeta Comae is a fixed binary: (6.0, 7.5; PA 237º, separation 3.6").

17 Comae and *24 Comae* are two binaries with contrasting companions.

17 Comae is one of the members of the Coma Star Cluster. The primary is white, the companion a soft blue: 5.3, 6.6; PA 251º, separation 145.3".

From *gamma Comae* follow the slight arc of stars south that bend to the east. First comes 14 Comae, then 15, and finally 17.

24 Comae is even more spectacular: a fixed binary with an orange primary and emerald component. (5.2, 6.5; PA 271º, separation 20.3").

This binary is located eight degrees west of alpha Comae and one degree north.

35 Comae is a slow double with an orbit of over 300 years. However, unlike most long period binaries, this one is presently quite close. The companion is beginning to emerge from its close pass with the primary, gradually lengthening its separation, recently having achieved one arc second of separation. The present values are: 5.2, 7.2; PA 185º and separation 1.04".

35 Comae is in a fairly barren part of the sky, found five degrees northwest of alpha Comae.

Struve 1633 is a very pleasant fixed binary: 7.1, 7.2; PA 245º, separation 9.0". To find it start from *gamma Comae*, then drop down exactly one degree south where you'll find 14 Comae. Struve 1633 is one degree to the west.

Struve 1639 is a closer binary: 6.8, 7.8; PA 327º, 1.6". This is a slow moving binary with an orbit of 678 years.

This double star makes a small triangle with 12 Comae and 13 Comae. Start at 14 Comae and look south. The bright star to the east is 15 Comae, while below this and to the west is 13 Comae. Nearby, immediately southwest, is 12 Comae. Now look between these two stars to the southeast, where you'll find the third point in the triangle. This is Struve 1639. (Not shown on the chart due to crowding.)

Variable stars in Coma Berenices:

The constellation doesn't have a wealth of variable stars. We list the two variables that might be of some interest.

13 Comae is an alpha-CV type variable with very small range (5.15-5.18).

R Comae is a long-period variable with period of 362.82 days, and range of 7.1 to 14.6. Thus the maximums are nearly a year apart. In the year 2000 the maximum should occur in the first week of December.

Deep Sky Objects in Coma Berenices:

There are eight Messier objects (M53, M64, M85, M88, M91, M98, M99, and M100), as well as a number of other fine galaxies, with NGC 4565 being the best of the bunch.

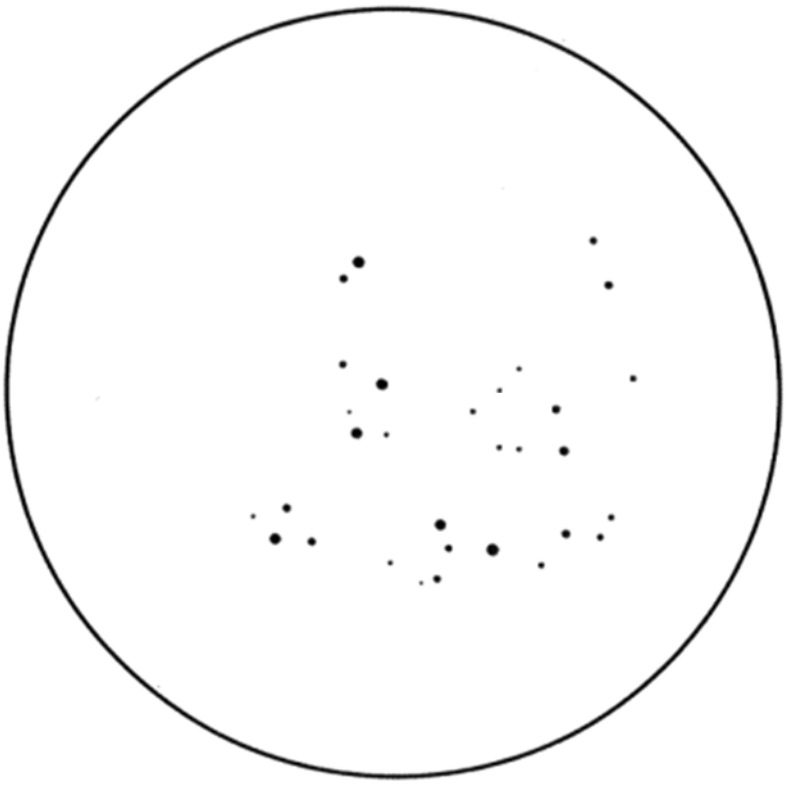
However the best object is the unrivalled open cluster known as 'The Coma Star Cluster'.

The Coma Star Cluster

Best seen in binoculars, the cluster fills the entire field of view: about 40 stars spread out over a five degree area.

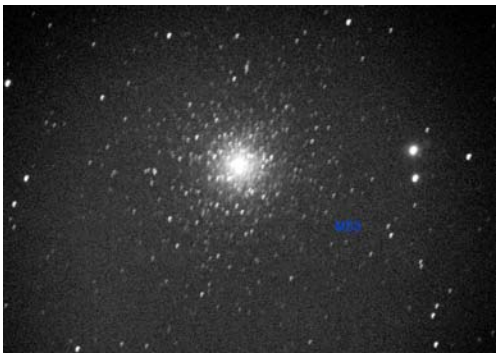
The cluster was once known as the tuft of hair at the end of Leo's tail. It now constitutes Berenice's golden tresses.

The cluster extends south from *gamma Com* (which is not, however, a member). At about 270 light years away, the cluster is one of the closest to our solar system.

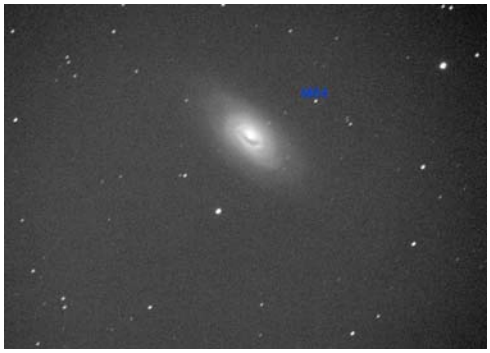


The brightest member of the cluster is 12 Comae. Other fourth-magnitude members are 13 and 14 Comae, and another thirty or so fainter stars go to make this one of the loveliest sight in the heavens.

The Messier Objects in Coma Berenices



M53 is a globular star cluster one degree northeast of *alpha Comae*. The brightest Messier in the constellation (7.7), it tends to be most impressive with larger telescopes, which are needed to resolve the individual stars. The cluster is thought to be 65,000 light years away.



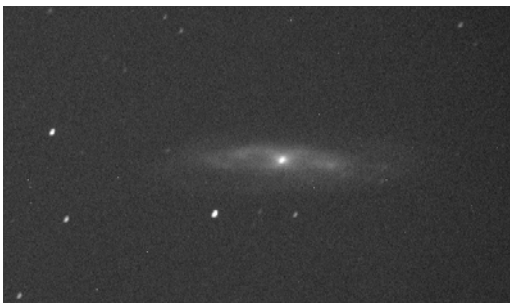
M64, the *Black Eye Galaxy*, is a bright (8.5) compact spiral one degree east-northeast of 35 Comae. The "black eye" can only be seen under ideal conditions with large telescopes. The galaxy is over 20 million light years away.

M85 is a bright spiral galaxy and member of the Virgo Galaxy Cluster, most of which is found about five degrees further

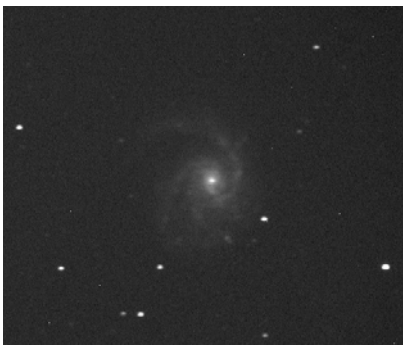
south. All the remaining deep sky objects discussed also belong to this cluster.

M88 is a many-armed spiral galaxy some forty million light years away. Quite bright (9.5), it's a favourite with many Messier observers.

M91 (NGC 4548) is another spiral galaxy, but is a rather confusing object, sometimes being labelled M58. It is a rather faint galaxy (10.2) and one wonders why, with so many galaxies in the region, spreading down through Virgo, that this one was chosen by Messier.



M98 is a faint (10.1) spiral seen practically edge-on, lying just half a degree west of 6 Comae.



M99 is roughly one and a half degrees east-southeast of M98. An open spiral seen face on, its several arms are visible in large scopes. It has a brightness of 9.8.

M100 is the largest of these spiral galaxies, although difficult to appreciate in small telescopes. It's seen face-on, and has a brightness of 9.4.

NGC 4565 is a well-known edge-on spiral with highly visible dust lane from end to end. It's the largest galaxy of its type and has a visual magnitude of 9.6. The galaxy is found one degree due east of 17 Comae.

Coma Berenices has many more deep sky objects, particularly the southern regions, where it borders Virgo. This is a fertile part of the sky to investigate, as the evenings grow a little warmer and more inviting.

All pictures be Andy Burns using various scopes and mainly Atik 372 camera, final colour shot of ngc 4565 was taken this March using DSLR.

ISS PASSES For April/May 2018 From Heavens Above website maintained by Chris Peat

Date	Brightness	Start	Highest point		End					
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
03 Apr	-3.8	20:38:32	10°	W	20:41:50	87°	N	20:44:38	14°	E
03 Apr	-2.5	22:15:03	10°	W	22:17:17	33°	WSW	22:17:17	33°	WSW
04 Apr	-3.7	21:22:44	10°	W	21:25:59	61°	SSW	21:27:03	37°	SE
05 Apr	-3.8	20:30:25	10°	W	20:33:42	78°	SSW	20:36:49	11°	ESE
05 Apr	-2.2	22:07:05	10°	W	22:09:28	25°	SW	22:09:28	25°	SW
06 Apr	-2.9	21:14:37	10°	W	21:17:44	38°	SSW	21:19:15	23°	SSE
07 Apr	-3.4	20:22:14	10°	W	20:25:28	54°	SSW	20:28:41	10°	ESE
07 Apr	-1.5	21:59:26	10°	WSW	22:01:26	15°	SW	22:01:42	15°	SSW
08 Apr	-2.0	21:06:38	10°	W	21:09:18	23°	SW	21:11:32	12°	SSE
10 Apr	-1.2	20:59:09	10°	WSW	21:00:44	13°	SW	21:02:18	10°	SSW
04 May	-1.4	04:48:46	10°	S	04:50:40	15°	SE	04:52:34	10°	ESE
06 May	-2.2	04:38:42	10°	SSW	04:41:27	25°	SSE	04:44:14	10°	E
07 May	-1.7	03:47:40	14°	S	03:48:58	17°	SE	03:51:09	10°	E
08 May	-1.2	02:56:50	10°	SE	02:56:50	10°	SE	02:57:10	10°	SE
08 May	-3.1	04:29:27	12°	SW	04:32:17	42°	SSE	04:35:25	10°	E
09 May	-2.6	03:38:33	22°	S	03:39:41	28°	SSE	03:42:34	10°	E
10 May	-1.9	02:47:36	18°	SE	02:47:36	18°	SE	02:49:33	10°	E
10 May	-3.7	04:20:12	12°	WSW	04:23:10	64°	SSE	04:26:26	10°	E
11 May	-3.4	03:29:13	29°	SSW	03:30:28	46°	SSE	03:33:38	10°	E
12 May	-2.8	02:38:11	31°	SE	02:38:11	31°	SE	02:40:48	10°	E
12 May	-3.9	04:10:46	10°	WSW	04:14:03	85°	S	04:17:21	10°	E

END IMAGES, OBSERVING AND OUTREACH

The planets Venus left and Mercury right just seen setting into the tree, March 19th. Evening light..

Messier Quiz Answers

1. Answer A: Virgo has 11, Sagittarius has 15.
2. Answer B: M45, size 110, Andromeda is 178.
3. Answer B: M1 in Taurus.
4. Answer C: M102.
5. Answer C: M7 at -34.49 Dec.
6. Answer C: M82 at +69.41 Dec.
7. Answer A: M30, cannot be seen from UK if doing marathon in March.
8. Answer C: M25, IC4725 in Sagittarius.
9. Answer B: M65 & M66 together with NGC 3628.
10. Answer B: Others were added in 20th century, he made notes about them.
11. Answer C: 35 with 26 for Open and 24 for Globular clusters.

Wiltshire Astronomical Society Observing Sessions 2017 – 2018		
Date	**Moon Phase**	**Observing Topic**
2018		
20th April	Waxing Crescent	Deep sky objects in the Great Bear and Leo
18th May	Slim Crescent	Jupiter low in the south east, and the return of the Summer Triangle

OUTREACH ACTIVITIES

Arrangements being made with several schools, but dates tbc.