NWASNEWS

Volume21, Issue 7

March 2016

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

Gravitational Waves, Meteors and Mars

On September 14, 2015 at 5:51 a.m. Eastern Daylight Time (09:51 UTC), the twin Laser Interferometer Gravitational-wave Observatory (LIGO) detectors, located in Livingston, Louisiana, and Hanford, Washington, USA both measured ripples in the fabric of spacetime – gravitational waves – arriving at the Earth from a cataclysmic event in the distant universe. The new Advanced LIGO detectors had just been brought into operation for their first observing run when the very clear and strong signal was captured.

This discovery comes at the culmination of decades of instrument research and development, through a world-wide effort of thousands of researchers, and made possible by dedicated support for LIGO from the National Science Foundation. It also proves a prediction made 100 years ago by Einstein that gravitational waves exist. More excitingly, it marks the beginning of a new era of gravitational wave astronomy – the possibilities for discovery are as rich and boundless as they have been with light -based astronomy.

The two merging black holes are each roughly 30 times the mass of the sun, with one slightly larger than the other. The event took place 1.3 billion years ago.

The stars appear warped due to the incredibly strong gravity of the black holes. The black holes warp space and time, and this causes light from the stars to curve around the black holes in a process called gravitational lensing. The ring around the black holes, known as an Einstein ring, arises from the light of all the stars in a small region behind the holes, where gravitational lensing has smeared their images into a ring.

The gravitational waves themselves would not be seen by a human near the black holes and so do not show in this video, with one important exception. The gravitational waves that are traveling outward toward the small region behind the black holes disturb that region's stellar images in the Einstein ring, causing them to slosh around, even long after the collision. The gravitational waves traveling in other directions cause weaker, and shorter-lived sloshing, everywhere outside the ring.

More in the Space news section.

We have also had two big meteor/bolide incursions into the Earths atmosphere, the first last week landing somewhere in the South Atlantic. This was larger than Chelynabinsk meteorite of 2014, but no ripple in the waves was detected onshore. Another fireball lit up the skies in Scotland above the skies of Glen Livet (hope it missed the fine distilleries) but it probably landed in the sea, Nick has abandoned his shovel.

But any one of these non-meteor showers meteors could be income debris from a young Moon or Mars. On of these Martian meteorites picked up from the surface of a glacier on Mars in 1987 was later to cause a stir as possible signs of former life were found inside the meteorite.

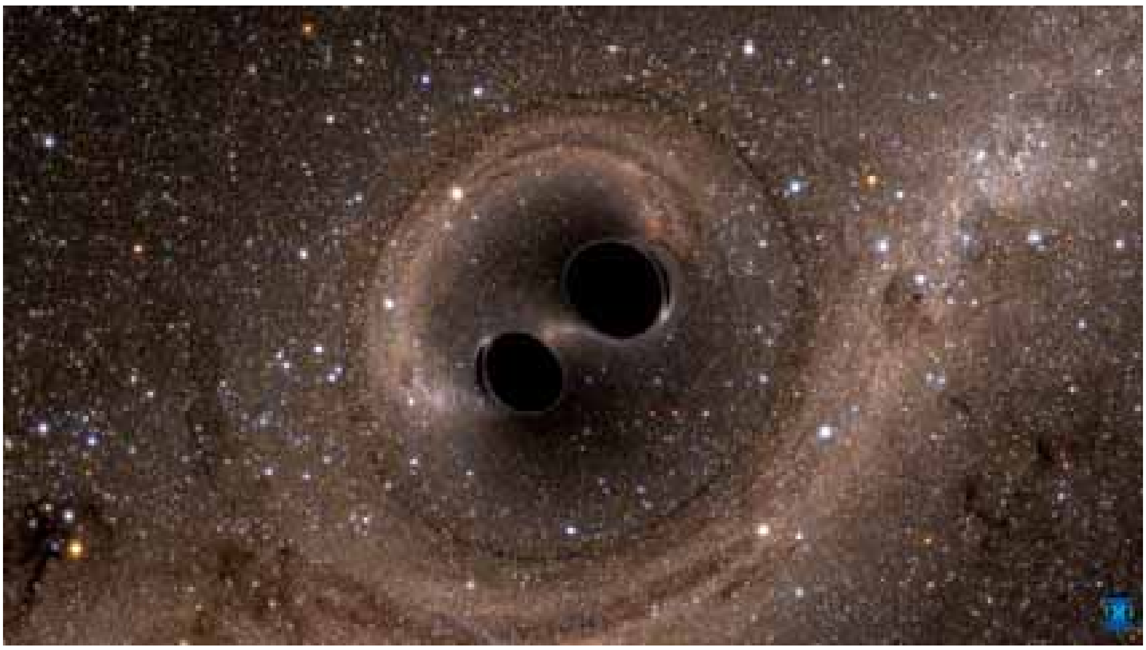
Detecting life on Mars has not burn the aim of any of the landers other than the Beagle 2 mission. Tonight's speaker, Dr Mark Sims worked on this project and he is working on many detection systems some of which cross over into diseasedetection.

Clear skies Andy

Two Black Holes Merge into One

Image Credit: SXS, the Simulating eXtreme Spacetimes (SXS) project (http://www.black-holes.org)

The collision of two black holes holes—a tremendously powerful event detected for the first time ever by the Laser Interferometer Gravitational-Wave Observatory, or LIGO—is seen in this still from a computer simulation. LIGO detected gravitational waves, or ripples in space and time generated as the black holes spiralled in toward each other, collided, and merged.



Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

Meetings 2015/2016Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

2016

Mar1st *Life on Mars : Professor Mark Sims*

Apr 5th *The Story of Star Names : Mark Hurn*

May 3rd *Oddities of the Solar System : Bob Mizon*

June 7th *The Current State of SETI : Martin Griffiths*

Membership Changes in fees to be discussed. Could be lowered!

Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

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

Vice chair: Keith Bruton

Bob Johnston (Treasurer)

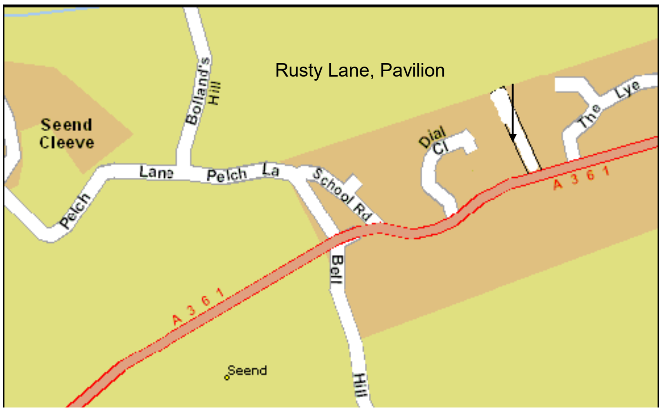
Philip Proven (Hall coordinator)

Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

Observing Sessions coordinators: Jon Gale, Tony Vale

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



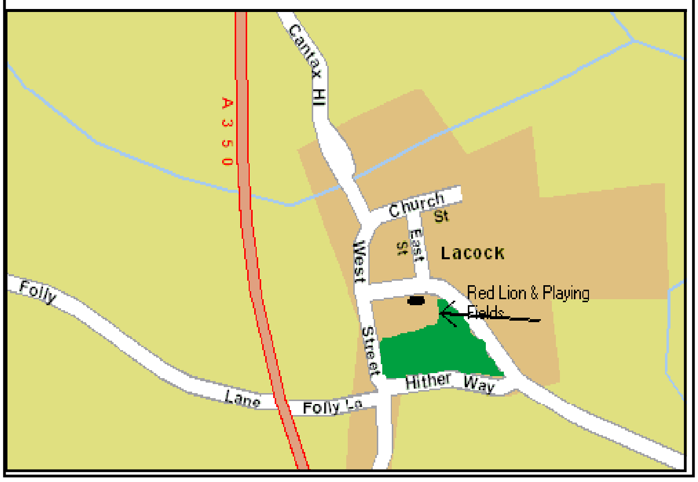
Observing Sessions

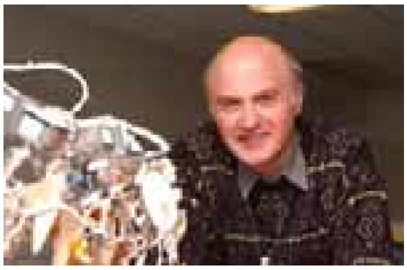
The Wiltshire Astronomical Society's observing sessions are open, and we welcome visitors from other societies as well as members of the public to join us.

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

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

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





Professor Mark Sims

Professor Sims obtained his PhD from the University of Leicester, working on x-ray astronomy shadow cameras. He was an European Space Agency Research Fellow based at ESTEC, Noordwijk, the Netherlands working on high energy x-ray astronomy detectors from May 1981 to January 1984. He returned to Leicester in February 1984 to work as assembly integration and test manager on the German-USA-UK X-ray and XUV ROSAT mission of which he became mission manager for the first year of operations post its launch in June 1990. He then became Leicester project manager for the JET-X ray telescope for the Russian Spectrum-RG mission until the project was cancelled in 1999. From July 1997 until September 2004 he was mission manager for the Beagle 2 Mars lander project (part of ESA's Mars Express mission) responsible for project study management until 1999 and instrumentation and mission operations thereafter. He led the internal inquiry into Beagle 2 following its failure to communicate following landing and its release from Mars Express.

Professor Sims has been involved in 9 space missions over his career with roles from data analysis, through launch site operations to flight operations and acting as Principal Investigator on the LMC project. He is co-director of the Diagnostics Development Unit based at the Leicester Royal Infirmary which is developing techniques for non-invasive diagnosis of disease currently as a screening tool in Accident and Emergency and Acute Care

Swindon Stargazers

Swindon's own astronomy group

The club meets once a month at Liddington Hall, Church Road, Liddington, Swindon, SN4 0HB at 7pm. See programme below.

Let's Celebrate Jupiter!

Jupiter reaches opposition on the 8th March and this is probably one of the best months to view it.

Of particular interest this month is the transit of Jupiter's largest and smallest Galilean moons (Ganymede and Io) on the night of Wednesday 16th March, start looking from 9pm to 10pm to get the best views (if it's clear!).

On the 20th March Jupiter will be close to the waxing Moon, as indeed it was on the 23rd February, a great sight!

For more information on the transit please see the following link:

http://www.swindonstargazers.com/telescope/telescope.htm

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.

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

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

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

Enjoy astronomy at it's best!

Members of the Wiltshire Astronomical Society always welcome!

Meetings for 2016

At Liddington Village Hall, Church Road, Liddington, SN4 0HB – 7pm onwards

The hall has easy access from Junction 15 of the M4, a map and directions can be found on our website at: http://www.swindonstargazers.com/clubdiary/directions01.ht

Friday 18 Mar 2016

Programme: AGM plus a presentation

Friday 15 Apr 2016

Programme: Mark Radice: Observing the Moon

Friday 20 May 2016

Programme: Owen Brazell: Shrouds of Night - Observing Dark Nebulae

Friday 17 Jun 2016

Programme: James Fradgely: How (on Earth) Did Life Start

Friday 16 Sep 2016

Programme: Guy Hurst: Star Clusters

Friday 21 Oct 2016

Programme: Paul Roche: Robotic Astronomy

Friday 18 Nov 2016

Programme: Mike Leggett: Exploration of Mars

Friday 16 Dec 2016

Programme: Christmas Social

Website:
http://www.swindonstargazers.co
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.co.uk
Address: 17, Euclid Street,

Swindon, SN1 2JW

BECKINGTON ASTRONOMICAL SOCIETY

We also have a new website www.beckingtonas.org where details of our programme and other useful information can be found. General enquiries about the society can be emailed to chairman@beckingtonas.org

So our committee is now:

Steve Hill, Chairman/Imaging 01761 435663
John Ball, Vice Chairman 01373 830419
Alan Aked, Treasurer 01373 830232
Rosie Wilks, Secretary 01225445814
Mike Witt, Membership 01373 303784
John Dolton, Telescope Hardware 01225335832

Meetings take place in Beckington Baptist Church Hall (see the location page for details of how to get to us) and start at 7:30pm.

Date	Title	Speaker
18th March	*Ten ways the Universe tries to kill you*	Stephen Tonkin
15th April	*Seven Moons*	Bob Mizon
20th May	*Tales from the Dark Side of the Universe*	Mike Witt
17th June	Annual General Meeting *Member Talks*	

The programme and details of how to contact the society are at www.beckingtonas.org

SALISBURY PLAIN OBSERVING GROUP

Where do you meet?

We meet at a variety of sites, including Pewsey Downs, Everleigh, Bratton Camp, Redhorn Hill and Whitesheet Hill. The sites are cold in winter so you will need warm clothing and a flask. We are always looking for good sites around the edge of the Plain.

Do I join?

No. We are not a club. We meet informally, so aside from contacting our friends to give a yes or no to meeting up, that's it.

I am a beginner—am I welcome?

Of course you are — whether you have a telescope, binoculars or just your eyes, there will be someone to observe with. We have a variety of equipment and are always happy for newcomers to look through.

So I just turn up?

Essentially yes, but please drop us an email as parking can be an issue at some of the meeting areas or at the pubs.

I am more experienced—what's in it for me?

If you have observing experience we prepare a monthly observing list chosen in rotation by the group. We pick some easy objects, some moderate and some tough ones. If you are experienced, why not share what you know?

SPOG OBSERVING SITES

Any ground rules for a session?

Common sense applies in the group; red light is essential to preserve night vision; we park cars so you can leave when you wish and not disturb others with your headlights.

Contact Details

Our Website

www.spogastro.co.uk

Our Email

spogastro@googlemail.com

Twitter

http://twitter.com/SPOGAstro

Facebook

http://www.facebook.com/group.php?gid=119305144780224

SOFTWARE AND APPS

Here is my first foray into this for some time. Where possible I choosing readily available and free software for PCs Macs or Apps for phones.

This first list is for YOU to check and report if it is the software you want me to review, otherwise I will run with my own software choice.

Firstly how do find what is up in the sky at any particuly day/night/time.

There are many sorts of app for the phone (Android or iPhone)

Google Sky Map

Planets

Starmap

Astronomist

Sky Safari Pro (it does have a free version and runs on Macs and iPhones plus Android… not PCs yet.)

How Aurora warnings: Aurora Watch alert works very well this year and gives audable warnings.

Satellite prediction

ProSat

SatelliteAR

ISS Detector

There is even an excellent weather predictor for viewing

Clear Outside for Android showed Fridays viewing window from days in advance.

For Deep Sky Objects, DS Browsers tells you what is up.

And the Moon, Moon HD is OK but for the sky I much prefer the bigger screen versions for the PCs and Macs.

Sky Charts:

Cartes du Ciel

Stellarium both free

Sky Safari Pro

Or the Sky are the expensiveoptions but give you so much more information.

The Moon on PCs and MACs there is one standout programme and it is free. Virtual Moon Atlas.

There are others I know, but these keep me informed and allow viewing session planning. Next month some image processing software.

Andy

The Closest New Stars To Earth

By Ethan Siegel

Image credit: NASA and ESA Hubble Space Telescope. Acknowledgements: Kevin Luhman (Pennsylvania State University), and Judy Schmidt, of the Chamaeleon cloud and a newly-forming star within it—HH 909A—emitting narrow streams of gas from its poles.

When you think about the new stars forming in the Milky Way, you probably think of the giant star-forming regions like the Orion Nebula, containing thousands of new stars with light so bright it's visible to the naked eye. At over 400 parsecs (1,300 light years) distant, it's one of the most spectacular sights in the night sky, and the vast majority of the light from galaxies originates from nebulae like this one. But its great luminosity and relative proximity makes it easy to overlook the fact that there are a slew of much closer star-forming regions than the Orion Nebula; they're just much, much fainter.

If you get a collapsing molecular cloud many hundreds of thousands (or more) times the mass of our sun, you'll get a nebula like Orion. But if your cloud is only a few thousand times the sun's mass, it's going to be much fainter. In most instances, the clumps of matter within will grow slowly, the neutral matter will block more light than it reflects or emits, and only a tiny fraction of the stars that form—the most massive, brightest ones—will be visible at all. Between just 400 and 500 light years away are the closest such regions to Earth: the molecular clouds in the constellations of Chamaeleon and Corona Australis. Along with the Lupus molecular clouds (about 600 light years distant), these dark, light-blocking patches are virtually unknown to most sky watchers in the northern hemisphere, as they're all southern hemisphere objects.

In visible light, these clouds appear predominantly as dark patches, obscuring and reddening the light of background stars. In the infrared, though, the gas glows brilliantly as it forms new stars inside. Combined near-infrared and visible light observations, such as those taken by the Hubble Space Telescope, can reveal the structure of the clouds as well as the young stars inside. In the Chameleon cloud, for example, there are between 200 and 300 new stars, including over 100 X-ray sources (between the Chamaeleon I and II clouds), approximately 50 T-Tauri stars and just a couple of massive, B-class stars. There's a third dark, molecular cloud (Chamaeleon III) that has not yet formed any stars at all.

While the majority of new stars form in large molecular clouds, the closest new stars form in much smaller, more abundant ones. As we reach out to the most distant quasars and galaxies in the universe, remember that there are still star-forming mysteries to be solved right here in our own backyard.

SPACE NEWS

Kelly, Kornienko about to wrap up 340 -day mission

Astronaut Scott Kelly and cosmonaut Mikhail Kornienko are making final preparations for return to Earth Tuesday evening, closing out a record 340-day stay aboard the International Space Station where they served as medical test subjects to learn more about the long-term effects of weightlessness, space radiation and isolation.

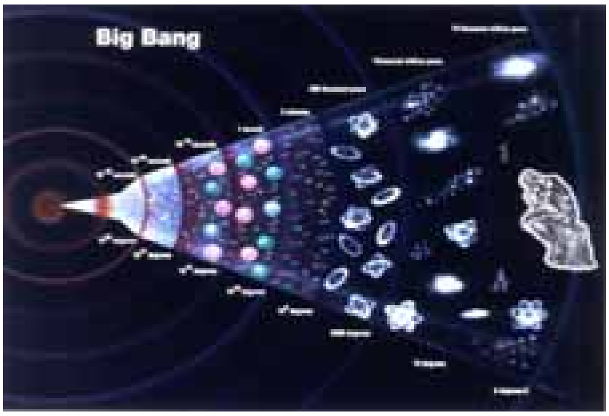
Are Supermassive Black Holes Hiding Matter?

29 Feb , 2016 by Matt Williams

Mapping the Universe with satellites and ground-based observatories have not only provided scientists with a pretty good understanding of its structure, but also of its composition. And for some time now, they have been working with a model that states that the Universe consists of 4.9% “normal” matter (i.e. that which we can see), 26.8% “dark matter” (that which we can’t), and 68.3% “dark energy”.

From what they have observed, scientists have also concluded that the normal matter in the Universe is concentrated in web-like filaments, which make up about 20% of the Universe by volume. But a recent study performed by the Institute of Astro- and Particle Physics at the University of Innsbruck in Austria has found that a surprising amount of normal matter may live in the voids, and that black holes may have deposited it there.

In a paper submitted to the Royal Astronomical Society, Dr. Haider and his team described how they performed measurements of the mass and volume of the Universe’s filamentary structures to get a better idea of where the Universe’s mass is located. To do this, they used data from the Illustris project – a large computer simulation of the evolution and formation of galaxies.



The Big Bang Theory: A history of the Universe starting from a singularity and expanding ever since. Credit: grandunification-theory.com

As an ongoing research project run by an international collaboration of scientists (and using supercomputers from around the world), Illustris has created the most detailed simulations of our Universe to date. Beginning with conditions roughly 300,000 years after the Big Bang, these simulations track how gravity and the flow of matter changed the structure of the cosmos up to the present day, roughly 13.8 billion years later.

The process begins with the supercomputers simulating a cube of space in the universe, which measures some 350 million light years on each side. Both normal and dark matter are dealt with, particularly the gravitational effect that dark matter has on normal matter. Using this data, Haider and his team noticed something very interesting about the distribution of matter in the cosmos.

Essentially, they found that about 50% of the total mass of the Universe is compressed into a volume of 0.2%, consisting of the galaxies we see. A further 44% is located in the enveloping filaments, consisting of gas particles and dust. The remaining 6% is located in the empty spaces that fall between them (aka. the voids), which make up 80% of the Universe.

However, a surprising faction of this normal matter (20%) appears to have been transported there, apparently by the supermassive black holes located at the center of galaxies. The method for this delivery appears to be in how black holes convert some of the matter that regularly falls towards them into energy, which is then delivered to the sounding gas, leading to large outflows of matter.

Artist’s impression of a supermassive black holes at the hearts of a galaxy. Credit: NASA/JPL-Caltech

These outflows stretch for hundreds of thousands of lights years beyond the host galaxy, filling the void with invisible mass. As Dr. Haider explains, these conclusions supported by this data are rather startling. “This simulation,” he said, “one of the most sophisticated ever run, suggests that the black holes at the center of every galaxy are helping to send matter into the loneliest places in the universe. What we want to do now is refine our model, and confirm these initial findings.”

The findings are also significant because they just may offer an explanation to the so-called “missing baryon problem”. In short, this problem describes how there is an apparent discrepancy between our current cosmological models and the amount of normal matter we can see in the Universe. Even when dark matter and dark energy are factored in, half of the remaining 4.9% of the Universe’s normal matter still remains unaccounted for.

Missing Matter Found! Fast Radio Bursts Confirm Cosmological Model

27 Feb , 2016 by Matt Williams

In July of 2012, researchers at the CERN laboratory made history when they announced the discovery of the Higgs Boson. Though its existence had been hypothesized for over half a century, confirming its existence was a major boon for scientists. In discovering this one particle, the researchers were also able to confirm the Standard Model of particle physics. Much the same is true of our current cosmological model.

For decades, scientists been going by the theory that the Universe consists of about 70% dark energy, 25% dark matter and 5% “luminous matter” – i.e. the matter we can see. But even when all the visible matter is added up, there is a discrepancy where much of it is still considered “missing”.

But thanks to the efforts of a team from the Commonwealth Scientific and Industrial Research Organization (CSIRO), scientists now know that we have it right.

This began on April 18th, 2015, when the CSIRO's Parkes Observatory in Australia detected a fast radio burst (FRB) coming from space. An international alert was immediately issued, and within a few hours, telescopes all around the world were looking for the signal. The CSIRO team began tracking it as well with the Australian Telescope Compact Array (ATCA) located at the Paul Wild Observatory (north of Parkes).

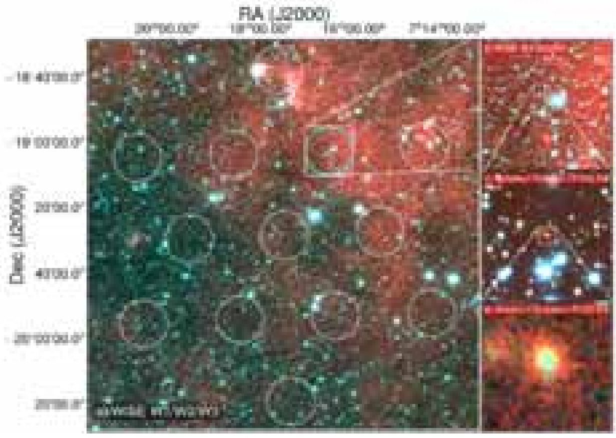


Image showing the field of view of the Parkes radio telescope (left) and zoom-ins on the area where the signal came from (left). Credit: D. Kaplan (UWM), E. F. Keane (SKAO).

With the help of the National Astronomical Observatory of Japan's (NAOJ) Subaru telescope in Hawaii, they were able to pinpoint where the signal was coming from. As the CSIRO team described in a paper submitted to *Nature*, they identified the source, which was an elliptical galaxy located 6 billion light years from Earth.

This was an historic accomplishment, since pinpointing the source of FRBs have never before been possible. Not only do the signals last mere milliseconds, but they are also subject to dispersion – i.e. a delay caused by how much material they pass through. And while FRBs have been detected in the past, the teams tracking them have only been able to obtain measurements of the dispersion, but never the signal's redshift.

Redshift occurs as a result of an object moving away at relativistic speeds (a portion of the speed of light). For decades, scientists have been using it to determine how fast other galaxies are moving away from our own, and hence the rate of expansion of the Universe. Relying on optical data obtained by the Subaru telescope, the CSIRO team was able to obtain both the dispersion *and* the redshift data from this signal.

As stated in their paper, this information yielded a "direct measurement of the cosmic density of ionized baryons in the intergalactic medium". Or, as Dr. Simon Johnston – of the CSIRO's Astronomy and Space Science division and the co-author of the study – explains, the team was not only to locate the source of the signal, but also obtain measurements which confirmed the distribution of matter in the Universe.

"Until now, the dispersion measure is all we had," he said. "By also having a distance we can now measure how dense the material is between the point of origin and Earth, and compare that with the current model of the distribution of matter in the Universe. Essentially this lets us weigh the Universe, or at least the normal matter it contains."

Dr. Evan Keane of the SKA Organization, and lead author on the paper, was similarly enthused about the team's discovery. "[W]e have found the missing matter," he said. "It's the first time a fast radio burst has been used to conduct a cosmological measurement."

As already noted, FRB signals are quite rare, and only 16 have been detected in the past. Most of these were found by sifting through data months or years after the signal was detected, by which time it would be impossible for any follow-up observations. To address this, Dr. Keane and his team developed a system to detect FRBs and immediately alert other telescopes, so that the source could be pinpointed.

Artists impression of the SKA-mid dishes in Africa shows how they may eventually look when completed. Credit: skatelescope.org

It is known as the Square Kilometer Array (SKA), an international effort led by the SKA Organization to build the world's largest radio telescope. Combining extreme sensitivity, resolution and a wide field of view, the SKA is expected to trace many FRBs to their host galaxies. In so doing, it is hoped the array will provide more measurements confirming the distribution of matter in the Universe, as well as more information on dark energy.

In the end, these and other discoveries by the SKA could have far-reaching consequences. Knowing the distribution of matter in the universe, and improving our understanding of dark matter (and perhaps even dark energy) could go a long way towards developing a Theory Of Everything (TOE). And knowing how all the fundamental forces of our universe interact will go a long way to finally knowing with certainty how it came to be.

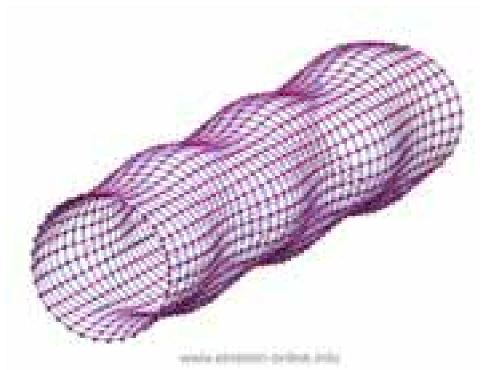
These are exciting time indeed. With every step, we are peeling back the layers of our universe!

Gravitational Waves and How They Distort Space

8 Feb , 2016 by Markus Pössel

It's official: on February 11, 10:30 EST, there will be a big press conference about gravitational waves by the people running the gravitational wave detector LIGO. It's a fair bet that they will announce the first direct detection of gravitational waves, predicted by Albert Einstein 100 years ago. If all goes as the scientists hope, this will be the kick-off for an era of gravitational wave astronomy: for learning about some of the most extreme and violent events in the cosmos by measuring the tiny ripples of space distortions that emanate from them.

Time to brush up on your gravitational wave knowledge, if you haven't already done so! Here's a visualization to help you – and we'll go step by step to see what it means:



Einstein's distorted spacetime

In the words of the eminent relativist John Wheeler, Einstein's theory of general relativity can be summarized in two statements: Matter tells space and time how to curve. And (curved) space and time tell matter how to move. (Here is a slightly longer version on *Einstein Online*.)

Einstein published the final form of his theory in November 1915. By spring 1916, he had realized another consequence of distorting space and time: general relativity allows for *gravitational waves*, rhythmic distortions which propagate through space at the speed of light.

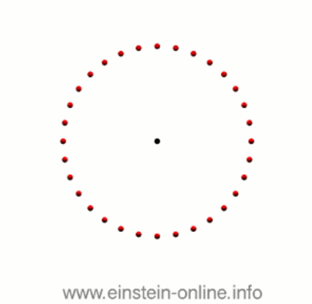
For quite some time, physicists weren't sure whether these gravitational waves were real or a mathematical artifact within Einstein's theory. (For more about this controversy, see Daniel Kennefick's book "Traveling at the Speed of Thought" and this article.) But since the 1980s, there has been indirect evidence for these waves (which earned its discoverers a Nobel prize, no less, in 1993).

Gravitational waves are emitted by orbiting bodies and certain other accelerated masses. Right now, major international efforts are underway to detect gravitational waves directly. Once detection is possible, the scientists hope to use gravitational waves to "listen" to some of the most violent processes in the universe: merging black holes and/or neutron stars, or the core region of supernova explosions.

Just as regular astronomy uses light and other forms of electromagnetic radiation to learn about distant objects, gravitational wave astronomy will decipher the information contained within gravitational waves. And if you go by recent rumors, gravitational wave astronomy might already have kicked off in mid-September 2015.

What do gravitational waves do?

But what do gravitational waves do? For that, let us look at a simplified, entirely hypothetical situation. (The following are variations on images and animations originally published here on *Einstein Online*.) Consider particles drifting in space, far from any sources of gravity. Imagine that the particles (red) are arranged in a circle around a



center (marked in black):

If a simple gravitational wave were to pass through this image, coming directly at the reader, distances between these particles would change rhythmically as follows:

Note the distinctive pattern: When the circle is stretched in the vertical direction, it is compressed in the horizontal direction, and vice versa. That's typical for gravitational waves ("quadrupole distortion").

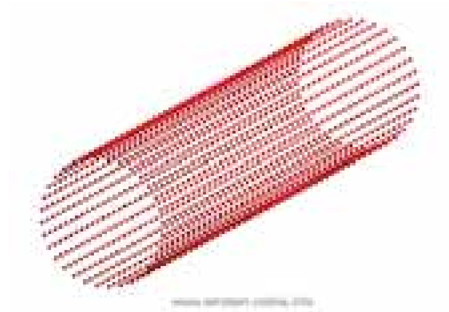
It's important to keep in mind that this animation, and the ones that will follow, exaggerate the gravitational wave's effect quite considerably. The gravitational waves detectors such as aLIGO hope to measure are much, much weaker. If our hypothetical circle of particles were as large as the Earth's orbit around the Sun, a realistic gravitational wave would distort it by less than the diameter of a hydrogen atom.

Gravitational waves moving through space

The animation above shows what could be called a "gravitational oscillation." To see the whole wave, we need to consider the third dimension.

We talk about a wave when oscillations propagate through space. Consider a water wave: At each point of the surface, we have an oscillation, with the surface rising and falling rhythmically. But it's only the fact that this oscillation propagates, and that we can see a crest moving over the surface, that makes this into a wave.

It's the same with gravitational waves. To see that, we will look not at a single circle of freely floating particles, but at many such circles, stacked one behind the other, forming the surface of a cylinder:

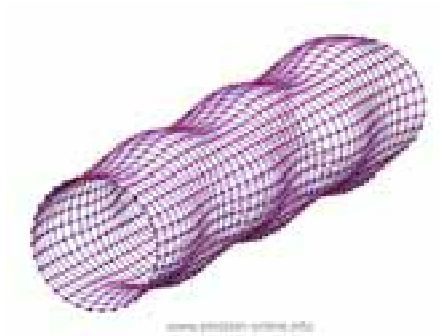


In this image, it's hard to see which points are in front and which in the back. Let us join each particle to its nearest neighbors with a blue line, and let us also fill out the area between those lines. That way, the geometry is much more

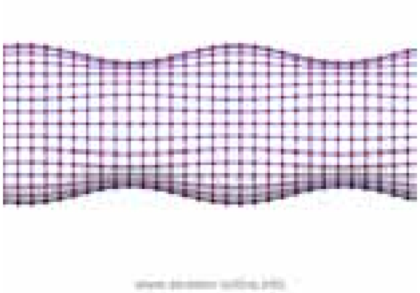
obvious:

Just remember that neither the lines nor the whitish surface is physical. On the contrary, if we want the particles to be maximally susceptible to the effect of the gravitational wave, we should make sure they are truly floating freely, and certainly they shouldn't be linked in any way!

Now, let us see what the same gravitational wave we saw before does to this assembly of particles. From this perspective, the wave is passing from the right-hand side in the back towards the left-hand side on the front:

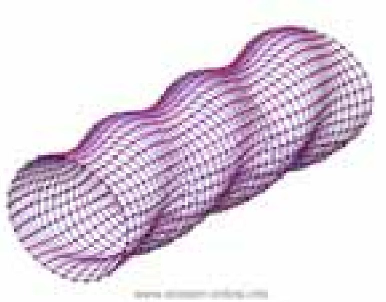


As you can see, the wave is propagating through space. For instance, the point where the vertical distances within the circle of particles is maximal is moving towards the observer. The wave nature can be seen even more clearly if we look at this cylinder directly



from the side:

What the animations show is just one kind of simple gravitational wave ("linearly polarized"). Here is another kind



("circularly polarized"):

This, then, is what the gravitational wave hunters are looking for. Except that they do not have particles floating in free space. Instead, their detectors contain test masses (notably large mirrors) elaborately suspended here on Earth, with laser light to detect the minute distance changes caused by gravitational waves.

More realistic gravitational wave signals, which contain information about merging black holes or the bulk motion of matter inside a supernova explosion, are more complicated still. They combine many simple waves of different frequencies, and the strength of such waves (their amplitude) will change over time in a characteristic fashion.

In these animations, gravitational waves look a bit like wriggling space worms. But these space worms could become the astronomers' best friends, carrying information about the cosmos that is hard or even impossible to obtain in any other way.

The Future of Gravitational Wave Astronomy: Pulsar Webs, Space Interferometers and Everything

25 Feb , 2016 by David Dickinson

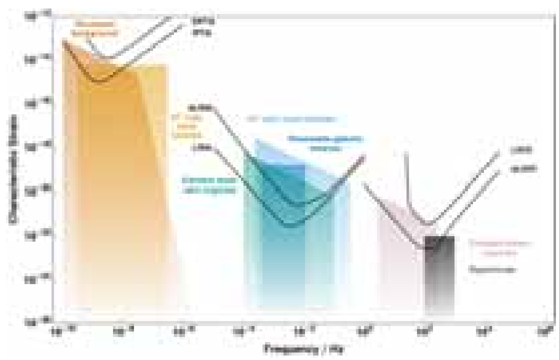
It's the hot new field in modern astronomy. The recent announcement of the direct detection of gravitational waves by the Laser Interferometer Gravitational-wave Observatory (LIGO) ushers in a new era of observational astronomy that is completely off the electromagnetic spectrum. This detection occurred on September 14th, 2015 and later earned itself the name GW150914. This occurred shortly after Advanced LIGO turned on in early September, a great sign concerning the veracity of the equipment.

Expect more to come. Perhaps the second gravitational wave detection won't be as ground breaking as the first, but it is certainly a strange universe out there. LIGO didn't happen overnight. The original LIGO ran for about a decade starting in 2002, with nary a gravitational chirp heard that managed to pass scientific scrutiny. There were actually Vegas odds placed on the direct detection of gravitational waves (along with CERN's discovery of the Higgs-boson particle) way back in 2013: we hope no one lost their shirt on that one.

And yes, you could trace the tale all the way back to Einstein's general theory of relativity a century ago in 1916, positing the existence of gravitational ripples in the fabric of space-time. Early attempts to detect gravitational waves using giant cylindrical Weber bars in the 1960s and 70s highlighted just how difficult the hunt for the little buggers would ultimately prove to be. The type of motion LIGO is looking for is *tiny*, on the order of a 1/1000th the diameter of a proton. Everything in LIGO's local environment shakes it more than that, the prime reason two geographically separate detectors are needed. The indirect detection of gravitational waves seen in the timing glitches of binary pulsar PSR B1913+16 earned Russell Hulse and Joseph Taylor the Nobel Prize in Physics in 1993.

LIGO is now open for business, but isn't the only game in town when it comes to gravitational wave astronomy.

Gravitational-wave astronomy is going international, as LIGO India (sometimes referred to as INDIGO) received the green light recently in the wake of the detection announcement. Set to begin science operations around 2019, the third LIGO detector will be constructed in India. This will give LIGO the 'third vector' it was initially envisioned with, allowing researchers to pin down the source direction in the sky. Other detectors are on the hunt as well, including VIRGO near Pisa, Italy, GEO600 in Germany, and KAGRA Japan.

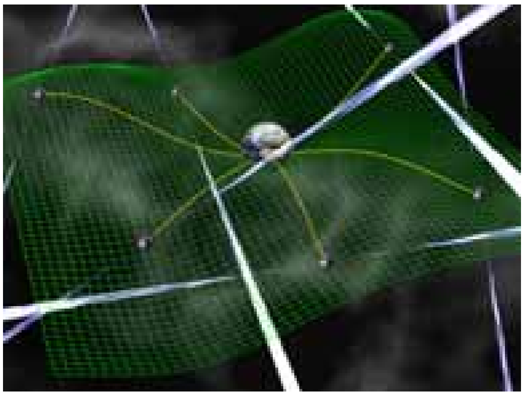


Relatives sensitivities, including LISA, LIGO and Advanced LIGO. Image credit: Wikimedia Commons/Christopher Cole, Robert Berry, Christopher Berry

Engineers aren't stopping with the current version of LIGO. Just as Advanced LIGO built on the hard lessons learned by old school original LIGO and Enhanced LIGO, later versions will hone those skills and techniques, featuring ever greater sensitivity.

LISA Pathfinder in space. image credit: ESA

LISA Pathfinder also started science operations this week. Launched on December 3rd, 2015 from Kourou, French Guiana, LISA Pathfinder won't detect gravitational waves. It will, however, pave the way for a full-up space based gravitational wave detector, set to launch sometime in the 2030s. Yes, its hard to imagine that 2030 is now closer to us in time than Y2K. eLISA stands for the evolved Laser Interferometer Space Antenna, and will feature three free flying variants of the LISA Pathfinder spacecraft with an interferometry baseline of a million kilometers on a side. The gold-platinum test masses are in free flight starting this week, a first. eLISA was born out the original joint NASA/ESA LISA mission, after NASA pulled out of the project in 2011. JAXA also has plans for a space-based gravitational wave detector dubbed the Deci-hertz Interferometer Gravitational-wave Observatory (DECIGO), planned for launch sometime around 2027.



An artist's conception of a 'pulsar web.' Image credit: David Champion/NASA/JPL

-And finally; could 'pulsar webs' be used to detect low frequency gravitational waves? It's not as outlandish an idea as it sounds. A recent study from the North American Nanohertz Observatory for Gravitational Waves (NANOGrav) is looking at using radio observations of millisecond pulsars. Unlike the violent event witnessed by LIGO – a merger of two black holes each about 30 times the mass of our Sun — low frequency gravitational waves should be generated by orbiting massive black holes resulting from galactic mergers. Such a ripple in space-time would sweep slowly past the Earth, but reveal itself in minute timing variations from remote pulsars. Imagine the Earth at the center of such a web, gently 'rocking' like a leaf on a pond as ripples pass by. Seeing this tell-tale variation across hundreds of pulsars would provide the smoking gun for this unique sort of detection.

All amazing stuff. We now live in an era where gravitational wave astronomy is now a reality.

Expect more amazing finds to come!

We Have Underestimated Our Sun's Destructive Reach

19 Feb , 2016 by Evan Gough

The Sun has enormous destructive power. Any objects that collide with the Sun, such as comets and asteroids, are immediately destroyed.

But now we're finding that the Sun has the ability to reach out and touch asteroids at a far greater distance than previously thought. The proof of this came when a team at the University of Hawaii Institute of Astronomy was looking at Near-Earth Objects (NEOs) catalogued by the Catalina Sky Survey, and trying to understand what asteroids might be missing from that survey.

An asteroid is classified as an NEO when, at its closest point to the Sun, it is less than 1.3 times the distance from the Earth to the Sun. We need to know where these objects are, how many of them there are, and how big they are. They're a potential threat to spacecraft, and to Earth itself.

The 60 inch Mt. Lemmon telescope is one of three telescopes used in the Catalina Sky Survey. Image: Catalina Sky Survey, University of Arizona.

The Catalina Sky Survey (CSS) detected over 9,000 NEOs in eight years. But asteroids are notoriously difficult to detect. They are tiny points of light, and they're moving. The team knew that there was no way the CSS could have detected all NEOs, so Dr. Robert Jedicke, a team member from the University of Hawaii Institute of Astronomy, developed software that would tell them what CSS had missed in its survey of NEOs.

This took an enormous amount of work—and computing power—and when it was completed, they noticed a discrepancy: according to their work, there should be over ten times as many objects within ten solar diameters of the Sun as they found. The team had a puzzle on their hands.

The team spent a year verifying their work before concluding that the problem did not lay in their analysis, but in our understanding of how the Solar System works. University of Helsinki scientist Mikael Granvik, lead author of the Nature article that reported these results, hypothesized that their model of the NEO population would better suit their results if asteroids were destroyed at a much greater distance from the sun than previously thought.

They tested this idea, and found that it agreed with their model and with the observed population of NEOs, once asteroids that spent too much time within 10 solar diameters of the Sun were eliminated. "The discovery that asteroids must be breaking up when they approach too close to the Sun was surprising and that's why we spent so much time verifying our calculations," commented Dr. Jedicke.

There are other discrepancies in our Solar System between what is observed and what is predicted when it comes to the distribution of small objects. Meteors are small pieces of dust that come from asteroids, and when they enter our atmosphere they burn up and make star-gazing all the more eventful. Meteors exist in streams that come from their parent objects. The problems is, most of the time the streams can't be matched with their parent object. This study shows that the parent objects must have been destroyed when they got too close to the Sun, leaving behind a stream of meteors, but no apparent source.

There was another surprise in store for the team. Darker asteroids are destroyed at a greater distance from the Sun than lighter ones are. This explains an earlier discovery, which showed that brighter NEOs travel closer to the Sun than darker ones do. If darker asteroids are destroyed at a greater distance from the Sun than their lighter counterparts, then the two must have differing compositions and internal structure.

"Perhaps the most intriguing outcome of this study is that it is now possible to test models of asteroid interiors simply by keeping track of their orbits and sizes. This is truly remarkable and was completely unexpected when we first started constructing the new NEO model," says Granvik.

Space Farmer Scott Kelly Harvests First 'Space Zinnias' Grown Aboard Space Station

18 Feb , 2016 by Ken Kremer

NASA astronaut Scott Kelly harvested his space grown Zinnia's on Valentine's Day, Feb. 14, 2016 aboard the International Space Station. Credit: NASA/Scott Kelly/@StationCDRKelly

KENNEDY SPACE CENTER, FL – Nearing the final days of his history making one-year-long sojourn in orbit, space farming NASA astronaut Scott Kelly harvested the first ever crop of 'Space Zinnias' grown aboard the International Space Station (ISS) on a most appropriate day – Valentine's Day, Sunday, Feb. 14, 2016.

After enduring an unexpected series of trial and tribulations – including a fearsome attack of 'space mold' – Kelly summoned his inner 'Mark Watney' and brought the Zinnia's to life, blossoming in full color and drenched in natural sunlight. See photo above.

He spent weeks lovingly nursing the near dead plants back to health and proudly displayed the fruits of his blooming labor through the windows of the domed Cupola, jutting out from the orbiting outpost and dramatically back dropped by the blue waters of Earth and the blackness of space.

"Nursed the #SpaceFlowers all the way to today and now all that remains are memories," tweeted NASA astronaut and Expedition 46 Commander Scott Kelly on Feb 14, 2016.

"Happy #Valentines Day!"

The zinnias are thus contributing invaluable experience to scientists and astronauts learning how to grow plants and food in microgravity during future deep space human expeditions planned for NASA's "Journey to Mars" initiative.

The experimental Space Zinnias are truly an important part of NASA's ongoing crop research activities and are being grown in the stations Veggie plant growth facility.

Photo of first ever blooming space Zinnia flower grown onboard the International Space Station's Veggie facility moved to catch the sun's rays through the windows of the Cupola backdropped by Earth. Credit: NASA/Scott Kelly/ @StationCDRKelly

But it wasn't always looking so rosy for the zinnias. Just before Christmas, Kelly found that these same Zinnias were suffering from a serious case of space blight when he discovered traces of mold on the flowers growing inside Veggie – as reported here.

Kelly asked to be given decision making power and was assigned as an "autonomous gardener," Gioia Massa, NASA Kennedy payload scientist for Veggie, explained to Universe Today during a visit to the Veggie ground control experiment facility at NASA's Kennedy Space Center (KSC) in Florida.

Ground truth Zinnia plants growing inside an experimental tray of six Veggie pillow sets in a controlled environment chamber in the Space Station Processing Facility at NASA's Kennedy Space Center in Florida. Credit: Ken Kremer/ kenkremer.com

Ever since then, the space stations zinnias have been on the rebound.

"I think we've learned a lot about doing this kind of experiment. We're being farmers in space," Kelly explained before the harvest.

"I was extra motivated to bring the plants back to life. I'm going to harvest them on Valentine's Day."

Meanwhile back on Earth, scientists harvested the counterpart 'ground truth' Zinnia's being grown at Veggie ground control in the Space Station Processing Facility at KSC on Feb. 11, the same way they are being grown and harvested on the ISS.

Gioia Massa, NASA Kennedy payload scientist for Veggie, works with ground control Zinnia plants growing in a tray of Veggie pillow sets inside a controlled environment growth chamber in the Space Station Processing Facility at NASA's Kennedy Space Center in Florida. Credit: Ken Kremer/ kenkremer.com

The team will compare and contrast the results of the ground and space grown zinnias in designing future space farming experiments.

Great Attractor Revealed? Galaxies Found Lurking Behind the Milky Way

10 Feb , 2016 by Evan Gough

Hundreds of galaxies hidden from sight by our own Milky Way galaxy have been studied for the first time. Though only 250 million light years away—which isn't that far for galaxies—they have been obscured by the gas and dust of the Milky Way. These galaxies may be a tantalizing clue to the nature of The Great Attractor.

On February 9th, an international team of scientists published a paper detailing the results of their study of these galaxies using the Commonwealth Scientific and Industrial Research Organization's (CSIRO) Parkes radio telescope, a 64 meter telescope in Australia. The 'scope is equipped with an innovative new multi-beam receiver, which made it possible to peer through the Milky Way into the galaxies behind it.

The area around the Milky Way that is obscured to us is called the Zone of Avoidance (ZOA). This study focused on the southern portion of the ZOA, since the telescope is in Australia. (The northern portion of the ZOA is currently being studied by the Arecibo radio telescope, also equipped with the new multi-beam receiver.) The significance of their work is not that they found hundreds of new galaxies. There was no reason to suspect that galactic distribution would be any different in the ZOA than anywhere else. What's significant is what it will tell us about The Great Attractor.

The Great Attractor is a feature of the large-scale structure of the Universe. It is drawing our Milky Way galaxy, and hundreds of thousands of other galaxies, towards it with the gravitational force of a million billion suns. The Great Attractor is an anomaly, because it deviates from our understanding of the universal expansion of the universe. "We don't actually understand what's causing this gravitational acceleration on the Milky Way or where it's coming from," said Professor Lister Staveley-Smith of The University of Western Australia, the lead author of the study.

"We know that in this region there are a few very large collections of galaxies we call clusters or superclusters, and our whole Milky Way is moving towards them at more than two million kilometres per hour."

The core of the Milky Way seen in Infrared. Seeing through this has been a real challenge. Credit: NASA/Spitzer

Professor Staveley-Smith and his team reported that they found 883 galaxies, of which over one third have never been seen before. "The Milky Way is very beautiful of course and it's very interesting to study our own galaxy but it completely blocks out the view of the more distant galaxies behind it," he said.

The team identified new structures in the ZOA that could help explain the movement of The Milky Way, and other galaxies, towards The Great Attractor, at speeds of up to 200 million kilometres per hour. These include three galaxy concentrations, named NW1, NW2, and NW3, and two new clusters, named CW1 and CW2.

University of Cape Town astronomer Professor Renée Kraan-Korteweg, a member of the team who did this work, says "An average galaxy contains 100 billion stars, so finding hundreds of new galaxies hidden behind the Milky Way points to a lot of mass we didn't know about until now."

How exactly these new galaxies affect The Great Attractor will have to wait for further quantitative analysis in a future study, according to the paper. The data from the Arecibo scope will show us the northern hemisphere of the ZOA, which will also help build our understanding. But for now, just knowing that there are hundreds of new galaxies in our region of space sheds some light on the large-scale structure of our neighbourhood in the universe.

With Oscars out of the way here is a book about the science content in the film industry...

Book Review: Hollyweird Science

23 Feb , 2016 by Mark Mortimer

Wondering if the science in that sci-fi movie you just saw is real? Get a hold of the book "Hollyweird Science – From Quantum Quirks to the Multiverse" by Kevin Grazier and Stephen Cass. With it, you can sift through a lot of "tropes and conceits" and glean some wonderful insights of both modern science and modern cinema.

View Tips and Notes:

Globuar clusters

Messier 5 (M5) – The NGC 5904 Globular Cluster

29 Feb , 2016 by Tammy Plotner

In the late 18th century, Charles Messier was busy hunting for comets in the night sky, and noticed several "nebulous" objects. After initially mistaking them for the comets he was seeking, he began to compile a list of these objects so other astronomers would not make the same mistake. Known as the Messier Catalog, this list consists of 100 objects, consisting of distant galaxies, nebulae, and star clusters.

Among the many famous objects in this catalog is the M5 globular star cluster (aka. NGC 5904). Located in the galactic halo within the Serpens Constellation, this cluster of stars is almost as old as the Universe itself (13 billion years)! Though very distant from Earth and hard to spot, it is a favorite amongst amateur astronomers who swear by its beauty.

Description:

At 13 billion years of age, M5 is believed to be one of the oldest globular clusters in our galaxy (over twice the age of our Solar System). Located 24,500 light years from Earth, it is home to more than 100,000 stars, with some estimates saying it has as many as 500,000. Of these, 105 variable stars call M5 home, as does a dwarf nova.

The cluster is also one of the largest known, measuring 165 light-years in diameter and exerting a gravitational influence over a radius of 200 light-years. The brightest and most easily observed variable star in M5 – Cepheid Variable 42 – changes from magnitude 10.6 to 12.1 in a period of just under 26.5 days. Amateur astronomers are encouraged to keep an eye out for it. Interestingly enough, M5 is also home to two millisecond pulsars, which were also discovered in 1997 by S. B. Anderson et al. over a five year period of observations.

History of Observation:

Gottfried Kirch and his wife Maria were the first to make a recorded observation of M5 on May 5th, 1702. While searching from comets, they stumbled across a huge, bright object that they considered to be a "nebulous star." On May 23rd, 1764, Charles Messier found it independently and labeled it as M5. As he recorded of it at the time:

"Beautiful Nebula discovered between the Balance [Libra] & the Serpent [Serpens], near the star in the Serpent, of 6th magnitude, which is the 5th according to the Catalog of Flamsteed [5 Ser]: it doesn't contain any star; it is round, & one sees it very well, in a fine [clear dark] sky, with an ordinary refractor of 1-foot."

In 1771, while compiling the first edition of the Messier Catalog, he described the object and his observations of it in more detail:

"The night of May 23 to 24, 1764, I have discovered a beautiful nebula in the constellation of Serpens, near the star of sixth magnitude; the fifth according to the catalog of Flamsteed. That nebula doesn't contain any star; it is round, and could have a diameter of 3 arc minutes; one can see it very well, under a good sky, with an ordinary [non-achromatic] refractor of one foot [FL]. I have observed that nebula in the Meridian, and I have compared it to the star Alpha Serpentis. Its position was right ascension 226d 39' 4", and its declination 2d 57' 16" north. On March 11, 1769, at about four o'clock in the morning, I have reviewed that nebula with a good Gregorian telescope of 30 pouces, which magnified 104 times, and I have ensured that it doesn't contain any star."

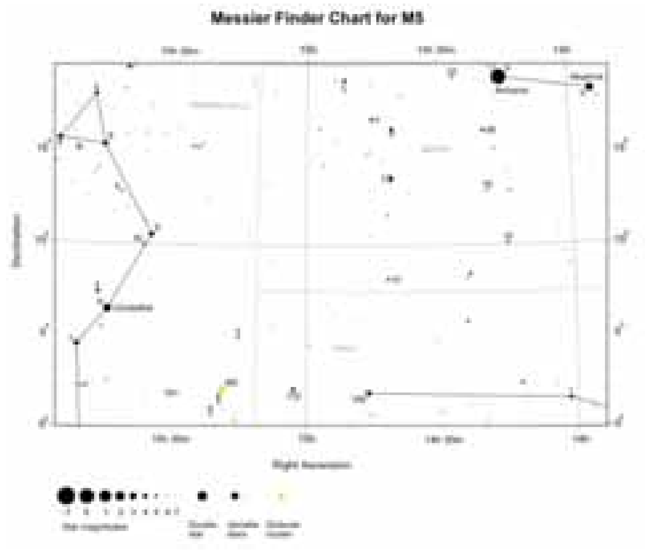
A wide-angle photograph of the M5 globular cluster. Credit: Robert J. Vanderbei

Enter William Herschel, who once again saved the day by seeing this object for what it was. In 1791, he was able to resolve the individual stars and counted up to 200 in this globular cluster. As he wrote of the cluster at the time:

"With a magnifying power of 250, it is all resolved into stars: they are very close, and the appearance is beautiful. With 600, perfectly resolved. There is a considerable star not far from the middle; another not far from one side, but out of the cluster; another pretty bright one; a great number of small ones. Here we have a case where the penetrating power of 20 fell short, when 29 resolved the nebula completely. This object requires also great magnifying power to shew the stars of it well; but that power had before been tried, in the 7-feet, as far as 460, without success, and could only give an indication of its being composed of stars; whereas the lower magnifying power of 250, with a greater penetrating power, in the 10-feet instrument, resolved the whole nebula into stars. I counted about 200 of them. The middle of it is so compressed that it is impossible to distinguish the stars."

Locating Messier 5:

Finding Messier Object 5 in binoculars is much like finding M3 – the key is the Arcturus star and the secondary star hop is Antares. You'll find M5 about 1/3 the distance between Alpha Bootes and Alpha Scorpii. For finderscopes, place Arcturus in the center and look for bright 109 and 110 Virginis to the southwest. To the east you'll see a small triangle of stars – aim there.



Messier finder chart for M5. Under very good viewing conditions, M5 can be just about glimpsed with the naked eye as a faint point of light. Credit: freestarcharts.com

Under ideal viewing conditions (i.e. where light pollution is not an issue), M5 can be spotted with the naked eye. It will appear as a faint point of light, located about 5° to the south-east (or 30 minutes to the east) of Alpha Serpentis (aka. Unukalhai). Using binoculars, spotting M5 is easy since it will appear quite bright, even under urban skies. However, it will be difficult to resolve because it is so dense.

Small telescopes will also have difficulty resolving this globular cluster, but will begin to pick out edge stars and notice that its shape is not quite round. Larger aperture telescopes will easily begin resolution and notice that nearby 5 Serpentis is also a double star.

For your convenience, here are the quick facts for Messier 5:

Object Name: Messier 5
Alternative Designations: NGC 5904
Object Type: Class V Globular Cluster
Constellation: Serpens
Right Ascension: 15 : 18.6 (h:m)
Declination: +02 : 05 (deg:m)
Distance: 24.5 (kly)
Visual Brightness: 5.6 (mag)
Apparent Dimension: 23.0 (arc min)

Enjoy your observations, and keep watching for Variable 42!

We have written many interesting articles about Messier Objects here at Universe Today. Here's Tammy Plotner's Introduction to the Messier Objects, M1 – The Crab Nebula, and David Dickison's articles on the 2013 and 2014 Messier Marathons.

Be to sure to check out our complete Messier Catalog.

For more information, check out the SEDS Messier Database.

Messier 3 (M3) – The NGC 5272 Globular Cluster

15 Feb , 2016 by Tammy Plotner

During the late 18th century, Charles Messier began to notice a series of "nebulous" objects in the night sky which he originally mistook for comets. With the hope of preventing other astronomers from making the same mistake, he began compiling a list of these in what would come to be known as the Messier Catalog. Consisting of 100 objects, the catalog became an important milestone in the discovery and research of Deep Sky objects.

One such object is Messier Object 3 (aka. M3 or NGC 5272) globular cluster that is located in the northern constellation of Canes Venatici. Since it was first observed, this globular star cluster has gone on to become one of the best-studied objects in the night sky, and is considered by many amateur astronomers to be one of the finest visible clusters.

Description:

M3 is one of the largest and brightest star clusters, and is made up of around 500,000 stars. It is located at a distance of about 33,900 light-years from Earth, the cluster spans about 220 light-years. It is estimated to be 8 billion years old, making M3 one of the oldest formations in our galaxy. To put that in perspective, this nebula was already half its current age when our own Sun was formed.

Despite the fact that it is farther from us than the center of our own galaxy, M3 is visible with just the slightest of optical aid. This is largely because it contains 274 known variable stars, which is by far the highest number found in any globular cluster. It contains at least 133 RR Lyrae variables – along with a surprising number of Blue Straggler Stars – blue main-sequence stars which appear youthful.

Globular Cluster Messier 3, as seen with amateur telescopes. Credit: Wikipedia Commons/Hewholooks

Since all stars in globular clusters are believed to be about the same age, it is possible these stars have had their outer layers stripped away while passing through the dense core region of M3. Messier 3 also commands about 760 light years of space – meaning that it keeps all stars within that distance tied to its rich core. The overall abundance of elements other than hydrogen and helium, Messier also has a relatively high abundance of heavier elements – making it "metal-rich".

History of Observation:

Oddly enough, when Charles Messier first noticed this object – on May 3rd, 1764 – it was only the 76th Deep Sky Object ever seen by human eyes (with the assistance of telescopes, that is). Although Charles had logged his previous two discoveries (the M1 “Crab Nebula” and the globular cluster M2) it was this third object that prompted him to begin his now famous catalog of ‘objects that are not comets’.

As Messier recorded at the time in in his notes:

“On May 3, 1764, when working on a catalog of the nebulae, I have discovered one between Bootes and one of the Hunting Dogs [Canes Venatici] of Hevelius, the southernmore of the two, exactly between the tail and the paws of this Dog, according to the charts of Flamsteed. I have observed that nebula on the meridian, and I compared with Mu Bootis; its right ascension has been found as 202d 51' 19", and its declination as 29d 32' 57" north. That nebula which I have examined with a Gregorian telescope of 30 pouces focal length, which magnifies 104 times, doesn’t contain any star; the center is brilliant, and the light gets lost fading [outward]; it is round, and could have 3 minutes of arc in diameter. One can see it in a good sky with an ordinary [nonachromatic] refractor of one foot [FL] , it doesn’t contain any star, its center is brilliant, and its light is gradually fading away, it is round; in a beautiful [dark] sky.”

Image of M3, based on observations made with the NASA/ESA Hubble Space Telescope, and obtained from the Hubble Legacy Archive. Credit: STScI/NASA/ST-ECF/ESA/CADC/NRC/CSA.

And as with other objects recorded by Messier, it was Sir William Herschel who first resolved the M3 into stars. As he recorded in his own observational notes:

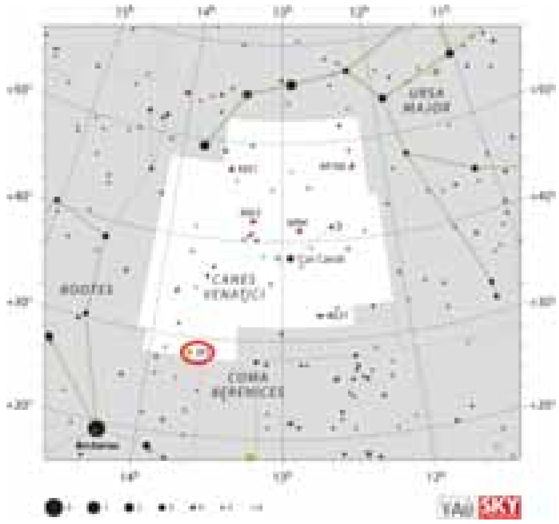
To these may added the 1st, 3d [M3], 27, 33, 57, 79, 81, 82, 101 [of Messier’s catalog], which in my 7, 10, and 20-feet reflectors shewed a mottled kind of nebulosity, which I shall call resolvable; so that I expect my present telescope will, perhaps, render the stars visible of which I suppose them to be composed…”

But none described it more eloquently than Admiral William Henry Smyth – an English astronomer and naval officer. As he wrote:

“A brilliant and beautiful globular congregation of not less than 1000 small stars, between the southern Hound and the knee of Bootes; it blazes splendidly towards the centre, and has outliers in all directions, except the sf [south following; SE], where it is so compressed that, with its stragglers, it has something of the figure of the luminous oceanic creature called Medusa pellucens. This noble object is situated in a triangle formed by three small stars in the np [north preceding; NW], nf [north following; NE], and sf [south following, SE] quadrabts, which, by their comparative brightness, add to the beauty of the field. It is nearly in mid-distance between the Arcturus star and Cor Caroli, at 11deg north-west of the former star. This mass is one of those balls of compact and wedged stars, whose laws of aggregation it is so impossible to assign; but the rotundity of figure gives full indication of some general attractive bond of union.”

Locating Messier 3:

For binoculars, the easiest way to discover this ancient beauty is to look about halfway between the pair of Arcturus and Cor Caroli, just east of Beta Comae. Many times, just starting at Arcturus and sweeping slowly up towards Cor Caroli is enough! If you still have trouble, locate the Coma Berenices star cluster (Melotte 111) and look east about a fist width.



Location of Messier 3 in the Cane Venatici constellation. Credit: IAU/skyandtelescope.com

You’ll find it 6 degrees north-northeast of Beta Comae and it will show very easily in the finderscope. In binoculars of all sizes and even under urban lighting conditions, Messier 3 is very bright and will begin to show some signs of resolution with larger models, such as 10X50. Even small telescopes will see individual stars come to life and it will explode into a fine, pinpoint mass in telescopes as small as 6″.

And for your convenience, here are the vital statistics on M3, aka NGC 5272:

Object Name: Messier 3
Alternative Designations: NGC 5272
Object Type: Class VI Globular Cluster
Constellation: Canes Venatici
Right Ascension: 13 : 42.2 (h:m)
Declination: +28 : 23 (deg:m)
Distance: 33.9 (kly)
Visual Brightness: 6.2 (mag)
Apparent Dimension: 18.0 (arc min)

As always, good luck with your search, and may your observations be rich!

We have written many interesting articles on Messier Objects here at Universe Today. For instance, here’s Tammy Plotner’s Introduction to the Messier Objects, M1 – The Crab Nebula, and David Dickison’s articles on the 2013 and 2014 Messier Marathons.

Be to sure to check out our complete Messier Catalog.

For more information, check out the SEDS Messier Database.

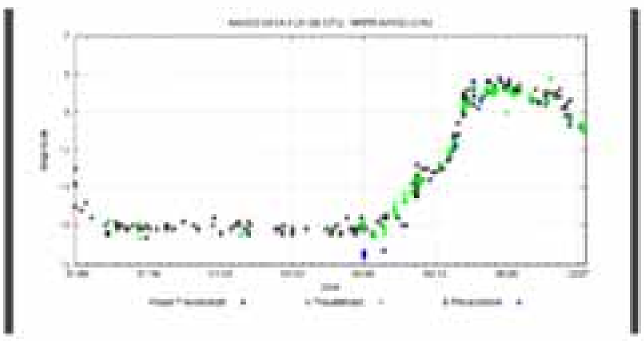
MEMBERS VIEWING LOGS and IMAGES

Log February 2016 Tony Vale

Variable star observations totalled 45 this month bringing the overall total to 580. The February observations include 11 observations of the dwarf nova SS Cygni. During the month I made an effort to make as many observations of this star as possible as a result of an appeal to amateur variable star observers made by researchers studying radio jets. These appeals are generally made through the AAVSO and passed around the amateur network. Although radio jets have been observed in accreting black holes and neutron stars (eg pulsars) they have only been observed in accreting white dwarves once before, in 2008 when they were observed in SS Cyg during the early stages of an outburst. The objective was to make observations using the e-Merlin array, a network of seven radio telescopes in the UK based at Jodrell Bank and another telescope at Cambridge (Arcminute Microkelvin Imager - Large Array or AMI-LA). It was intended to make the observations throughout the outburst but most importantly in the early stages and correlate the results with visual observations reported through the AAVSO. If the observations could not be started early enough in the outburst it was intended to delay the programme and wait for another opportunity. Outbursts occur roughly every 50 days or so and at the time of the request another one was due. The amateur community was asked to monitor the star and report urgently if the magnitude rose above 11.5.and to continue monitoring throughout the outburst.

SS Cyg is currently fairly well placed from the UK before dawn but low in the North West after sunset. At sunset in the UK and Europe it would still be daylight in the US, so observers in the US would not be able to see it at that time. Early on the evening of the10th Feb, the weather was clear and I was able to observe it at 10.9 so I raised an alert through the BAAVSS network asking for confirmation and posted the result on the AAVSO database. I received a response almost immediately with a photometric result of 11.1 and there was more photometry from earlier in the day from the morning which was around 11.3 so it seemed the outburst was underway.

An extract of the light curve from the AAVSO database is shown below and consists of observations made by 46 observers from all over the world. The light curve is a little unusual in that it seemed to "stutter" a little but went on to a full outburst in the end. It is now fading back towards its quiescent magnitude of around 12.



.Tony

Viewing Log for 10th February

Mike Partridge from Swindon Stargazers arranged a viewing session at Blakehill Nature Reserve (owned by Wiltshire Wildlife Trust) near Cricklade. This would be the first time we have used this place without a nearly full moon to spoil the sky, so it would interesting to see how different it would be from Uffcott?

I arrived at Blakehill and had my Meade LX 90 set up and ready for some viewing by 19:45, this time I would be using a Pentax 14 mm eye piece this would give me a magnification of just under 143. For this session I wanted to start a new viewing challenge, to finish the Herschel 400 list I will have to wait until the summer months as the four objects I need to tick off are in Scorpius, Ophiuchus (x2) and Virgo unless I do a late night session one day? I have covered a lot of the Messier objects but never dome them all, so I thought I would do a Messier marathon but using GOTO equipment! I know it is not in the spirit of the challenge but I know there are some I could not star hop too? So by following the classic list I should be able to get them all in about five sessions if I plan it correctly? So here goes….

Before I started the list I wanted to look at Uranus before it got too low to view, as usual all I could make out was its greenish hue thru the eye piece. The first two objects are Spiral Galaxies which I find hard to locate, these are M 77 in Cetus and M74 in Pisces both objects were faint fuzzy blobs to look at! M33, the Pinwheel Galaxy in Triangulum was a misty patch to look at. M31, the Andromeda Galaxy was good to look at, if you have good eye sight this object is the most distance you can see, personally I have never seen it without aid from at least binoculars. Nearby is M32 a dim Elliptical Galaxy and on the other side of M32 is M110 which was hard to locate for me! Into Cassiopeia and M52 and M103 these two are Open Clusters (O C) and dim to view but still my favourite deep sky object to look atJ. M76, the Little Dumbbell Nebula in Perseus is an object I rarely look at so it was a pleasure to see it, this Planetary Nebula has a magnitude of 11 which is about the limits for my telescope? Another O C I do not look at is M34 in Perseus, to be fair this is a constellation I never look at! M45, the Pleiades or Seven Sisters in Taurus is an object even I can see with my eye ball (in fact this object has the greatest brightness of 1.2 in the whole Messier list of 110 objects), it is best to view with my finder scope as I look thru the O C if viewed with the eye piece. An odd ball Globular Cluster (G C) is M79 in Lepus, it should not be there as most G C's are located towards the centre of the Milky Way galaxy? Another pair of easy Messier objects is M42 (Great Orion Nebula) and M43 normally in the same field of view? The other Messier object in Orion is M78, a Bright Nebula even though its location is easy to find (eastern end belt star and go up a bit) I have trouble finding it, maybe a filter would help? M1 (Crab Nebula) the only Supernova remnant (from 1054) on the list was a faint patch to look at. The next four objects are all O C's and I ranked them in brightness from M37, M38, M35 and finally M36? Wonder if other viewers would put them in a different order? Their magnitudes are: 5.6 (M37), 6.4 (M38), 5.1 (M35) and 6.0 (M36). By now time was marching on and Mike wanted to lock the place up, so my final object of the evening was Jupiter with its four main moons with Calisto and Europa to the east of Jupiter and Io and Ganymede to the west. It was now 21:50 and the telescope had a nice coating of frost on the tube, with little or no wind it was a great night to get out under the stars.

As for Blakehill being better than Uffcott, yes it probably is but not much better that is only my opinion others might disagree? The only light pollution comes from Swindon to the east which is an area of sky I do not view much anyway. Time to head home and warm up with a cup of coffee before putting all of the equipment used that night into the lounge and dry overnight (this is most important) before packing it all up the following day ready for the next clear nightJ. As I write this (24th February) we have had four clear nights on the trot, unfortunately this is around a full moon and not very good for deep sky objects!

During that session I have seen 20 of the 110 objects on his list, so hopefully I am still on track to complete all the objects in five sessions? My biggest challenge will come during the summer months when I view Scorpius and Sagittarius, these constellations do not raise much above the horizon from the UK! The lowest object is M7 which I have seen before from Uffcott so I know I can see all of them assuming the weather is on myside?

Clear skies.

Peter Chappell

Hi Andy,

Could you put this picture in magazine if I am still in time please?

Jupiter and Moon combined from two pictures.

Tech details: Jupiter picture taken at 0.4 of a second and Moon picture taken at 1/1600 of a second, both pictures at f5.6.

Taken with a Canon 60Da DSLR camera and 70 – 300 mm Sigma zoom lens set at 300 mm on a Porta Mount II tripod.

If you look at the picture on the website you might be able to make out the tiny dots of Jupiter's moons? I can see them clearly on my computer screen BUT they might not show up in the published picture?

Would like to thank Andy Burns for giving up his time on a Wednesday afternoon for showing me how to combine two pictures with Photoshop Elements programmeJ, now all I have to do is remember how we did it for future combining of pictures, I have written down some notes so hopefully that will help me out?

Peter

TRANSIT OF MERCURY MAY 9th

Work is going ahead with a joint presentation at Stonehenge visitor centre near Salisbury. Initial talks and review have gone ahead and here is a summary from the contact there:

EVENT: Transit of Mercury

DATE: 9th May

PARTNER: Wiltshire Astronomical Society

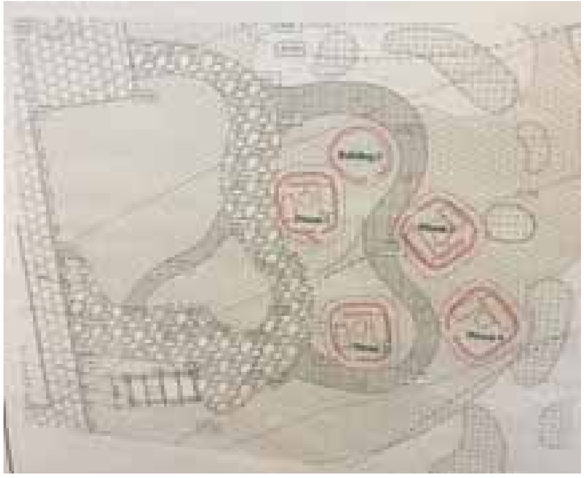
CONTACT: Andrew Burns (anglesburns@hotmail.com)

PR CONTACT: Jessica Trethowan 07880 052025

SITE OPERATIONAL LEAD: Cecilia Webb 07786 524312

SAFETY: Risk Assessments and safety documents to be provided by WAS

POSITION: south side of Neolithic Houses, outside house 4 – setting up laptop inside house 4 and using house as wet weather shelter for equipment.



Must take care not to obstruct visitor flow.

Possible evening set up in monument field – taking care not to disturb SCA visit. Possible contact with SCA group to be made prior to date.

TIMINGS: 11:30-8pm

WEATHER PLANNING:

View to be taken 10 days before event and again 24 hours before

Advance PR:

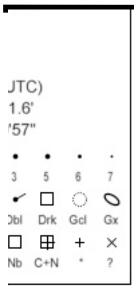
Andy Burns contacting BBC Wiltshire

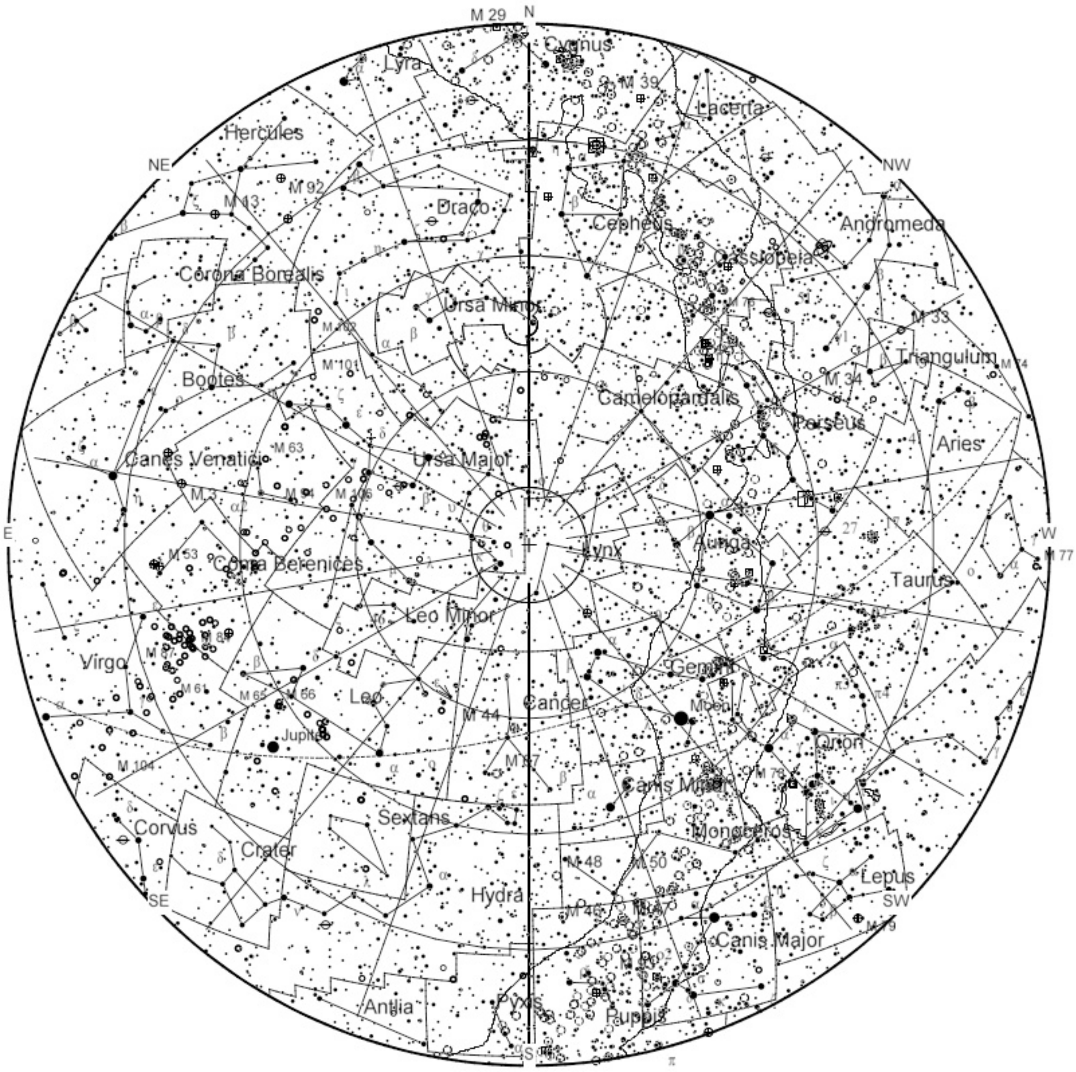
JT to contact Salisbury Journal & Spire FM

Social media

Hut 4

Below is looking back to Stonehenge from the bridleway along the 287º line to Stonehenge. Just before transit finishes Mercury and the Sun will be 8º above the horizon BEHIND the photography. Sheep are an optional extra. Andy





•**March 8** - **Jupiter at Opposition.** The giant planet will be at its closest approach to Earth and its face will be fully illuminated by the Sun. It will be brighter than any other time of the year and will be visible all night long. This is the best time to view and photograph Jupiter and its moons. A medium-sized telescope should be able to show you some of the details in Jupiter's cloud bands. A good pair of binoculars should allow you to see Jupiter's four largest moons, appearing as bright dots on either side of the planet.

•**March 9** - **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 01:54 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.

March 9 - **Total Solar Eclipse.** A total solar eclipse occurs when the moon completely blocks the Sun, revealing the Sun's beautiful outer atmosphere known as the corona. The path of totality will only be visible in parts of central Indonesia and the Pacific Ocean. A partial eclipse will be visible in most parts of northern Australia and southeast Asia. (NASA Map and Eclipse Information) (NASA Interactive Google Map)

•**March 20** - **March Equinox.** The March equinox occurs at 04:30 UTC. The Sun will shine directly on the equator and there will be nearly equal amounts of day and night throughout the world. This is also the first day of spring (vernal equinox) in the Northern Hemisphere and the first day of fall (autumnal equinox) in the Southern Hemisphere.

•**March 23** - **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 12:02 UTC. This full moon was known by early Native American tribes as the Full Worm Moon because this was the time of year when the ground would begin to soften and the earthworms would reappear. This moon has also been known as the Full Crow Moon, the Full Crust Moon, the Full Sap Moon, and the Lenten Moon.

•**March 23** - **Penumbral Lunar Eclipse.** A penumbral lunar eclipse occurs when the Moon passes through the Earth's partial shadow, or penumbra. During this type of eclipse the Moon will darken slightly but not completely. The eclipse will be visible throughout most of extreme eastern Asia, eastern Australia, the Pacific Ocean, and the west coast of North America including Alaska

March is also a good time to do the Messier marathon challenge, using the Moonless nights of this weekend and next (just) all the objects of the Messier catalogue can be seen in one very long night (although this is easier from further south because of extended twilight in more northerly climbs. About 103 is the maximum from the UK.

Also be aware that March is the spring equinox and either side of this event Aurora are more commonly seen.

At the equinox dawn the sun can be seen rising through the length of the West Kennet Log Barrow (and two days either side to avoid the hippies).

Clear Skies

Andy

Double Shadow Transit Season for the **Jovian Moons Begins**

23 Feb , 2016 by David Dickinson

Watching the inky-black shadow of a Jovian moon slide across the cloud-tops of Jupiter is an unforgettable sight. Two is always better than one, and as the largest planet in our solar system heads towards opposition on March 8th, so begins the first of two seasons of double shadow transits for 2016.

With an orbit of 1.8 days, shadow transits of the innermost Galilean moon Io are by far the most common. The innermost three large moons of Jupiter (Io, Europa and Ganymede) are in a 1:2:4 resonance, meaning that double shadow transits involving Io and Europa and the most common. With an orbital period of 16.7 days, outermost Callisto is the only large moon of Jupiter that can occasionally ‘miss’ transiting the disk of Jove, owing to its slight 0.2 degree orbital inclination. The current ongoing season of Callisto transits wraps up this year on September 1st, and will not resume again until late 2019.

An Iphone+telescope capture of the double shadow transit. Image credit and copyright: Andrew Symes

Here’s a selection of favorable double shadow transit events this coming Spring for North America:

February 26th (Io-Europa) from 9:39-10:01 UT

March 4th (Io-Europa) from 11:32-12:38 UT

March 8th (Io-Europa) 00:28-01:56 UT

March 15th (Io-Europa) 2:21-4:34 UT

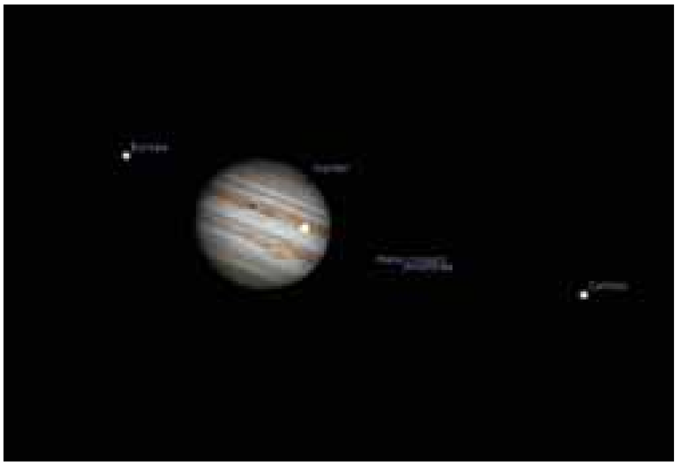
March 22nd (Io-Europa) 4:23-7:10 UT

March 29th (Io-Europa) 7:00-8:24 UT

April 5th (Io-Europa) 9:36-10:17 UT

April 12th (Io-Europa) 12:11-12:14 UT

May 7th (Io-Callisto) 4:38-5:44 UT

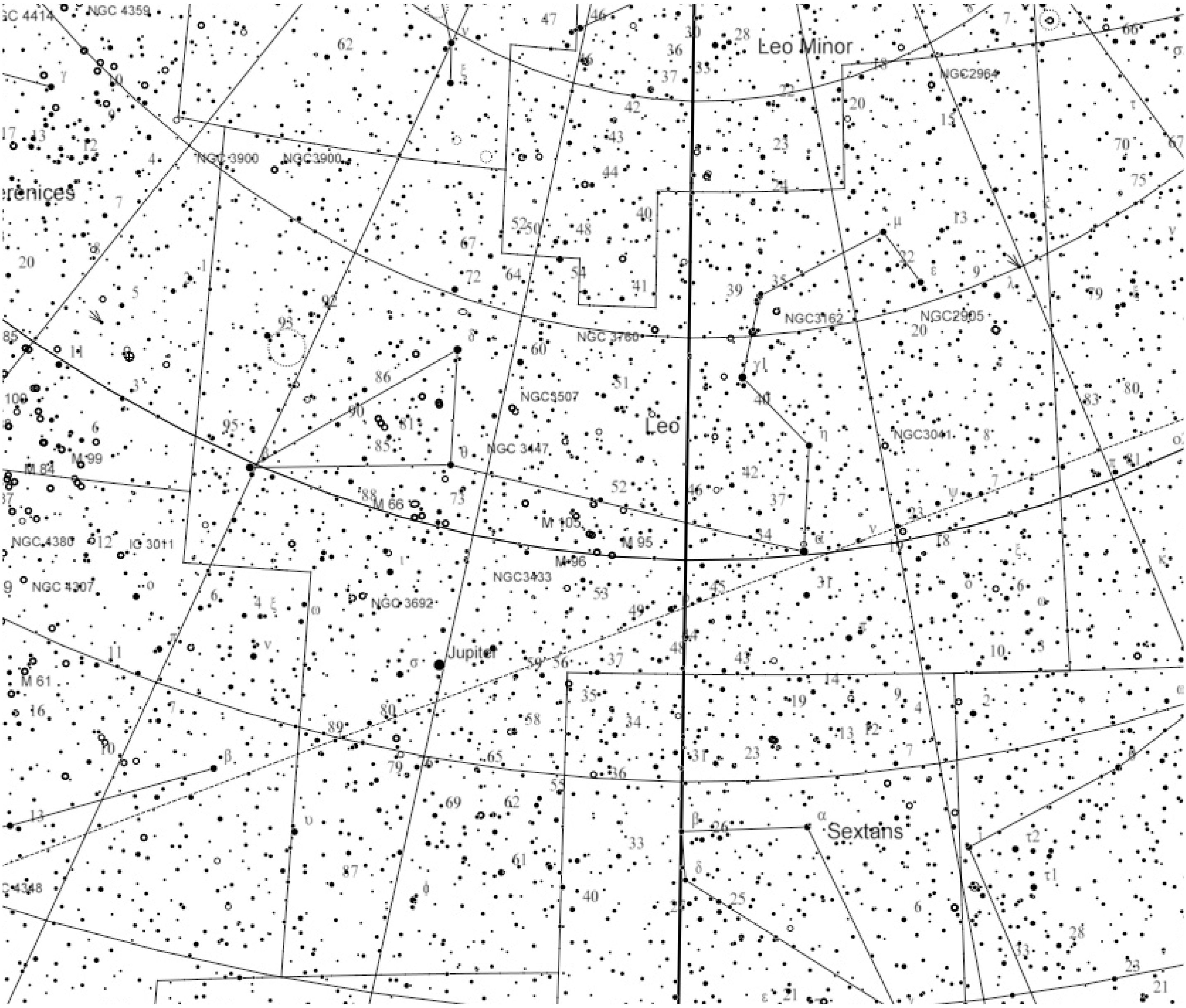


The May 7th double shadow transit of Io and Callisto. Image credit Stellarium

You can see a complete list of double shadow transits worldwide for 2016 here.

The first good event of the series kicks off this week early on the morning of Friday, February 26th, and the series runs until May 7th. The second season of the year runs from August 7th to November 8th but is less than favorable, as Jupiter reaches solar conjunction on September 26th, and is hence near the Sun when the next series occurs. We combed through all mutual shadow transit events for 2016, and found 27 overall.

CONSTELLATIONS OF THE MONTH: LEO



The first on the list of Heracles' labours was the task of killing the Nemean Lion, a giant beast that roamed the hills and the streets of the Peloponnesian villages, devouring whomever it met.

The animal's skin was impervious to iron, bronze, and stone. Heracles' arrows harmlessly bounced off the lion; his sword bent in two; his wooden club smashed to pieces. So Heracles wrestled with the beast, finally choking it to death. He then wrapped the lion's pelt about him; it would protect him from the next labour: killing the poisonous Hydra.

As the story goes, the lion found its way to the heavens to commemorate the great battle with Heracles. Yet this isn't all there is to the story. For even in antiquity, long before the Greeks began telling stories, the lion was an ancient symbol of power.

Approximately three thousand years before the Christian era carvings and sculptures showed kings flanked with rampant lions. Indeed, the archaeological evidence suggests that at about this time the lion had already replaced an even earlier "sacred" symbol, the bull.

It has been suggested that this transfer of power from a horned animal to the lion was a change-over from a lunar-based to a solar-based religion. That is, instead of drawing their inspiration from a night-time symbol with a monthly cycle--a symbol which dealt with the fecundity of the earth and of its animals--the new rulers identified with an animal of strength and power, and with a heavenly body that ruled the day. Thus, as the bull had been identified with the moon, the lion was now associated with the sun. To assert this new religion, or new political structure, the lion was made to kill the bull. Its place in the heavens was therefore critical.

An intriguing theory, put forth thirty years ago by Professor Willy Hartner, eloquently describes the result. Briefly put, at about 4000 BC, the Lion is seen chasing the Bull over the horizon, announcing the end of winter and the beginning of spring. I shall quote Professor Hartner's descriptive words:

"The constellation Leo would have been directly overhead, standing at zenith and displaying thereby its maximum power [as it] kills and destroys the Bull trying to escape below the horizon, which during the subsequent days disappears in the Sun's rays to remain invisible for a period of forty days, after which it is reborn, rising again for the first time (March 21) to announce Spring equinox." [See W. Hartner, "The Earliest History of the Constellations in the Near East and the Motif of the Lion-Bull Combat" *JNES* 24(1965)1-16.]

Thus Leo, slayer of Taurus, dominated the summer skies, the time that the sun passed through this constellation. Due to precession, the sun currently passes through Leo at the end of summer, from mid-August through mid-September.

▪

Leo is a fairly compact constellation and, unlike so many other constellations, it is readily recognisable. *Alpha Leonis* is named "Regulus" because it was seen as the Heaven's Guardian, one who regulated all things in the heavens. While the name Regulus was given us by Copernicus, the star was better known in antiquity as *Cor Leonis*, the Lion's Heart.

Regulus is a multiple binary, discussed below. Also, because Regulus lies so close to the ecliptic, the moon often passes close by, and even occults the star on very rare occasions.

Like other ancient constellations, many of the stars in Leo are named.

Beta Leonis is called "Denebola": the Lion's Tail.

Gamma Leonis is "Algeiba", Arabic for forehead, but more correctly named *Juba*, meaning mane.

Zeta Leonis is "Aldhafera", the meaning is uncertain;

Epsilon Leonis and *mu Leonis* go under the name of "Al Ashfar", the eyebrows.

Delta Leonis is "Zosma", a Greek word meaning girdle.

Lambda Leonis is Alterf, apparently meaning "extremity". It's located right at the tip of the lion's mouth.

Double stars in Leo:

Alpha Leonis (Regulus) is a multiple system. Component B is very wide: (8.1m, PA 307 degrees, 177"), and this star has its own companion ("C"), a very faint 13m dwarf, with a period of about 2000 years, now approximately 2.6" and a PA of about 86 degrees.

A fourth companion, D, is only optical. That is, there is no gravitational bond with the others, but before that was established, it too became a part of the group. It is found at 274 degrees, and 217".

Gamma Leonis is a notable binary with a slow orbit. While Burnham lists three possible periods (407y, 701.4, and 618.6) we have settled on the latter as the most probable, and based its orbit on this period.

Presently the companion is very gradually drawing away from the primary. The current values are: PA 124 degrees and separation 4.4".

Iota Leonis is a more rapid binary, with a period of 192 years. Its orbit shows that the 6.7m companion is slowly increasing its distance (now at PA 122 degrees and separation 1.62").

Variable stars in Leo:

R Leonis is the only variable of note in Leo. This isn't your typical Mira-type long-period variable. First of all, it's usually a very faint 11.3m star, which grows to an extremely bright 4.4m every 309.95 days. In 2000 the maximum should arrive in the last week of February.

Secondly, its colour is an unusually deep red, approaching purple. Surrounded by a number of white stars (18, 19, 21 Leo.) its own colour is even more pronounced. Thus *R Leonis* has become a favourite subject for many variable star observers.

Deep Sky Objects in Leo:

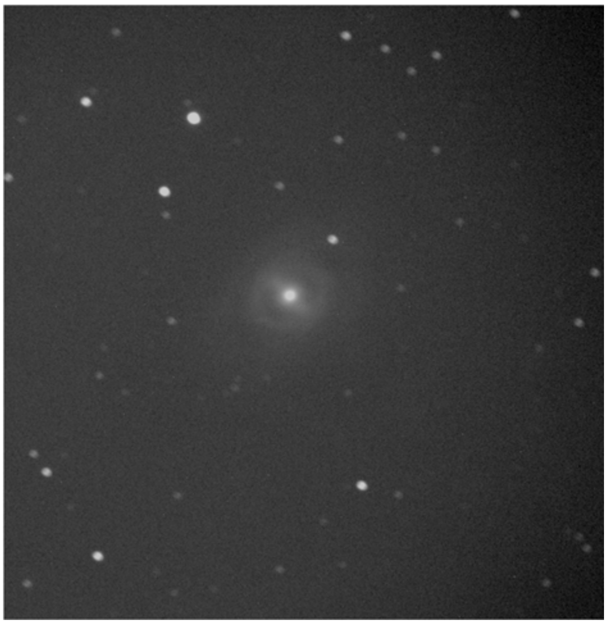
Leo has five Messier objects: *M65*, *M66*, *M95*, *M96*, and *M105*.

M65 (NGC 3623) and *M66* (NGC 3627) make a splendid pair of spiral galaxies in the same field, between theta Leonis and iota Leonis.

This is a fine binocular duo, or use a small telescope. M66 is the one to the east. Both galaxies are elongated north-south; M65 has a tighter spiral and is perhaps the more noticeable.

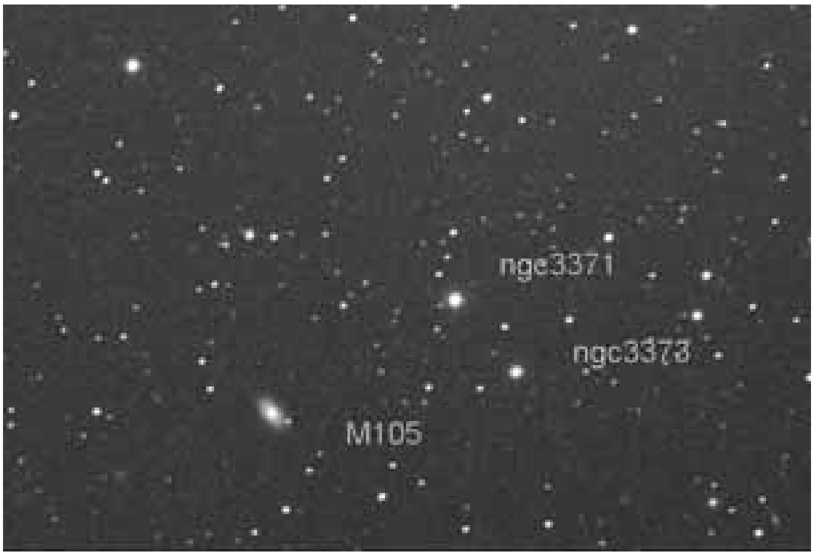
About a degree north, hovering just between M65 and M66, is NGC 3628, a galaxy seen edge-on. Actually this is larger than either Messier object, but much dimmer because it is seen edge-on.

M95 (NGC 3351) and *M96* (NGC 3368) form another nice pair, although farther apart. The two are found is a group of galaxies midway between alpha Leonis and theta Leonis, and just slightly to the south.



Of the two, M95 is to the west. This is a curious round object, with a very faint circular bar. M96 is a

tight spiral galaxy, much brighter than its neighbour. Both



this pair and M65/M66 are considered to be about 30 million light years away.

M105 (NGC 3379) is a much dimmer galaxy to the north-north-east of M96. Along with NGC 3384 and NGC 3389, which lie just to the east, this object forms a small triangle of galaxies.

Then there is *NGC 2903*, which somehow escaped Messier's telescope. This deep sky object is judged to be a visual magnitude of 8.9, which makes it brighter than any of the above Messier objects, and covering a larger area as well. It is an elongated multiple-armed spiral located directly south of lambda Leonis, one and a half degrees.

Indeed, there are many more galaxies in Leo to explore. Most of them lie between alpha and beta Leonis, with a smaller group scattered around gamma Leonis. Most of them are 10-12m, so the larger the telescope the more favourable the viewing.

If you wish a real deep sky challenge, try *Wolf 359*. This is an extremely faint red dwarf, and the third closest star, at 7.65 light years. It has a visual magnitude of only 13.53, which renders it all but lost among the millions of other stars. Only as large as Jupiter, it has a luminosity about 1/65,000 of the Sun's; its absolute magnitude is calculated at 16.7m.

Its Epoch 2000 values are: right ascension 10h 56m, declination 07 degrees, one second. If using Tirion's *SkyAtlas 2000.0*, while this chart doesn't show the star, you can easily find the region. Locate 56 Leo (west of sigma Leonis) then place a mark on the ecliptic just above this star. (The ecliptic is the dotted line running north of this star). This is where you'll find *Wolf 359*. Now you'll need Burnham's finder (on his page 1072), a nice dark sky, and plenty of patience.

AURORA SHOT FROM MARCH 2014 from WILTSHIRE

ISS PASSES For February 2016 From Heavens Above website maintained by Chris Peat

Date	Brightness	Start			Highest point			End		
	(mag)	Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
05 Mar	-0.3	06:08:45	10°	S	06:10:22	13°	SE	06:12:00	10°	ESE
07 Mar	-1.1	05:58:54	10°	SSW	06:01:34	23°	SE	06:04:15	10°	E
08 Mar	-0.6	05:07:18	10°	S	05:09:18	15°	SE	05:11:18	10°	ESE
09 Mar	-2.1	05:49:44	10°	SW	05:52:50	38°	SSE	05:55:56	10°	E
10 Mar	-1.6	04:58:37	16°	SSW	05:00:27	26°	SSE	05:03:16	10°	E
11 Mar	-1.0	04:08:16	17°	SE	04:08:16	17°	SE	04:10:24	10°	E
11 Mar	-3.0	05:40:55	10°	WSW	05:44:07	61°	SSE	05:47:23	10°	E
12 Mar	-2.5	04:50:29	29°	SSW	04:51:40	43°	SSE	04:54:48	10°	E
13 Mar	-1.5	03:59:59	27°	ESE	03:59:59	27°	ESE	04:02:09	10°	E
13 Mar	-3.3	05:32:37	13°	WSW	05:35:27	83°	S	05:38:45	10°	E
14 Mar	-3.2	04:42:03	44°	SW	04:42:54	66°	SSE	04:46:10	10°	E
15 Mar	-1.8	03:51:28	33°	ESE	03:51:28	33°	ESE	03:53:34	10°	E
15 Mar	-3.3	05:24:05	15°	W	05:26:46	85°	N	05:30:04	10°	E
16 Mar	0.1	03:00:50	10°	E	03:00:50	10°	E	03:00:55	10°	E
16 Mar	-3.4	04:33:28	52°	WSW	04:34:10	87°	SSE	04:37:28	10°	E
17 Mar	-1.8	03:42:49	34°	E	03:42:49	34°	E	03:44:51	10°	E
17 Mar	-3.3	05:15:27	15°	W	05:18:02	87°	N	05:21:20	10°	E
18 Mar	0.1	02:52:10	10°	E	02:52:10	10°	E	02:52:14	10°	E
18 Mar	-3.4	04:24:47	55°	W	04:25:25	85°	N	04:28:42	10°	E
19 Mar	-1.6	03:34:08	33°	E	03:34:08	33°	E	03:36:04	10°	E
19 Mar	-3.4	05:06:46	16°	W	05:09:16	78°	SSW	05:12:32	10°	ESE
20 Mar	-3.4	04:16:08	62°	W	04:16:37	89°	N	04:19:55	10°	E
21 Mar	-1.4	03:25:32	28°	E	03:25:32	28°	E	03:27:15	10°	E
21 Mar	-3.1	04:58:09	18°	W	05:00:23	55°	SSW	05:03:35	10°	ESE
22 Mar	-3.5	04:07:37	71°	SW	04:07:45	73°	SSW	04:11:01	10°	ESE
23 Mar	-1.0	03:17:08	21°	E	03:17:08	21°	E	03:18:23	10°	E
23 Mar	-2.6	04:49:46	21°	W	04:51:21	34°	SSW	04:54:22	10°	SE
24 Mar	-2.7	03:59:25	42°	SSE	03:59:25	42°	SSE	04:01:57	10°	SE
25 Mar	-0.4	03:09:11	11°	ESE	03:09:11	11°	ESE	03:09:23	10°	ESE
25 Mar	-1.9	04:41:51	20°	SW	04:42:12	21°	SW	04:44:44	10°	SSE
26 Mar	-1.0	03:51:50	15°	SSE	03:51:50	15°	SSE	03:52:36	10°	SE
30 Mar	-0.9	21:11:36	10°	S	21:11:53	11°	S	21:11:53	11°	S
31 Mar	-1.1	20:20:50	10°	SE	20:21:15	10°	SE	20:21:39	10°	SE
31 Mar	-1.3	21:53:54	10°	SW	21:55:00	19°	SW	21:55:00	19°	SW
01 Apr	-2.3	21:01:30	10°	SSW	21:04:21	28°	SSE	21:05:07	25°	ESE
01 Apr	-0.6	22:37:15	10°	WSW	22:37:47	14°	WSW	22:37:47	14°	WSW
02 Apr	-3.3	21:44:31	10°	WSW	21:47:38	63°	S	21:47:38	63°	S
03 Apr	-3.0	20:51:52	10°	SW	20:55:00	45°	SSE	20:57:19	16°	E
03 Apr	-1.7	22:28:05	10°	W	22:29:57	32°	W	22:29:57	32°	W
04 Apr	-3.4	21:35:14	10°	WSW	21:38:31	85°	S	21:39:28	44°	E
04 Apr	-0.3	23:11:43	10°	W	23:12:06	13°	W	23:12:06	13°	W
05 Apr	-3.3	20:42:27	10°	WSW	20:45:42	69°	SSE	20:48:52	11°	E
05 Apr	-2.7	22:18:52	10°	W	22:21:30	54°	W	22:21:30	54°	W
06 Apr	-3.4	21:26:00	10°	W	21:29:17	85°	N	21:30:48	29°	E
06 Apr	-0.8	23:02:28	10°	W	23:03:25	18°	W	23:03:25	18°	W
07 Apr	-3.3	20:33:07	10°	W	20:36:25	88°	SSE	20:39:42	10°	E
07 Apr	-3.3	22:09:36	10°	W	22:12:39	74°	WSW	22:12:39	74°	WSW
08 Apr	-3.4	21:16:43	10°	W	21:20:00	88°	N	21:21:51	24°	E
08 Apr	-1.1	22:53:11	10°	W	22:54:28	20°	W	22:54:28	20°	W
09 Apr	-3.3	22:00:16	10°	W	22:03:31	59°	SSW	22:03:38	59°	S

END IMAGES

NGC 2244 (the inner star cluster is surrounded by the remnants of a huge gas cloud we see from the light of the stars as a ring known as the Rosette Nebula. Most rings we associate with planetary nebula or exploded stars, but this is a ball of gas (as we look down through the ball the edges are longer and more gas so we see it as a ring. Andy Burns 60sec Nikon D810a on Televue 127 no eyepiece or filter. I have 1hour per night to catch this between houses on moonless nights.

Date	Moon Phase	Observing Topic
2016		
Friday 25th March	Full	Lunar targets
Friday 29th April	Last quarter	Lunar targets
Monday 9th May		*Transit of Mercury*
Friday 27th May	Waning gibbous	
Wiltshire Astronomical Society Observing Sessions 2015 – 2016		

OUTREACH ACTIVITIES

Some evening sessions are being arranged.

May 9th 11:30-20:00, Stonehenge, Transit of Mercury.