NWASNEWS

Volume24, Issue 8

April 2019

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

How Is the Universe Going to Get Us

Tonight I welcome my good friend and accomplished author, lecturer Martin Griffiths . Hopefully we have time to hear all his talk before the Universe wipes out life on Earth.

I did miss last month's meeting which was a shame, because the new Facebook Wiltshire Astronomical Society Members page was opened and introduced to you all.

https://www.facebook.com/groups/wiltshire.astro.society/

You must be invited and then accepted to be able to work within the members section. I will still keep the front page going because this has enabled us to attract new members from outside the society.

The work Sam Franklin has done on the website is beginning to pay off, and I congratulate him on getting this vital link up and running. Only sorry to have been out of reach early in the month then severely restricted by my arthritis (and associated medication).

Clear Skies Andy

Two front page images. Top is the near conjunction (line of sight) between Mars and the Pleiades cluster (M45) in Taurus. Mars will be running up from this position all through April iand is easily covered in a 300mm lens, taken last night you can see the affects of thin cloud in our own atmosphere.
Below on of many pictures I took in northern Iceland of the most wonderful aurora borealis I have witnessed. This was a wideangle lens (16mm fisheye on a full frame Nikon Z7). ISo3200, 6 seconds. The colours are greatly enhanced by photography, particularly the green the the human eye converts to whiter colours. Andy

Wiltshire Society Page

Wiltshire Astronomical Society

Web site: www.wasnet.org.uk

Facebook members page: https://www.facebook.com/groups/wiltshire.astro.society/

Meetings 2018/2019Season.

NEW VENUE the Pavilion, Rusty Lane, Seend

Meet 7.30 for 8.00pm start

Date	Speaker	Title
2019		
2 April	Martin Griffiths:	'Universal Death' or How the Universe is trying to kill us.
7 May	Mark Radice:	Observing the Solar System.
4 Jun	Jon Gale:	Observing the Herschel 400.

Martin Griffiths is an astronomer and science presenter with Dark Sky Wales, a former senior lecturer in Astronomy at the University of South Wales, and a founder member of NASA's Astrobiology Science Communication team. He assisted the Brecon Beacon national parks successful campaign to gain International dark sky status and in 2014 became Director of the Brecon Beacon Observatory, a public educational resource at the National Park Visitor Centre. He is the local representative for the BAA campaign for Dark Skies.

Griffiths is a Fellow of the Royal Astronomical Society; a Fellow of the Higher Education Academy; a member of the British Astronomical Association; the Webb Deep-Sky Society; the Society for Popular Astronomy; The Astronomical Society of the Pacific and the Astronomical league. Astrobiology Society of Britain; The European Science Communication Network; The European Society for the History of Science; The Planetary Society and the British Science Association.

From Celtic legends and myths in the stars, astrobiology, science fiction, history of astronomy plus many excellent practical observing books to his name, Martin has also been a regular visitor to the society.

(What is going on under the blanket can only be his observing one of the ways the universe can kill us all).

Membership Meeting nights £1.00 for members £3 for visitors

Wiltshire AS Contacts

Keith Bruton Chair, keisana@tiscali.co.uk

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

Bob Johnston (Treasurer) Debbie Croker (vice Treasurer)

Philip Proven (Hall coordinator) Dave Buckle (Teas)

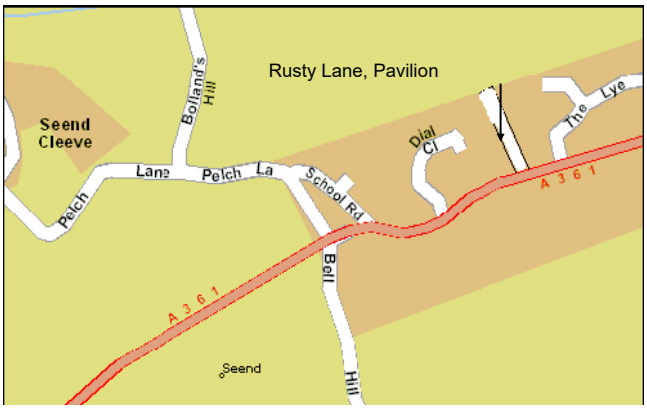
Peter Chappell (Speaker secretary)

Nick Howes (Technical Guru)

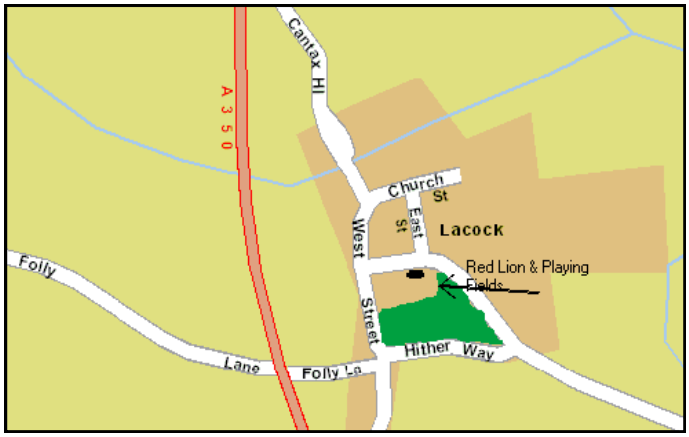
Observing Sessions coordinators: Jon Gale, Tony Vale

Web coordinator: Sam Franklin

Contact via the web site details.



Observing Sessions



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

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

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

Swindon Stargazers

Swindon's own astronomy group

April Meeting: Dr. Sarah Bosman

Sarah is a postdoctoral researcher at University College London (UCL)

She will be giving a talk on: Late Cosmology: how stars and black holes emerged from primordial gas, and how we can spot them

New Chairman

At the recent AGM on 15th March, our Chairman, Peter Struve, retired through ill health after 10 years in the post. He is succeeded by Robin Wilkey, who will also continue his role as web developer for the club.

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.

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

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

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

Enjoy astronomy at it's best!

Members of the Wiltshire Astronomical Society always welcome!

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

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

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

Meeting Dates for 2019

Friday 12 April 2019

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

Friday 17 May 2019

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

Friday 21 June 2019

Programme: Peter Chappell: My Aurora Adventure

July & August: Summer break

Friday 20 September 2019

Programme: Dr. Lilian Hobbs: How Astronomy Has Changed

Friday 18 October 2019

Programme: Robert Slack: The Grand Tour

Friday 15 November 2019

Programme: TBA

Friday 13 December 2019

Programme: TBA

Website:

http://www.swindonstargazers.com

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BECKINGTON ASTRONOMICAL SOCIETY

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

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

Our Committee for 2016/2017 is

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

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

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

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

Post Code for Sat Nav is BA11 6TB.

Our start time is 7.30pm.

26th April	*Observing and Sketching the Deep Sky*	Mark Radice
17th May	*The Herschel 400*	Jonathan Gale
21st June	Annual General Meeting *Member Talks*	

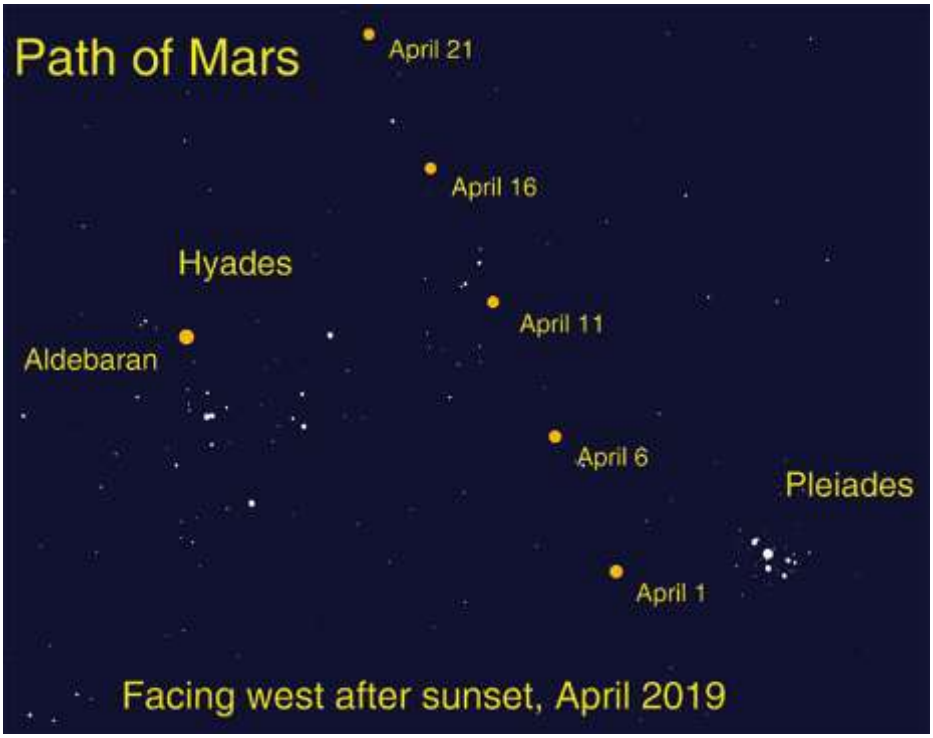
SPACE STATION IMAGES
We have had some superb space station transits in the last week, but these finish at the end of this week and won't be seen again until May.

Mars the Wanderer
By David Prosper

April's skies find Mars traveling between star clusters after sunset, and a great gathering of planets just before sunrise.

Mars shows stargazers exactly what the term "planet" originally meant with its rapid movement across the evening sky this month. The ancient Greeks used the term *planete,* meaning *wanderer*, to label the bright star-like objects that travelled between the constellations of the zodiac year after year.

You can watch Mars as it wanders through the sky throughout April, visible in the west for several hours after sunset. Mars travels past two of the most famous star clusters in our night sky: the **Pleiades** and **Hyades**. Look for the red planet next to the tiny but bright Pleiades on April 1st. By the second week in April, it has moved eastward in Taurus towards the larger V-shaped Hyades. Red Mars appears to the right of the slightly brighter red-orange star **Aldebaran** on April 11th. We see only the brightest stars in these clusters with our unaided eyes; how many additional stars can you observe through binoculars?



Caption: The path of Mars between the Pleiades and Hyades in April.
Image created with assistance from Stellarium.

Open clusters are made up of young stars born from the same "star nursery" of gas and dust. These two open clusters are roughly similar in size. The Pleiades appears much smaller as they are 444 light years away, roughly 3 times the distance of the Hyades, at 151 light years distant. Aldebaran is in the same line of sight as the Hyades, but is actually not a member of the cluster; it actually shines just 65 light years away! By comparison, Mars is practically next door to us, this month just a mere 18 light minutes from Earth - that's about almost 200 million miles. Think of the difference between how long it takes the light to travel from these bodies: 18 minutes vs. 65 years!

The rest of the bright planets rise before dawn, in a loose lineup starting from just above the eastern horizon to high above the south: **Mercury**, **Venus**, **Saturn**, and **Jupiter**. Watch this month as the apparent gap widens considerably between the gas giants and terrestrial planets. Mercury hugs the horizon all month, with Venus racing down morning after morning to join its dimmer inner solar system companion right before sunrise. In contrast, the giants Jupiter and Saturn move away from the horizon and rise earlier all month long, with Jupiter rising before midnight by the end of April.

The **Lyrids** meteor shower peaks on April 22nd, but sadly all but the brightest meteors will be washed out by the light of a bright gibbous Moon.

You can catch up on all of NASA's current and future missions at nasa.gov

SPACE NEWS FOR APRIL

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

Sorry Hollywood, it's Going to Take a Lot More to Destroy an Asteroid

It's become something of an action movie cliche: an asteroid is hurling towards Earth, its impact will cause a mass extinction, and the only hope for humanity is a ragtag group of astronauts and average Joes who will fly to the asteroid and blow it to pieces using nukes. The idea has been explored so many times by Hollywood that it seems like this is actually something space agencies have planned.

And in truth, they are, though the execution may be a little more sophisticated. For decades, space agencies have considered various methods for destroying asteroids that threaten Earth. But according to a new study led by researchers from John Hopkins University, incoming asteroids may be harder to break apart than we thought.

A Newer, More Accurate Measurement Sets the Mass of the Milky Way at 1.5 Trillion Solar Masses

Astronomers keep trying to measure the mass of the Milky Way and they keep coming up with different numbers. But it's not that they're bad at math. Measuring the mass of something as enormous as the Milky Way is confounding. Plus, we're embedded in it; it takes some very clever maneuvering to constrain its mass.

The Milky Way's mass is a fundamental scientific question that astronomers have been trying to answer for decades. The problem is, even astronomers' best estimates vary wildly. The difficulty arises not from measuring the mass of the stars themselves. It comes from the challenge of measuring dark matter.

Don't know what dark matter is? Okay, Universe Today is here to help. (If you do know what it is, then you can skip the next section.)

The Obligatory "What is Dark Matter?" Part

First of all, dark matter is hypothetical. We don't really know what it is. But we know it's there, or rather we know something's there.

The things we can see and interact with are made of what's called 'baryonic matter.' It's made of atoms and it's all the stuff we're familiar with: Our bodies, the planets, stars, Kim Jong-un's eyeglasses, etc. But baryonic matter only makes up about 10-15% of matter in the universe.

We think that dark matter makes up about 85-90% of the matter in the universe. It's distinct from regular matter because it doesn't interact with light and we can't see it. That's why it's called dark matter.

But we know it's there because galaxies behave as if they have way more mass than we can see. The hint that it's there is in the gravity. Galaxies must have more mass, and hence more gravity, than we can see in their regular matter, or they would just fly apart. Their mass and gravity hold them together.

The short version is that things just couldn't be the way they are unless there was a lot more mass than we can measure.

It's Really Hard to Measure

"*We just can't detect dark matter directly.*"

Laura Watkins, European Southern Observatory

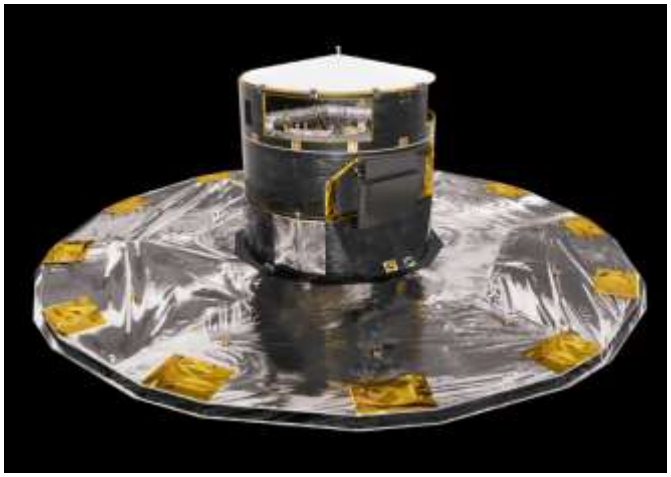
"*We just can't detect dark matter directly,*" explains Laura Watkins (European Southern Observatory, Germany), who led the team performing the analysis. "*That's what leads to the present uncertainty in the Milky Way's mass – you can't measure accurately what you can't see!*"

So how can we measure something we can't see? Astronomers busy themselves measuring the effect of dark matter and then kind of work backwards. But even with all the effort put into it, estimates vary wildly, from as low as 500 billion times the mass of our Sun, up to 3 trillion times the mass of our Sun. That's a huge discrepancy, and a real nagging problem in astronomy. And it's because of the difficulty of measuring all the dark matter.

Now a new study led by Laura Watkins from the European Southern Observatory thinks they've come closest yet to measuring the dark matter, and hence the entire mass, of the Milky Way. Their number?

They say the Milky Way contains 1.5 trillion times as much mass as our Sun, or 1.5 trillion solar masses, within a radius of 125,000 light years from the galactic centre.

The study relies on the second data release from the European Space Agency's Gaia mission. The authors combined it with observations from the workhorse Hubble Space Telescope.



The ESA's Gaia spacecraft. Gaia is measuring the positions of billions of stars with greater accuracy than ever before. Image Credit:
ESA/ATG medialab

Let's get into the guts of how astronomers measure the Milky Way's mass.

Astronomers can't just take sample measurements of stars and then extrapolate. That doesn't work because they can't see all the dark matter. So they measure other things. And thanks to the Gaia mission, a bunch of measuring has already been done for them.

Enter Gaia and Globular Clusters

Gaia is the ESO's mission to create a 3D map of the Milky Way. It's an ambitious mission, but it has yielded great results. Gaia has measured the positional and radial velocity of about one billion of the stars in the Milky Way, and in the Local Group. This is about one percent of the stars in our galaxy. That may not sound like a lot, but the accuracy of the measurements is also really important, especially when it comes to measuring dark matter.

Some of the approximately one billion stars that Gaia measured are in the globular clusters that are near the Milky Way. Globular clusters are spherical collections of stars, and there about 150 of them orbiting the Milky Way. Most importantly, the more massive the galaxy is, the faster the globular clusters orbit. And Gaia has given us more accurate measurements of their velocity than ever before.

"*The more massive a galaxy, the faster its clusters move under the pull of its gravity.*"

N. Wyn Evans, University of Cambridge, UK.

"*The more massive a galaxy, the faster its clusters move under the pull of its gravity*" explains N. Wyn Evans (University of Cambridge, UK). "*Most previous measurements have found the speed at which a cluster is approaching or receding from Earth, that is the velocity along our line of sight. However, we were able to also measure the sideways motion of the clusters, from which the total velocity, and consequently the galactic mass, can be calculated.*"

A Hubble Space Telescope image of the globular cluster NGC 4147, one of the clusters used to measure the Milky Way's mass in this new study. NGC 4147 is about 60,000 light years from Earth. Image Credit:
ESA/Hubble & NASA, T. Sohn et al.

The Hubble Helps Out

The further away the globular cluster, the more they tell us about the Milky Way's mass. Although Gaia provided the extremely accurate velocity measurements of the clusters, it was the venerable Hubble Space Telescope that measured clusters as far away as 130,000 light years from Earth, adding a great deal of accuracy to the new mass measurement for the Milky Way.

"*Global clusters extend out to a great distance, so they are considered the best tracers astronomers use to measure the mass of our galaxy*" said Tony Sohn (Space Telescope Science Institute, USA), who led the Hubble measurements.

"*We were lucky to have such a great combination of data,*" explained Roeland P. van der Marel (Space Telescope Science Institute, USA). "*By combining Gaia's measurements of 34 globular clusters with measurements of 12 more distant clusters from Hubble, we could pin down the Milky Way's mass in a way that would be impossible without these two space telescopes.*"

Why It Matters

So now what?

The mass of the Milky Way is more than just a curiosity, it's an intrinsic and important part of much larger questions. A galaxy's dark matter content is linked to the formation and growth of structures in the Universe.

This more accurate measurement of the Milky Way's mass helps us understand our home galaxy and its place in the cosmos.

Not bad.

Sources:

Research Paper: Evidence for an Intermediate-Mass Milky Way from Gaia DR2 Halo Globular Cluster Motions

Press Release: Hubble and Gaia Accurately Weight the Milky Way

Which Habitable Zones are the Best to Actually Search for Life?

Looking to the future, NASA and other space agencies have high hopes for the field of extra-solar planet research. In the past decade, the number of known exoplanets has reached just shy of 4000, and many more are expected to be found once next-generations telescopes are put into service. And with so many exoplanets to study, research goals have slowly shifted away from the process of discovery and towards characterization.

Unfortunately, scientists are still plagued by the fact that what we consider to be a "habitable zone" is subject to a lot of assumptions. Addressing this, an international team of researchers recently published a paper in which they indicated how future exoplanet surveys could look beyond Earth-analog examples as indications of habitability and adopt a more comprehensive approach.

The paper, titled "Habitable Zone predictions and how to test them", recently appeared online and was submitted as a white paper to the Astro 2020 Decadal Survey on Astronomy and Astrophysics. The team behind it was led by Ramses M. Ramirez, a researcher with the Earth-Life Science Institute (ELSI) and the Space Science Institute (SSI), who was joined by co-authors and co-signers from 23 universities and institutions.

The purpose of the decadal survey is to consider previously-made progress in various fields of research and to set priorities for the coming decade. As such, the survey provides crucial guidance to NASA, the National Space Foundation (NSF), and the Department of Energy as they plan their astronomy and astrophysics research goals for the future.

At present, many of these goals focus on the study of exoplanets, which will benefit in the coming years from the deployment of next-generation telescopes like the *James Webb Space Telescope* (JWST) and the *Wide-Field Infrared Space Telescope* (WFIRST), as well as ground-based observatories like the Extremely Large Telescope (ELT), the Thirty Meter Telescope, and the Giant Magellan Telescope (GMT).

One of the overriding priorities of exoplanet research is looking for planets where extra-terrestrial life could exist. In this respect, scientists designate planets as being "potentially-habitable" (and therefore worthy of follow-up observations) based on whether or not they orbit within their stars' habitable zones (HZ). For this reason, it is prudent to take a look at what goes in to defining a HZ.

As Ramirez and his colleagues indicated in their paper, one of the major issues with exoplanet habitability is the level of assumptions that are made. To break it down, most definitions of HZs assume the presence of water on the surface since this is the only solvent currently known to host life. These same definitions assume that life requires a rocky planet with tectonic activity orbiting a suitably bright and warm star.

The "Goldilocks" zone around a star is where a planet is neither too hot nor too cold to support liquid water. Credit: Petigura/UC Berkeley, Howard/UH-Manoa, Marcy/UC Berkeley.

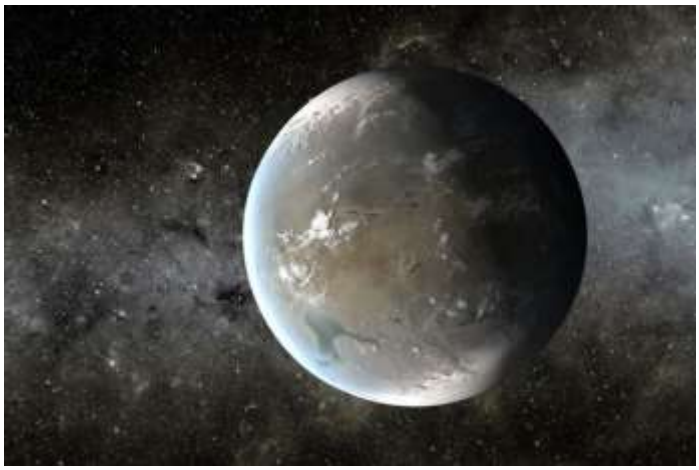
However, recent research has cast doubt on many of these assumptions. This includes studies that indicate how atmospheric oxygen does not automatically mean the presence of life – especially if that oxygen is the result of chemical dissociation and not photosynthesis. Other research has shown how the presence of oxygen gas during the early periods of a planet's evolution could prevent the rise of basic life forms.

Also, there have been recent studies that have shownn how plate tectonics may not be necessary for life to emerge, and that so-called "water worlds" may not be able to support life (but still could). On top of all that, you have theoretical work that suggests that life could evolve in seas of methane or ammonia on other celestial bodies.

The key example here is Saturn's moon Titan, which boasts an environment that is rich in prebiotic conditions and organic chemistry – which some scientists think could support exotic lifeforms. In the end, scientists search for known biomarkers like water and carbon dioxide because they are associated with life on Earth, the only known example of a life-bearing planet.

But as Ramirez explained to Universe Today via email, this mindset (where Earth-analogues are considered suitable for life) is still fraught with problems:

"The classical habitable zone definition is flawed because its construction is mainly based on Earth-centric climatological arguments that may or may not be applicable to other potentially habitable planets. For instance, it assumes that multi-bar CO2 atmospheres can be supported on potentially habitable planets near the habitable zone outer edge. However, such high CO2 levels are toxic to Earth plants and animals, and thus without a better understanding of the limits of life, we do not know how reasonable this assumption is.



Exoplanet Kepler 62f would need an atmosphere rich in carbon dioxide for water to be in liquid form. Artist's Illustration: NASA Ames/JPL-Caltech/T. Pyle

"The classical HZ also assumes that CO2 and H2O are the key greenhouse gases sustaining potentially habitable planets, but several studies in recent years have developed alternative HZ definitions using different combinations of greenhouse gases, including those that, although relatively minor on Earth, could be important for other potentially habitable planets."

In a previous study, by Dr. Ramirez showed how the presence of methane and hydrogen gas could also cause global warning, and thus extend the classical HZ somewhat. This came just a year after he and Lisa Kaltenegger (an associate professor with the Carl Sagan Institute at Cornell University) produced a study that showed how volcanic activity (which releases hydrogen gas into the atmosphere) could also extend a star's HZ.

Luckily, these definitions will have the opportunity to be tested, thanks to the deployment of next-generation telescopes. Not only will scientists be able to test some of the long-standing assumptions on which HZs are based, they will able to compare different interpretations. According to Dr. Ramirez, a good example levels of CO2 gas that are dependent on a planet's distance from its star:

"Next generation telescopes could test the habitable zone by searching for a predicted increase in atmospheric CO2 pressure the farther away that potentially habitable planets are from their stars. This would also test whether the carbonate-silicate cycle, which is what many believe has kept our planet habitable for much of its history, is a universal process or not."

Artist's depiction of a waterworld. A new study suggests that Earth is in a minority when it comes to planets, and that most habitable planets may be greater than 90% ocean. Credit: David A. Aguilar (CfA)

In this process, silicate rocks are converted to carbon rocks through weathering and erosion, while carbon rocks are converted to silicate rocks through volcanic and geological activity. This cycle ensures the long-term stability of Earth's atmosphere by keeping CO2 levels consistent over time. It also illustrates how water and plate tectonics are essential to life as we know it.

However, this type of cycle can only exist on planets that have land, which effectively rules out "water worlds". These exoplanets – which may be common around M-type (red dwarf) stars – are believed to be up to 50% water by mass. With this amount of water on their surfaces, "water worlds" are likely to have dense layers of ice at their core-mantle boundary, thus preventing hydrothermal activity.

But as noted already, there is some research that indicates that these planets could still be habitable. While the abundance of water would prevent the absorption of carbon dioxide by rocks and suppress volcanic activity, simulations have shown that these planets could still cycle carbon between the atmosphere and the ocean, thus keeping the climate stable.

If these types of ocean worlds exist, says Dr. Ramirez, scientists could detect them through their lower planetary density and high pressure atmosphere. And then there is the matter of various greenhouse gases, which are not always an indication of warmer planetary atmospheres, depending on the type of star.

Artist's impression of Sirius A (a main-sequence type A star) and Sirius B (white dwarf companion). Credit: NASA, ESA and G. Bacon (STScI)

"Although methane warms our planet, we found that methane actually cools the surfaces of habitable zone planets orbiting red dwarf stars!" he said. "If that is the case, high atmospheric methane amounts on such planets could mean frozen conditions that are perhaps unsuitable for hosting life. We will be able to observe this in planetary spectra."

Speaking of red dwarfs, the debate rages on as to whether or not planets that orbit these stars would be

capable of maintaining an atmosphere. In the past few years, multiple discoveries have been made that suggest that rocky, tidally-locked planets are common around red dwarf stars, and that they orbit within their stars' respective HZs.

However, subsequent research has reinforced the theory that the instability of red dwarf stars would likely result in solar flares that would strip any planets orbiting them of their atmospheres. Lastly, Ramirez and his colleagues raise the possibility that habitable planets could be found orbiting what has (until recently) been considered an unlikely candidate.

These would be main sequence type-A stars – like Sirius A, Altair, and Vega – which were thought to be too bright and hot to be suitable for habitability. Said Dr. Ramirez of this possibility:

"I am also interested in finding out if life exists on habitable zone planets orbiting A-stars. There has not been a lot of published assessments of A-star planetary habitability, but some next-generation architectures plan to observe them. We will soon learn more about the suitability of A-stars for life."

Artist's concept of Earth-like exoplanets, which (according to new research) need to strike the careful balance between water and landmass. Credit: NASA

Ultimately, studies like this one, which question the definition of "habitable zone", will come in handy when next-generation missions commence science operations. With their higher-resolution and more sensitive instruments, they will be able to test and validate many of the predictions that have been made by scientists.

These tests will also confirm whether or not life could exist out there only as we know it, or also beyond the parameters that we consider to be "Earth-like". But as Ramirez added, the study that he and his colleagues conducted also highlights just how important it is that we continue to invest in advanced telescope technology:

"Our paper also stresses the importance of a continued investment in advanced telescope technology. We need to be able to find and characterize as many habitable zone planets as possible if we wish to maximize our chances of finding life. However, I also hope that our paper inspires people to dream beyond just the next 10 years so. I really believe that there will eventually be missions that will be far more capable than anything that we are currently designing. Our current efforts are just the beginning of a much more committed endeavor for our species."

The 2020 Decadal Survey meeting is being hosted jointly by Board of Physics and Astronomy and the Space Studies Board of the National Academy of Sciences, and will be followed by a report to be released roughly two years from now.

Further Reading: arXiv, *National Academy of Sciences – Astro 2020*

Almost 13,000 Years Ago, a Comet Impact Set Everything on Fire

Roughly 12,800 years ago, planet Earth went through a brief cold snap that was unrelated to any ice age. For years, there have been geologists that have argued that this period was caused by an airburst or meteor fragments (known as the Younger Dryas Impact Theory). This event is beleived to have caused widespread destruction and the demise of the Clovis culture in North American.

This theory has remained controversial since it was first proposed. However, an international team of scientists recently discovered geological evidence in South America that could settle the debate. As the latest indication of an impact that took place during the Younger Dryas Boundary (YDB) period, this crater indicates that the effects of this event may have been more widespread than previously thought.

Pulsar Seen Speeding Away From the Supernova That Created it

When a star exhausts its nuclear fuel towards the end of its lifespan, it undergoes gravitational collapse and sheds its outer layers. This results in a magnificent explosion known as a supernova, which can lead to the

creation of a black hole, a pulsar or a white dwarf. And despite decades of observation and research, there is still much scientists don't know about this phenomena.

Luckily, ongoing observations and improved instruments are leading to all kinds of discoveries that offer chances for new insights. For instance, a team of astronomers with the National Radio Astronomy Observatory (NRAO) and NASA recently observed a "cannonball" pulsar speeding away from the supernova that is believed to have created it. This find is already providing insights into how pulsars can pick up speed from a supernova.

Asteroid Bennu has Already Thrown Material off into Space 11 Times Since OSIRIS-REx Arrived

On Dec. 31st, NASA's Origins, Spectral Interpretation, Resource Identification, Security-Regolith Explorer (OSIRIS-REx) rendezvoused with the asteroid 101955 Bennu. As part of an asteroid sample-return mission, NASA hopes that material from this near-Earth Asteroid (NEA) will reveal things about the history of the Solar System, the formation of its planets, and the origins of life on Earth.

Since the spacecraft established orbit around the asteroid, it has witnessed some interesting phenomena. This includes the first-ever close-up observations of particle plumes erupting from an asteroid's surface. Since that time, the mission team has kept an eye out for these eruptions, which has allowed them to witness a total of 11 "ejection events" since the spacecraft first arrived.

Rivers on Mars Flowed for More Than a Billion Years

The ancient climate of Mars is a mystery to scientists. Even with all we've learned about Mars, it's still difficult to explain how lakes and rivers existed. A new study shows that Martian rivers were swollen with runoff and that they flowed far later into the planet's history than previously thought.

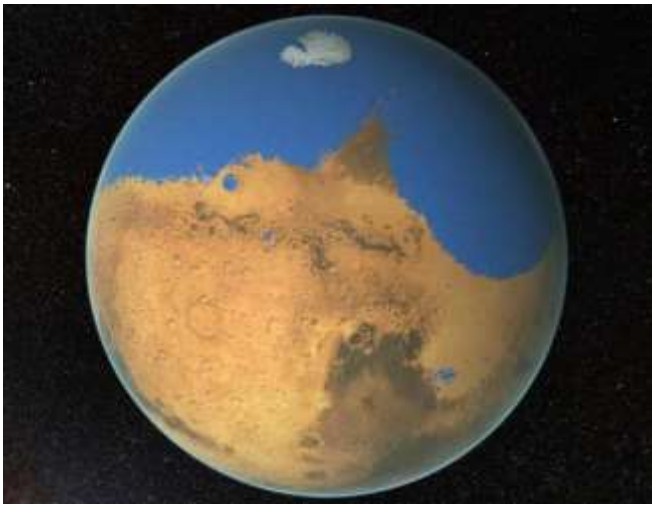
The question is, how did the Martian climate create these conditions?

The new study comes from researchers at the University of Chicago and other institutions, including the USGS Astrogeology Program, the Imperial College of London, and the Smithsonian Institution. It's titled "Persistence of intense, climate-driven runoff late in Mars history" and was published in Science Advances. The lead author is U of Chicago Assistant Professor Edwin Kite. Kite is an expert in Martian history and in the climates of other worlds.

"It's already hard to explain rivers or lakes based on the information we have. This makes a difficult problem even more difficult."

Study lead author Edwin Kite, University of Chicago.

As spacecraft have revealed, water channels are not rare on Mars. There are hundreds of old river channels on the surface of the planet, alongside other evidence of water. There are basins full of silt, and pebbles worn round from tumbling in the water. One line of inquiry even suggests that Mars may have had a large ocean, possibly covering as much as one third of the planet.



At one time, Mars had a global ocean that may have covered about one third of the planet. Credit: NASA/GSFC

This new study shows that there were hundreds of rivers on Mars, and that they were wider than rivers on Earth. It also shows that the rivers were fed by run-off, and that they persisted for much longer than previously thought. But we still don't know why Mars had water.

The Martian atmosphere is extremely thin, though evidence shows it must have been much thicker in the ancient past. But in the ancient past, in the early days of our Solar System, Mars would have received a lot less energy from the Sun than it does now. It may have only have received one-third the energy that the Earth does in present day.

"Indeed, even on ancient Mars, when it was wet enough for rivers some of the time, the rest of the data looks like Mars was extremely cold and dry most of the time."

Edwin Kite, University of Chicago.

There's conflicting data when it comes to water on ancient Mars. Some evidence shows it was warm enough for liquid water, but only some of the time. The rest of the time, it was cold and dry. How does all this make sense?

Images of Martian riverbeds captured by the European Space Agency's Mars Express Orbiter. Image Credit: ESA/ DLR/FU Berlin, CC BY-SA 3.0 IGO

In this study, Kite and his colleagues analyzed over 200 Martian riverbeds spanning a timeline greater than a billion years. They focused on photographs and elevation models, and the detail in the riverbeds provide a lot of clues about the rivers and the climate that created them. According to a press release, the steepness and the width of the riverbeds, and the size of the pebbles in them, reveal a lot about the force of the water flowing through them. The amount of gravel left behind also gives a clue to the volume of water.

The results of the analysis show that there was persistent and powerful run-off fuelling the rivers, well into the last stage of Mars' wet climate. Intuition tells us that river flow would taper off leading up the end of the wet climate, but that's not what the evidence shows. The rivers got shorter as the end of the wet climate approached, the their flow was still strong.
"You would expect them to wane gradually over time, but that's not what we see," Kite said. "The wettest day of the year is still very wet."

This study doesn't explain what happened to the Martian climate, and its water, but it puts some constraints on what happened. The rivers were large and flowed continuously, not just during what's termed "climate high noon." Scientists modelling the ancient Martian climate need to account for that. The average daily temperature had to be high enough to keep water in liquid form.

Lead author Kite speculated that the climate may have had some sort of intermittent on/off switch, which made Mars flip back and forth between wet and dry times.

But somewhere in our understanding of Mars, we've got something wrong.
"Our work answers some existing questions but raises a new one. Which is wrong: the climate models, the atmosphere evolution models, or our basic understanding of inner solar system chronology?" Kite said.

There may have been strong positive feedbacks in Mars early climate system. In their paper, the authors suggest that methane may have been released from clathrate hydrates as they thawed. Along with other feedbacks, this may have contributed to the Martian climate, and contributed to the difficulty in modelling the ancient Martian climate.

For now, the ancient raging Martian rivers are a mystery, much like most of the rest of Mars.

Sources:

Press Release: Rivers raged on Mars late into its history

Research Paper: Persistence of intense, climate-driven runoff late in Mars history

Press Release: Rain or snow likely formed Martian rivers

E Mails Viewings Logs and Images from Members.

Observing Log Tuesday 26th. February 2019.

After giving my telescope a much-needed airing at the week-end, I went to Uffcott to give the telescope/ camera combination a more serious trial. Arriving about 7:30 I went to set up and realised that I'd brought everything except the telescope, so a quick run home and back and I was set up by shortly after 8:00. Slewing to the first target the telescope stopped moving, although it was making all the right noises. After a minute or two I found out that the RA lock had spun loose so that the drive was disconnected. So, re-tighten and set up again then aim at M42, as a bright object that should be easy to pick up with the camera (Nikon D50 DSLR).

A quick look though the eyepiece to remind myself what it looked like then fit the camera and try to find a focus. I used a Bahtinov mask at first, as I though that would achieve a more accurate focus, but found that through the viewfinder (the D50 doesn't have liveview) it was impossible to see the pattern caused by the mask, so had to rely on the Mk. 1 eyeball. I forgot about taking test images with the mask on so that I could see how the diffraction spikes moved to show the focus point. I took 1 shot at 20 sec. exposure, and on the screen the result seemed bright and close to focus, so I decided not to change anything and take a series of images at the same settings. 20 images later I moved to the Pleiades and then the Andromeda Galaxy, about 10 images of each. I then decided to take some more images of M42 and M31, but this time with 10 sec. exposure.

Looking at the images on the laptop later I was pleased with the amount of detail captured, but not so pleased with the focus. The shots of M42 in particular revealed a considerable amount of colour, and stacking them with DeepSkyStacker intensified this, as well as bringing out more detail. In the M31 image only the nucleus is really visible, but M32 was captured in the 10 second exposures. Dark markings appearing to be the spaces between the spiral arms were just about visible, but were virtually wiped out by the light pollution from Swindon. It will be interesting to see what better processing brings out.

I was quite pleased with the session, but it highlighted a few problems - I need to improve my focusing, I

need a better camera and I also need a better memory. I could probably do with making up an equatorial mount to cut out field rotation, as well, but that's a project for the summer.

Peter Eslick

Viewing Log for 22nd February

Tony Vale had arranged a Wiltshire AS viewing session at Lacock AND the clouds did not come over as usual, well not at the start when I left Swindon! As it was a free evening for me I packed up my telescope gear had headed off to the playing field behind the Red Lion in Lacock. While on the M4 I noticed some cloud coming up from a westerly direction, could yet be clouded out?

Anyway I arrived at Lacock and had my 8 inch Meade LX90 GOTO telescope set up and ready by 19:10, tonight I would be using a Pentax XW 14 mm eye piece (fairly standard equipment for me). The cloud bank was now coming in, we also had fog to deal with, not the best of starts! I could see Orion in the south so I had a look at M42, as usual it did not disappoint me? Mars was behind a big cloud but I could just make out Uranus? While slewing to my next target M38 in Auriga, I heard somebody asking for me, turned out to be Ian and Kristen Pass + Mia (their child of nine) after having a big hello session and catching up with what has happened to them I had a keen child who wanted to look at somethings in the sky! It was lucky I had brought down a small step ladder which I used to put a towel over the light sensor in the car park as the telescope was set up too high for Mia to look thru without being held up by one of the parents? After getting the steps out of the car and showing her where the eye piece was and how to use it we had a look at the open clusters of M38, 37 & 36. Got the answer of I cannot see anything, probably not looking long enough for one's eyes to get use to the darkness? So I tried another plan of action and look at coloured stars instead. The red giant of Betelgeuse in Orion got some comments, off to the double star of Castor in Gemini, followed by the brightest star in the night sky and Sirius. Had a go at M41, an open cluster about 4 ° south of Sirius but I could not make this object out, think the low lying fog in this area blanked it out? Back into Orion and the brilliant white/blue star of Rigel. I could make out Ursa Major so I showed Mia the double double star of Mizar and Alcor. Across to M45 (the Pleiades or Seven Sisters) before going back to M51 (the Whirlpool Galaxy), this galaxy I could not make out? By now Mia was getting bored and probably cold, so Ian and Kristen started to head back home to Bath? The conditions had got a lot worst, could hardly see any constellations at all. I was surprised I could make out M97 (the Owl Nebula in Ursa Major), by now it was getting hopeless, had another quick look at M42 before throwing in the towel at 21:03.

To start with we had a good turnout of people, I think there was around 10 people to start with, some old regulars and a few new ones to me. By the end there was only Vicki and me with telescopes out, Tony had just packed his gear away, thought it would be a good thing for me to do as well, Vicki followed suit as well!

This viewing log would have been done for the March edition of the WAS magazine but I thought there was only going to be a four page booklet for the meeting; hence the late write up by me.

Clear skies.

Peter Chappell

Viewing Log for 25th of February

I had no evening driving jobs and the sky was clear, so I decided I would have a viewing session at Uffcott to finish the day off.

When I arrived the sky was very clear with a temperature of 7 ° and with no wind blowing should make a very pleasant session, only time will tell there? I had my Meade 8 inch LX90 set up and ready for viewing by 20:34, tonight I was going to use my 14 mm Delos eyepiece instead of the Pentax XW eye piece. With the Messier marathon season nearly with us I thought I would have a go at bagging a few of them but before I started that it was off to the planets and start with Mars. This time the red planet was within the field of view of the eye piece (in previous sessions, the planets were not in the eye piece field of view yet deep sky objects were!), as usual I could not make anything out on this planet, as for Uranus I could not find it at all. Maybe I still have the problem with planets and this telescope? Now on to the Messier objects starting with M74 (I would be following the suggested viewing order), this Spiral Galaxy (S G) looked like a Faint Fuzzy Blob (F F B) which I found hard to locate with GOTO equipment, do not think I would ever find it by star hopping only? Off to another S G and M77, this was a bit better and I classified it as a Faint Blob (F B). Fast forward to number 10 on the list and M34 in Perseus, this Open Cluster (O C) was sparse and loose to look at? Still in Perseus and M76, the Little Dumbbell nebula, for a change this was good to look at! I now decided to change the eye piece to a 17.3 mm Delos (this would give me a slighter wider field of view to look at (F10 telescopes are not the best to view deep sky objects). On to Cassiopeia and M103, this O C looked like a bent propeller, to me anyway? I had to look at M52 (another O C) thru a tree, hence it was dim to look at. Where I park at Uffcott some objects could be non-viewable due to a small tree right beside the layby I park in. Going back up the list (103 and 52 were 6 & 7 on the list) to 4 thru 6 and the galaxies in Andromeda namely M31 (large bright core), M32 (much smaller but a bright core) and finally M110 (an F B viewed thru that tree again). Number 3 on the list is M33; this S G was barely seen by me as it was very low to the horizon! M45 really does not need anything more than the mark one eye ball to see this large O C! An odd ball Globular Cluster (G C) in M79 in Lepus was small to look at. Why odd ball, no other G C's are in the area, most are found in the summer month constellations? Another change in viewing order, off to M41, an easy to find O C about 4 ° below Sirius, this is a loose O C. Of-

ten overlooked is M93 in Puppis, a compact O C, it's neighbours in M47 (not many stars in this O C but bright) and M46 (lots of stars in this O C but dim). Only Messier object in Monoceros is M50, yet another O C in this part of the sky, this O C is well spread out? In Orion M78 is also overlooked as it is nowhere as famous as M42 (Great Orion nebula), M78 looked like two stars could not really see the nebula around it? On to M42, just one word for this object: brilliant! M43 is also in the same field of view but like M78 is often overlooked? The only Supernova remnant on the list is M1, I made this out to be a large grey blob? The next 4 objects I did in quick time as I wanted to see what they looked like while still in my memory. These are all O C's in M35 (in Gemini, bright), M36 (dim), M37 (dense probably got most stars?) and finally M38 (spread out), last 3 are all in Auriga. In Cancer it is best to view M44 with the finder scope as it is that large, the main scope just goes thru this O C, this is similar for M45. M67 is a small and dim O C, again often over looked by its famous neighbour? Now back to least favourite objects and galaxies starting in Leo with M95, M96 and M105, all of these are F F B's to look at? Part of the Leo triplets are M65 and M66, again F F B's to look at? All of these are S G's apart from M105 which is an Elliptical galaxy. My final object for the evening was M97 in Ursa Major this Planetary nebula looked big to view, seeing conditions were good that night as in the past I have had trouble finding it?

I called it a day at 22:19; I had seen 34 objects in the space of about 100 minutes which was pretty good? During that time only 3 cars went past me and 2 of them happened while I was setting up the telescope so they really did not affect my night vision by much? Dew was not a problem tonight but I would still have to dry all equipment used that night once I got back home. Finishing temperature was 4 ° which for winter viewing is quite good, far warmer than normal as I did not have any wind to deal with.

Clear skies.

Peter Chappell

Viewing Log for 24th March

This was going to be a similar viewing session I had back in February as a mini Messier marathon was planned for the following Friday (assuming weather was good for the evening?) at Lacock.

Being a Sunday evening I was not expecting much traffic to go past me, so my night vision should not be affected too much? I arrived at my usual location near Uffcott off the A4361 south of Swindon and started setting up my Meade LX90 GOTO telescope using a 20 mm Pentax XW eye piece (giving magnification of 100), while adding pieces to the telescope I noticed the ISS coming closer to me from the south west. I watched it for the whole travel across my location; it went just south of the star Rigel in Orion and north of Procyon in Canis Minor. ISS gone I finished off setting up the telescope and was ready by 20:16.

As usual I would start with any planets on view and was namely Mars and nothing else (assuming you do not include the Earth!), being only 4 arc minutes in diameter I could not make anything out, usual story there! Now on the marathon, I would be viewing the object and taking note of where the object is in the night sky. Hopefully that would up help me the coming Friday as I would not be using GOTO on the evening, keeping in the spirit of the marathon? M77 was behind a small tree beside the lay-by I stopped in, so could not get that one, M74 was just above this tree but being a Spiral Galaxy (S G). All I could make out it was a Faint Fuzzy Blob (F F B)! The Pinwheel Galaxy, M33 in Triangulum I could only just make out with averted vision. The Andromeda Galaxy M31 was in the same field of view as M32, its satellite galaxy. M31 was a large Fuzzy Blob (F B) while M32 was an F F B to look at? M110 which is close to the other galaxies just mentioned I could only find with adverted vision, this was an F F B at best! Into Cassiopeia and M52, the first of the Open Clusters (O C) on this list, M52 was dim to view, the same could not be said for M103, much brighter and it looked like a three sided triangle of stars (never noticed that before?) First of the Planetary Nebula on the list was M76, the Little Dumbbell nebula in Perseus, at best this is an F F B to view? I think M79, in Lepus should be a bit higher in this list as it was now getting close to the horizon and I could only just make it out, this is the first of the Globular Clusters on the list. Also in Perseus we have M34, a loose O C yet M45 (the Pleiades) you can make out with the eye, nothing else needed I used the finder scope to view this object as the telescope goings straight thru this cluster. M42, the Great Orion nebula was in the same field of view as M43, as usual M42 really stands out. Often over looked is the third member in this constellation and M78 a bright reflection nebula north of the belt stars, to me it just looked like two stars could not make out any nebula at all? M1 in Taurus (which started this whole list) was a large F B to look at. Onto the four O C's in the trot which I view quickly and M35 (large and bright), M37 (also like M35), M36 (small and loose) and finally M38 (loose), first in Gemini and the others in Auriga. Going further east and M41 not far below Sirius, this O C is very loose to view. M93 in Puppis is much more compact than M41. Also in Puppis and close together is M46 and M47 (which can be seen thru binoculars in the same field of view), M47 is very loose while M46 is large and dim. M50 is about a third away from Sirius towards Procyon; this O C was loose to look at. M48 which I do not look at much was a large and loose O C in Hydra. By now high thin cloud had started to roll in and would affect my viewing a bit! M44 is best viewed thru the finder scope like M45 it is too big for the main scope? Often over looked within same constellation is M67, a dim and compact O C. Off into Leo and faint fuzzes again, starting with M95, M95 and M105, all of these were F F B's to me! I am wondering if I noticed another galaxy in the same field of view while looking at M105? Part of the Leo triplets is M65 and M66, both of these were F F B's; the other member is NGC3628 if you were wondering? Slew across the sky to Ursa Major and started with M81, to me it was an F B, normally better than that but I guess the sky was now against me, M82 was even harder to locate! Could not

make out M97, the Owl Nebula (nothing new for me!); just about see M40, the only double star on the list? As the seeing was not getting any better I had a go at M13 which I know is fairly bright but I could not make that out at all?

Time to call it an evening, I had just had enough! It has been a full on day for me, started in the morning cleaning out the budgie, doing a bit of gardening before doing a driving job for work. Once that was finished I had a game of golf followed by this viewing session. So I started packing up the gear at 21:42 and there was no dew at all on the equipment J, I would still be drying all used gear overnight just to be on the safe side, do not want to put damp gear away for a while as I am sure I would come back to a nice surprise or two? I managed to see 35 out of 39 objects on the evening, when I next go out for a session I will probably carry on from where I left off and start seeing the spring objects in the Virgo area?

Clear skies.

Peter Chappell

Viewing Log for 29th of March

This was the second month on the trot that a WAS planned viewing session went ahead, record must be three?

As we were doing a mini Messier marathon this evening I went with the spirit of the marathon and only used non GOTO equipment, so I brought along my 98 mm William's Optic FLT refracting telescope with 13 mm Televue Ethos eye piece on a Porta Mount II hopefully I would be able to pick out faint fuzzes with this equipment, how wrong I would be!

I arrived and had the equipment set up and ready by 19:41, the sky was still fairly light, so could not start for a while longer. In the mean time I covered the security light sensor for the car park with a towel, so that would get rid of some light pollution for the evening, I noticed when I arrived there was a lot of cars in the car park. There seemed to be a low mist surrounding the area as well, so low objects might not be able to be located?

I had done a mini session earlier in the week; hopefully this would give me some ideas of where to look. I threw the suggested viewing list out of the window as M77 and M74 were already too low to view, too late in the season I think? So I started with M42 and M43 using my 15x70 binoculars on a tripod, these appeared ok. I then turned to M45; the Pleiades cluster in Taurus, the stars looked very nice to view. By now smoke was coming across the playing field, turns out somebody in the village had lit a bonfire! The smoke went on for about 20 minutes, so we could not do much about that. There were also a few people in and around the playing field which had nothing to do with the society, so we had white lights to contend with! Another noticeable problem was the number of security lights shinning into the fields (this does not include the one I covered up!) and the hedges had been cut recently, so they were on the low side and fairly bear of leaves! Anyway back to the hunting once the smoke had gone, I tried to locate M78 using my Sky Atlas, no joy with this reflection nebula even trying to locate the two stars within it did not work! Onto M46 and M47, two open clusters (O C) in Puppis, normally I can locate these with binoculars but not tonight, think the possible mist we had kept them covered from me? Could make out M50 fairly well, again using binoculars. Around to Auriga and the three O C's in this constellation, never before had I tried to find them using star hopping method. I found M37 and M36 pretty easy but M38 was a bit harder to find? Chris who had set up next to me help me find M44 using my laser pen, using my hand grenade eye piece better known as the Televue Nagler 31 mm, this cluster looked fine.

In a break from looking for Messier objects the ISS came over, so I tried an idea with Chris, how long could I see the ISS with binoculars after he lost it with his eyes? Turns out I could see the ISS for a good 20 seconds + after he said it had gone, just a lot dimmer!

The light problem did not get much better, so we called in a night at 22:12. About 13 people turned up during the session which is pretty good for the society, had a nice chat with our present chair (Keith Bruton) and a few other members. I was very disappointed with the number I got for the evening, I had hoped for a few more but the seeing conditions plus the security light problems did not help at all!

During the evening my left foot became uncomfortable a few times, this meant I had to go back to the car and give it a rest. Once out again I had to get my eyes use to the night sky. Only once I got home I noticed a large split over the toe area of the boot, how that got there I have no idea (picture attached).

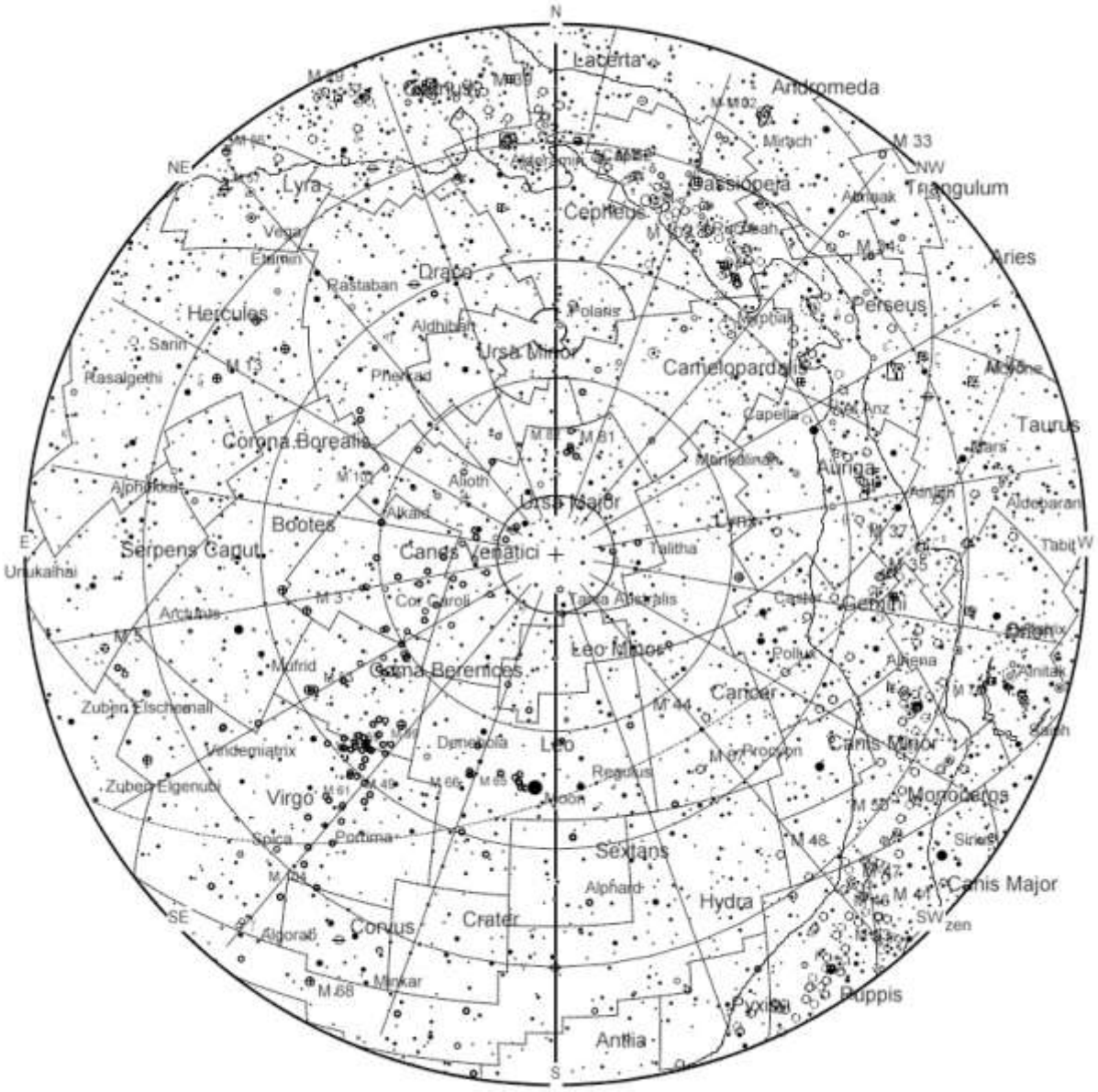
At least the temperature was very pleasant for viewing; I did not have my warm trousers on for the evening and with not much wind also helped.

Hopefully if I do another Messier session, the results are better than tonight's poor effort?

Clear skies.

Peter Chappell

WHATS UP, APRIL 2019



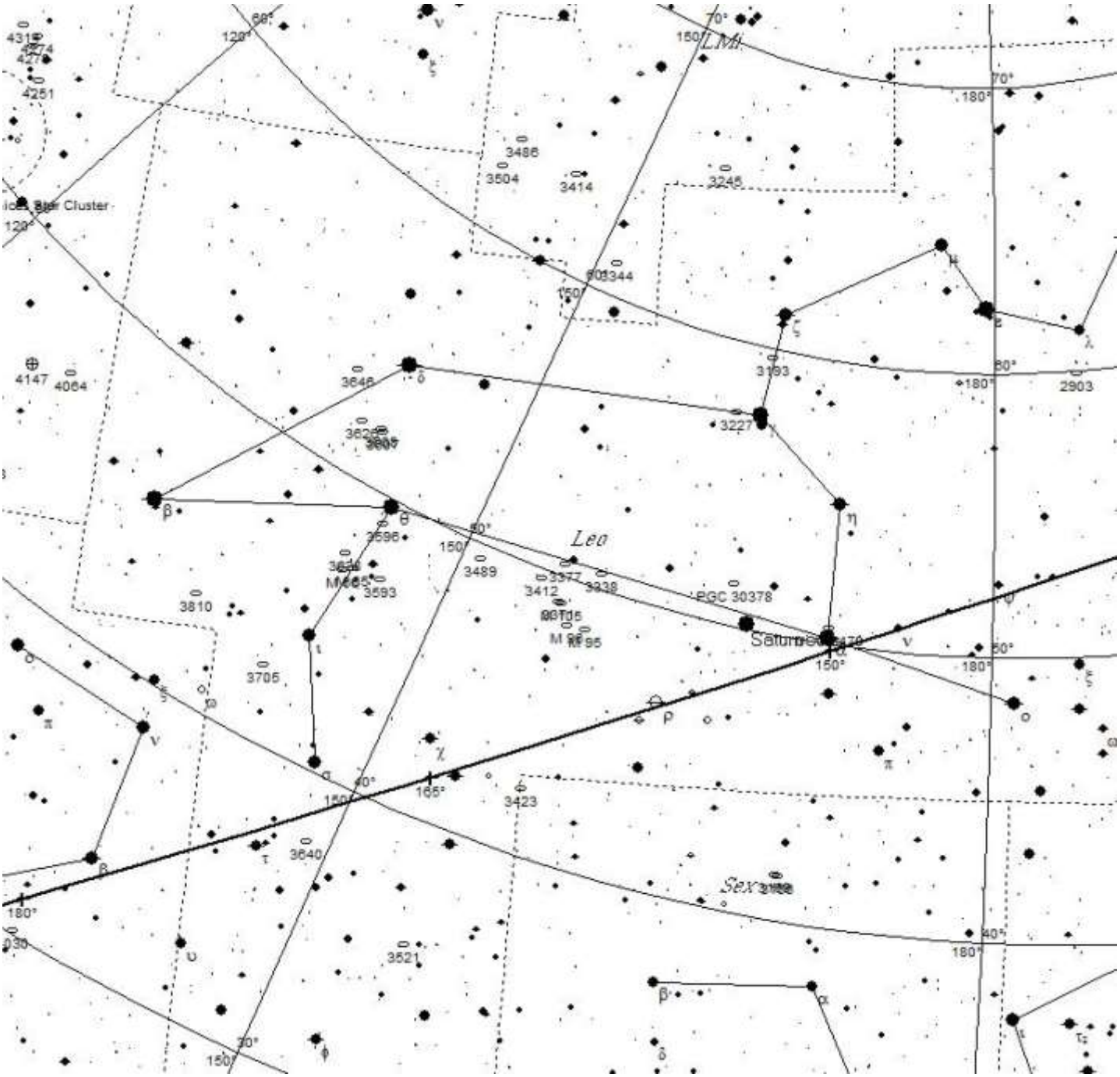
April 5 - **New Moon.** The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This phase occurs at 08:51 UTC. This is the best time of the month to observe faint objects such as galaxies and star clusters because there is no moonlight to interfere.

April 11 - **Mercury at Greatest Western Elongation.** The planet Mercury reaches greatest western elongation of 27.7 degrees from the Sun. This is the best time to view Mercury since it will be at its highest point above the horizon in the morning sky. Look for the planet low in the eastern sky just before sunrise.

April 19 - **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 11:12 UTC. This full moon was known by early Native American tribes as the Full Pink Moon because it marked the appearance of the moss pink, or wild ground phlox, which is one of the first spring flowers. This moon has also been known as the Sprouting Grass Moon, the Growing Moon, and the Egg Moon. Many coastal tribes called it the Full Fish Moon because this was the time that the shad swam upstream to spawn.

April 22, 23 - **Lyrids Meteor Shower.** The Lyrids is an average shower, usually producing about 20 meteors per hour at its peak. It is produced by dust particles left behind by comet C/1861 G1 Thatcher, which was discovered in 1861. The shower runs annually from April 16-25. It peaks this year on the night of the night of the 22nd and morning of the 23rd. These meteors can sometimes produce bright dust trails that last for several seconds. The waning gibbous moon will block out many of the fainter meteors this year, but if you are patient you should still be able to catch a few of the brightest ones. Best viewing will be from a dark location after midnight. Meteors will radiate from the constellation Lyra, but can appear anywhere in the sky.

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.

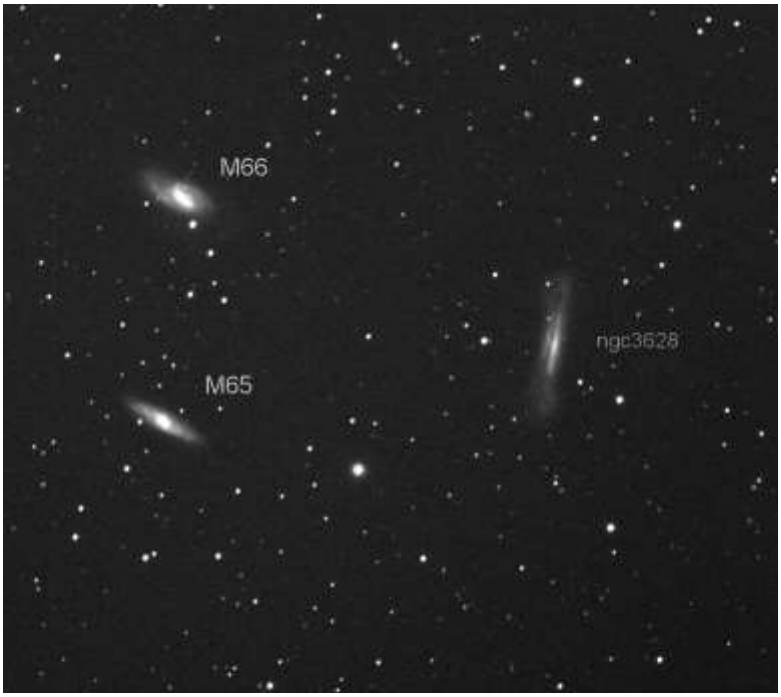
Deep Sky Objects in Leo:

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

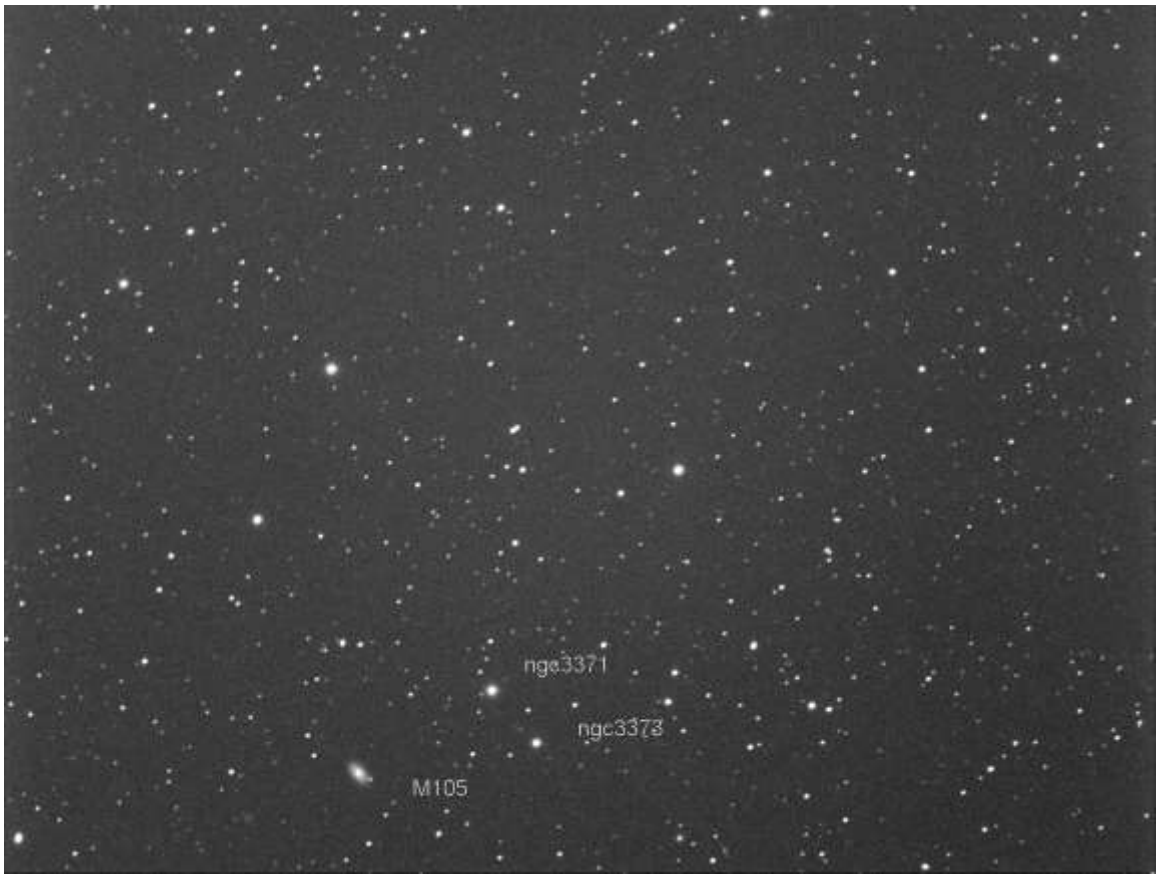


NGC 3628, a galaxy seen edge-on. Actually this is larger than either Messier object, but much dimmer because it is seen edge-on.

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.

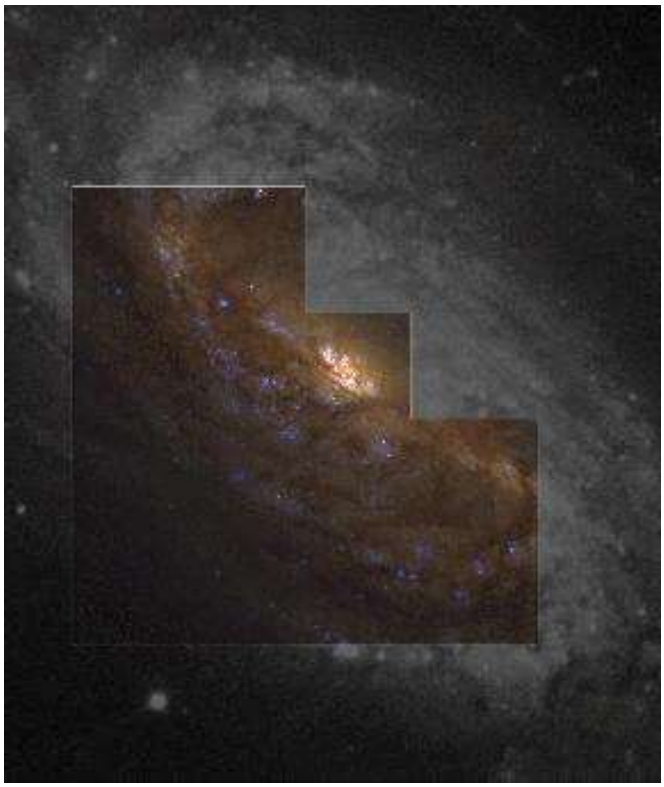


Indeed, there are many more galaxies in Leo to explore. Most of them lie between alpha and beta Leonis, with a smaller group scattered around gamma Leonis. Most of them are 10-12m, so the larger the telescope the more favourable the viewing.

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.

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.



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11th March 2019

Dear Andy

I am writing to express our thanks to you and your team for volunteering to come and present at our wonderful Stargazing event on 28th February 2019.

As you saw, we had a packed hall (we estimated 220 adults and children attended!) and the atmosphere was great. We have posted many pictures on Facebook which show our families coming together to enjoy the evening that you put on so well.

Highlights for us were the children's faces as they watched your presentation of our school and its place in space; inter-generational families coming together to learn something; children using the telescopes; and of course, the hot chocolate!

It was a shame that we could not go outside, but the children were so happy with your contingency - we did not have any grumbles!

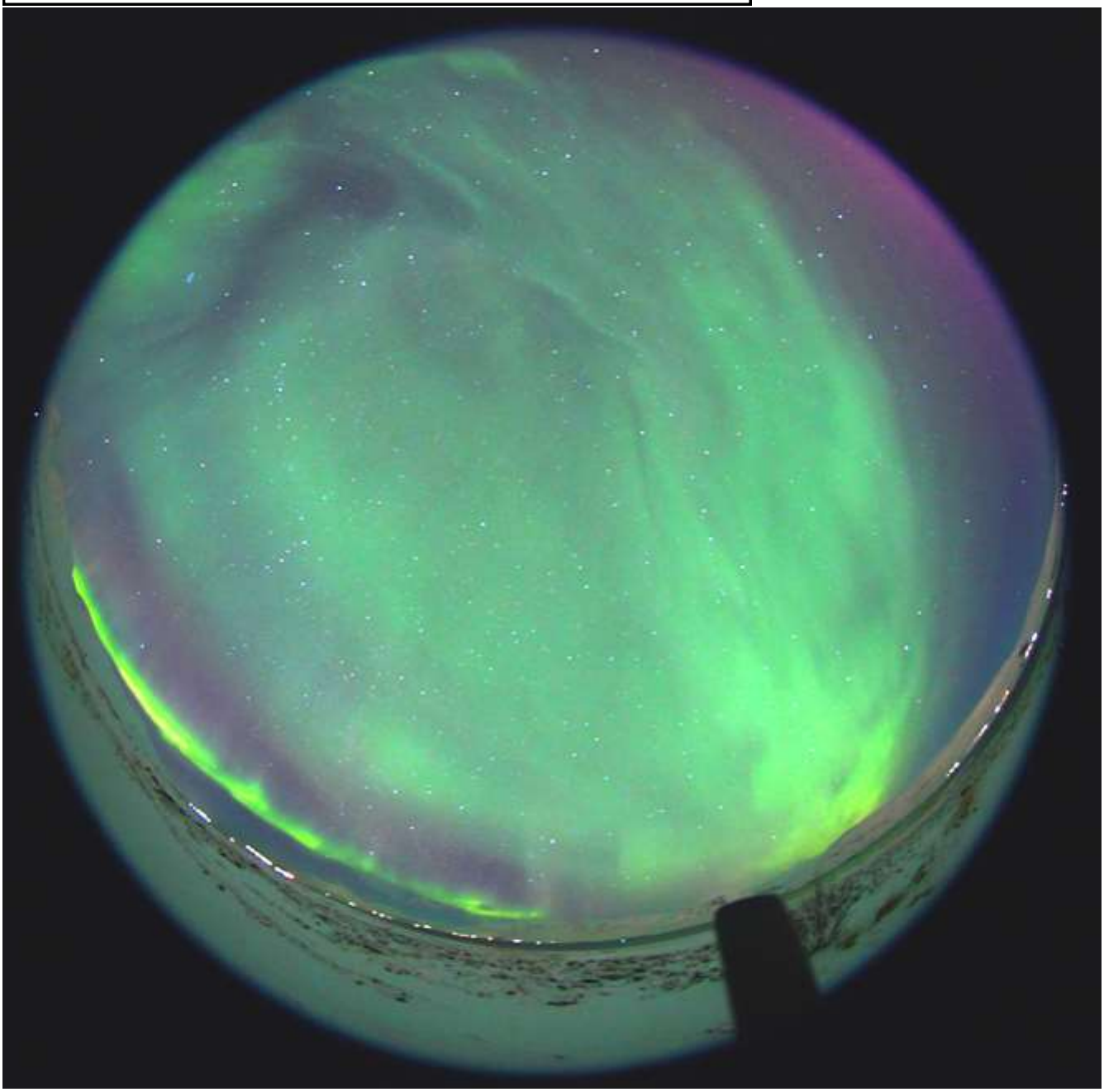
I will be in touch again to ask if you will repeat this experience for us in the future. We appreciate your efforts. Please pass on our thanks to your team who attended too.

Abi Isherwood, on behalf of everyone at Westbury Leigh Primary School.

ISS PASSES For March/Early April 2019 From Heavens Above website maintained by Chris Peat

Date	Brightness (mag)	Start			Highest point			End		
		Time	Alt.	Az.	Time	Alt.	Az.	Time	Alt.	Az.
02 Apr	-3.1	21:32:59	10°	W	21:36:08	40°	SSW	21:36:40	37°	S
03 Apr	-3.4	20:42:15	10°	W	20:45:30	56°	SSW	20:48:01	15°	SE
03 Apr	-1.3	22:19:31	10°	WSW	22:20:47	15°	WSW	22:20:47	15°	WSW
04 Apr	-2.1	21:28:23	10°	W	21:31:05	23°	SW	21:32:09	20°	S
05 Apr	-2.5	20:37:28	10°	W	20:40:30	33°	SSW	20:43:31	10°	SE
06 Apr	-1.2	21:24:23	10°	WSW	21:25:51	12°	SW	21:27:20	10°	SSW
07 Apr	-1.5	20:32:56	10°	W	20:35:20	19°	SW	20:37:45	10°	S
02 May	-1.2	04:12:18	10°	SSE	04:13:36	12°	SE	04:14:57	10°	ESE
03 May	-2.6	04:55:38	10°	SW	04:58:37	32°	SSE	05:01:37	10°	E
04 May	-2.1	04:06:00	15°	S	04:07:42	22°	SE	04:10:21	10°	E
05 May	-1.6	03:16:45	15°	SE	03:16:51	15°	SE	03:18:49	10°	ESE
05 May	-3.4	04:49:39	10°	WSW	04:52:53	54°	SSE	04:56:08	10°	E
06 May	-3.0	04:00:09	21°	SSW	04:01:53	38°	SSE	04:05:00	10°	E
07 May	-2.6	03:10:47	27°	SSE	03:10:55	27°	SSE	03:13:46	10°	E
07 May	-3.8	04:43:53	10°	WSW	04:47:12	79°	SSE	04:50:31	10°	E
08 May	-1.4	02:21:23	14°	ESE	02:21:23	14°	ESE	02:22:21	10°	E
08 May	-3.7	03:54:05	21°	WSW	03:56:07	62°	SSE	03:59:23	10°	E
09 May	-3.5	03:04:39	43°	S	03:05:03	45°	SSE	03:08:15	10°	E
09 May	-3.8	04:38:12	10°	W	04:41:31	86°	N	04:44:51	10°	E
10 May	-2.2	02:15:10	25°	ESE	02:15:10	25°	ESE	02:17:02	10°	E
10 May	-3.9	03:47:52	16°	WSW	03:50:22	85°	S	03:53:41	10°	E
11 May	-1.0	01:25:39	10°	E	01:25:39	10°	E	01:25:41	10°	E
11 May	-3.9	02:58:20	43°	SW	02:59:14	71°	SSE	03:02:32	10°	E
11 May	-3.8	04:32:29	10°	W	04:35:48	86°	N	04:39:07	10°	E

END IMAGES, OBSERVING AND OUTREACH



An all sky view of the eclipse I witnessed in Iceland. Sigma 8mm lens, f2.8, 6 seconds, 3200ISO. This gives an idea of how much of the sky was covered with the green aurora. Even then the purple phase was on the southern horizon.

This was our only clear night on the holiday, and the only aurora available. KP3-3.5. Not a very strong pulse from the Sun, but very high index events can be invisible from Iceland, being to far south to be seen. Andy Burns

Wiltshire Astronomical Society	**Observing Sessions 2018 – 2019**	
Date	**Moon Phase (%)**	**Moonrise**
2019		
26th April	Waning Gibbous (58%)	After midnight
24th May	Waning gibbous (75%)	After midnight

OUTREACH

To be arranged Great Wishford School, nr Wilton. Viewing evening

Kings Lodge Year 1/2s Moon talk and viewing from 7pm To be re arranged due to heating problem

July 4th-5th Nibley Music Festival