# New Zenith

*The Monthly Newsletter of the Vectis Astronomical Society*

Vol 27 Issue 3 — April 2019 *When Printed, this Newsletter costs VAS at least £1*

## Society News

### *PLEASE NOTE*

Due to availability and booking of the Pavilion and Field near our observatory we are looking to change our **Young Science and AstroFest to Saturday 27th July**.

Probably 6-10pm (maybe 6-9pm). We want it to finish late to try to get some Stargazing in.

Please could you let me know if you are available to come along and help with this event. We need as many people as possible.

More details to follow if you are available

**Contact me at elainespear1@gmail.com**

## VAS Websites

VAS has a couple of websites which need a bit of an update. It's been at least a couple of years since I made any real effort to update them and, since then, they have more or less been left as dormant adverts about us.

I just don't seem to have the time to refresh them so I ask, "Is anybody interested in learning how to administer the VAS websites?" it's not hard and really shouldn't take too much time. There is no rush to get them sorted and apart from an internet connected computer, no special equipment is needed

We use WordPress which is the most popular web-building application available.

If you fancy learning a new and useful skill, drop me an email and I'll happily show you what is involved.

*Brian Curd*
*Observatory Director and NZ Editor*

## VAS Website: wightastronomy.org

Submissions or letters to New Zenith are always welcome and should be sent to:

**The Editor, New Zenith**
**Carpenter's Cottage**
**Dennett Road**
**Bembridge**
**Isle of Wight PO35 5XF**

Tel: **01983 872875** or email: **editor@wightastronomy.org**

Material for the next issue by the 6th of the month please.



## Observatory Diary

| | |
|---|---|
| Monday, 19.30hrs | Members Only and by arrangement<br>Telescope and night sky training.<br>Please contact Martyn Weaver 07855 116490 |
| Thursday | Members (19.30hrs) and Public (20.00hrs).<br>Informal meeting and observing |

## VAS Website: wightastronomy.org

## Contents this Month

## 2019 Monthly Meetings

| Date | Subject | Speaker |
|---|---|---|
| Check *http://www.wightastronomy.org/meetings/* for the latest information | | |
| 22 Mar | Isle of Wight Dark Sky Park Update | AONB, CPRE & VAS |
| 26 Apr | Can we Live on Mars? | Greg Smye-Rumsby |
| 24 May | The Rise and fall of the Herstmonceux Observatory | Keith Brackenborough |
| 28 June | TBA | TBA |
| **Sat 27 July** | "Young Science and AstroFest" Young Astronomers' Event | |
| 23 Aug | AGM and Social Evening | |
| 27 Sept | A transportable/deployable radio telescope for hydrogen line observation | Alan and Martin Thompson |
| 25 Oct | Dark Skies Event | |
| 22 Nov | TBA | TBA |

## Observatory Visits Booked

No bookings so far

***Please phone me for the current situation (number on the front page)***

It would be appreciated if members could avoid using the observatory at these times.

***The Committee Needs A Programme Organiser***

***If you could help organise the VAS programme of monthly meetings, we'd love to hear from you***

## VAS Contacts 2018/19

| | |
|---|---|
| **President** | Barry Bates president@wightastronomy.org |
| **Chairman** | Bryn Davis chairman@wightastronomy.org |
| **Secretary** | Richard Flux secretary@wightastronomy.org |
| **Treasurer** | Simon Plumley treasurer@wightastronomy.org |
| **Observatory Director** | Brian Curd director@wightastronomy.org |
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| **NZ Editor** | Brian Curd editor@wightastronomy.org |
| **Membership Secretary** | Norman Osborn members@wightastronomy.org |
| **NZ Distribution** | Graham Osborne distribution@wightastronomy.org |
| **Others** | Mark Williams, Nigel Lee, Stewart Chambers, Elaine Spear |

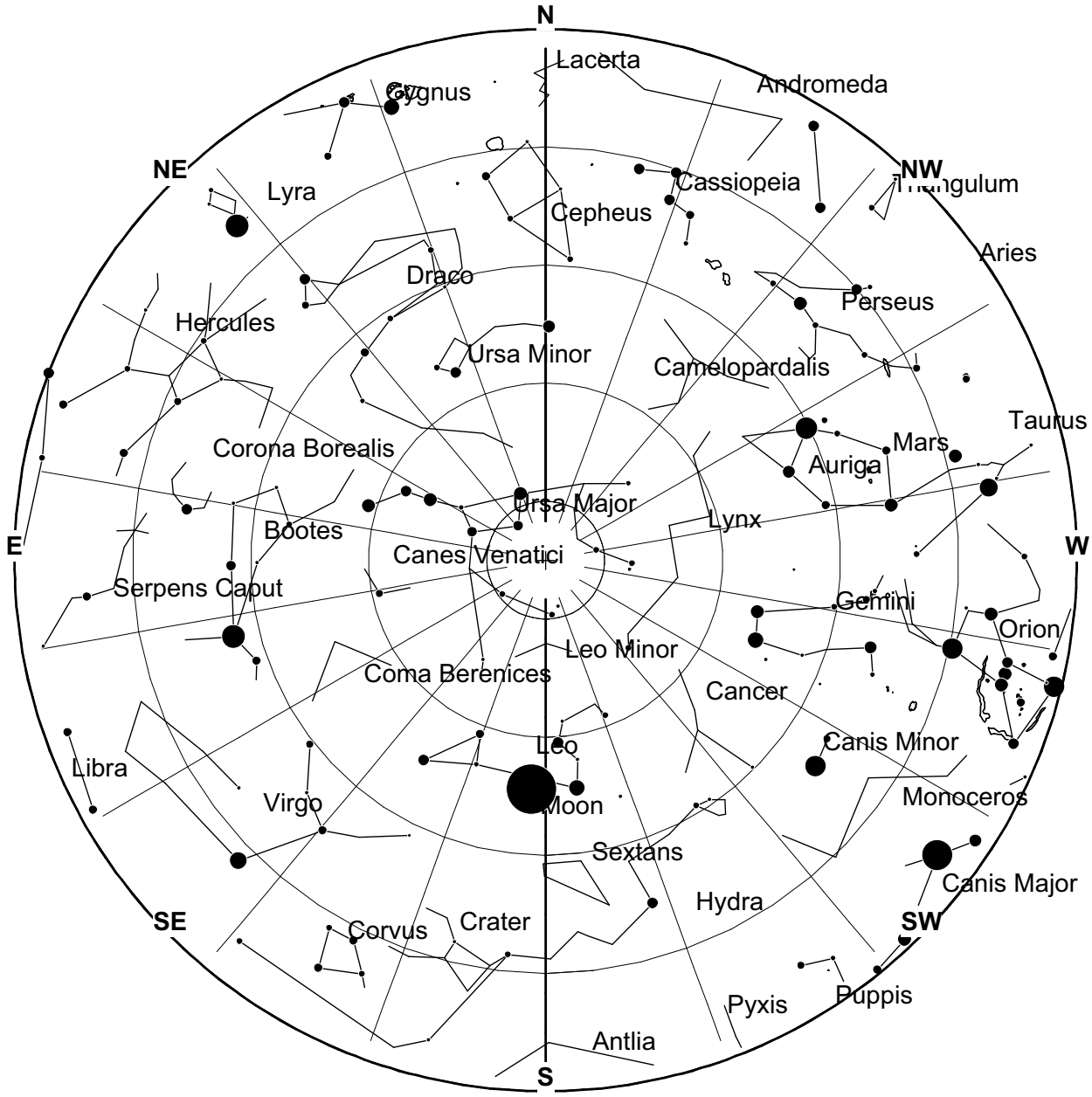
## Important

Members using the observatory MUST enter a line or two in the Observatory Log Book.

On several occasions, lights, heaters and the Meade LX200 have been left on!

When leaving, please ensure all is secure and all lights, heaters and telescopes are TURNED OFF.

# April 2019 Sky Map




*View from Newchurch Isle of Wight UK - 2200hrs - 15 April 2019*


**Leo** is one of the constellations of the zodiac, lying between Cancer the crab to the west and Virgo the maiden to the east. Its name is Latin for lion, and to the ancient Greeks represented the Nemean Lion killed by the mythical Greek hero Heracles meaning 'Glory of Hera' (known to the ancient Romans as Hercules) as one of his twelve labours. One of the 48 constellations described by the 2nd-century astronomer Ptolemy, Leo remains one of the 88 modern constellations today, and one of the most easily recognizable due to its many bright stars and a distinctive shape that is reminiscent of the crouching lion it depicts. The lion's mane and shoulders also form an asterism known as "The Sickle," which to modern observers may resemble a backwards "question mark."

# April 2019 Night Sky

## Moon Phases

| New | First Qtr | Full | Last Qtr |
|---|---|---|---|
|  |  |  |  |
| 5th | 12th | 19th | 26th |

## Planets

### *Mercury*

At this time of year observing planets, particularly the inner planets in the morning sky is difficult as they rise only just before the Sun. Mercury is in this position this month. It can however be observed with a telescope during the day, but care must be taken to avoid any possibility of accidentally pointing at the Sun. Placing, and keeping the telescope in the shade is a good precaution.

### *Venus*

Venus, like Mercury rises at about the same time as the Sun and is getting closer by the day. It can also be observed during the day with the same precautions.

### *Mars*

As the sky darkens Mars is quite low in the west-north-western sky, and is so far away from the Earth as to be unfavourably placed for any observation.

### *Jupiter*

Jupiter is well placed for observation in the southern sky from the early hours until sunrise. It is rather low in our sky so atmospheric turbulence may be a problem on occasions.

### *Saturn*

Saturn is low in the south eastern sky for a few hours before dawn. It is not as bright as Jupiter, but is the brightest object in that part of the sky.

### *Uranus & Neptune*

Both outer planets this month are too close to the Sun for observation

## Deep Sky

**Leo Triplet M65, M66, NGC3628**
**RA 11h 20m Dec 13° 14'**

Just under the lion's hind legs in an area not much larger than the full moon are three spiral galaxies. Using a low power all three can be seen in the same field of view. Each is about half way between edge on and face on so appear as an oval smudge with a bright core. Why NGC3628 is the largest of the three and the faintest, just (mag 9.5), why it does not have its own place in the Messier catalogue we will never know, perhaps it says something for the quality of 18th century optical equipment.

**M51 The Whirlpool Galaxy**
**RA 13h 30m Dec 47° 10'**
**mag 8.0**

M51 together with its companion NGC5195 are one of the most famous galaxy pairs in the sky. The spiral nature of nebulae was first observed in this galaxy by Lord Rosse with his Leviathon telescope. The pair are easily seen today in small telescopes, and thanks to the intense star formation a medium sized telescope easily shows that spiral structure.

**NGC5866/M102 Spindle Galaxy**
**RA 15h 7m Dec 55° 44'**
**mag 10.5**

Is this really M102? Did Messier ever see this galaxy or was it all a great mistake, and just a duplicate observation of M101, perhaps we will never know. An almost perfectly edge on galaxy, visually it lives up to its name, small telescopes show it as a silvery spindle of light against a hopefully dark background. Larger 'scopes may, if the seeing is good enough show a thin dust lane cutting through the central bulge.

*Peter Burgess*

# Isle of Wight Space Camps - Volunteers needed

A very innovative Island teacher who won, Science Teacher of the Year 2018, is working hard at promoting science and astronomy to all Isle of Wight school children.

She is in contact with many primary schools around the Island, and in the process of organising 'Space Camps' in conjunction with the Stephen Hawking Foundation.

She has been sent 5 celestron telescopes from the foundation and plans to run observing sessions in the evenings of all the Space Camps. She needs help to operate the telescopes - ***that's where you come in***. Please consider giving up some of your time to support this endeavour.

The list below shows the Camps organised so far

| Date | Venue | VAS Members | Solar Scope | Talk |
|---|---|---|---|---|
| Thurs 21st March | Nineacres Primary School South View, Newport PO30 1QP | Bert Paice, Bryn Davis, Elaine Spear, Mark Taylor | No | Bryn Davis "Making Sense of the Night Sky" |
| Wed 27th March | St Helens Primary School Broomlands Close, St Helens, PO33 1XH | Brian Curd, Graham Osborne, Mark Taylor, John Slinn | Yes John Slinn | Brian Curd "Stellarium - your very own planetarium" |
| Thurs 4th April | Gurnard Primary School Baring Road, Cowes PO31 8DS | Elaine Spear, Bert Paice, Mark Taylor, John Slinn | Yes John Slinn | John Slinn "All about the Sun" |
| Thurs 25th April | Greenmount Primary School St Vincent's Road, Ryde PO33 3PT | Stuart Chambers, Bert Paice, Mark Taylor, John Slinn, Elaine Spear | Yes John Slinn | John Slinn "All about the Sun" |
| Thurs 23rd May | Broadlea Primary School Newport Road, Lake PO36 9PE | Bryn Davis, | | |
| Fri 7th June | Ryde School (Junior and Fiveways) 7 Queen's Road, Ryde P033 3BE | | | |
| Fri 27th June | Broadlea Primary School Newport Road, Lake PO36 9PE | | | |
| Wed 3rd July | All Saints Primary School 79 School Green Road, Freshwater, PO40 9AX | | | |
| Thurs 9th May | Wootton Primary | | | |

HELP!

Times are to be confirmed, but I'm guessing around 7-9pm, maybe later in the summer months of darker skies.

Please let me know which Camps you can attend. I hope to get three members for each camp.

Attending as many schools as possible will have a dual affect, as it gets the VAS name spread around, and we can promote our Young Astronomers events we are organising in July.

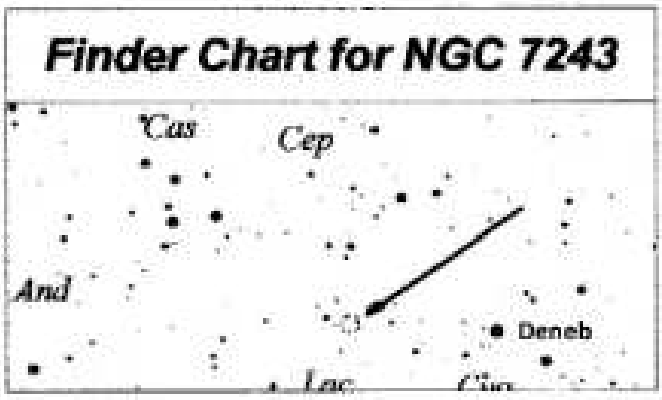
**Contact me at elainespear1@gmail.com**

*Elaine Spear*

# My 100 Best Night Sky Sights

## Galactic Cluster

**Coordinates: RA 22h 15m 18s, Dec +49° 53'**

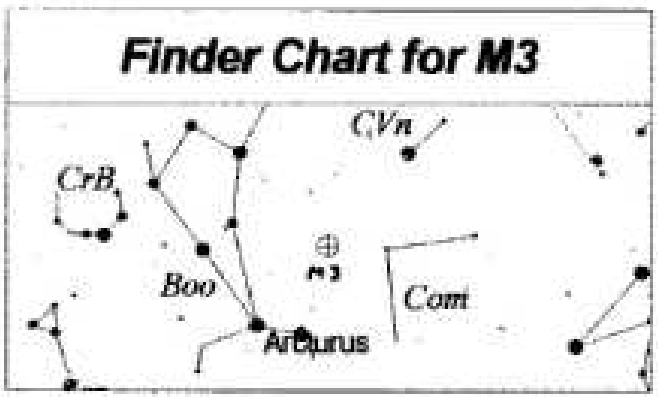



The rather innocuous constellation of Lacerta the Lizard, uneasily squeezed between its more illustrious neighbours Cygnus and Andromeda, desperately tries to achieve recognition by emulating another near-neighbour, Andromeda. It fails. It does manage to form a 'W' of sorts but only with 4th magnitude stars whereas the queen's quintet is 2nd magnitude. In its efforts to get noticed it attempts to do better with three more stars extending the 'W' into a N-S zigzag but you have to look closely to see this. However, for amateur astronomers Lacerta has one jewel in its treasury.

Unmentioned by some astronomy guides and receiving only a passing reference in most others the open cluster ***NGC 7243*** is a beauty, really fine at powers up to around 120x but superb when seen through low power eyepieces. The whole field is filled with many dozen bright stars including a fine pair near the centre, two of the triple system Struve 2890. Aficionados of open clusters should not miss this scene, in my opinion far superior to several Messier clusters. Locate NGC7243 in autumn 1½° WNW of the mag 4.5 star 4 Lac, the centre one of the 'W' asterism.

## Globular Cluster

**Coordinates: RA 13h 42m 12s, Dec +28° 23'**

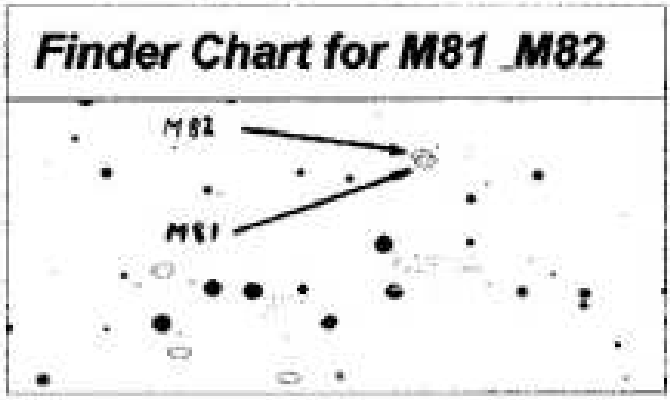



Arguably one of the very best globular cluster in northern skies, ***M3*** in ***Canes Venatici*** is little short of stunning. Spanning about 16' it's compact enough for the small field of view of a high power eyepiece to contain all of it – and what a view. With a 10" telescope at 250x a glowing ball of countless pinpoint stars like tiny diamonds across the whole cluster greets the eye, a scene no photograph or CCD image can emulate. With an eyepiece giving a 24" field some central 'grains' merge but three foreground stars (mags 8, 9 and 10) enter the scene, framing the cluster beautifully in a neat triangle and rendering the whole picture quite enchanting.

An 8" instrument at around 150x can expect to capture this latter spectacle and, although resolution of the central region will be beyond a 6', it will nevertheless provide a rewarding sight. M3 is right on the border of its parent constellation and those of Coma Berenices and Boötes and is most easily located in late spring with reference to Alpha Boötis (Arcturus) from which it lies 12° NW.

## Spiral Galaxies

**Coordinates:**
**M81: RA 09h 55m 36s, Dec +69° 04'**
**M82: RA 09h 55m 48s, Dec +69° 41'**




Although not quite in our backyard, two galaxies a mere 7 million light years away provide us with one of the most exciting views of these generally disappointingly faint objects. ***M81*** and ***M82*** in ***Ursa Major*** are the primary members of a local galaxy group and therefore neighbours, but they could hardly be more different from each other.

M81 is a classical spiral seen partially edge-on, clearly visible in any telescope in dark skies. If the sky is very clean it can be seen as a tiny smudge of light through binoculars. According to one source the faint spiral arms can be glimpsed through a 16" telescope in very good seeing but I have noted a hint of these in less than ideal conditions through my 10". In fact this is one galaxy that in some respects is harder to study visually with large instruments. The reason is its sheer size, some 35' across the longer axis, which makes it spill out of the restricted field of a big telescope. The thin outer arms, having very small contrast with the background sky are therefore hard

to identify. The nucleus however is bright and the surrounding 'coma' extensive making it interesting to observe whether or not the spiral arms are glimpsed. Nevertheless it would still not be an exceptional sight were it not for the fact that its neighbour, M82, is in the same low power eyepiece field.

M82 is a ***very*** different kettle of fish. An ***irregular*** galaxy, it has long mystified astronomers. Some believe it's exploding (?), others that it's interacting with huge clouds of dust. Yet a third group holds that the dust clouds are falling inwards upon the disk of the galaxy (***im***ploding?). Whatever the truth it's certainly different from other edge-on spiral galaxies. Through a 6" telescope you won't notice its peculiar nature but you ***will*** see a long, thin needle of light characteristic of edge-on spirals. With an 8" or larger instrument however M82 shows a cigar shape with a prominent dark patch bisecting it ***across its width*** and big telescopes show others near one end cutting it at an angle. Many edge-on spirals exhibit dust lanes along the plane of the galaxy but only M82 has tangential ones. Through my 10" the galaxy is large and very bright, the bisecting dust patch clearly visible and other dark patches alternate with the brighter sections – a really peculiar object that earns its place in my top 100 on its own merit. When coupled with M81 displayed at right angles to M82 in the same field it's a winner.

Being circumpolar these two galaxies can be seen at any time of the year but are best viewed from February to June. Look for them 10° NW of Alpha Ursa Majoris (Dubhe), the top 'pointer' star of the Plough.

*Originally published September 1999*
*Bert Paice*

*An example of a Spiral Galaxy*

## Scientists luck upon a new way to make a rainbow

Chemists have stumbled across a new way to separate reflected light into the colors of the rainbow - a phenomenon known as iridescence. The surprisingly simple technique, which is something of a hybrid of previously known ones, could have applications both scientific and aesthetic.

"It's really cool," says Kenneth Chau, an optical engineer at the University of British Columbia in Kelowna, Canada, who was not involved in the work. "I'm surprised I didn't see it in the lab myself."

In iridescence, an object reflects different colors at different angles, separating white light into its constituent colors. One way to achieve it is through refraction, the bending of light as it passes from one translucent medium to another. For example, a rainbow emerges when light bends as it enters spherical raindrops, bounces off the back of them, and then bends again as it exits the drops. The entire process redirects different colors at slightly different angles, spreading them to create the rainbow.

Iridescence can also arise when a thin translucent film lies atop a reflective surface, like oil on a puddle. Some light waves reflect off the top of the film and some from the bottom. Depending on the thickness of the film, the angle at which it's viewed, and the wavelength of the light, the waves will recombine and interfere to either reinforce each other or cancel each other out. Such thin-film interference gives an oily puddle its colourful stripes.

Finally, iridescence can arise through diffraction, when light reflects off a more complicated periodic structure, such as the grooves in a compact disk. Again, the light waves rebounding from the grooves can interfere to reinforce or cancel one another, depending on the wavelength of the light and the angle at which it is viewed. Such diffraction explains the brilliant colors of some butterfly wings and humanmade photonic crystals.

Now, Lauren Zarzar, a materials chemist at Pennsylvania State University in State College, and colleagues report producing iridescence in a new way. They happened across the effect in early 2017, when they cooked up micron-size spherical droplets containing two types of oil in which the lighter oil formed a lentil-shaped upper layer the researchers hoped to use as a lens. But surprisingly, when illuminated from above, the edges of the lentils glowed with a color that depended on their size and the angle at which they were viewed, the team reports today in Nature.

*Read More at: https://www.sciencemag.org/*

# Fusion Science and Astronomy Collaboration Enables Investigation of the Origin of Heavy Elements

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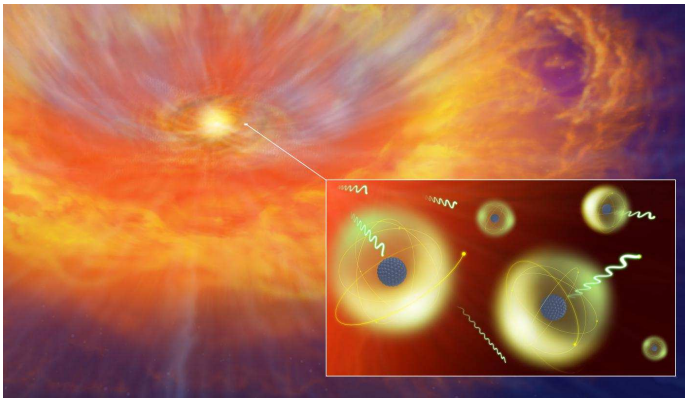

*Artist's impression of a kilonova caused by a neutron star merger. In the material released by the merger, various heavy elements are form*
*ed, which then absorb and emit light. New atomic data calculations help to clarify kilonovae. Credit NAOJ*

A research team of experts in atomic physics, nuclear fusion science, and astronomy succeeded in computing millions of highly accurate atomic data of neodymium ions in the Japan-Lithuania international collaboration. This research accelerates studies of a long-standing mystery regarding the origin of precious metals such as gold and platinum in our universe.

It is not yet identified where and how elements heavier than iron in the universe have been made. Drawing attention as one of the origins of the heavy elements is a merger of two neutron stars. In August 2017, gravitational waves caused by the merger of two neutron stars 130 million years ago were detected. At the same time, emission of the light called kilonova was also observed. The light of a kilonova comes from the material released by the merger of the neutron stars, and it is believed that the material contains abundant heavy elements, including precious metals such as gold and platinum, and rare earth metals such as neodymium.

Elements have the property of absorbing light. The wavelength of the light absorbed by the element and the degree of its absorption are unique to each element and they are called atomic data. By using this atomic data, we can estimate the species and the abundance of heavy elements produced in the merger of neutron stars by analyzing the brightness and the wavelength distributions of the light of a kilonova. However, the available atomic data of heavy elements are extremely limited in widely used world standard databases of the National Institute of Standards and Technology (NIST). Therefore, collaborative research in the fields of atomic physics, astronomy and fusion science is conducted to provide highly accurate atomic data for the light of a kilonova. In nuclear fusion research, atomic data is necessary to analyze the amount and transport of impurities such as iron ions in high temperature plasmas. Daiji Kato, an Associate Professor at the National Institute for Fusion Science (NIFS) in Japan, is collaborating with Gediminas Gaigalas, Professor at Vilnius University in Lithuania, and colleagues in his group to advance research for constructing highly accurate atomic data by computation. Methods of computation that have been used for nuclear fusion research can be applied for atomic data to analyze the light of a kilonova.

The research team focused on singly-, doubly-, and triply-ionized neodymium ions which have the largest influence on the light of kilonovae. Neodymium ions can form more arrangements of constituent electrons than those of lighter elements such as iron, and provide a tremendous number of wavelengths for light absorption.

High precision computation of multiple-electron atoms is challenging due to difficulties in accounting for subtle correlations among electrons. In quantum mechanics, the correlation effects are represented by coherent superposition of different arrangements of constituent electrons. A virtually infinite number of arrangements are possible. The research team tested different sets of arrangements as to provide high accuracy data in realistic computation times, and succeeded in finding the optimal set of arrangements for each neodymium ion. Computed energies of constituent electrons agree with NIST's world standard data within approximately 10% error in average, which is a much higher accuracy than has ever been achieved by the research team, and provide millions of wavelengths and probabilities for light absorption. An astronomer in the team, Masaomi Tanaka, Associate Professor at Tohoku University simulated the light of kilonovae using both the data with the highest precision and the data with a poor accuracy. The influence of the difference in precision on the brightness of the light is evaluated quantitatively for the first time to be approximately 20% at most. This value is sufficiently small to increase confidence in analysis of the light of kilonovae. Thus, the results of this research will accelerate research to elucidate the origins of precious metals such as gold and platinum in our universe by using the atomic data of highest precision.

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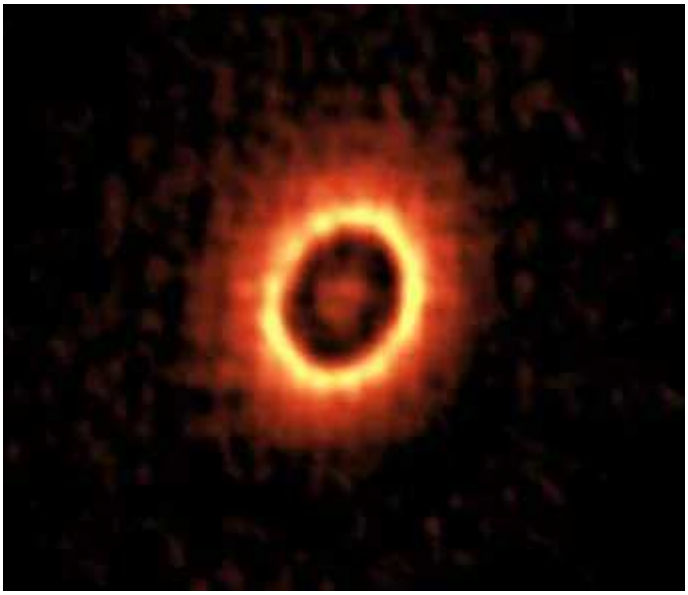
These research results were published as Gaigalas et al. “Extended Calculations of Energy Level and Transition Rates of Nd II-IV Ions for Application to Neutron Star Mergers” in the Astrophysical Journal Supplement Series in February 2019.

*From: https://www.eurekalert.org/*

# Yes! Pack Your Bags! Blossoming Planetary System Strikingly Similar to Ours Found by Boffins

## *It may have an asteroid belt, worlds similar to Earth and Neptune – and only 470 light years away*



*ALMA picture of the DM Tau system. Image credit: ALMA (ESO/NAOJ/NRAO), Kudo et al.*

If, like us, you're dying to get off this ridiculous little rock, here's some hope* to cling onto.

There's a planetary system slowly forming about 470 light years away from Earth that looks uncannily like our Solar System in its younger days.

An image taken by the Atacama Large Millimeter/submillimeter Array (ALMA), an interferometer fashioned out of 66 telescopes in the Atacama desert in Chile, shows a fuzzy red blob surrounded by bright concentric rings.

The blob is a young star known as DM Tau, and the rings around it are dust and other cosmic debris. DM Tau is a small star, about half the mass of the Sun and is about three to five million years old. What's intriguing is that the first circle is at a similar distance to where our own asteroid belt sits, and the second one is located at about Neptune's orbit.

It's difficult to make out with all that dust, but the researchers have a sneaking suspicion that the inner ring could harbor planets similar to Earth, while the outer ring could be hiding planets like Uranus or Neptune.

"Previous observations inferred two different models for the disk around DM Tau," said Tomoyuki Kudo, an astronomer at the National Astronomical Observatory of Japan and co-author of the study published in The Astrophysical Journal, on Thursday.

"Some studies suggested the radius of the ring is about where the Solar System's asteroid belt would be. Other observations put the size out where Neptune would be. Our ALMA observations provided a clear answer: both are right. DM Tau has two rings, one at each location.

The research is being presented at the annual meeting of the Astronomical Society of Japan this week. The team are particularly intrigued with the inner ring.

It's believed that asteroids delivered water, a vital ingredient for life, onto Earth when they crashed into its surface. If DM Tau's system is, indeed, like the Solar System and has an Earth-like planet forming within a of the ring known as the "water snowline", it's possible that water might be transported onto its inner planet too.

"Should terrestrial planets be forming inside its snowline, water delivery from the inner ring onto the inner planets might be plausible," according to the paper. That could mean there is life in that system, or habitable conditions. Or they could be harsh barren rocks.

Jun Hashimoto, a researcher at the Astrobiology Center in Japan said studying the region could help scientists understand how the Earth formed around the Sun over 4.5 billion years ago: "The distribution of dust in the inner ring around DM Tau will provide crucial information to understand the origin of planets like Earth."

* *Faster-than-light drive sold separately.*

*From: https://www.theregister.co.uk/*

*Some of the comments attached to the article make for interesting and entertaining reading.*

# Astronomers Discover 83 Supermassive Black Holes in the Early Universe

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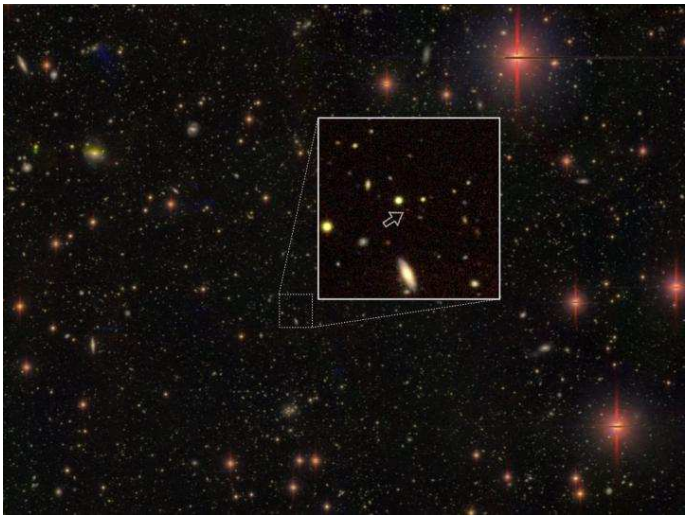


*It shows a lonely quasar in the early universe, 13.05 billion light-years away from Earth. The other objects in the field are mostly foreground stars and galaxies. Credit: NAOJ*

A team of astronomers has discovered 83 quasars powered by supermassive black holes (SMBHs) in the early Universe. This increases the number of black holes known at that epoch considerably, and reveals, for the first time, how common SMBHs were early in the Universe's history.

Supermassive black holes are found at the centers of galaxies, and have masses millions or even billions of times that of the Sun. While they are prevalent in the modern Universe, it is unclear when they first formed, and how many existed in the early Universe. We cannot observe black holes directly, but when a large quantity of matter falls into a SMBH it releases energy as a bright light that can be seen from across the Universe. This phenomenon is known as a quasar.

The research team led by Yoshiki Matsuoka (Ehime University) used the Subaru Telescope to look for quasars in the distant Universe. The most distant quasar discovered by the team is 13.05 billion light-years away, which is tied for the second most distant SMBH ever discovered. Because of the finite speed of light, the light emitted from these objects located 13 billion light-years away must have travelled for 13 billion years to reach us. Thus, the light provides an image of how things looked when it was emitted 13 billion years ago, when the Universe was only five percent of its current age. The survey revealed 83 previously unknown very distant quasars; together with the 17 quasars already known in the survey region. Previous studies have been sensitive only to the most luminous quasars, and thus the most massive black holes. The new discoveries probe the population of SMBH with masses characteristic of the most common ones seen in the modern Universe, and thus shed light on their origin. The survey has found that the average spacing between supermassive black holes is a billion light-years.

"The quasars we discovered will be an interesting subject for further follow-up observations with current and future facilities," said Matsuoka. "We will also learn about the formation and early evolution of SMBHs, by comparing the measured number density and luminosity distribution with predictions from theoretical models."

*From: https://www.eurekalert.org/*

# The Milky Way Contains the Mass of 1.5 Trillion Suns

***Astronomers are using Gaia and the Hubble Space Telescope to make the most precise measure of the Milky Way's mass to date. The new result puts our galaxy on par with — if not more massive than — Andromeda Galaxy.***

The mass of the Milky Way has long been debated, to the point that we don't even know where it stands in the Local Group of galaxies. Is it the heavyweight champion, or does our sister galaxy, Andromeda, outweigh us?

Laura Watkins (Space Telescope Science Institute) and colleagues have used data recently released by the European Space Agency's Gaia satellite, as well as roughly ten years of Hubble Space Telescope observations, to peg the motions of 46 tightly packed bunches of stars. Known as globular clusters, their orbits help pin down the Milky Way's mass.

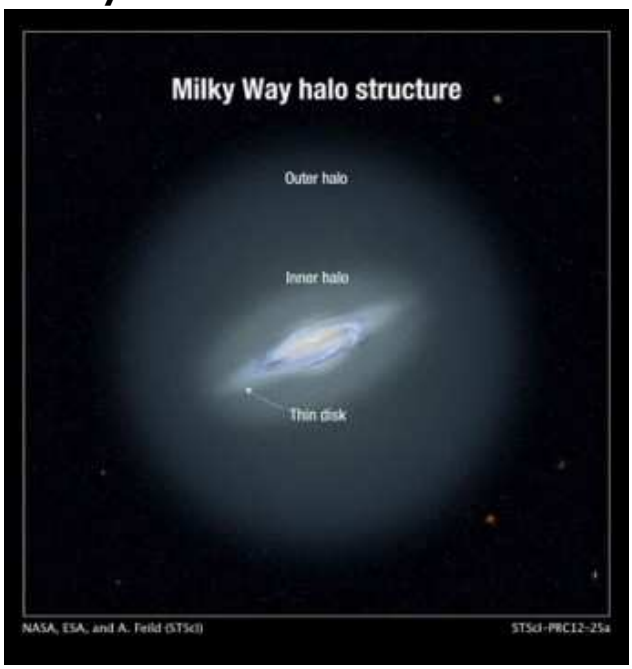
*This artist's impression shows a computer generated model of the Milky Way and the accurate positions of the globular clusters used in this study surrounding it. ESA / Hubble, NASA / L. Calçada*

Our galaxy's gravitational pull determines the clusters' movements, explains coauthor N. Wyn Evans (University of Cambridge, UK). If our galaxy is more massive, the clusters will move faster under the stronger pull of its gravity. The key is to understand exactly how fast the clusters are moving.

Many previous measurements have measured the speed at which a cluster is approaching or receding from Earth. "However," Evans says, "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."

The team finds a mass equivalent to 1.5 trillion Suns. The results will appear in the Astrophysical Journal.

## A Tricky Scale




*The Milky Way's disk of stars (labelled here as "thin disk") are relatively insignificant to the galaxy's massive dark matter halo. NASA / ESA / A. Feild*

Astronomers have been fussing over the mass of the Milky Way the way parents fuss over their newborns. Understandably so: Just as a baby's weight serves as an indicator of more important things, like their growth and well-being, the heft of our galaxy affects everything from our understanding of its formation to the nature of dark matter.

But while the paediatrician will usually tell you your baby's weight to within a percent (equivalent to a tenth of an ounce if you're in the U.S.), the Milky Way's mass is known only to within a factor of two. Imagine putting your newborn on the scale, only to have the needle waver between 5 and 10 — is baby failing to thrive? Or doing just fine? The uncertainty would render the result meaningless.

On the galactic scale, of course, there are a few more zeroes involved: Over the years, astronomers have found that the Milky Way's mass is somewhere between 0.5 trillion and 3 trillion Suns. There are plenty of reasons for the large range. First, studying our galaxy is difficult because we're inside of it; things like dust or the galactic plane of stars can block our view. Second, even when astronomers trace the orbits of objects — such as globular clusters — measuring their motion across the sky is trickier. It takes many years of observations to nail down their so-called proper motions. That's what Watkins and her colleagues have done, using dedicated Hubble programs that have monitored stellar motions over roughly 10 years, as well as the second data release from the Gaia mission that has been monitoring stars since 2014.

By far the trickiest part of the problem, though, is that much of the mass astronomers are trying to measure can't be seen. The bulk of the Milky Way is in dark matter, not stars. Moreover, the Milky Way's dark matter halo may extend 1 million light-years out from the galaxy's center. Even if astronomers follow the orbit of a globular cluster around the galaxy, it will only reveal the mass inside its orbit. The farthest globular cluster in Watkins's study is out at 130,000 light-years. To measure the mass beyond that distance, the astronomers must make some assumptions about the nature and shape of the dark matter halo.

## A More Exact Mass

Nevertheless, the new measurement is so precise that it has helped narrow things down. "Together with another analysis of similar data by Posti & Helmi, [this study] has tipped the scale towards a heavier Milky Way," says Ana Bonaca (Harvard-Smithsonian Center for Astrophysics), who was not involved in the study. "Thanks to these studies, we now know that a very low value for the mass of the Milky Way is unlikely."

For astronomers, this new mass estimate will be most relevant for understanding the Milky Way's swarm of satellite galaxies. For the rest of us: Phew — we're not smaller than Andromeda after all!

There's still work to be done, though. The ideal tracer would be in the outer halo, Bonaca notes, out beyond 300,000 light-years. The trick is finding something that far out that we can still see, such as globular clusters, dwarf galaxies, or even streams of stars that the Milky Way's gravity has torn from an infalling cluster or dwarf. Watkins and colleagues for their part think it's likely that Gaia will continue to estimate the motions of many more globular clusters. No doubt, researchers will continue to narrow down the Milky Way's mass using this and other methods for some time to come.

*More at: https://www.skyandtelescope.com/*

# THE BACK PAGE

LINKS, COMMENTS AND OBSERVATIONS

## More Interesting Stuff!

### Sometimes 'tiz and sometimes 'taint.....

The BBC World Service's programme "More or Less" looks at statistics and numbers in the news. In a recent episode (19/1/2019) one listener had challenged the Sky at Night presenter Prof. Chris Lintott when he said that Mars was the closest planet to Earth. Surely, they asked, the orbit of Venus is closer to Earth than that of Mars. Well yes it is, but Chris Lintott also wasn't wrong. On the day of his broadcast Mars was closer - that was true - it all depends on the relative positions of the planets as they orbit at different speeds.

So what if they asked the question a bit differently: "Which of the planets is closest to Earth most of the time?" The answer often surprises people: it's Mercury! Since both Mars and Venus spend half of their time on the other side of the sun with respect to us, Mercury is often closer - forty-six per cent of the time in fact! (The approximate figures for Venus and Mars are 36% and 18% of the time, respectively).

There's also some more info on this at: *https://bigthink.com/strange-maps/mercury-closest-planet-to-earth*

*Thanks to Simon Gardner for reporting this*

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### Mining the Moon

How can we use the resources that are already on the Moon to make human exploration of the satellite as economical as possible?

If you were transported to the Moon this very instant, you would surely and rapidly die. That's because there's no atmosphere, the surface temperature varies from a roasting 130 degrees Celsius (266 F) to a bone-chilling minus 170 C (minus 274 F). If the lack of air or horrific heat or cold don't kill you then micrometeorite bombardment or solar radiation will. By all accounts, the Moon is not a hospitable place to be.

Yet if human beings are to explore the Moon and, potentially, live there one day, we'll need to learn how to deal with these challenging environmental conditions. We'll need habitats, air, food and energy, as well as fuel to power rockets back to Earth and possibly other destinations. That means we'll need resources to meet these requirements. We can either bring them with us from Earth – an expensive proposition – or we'll need to take advantage of resources on the Moon itself. And that's where the idea of "in-situ resource utilization," or ISRU, comes in.

Underpinning efforts to use lunar materials is the desire to establish either temporary or even permanent human settlements on the Moon – and there are numerous benefits to doing so. For example, lunar bases or colonies could provide invaluable training and preparation for missions to farther flung destinations, including Mars. Developing and utilizing lunar resources will likely lead to a vast number of innovative and exotic technologies that could be useful on Earth, as has been the case with the International Space Station.

*More at: https://bigthink.com/*

### At The Observatory

**For your own safety, please bring a torch.**
**Make sure you close and lock the car park gate if you are the last to leave (if you need the combination to the lock, please contact a member of the committee)**

### Articles Needed

**NZ needs letters, articles, reviews or pictures related to astronomy.**

*"Computers are incredibly fast, accurate and stupid. Human beings are incredibly slow, inaccurate and brilliant. Together they are powerful beyond imagination"*
***Albert Einstein***

*"The presence of those seeking the truth is infinitely to be preferred to the presence of those who think they've found it"*
***Terry Pratchett***

*"Nothing in life is to be feared, it is only to be understood"*
***Marie Curie***

*"There are two kinds of fool. One says, 'This is old, and therefore good.' And one says 'This is new, and therefore better'"*
***John Brunner***

*"A great deal more is known than has been proved"*
***Richard Feynman***