JANUS
THE NEWSLETTER OF EWELL ASTRONOMICAL SOCIETY

December 2025

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Important Reminder:

To allow sufficient time to compile Janus and place it on the EAS Website by the 1st of the month any submissions for publication are required at least 3 days before the end of the month. Any items received after this date will be held over until the following month.

Editorial

Welcome to the December edition of Janus. As noted last month, there will be no lecture this month as the monthly meeting will be devoted to our AGM. Copies of the AGM Agenda and Chairman's Report will be available in the Reports Section of the Society's web site prior to the meeting for those who wish to read them in advance. Don't think that the evening will be boring; the usual routine AGM business shouldn't take too long and will be followed by a quiz. There will also be a raffle for those who like a gamble! Then there will be ample time to talk to fellow members, and refreshments will be provided, so make a note in your diary to attend.

The first meeting of 2026 will be on Friday 9 January when Phil Halper from the Royal Astronomical Society will talk on "The Battle of the Big Bang – The New Tales of Our Cosmic Origins".

December sees the Winter Solstice, marking the shortest day of the year, and the start of a gradual lengthening of the days – not that this is likely to be noticeable - or (if maximum observing time is what you seek) necessarily welcome. Personally, I like to view it as the beginning of a slow transition to Spring and (hopefully) less gloomy weather.

This month's edition of Janus contains the usual mixture of features. Martin Howe is back to presenting his "Object of the Month", while John Pillar contributes yet another fascinating article expanding on what NASA's reporting of potential "biosignatures" in images and data from the Perseverance rover - samples described by them as "the closest we have come to discovering life on Mars" - may mean. Time will tell.

Around 800 years ago, there must have been a similarly controversial debate when Richard Fishacre, a Dominican friar at Oxford University, used his knowledge of light and colour to show that the stars and planets are made of the same elements found here on Earth. Significantly ahead of his time, he was subsequently proved right (see page 14 for the first of two articles from THE CONVERSATION).

Finally, I'd like to take this opportunity to wish all our readers a very Happy Christmas.

John

In this edition:

The Solar System November

MERCURY: begins the month emerging into the morning sky as it approaches greatest elongation W. It will be difficult to see, reaching its highest point in the sky during daytime and being no higher than 8° above the horizon at dawn. Visibility continues to be poor or non-existent and, by the end of the month, soon passing behind the Sun, it is not observable, reaching its highest point in the sky during daytime and being no higher than 1° above the horizon at dawn.

VENUS: will soon pass behind the Sun. It begins the month difficult to see as it will reach its highest point in the sky during daytime and be no higher than 2° above the horizon at dawn. Visibility remains poor throughout the month and by the end of the month, now close to the Sun, it is not observable.

MARS: will soon pass behind the Sun at solar conjunction. Throughout the month, it will not be observable – it will reach its highest point in the sky during daytime and be below the horizon at dusk.

JUPITER: begins the month visible as a morning object in the morning sky, becoming accessible around 20:06, when it reaches an altitude of 7° above the NE horizon. It will then reach its highest point in the sky at 03:04, 60° above the S horizon, before being lost to dawn twilight around 07:16, 33° above the W horizon. By the end of the month, now approaching opposition, it is visible in the morning sky, becoming accessible around 17:51, when it reaches an altitude of 7° above the NE horizon. Reaching its highest point in the sky at 00:53, 60° above the S horizon, it will be lost to dawn twilight around 07:38, 10° above the W horizon.

SATURN: is currently an early evening object, now receding into evening twilight. It begins the month visible in the evening sky, becoming accessible around 16:46,27° above the SE horizon, as dusk fades to darkness. It will then reach its highest point in the sky at 19:01, 34° above the S horizon, and will continue to be observable until around 23:23, when it sinks below 11° above the SW horizon. By the end of the month, still visible in the evening sky, it will become accessible around 16:54, 34° above the S horizon, as dusk fades to darkness. Reaching its highest point in the sky at 17:07, 34° above the S horizon, it will continue to be observable until around 21:29, when it sinks below 11° above the W horizon.

URANUS: recently passed opposition and begins the month visible between 17:41 and 04:23. Becoming accessible at around 17:41, when it rises to an altitude of 21° above the E horizon, it will reach its highest point in the sky at 23:02, 58° above the S horizon. It will become inaccessible at around 04:23 when it sinks below 21° above the W horizon. By the end of the month, still an early evening object, visible in the evening sky, it will become accessible around 17:30, 38° above the E horizon, as dusk fades to darkness. It will then reach its highest point in the sky at 21:00, 58° above the S horizon, and will continue to be observable until around 02:19, when it sinks below 21° above the W horizon.

NEPTUNE: is currently an early evening object, now receding into evening twilight. Although difficult to see, it begins the month visible in the evening sky, becoming accessible around 17:23, 31° above the SE horizon, as dusk fades to darkness. It will then reach its highest point in the sky at 19:15, 37° above the S horizon, and will continue to be observable until around 22:37, when it sinks below 21° above the SW horizon. By the end of the month, still difficult to see, it will become visible at around 17:30, 37° above the S horizon, as dusk fades to darkness. It will then sink towards the horizon, before setting at 23:13.

Notable Events:

Some observations will require a telescope, others will be visible with the naked eye. More information at: *https://in-the-sky.org*

December

2	Pheonicid meteor shower 2025 Comet C/2025 T1 (ATLAS) passes perihelion
3	The Moon at aphelion
4	Close approach of the Moon and M45 Mercury at dichotomy The Moon at perigee Full Moon
5	Lunar occultation of Beta Tauri Mercury at highest altitude in morning sky
6	December φ-Cassiopeid meteor shower 2025
7	Puppid-Velid meteor shower 2025 Conjunction of the Moon and Jupiter Close approach of the Moon and Jupiter
8	Mercury at greatest elongation west Asteroid 16 Psyche at opposition
9	Monocerotid meteor shower 2025
10	Lunar occultation of Regulus Neptune ends retrograde motion
11	Moon at Last Quarter
12	σ-Hydrid meteor shower 2025 The Large Magellanic Cloud is well placed
14	Geminid meteor shower 2025
15	The Running Man cluster is well placed The Orion Nebula is well placed
16	Comae Berenicid meteor shower 2025
17	The Moon at apogee
18	Conjunction of the Moon and Mercury
20	December Leonis Minorid meteor shower 2025 New Moon The Moon at perihelion
21	December solstice
22	Ursid meteor shower 2025
27	Close approach of the Moon and Saturn Conjunction of the Moon and Saturn Moon at First Quarter
28	The cluster NGC 2232 is well placed
29	The Rosette Nebula is well placed
31	Close approach of the Moon and M45

January

1	The Moon at perigee
2	Lunar occultation of Beta Tauri Asteroid 40 Harmonia at opposition The cluster Messier 41 is well placed
3	Full Moon The Moon at aphelion The Earth at perihelion Conjunction of the Moon and Jupiter Quadrantid meteor shower 2026 Close approach of the Moon and Jupiter
4	Comet 24P/Schaumasse passes perigee
5	Close approach of the Moon and M44
6	Mercury at aphelion Comet 24P/Schaumasse reaches peak brightness Venus at superior solar conjunction Lunar occultation of Regulus
8	Comet 24P/Schaumasse passes perihelion
9	Jupiter at perigee Mars at solar conjunction
10	Jupiter at opposition Moon at Last Quarter
13	The Moon at apogee
14	Lunar occultation of Antares
15	The cluster Messier 47 is well placed NGC 2403 is well placed
17	The Moon at perihelion The cluster NGC 2451 is well placed
18	New Moon
19	γ-Ursae Minorid meteor shower 2026
20	Comet C/2024 E1 (Wierzchos) passes perihelion The cluster NGC 2516 is well placed
21	Mercury at superior solar conjunction
22	Venus at aphelion
23	Close approach of the Moon, Saturn and Neptune 134340 Pluto at solar conjunction Conjunction of the Moon and Saturn Asteroid 44 Nysa at opposition The cluster NGC 2547 is well placed
26	Moon at First Quarter Comet C/2024 E1 (Wierzchos) reaches peak brightness
27	Close approach of the Moon and M45
29	Lunar occultation of Beta Tauri The Moon at perigee
31	Conjunction of the Moon and Jupiter Close approach of the Moon and Jupiter The Beehive cluster is well placed The Omicron Velorum cluster is well placed The cluster IC 2395 is well placed

Collected Observations (and thoughts) – Gary Walker

40 years since Halley's Comet was last visible! – Posted 4 November

This month, it is amazing to think that it is now exactly 40 years since Halley's Comet became visible in our skies! Yet, before 1985, the appearance of this comet, just like the August 1999 Total Solar Eclipse, was so far in the future, that it seemed that it would never come!

I first saw this comet on the evening of 11 November 1985. I observed it in two separate viewing periods, the first being from November 1985 to the end of January 1986, at which point, during February and March 1986, it became too far South to be seen from the UK. The second period of visibility was shorter, from 25 April to 15 May 1986.

The comet was, for me, never visible with the naked eye, so I had to observe it through my 10 X 50 binoculars and my 60mm refractor telescope - at that time, it was years before I obtained my present 8"SCT.

In my binoculars and telescope, the comet appeared as a fuzzy ball, with a brighter centre surrounded by a fainter haze. I only suspected seeing a faint, and short, tail in my telescope, extending from the upper left of the Coma, in late December 1985 and January 1986. I saw that the comet was a little fainter, and smaller, than the M31 galaxy.

Unfortunately, this was the worst apparition of Halley's Comet in about 2000 years, because it was behind the Sun and, at its brightest, did not pass very close to the Earth, unlike it had done in 1910! Since then, I have seen a lot of comets, far brighter, and much more impressive, including the most recent one of Comet Lemmon.

However, at the time, I found it exciting, especially as it was such a famous comet. The bookshops had loads of Halley's Comet guidebooks on how to find it and observe it. Of course, I bought virtually all of them!

On 15 November 1985, there was a lecture by Nigel Henbest, held at Sutton Library, which I attended, along with at least 50 - 70 others. I found that I was sitting next to his partner, Heather Couper. She had, by this time, become the first ever female President of the British Astronomical Association!

Sutton Library also published a few leaflets on how to observe this comet. The Comet was often on the News and topical events TV Programmes.

Inevitably, the weather in November and December 1985 was its usual cloudy self, and I only managed to observe the Comet on a total of 6 and 7 nights, respectively, during these 2 months, but in January 1986 I managed to see it on a total of 13 nights!

A couple of years ago, Halley's Comet reached its furthest point in its orbit from the Sun and has now started its return towards us…. But it will be another 36 years, or so, before it gets here in 2061!

Needless to say, Sir Patrick Moore was heavily involved in observing and promoting this comet, as he would also be for the August 1999 Total Solar Eclipse, some 14 years later!

A number of space probes from Russia, Japan, and Europe entered the comet, with the European Giotto Mission passing within a few hundred miles of the Nucleus on 13 March 1986. This probe managed to image the Nucleus, complete with jets spouting out from it.

Aurora again! – Posted 13 November

Due to a large solar flare, the Northern Lights have been in the News again in the past two days. During the night of 11-12 November, one photo from Surrey, on the

News, showed the Aurora shining through gaps in the clouds!

They were also forecast for the following nights, so I looked out, and took a few photos to see if they showed up on them, but there was nothing to see.

The trouble is that Aurora are one of those annoying Astronomical phenomena that are impossible to predict accurately. The same goes for Noctilucent Clouds, Comets, and Meteor Showers!

The only astronomical phenomena that do "exactly what it says on the tin", are Solar and Lunar Eclipses, Transits of Mercury and Venus, and Occultations of stars and planets by the Moon. These will always take place exactly on time. The "only fly in the ointment" being, of course, the Weather!

In the end, after much searching for the Aurora, they only finally became visible, even from Surrey, at about 4am – so, many people (including me) missed them! As noted above, this just emphasises the difficulty inherent in trying to see them, as they are so unpredictable!

Saturn, and its Rings at closest to edge-on – Posted 13 November

From about 11 November to 8 December, the Rings of Saturn come their closest to being edge on. Unfortunately, we missed the point at which they actually went edge on last March, because Saturn was behind the Sun at that time!

On 12 November, for example, I observed Saturn through my telescope. The Rings were still fairly easy to see, but now just appeared as two thin lines extending from opposite sides of the disk of Saturn itself. I could also see the thin shadow of the Rings crossing the globe of Saturn. This certainly makes Saturn appear very strange!

I last saw the Rings go edge-on in 1995 - 30 years ago - but in the next Ring Plane Passage, it was again, behind the Sun!

On the way to tonight's meeting! – Posted 15 November

On the way to tonight's meeting, at the bus stop, I heard an elderly man talking to someone else. He said that a Comet had crashed into the Sun at the beginning of this year, moving it slightly, so resulting in this year's warm weather. I have no idea where this idea came from, but I couldn't be bothered to disagree with him!

Of course, no Comet could affect the Sun, although, over the years, many Comets have been seen to crash into the Sun.

Jupiter and Saturn – Posted 18 November

Yesterday, we had the first clear, cloudless, evening for ages, and the first frosty night as well.

Saturn's Rings are now at their closest to being edge-on. In my 8"SCT, they appear only as extremely thin, fairly dim, lines of light extending either side of Saturn, with the thin shadow of the Rings just visible as a thin dark line crossing the planet.

Jupiter is now coming up in the late evening and is forming a line of 3 "Stars", as it is presently very close to Castor and Pollux, in Gemini.

A Double Shadow Transit of Jupiter – Posted 21 November

Early this morning, I saw a double shadow transit on Jupiter of the moons of Io and Callisto. They were moving parallel to each other, with Io moving along the Southern Equatorial Belt, and Callisto lower down.

Callisto only rarely appears as a shadow transit, and only because Jupiter is reaching its Equinox, so this outermost moon of Jupiter is now sufficiently edge-on to Jupiter to start to interact with its disk. Normally, Callisto always misses these events because it is further out from the disk of Jupiter.

Jupiter only has an Equinox about every 6 years.

Shadow transits appear as jet black dots upon Jupiter and appear as if they are above it, thus creating a 3D effect.

Jupiter was making a striking naked eye appearance, being only a few degrees from Pollux and Castor, in Gemini. Indeed, I saw a local post on social media with some asking what "those lights were" - some thought that they were satellites!

So, the King has now returned to the sky at fairly reasonable hours!

I also saw Saturn earlier in the evening, appearing strange with its now very thin and delicate rings. As usual, Titan was exactly in line with the rings, as all of Saturn's moons will be, during this edge-on period. Despite its slightly dimmed magnitude, Saturn is still obvious in the evening sky, as it is on its own, there!

Opening of Nonsuch Park Solar System Walk – Posted 21 November

The December issue of the Astronomy Now magazine carried a report about the opening of the Nonsuch Park Solar System Walk, written by Martin Howe. The report, which included two photographs, is excellent publicity for the Society!

A late observation of Venus – Posted 23 November

Venus has, of late, been drawing closer to the Sun, and only rising in the early hours, before dawn.

Today, however, I managed to find it in my telescope during the day time, at around 10.35am. It was only a few degrees to the West of the Sun, so I made certain that the finder scope was covered!

It appeared as a small disk, or globe, as it is now almost at "Full" phase (98% to be precise). Even at 222X, it appeared small, but more like a planet. However, even at 62X, the phase was still visible, as Venus never gets as small as Mars, Uranus, or Neptune! Its angular size was now 10' arcseconds. I only rarely see it this Full, because it is more difficult to observe.
It is worth noting that, as Venus is about the same size as the Earth, it means that, from Venus (of course, above the clouds), the Earth would appear at this same size. Indeed, whenever you see Venus through your telescope, the same rule will apply!

Object of the month – The moons and rings of Saturn - Martin Howe

Saturn passed opposition on the 21st of September – opposition being when Saturn and the Sun are diametrically opposite one another in the sky, or, in other words, when seen from above, the Earth lies on a straight line connecting the Sun and Saturn. Saturn passes due south about 7pm, on the 1st of December and so clearly visible in an otherwise barren patch of sky. Saturn is also climbing higher in the sky as its orbit starts to take it closer to the ecliptic from its southerly position of recent years – crossing the meridian at an altitude of nearly 35° (compared to 30° this time last year).

Saturn's rings are its most famous feature, however, again, due to its passage along its orbit, we are now seeing these almost edge-on – an event that occurs about every 14 years. Saturn's rings stretch out for thousands of kilometres but are very thin — less than a kilometre in thickness. It is their icy composition that make them so clearly visible from Earth when at a wide angle, but the thinness of the rings is clearly (not!) evident at certain points in its orbit as they are now.

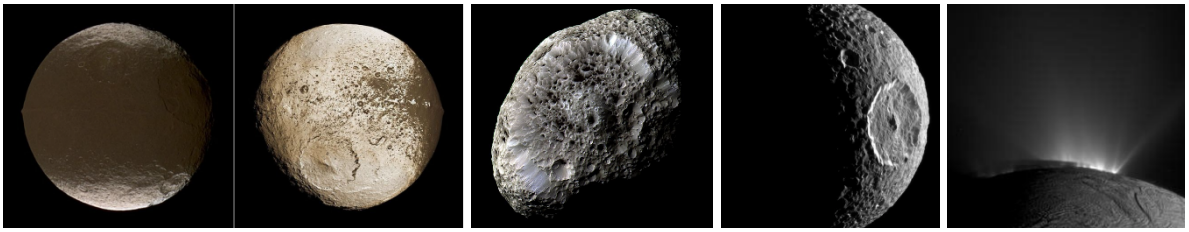
Another fascinating feature of the Saturnian system is its retinue of moons – 274 at the last count – and a number of which are of particular interest to planetary scientists. First and foremost is Titan, originally thought to be the largest moon in the solar system, but the confirmed discovery of an atmosphere in the 20th century resulted in the demotion of Titan into second place behind Jupiter's Ganymede (2,575km versus 2,634 km radii respectively). The atmosphere is thought to be up to 500km thick, hence giving the impression that it was much larger than it really was, and much larger than Ganymede by visual appearance. Titan also holds the accolade of being the first moon beyond our own to host a landing probe – the Huygens probe released from the Cassini mission in 2005. Titan's atmosphere is primarily composed of nitrogen and methane and has liquid methane lakes on its surface.

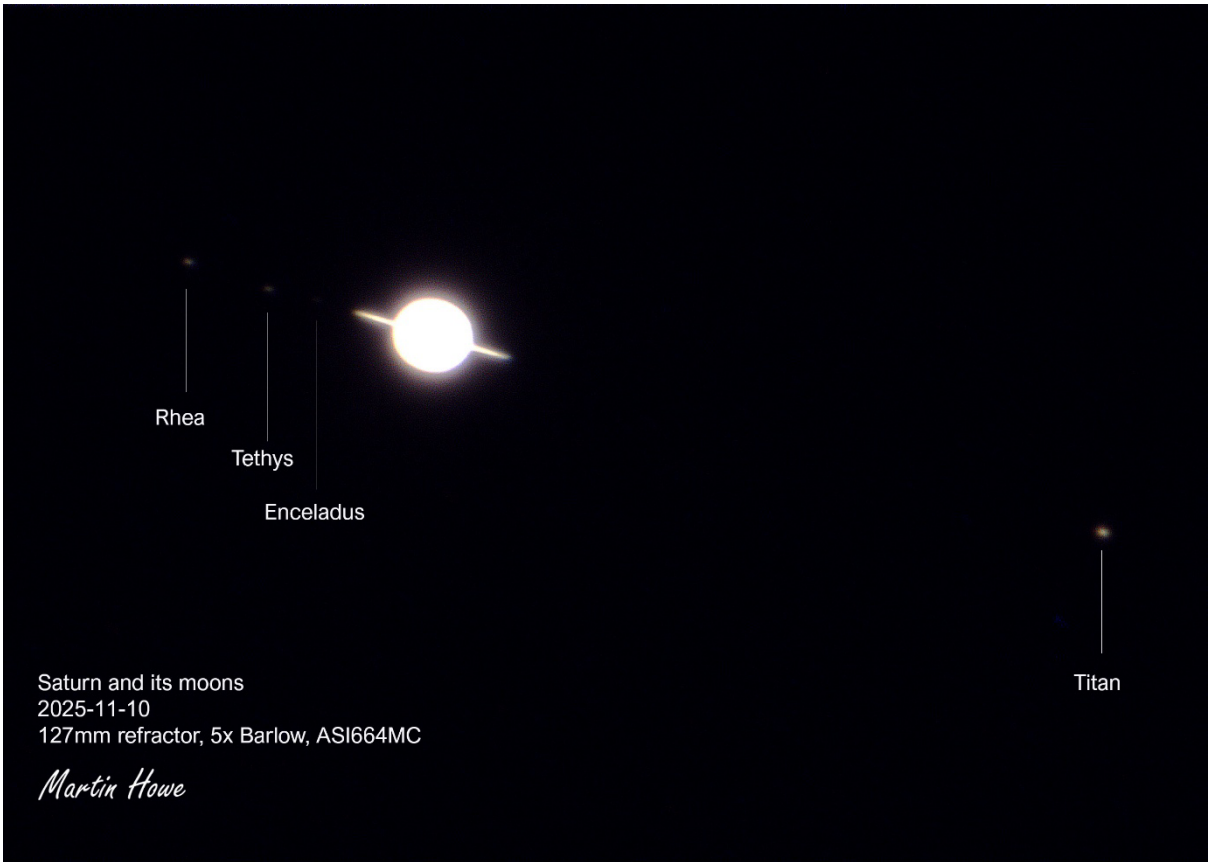
The other moon that attracted a lot of attention during the Cassini mission was Enceladus, which hit the headlines due to the discovery of plumes of water vapour being ejected from its icy surface. It is speculated that these originate from a liquid ocean beneath the icy crust which could even potentially harbour life.

The Cassini mission also returned close up images revealing the fascinating surfaces of Saturn's other moons, including the honeycomb appearance of Hyperion, the Star Wars "Death Star" appearance of Mimas, and the two-faced Iapetus, with one very reflective hemisphere and the other being very dark.

These variations in surface features are illustrated by the images below from NASA, showing the two faces of Lapetus, Hyperion, Mimas and the water vapour plumes from Enceladus.

Below that is an over-exposed image of Saturn taken during November, showing the narrow angle of view of the rings, but also four of its moons, strung out in a line similar to the typical view we have of Jupiter's Galilean moons.




Rhea
Tethys
Enceladus
Titan
Saturn and its moons
2025-11-10
127mm refractor, 5x Barlow, ASI664MC
Martin Howe

Mars life? – John Pillar

Martians, little green men, irrigation canals, seasonal farmlands… a belief that Mars is inhabited by intelligent beings has inspired movies, books, comics and nightmares since the early late 1800s. William Herschel documented seasonal changes in Mars' ice caps, and an Italian astronomer, Schiaparelli, described "canals", which were proposed by American

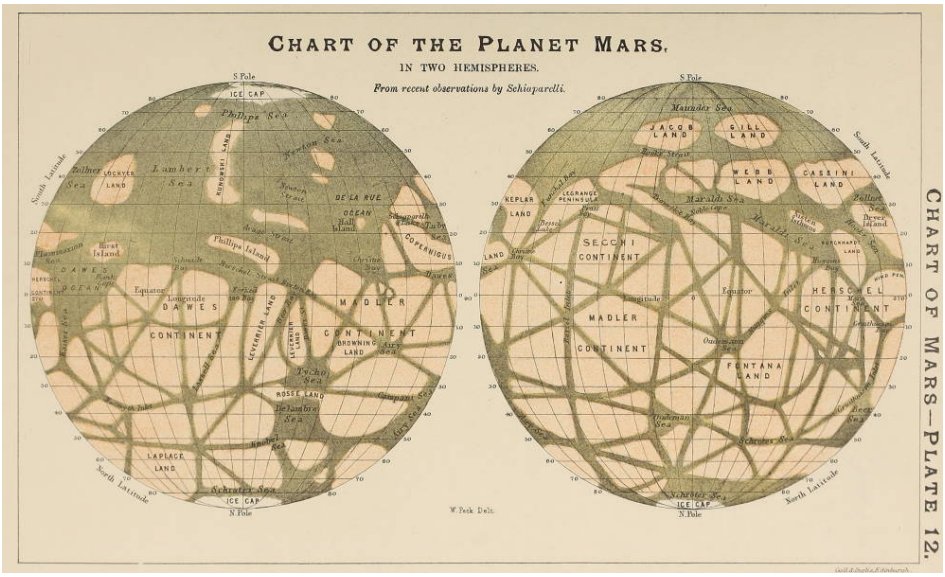


Figure 1. A map of Mars drawn by Italian astronomer Giovani Schiaparelli in the 1880s, showing waterways on the planet's surface. It was Schiaparelli who first proposed the canal theory. From the book "A Popular Handbook and Atlas of Astronomy" by William Peck, 1891.

astronomer Percival Lowell as irrigation canals constructed to transport water from the ice caps to the equatorial desert regions. Lowell published three books that captured the public imagination, and in 1897 H.G. Wells wrote "War of the Worlds" - telling of an invasion of earth by Martian aliens fleeing a dry, uninhabitable planet.

Popular science was brought to reality by the Viking I and II landers in 1976 – but as the aliens have hid, the belief that Mars may have harboured early, primitive life, has gained credibility - and today robots trundle the surface of Mars, scanning, imaging and drilling the surface in the search for evidence of past life.

In September (2025) NASA made the headlines with a press release reporting potential "biosignatures" in images and data from the Perseverance rover - samples described by NASA as "the closest we have come to discovering life on Mars". I'm not an expert (not at all 😳) in the mineralogy and chemistry observed by NASA on the surface of Mars but with over 40 years of experience in geology … a little knowledge is a dangerous thing, so I thought I'd try and pick out the key observations, put the samples in context, and maybe dare to make some comments that may be of interest (actually I found the reports very difficult to follow, with lots of seemingly random outcrop names and obscure minerals… hopefully I can make some sense of it).

On the same day as NASA's press release, a paper was released describing the findings in detail: Hurowitz, J.A., Tice, M.M., Allwood, A.C. et al. Redox-driven mineral and organic associations in Jezero Crater, Mars. Nature 645, 332–340 (2025).

This paper focuses on images and samples taken from an outcrop located within a canyon cut by a river flowing into the Jezero crater and delivering sediment to a delta (that I discussed in Janus July 2025) shown in Figure 2 In particular, an image taken at “Cheyava Falls” (just a name for a spot in the outcrop) was highlighted by NASA as showing features they considered to be very significant potential indicators of Martian life.

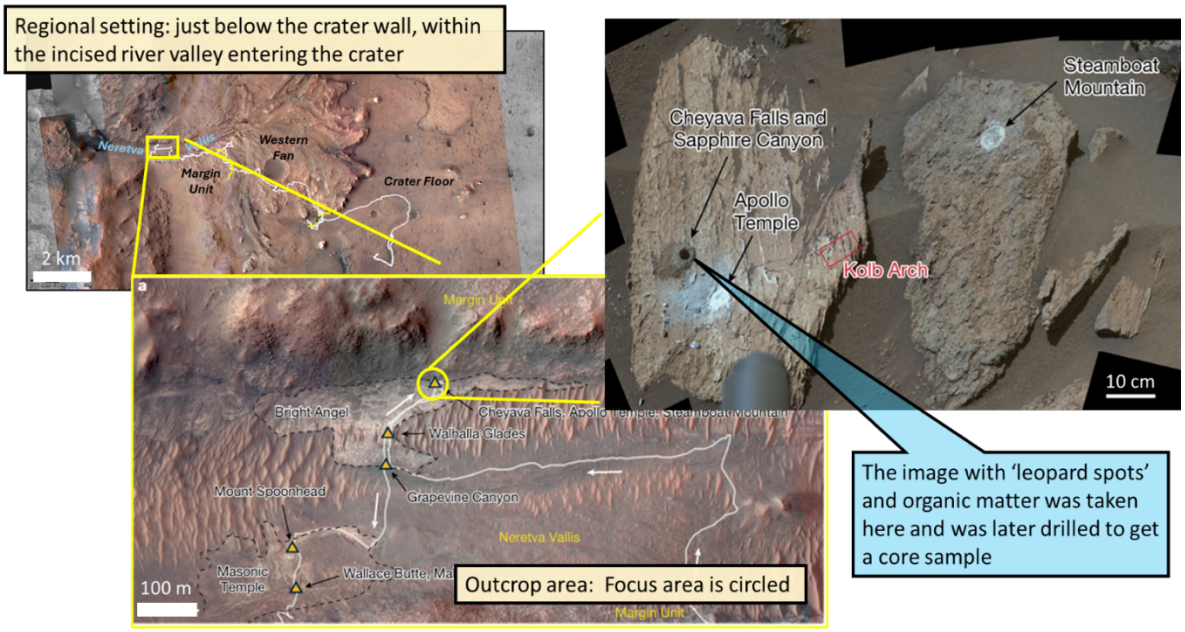


Figure 2. Location of the Cheyava Falls samples. The regional location on the inner edge of the Jezero Crater is shown top-left, and a localised view below. Top-right shows an image of the rocks from which the ‘leopard spots’ sample was taken. Scale bars are shown on each image… notice that the image on the top-right is actually of a very small area.

The Cheyava Falls sample image, shown in Figures 3 and 4 (below), is about 2.5cm across, and consists of interlayered red mudstone and white gypsum layers. The red mudstone layers showed indications of containing organic carbon – in presumably very fine-grained microcrystalline form (not directly visible in the images e.g. Figure 3).

Bottom line: NASA suggest that organic matter in the rocks promoted a reaction that went something like (apologies for the gross simplification):

Red mudrock (iron oxide) + life-form = unoxidised mudrock (white) + iron phosphate/sulphate

Red mudstone layers

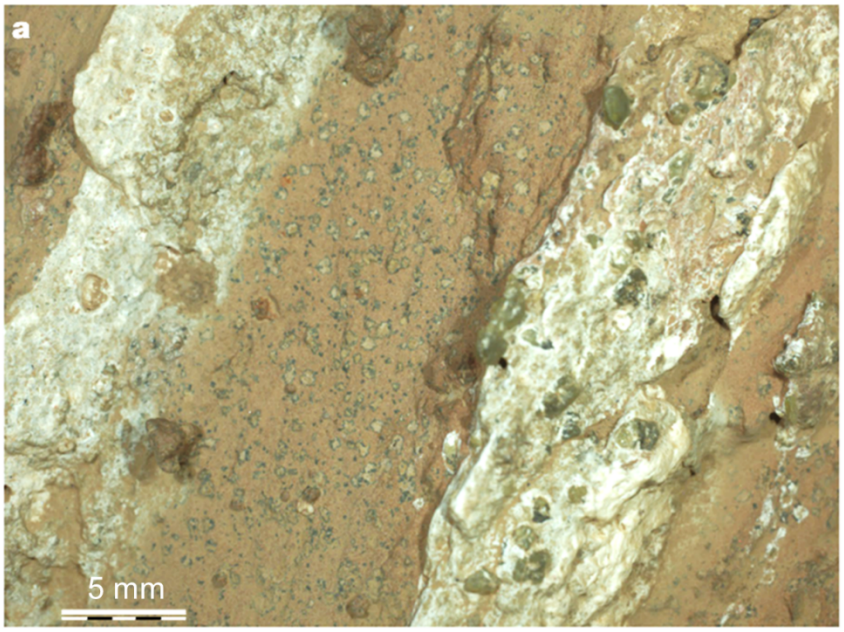


Image scaled to match a pound coin. The red and the whitish layers are much thinner than the width of the coin

Figure 3: The famous image shown by NASA - Cheyava Falls image showing layers of mudrock (red-brown) and gypsum-type (calcium sulphates). Notice how small an area this image covers - it's only a few mm across, and the mineral grains are very tiny. From Figure 3 of the Hurowitz paper.

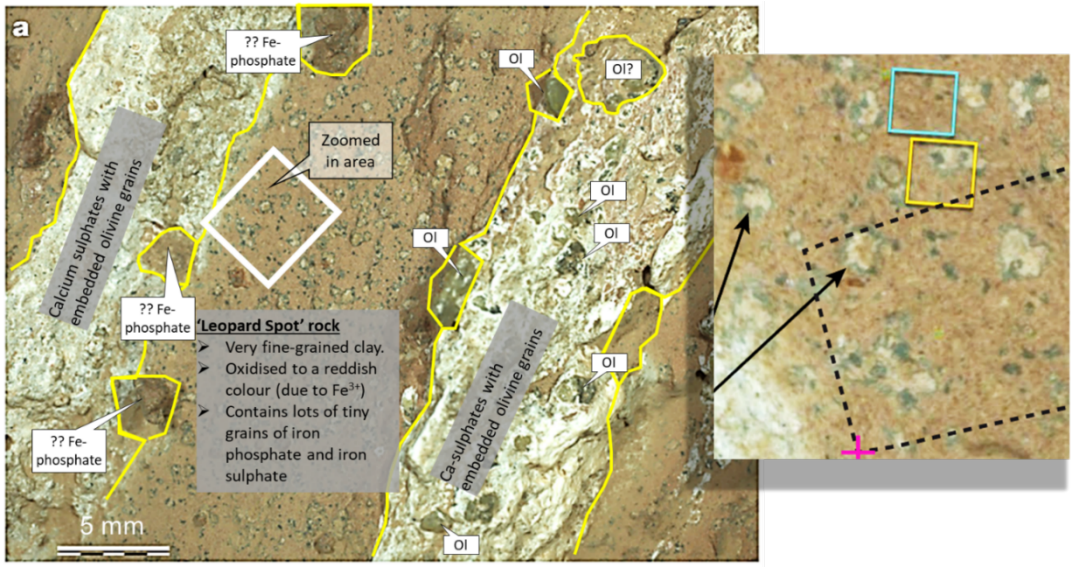
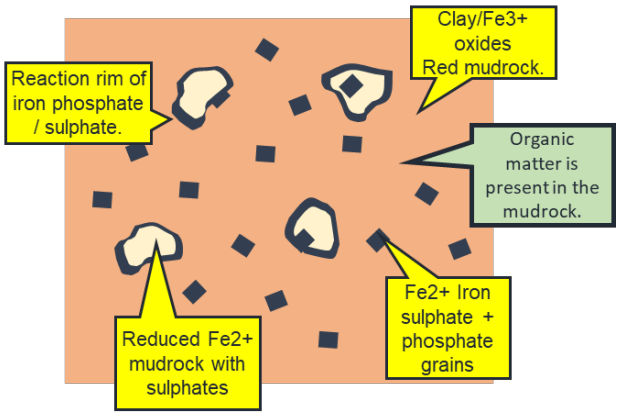


Figure 4: Annotated version of Figure 3. The zoomed in area shows the 'leopard spot' texture. The many little black dots are a mix of iron-phosphate and iron-sulphate, the white blobs have thin dark coloured rims (also iron-phosphate/sulphate) against the reddish clay of the mudrock. The white layers are calcium sulphate (gypsum type) mineral and intriguingly include floating grains of olivine.

The red colour of the mudstone is caused by iron oxide (Fe^{3+}, ie. rust, or more specifically, ferri-hydrite). Within the mudstone are many tiny dark coloured grains and whiter irregular blebs. The whiter blebs have rims of a dark mineral – these rims form a reaction rim between the whiter material inside and the red mudstone on the outside.



The dark grains and reaction rims are believed to be a mixture of an iron phosphate mineral $Fe_3(PO_4)\cdot 8H_2O$ called vivianite and an iron-sulphide mineral Fe_3S_4 called greigite (I'd never heard of these minerals either 😊).

I've not been able to find any definitive answer to what the lighter blebs consist of – my best guess is that they are mudstone (same as the red mudstone) but have 1) gained some sulphate (gypsum-like mineral) and 2) have lost their red colour because iron in them has been reduced from Fe^{3+} to Fe^{2+} (or was never oxidised to form red "rust" in the first place…. in which case the white colour is their original colour).

Anaerobic single-celled organisms are known on earth to use redox Fe^{3+} to Fe^{2+} reaction as an energy source and produce vivianite and greigite minerals as by-products (we derive our energy from an oxygen to CO_2 reaction whereas organisms living in anaerobic conditions are very inventive and "breath" sulphur or iron). The observation in the Martian samples of the key components of this characteristic reaction is what NASA claims may be evidence for microbial life on Mars.

The very fine-grained texture of the mudrock implies that the layer was deposited from very still, calm, standing water on the flood plain after a flood event. It's also possible that the mudrock formed from wind-blown dust that 'stuck' to a damp region on the flood plain to accumulate into a thin sedimentary layer.

White sulphate layers

The white layers are very strange, and NASA doesn't implicate these layers as evidence for Martian life.

The white mineral is Ca-sulphate, gypsum, $CaSO_4$, commonly found on earth in mineralised veins OR as evaporites in deserts on the edge of salt-lakes. NASA confusingly describes the gypsums as "layers" or as "veins". These are two completely different things - "layers" implies they formed on the ground surface, potentially as salt-pan evaporites on the edge of a salty lake (perhaps Jezero crater lake), whereas "veins" suggests they were injected under intense pressure into fractured rock. In summary, there's a lot of calcium sulphate in the system, whether it's depositional (formed on the ground surface) or injected into the rocks as veins.

The occurrence of olivine (as pristine crystal grains) in these gypsum layers is extremely weird. I've never seen or heard of anything like this gypsum-olivine combination in the geological record on earth. Olivine is a high temperature mineral found as a constituent of igneous rocks (of basalt chemistry), a complete contrast to low temperature gypsum (gypsum is a familiar component of the "scale" in your kettle if you live in a hard water area). You may remember olivine is a key component of dust in the proto-solar system disk, and also forms a significant proportion of the inner mantle/core of the moon and earth.

A sulphate-rich solution from which gypsum forms is acidic and reacts strongly with olivine – the occurrence of undissolved olivine crystals in the gypsum layers implies that the olivine crystals were in contact with sulphate solutions for a very short time before the solution crystallised to form the white gypsum, embedding the olivine crystals.

Figure 5: Olivine sand from Hawaii

Olivine "sands" are known on earth in a few places where grains of olivine are weathered out of basaltic rocks – Papakolea Beach on Hawaii is an example, where olivine is derived from a nearby volcanic cone.

Olivine sands are also known from remote sensing on Mars, occurring on the floor of Jezero Crater and more widely across the Nili Fossae (an area located to the west of Jezero Crater - an area of deep rift valleys associated with a major impact crater). The olivine crystals are believed to have formed in large magma bodies and have been exposed by deep erosion and/or meteoritic impacts. Commonly the Martian olivine-bearing terrains also show strong evidence of carbonates (here a magnesium carbonate called magnesite ($Mg(CO_3)$) – these carbonates are believed to have formed by weathering of the olivine, so it makes sense that they are found together.

The sulphate – olivine mix seen in the images from Cheyava Falls (Figure 3) is not the same as the carbonate-olivine mix found in the wider area. The olivine crystals in the Cheyava Falls sample are almost pristine – you may be able to see original crystal shapes. Also, I can't see any evidence for corrosion or reaction of the olivine with the surrounding white sulphate, implying that the two minerals were brought together at low temperature, in a general absence of water, and that the layer was solidified/buried rapidly.

A speculative suggestion for these enigmatic sulphate–olivine layers is that the sulphate layers (only a few mm thick) formed from very fine grained, wind-blown, volcanic ash that was rich in sulphate. The olivine grains (already on the surface as 'sand grains') were embedded in the sulphate 'crust' forming on the ground surface.

I think a depositional sedimentary origin for the sulphate layers is more likely than an "injected vein" mechanism. It's difficult to envisage how occasional olivine grains would have been 'picked up' and carried by a hot sulphate-rich hydrothermal fluid and forced into cracks in the rock without being corroded and dissolved.

One can imagine an off-world environment: torrential rains, torrents of water rushing down river canyons into Jezero Crater under a sulphurous CO_2 atmosphere clouded with volcanic dust and ash.

Take aways …

The many unusual features in the images and data form a confusing fog and preclude making definitive statements about "life on Mars".

NASA has undoubtedly uncovered strong evidence for the presence of complex "organic" carbon material in the rocks deposited on the margins of the Jezero Crater Sea. However, that's maybe as much as can be said for now… "organic" carbon is not necessarily "biologic"

carbon. In fact, indications of carbon organic matter have been found in many locations by Curiosity and Perseverance rovers…. Organic matter is very abundant on Mars.

The solar system is replete with organic matter - e.g. the carbonaceous chondrite asteroids such as Ryugu and Bennu, from which we have physical samples (September 2025, Janus), are rich in complex carbon "organic" compounds formed in the outer solar system. Multiple impacts by meteorites delivered significant amounts of complex carbonaceous material to the atmosphere and surface of Mars that ultimately was buried and preserved in sediment, such as the mud-rock of the Cheyava Falls sample.

Meteorites smaller than a few 10's of meters in size can reach the surface largely intact. On entry through the atmosphere only the outer thin skin of the meteorite gets hot – it 'ablates' (e.g. the Apollo re-entry modules) and protects the interior of the meteorite – preserving any interplanetary carbon compounds. Sometimes meteorites are found on earth that are covered in frost because the inside is still at near-zero temperature.

Living organisms on earth preferentially incorporate the carbon-12 isotope (6 neutrons in the nucleus) rather than the heavier carbon-13 (7 neutrons), causing a characteristic depletion of C^{13} in biological organic matter. If the organic matter in the Mars' samples has less C^{13} than the CO_2 in the Martian atmosphere it would be a strong indicator of a biological origin.

Ryugu asteroid carbon is very rich in C^{13}, in contrast to carbon found in living biology

Biological processes for organic molecules with non-random, long-chain fatty acids with even numbers of carbon atoms, whereas non-biological processes generally form a less organised, random mix of molecules. Detecting specific molecular patterns in the Mars' samples would be a strong discriminator in favour of biological activity.

Conclusive evidence for the Cheyava Falls carbon being of "biological" origin will require the samples to be analysed in laboratories on return to earth and their isotopic ratios and molecular structure analysed.

How a medieval Oxford friar used light and colour to find out what stars and planets are made of

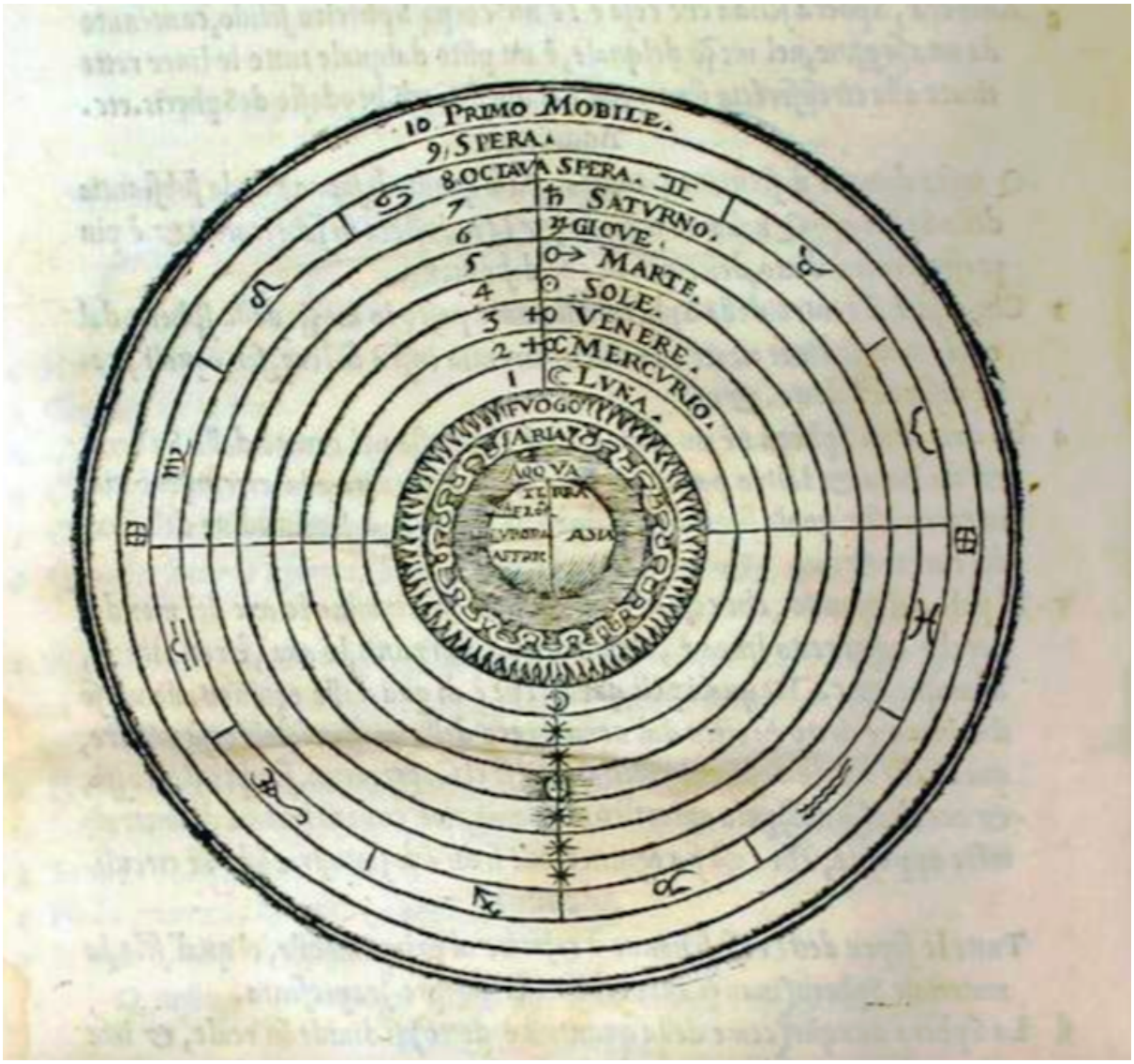
Acknowledgement: This article was written by William Crozier, Duns Scotus Assistant Professor of Franciscan Studies, Durham University and was first published in THE CONVERSATION on 7 November 2025. It is republished in full under a Creative Commons Licence. The original article, with additional links and images can be found here: https://theconversation.com/how-a-medieval-oxford-friar-used-light-and-colour-to-find-out-what-stars-and-planets-are-made-of-262652

During the 1240s, Richard Fishacre, a Dominican friar at Oxford University, used his knowledge of light and colour to show that the stars and planets are made of the same elements found here on Earth. In so doing he challenged the scientific orthodoxy of his day and pre-empted the methods and discoveries of the 21st-century James Webb space telescope.

Following the Ancient Greek philosopher Aristotle, medieval physics affirmed that the stars and planets were made from a special celestial element – the famous "fifth element" (*quinta*

essentia) or “quintessence”. Unlike the four elements found here on Earth (fire, water, earth and air), this “fifth element” is perfect and unchanging.

Fully transparent, it formed the basis of what were believed to be the nine concentric celestial “spheres” surrounding the Earth, as well as the various stars and planets attached to them. These, it was argued, were merely condensed versions of the “fifth element”, with each of the first seven spheres having its own planet, and the outermost eighth and ninth spheres containing the stars and heaven itself, respectively.



A medieval chart of the nine concentric celestial ‘spheres’ surrounding the earth. Oxford University

Colour, light and the stars

Lacking access to telescopes and rock samples, Fishacre – the first Dominican friar to teach theology at Oxford University – openly rejected the idea that the stars and planets were made from some special “fifth element”. In his opinion, they consisted of the same four elements found here.

His reason for asserting this position was his understanding of how colour and light behave. Colour, Fishacre noted, is typically associated with opaque bodies. These, however, are always composite, meaning made up of two or more of the four terrestrial elements. When we look up at the stars and planets, however, we see that the light they emit often has a faint colour. Mars appears red, and Venus yellow, for example. This suggests, of course, that they are composite and thus made "*ex quattuor elementis*" – "out of the four elements".

In Fishacre's opinion the surest proof that the stars and planets were not made of some special "fifth element" came from the Moon. It has a very definite colour, and, crucially, every so often it eclipses the Sun. Were it made from the transparent fifth element – even a highly condensed version of it – then surely the Sun's light would pass through it, just as it does a pane of glass. This, however, is not the case.

The Moon, Fishacre reasoned, must therefore be made of the same elements found on Earth. And if this was true of the Moon, which is the lowest celestial body, then it must also be true of all the other stars and planets.

The James Webb space telescope confirmed what Richard Fishacre claimed about the composition of stars and planets 800 years earlier. Shutterstock

A brave move

In arguing this, Fishacre knew that he was risking criticism. “If we posit this position,” he wrote, “then they, that crowd of Aristotelian know-it-alls (*scioli aristoteli*), will cry out and stone us”.

Sure enough, stones were thrown at Fishacre – and from high places. In 1250, his teaching was denounced at the University of Paris by St Bonaventure of Bagnoregio, a Franciscan friar who ridiculed in his lectures those “moderns” like Fishacre who foolishly questioned Aristotle’s teaching on the celestial fifth element.

Contemporary astrophysics has, of course, vindicated Fishacre’s position. The stars and planets are not made of some special fifth element, but rather from many of the same metals and elements found here on our home planet. The James Webb space telescope, for example, recently established that the atmosphere of the Neptune-like exoplanet TOI-421 b, some 244 light years away, contains high quantities of water and sulphur dioxide.

Remarkably, how the James Webb space telescope established this – a process known as transmission spectroscopy – is very similar, at least in principle, to the method which Fishacre employed. It detected subtle variations in the brightness and colour of the light emitted by TOI-421 b which could only be caused by water and sulphur dioxide.

Given how much criticism his claims received, Fishacre would no doubt have been delighted to know that nearly 800 years after his death, contemporary astronomy, just like him, is using light and colour to show that far flung stars and planets are all made from the same elements.

String theory: scientists are trying new ways to verify the idea that could unite all of physics

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In 1980, Stephen Hawking gave his first lecture as Lucasian Professor at the University of Cambridge. The lecture was called “Is the end in sight for theoretical physics?”

Hawking, who later became my PhD supervisor, predicted that a theory of everything – uniting the clashing branches of general relativity, which describes the universe on large scales, and quantum mechanics, which rules the microcosmos of atoms and particles – might be discovered by the end of the 20th century.

Forty-five years later, there is still no definitive theory of everything. The main candidate is string theory, a framework that describes all forces and particles including gravity. String theory proposes that the building blocks of nature are not point-like particles like quarks (which make up particles in the atomic nucleus) but vibrating strings.

It suggests that, if we could look deep inside electrons, we would see loops of strings, vibrating just like those on a violin. Different patterns of string vibrations correspond to different particles.

String theory unifies all the forces of nature. Forces that seem very different, such as gravity and electricity, are deeply related to one another. The forces are linked by so-called dualities: the same underlying phenomena can be described in different ways.

The force of gravity is described in terms of geometry, shapes and positions. Other forces are described in terms of different mathematical concepts, including algebra and numbers. The unification of forces hence implies profound relationships between branches of mathematics. Such relationships had previously been proposed by mathematicians, particularly by Robert Langlands, and string theory gives physical explanations for the relationships.

Although string theory could be the correct theory of everything, it is hard to test experimentally. The effects of string theory become visible at very small scales and very high energies.

Particle accelerators explore the internal structure of particles by colliding them and breaking them apart. However, even the biggest colliders at Cern in Switzerland don't have enough energy to break particles down into strings.

Clues in the cosmos

How can we test string theory experimentally if we can't reach high enough energies in colliders? The answer may lie in looking up to the skies.

The very early universe was dense and hot, and the primordial soup would have been made up of strings. We can see the history of the universe imprinted in current day observations, from surveys of galaxies through to measurements of the cosmic radiation that permeates all of space and is a leftover from the big bang.
In the early 20th century, American astronomer Edwin Hubble showed that the universe is expanding. Galaxies are moving further apart from each other.

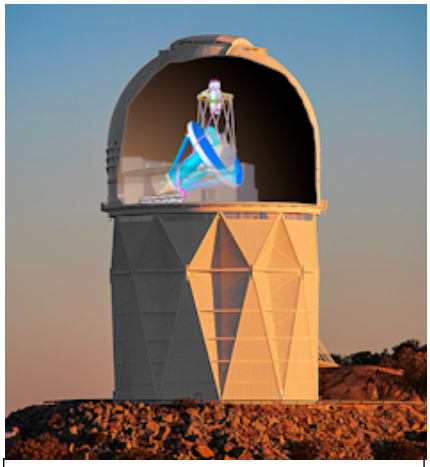
At the end of that century, detailed observations of the expansion showed that it is in fact accelerating. Galaxies today are moving apart faster than they were a million years ago. What is driving this acceleration? Gravity is an attractive force, so it slows down the expansion of the universe. The acceleration of the universe is driven by a new kind of energy, which is spread throughout the whole of space. Scientists call this dark energy and it makes up about 70% of the energy of the universe.

We don't know exactly what dark energy is. The most plausible explanation is that it is the inherent quantum energy of the universe. In the quantum world, particles can never just sit still, with no energy. There is always a little bit of quantum jitter and associated energy.

Atoms cooled down to absolute zero temperature still have energy because of their quantum motion. Dark energy could potentially be explained as being the underlying quantum energy of all the forces and particles in nature, including gravity.

Experiments are pinning down the properties of dark energy. Desi is an observatory based in Arizona, US, which is mapping out galaxies and quasars. The space based telescopes Euclid and Roman will measure the universe in unprecedented detail, mapping out the history of billions of galaxies over billions of years.

Recent results from Desi suggest that dark energy is changing in time in a way that is consistent with string theory models – although this is yet to be fully verified by further measurements.



Desi sits in the dome of the Nicholas U. Mayall 4-meter Telescope at the Kitt Peak National Observatory wikipedia, CC BY-SA

This doesn't prove string theory because string theory can produce a variety of different universes, with differing patterns of dark energy. However, the Desi results suggest that interpreting dark energy as quantum energy of strings may be on the right track. There are of course phenomena other than strings that could explain the change in dark energy.

Euclid and Roman will make very precise measurements and will be able to exclude many such theories of dark energy and some specific versions of string theory – helping to narrow down the bits theorists should focus on.

Another way to verify string theory may be via black holes. Once something falls inside a black hole, it cannot escape. Inside a black hole there are very strong forces and particles are torn apart. We still don't understand exactly what happens inside a black hole, but string theory teaches us how a black hole retains information about what has fallen inside.

That's because string theory assumes there is no "singularity" inside a black hole – a point of infinite density and gravity – but instead that the objects are spread out as balls of strings called fuzzballs.

Future, more precise, measurements of gravitational waves (ripples in the fabric of spacetime) will be looking for the subtle signals of the quantum behaviour inside black holes predicted by string theory. If black holes are fuzzballs, they should produce a different signal when they merge, lasting longer and containing echoes. What's more, if extra dimensions exist, as string theory proposes, black holes may oscillate in different ways which we could also detect.

In addition to cosmological measurements, scientists can run thought experiments, just as Einstein did with his theories of relativity. String theory has led to new insights not just in mathematics but also in other areas of science. For example, string theory has proven to be useful in understanding how quantum systems can be used in computing.

I don't think a complete understanding of a theory of everything is just around the corner, but in the 45 years since Hawking's Lucasian lecture we have certainly learned a lot. And right now, things are looking up for string theory.

Up Next:

AGM: 8pm Friday 12 December – Nonsuch High School

Usual AGM business with raffle, quiz and refreshments.

There will also be the usual presentation on the sky at night for the coming month.

NEXT MEETING: 8pm Friday 9 January – Nonsuch High School

Phil Halper from the Royal Astronomical Society will talk about the Battle of the Big Bang – The New Tales of Our Cosmic Origins.

Phil is the creator of the popular YouTube series Before the Big Bang, which has had several million views, and was previously journalist in residence at the Penn State Institute for Gravitation and the Cosmos. His astronomy images have been featured in major media outlets including The Washington Post, the BBC, and The Guardian, and he has published several papers in peer-reviewed journals.

As usual, there will also be a presentation on the sky at night for the coming month.

NEXT USER GROUP:

Suspended until further notice.

NEXT DENBIES OBSERVING SESSION:

The next sessions, allowing for moon rise & set times and cloud conditions, should be sometime around the new moon which is on 20 November.

The precise date and timings of any session will be advised by email and WhatsApp a few days in advance but should be within the period 17 – 23 November.

AD HOC OBSERVING AT WARREN FARM:

These will be at short notice when the weather is favourable, and may replace, or be additional to, sessions at Denbies. Please watch our WhatsApp feed for alerts