JANUS

THE NEWSLETTER OF EWELL ASTRONOMICAL SOCIETY

November 2025

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Important Reminder:

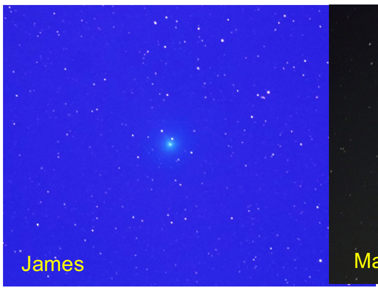
To allow sufficient time to compile Janus and place it on the EAS Website by the 1st of the month any submissions for publication are required at least 3 days before the end of the month. Any items received after this date will be held over until the following month.

Editorial

Welcome to the November edition of Janus. This month's lecture, to be given on Friday 14 November by Dr Eugene Vasiliev from University of Surrey, is entitled "The Evolution of the Milky Way". It will be followed by the customary presentation on the sky at night for the coming month. The lecture will be the last for 2025 as the December meeting will be our AGM. The usual AGM business will be followed by a quiz; there will also be a raffle, and refreshments will be provided, so make a note in your diary to attend.

Saturday 25 October saw the eagerly awaited inauguration of the Society's Solar System Walk in Nonsuch Park. As reported elsewhere, the weather was kind to us, and the event was attended by the mayors of Epsom & Ewell and Sutton, our president, Professor Andrew Coates, committee members and a number of other Society members and their friends.

The other focus of interest during October was the hunt for Comets Lemmon and Swan. Several members attempted to observe them, with varying degrees of success, particularly in the case of the fainter, more elusive, Swan. I've included a couple of the best images of (a very bright) Lemmon, and one of (fuzzy, dim) Swan here.



There were many others too numerous to include!

There is a third comet in our skies -31/ATLAS, an interstellar object – first spotted in July, but currently too close to the Sun to be observed.

John

In this edition:

skyUpdate
What's up this month?

The Solar System November

MERCURY: begins the month emerging into the evening sky as it approaches greatest elongation E. It will be difficult to observe as it will reach its highest point in the sky during daytime and be on the horizon at dusk. Visibility continues to be poor or non-existent and, by the end of the month, emerging into the morning sky as it approaches greatest elongation W, it remains difficult to observe, reaching its highest point in the sky during daytime and being no higher than 7° above the horizon at dawn.

VENUS: will soon pass behind the Sun, and begins the month visible in the dawn sky, rising at 05:14 – 1 hour and 37 minutes before the Sun. Reaching an altitude of 10° above the SE horizon, it will fade from view as dawn breaks at around 06:29. By the end of the month, it is not observable, reaching its highest point in the sky during daytime and being only 3° above the horizon at dawn.

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: is currently emerging from behind the Sun. It begins the month visible in the morning sky, becoming accessible around 22:06, when it reaches an altitude of 7° above the NE horizon. It will then reach its highest point in the sky at 05:03, 59° above the S horizon, before being lost to dawn twilight around 06:29, 55° above the SW horizon. By the end of the month, visible in the morning sky, it becomes accessible around 20:10, when it reaches an altitude of 7° above the NE horizon. Reaching its highest point in the sky at 03:08, 60° above the S horizon, it will be lost to dawn twilight around 07:15, 33° above the W horizon.

SATURN: is currently an early evening object, and begins the month visible in the evening sky, becoming accessible around 17:18, 16° above the SE horizon, as dusk fades to darkness. Reaching its highest point in the sky at 21:02, 34° above the S horizon, it will continue to be observable until around 01:26, when it sinks below 11° above the W horizon. By the end of the month, now receding into evening twilight, it is visible in the evening sky, from around 16:46, 26° above the SE horizon, as dusk fades to darkness. It will then reach its highest point in the sky at 19:05, 34° above the S horizon, and will continue to be observable until around 23:27, when it sinks below 11° above the SW horizon.

URANUS: begins the month approaching opposition and is visible as a morning object, becoming accessible around 19:47, when it reaches an altitude of 21° above the E horizon. Reaching its highest point in the sky at 01:09, 58° above the S horizon, it will be lost to dawn twilight around 05:30, 30° above the W horizon. By the end of the month, now past opposition, it will become accessible at around 17:45, when it rises to an altitude of 21° above the E horizon. It will then reach its highest point in the sky at 23:06, 58° above the S horizon, and will become inaccessible at around 04:27 when it sinks below 21° above the W horizon.

NEPTUNE: is currently an early evening object, and begins the month accessible from around 17:54, 22° above the SE horizon, as dusk fades to darkness. Reaching its highest point in the sky at 21:15, 37° above the S horizon, it will continue to be observable until around 00:38, when it sinks below 21° above the SW horizon. By the end of the month, now receding into evening twilight, it becomes 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 19:19, 37° above the S horizon, and will continue to be observable until around 22:41, when it sinks below 21° above the SW horizon.

Notable Events:

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

November

2	Mercury at highest altitude in evening sky Close approach of the Moon and Saturn Conjunction of the Moon and Saturn
3	The Moon at aphelion
4	Mercury at dichotomy
5	Full Moon The Moon at perigee
6	Close approach of the Moon and M45
8	Lunar occultation of Beta Tauri
10	Close approach of the Moon and Jupiter Conjunction of the Moon and Jupiter
11	Jupiter enters retrograde motion Asteroid 471 Papagena at opposition
12	Moon at Last Quarter Northern Taurid meteor shower 2025 Conjunction of Mercury and Mars
13	Lunar occultation of Regulus
17	Leonid meteor shower 2025 The Pleiades cluster is well placed
20	The Moon at apogee New Moon Mercury at inferior solar conjunction
21	Uranus at opposition Conjunction of the Moon and Mars α-Monocerotid meteor shower 2025
22	The Moon at perihelion Comet 210P/Christensen passes perihelion
23	Mercury at perihelion
24	Lunar occultation of Sigma Sagittarii
27	The Hyades cluster is well placed
28	Saturn ends retrograde motion Moon at First Quarter November Orionid meteor shower 2025
29	Close approach of the Moon and Saturn Conjunction of the Moon and Saturn
30	Mars at apogee

December

2	Pheonicid meteor shower 2025
3	The Moon at aphelion
4	Close approach of the Moon and M45 Mercury at dichotomy Mercury at highest altitude in morning sky The Moon at perigee Full Moon
5	Lunar occultation of Beta Tauri
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
19	December Leonis Minorid meteor shower 2025
20	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

Collected Observations (and thoughts) – Gary Walker

Latest Observations – Posted 1 October

In the early hours of 1 October, at around 1.30am, I saw a bright meteor, or rather a Fireball, fly across the sky from West to East. It was orange in colour and appeared as the usual teardrop shape. Its path was to the South of Taurus, and probably across Cetus.

Over the last few nights, the Moon has, again, been very low down in the South.

Saturn – Posted 2 October

The Rings of Saturn are becoming even MORE edge on and, in November, will be tilted by only 0.4 degrees. This will be the nearest to edge-on that we will see in this present apparition as, of course, we missed the actual edge-on period last March, because Saturn was behind the Sun – and hence, unobservable!

The Sky at Night magazine said that the rings will disappear in smaller telescopes, but will be visible in larger scopes. So, I will be observing it to try and follow the Rings!

At the beginning of October, they appeared like 2 very thin, "bars", or "handles" extending from either side of Saturn's disk!

Saturn is easy to find with the naked eye, as it is now well up in the evening sky, quite bright, and with no confusingly bright stars anywhere near it!

This Month's Lecture – Posted 11 October

Yesterday, Peter Bull gave a magnificent lecture on Cosmology entitled, "A Window through the Universe ". This touched on a range of topics ranging from matter and atoms, through the lives and deaths of stars, down to Black Holes!

He issued a handout of a chart, summarising his talk, beforehand. It was then, that I realised that he had given us a similar talk before, on 11 February 2022, (i.e. about three and a half years ago)!

Unusually, he must be the only speaker not using computers and PowerPoint technology, instead he just used two whiteboards, with flip pages, which he wrote on with a special pen!

That could actually be useful as, at least, there was no irritating technology to break down, as happens sometimes in our talks! For once, there was no computer that wouldn't "talk" to some other piece of technology!

He spoke very well and clearly, although some of it, perhaps, went over some people's heads!

The idea of what happened before the Big Bang is absolutely mind boggling, and you cannot imagine it just appearing out of nothing.

When Peter was discussing how the Universe came about, and that it may have originated from previous Universes before the Big Bang, I keep wondering when did the cycle start! And, WHAT started the first Universe in this cycle?! And, what happened, BEFORE that?

Without being religious, the start of the Universe is somewhat similar to the beginning of Genesis, in the Bible - especially as it says about it being a dark void, and then God says "Let there be Light, and there was Light"! This sounds as if it was describing the Big Bang!

First Anticyclonic Gloom of this Autumn/Winter – Posted 17 October

Undeniably, the weather since 13 October has been pretty appalling for all Astronomy, with the first Anticyclonic Gloom of this Autumn and Winter! These anticyclones are common, especially around November and December.

Ironically, they form in High Pressure areas but, unlike in Summer, when they result in clear weather, in the Autumn and Winter, it just means that the sky infills with cloud cover. This results in a stubborn overcast sky for days on end, as it has been over the past 5 days!

The only good thing about it, is that the weather has been benign, with dead calm conditions, and fairly warm.

Even Solar Observations have been impossible; technically, the Sun HAS been visible on several days, but only in "flashes", so impossible to observe!

The whole of the UK has been covered by this stratocumulus overcast, except for occasional breaks in Scotland, Weymouth and, yesterday, as close as Hampshire.

A Tale (Tail) of Two Comets – Posted 21 October

As stated in my previous post, since 13 October, we have had a long and terrible period of overcast skies - first an anticyclone, and then, "unsettled weather" with EVEN MORE clouds!

I was thinking that I would miss the entire period of Comet Lemmon's visibility in our sky. Today, however, the sky cleared enough to see and actually observe the Sun. That said, in the early to mid-evening, the weather was still messing about, with some clear breaks, and then clouding back over again.

However, finally, about 8pm, the sky cleared, and I was able to observe Comet C/2025 A6 Lemmon for the first time although, by this time it was fairly low in the West.

Observing it through my 8"SCT, it appeared similar to other moderately bright comets, with a tiny central disk (the "False Nucleus"), surrounded by a fuzzy halo. I could also see the tail, particularly when I moved the scope slightly, as this is a good trick to enhance the visibility of faint objects. The tail was at least half a degree in length, as it filled the width of my 62X eyepiece field of view.

I could also see it quite easily using my 11 X 80 binoculars, appearing as a small fuzzy patch, and the tail was also visible.

I then went on to try for Comet Swan in the Southwest sky, but I couldn't see this in my scope, or not definitely, although I might have seen a very diffuse patch where it should have been! Thus, this comet had to be very diffuse, and faint, even though it was only a magnitude or so, fainter than Comet Lemmon.

To top it off, I saw a procession of bright satellites rising up from the West, which faded into the Earth's shadow before they reached the zenith. No doubt, more of Elon Musk's SpaceX launches! These satellites were very bright, and yellow in colour, rather than blue.

According to the Night Sky website, Comet Lemmon is now at magnitude 4.2, whilst Comet C/2025 (SWAN), is at magnitude 5.7. The tail of Comet Lemmon was listed by this website as being 2 degrees in length (you will recall that I saw it at about half a degree in length).

Incidentally, it reached Perigee this night, at 56 million miles from the Earth!

Comet Lemmon marks the 48th comet that I have seen.

The Space Weather News site is full of beautiful images of this comet, but there are hardly any of Comet Swan. Where Comet Swan is shown, it is obviously much more diffuse and, thus, dimmer than Comet Lemmon!

Some media sites have been saying about "Two Green Comets" being visible, but the colour, as usual, is sadly not visible, visually, through telescopes, but only on images. This is because, unlike the human eye that has difficulty seeing colour in dimmer objects, cameras will create images over time, making the comet appear brighter and, so it will show colours in blue or green!

Most in the Society will remember Halley's Comet, which first became visible, 40 years ago, in November 1985. At this time, in October 1985, there were loads of guidebooks on how to observe it - of course, I bought as many as I could!

Comets Lemmon and Swan – Posted 24 October

Last night, the sky cleared far too late to see Comet Lemmon, as it only cleared about Midnight! There was only a narrow window of observation, between about 7pm, and 10pm, as the comet was setting earlier and earlier each evening, meaning the time to see the comet before it sank into the Southern Hemisphere, would not be long.

As usual, despite an unusually clear and sunny day, showers were threatened to roll in, this evening. Indeed, just as it was getting dark, a mass of cloud, rolled in. I was thinking that that would be typical of the weather but, fortunately, and to my surprise, it passed over, and the sky was clear enough to observe Comet Lemmon!

It appeared the same as the other night, but in my 11 X 80 binoculars, it appeared really good, with a fuzzy ball, and a distinct tail, maybe extending upwards, for about a degree.

Then I tried again for Comet Swan. This time, I found it. It appeared as a large, fuzzy ball, but quite faint and diffuse. The Coma of this comet was larger than that of Comet Lemmon.

That makes the 49th comet that I have seen – that said, the weather has certainly been a real pain, lately, for any observations!

The Official opening of the Solar System Walk in Nonsuch Park – Posted 25 October

This morning, I attended the official opening of the Solar System Walk at Nonsuch Park. We met just outside Nonsuch Mansion, where two stalls were set up with free astronomy magazines and refreshments. There were at least 14 members from the Society, probably somewhat more than that, in reality!

Our Patron, Ian Morrison was present, and he gave a talk before the official opening, as well as Anita King.

The Mayor officially opened the Walk, by taking a sheet off the first plaque of the Walk, outside Nonsuch Mansion.

Then, members of the Society and others, including the Mayor, started on the Walk, going from the Sun, as far as Jupiter. The Sun, with Mercury, Venus, Earth and Mars, were quite close together, but it was noticeable that, from Jupiter, onwards, the posts and information plaques representing each planet rapidly became much further apart! Jupiter was quite a way from Mars, and Saturn was a few hundred yards on from Jupiter! The increasing separation became even more obvious with the outer planets of Uranus, Neptune, and Pluto, which must have each been hundreds of yards apart from each other, or more! This shows the scale of the Solar System, and how the outer planets are far more distant than the innermost planets!

The whole walk is 1.3 km in length. This shrinks the scale of the Solar System down by 4.75 billion times. It was pointed out that, on this scale, Proxima Centauri would be in Central America; I dread to think how far the Andromeda Galaxy of M31 would have been on this scale!

Each Planet, and Celestial Body, including the Sun, and the Asteroid Belt, was marked by an information plaque on a wooden post.

Martin Howe led my walk, as far as Jupiter, whilst Anne Lees led another group. Most of my group gave up after Jupiter, but the rest of us - about 8 people - soldiered on to the bitter end. Anita led the rest of our walk, after Jupiter, up to Pluto. The outermost planets on this Walk, cross the site of Nonsuch Palace!

During the official proceedings, and on the Walk, we were filmed by a woman from

WhisleStop Arts who have been involved in the artwork of this installation. The weather was sunny at first, clouding up later, with a few spots of rain but, overall, we were really lucky with the weather!

Comets Lemmon and Swan – Posted 25 October

I saw both Comet Lemmon and Comet Swan again this evening. Comet Lemmon, was still bright in binoculars, with a tail extending about 2.5 degrees in length. In my telescope, a small central disk (the "False Nucleus"), was surrounded by a fuzzy halo (the Coma). It is called the "False Nucleus", as it appears at the centre of the Coma. In reality the real Nucleus is far too small to be seen, as it is only a few miles in size and, in any case, it is hidden by the Coma surrounding it!

When a Comet is this bright, (or even brighter!), the best overall views are often seen in binoculars, as you can fit the whole tail in. In telescopes, only the Coma, and a bit of the tail will fit in even a low power field of view!

Once again, Comet Swan, appeared entirely different, appearing as a large, diffuse, and consequently faint, fuzzy ball of light! It is therefore not surprising that the amateur astronomy websites are mostly concentrating on Comet Lemmon, rather than Comet Swan!

Official Launch of the Nonsuch Park Solar System Walk - Martin Howe

Thank you to all those people who turned out on Saturday 25 October for the official launch of our solar system walk. The launch was well attended by maybe 50 or so people, including our patron (Professor Andrew Coates), councillor Steven McCormick, and the mayors of Sutton and Epsom & Ewell.

We set up a stall, to give away old copies of astronomy magazines, fridge magnets membership forms, and the flyer that Steve put together. Suzanne procured some planet-themed helium filled balloons, which were then given away after the launch to children and adults – all of them were given away except for Venus which came loose and made a bid for freedom! The mayor of Sutton was also keen to have one, so walked off with the Earth. I did ask if it was for her son, but she said no, it was for herself!

The formal proceedings commenced with Anita thanking me for my efforts in managing the delivery of the walk, with a small (unexpected!) gift of a crystal ball etched with a solar system. Very apt, and it now sits on my desk in front of me as I write this – so thank you!

I then gave a brief overview of the inspiration for the walk and the many thanks owed to the whole team of people who contributed to the project. For the record I would like to repeat it here:

Initiation

- Nonsuch park Joint Management Committee, for their permission (and enthusiasm) for the walk in the park
- Councillor Steven McCormick for sponsoring the walk with a community grant from Surrey County Council

Design

- Whistlestop Arts, who did a fantastic job with the artwork for the walk and the graphics for the webpages
- The EAS working group, consisting of Peter, Suzanne, Shirish and Srikala

Installation

- Sam Whitehead from Epsom & Ewell council, who provided support in so many ways, including printing leaflets and arranging refreshments on the day
- Jon and the Nonsuch Voles for advice and also providing tools and labour to put the posts in the ground and attach the signs
- Dennis King (Anita's husband) for drilling the holes for the posts, saving dozens of hours of hard work
- The EAS volunteers who helped put the posts in and attach the signs, including Anita, Casper, Suzanne, John P, Steve and Ron.

Following my long list of thanks, our patron, Professor Andrew Coates spoke about his role at MSSL in the exploration of the solar system, including missions to Venus, Mars, Saturn and also the Giotto mission to Halley's Comet in 1986. I remember watching the TV coverage of Giotto in a room at university, commentated by Patrick Moore if I recall correctly. Professor Coates is also currently leading the team at MSSL who are building the PanCam camera for ESA's Rosalind Franklin Mars rover.

Councillor McCormick then spoke a few words before handing over to the mayors of Sutton and Epsom & Ewell to also say a few words before officially unveiling the large sign at the start of the walk. Peter and Anita then led guided walks along the trail – Peter, with the mayors and Professor Coates, as far Jupiter, whereas Anita went all the way to the universe beyond the Kuiper Belt!

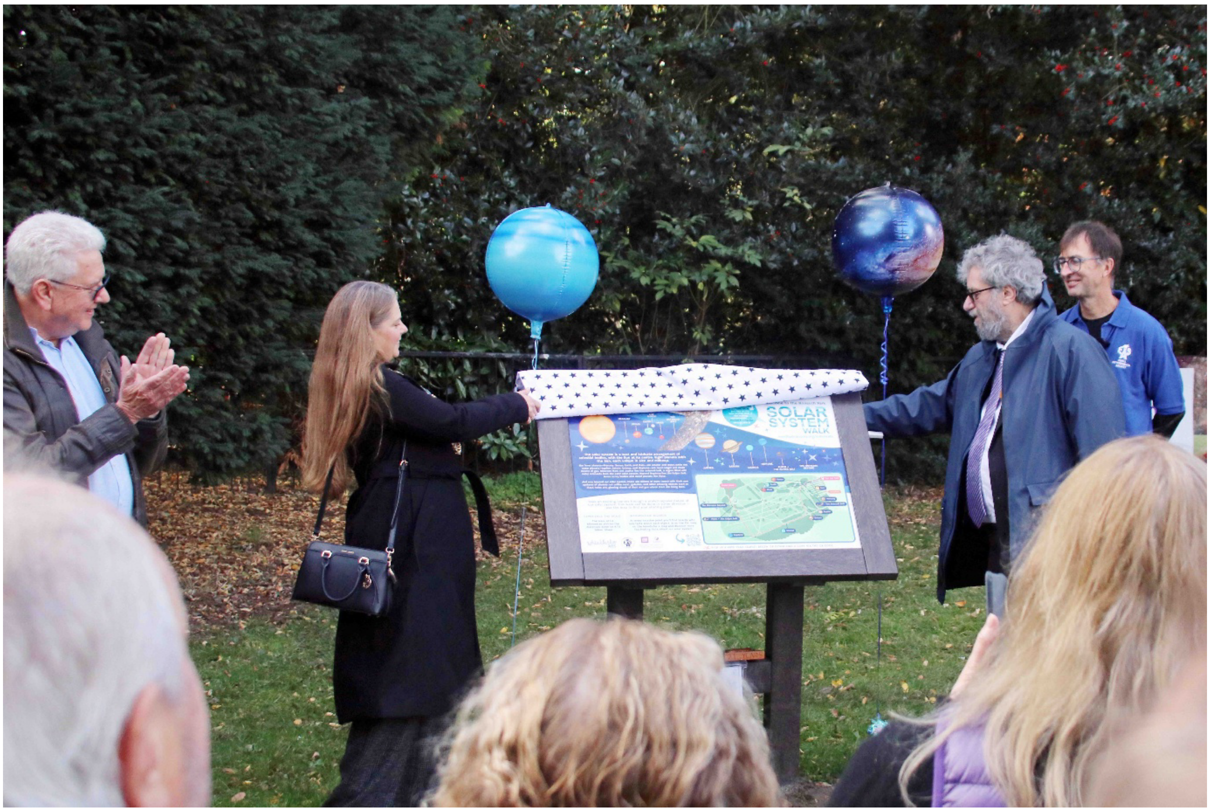
Fortunately, the weather stayed dry, but started to rain as I was driving home, so we were very lucky.

There are still a few final tasks to be done – some post publicity with local papers (so keep your eyes open – I hope we get a mention); some publicity with local schools; and also Shirish is working on generating some audio transcripts of information about the planets for the visually impaired. I encourage you to look at the website, and if you see something that you think looks odd, or have some suggestions for further enhancements or features, then please do let me know.

Having just (all but) completed this project we now roll directly onto the next one – the Maurice Gavin Observatory. It is worth noting that Councillor McCormick was very inspired by our efforts such that he wants to see what he can do to try and support the completion of the observatory (and also wants to talk to me for advice about telescopes!).

Below is a photo of the mayors unveiling the sign at the start of the walk. A larger collection of photos can be viewed here: *https://photos.app.goo.gl/r2a8CcmhMMG3WWiT7*

Editor's Note: There were many other photos on the WhatsApp group, far too numerous to include. Apologies to those whose photos I haven't used.



An Extraordinary Feat: Pat Hart's Solar System Crochet – Casper Dyne

Introduction

I wanted to share the remarkable story of Pat Hart, an 80-year-old lady who is both deaf and blind, and her incredible achievement in creating a large, round crochet blanket which depicts the solar system.

About Pat Hart

Pat Hart has been deaf from birth, but then lost her sight in her 50's. Despite these significant challenges, she undertook the ambitious project of crocheting a blanket of the solar system. What makes this accomplishment even more extraordinary is that she completed the entire project without any lighting, relying solely on her sense of touch and memory. It took her approximately eight months to finish this intricate piece.

Inspiration Behind the Project

Pat's passion for astronomy was shared with her late husband during their earlier years. When I began assisting her in her flat, she learned of my own interest in astronomy with Ewell Astronomical Society. This sparked memories of her past enthusiasm for the subject, inspiring her to choose the solar system as the theme for her blanket.

Craftsmanship and Support

Throughout the process, I witnessed Pat's meticulous skills, as well as the vital support provided by my wife, Katie, Liz and outreach worker, Vic who helped guide her in placing the planets, selecting appropriate colours, and accurately representing the asteroids and stars. The attention to detail and precision in her work left me utterly speechless.

Conclusion

It is truly astonishing that Pat was able to pinpoint the locations of the planets and choose their colours so accurately, all without the aid of sight or light. This achievement is a testament to her talent, determination, and enduring love for astronomy. What an outstanding accomplishment!

Hey baby, you're a star - John Pillar

The Pelican Nebula is a beautiful nebula of gas and dust in the constellation of Cygnus, near the wonderful bright star, Deneb (Figure). Also known as IC5070, the nebula is visible as a fuzzy light from a dark site using binoculars – some say the best way to view the Pelican Nebula and its neighbour, the North America nebula, is indeed through binoculars because they cover such a large area of the sky.

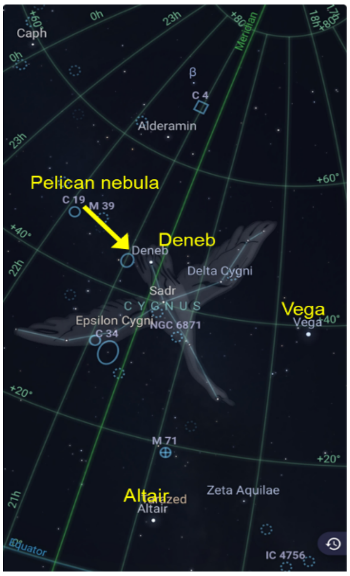


Figure 1: Location of the Pelican Nebula, in Cygnus, with the 3 key stars of the Summer Triangle, Deneb, Vega and Altair also marked

Two clear nights gave me the chance to capture the image shown in Figure from my backyard in Dorking, showing vast clouds of gas and dark lanes of dust, illuminated by young, energetic stars. The stars in this region emit such strong ultraviolet energy that the local gas clouds are ionised – electrons on hydrogen and oxygen atoms are raised to high energy levels and when they decay back to their base energy level, they release photons at particular, characteristic wavelengths. The red shades in Figure are from Hii emission, and the blueish shades are from Oiii emission.

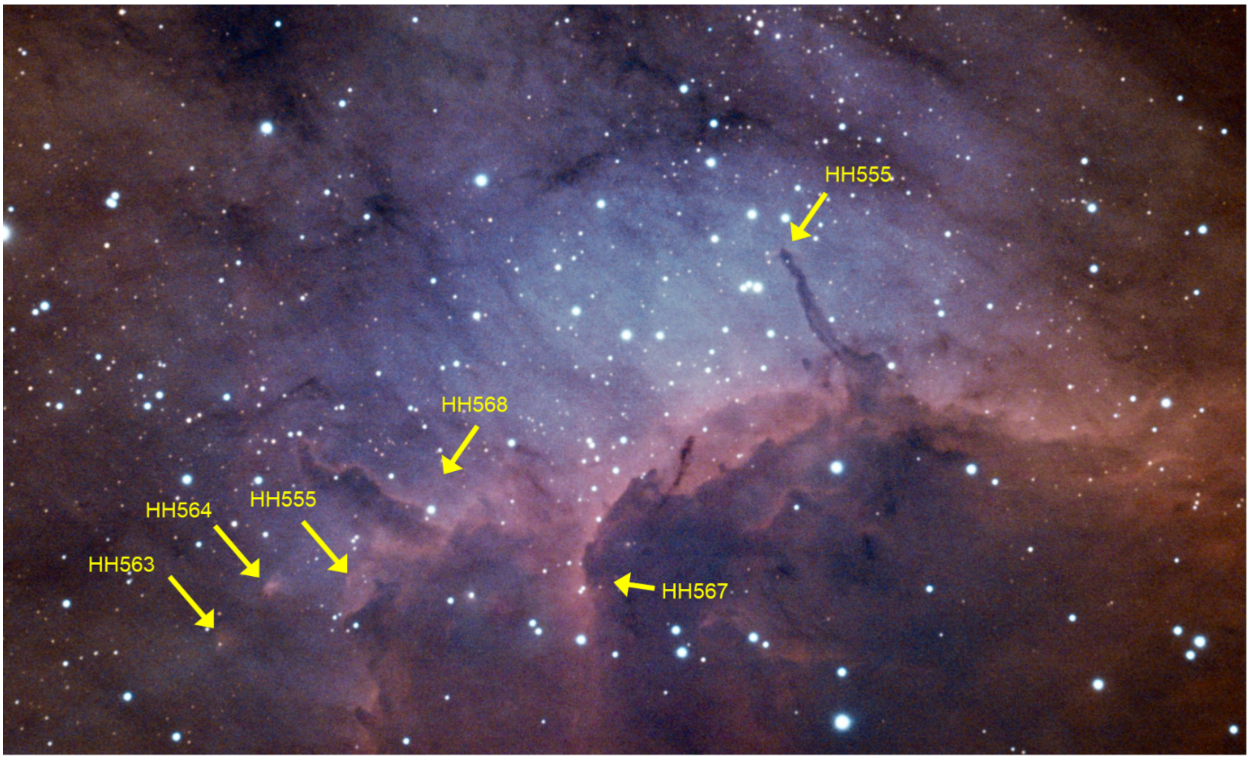


Figure 2: The Pelican Nebula (IC5070) captured from my Dorking backyard using a Celestron 9.25 SCT. About 10 hours of 3-minute frames with a dual narrowband Ha and Oiii filter, and then an extra 3 hours just with Oiii. Processed in Siril and Gimp

Hii refers to a region of singly ionised hydrogen gas, and Ha is one of the characteristic wavelengths of light (656.3 nano-metres) emitted by Hii gas.

The gas clouds and dust of this nebula are the ingredients for new stars – and there are many nascent stars in this region, nucleating in swirling proto-planetary disks of gas, ice, and dust until they burst into life and shine for many millions of years. Some of the known areas of active star formation are labelled in Figure – they are recognised as Herbig-Haro objects, HH for short. Herbig and Haro were two astronomers working independently in the 1940's, studying young stars in regions of active formation in the Orion nebula. They met by chance at a conference in Tucson and in due course realised the true significance of the objects that hitherto they'd not paid a lot of attention too. The term Herbig-Haro object was coined by a Russian astronomer, Victor Ambartsumian, who suggested that they might represent the early stage of formation of T-Tauri stars.

T-Tauri stars are pre-main sequence stars that have coalesced from dust and gas and begun to shine in visible wavelengths. They are characterised by having lithium in their spectra – this is an indicator of a young star because it disappears as the star becomes mature. The Pleaides cluster contains several T-Tauri stars.

Of the several HH objects visible in Figure perhaps the most interesting is HH555, shown in close-up in **Error! Reference source not found.**. I've included an image from the Liverpool Telescope to highlight two jets – filaments of Ha and S emission observed to the north and south (left and right in the image). Spectra of these filaments indicate that they are impacting into the surrounding molecular cloud at a velocity of between 30 and 80km/s. These jets are being ejected by a proto-star hidden in the tip of the dark dust-lane. Interestingly the two jets are deformed (they are bent) toward the west indicating that there

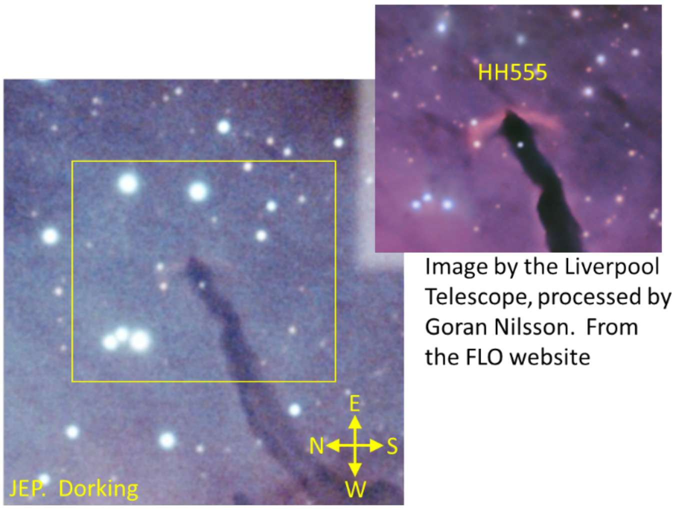


Image by the Liverpool Telescope, processed by Goran Nilsson. From the FLO website

Figure 1. HH555 - at the tip of the dense filament of cold gas and dust, two jets can be seen, emitted by a spinning newborn star

is a strong 'side wind' of material blowing from the east, which is where the main stars that are ionising the Pelican Nebula are located.

Jets such as these observed at HH555 are critical to the successful formation of a new star – they act like pressure safety-valves.

Gas clouds from which stars are formed carry significant angular momentum. As the cloud collapses under gravity to form a proto-stellar disk it spins faster and faster - like water from a bath spinning as it goes down the plughole. Some of the gas that falls toward the rotating disk is ejected along the axis of rotation as high velocity jets… these jets carry away excess angular momentum which would otherwise cause the star to rotate too rapidly and disintegrate.

The impact of the jets with the interstellar medium causes the emission of light, the Herbig-Haro object. The jets may vary in intensity, and knots and clumps within them may appear or disappear over a timescale of a few years as the proto-star evolves toward main-sequence maturity. HH objects consist mostly of hydrogen, but also contain minor amounts of heavier elements such as oxygen, sulphur, nitrogen, calcium, iron and magnesium, plus water, CO_2 and complex organic compounds – the building blocks of rocky planets such as Mercury, Venus, Earth and Mars.

Around 4.6 billion years ago two energetic jets of gas, like those observed at HH555, probably heralded the formation of our sun, planetary disk and solar system.

Our quest to find a truly Earth-like planet in deep space

Acknowledgement: This article was written by Christopher Watson, Professor, Astrophysics Research Centre, School of Mathematics and Physics, Queen's University Belfast and Annelies Mortier, Associate Professor in Astronomy, School of Physics and Astronomy, University of Birmingham and was first published in THE CONVERSATION on 3 October 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/our-quest-to-find-a-truly-earth-like-planet-in-deep-space-266550*

On 6 October 1995, at a scientific meeting in Florence, Italy, two Swiss astronomers made an announcement that would transform our understanding of the universe beyond our solar system. Michel Mayor and his PhD student Didier Queloz, working at the University of Geneva, announced they had detected a planet orbiting a star other than the Sun.

The star in question, 51 Pegasi, lies about 50 light years away in the constellation Pegasus. Its companion – christened 51 Pegasi b – was unlike anything written in textbooks about how we thought planets might look. This was a gas giant with a mass of at least half that of Jupiter, circling its star in just over four days. It was so close to the star (1/20th of Earth's distance from the Sun, well inside Mercury's orbit) that the planet's atmosphere would be like a furnace, with temperatures topping 1,000°C.

The instrument behind the discovery was Elodie, a spectrograph that had been installed two years earlier at the Haute-Provence observatory in southern France. Designed by a Franco-Swiss team, Elodie split starlight into a spectrum of different colours, revealing a rainbow etched with fine dark lines. These lines can be thought of as a "stellar barcode", providing details on the chemistry of other stars.

What Mayor and Queloz spotted was 51 Pegasi's barcode sliding rhythmically back-and-forth in this spectrum every 4.23 days – a telltale signal that the star was being wobbled back and forth by the gravitational tug of an otherwise unseen companion amid the glare of the star.

After painstakingly ruling out other explanations, the astronomers finally decided that the variations were due to a gas giant in a close-in orbit around this Sun-like star. The front page of the Nature journal in which their paper was published carried the headline: "A planet in Pegasus?"

The discovery baffled scientists, and the question-mark on Nature's front cover reflected initial scepticism. Here was a purported giant planet next to its star, with no known mechanism for forming a world like this in such a fiery environment.

While the signal was confirmed by other teams within weeks, reservations about the cause of the signal remained for almost three years before being finally ruled out. Not only did 51 Pegasi b become the first planet discovered orbiting a Sun-like star outside our Solar System, but it also represented an entirely new type of planet. The term "hot Jupiter" was later coined to describe such planets.

This discovery opened the floodgates. In the 30 years since, more than 6,000 exoplanets (the term for planets outside our Solar System) and exoplanet candidates have been catalogued.

Their variety is staggering. Not only hot but ultra-hot Jupiters with a dayside temperature exceeding 2,000 °C and orbits of less than a day. Worlds that orbit not one but two stars, like Tatooine from Star Wars. Strange "super-puff" gas giants larger than Jupiter but with a fraction of the mass. Chains of small rocky planets all piled up in tight orbits.

The discovery of 51 Pegasi b triggered a revolution and, in 2019, landed Mayor and Queloz a Nobel prize. We can now infer that most stars have planetary systems. And yet, of the thousands of exoplanets found, we have yet to find a planetary system that resembles our own.

The quest to find an Earth twin – a planet that truly resembles Earth in size, mass and temperature – continues to drive modern-day explorers like us to search for more undiscovered exoplanets. Our expeditions may not take us on death-defying voyages and treks like the past legendary explorers of Earth, but we do get to visit beautiful, mountain-top observatories often located in remote areas around the world.

We are members of an international consortium of planet hunters that built, operate and maintain the Harps-N spectrograph, mounted on the Telescopio Nazionale de Galileo on the beautiful Canary island of La Palma. This sophisticated instrument allows us to rudely interrupt the journey of starlight which may have been travelling unimpeded at speeds of 670 million miles per hour for decades or even millennia.

Each new signal has the potential to bring us closer to understanding how common planetary systems like our own may (or may not) be. In the background lies the possibility that one day, we may finally detect another planet like Earth.

The origins of exoplanet study

Up until the mid-1990s, our Solar System was the only set of planets humanity ever knew. Every theory about how planets formed and evolved stemmed from these nine, incredibly closely spaced data-points (which went down to eight when Pluto was demoted in 2006, after the International Astronomical Union agreed a new definition of a planet).

All of these planets revolve around just one star out of the estimated 10^{11} (roughly 100 billion) in our galaxy, the Milky Way – which is in turn one of some 10^{11} galaxies throughout the universe. So, trying to draw conclusions from the planets in our Solar System alone was a bit like aliens trying to understand human nature by studying students living together in one house. But that didn't stop some of the greatest minds in history speculating on what lay beyond.

The ancient Greek philosopher Epicurus (341-270BC) wrote: "There is an infinite number of worlds – some like this world, others unlike it." This view was not based on astronomical observation but his atomist theory of philosophy. If the universe was made up of an infinite number of atoms then, he concluded, it was impossible not to have other planets.

Epicurus clearly understood what this meant in terms of the potential for life developing elsewhere:

We must not suppose that the worlds have necessarily one and the same shape. Nobody can prove that in one sort of world there might not be contained – whereas in another sort of world there could not possibly be – the seeds out of which animals and plants arise and all the rest of the things we see.

In contrast, at roughly the same time, fellow Greek philosopher Aristotle (384-322 BC) was proposing his geocentric model of the universe, which had the Earth immobile at its centre with the Moon, Sun and known planets orbiting around us. In essence, the Solar System as Aristotle conceived it was the entire universe. In On the Heavens (350BC), he argued: "It follows that there cannot be more worlds than one."
Such thinking that planets were rare in the universe persisted for 2,000 years. Sir James Jeans, one of the world's top mathematicians and an influential physicist and astronomer at the time, advanced his tidal hypothesis of planet formation in 1916. According to this theory, planets were formed when two stars pass so closely that the encounter pulls streams of gas

off the stars into space, which later condense into planets. The rareness of such close cosmic encounters in the vast emptiness of space led Jeans to believe that planets must be rare, or – as was reported in his obituary – “that the solar system might even be unique in the universe”.

But by then, understanding of the scale of the universe was slowly changing. In the “Great Debate” of 1920, held at the Smithsonian Museum of Natural History in Washington DC, American astronomers Harlow Shapley and Heber Curtis clashed over whether the Milky Way was the entire universe, or just one of many galaxies. The evidence began to point to the latter, as Curtis had argued for. This realisation – that the universe contained not just billions of stars, but billions of galaxies each containing billions of stars – began to affect even the most pessimistic predictors of planetary prevalence.

In the 1940s, two things caused the scientific consensus to pivot dramatically. First, Jeans’ tidal hypothesis did not stand up to scientific scrutiny. The leading theories now had planet formation as a natural byproduct of star formation itself, opening up the potential for all stars to host planets.

Then in 1943, claims emerged of planets orbiting the stars 70 Ophiuchus and 61 Cygni c – two relatively nearby star systems visible to the naked eye. Both were later shown to be false positives, most likely due to uncertainties in the telescopic observations that were possible at the time – but nonetheless, it greatly influenced planetary thinking. Suddenly, billions of planets in the Milky Way was considered a genuine scientific possibility.

For us, nothing highlights this change in mindset more than an article written for the Scientific American in July 1943 by the influential American astronomer Henry Norris Russell. Whereas two decades earlier, Russell had predicted that planets “should be infrequent among the stars”, now the title of his article was: “Anthropocentrism’s Demise. New Discoveries Lead to the Probability that There Are Thousands of Inhabited Planets in our Galaxy”.

Strikingly, Russell was not merely making a prediction about any old planets, but inhabited ones. The burning question was: where were they? It would take another half-century to begin finding out.

How to detect an exoplanet

When we observe myriad stars through La Palma’s Italian-built Galileo telescope using our Harps-N spectrograph, it is amazing to consider how far we have come since Mayor and Queloz announced their discovery of 51 Pegasi b in 1995. These days, we can effectively measure the masses of not just Jupiter-like planets, but even small planets thousands of light years away. As part of the Harps-N collaboration, we have had a front-row seat since 2012 in the science of small exoplanets.

Another milestone in this story came four years after the 51 Pegasi b discovery, when a Canadian PhD student at Harvard University, David Charbonneau, detected the transit of a known exoplanet. This was another hot Jupiter, known as HD209458b, also located in the Pegasus constellation, about 150 light years from Earth.

Transit refers to a planet passing in front of its star, from the perspective of the observer, momentarily making the star appear dimmer. As well as detecting exoplanets, the transit technique enables us to measure the radius of the planet by taking many brightness measurements of a star, then waiting for it to dim due to the passing planet. The extent of blocked starlight depends on the radius of the planet. For example, Jupiter would make the Sun 1% dimmer to alien observers, while for Earth, the effect would be a hundred times weaker.

In all, four times more exoplanets have now been discovered using this transit technique compared with the “barcode” technique, known as radial velocity, that the Swiss astronomers used to spot the first exoplanet 30 years ago. It is a technique that is still widely used today, including by us, as it can not only find a planet but also measure its mass.

A planet orbiting a star exerts a gravitational pull which causes that star to wobble back and forth – meaning it will periodically change its velocity with respect to observers on Earth. With the radial velocity technique, we take repeated measurements of the velocity of a star, looking to find a stable periodic wobble that indicates the presence of a planet.

These velocity changes are, however, extremely small. To put it in perspective, the Earth makes the Sun change its velocity by a mere 9cm per second – slower than a tortoise. In order to find planets with the radial velocity technique, we thus need to measure these small velocity changes for stars that are many many trillions of miles away from us.

The state-of-the-art instruments we use are truly an engineering feat. The latest spectrographs, such as Harps-N and also Espresso, can accurately measure velocity shifts of the order of tenths of centimetres per second – although still not sensitive enough to detect a true Earth twin.

But whereas this radial velocity technique is, for now, limited to ground-based observatories and can only observe one star at the time, the transit technique can be employed in space telescopes such as the French Corot (2006-14) and Nasa’s Kepler (2009-18) and Tess (2018-) missions. Between them, space telescopes have detected thousands of exoplanets in all their diversity, taking advantage of the fact we can measure stellar brightness more easily from space, and for many stars at the same time.

Despite the differences in detection success rate, both techniques continue to be developed. Applying both can give the radius and mass of a planet, opening up many more avenues for studying its composition.

To estimate possible compositions of our discovered exoplanets, we start by making the simplified assumption that small planets are, like Earth, made up of a heavy iron-rich core, a lighter rocky mantle, some surface water and a small atmosphere. Using our measurements of mass and radius, we can now model the different possible compositional layers and their respective thickness.

This is still very much a work in progress, but the universe is spoiling us with a wide variety of different planets. We’ve seen evidence of rocky worlds being torn apart and strange planetary arrangements that hint at past collisions. Planets have been found across our galaxy, from Sweeps-11b in its central regions (at nearly 28,000 light years away, one of the most distant ever discovered) to those orbiting our nearest stellar neighbour, Proxima Centauri, which is “only” 4.2 light years away.

Searching for ‘another Earth’

In early July 2013, one of us (Christopher) was flying out to La Palma for my first “go” with the recently commissioned Harps-N spectrograph. Keen not to mess up, my laptop was awash with spreadsheets, charts, manuals, slides and other notes. Also included was a three-page document I had just been sent, entitled: Special Instructions for ToO (Target of Opportunity).

The first paragraph stated: “The Executive Board has decided that we should give highest priority to this object.” The object in question was a planetary candidate thought to be orbiting Kepler-78, a star a little cooler and smaller than our Sun, located about 125 light years away in the direction of the constellation Cygnus.

A few lines further down read: “July 4-8 run … Chris Watson” with a list of ten times to observe Kepler-78 – twice per night, each separated by a very specific four hours and 15 minutes. The name above mine was Didier Queloz’s (he hadn’t been awarded his Nobel prize yet, though).

This planetary candidate had been identified by the Kepler space telescope, which was tasked with searching a portion of the Milky Way to look for exoplanets as small as the Earth. In this case, it had identified a transiting planet candidate with an estimated radius of 1.16 (± 0.19) Earth radii – an exoplanet not that much larger than Earth had potentially been spotted.

I was in La Palma to attempt to measure its mass which, combined with the radius from Kepler, would allow the density and possible composition to be constrained. I wrote at the time: “Want 10% error on mass, to get a good enough bulk density to distinguish between Earth-like, iron-concentrated (Mercury), or water.”

In all, I took ten out of our team’s total of 81 exposures of Kepler-78 in an observing campaign lasting 97 days. During that time, we became aware of a US-led team who were also looking for this potential planet. In true scientific spirit, we agreed to submit our independent findings at the same time. On the specified date. Like a prisoner swap, the two teams exchanged results – which agreed. We had, within the uncertainties of our data, reached the same conclusion about the planet’s mass.

Its most likely mass came out as 1.86 Earth masses. At the time, this made Kepler-78b the smallest extrasolar planet with an accurately measured mass. The density was almost identical to that of Earth’s.

But that is where the similarities to our planet ended. Kepler-78b has a “year” that lasts only 8.5 hours, which is why I had been instructed to observe it every 4hr 15min – when the planet was at opposite sides of its orbit, and the induced “wobble” of the star would be at its greatest. We measured the star wobbling back and forth at about two metres per second – no more than a slow jog.

Kepler-78b's short orbit meant its extreme temperature would cause all rock on the planet to melt. It may have been the most Earth-like planet found at the time in terms of its size and density, but otherwise, this hellish lava world was at the very extremes of our known planetary population.

In 2016, the Kepler space telescope made another landmark discovery: a system with at least five transiting planets around a Sun-like star, HIP 41378, in the Cancer constellation. What made it particularly exciting was the location of these planets. Where most transiting planets we have spotted are closer to their star than Mercury is to the Sun (due to our detection capabilities), this system has at least three planets beyond the orbital radius of Venus.

Having decided to use our Harps-N spectrograph to measure the masses of all five transiting planets, it became clear after more than a year of observing that one instrument would not be enough to analyse this challenging mix of signals. Other international teams came to the same conclusion and, rather than compete, we decided to come together in a global collaboration that holds strong to this day, with hundreds of radial velocities gathered over many years.

We now have firm masses and radii for most of the planets in the system. But studying them is a game of patience. With planets much further away from their host star, it takes much longer before there is a new transit event or the periodic wobble can be fully observed. We thus need to wait multiple years and gather lots of data to gain insight in this system.

The rewards are obvious, though. This is the first system that starts resembling our Solar System. While the planets are a bit larger and more massive than our rocky planets, their distances are very similar – helping us to understand how planetary systems form in the universe.

The holy grail for exoplanet explorers

After three decades of observing, a wealth of different planets have emerged. We started with the hot Jupiters, large gas giants close to their star that are among the easiest planets to find due to both deeper transits and larger radial velocity signals. But while the first tens of discovered exoplanets were all hot Jupiters, we now know these planets are actually very rare.

With instrumentation getting better and observations piling up, we have since found a whole new class of planets with sizes and masses between those of Earth and Neptune. But despite our knowledge of thousands of exoplanets, we still have not found systems truly resembling our solar system, nor planets truly resembling Earth.

It is tempting to conclude this means we are a unique planet in a unique system. While this still could be true, it is unlikely. The more reasonable explanation is that, for all our stellar technology, our capabilities of detecting such Earth-like planets are still fairly limited in a universe so mind-bogglingly vast.

The holy grail for many exoplanet explorers, including us, remains to find this true Earth twin – a planet with a similar mass and radius as Earth's, orbiting a star similar to the Sun at a distance similar to how far we are from the Sun.

While the universe is rich in diversity and holds many planets unlike our own, discovering a true Earth twin would be the best place to start looking for life as we know it. Currently, the radial velocity method – as used to find the very first exoplanet – remains by far the best-placed method to find it.

Thirty years on from that Nobel-winning discovery, pioneering planetary explorer Didier Queloz is taking charge of the very first dedicated radial velocity campaign to go in search of an Earth-like planet.

A major international collaboration is building a dedicated instrument, Harps3, to be installed later this year at the Isaac Newton Telescope on La Palma. Given its capabilities, we believe a decade of data should be enough to finally discover our first Earth twin.

Unless we are unique after all.

Up Next:

NEXT MEETING: 8pm Friday 14 November – Nonsuch High School

Dr Eugene Vasiliev from the University of Surrey will talk about the Evolution of the Milky Way.

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

AGM: 8pm Friday 12 December – Nonsuch High School

Usual AGM business with raffle, quiz and refreshments.

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