New Zenith

The Monthly Newsletter of the Vectis Astronomical Society

Vol 29 Issue 8 — September 2021

When Printed, this Newsletter costs VAS at least £1

Society News

Annual General Meeting

Unfortunately we had a very limited attendance to our latest AGM in September. Thankfully, those who did turn up continued to offer their services on the VAS Committee for another year. This means that the structure of VAS remains as it was.

The meeting was quite short but we also discussed a few plans for the future and identified some further maintenance items that will need attention in the next month or two.

Monthly Meetings

The programme of monthly meetings is going well and the calendar is filling up for next year.

Please look at the Meetings Diary on page 2 of this NZ for details of the events planned. Some of these will still be Zoom meetings - they are clearly shown in bold text.

Zoom has become an important tool as it allows us to attract speakers from further afield at minimal cost to the society. We are also looking at methods to "Zoom" every meeting as well as holding each normally but this requires some extra work and won't happen until there is a reliable and cost effective internet connection to the pavilion/ observatory.

Winter is coming!

It's now September and the nights are drawing in. It's time to think about using Thursday evenings a way of restarting your astronomy activities.

Don't forget, the observatory is now open every Thursday from 7.30pm so please make use of it. We have plenty of equipment and quite a lot of expertise to share.

Extra Pages?

As a special treat, there are a few more pages in this month's NZ, I hope you enjoy them.

If you have pictures, equipment reviews or general articles you'd like me to include here, please send them!

Brian Curd

VAS Website: wightastronomy.org

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

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St John's Crescent
Sandown
Isle of Wight
PO36 8EE
Tel: 07594 339950 or email: **editor@wightastronomy.org**

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

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Observatory Diary

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

VAS Website: wightastronomy.org

Contents this Month

2021 Monthly Meetings

Check *http://www.wightastronomy.org/meetings/* for the latest information

Date	Subject	Speaker
26 Mar	Space Traffic Control	Dr Stuart Eves
23 Apr	HOYS	Dirk Froebrich
28 May	Can we live on Mars?	Greg Smye-Rumsby
25 Jun	The Astronomy of Robert Hooke in Context	Paul Bingham
Jul	No Meeting	
27 Aug	**AGM followed by open meeting**	
24 Sep	Two Eyes are Better than One - Binocular Astronomy	Stephen Tonkin
22 Oct	Gravitational Waves	Dr Laura Nuttall
26 Nov	**Martin Lunn John Goodricke and Edward Pigott the 'Fathers of Variable Star Astronomy**	**This will be a Zoom Meeting**

Observatory Visits Booked

No bookings so far

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

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

IMPORTANT

Could all VAS members please ensure they notify the Membership Secretary of any change of address.

To ensure our compliance with GDPR rules, we must maintain accurate membership records.

VAS Contacts 2021

President	Barry Bates president@wightastronomy.org
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NZ Distribution	Graham Osborne distribution@wightastronomy.org
Others	Dudley Johnson

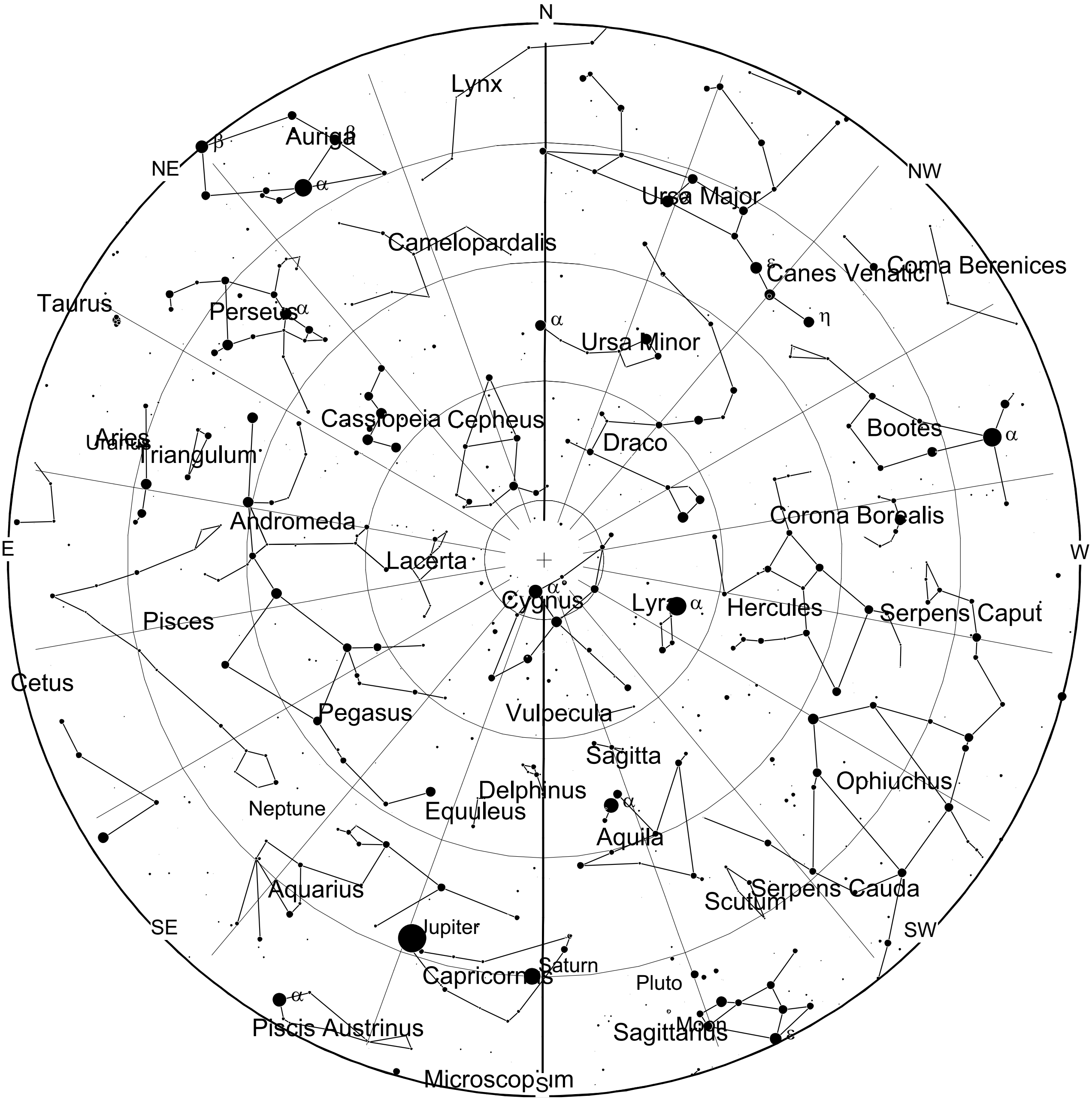
Important

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

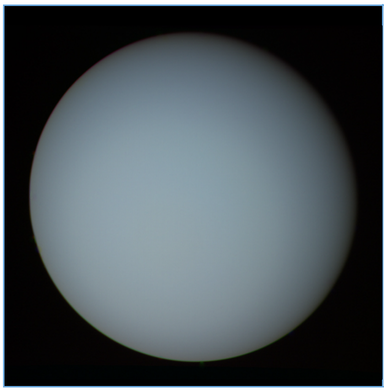
On several occasions, lights, heaters and the Meade LX200 have been left on!

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

September 2021 - Sky Map



View from Newchurch Isle of Wight UK - 2200hrs - 15 September 2021



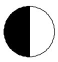
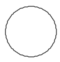
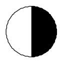
Uranus is the seventh planet from the Sun. Its name is a reference to the Greek god of the sky, Uranus, who, according to Greek mythology, was the great-grandfather of Ares (Mars), grandfather of Zeus (Jupiter) and father of Cronus (Saturn). It has the third-largest planetary radius and fourth-largest planetary mass in the Solar System. Uranus is similar in composition to Neptune, and both have bulk chemical compositions which differ from that of the larger gas giants Jupiter and Saturn. For this reason, scientists often classify Uranus and Neptune as "ice giants" to distinguish them from the other giant planets. Uranus's atmosphere is similar to Jupiter's and Saturn's in its primary composition of hydrogen and helium, but it contains more "ices" such as water, ammonia, and methane, along with traces of other hydrocarbons.

September 2021- Night Sky

Autumnal Equinox

The autumnal equinox, the time at which Sun crosses the equator on its way south, and day and night are of equal length occurs this year on September 22 at 20:21. From this time on the nights in the northern hemisphere are longer than the days.

Moon Phases

New	First Qtr	Full	Last Qtr
7th	13th	20th	29th
			

Planets

Mercury

Mercury is to the east of the Sun this month but is a difficult object to observe without a telescope. It sets very shortly after the Sun when the sky is still too bright to see the planet with the naked eye. It is best observed during the day using a telescope. To do this, make sure that the telescope is in the shade so that there is no chance of accidentally pointing it directly at the Sun. The best time is from midday onward when the planet is at its highest in the sky. To find it use a planetarium program to get the altitude and azimuth for the day and time of the observation.

Venus

Like Mercury, Venus is not particularly well placed for observation. Although it is well spaced away from the Sun it is quite low on the horizon at sunset setting only an hour after the Sun. It is bright enough to be easily visible in the still bright twilight sky. It can also be observed during the day using either binoculars or a telescope, or if the sky is very clear the naked eye during the afternoon when it is at its highest above the horizon. Again take care to make observations from in the shade so that there is no chance of accidentally looking directly at the Sun.

Mars

Mars is on the far side of the Sun approaching conjunction next early next month, and is not visible again until the end of the year.

Jupiter

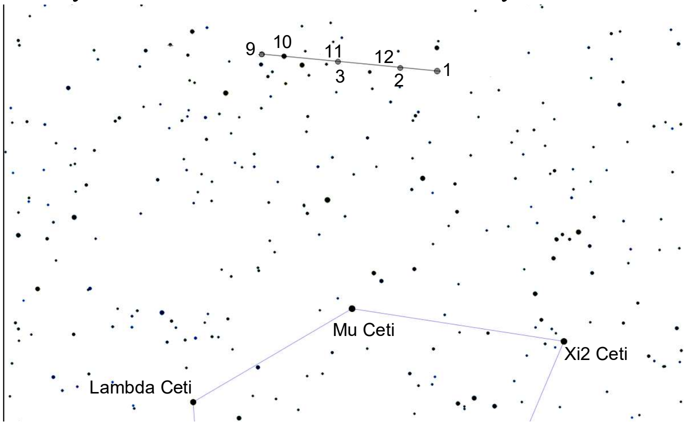
The brightest star like object to be found in the southern sky after dark is Jupiter. A pair of binoculars will show the 4 Galilean moons and a small telescope will show the cloud belts and if it is on side facing us, the great red spot. The spot is not bright red so may be difficult to see appearing only as a darker bulge in the cloud band.

Saturn

To the right Jupiter by about two hand widths is Saturn. It is much fainter than Jupiter, but is still brighter than any nearby star. While Jupiter looks a bright white in colour Saturn has a much more subdued yellow hue.

Uranus

Uranus is in the constellation of Aries, a part of the sky where there a very few bright guide stars the nearest being the fourth magnitude star Mu Ceti about 5 degrees to the south. The finder chart shows the path of Uranus at the first of very month from now until March next year.



Finder Chart For Uranus
From September 1 2021 to March 1 2022

Neptune

Neptune is about 4 degrees east of the fourth magnitude star Phi Aquarii. Unfortunately there are no nearby bright guide stars to assist in its location. At magnitude 8 it can be seen through a pair of binoculars or small telescope. Use the finder chart in August New Zenith of a planetarium program to assist in its location.

Deep Sky

Collinder 399 The Coat Hanger Cluster RA19h 26m Dec 20°12' mag 3.6

The universe really does have a sense of humour; this is a coat hanger, floating above the starry background out there in the Milky Way. It can be seen with the naked eye as a brighter knot in the Milky Way just on the Vulpecula side of the border with Sagitta. Any optical aid shows the coat hanger with it’s rather over sized hook. A telescope may be too much for this cluster unless the magnification can be kept very low. If a telescope is available try to spot NGC6802, this rather small magnitude 8.8 cluster would make the seventh and most eastward star in the bar of the hanger.

M72 Globular Cluster RA 20h 54m Dec -12° 31' mag 10.0

Visually a rather small globular but it can be forgiven its apparent size when you consider that it is on the other side of the galaxy from us. It can be just seen in binoculars and a small to medium sized telescope with some magnification is needed to resolve any of the stars. It is not as tightly packed in the core as many globulars.

M73 Star Cluster
RA 20h 59m Dec -12° 36' mag 9.0

This is a grouping of just four stars that form a Y pattern or perhaps a lambda depending on which way up it appears. The stars can be resolved in the smallest of telescopes used today and shows no sign of nebulosity. This is perhaps another pointer to the quality of some optical instruments being used in Messier's time that he mistook this object for something that looked like a comet. It is not known if this is just a chance alignment of stars or whether they form a true cluster.

Peter Burgess

Measuring a Black Hole's Mass isn't Easy

An actively feeding black hole surrounds itself with a disk of hot gas and dust that flickers like a campfire. Astronomers have now found that monitoring changes in those flickers can reveal something that is notoriously hard to measure: the behemoth's heft.

"It's a new way to weigh black holes," says astronomer Colin Burke of the University of Illinois at Urbana-Champaign. What's more, the method could be used on any astrophysical object with an accretion disk, and may even help find elusive midsize black holes, researchers report in the Aug. 13 Science.

It's not easy to measure a black hole's mass. For one thing, the dark behemoths are notoriously difficult to see. But sometimes black holes reveal themselves when they eat. As gas and dust falls into a black hole, the material organizes into a disk that is heated to white-hot temperatures and can, in some cases, outshine all the stars in the galaxy combined.

Measuring the black hole's diameter can reveal its mass using Einstein's general theory of relativity. But only the globe-spanning Event Horizon Telescope has made this sort of measurement, and for only one black hole so far (SN: 4/22/19). Other black holes have been weighed via observations of their influence on the material around them, but that takes a lot of data and doesn't work for every supermassive black hole.

So, looking for another way, Burke and colleagues turned to accretion disks. Astronomers aren't sure how black holes' disks flicker, but it seems like small changes in light combine to brighten or dim the entire disk over a given span of time. Previous research had hinted that the time it takes a disk to fade, brighten and fade again is related to the mass of its central black hole. But those claims were controversial, and didn't cover the full range of black hole masses, Burke says.

So he and colleagues assembled observations of 67 actively feeding black holes with known masses. The behemoths spanned sizes from 10,000 to 10 billion solar masses. For the smallest of these black holes, the flickers changed on timescales of hours to weeks. Supermassive black holes with masses between 100 million and 10 billion solar masses flickered more slowly, every few hundred days.

"That gives us a hint that, okay, if this relation holds for small supermassive black holes and big ones, maybe it's sort of a universal feature," Burke says.

Out of curiosity, the team also looked at white dwarfs, the compact corpses of stars like the sun, which are some of the smallest objects to sport consistent accretion disks. Those white dwarfs followed the same relationship between flicker speed and mass.

The analyzed black holes didn't cover the entire possible range of masses. Known black holes that are from about 100 to 100,000 times the mass of the sun are rare. There are several potential candidates, but only one has been confirmed (SN: 9/2/20). In the future, the relationship between disk flickers and black hole mass could tell astronomers exactly what kind of disk flickers to look for to help bring these midsize beasts out of hiding, if they're there to be found, Burke says.

Astrophysicist Vivienne Baldassare of Washington State University in Pullman studies black holes in dwarf galaxies, which may preserve some of the properties of ancient black holes that formed in the early universe. One of the biggest challenges in her work is measuring black hole masses. The study's "super exciting results … will have a large impact for my research, and I expect many others as well," she says.

The method offers a simpler way to weigh black holes than any previous technique, Burke says — but not necessarily a faster one. More massive black holes, for example, would need hundreds of days, or possibly years, of observations to reveal their masses.

More at: https://www.sciencenews.org/

Home Observatory Dome Automation

Introduction

Discovering the inconvenience of setting up a mount, telescope and computer in the open led to the construction of an observatory during 2012. The observatory houses the mount and telescope under a Pulsar dome separate to the area housing the computers and operator. A dome might look the part and provide some shelter from the wind but using manual rotation is inconvenient. Alternatively implementing automated rotation presents a significant challenge.

Mechanical Configuration

A satisfactory mechanical arrangement to rotate the dome would be required, irrespective of the means to control the motion. Instead of relying upon a friction drive as a means of transmission, susceptible to slippage, a gear type arrangement would provide a solution ensuring zero slippage. Cycle chain or toothed aluminium strip mounted on the inside of the dome, were just two candidate solutions however searching the Internet revealed an open ended toothed belt and a drive sprocket could be obtained for the task. Directly gluing the belt to the skirt was not an option because the dome, assembled as four quadrants, did not provide a smooth surface at the joints.

Mounting the Toothed Belt

Four pieces of 5mm thick aluminium strip, a few mm wider than the toothed belt, were bent to the same radius as the dome skirt with the intention of forming a hoop around the dome skirt on which the belt could be glued. Strips were temporarily held in position with tape around the skirt so each strip straddled a discontinuity and the lengths determined ready for cutting. An iterative process was devised to reduce the diameter of the hoop until the join of the two belt ends appeared continuous. This process used filler interposed between the aluminium strips backed with paper and the skirt. The aluminium strips were subsequently screwed into position with M5 countersunk screws and then the belt glued to the aluminium. Contact adhesive was considered satisfactory because the forces imposed would be shear.

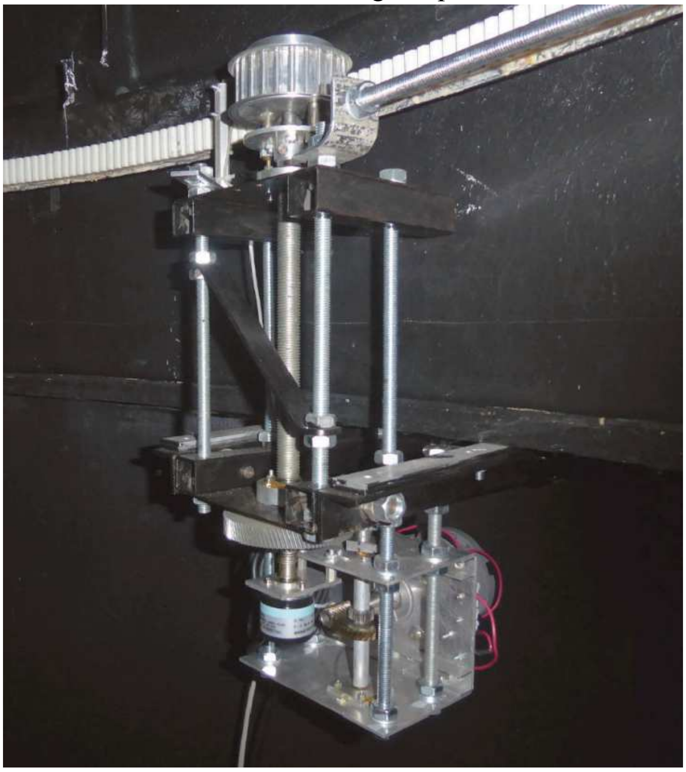
Sensing the Dome Position

Steering the dome shutter to accurately align with the telescope site line was deemed the prime requirement. Several ideas were explored to define the dome angular position, one of these included painting white vertical stripes around the rim of the dome to form, in conjunction with an optical sensor, a simple on off binary encoder. It was dismissed as being too involved to implement. Dirt, chipped paint and knocking the detectors would contribute to unreliable operation. Providing absolute positional data was considered even more onerous.

A simple quadrature shaft encoder linked to the toothed gear driving the dome was finally chosen as being viable. A reed relay mounted on the turning mechanism in conjunction with a magnet mounted on the dome rim was chosen as a means of signalling a reference position, such as when the shutter is facing north.

Turning Mechanism

Design of the turning mechanism was straightforward based on a high torque, low voltage electric motor and gear train mounted in a rigid open frame. A gear ratio was chosen to rotate the dome at 3 revolutions per minute, faster than that achieved by the mount. Bracing members were included in the frame design to prevent distortion.



An image of the mechanical assembly is shown above. Note: the drive sprocket is mounted on two pins so it can slide up and down to facilitate tracking the vertical movement caused by the variations in height of the toothed belt. The shaft encoder is visible below the large gear wheel. Slippage is avoided by ensuring the sprocket is forced against the belt by a spring acting on the pivoted frame.

An additional brace linked to the observatory housing reduces the lateral movement of the assembly. The dome is heavy, rides on hard rubber wheels and requires a considerable force to initiate turning.

Relays control the motor rotation because they are cheap and present a very low loss. Current requirements for the motor are about 7A peak.

Tracking the Telescope Movement

Various ideas for tracking the actual telescope movement were explored. An optical technique with light sources mounted on the telescope and/or mount was investigated but found to be too complicated as it involved multiple sensors and light sources, hardly compatible with sensitive cameras. It would have meant supplying power to the dome or mounting a battery on the dome. Another technique considered was based on electromagnetic radiation at audio frequencies. This involved constructing very low frequency ferrite rod resonators with detectors and placing them around the dome in strategic positions to act as receivers. Experiments showed searching for the nulls in the coupling were successful but required several resonators operating at various frequencies. As in the case of the optical candidate solution supplying power to the dome would have been required. All the ideas for physically tracking the telescope position were abandoned in favour of using the data that controls the mount.

Processing

During the early phase of development it was decided to split the processing into two parts: a hard wired logic processor and a programmable computer. Before any work commenced on the processing a requirement list was generated.

Requirements

1. Dome shall track the telescope sight-line to achieve optimum field of view through the shutter. Design aim ± 1°

2. Dome shall be capable of fast slew in response to a fast slew by the telescope but without the need to track. Upon completion of the fast slew the dome shall assume the requirement in (1).

3. Update frequency shall be minimal consistent with achieving requirement (1).

4. Dome reference shall align to the Celestial North Pole.

5. Control of the dome position shall be stable without oscillation.

6. Operation shall be initiated after application of power without operator intervention.

7. Dome control system shall be compatible with both the mount hand controller data and the PC ASCOM control data.

8. Data controlling the mount, timing and voltages shall not be modified by implementation of the dome controller.

9. Dome controller shall be compatible with all data sets controlling the range of Skywatcher equatorial mounts

Hardwired Logic Processor

The hardwired processor performs the task of relaying the instructions from the mount data stream to the computer. It also manages the translation of voltages between the various subsystems and provides a means of counting the pulses from the shaft encoder.

Based on the gear ratio the shaft encoder rotates 25⅔ turns to rotate the dome one single rotation. The shaft encoder generates 600 pulses per revolution hence 600x25⅔ = 15,400 pulses generated per dome revolution. Digital counters are configured to count these pulses so the quadrature output from the shaft encoder enables the counters to count up when the dome rotates in one direction and count down when the dome rotates in the opposite direction.

The counters are reset to zero when the Celestial North Pole is registered. Output from the counters representing the dome shutter angle in the form of a parallel binary code is available for further processing by the computer.

Data representing the dome position are retained all the time power is supplied to the counters.

Algorithm Development

Before attempting any programming some algorithms were developed in Mathcad, a mathematical computer program in which equations can be built and, in this particular case, linked graphically to assist with the thinking in 3 dimensions. Once the algorithms had been developed they were implemented in the computer program.

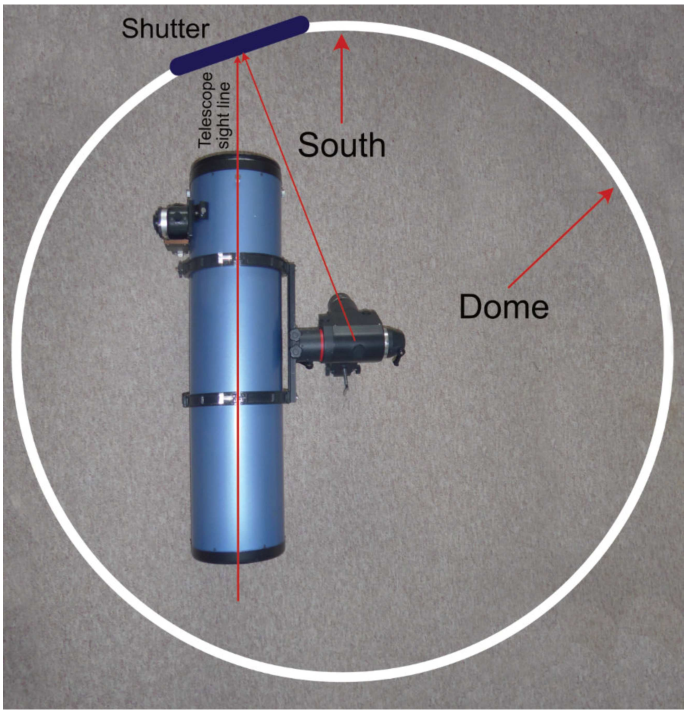
Diagram 1 (page 9), considered essential for developing the algorithm, represents the mount structure viewed in three planes as a series of lines, each line joined to the next at an angle. P1, P2, P3, P4 identifies the joints. Some angles are constant right angles, depending upon the viewing plane, whereas two other angles Θ and ϕ relate to the movement of the mount.

Ψ represents the latitude angle. L1, L2, L3 and L4 are constants representing the dimensions of the mount structure. These dimensions depend upon the various versions of Skywatcher mounts. It should be noted that the diagram represents the mount set to a latitude of 90°, that is, the telescope sight line points to the zenith. After initial calculations the latitude is set to the required angle.

A crucial part of the algorithm is to generate the position of the telescope in relation to the dome centre so the dome rotation angle can be calculated.

An equatorial mount does not pivot about a central point thus the telescope sightline angle does not relate to the angle of the dome shutter, hence the need to calculate the telescope coordinates relative to the dome.

This is illustrated in the image below where the mount centre is coincident with the centre of the circle representing the dome and the telescope site-line is pointing south. A different dome angle is required to facilitate viewing through the shutter. Note: the telescope sight line is not normal to the shutter thus effectively reducing the available field of view.



Programming

A Raspberry Pi was selected to perform the major processing tasks because of easy access to a large number of General Purpose In Out (GPIO) ports. Python, being the recommended language for the Pi, was chosen to provide all the necessary functions for programming the computer.

The same variable names assigned in the Mathcad algorithm development are used in the computer program source code however implementation of some math processes in Python are different to those in Mathcad. This does not detract from comparing Python results with Mathcad results for efficacy.

Program routines were written in modular form to ease fault finding, modifications and implementation.

The main modules are:

- capture - reads the mount DEC and RA data to calculate the respective angles. These data from the mount, in the form of an ASCII string, require separation from other data not relating to the task.

- dome angle - calculates the dome angle from various input conditions:
  - RA and DEC angles
  - latitude angle
  - the mount dimensions
  - dome radius

- jump - ascertains the direction of the dome and manages the transition to and from zero degrees of the dome angle, for example 359° to 0° or 0° to 359°

- count - manages the parallel data from the logic counters and converts them to dome angle.

- motor_dir - defines the direction of the dome rotation

- start_motor - starts the dome motor

- stop_motor - stops the dome motor

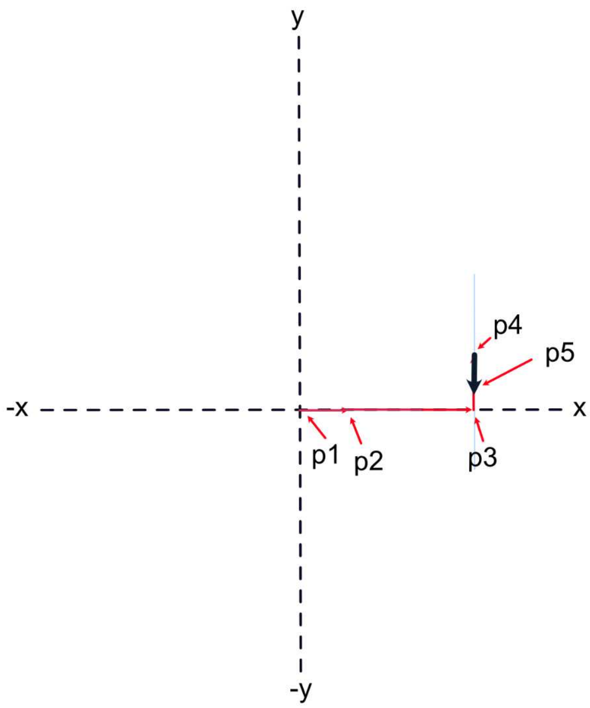
Conclusion

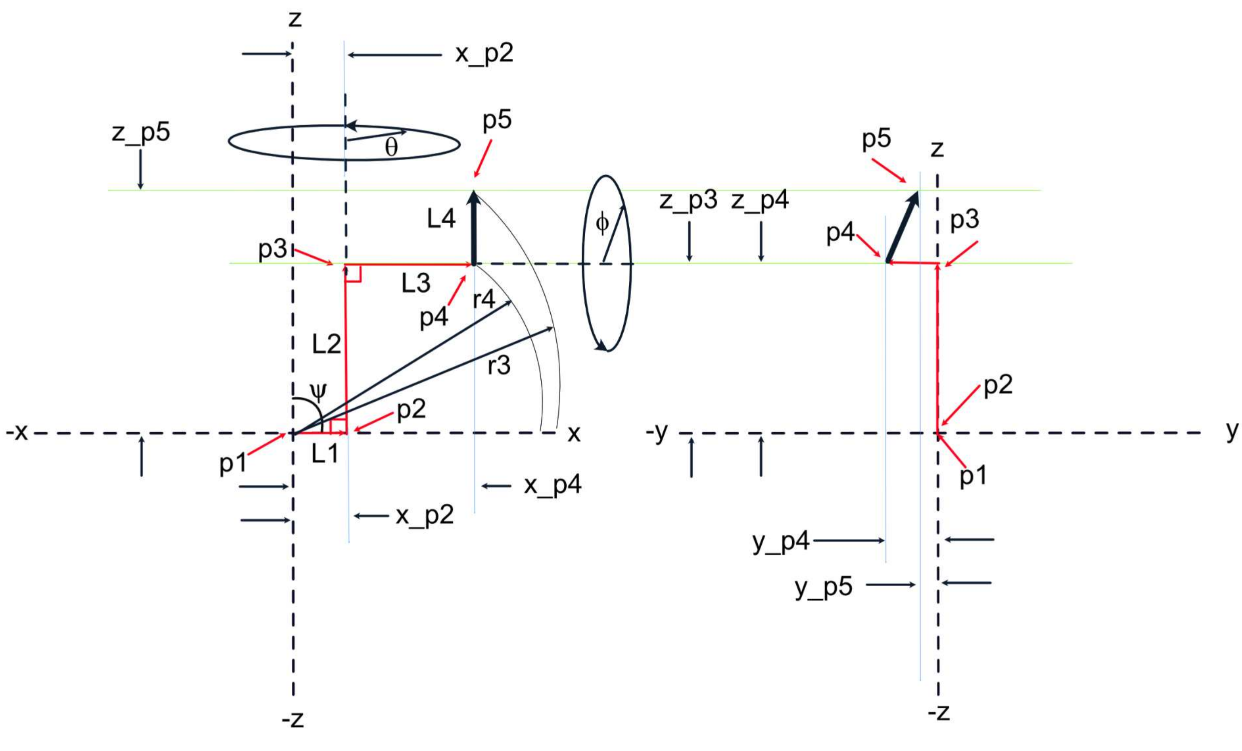
The system has taken several years to develop but now manual rotation of the dome is no longer required. Performance of the system closely matches the requirements. The cost of the system is less than £150 but some components such as the gears and motor were available from the 'junk box'. A lathe and pillar drill were essential for machining.

A couple of minor issues need to be remedied but these can be addressed in the longer term: Faults with data controlling the mount can cause the Raspberry Pi to crash. The dome exhibits some mechanical hysteresis during stop/start rotation.

Dudley Johnson

Diagram 1





Angle Ψ is latitude, angle at p2 and p3 are always 90° when viewed in the plane x, z. Angles θ and ϕ are defined by mount RA and DEC angles. L1 is the actual length between p1 and p2, L2 between p2 and p3, L3 between p3 and p4 and L4 the length from P4 to the front of the telescope

Small Stars Share Similar Dynamics to our Sun, Key to Planet Habitability

Stars scattered throughout the cosmos look different, but they may be more alike than once thought, according to Rice University researchers.

New modelling work by Rice scientists shows that "cool" stars like the sun share the dynamic surface behaviors that influence their energetic and magnetic environments. This stellar magnetic activity is key to whether a given star hosts planets that could support life.

The work by Rice postdoctoral researcher Alison Farrish and astrophysicists David Alexander and Christopher Johns-Krull appears in a published study in The Astrophysical Journal. The research links the rotation of cool stars with the behavior of their surface magnetic flux, which in turn drives the star's coronal X-ray luminosity, in a way that could help predict how magnetic activity affects any exoplanets in their systems.

"All stars spin down over their lifetimes as they shed angular momentum, and they get less active as a result," Farrish said. "We think the sun in the past was more active and that might have affected the early atmospheric chemistry of Earth. So thinking about how the higher energy emissions from stars change over long timescales is pretty important to exoplanet studies."

"More broadly, we're taking models that were developed for the sun and seeing how well they adapt to stars," said Johns-Krull.

The researchers set out to model what far-flung stars are like based on the limited data available. The spin and flux of some stars have been determined, along with their classification -- types F, G, K and M -- which gave information about their sizes and temperatures.

They compared the properties of the sun, a G-type star, through its Rossby number, a measure of stellar activity that combines its speed of rotation with its subsurface fluid flows that influence the distribution of magnetic flux on a star's surface, with what they knew of other cool stars. Their models suggest that each star's "space weather" works in much the same way, influencing conditions on their respective planets.

"The study suggests that stars -- at least cool stars -- are not too dissimilar from each other," Alexander said. "From our perspective, Alison's model can be applied without fear or favor when we look at exoplanets around M or F or K stars, as well, of course, as other G stars.

"It also suggests something much more interesting for established stellar physics, that the process by which a magnetic field is generated may be quite similar in all cool stars. That's a bit of a surprise," he said. This could include stars that, unlike the sun, are convective down to their cores.

"All stars like the sun fuse hydrogen and helium in their cores and that energy is first carried in the radiation of photons toward the surface," Johns-Krull said. "But it hits a zone about 60% to 70% of the way that's just too opaque, so it starts to undergo convection. Hot matter moves from below, the energy radiates away, and the cooler matter falls back down.

"But stars with less than a third of the mass of the sun don't have a radiative zone; they're convective everywhere," he said. "A lot of ideas about how stars generate a magnetic field rely on there being a boundary between the radiative and the convection zones, so you would expect stars that don't have that boundary to behave differently. This paper shows that in many ways, they behave just like the sun, once you adjust for their own peculiarities."

Farrish soon, noted the model applies only to unsaturated stars.

"The most magnetically active stars are the ones we call 'saturated,'" Farrish said. "At a certain point, an increase in magnetic activity stops showing the associated increase in high energy X-ray emission. The reason that dumping more magnetism onto the star's surface doesn't give you more emission is still a mystery.

"Conversely, the sun is in the unsaturated regime, where we do see a correlation between magnetic activity and energetic emission," she said. "That happens at a more moderate activity level, and those stars are of interest because they might provide more hospitable environments for planets."

"The bottom line is the observations, which span four spectral types including both fully and partially convective stars, can be reasonably well represented by a model generated from the sun," Alexander said. "It also reinforces the idea that even though a star that is 30 times more active than the sun may not be a G-class star, it's still captured by the analysis that Alison has done."

"We do have to be clear that we're not simulating any specific star or system," he said. "We are saying that statistically, the magnetic behavior of a typical M star with a typical Rossby number behaves in a similar fashion to that of the sun which allows us to assess its potential impact on its planets."

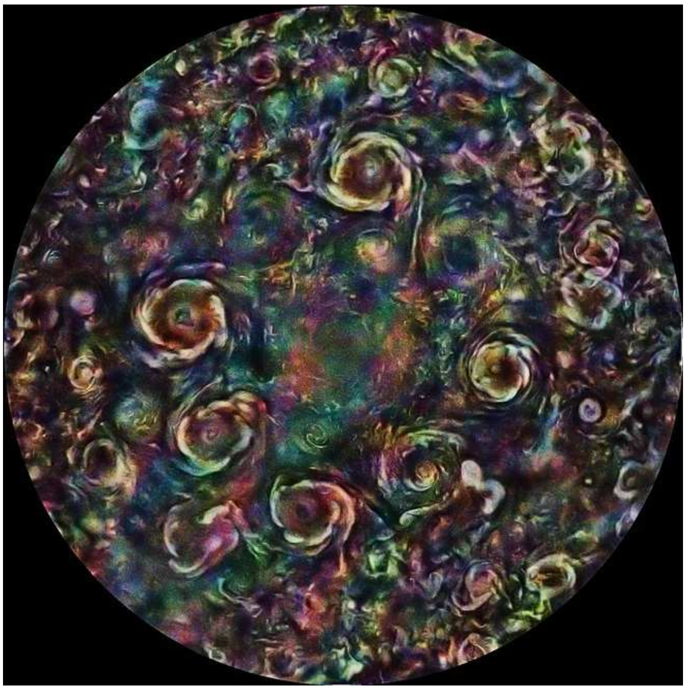
More at: https://www.sciencedaily.com/

Juno Spacecraft Captured some Seriously Impressive Images of Jupiter and its Moons

NASA's Juno spacecraft was designed to help us explore Jupiter and analyse the planet to assess how giant planets like it help with the formation of other planets.

It's thought that by studying Jupiter scientists will be able to better understand how our solar system formed. Juno originally launched back in 2011 and arrived in Jupiter's orbit several years later in the middle of 2016.

Juno has produced some incredible images, here are a few samples:



The link here is well worth a visit. There are more pictures plus full descriptions of each.

Much More at: https://www.pocket-lint.com/

Solved: A 50-year Mystery about Jupiter

- The source of most of Jupiter's heat has baffled scientists for decades.
- A new study suggests that Jovian auroras provide the energy that heats the upper atmosphere.
- The findings confirm a mechanism long suspected but never proven to be at work.

Much like the Earth, Jupiter has had a sort of "energy crisis" for the last few decades relating to global temperatures. Compared to how warm the planet should be given how far it is from the sun, Jupiter has a remarkable amount of heat. The cause of this disconnect has troubled scientists for decades, though several possible ideas for the cause have been proposed.

This month, a solution has finally been found. In a study published in Nature, a team of researchers using data from the Keck II telescope and several satellites has determined that the incredibly powerful Jovian aurora is heating the upper atmosphere to extremely high temperatures.

Some like it hot

According to NASA, we should expect Jupiter's upper atmosphere to be at a temperature of about -73 C° (-100 F°) given how little sunlight it receives. However, observation after observation points to a blazing average temperature closer to 426 C° (800 F°).

Existing heat maps of Jupiter's atmospheric temperature were sparse in detail, necessitating more precise information to solve the puzzle of where the heat was coming from. By combining observational data from the Keck II telescope and information on Jupiter's magnetic field from the Hisaki and Juno satellites, the team was able to observe bursts of energy moving from the polar aurora down toward the equatorial regions of Jupiter on two occasions.

By chance, the nights the instruments observed Jupiter coincided with a considerable solar wind that reached the planet, improving the data. Heat from the electrically charged particles could be tracked with ease as that heat moved outward from the poles in pulses. The data show the heat is widely distributed, centered around the poles, and gradually declining at lower latitudes.

Confirming what was long suspected

The strength of Jupiter's electromagnetic field - 20,000 times stronger than Earth's - has been known for some time. The frequency and intensity of its aurora, some of which is fueled by eruptions from the moon Io, has also been established. However, while this was proposed as a possible mechanism for the observed temperatures, traditional models of gas giants presume that Coriolis forces (the effect caused by planetary rotation that causes weather patterns to veer off rather than move in a straight line) would be able to keep auroral energy confined to the poles.

The study's lead author Dr. James O'Donoghue explained how long this process took:

"We first began trying to create a global heat map of Jupiter's uppermost atmosphere at the University of Leicester. The signal was not bright enough to reveal anything outside of Jupiter's polar regions at the time, but with the lessons learned from that work we managed to secure time on one of the largest, most competitive telescopes on Earth some years later."

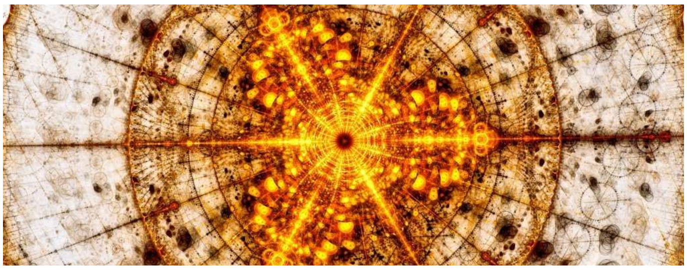
Co-author Dr. Tom Stallard of the School of Physics and Astronomy at the University of Leicester placed the findings in further context:

"This 'energy crisis' has been a long standing issue - do the models fail to properly model how heat flows from the aurora, or is there some other unknown heat source near the equator? This paper describes how we have mapped this region in unprecedented detail and have shown that, at Jupiter, the equatorial heating is directly associated with auroral heating."

Other theories on why the atmosphere is so hot include acoustic waves from the planet's interior or gravity waves providing the needed energy. While this study did not entirely rule these models out, it does suggest that the primary mechanism is the aurora.

More with audio: https://bigthink.com/

Physicists Detect Strongest Evidence Yet of Matter Generated by Collisions of Light



According to theory, if you smash two photons together hard enough, you can generate matter: an electron-positron pair, the conversion of light to mass as per Einstein's theory of special relativity.

It's called the Breit-Wheeler process, first laid out by Gregory Breit and John A. Wheeler in 1934, and we have very good reason to believe it would work. But direct observation of the pure phenomenon involving just two photons has remained elusive, mainly because the photons need to be extremely energetic (i.e. gamma rays) and we don't have the technology yet to build a gamma-ray laser.

Now, physicists at Brookhaven National Laboratory say they've found a way around this stumbling block using the facility's Relativistic Heavy Ion Collider (RHIC) - resulting in a direct observation of the Breit-Wheeler process in action.

"In their paper, Breit and Wheeler already realized this is almost impossible to do," said physicist Zhangbu Xu of Brookhaven Lab.

"Lasers didn't even exist yet! But Breit and Wheeler proposed an alternative: accelerating heavy ions. And their alternative is exactly what we are doing at RHIC." But what do accelerated ions have to do with photon collisions? Well, we can explain.

The process involves, as the collider's name suggests, accelerating ions - atomic nuclei stripped of their electrons. Because electrons have a negative charge and protons (within the nucleus) have a positive one, stripping it leaves the nucleus with a positive charge. The heavier the element, the more protons it has, and the stronger the positive charge of the resulting ion.

The team used gold ions, which contain 79 protons, and a powerful charge. When gold ions are accelerated to very high speeds, they generate a circular magnetic field that can be as powerful as the perpendicular electric field in the collider. Where they intersect, these equal fields can produce electromagnetic particles, or photons. "So, when the ions are moving close to the speed of light, there are a bunch of photons surrounding the gold nucleus, traveling with it like a cloud," Xu explained.

At the RHIC, ions are accelerated to relativistic speeds - those that are a significant percentage of the speed of light. In this experiment, the gold ions were accelerated to 99.995 percent of light speed.

This is where the magic happens: When two ions just miss each other, their two clouds of photons can interact, and collide. The collisions themselves can't be detected, but the electron-positron pairs that result can.

However, it's not enough to just detect an electron-positron pair, either. That's because the photons produced by the electromagnetic interaction are virtual photons, popping briefly in and out of existence, and without the same mass as their 'real' counterparts.

To be a true Breit-Wheeler process, two real photons need to collide - not two virtual photons, nor a virtual and a real photon.

At the ions' relativistic speeds, the virtual particles can behave like real photons. Thankfully, there's a way physicists can tell which electron-positron pairs are generated by the Breit-Wheeler process: the angles between the electron and the positron in the pair generated by the collision.

Each type of collision - virtual-virtual, virtual-real and real-real - can be identified based on the angle between the two particles produced. So the researchers detected and analyzed the angles of over 6,000 electron-positron pairs generated during their experiment.

They found that the angles were consistent with collisions between real photons - the Breit-Wheeler process in action.

"We also measured all the energy, mass distributions, and quantum numbers of the systems. They are consistent with theory calculations for what would happen with real photons," said physicist Daniel Brandenburg of Brookhaven Lab.

"Our results provide clear evidence of direct, one-step creation of matter-antimatter pairs from collisions of light as originally predicted by Breit and Wheeler."

The argument could be very reasonably made that we won't have a direct first detection of the pure, single photon-photon Breit-Wheeler process until we collide photons approaching the energy of gamma rays.

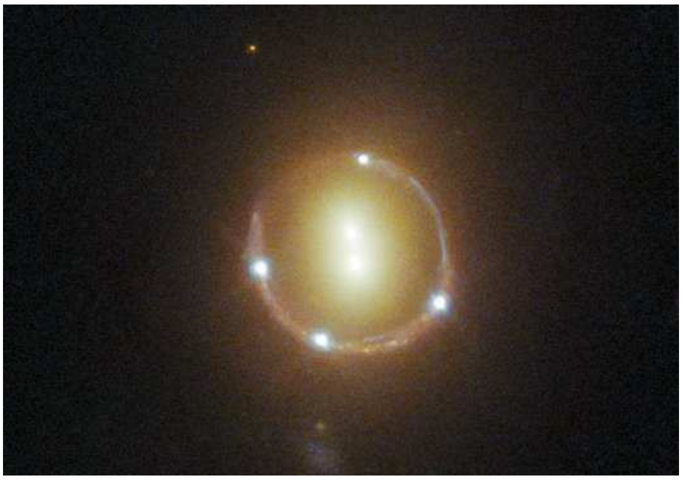
More at: https://www.sciencealert.com/

Hubble Captures a Stunning 'Einstein Ring' Magnifying The Depths of The Universe

Gravity is the weird, mysterious glue that binds the Universe together, but that's not the limit of its charms. We can also leverage the way it warps space-time to see distant objects that would be otherwise much more difficult to make out.

This is called gravitational lensing, an effect predicted by Einstein, and it's beautifully illustrated in a new release from the Hubble Space Telescope.

In the center in the image (below) is a shiny, near-perfect ring with what appear to be four bright spots threaded along it, looping around two more points with a golden glow.



(ESA/Hubble & NASA, T. Treu; Acknowledgment: J. Schmidt)

This is called an Einstein ring, and those bright dots are not six galaxies, but three: the two in the middle of the ring, and one quasar behind it, its light distorted and magnified as it passes through the gravitational field of the two foreground galaxies.

Because the mass of the two foreground galaxies is so high, this causes a gravitational curvature of space-time around the pair. Any light that then travels through this space-time follows this curvature and enters our telescopes smeared and distorted – but also magnified.

This, as it turns out, is a really useful tool for probing both the far and near reaches of the Universe. Anything with enough mass can act as a gravitational lens. That can mean one or two galaxies, as we see here, or even huge galaxy clusters, which produce a wonderful mess of smears of light from the many objects behind them.

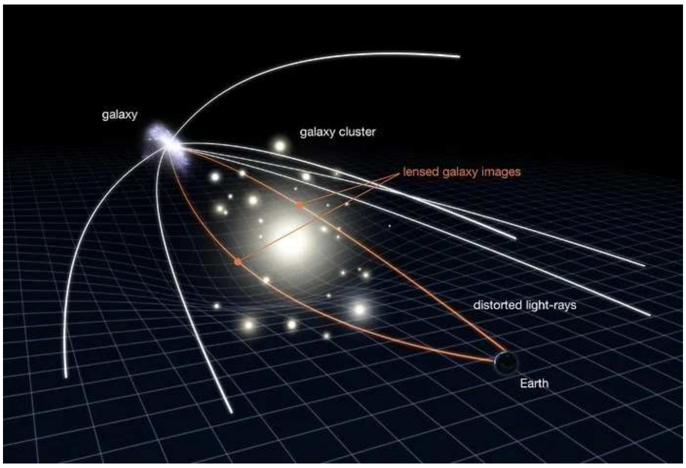


Illustration of gravitational lensing. (NASA, ESA & L. Calçada)

Astronomers peering into deep space can reconstruct these smears and replicated images to see in much finer detail the distant galaxies thus lensed. But that's not all gravitational lensing can do. The strength of a lens depends on the curvature of the gravitational field, which is directly related to the mass it's curving around.

So gravitational lenses can allow us to weigh galaxies and galaxy clusters, which in turn can then help us find and map dark matter – the mysterious, invisible source of mass that generates additional gravity that can't be explained by the stuff in the Universe we can actually detect.

A bit closer to home, gravitational lensing - or microlensing, to be more precise - can help us find objects within the Milky Way that would be too dark for us to see otherwise, such as stellar-mass black holes.

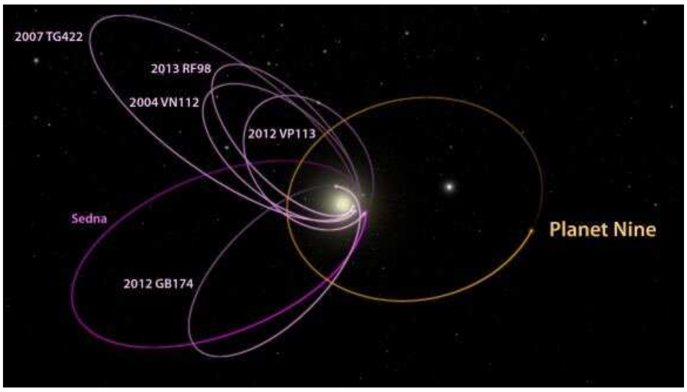
And it gets smaller. Astronomers have managed to detect rogue exoplanets – those unattached from a host star, wandering the galaxy, cold and alone – from the magnification that occurs when such exoplanets pass between us and distant stars. And they've even used gravitational microlensing to detect exoplanets in other galaxies.

It's pretty wild what the Universe has up its gravitational sleeves.

You can download a wallpaper-sized version of the above image on ESA's website.

From: https://www.sciencealert.com/

If Planet 9 is Out There, Here's Where to Look



The possible orbit of Planet Nine.
Credit: CalTech/R. Hurt (IPAC)

There are eight known planets in the solar system (ever since Pluto was booted from the club), but for a while, there has been some evidence that there might be one more. A hypothetical Planet 9 lurking on the outer edge of our solar system. So far, this world has eluded discovery, but a new study has pinned down where it should be.

The evidence for Planet 9 comes from its gravitational pull on other bodies. If the planet exists, its gravity will affect the orbits of other planets. So if something seems to be tugging on a planet, just do a bit of math to find the source. This is how Neptune was discovered, when John Couch Adams and Urbain Le Verrier noticed independently that Uranus seemed to be tugged by an unseen planet.

In the case of Planet 9, we don't have any gravitational effect on a planet. What we do see is an odd clustering of small icy bodies in the outer solar system known as Kuiper belt objects (KBOs). If there were no planet beyond the Kuiper belt, you would expect the orbits of KBOs to be randomly oriented within the orbital plane of the solar system. But instead, we see lots of KBO orbits are clustered in the same orientation. It's possible that this is just due to random chance, but that isn't likely.

Back in 2016, the authors looked at the statistical distribution of KBOs and concluded the clustering was caused by an undetected outer planet. Based on their calculations, this world has a mass of five Earths and is about 10 times more distant from the sun than Neptune. The paper even calculated a broad region of the sky where the planet might be. But searches turned up nothing. This led some to conclude the planet doesn't exist. Orbital oddness doesn't prove a planet exists. Just ask Planet Vulcan. Others went so far as to argue Planet 9 does exist, but we can't see it because it's a primordial black hole.

This new study reexamines the original work in light of some of the criticism it received. One big criticism is that outer solar system bodies are difficult to find, so we look for them where it's convenient. The clustering effect we see could just be due to biased data. Taking observational bias into effect, the authors find the clustering is still statistically unusual. There's only a 0.4% chance of it being a fluke. When they recalculated the likely orbit of Planet 9, they were able to better localize where to look.

One interesting aspect of the study is that the newly calculated orbit puts Planet 9 closer to the sun than originally thought. This is odd, because if it is closer then we should have already found it. The authors argue that observations thus far have ruled out the closest options for Planet 9, which helps narrow down its possible location even further. If the planet exists, it should be detectable by the Vera Rubin Observatory in the near future.

This study isn't conclusive, and many astronomers still argue that Planet 9 doesn't exist. But this study makes it clear that we won't have to argue about it for much longer. Either it will be discovered soon, or observations will rule it out as an explanation for the KBO clustering effect.

From: https://phys.org/

"Two Eyes are Better than One"

September's Monthly Meeting 19:30 Friday 24th September 2021

The binocular is not limited to being a beginner's instrument and a subordinate adjunct to a telescope, but is an exceptionally valuable astronomical instrument in its own right. Find out how to choose and use binoculars for astronomy: discover what makes a good (or bad!) binocular, distinguish between valuable information and advertising hype, and learn how to optimise your viewing experience.

Steve Tonkin

Steve is a Fellow of the Royal Astronomical Society and has authored many articles and several books on practical aspects of astronomy. He taught astronomy to adults and children for more than 40 years. Steve is the Dark Skies Advisor to the International Dark Sky Reserve on the Cranborne Chase AONB and splits his time between this and astronomical outreach. He is in demand as a speaker to astronomical societies throughout Britain, volunteers as a STEM ambassador, and has a monthly column in BBC Sky at Night Magazine, for which he also writes equipment and book reviews.

Steve has an excellent website: *https://binocularsky.com* and has published a book: "Discovering the Night Sky Through Binoculars: A systematic guide to binocular astronomy" (2018).

THE BACK PAGE

LINKS, COMMENTS AND OBSERVATIONS

Important News - Virtual Monthly Meetings

As the Observatory is now **OPEN** and we can now use the Newchurch Pavilion, most monthly meetings will now be back to normal.
That is they will be held in the Pavilion.

We may still use Zoom from time-to-time and these meetings will be clearly marked in the Monthly Meetings list on Page 2.

If there are Zoom meetings please use this link:

https://us02web.zoom.us/j/81142510951?pwd=a2RCQXZKMmRMeXBMSXEvU0dxS2gzUT09
Meeting ID: 811 4251 0951 and Passcode: 346096

It'll be good to meet up properly again - please let's all behave sensibly.
Keep washing your hands, keep a sensible distance between you and any others not in your group, and wear a face covering in crowded spaces.

Moon Types?

A Blue Moon

When you hear someone say, "Once in a blue moon …" you know they are talking about something rare. A blue moon is not blue in color. In fact, a blue moon does not look any different than a regular, monthly full moon.

Rather, a blue moon is special because it is the "extra" Moon in a season with four full moons. This usually only happens every two-and-a-half years. Since the 1940s, the term "blue moon" has also been used for the second full moon in a calendar month. This usually happens only every two-and-a-half years.

A Harvest Moon

The term "harvest moon" refers to the full, bright Moon that occurs closest to the start of autumn. The name dates from the time before electricity, when farmers depended on the Moon's light to harvest their crops late into the night. The Moon's light was particularly important during fall, when harvests are the largest.

A Super Moon

A "supermoon" appears to us as a larger-than-usual Moon in our night sky. A supermoon looks larger just because it's a bit closer to Earth. "Supermoon" is actually just a nickname for what astronomers call a perigean full moon – a moon that is full and at its closest point in its orbit around Earth.

At The Observatory

1. **Please bring a torch.**
2. **Make sure you close and lock the car park gate if you are the last to leave.**

Articles Needed

NZ needs astronomy related content. Contact details on page 1.

"We are just an advanced breed of monkeys on a minor planet of a very average star. But we can understand the Universe. That makes us something very special"

"My expectations were reduced to zero when I was 21. Everything since then has been a bonus"

"If time travel is possible, where are the tourists from the future?"

"In an infinite universe, every point can be regarded as the center, because every point has an infinite number of stars on each side of it"

"The human race does not have a very good record of intelligent behaviour"

"Primitive life is very common and intelligent life is fairly rare. Some would say it has yet to occur on Earth"

"Intelligence is the ability to adapt to change"

Stephen Hawking