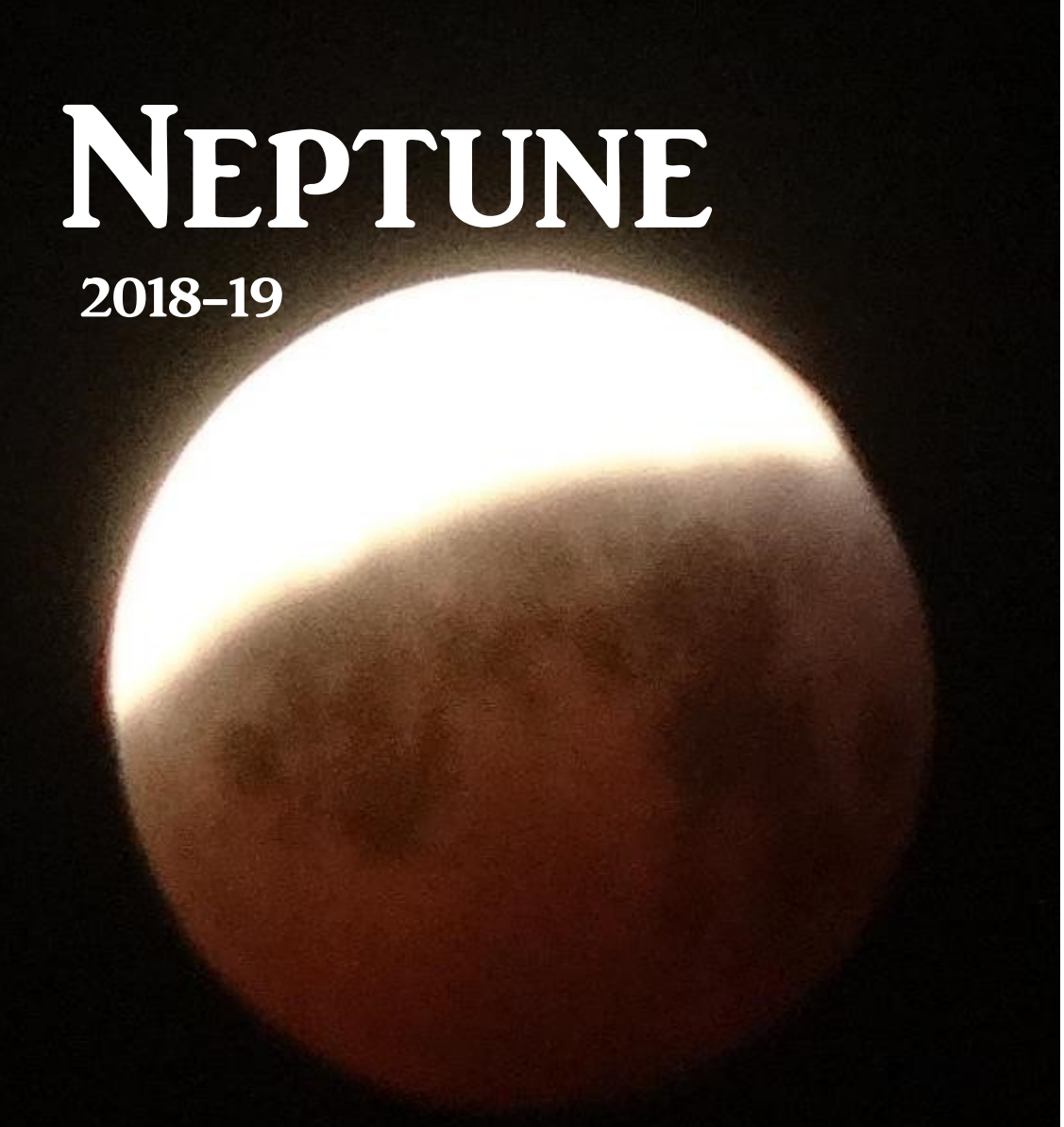
# Neptune

## 2018–19



CUAS Cambridge University Astronomical Society

Cover photo: Colin Reeves (Chair 1967-68) 2019 lunar eclipse from Delft

# Welcome!

For the first time in two years, this publication has not been edited by Andrew, in fact, he has been replaced by two volunteers who are either quite brave, or quite stupid, by trying to continue the tradition of Neptune. They did it on the condition that members of the committee would submit articles in lieu of reading through the generous submissions from our members. We got items from 2 out of 3 of the remaining committee, which ain't bad (in the words of Meatloaf). Andrew's article is his only contribution to the magazine, which is fortunately not a summary of how GDPR impacted the society, and how we comply with it.

As well as submissions from committee, we have had many contributions from our alumni - such as a collection of photos from around the UK (and further afield) of lunar eclipses, past and present. We have also received several submissions of articles, some of which had to be cut down a little to keep the magazine from becoming a small book (this is a nice change from previous years where begging emails have been sent to get enough content), on a wide range of topics. Topics include the ethics of space science research, the observatories from Mauna Kea and observing Pluto. Additionally, we have a submission from someone who is possibly the youngest member of CUAS. So it seems that the fates have smiled upon us, showering us with content.

Due to the lunar eclipse looming large in our collective memory (perhaps negatively in the minds of those of us who were restricted to cloudy Cambridge), the photography in this edition is mostly lunar images, compared to previous editions, where we have seen some of the treats that deep sky imaging can offer.

We hope you enjoy reading this as much as we have enjoyed putting it together.

Hannah, Chair & James, Treasurer

# Chair's Review of the Year

The year began with the annual Science Societies Garden Party, this year hosted in St John's College and with two ObsSecs staying in Cambridge over the summer we were able to hold two ObsNights. Observing the summer skies enabled us to observe comet Giacobini-Zinner and enjoy the novelty of observing in just T-shirt and shorts! In Michaelmas term, things took off with such large attendance at the Fresher's Quiz that people were filling in the quiz on every flat surface. Our first talk of the year was from a leader in cosmology, Professor Carlos Frenk, who spoke on the evolution of structure in the universe. Over 150 people attended our first talk and we've enjoyed an increase in membership with 160 new members. It's not possible to determine whether this was due to our new roller banner at Freshers Fair, Evi's great posters, the post-talk refreshments (with a new favourite addition – salt and vinegar twists) or a certain committee member's aggressive recruitment of their college children.

We've had a busy year of talks. Highlights included BBC Sky at Night presenter and ex-CUAS Chair, Chris Lintott, with an aptly timed eulogy to Kepler, which managed to mention both penguins and megastructures. In what is said to be a first for CUAS, we had a talk on the industrial and political aspects of space exploration where we welcomed Claire Barcham, Commercial Director of the UK Space Agency. Talks on Gaia, LISA Pathfinder, Cassini-Huygens and the recently launched BepiColombo mission gave us a flavour for the challenges in planning such ambitious space missions, several of which are over 20 years in the making, and got us excited about the new data these missions will provide us with. This year has also been an exciting one for observing. We've held 11 ObsNights and issued 33 new ObsCards. The Northumberland also got a much-needed new focuser, which combined with a new Explore Scientific 40mm 68° eyepiece has enabled us to enjoy fantastic views of M42 over the last few months. The new focuser



should also ease usage of the Northumberland for astrophotography, some techniques for which Dan (one of our Observation Secretaries) demonstrated at a recent ObsNight. A personal observing highlight this year was the Europa shadow transit on 5th May, where we saw the bright spot of Europa fade, leaving only the shadow of the moon visible as it transited across the planet. Also visible were three more of Jupiter's moons (Callisto, Ganymede and Io) and the two equatorial cloud belts were clearly visible.

The CUAS year is slowly drawing to a close, with the Annual Dinner and our final talk of the year. Whilst being Chair has been hard work, it has been a privilege to be a part of CUAS; to keep the society running well over the year and I will be sad to step down. I'd like to thank the committee, who, although they may tease me mercilessly about being cold, have worked incredibly hard this year to make all our events a success and to ensure I wasn't left to do everything on my own. I wish the new committee the best of luck for the coming year and hope CUAS continues to go from strength to strength.

Clear Skies

Hannah Sanderson

CUAS Chair 2018-19

## 2018-19 Committee

Chair: Hannah Sanderson

Treasurer: James Rawson

Secretary: Andrew Sellek

Observational Secretaries: Harry Metrebian, Daniel Mortimer

*Senior Committee: President: Mike Irwin, Senior Treasurer: Jonathan Shanklin*

# Incoming Committee

From left to right: James Rawson, Tommy Tai, Amber Parsons, Zak Shumyalov, Hannah Sanderson, Oliver Normand, Matthew Zhang, Harry Metrebian

We are excited to announce the incoming committee for 2019-20

Chair: Oliver Normand

Secretary: Matthew Zhang

Treasurer: Zak Shumaylov

General Members: Amber Parsons, Harry Metrebian, James Rawson, Tommy Tai, Hannah Sanderson

It's great to have so many people, who want to get involved in CUAS and have such a large committee for next year. Congratulations to the new committee and we look forward to getting to know them next year.



# Total Eclipses

There was a total lunar eclipse on the morning of 21st January 2019, but it was cloudy here in Bristol (and I understand in Cambridge too). Most unfortunate, but it prompted me to check my records for previous total eclipses.

My first was on 8th December 1946, when I was just under 4. The Full Moon was low down in the east, and the event was early enough for a youngster to be allowed to stay up to see it. I was just amazed. The Moon gradually disappeared, stayed almost invisible, and reappeared again. Now, I am sure that my interest in astronomy would have developed anyway, but from that day forward I was hooked (to the annoyance of my father, as I kept asking questions to which he did not know the answer).

During my undergraduate days (1961-64) there was not a single total eclipse visible from Cambridge. Indeed for two years all lunar eclipses were penumbral – not very interesting! But on graduating I spent 3½ months in America and, among other things, visited the Harvard, Yerkes and Lowell observatories. I found then, and later, that if you turned up and said that you were from "the Astronomical Society of Cambridge University", doors were opened. Try it. It might still work.

I have seen more lunar eclipses, but it would be of no interest to record them. My next serious eclipse was the total solar eclipse of 11th August 1999, visible for a few seconds from Cornwall. With a group of friends, I decided to go to Austria and a site on the central line of the eclipse track. Well, the weather was good before and after, but at the time of totality it was completely overcast. It did become pretty dark, the cattle lay down, and the locals celebrated with fireworks! I do hope that they would not have done so if the eclipse had actually been visible.

Next was the total solar eclipse on 29th March 2006, visible *inter alia* from the far north-west corner of Egypt. I went with a Cambridge Alumni tour, with Gerry Gilmour from the IoA as one of the hosts; this included a Landrover trip across the Western Desert – fascinating. I was a bit concerned about the arrangements on eclipse day (we stayed at least 50 miles away), but it was all very efficient. The morning mist soon cleared. Upon reaching the observing site (about a mile from the Libyan border), I was rather concerned about the number of armed soldiers. Were we really at such risk of attack from Colonel Gadaffi? No. They were there to protect President Mubarak, who flew in (and out again) by helicopter for the duration of the eclipse.

Finally, we come to the total lunar eclipse on 3rd March 2007. On that date I was privileged to attend a Sidney Sussex College Feast, and at the end of the evening we all retired to the Master's Lodge for coffee, claret and port (and no doubt other things too, but it was the third that interested me). Now, I knew that there was a total eclipse that night (I may have been the only one of the 100 or so present who did so), and so I sneaked out onto the balcony to have a look. Conditions were superb, and within minutes everyone was crowding out to see.

After proceedings closed, I wandered down to the Fellows' Garden to continue to observe. I found a couple of undergraduates, David Adamczyk and Thomas Haggett, taking photos with some quite sophisticated equipment. We kept in touch, and as a result one of their photos appeared on the back cover of the College Annual for 2007. Without our meeting and my prompting, I don't think it would have occurred to them to submit it.

There is a follow-up to this story. Some months later I met them again and asked, 'What are you going to do next?' Both had jobs lined up, and David said, 'I am joining a consultancy firm'. I asked which one, and on his reply, I said, 'That is a coincidence, my niece works for that firm'. 'What is her name?' I told him, and he said, 'She was the one who interviewed me, and offered me the job'. It can sometimes be a very small world.

David Purchase, Chairman, 1963-64



# Eclipse Photography

Above: Photos and montage from the 2007 eclipse taken by David Adamczyk and Thomas Haggett from the grounds in Sidney Sussex College. The six images have been arranged for artistic effect: they are not chronological.

Left (and front cover): Photograph of the January 2019 eclipse from Delft by Colin Reeves (CUAS Chair 1967-68)

After a disappointingly cloudy lunar eclipse in Cambridge in January, we were delighted to receive pictures from alumni in the UK and abroad. This inspired us to showcase photographs of this year and previous year's lunar eclipses. Here is an anecdote from one of our alumni, Derek Jones, about his experiences photographing eclipses.

'During the latter part of the 20th century I was on the staff of the Roque de los Muchachos observatory on La Palma in the Canary Islands. The 1989 image is from a photographic plate taken with the 1-metre Jacobus Kapteyn Telescope there. On 1989 August 17, when the telescope was scheduled for a programme of photographic astrometry, I sneaked in the eclipse photograph unofficially. When not observing I lived with my wife in a house about 1000 ft above sea-level with great views to the East. On clear days we could see the volcano Teide on Tenerife about 70 miles away. We had an 80 mm bird watching telescope with an attachment for a 35 mm film camera. Purely for fun and enjoyment I took a series of photographs of the Lunar Eclipse of 1993 Nov 29. Each picture has South at the top; the series ended when the Moon set behind the mountains to the West.' Derek Jones (Chair 1957-58)

Below: 1993 eclipse in La Palma taken by Derek Jones (Chair 1957-58)



Photographs of the 2019 eclipse in Sandwich by James Lancashire (ObsSec 1990-91, Chair 1991-92)

‘I found a few pre-work dog-walkers on the streets of this medieval town. Plus a guy scurrying out of his house with a large tripod and camera case and starting his car. I think he must have seen it on the news and wasn't prepared as totality had ended already!’ - James Lancashire



# Observing Pluto with the Northumberland Telescope

It’s not too difficult to observe all eight planets of the Solar System: all except Uranus and Neptune are easily visible with the naked eye (although with Mercury you need to know when to look), and those two are visible with binoculars or a small telescope. But if you (wrongly) count Pluto as a planet, observing all the planets becomes much harder. Pluto is tiny and a long way away, so appears far fainter than any of the actual planets. But it’s still just about possible to see it with the Northumberland telescope, as I discovered last summer.

I could not find any recent observations of Pluto in the Northumberland observing book, but some were recorded in an issue of Neptune from 1991, when Pluto was near its closest point to the Sun. At the time, its magnitude was 13.7, which is well within the capability of the Northumberland. It also reached a reasonable altitude, as it was only just south of the celestial equator. Since then, things have got worse. Pluto has moved further from the Sun in its elliptical orbit and is half a magnitude fainter as a result. Furthermore, it is now 22 degrees south of the equator and does not get higher than 16 degrees above the horizon from Cambridge, so observing it is much more of a challenge.

There is one advantage I had over the observers of the 1990s and previous decades: the availability of charts which reliably show stars fainter than Pluto. As Pluto looks just like a star, the traditional method for identifying it was to sketch the field of view, return a few nights later and see which “star” had moved. This is no longer necessary.

In fact, I was not originally planning to try for Pluto on the night when I first saw it (5/6 August 2018). I was observing other objects in the southern sky, realised Pluto was in the same area, and decided to give it a go. I was able to bring up a DSS image of the region on my phone, as well as star charts down to around magnitude 15. Finding the correct field of view was easy. However, seeing Pluto was anything but. As it happened, there was a star slightly brighter than Pluto only half an arcminute away, so I pushed the magnification up to over 300x. Eventually I managed to glimpse Pluto with averted vision, and I spent around 15 minutes staring at the same field of view to make absolutely sure I had seen it. I observed Pluto again on the night of 16/17 August, when it had moved substantially from its previous position. It was slightly easier to see this time, probably because there was no nearby star to interfere with the observation.

Pluto is currently best seen in the summer, as it reaches opposition in July. From Britain you will probably need at least a 12-inch telescope (such as the Northumberland), and a relatively low southern horizon. Observing Pluto will only get harder over the coming years, as it will remain at a low altitude for decades, getting fainter all the time. In ten years it will likely be impossible to see it with the Northumberland, though I would like to be proven wrong!

Harry Metrebian

Observation Secretary (2017-20)





# Pluto hunting

Introduction

Pluto was discovered in 1930 by Clyde Tombaugh who made a search of photographic plates taken at the Lowell and Mount Wilson Observatories in the USA. The existence of a planet more distant than Neptune was postulated independently by Percival Lowell and William Pickering, although as the mass of Pluto is too small to perturb the orbits of Uranus and Neptune noticeably, that it was found within 5° of the predicted position must be regarded as chance. The mean distance of Pluto from the Sun is 39.6AU (compared to Neptune's 30.0AU) but its very large (for planets) orbital eccentricity of 0.25 means than it can be closer to the Sun than Neptune, as indeed happens between 1979 and 1998. The magnitude of Pluto is about +14/15 but at the moment, as Pluto is at its very closest to the Earth (28.7AU), its magnitude is +13.7. After reading articles in *Sky & Telescope* and *Astronomy*, Jeff Knight, Graham Dann and myself were spurred on to locate the final planet in the Solar System using the 12" Northumberland refractor (limiting mag about +15).

The search

A clear, moonless night is required so, with opposition on May 10, the best chance to observe was the week on either side of the new moon of May 14th. The crucial method in locating Pluto would be using charts to star-hop from one star to another, getting closer to the target area with each 'hop'. To practise this beforehand, we used Messier clusters and galaxies as our targets and soon gained the confidence and experience that would be so necessary as well as having some good sights in the process (eg the spiral arms of M51).

May 11/12: We star-hopped from β Librae as shown in *Astronomy* and found the correct region around SAO 140473 (mag +6.4) but could not see any stars fainter than 13th mag.

May 20/21: We had the wrong area to start with, but a visit to the IoA Library furnished us with some charts from *Uranometria* and a chart from the Royal Astronomical Society of Canada's *Observer's Handbook* which was better than the one in *Sky & Telescope*. However, we were beaten again by some thin cloud cover whilst waiting for conditions to *improve*!

May 21/22: After all the practice we'd had, it had to be third time lucky! We quickly found SAO 140473, then we changed from the comet eyepiece to the 40mm. We saw the other guide stars; two fields away, was the location of Pluto. After a few moments using averted vision, we could see a 'star' in the position marked 'x'. The faintest stars marked on the chart were mag +14.5 and we could see those, so the 'x', slightly brighter, had to be Pluto. When each of us had had a look, the tiny point of light was obvious at the next look through the Northumberland. We were pleased that our efforts had been rewarded and we will try to verify our observations after the exams when the Moon does not interfere. The 'star' should then be to the NW of SAO 140473.

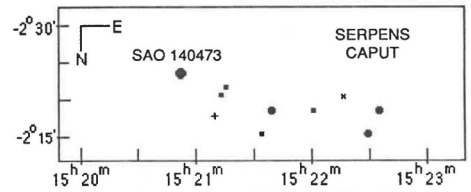
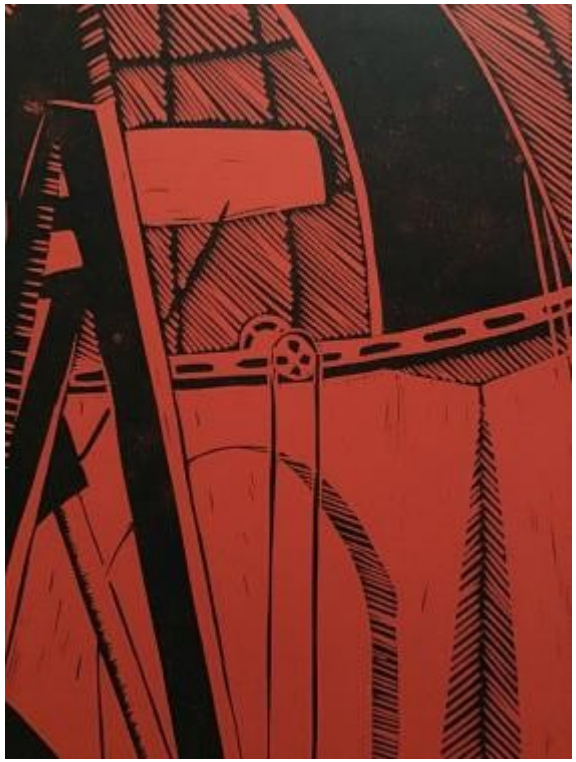



*Diagram from the* Observer's Handbook*: 'x' marks the spot*

James Lancashire

*Well, it so happens that James was back at the observatory on the morning of 2nd June. He managed to find Pluto again, and, surprise surprise, it had moved. The vertical cross on the diagram indicates the planet's position that night.*

James Lancashire's article about observing Pluto from Neptune 1991



Above: star trails above the Northumberland dome by Eva-Maria Ahrer

Right: ‘Night in the Observatory’ lino-cut on red card of the inside of the Northumberland by Michael Johns-Perring



Pleiades by James Rawson (Treasurer 2018-19) How many asteroids can you spot?

# Hippocamp

## a new moon of Neptune

In a paper published last month in Nature, a team of US-based astronomers led by Mark Showalter, described the discovery of the 14th known moon of Neptune.

To come about their discovery, they used observations of the Neptune system from the Hubble Space Telescope. The moons they sought to study are very faint and would require relatively long observations to appear in the raw photographs above the background noise. However, as any astrophotographer would know, exposure times that are too long will lead to trailing: this this case not due to the rotation of the Earth but due to the orbits of the moons about the planets themselves. While we are used to thinking about long timescales – the stars don't move appreciably relative to one another over the course of a night – the moons of some of the giant planets can have orbits lasting a few days or even less. If you are lucky then at an Obsnight you may even get to see one of Jupiter's moons transiting its face or emerging from behind its shadow. When this smearing happens, we no longer see an improvement above the noise.

To account for this, the team had to accurately model orbits about Neptune, with speeds that vary with distance (according to Newton's laws, the speed of the orbiting moons will decline with the square root of the distance). To do this, they calculated the average speed at each pixel's radius from the planet, accounting for all the necessary corrections for the planet not being a perfect sphere, but slightly flattened due to its rotation. Thus, they could effectively de-rotate and add 8-11 frames on a pixel-by-



pixel basis. This allowed them to make 20 detections of a new 26.5th magnitude moon (sadly over 10,000 times too faint [even for Harry!] to see with the Northumberland, so we can keep up the telescope's tradition of not observing), extending back to 2004. They also saw some known moons, which have only been seen sporadically since their discovery.

With the approval of the International Astronomical Union (IAU), the team decided to name the moon "Hippocamp"; in Greek mythology the Hippocamp was a half-horse, half-fish monster that also gives its name to the genus Hippocampus, the scientific name of the seahorse, enhancing its appeal to Showalter, a keen scuba diver. IAU rules state that all moons of Neptune must have names related to water beings in Greek mythology, and it certainly makes for a more fun designation that S/2004 N1, indicating that it was the 1st Satellite of Neptune to be first discovered in data from 2004.

Assuming that Hippocamp is similarly reflective to the other moons of Neptune, the team derive its diameter to be roughly 34 km, making it just a little bit larger than Ultima Thule, the flattened snowman-shaped Kuiper Belt Object visited by the New Horizons probe over the New Year, or roughly the distance from the Northumberland Telescope to the centre of Letchworth Garden City.

Most interesting, however, is its orbit. Hippocamp orbits just 12000 km, about the diameter of the Earth, from Proteus, Neptune's second largest moon. Proteus, like our own moon, is moving away from its host planet as the length of its day slowly decreases. This means that the moons were once impossibly close, and Proteus should have disrupted the orbit of Hippocamp, either consuming it or making its orbit less circular, which is not

seen. Showalter et al. suggest that the smaller moon was created by material ejected off Proteus - it has a crater called Pharos which would have contained 50 times as much mass as needed to build Hippocamp – and that it went through several disruption and reforming events over its history, each of which reset its orbit.

Andrew Sellek (Chair 2016-17, Treasurer 17-18, Secretary 18-19)

# Is Space Research Worth The Money?

The readers of this publication are, in all probability, space enthusiasts. Again, in all probability, each of us, then, is inclined to support a high level of public expenditure on technical research and development, which impacts the fields of astronomy, space exploration, and technology, as well as the purely-theoretical work which underpins or develops this area of research.

How often, though, have we been pressed for a justification of what is perceived as a field of abstract value? There is little utilitarian benefit to the ordinary taxpayer if we know that a given star has stronger calcium lines than we anticipated.
In these uncertain times, can any national space science program possibly be a good investment when everyone, regardless of ideological or political affiliation, is understandably demanding fiscal reform? NASA does expensive, risky things. All space programs do. What's the point when the people have much more pressing needs, and pay too much in taxes anyway?



In the USA, the largest single contributor to women's STEM programs is... the National Aeronautics and Space Administration.
In the USA, the largest single contributor to colleges and universities is... the National Aeronautics and Space Administration.
There could be other, bigger contributing agencies, but there aren't. (Legislating, funding, and staffing new agencies with that sort of social agenda would be controversial, time-consuming, and, until efficient methodologies were found, likely not as effective.) Still, granted, the primary purpose of a space-research ministry is not social change. No one would claim that more resources could not be dedicated to Women's STEM programs, or tertiary education in general, in some other way, but this is how it happens in the United States, now.

Random surveys repeatedly demonstrate that the American public is largely ignorant of the scale of jobs-development from space research, while at the same time respondents are repeatedly seen to quite regularly overestimate, even in a well-designed multiple-choice survey, the size of NASA's budget, both in real terms and in proportion to federal expenditure.

NASA does not have a $250 billion budget.
NASA does not represent 25% of the budget.
NASA does not cost the average American taxpayer an extra $800per year.

The reality is NASA costs the average taxpayer about $2.25 a week, or around 30 cents a day. At Federal minimum wage that will take a worker around two-and-a half-minutes to earn. Despite the overestimation, 85% of respondents are willing to see an *increase in NASA spending. Americans, in these uncertain times, agree on little, but they agree on that.*

On this background, NASA continues to invent things as diverse as the grooved pavement, originally used for runways but now used on slippery roads all over the world, and clear-air-turbulence warning systems which prevent sudden, unsafe jolts on commercial air-

liners. NASA provides the USA with a GPS system, tested for civilian use by NASA airborne astronomy.

Velcro, pressurized ink pens and powdered orange-drink were actually not pioneered by NASA technologists, but freeze-drying and cochlear implants were. These aren't necessarily venture-capital-friendly areas. Other agencies or corporations *could* have invented those things, and many others, but the space agency *has.*

NASA Ames Research Center scientists were at the forefront of the ozone-hole discovery and its measurement. They have made critical contributions to climate science, which may help us all determine the future of life on this planet. (Even that paradigm, that of a planetary environment, is one obviously and strongly influenced by the Voyager spacecraft's vision of the "Pale Blue Dot".)

NASA earth sciences guide us in agriculture, water management, pollution control, and species habitat preservation. We may make poor choices, but not for want of rich data.

NASA spends, yes, but the expenditures have a "expenditures multiplier" factor estimated as high as 16. The military has a multiplier of less than 4. That means that when NASA spends a pound it impacts the economy as much as though you or I spent sixteen.

Why is this? We don't spend money in space, we spend it here on Earth. There's nowhere to spend money in space. Not yet. When NASA spends, a large part of the expenditure is for new technologies. This expands the economy.

It does or has done so in states like Japan, the United States, India, Norway, the former Soviet Union, and China. All these different polities with all their different ideologies have seen space research not only in terms of national prestige but as an economic stimulus.

CUAS recently hosted a talk by the brilliant Claire Barcham, the Commercial Space Director for the United Kingdom Space Agency (UKSA) which has a small apparent profile, often subsumed by the



larger, seemingly more ambitious ESA. But the UKSA has leverage. With a staff of only 170 and a budget well under a half-billion GBP, it supports 42,000 jobs with an estimated impact in the range of 13.7 billion GBP, in the neighbourhood of 7% of global space-related industry. This is astonishingly efficient. One can only wonder what the UKSA could accomplish with a larger budget. Nor can the technological and scientific progress backgrounded by the economic development engendered by UKSA be ignored.

But the United States, while sharing many traditions of academe, is different from Britain simply because of its economic scale. In part, the American experience has been one in which several big research facilities were built, mid-twentieth century, in otherwise economically depressed areas. This certainly skews the analysis somewhat, though undeniably to the social good. The impact of economic progress on any community always produces some discomfort, but mostly has the opposite, desired effect of bringing higher incomes to those in need, with ancillary services providing employment for less-skilled labour. This cascades through the community as those people in turn also develop some degree of discretionary income, but even the movement of money through a community, for ordinary needs like food, housing, or transport, will continue to stimulate.

So, the short answer is "public spending is good for the economy, and space research actually doesn't cost that much." This is all true.

Space research is good for everyone, it turns out.

P.G. Mulvaney

# Astronomy Quiz

Here are a selection of questions from our annual CUAS Quiz, which we held in December.

Astronomy news 2018-19

1. What sort of object is Ryugu, which Japanese spacecraft Hayabusa 2 has been visiting since 27th June 2018?
2. What is the Neptune sized object, Kepler 1625b that was discovered in 2018?
3. The EDGES radio antenna claimed to have picked up a signal from the first what to form in the Universe in February 2018?
4. The GAIA spacecraft released its second data batch in April 2018. These data suggest that which popular double star is, in fact, just a chance alignment, not a true binary pair?

Solar system Astronomy

5. On which planet does a day last longer than a year?
6. How many times could you fit the Earth inside the sun?
7. Which mission named after a Portuguese explorer visited Venus?
8. How many known moons does Saturn have?
9. Which solar system object was named by 11-year-old Venetia Burney?
10. Which planet has the fastest winds?

Answers: 1. Asteroid 2. Exomoon 3. Stars 4. Albireo 5. Mercury 6. 1.3 million +- 0.1 million 7. Magellan 8. 62 9. Pluto 10.Neptune has clouds of frozen methane that whip across it at 2000 km/h



# The Mauna Kea Observatories

Last year, I had the opportunity to visit Hawaii's Big Island for a conference and stayed on for a bit. Naturally, I brought a scope along and took the time to visit the observatories on top of Mauna Kea. On arrival, I was pleasantly surprised to be able to see the observatories from the coast, over 45 km away. Driving across the island consists of an hour going uphill, followed by an hour going downhill. At around the halfway point, an access road splits off towards the mountain, going uphill with constantly popping ears. At 2.8 km altitude, you reach the visitor centre, and the end of the road accessible to normal cars. There's a small gift shop with hot drinks and sou-

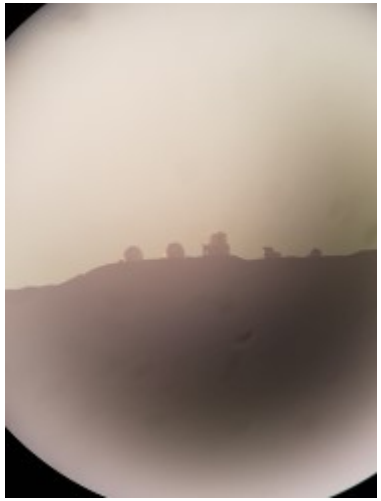


Figure 1 - Summit of Mauna Kea 45 km cosine distance, taken from Waikoloa afocally through with 85 mm Vortex Razor HD spotting scope @ 60x. From left: Keck twins, Subaru, U Hawaii 2.2m and UKIRT

venirs, along with a collection of pretty large telescopes huddled in the corner (expensive kit - Astro Physics mounts with 11” & 14” Schmidt-Cassegrains). These are brought out regularly for public observing sessions run by volunteers from the local university.


Figure 2 - View from Gemini North telescope. From left: Subaru, Keck twins, IRTF.

To reach the summit and observatories, one can hike to the top from the visitor centre (8+ hour round trip starting at dawn!), travel in an organised tour from sea-level or possess a fully-capable 4-wheel drive vehicle. Unable to do any of these, we were fortunate to hitch a ride with a couple who possessed the latter. Going up the slightly-perilous, winding access road, the temperature plummeted from 30 °C at sea level, 15 °C at the visitor centre, to around -2 °C at the top (4200 m altitude).

Figure 3 - From left: Caltech Submilimeter Observatory, James Clerk Maxwell Telescope, Smithsonian Submillimeter Array, Subaru, Keck twins.



The view from the top was absolutely stunning - you could see lots of domes with huge telescopes inside. The landscape was also nice. The bulk of the clouds ended shortly above the visitor centre, over a kilometre below, thus one could see across the entire island. At the time, it was quite gusty but the air clarity was superb. We parked near the Gemini North dome and waited for the sunset over a sharp horizon. Visitors were prohibited from the summit 30 minutes after sundown and we made our way back down to the visitor centre. At the latitude of Hawaii, the twilight ended quickly. In the darkness, the red glow of ongoing volcanic eruptions in the south of the island was visible in the distance.

At the visitor centre, a volunteer was giving a tour of the constellations with green laser pointer. I set up my spotting scope and had a look at the Moon, Jupiter, Saturn and some southern objects. Tracking the planets was difficult, as the mount was a photographic tripod with ball head and searching for deep sky objects was even harder without a finder. However, I was eventually able to find the humongous and excellent Omega Centauri and the annoyingly southern Messier 7, before heading back down to sea level, ears popping all the way.

James Xiao, Observation Secretary (2015-18)

A selection of astro-photography by James Rawson (Treasurer 2018-19)

Left: Comet 21P/ Giacobini-Zimmer

Below: Triangulum galaxy (M33)



Left: Cocoon nebula (IC5146)

Below: White Rose Cluster (NGC7789)

# Astronomy Jokes

Probably the youngest member of our society, Sebastian Thornton (9) is a regular attender of CUAS talks. He also attends public open evenings at the Institute of Astronomy, where he contributes to the 'Joke of the Day' board. Here are a selection of his jokes.

Q. What did one black hole say to the other black hole?
A. Nothing, they just waved.

Never trust an atom, they make up about 5% of everything!

Q. Why was the accretion disk so serious?
A. Because it was consumed by the gravity of the situation.

Q. What is invisible and goes quark, quark?
A. Duck Matter!

An astronomer needs their space.

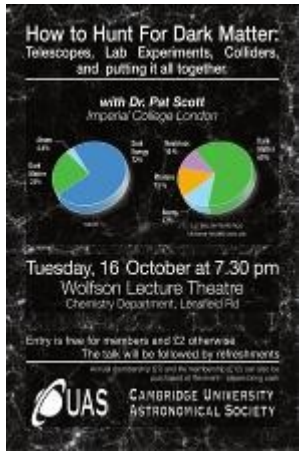
Q. What do the astronauts on the ISS use to write home?
A. Space Stationery

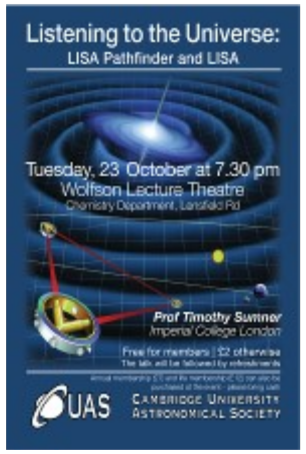
Q. Why didn't the astronaut make a trip to Pluto?
A. They couldn't planet.

Q. Why are electrons no good at rugby?
A. They're always lepton.

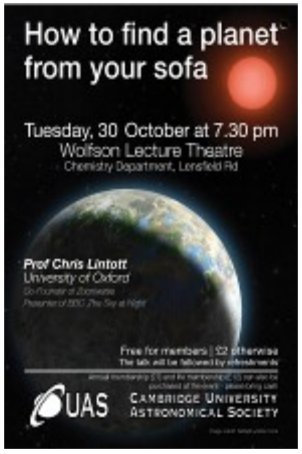
Q. Why are photons massless?
A. Because they're light.

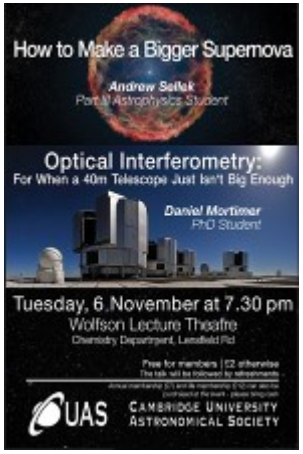


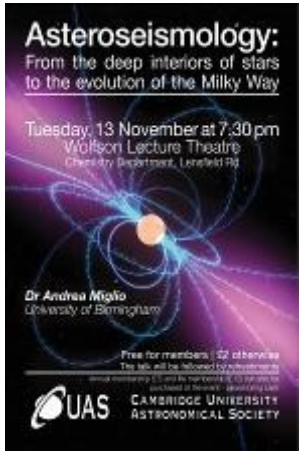




# Posters for the 2018–19 talks produced by Eva-Maria Ahrer




Cassini-Huygens:
Odyssey to Saturn and Titan
WHOOSH
with Prof David Southwood
Imperial College London
Former Director of Science at ESA
Tuesday, 20 November at 7.30 pm
Wolfson Lecture Theatre
Chemistry Department, Lensfield Rd
Free for members | £2 otherwise
The talk will be followed by refreshments
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ASTRONOMICAL SOCIETY


Gaia - The Milky Way Census
with Prof Gerry Gilmore
Institute of Astronomy,
University of Cambridge
Tuesday, 22 January at 7.30 pm
Wolfson Lecture Theatre
Chemistry Department, Lensfield Rd
Free for members | £2 otherwise
The talk will be followed by refreshments
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ASTRONOMICAL SOCIETY


Characterising Exoplanet Atmospheres
Tuesday, 29 January at 7.30 pm
Wolfson Lecture Theatre
Chemistry Department, Lensfield Rd
Ryan MacDonald
Institute of Astronomy,
University of Cambridge
Free for members | £2 otherwise
The talk will be followed by refreshments
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Leading the New Space Age
Tuesday, 5 February at 7.30 pm
Wolfson Lecture Theatre
Chemistry Department, Lensfield Rd
with
Clare Barcham
from the UK Space Agency
Free for members | £2 otherwise
The talk will be followed by refreshments
UAS


HERA and SKA: Exploring the early Universe with super radio-telescopes
Tuesday, 12 February at 7.30 pm
Wolfson Lecture Theatre
Chemistry Department, Lensfield Rd
Nicolas Fagnoni
Cavendish Laboratory,
University of Cambridge
Free for members | £2 otherwise
The talk will be followed by refreshments
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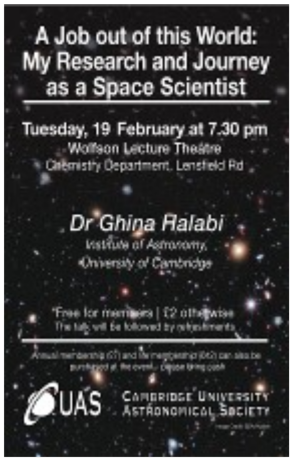
A Job out of this World: My Research and Journey as a Space Scientist
Tuesday, 19 February at 7.30 pm
Wolfson Lecture Theatre
Chemistry Department, Lensfield Rd
Dr Ghina Halabi
Institute of Astronomy,
University of Cambridge
Free for members | £2 otherwise
The talk will be followed by refreshments
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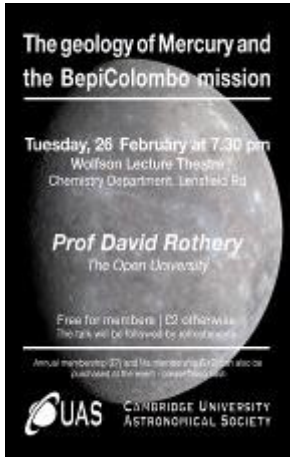
The geology of Mercury and the BepiColombo mission
Tuesday, 26 February at 7.30 pm
Wolfson Lecture Theatre
Chemistry Department, Lensfield Rd
Prof David Rothery
The Open University
Free for members | £2 otherwise
The talk will be followed by refreshments
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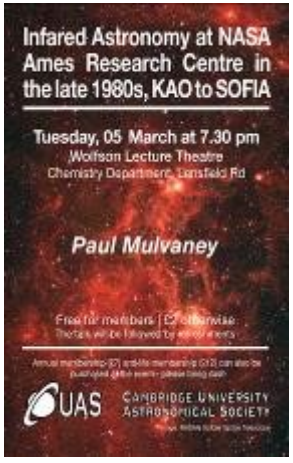
Infared Astronomy at NASA Ames Research Centre in the late 1980s, KAO to SOFIA
Tuesday, 05 March at 7.30 pm
Wolfson Lecture Theatre
Chemistry Department, Lensfield Rd
Paul Mulvaney
Free for members | £2 otherwise
The talk will be followed by refreshments
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Catching Comets by their Tails
Tuesday, 12 March at 7.30 pm
Wolfson Lecture Theatre
Chemistry Department, Lensfield Rd
Prof Geraint Jones.
UCL Mullard Space Science Laboratory
Free for members | £2 otherwise
The talk will be followed by refreshments
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