CAMBRIDGE UNIVERSITY ASTRONOMICAL SOCIETY

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NEPTUNE is the annual publication of the Cambridge University Astronomical Society. It is comprised of works produced by members of the society.

2024 Edition compiled *by* **Charles Mack**

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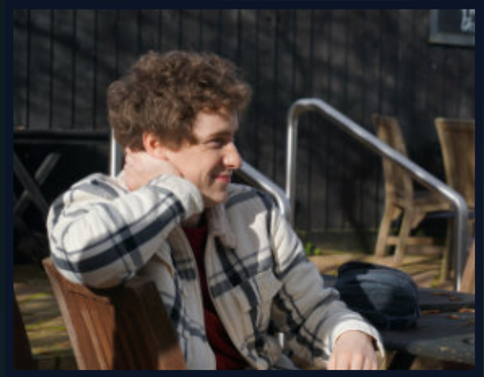
SOME WORDS FROM THE EDITOR

Charles Mack



My dear reader, I present to you Neptune 2024 - although in truth what I present is not at all my work. This edition of Neptune represents the focus and creativity of its numerous collaborators, without whom this edition simply would not exist. To each and every collaborator, you were an absolute delight to work with, and I sincerely hope that you are happy with how your works are presented here.

From Almudena Visser Velez's account of an internship at the IoA, to Kevin Reid's fascinating and technical documentation of image comparisons of Jupiter, to Peter Jackson and Justin Whitaker's aethereal nebulae photographs, to Sofia Vasieva's deep-sky watercolours, this edition contains a bit of everything "astronomy".

Over the past few months, my inbox has slowly seen files arrive and conversations grow out of the material, and I thoroughly enjoyed the process of rediscovering each submission as I came to organising the edition. On putting together the final spread, Stef Carras' photographs of the night sky jumped out at me anew, and struck me with the same force of awe as I experienced the first time I looked over them.

This edition of Neptune was somewhat of an experiment, as I departed from the previous template to create something new. I want to extend my thanks to the (legendary) Ralph Battle, who supported the English tripos student who'd decided to dip their toe in astronomy, and who found value in widening the CUAS space. I hope that this edition will spark a new tradition of experimentation with the Neptune magazine, and I'm sure (and very much hope) my successor will outgrow my own template. If Neptune is something for us all to remember our years as members of this society by, then let's have it represent just how special those years are.

I hope that you enjoy this edition of the Neptune Magazine. Floreat CUAS.

SOME WORDS FROM THE CHAIR

Alexander Blake-Martín

The CUAS year began, as it always does, quietly in late spring. With looming exams and increasingly late sunsets, the society's plans become largely theoretical exercises. In June, CUAS joined forces with Cambridge's assorted science societies to host a garden party at Darwin college that rivalled those of Murray Edwards and Newnham, complete with music, games, and Cambridge's finest ice cream. The next day, the ObsSecs were summoned to attend the Emmanuel College May Ball for a night of stargazing, cut short by CUAS' nemesis – cloudy skies. Nonetheless, the guests were impressed and thoroughly entertained.

Like clockwork, the start of autumn ushered in a new academic year, and with it came new challenges and new faces.

The year's talks were kicked off with Cambridge's own Dr Anke Ardern-Arentsen, who spoke on the subject of galactic archaeology, and the first of many pre-talk dinners at Pho. Also on the menu for Michaelmas were X-ray astronomy, and several talks on cosmology, which were rounded off by Professor Ofer Lahav's discussion of the of applications of deep learning in the field. The SU Societies Fair was both fruitful and entertaining, the temporarily instated Fresher Relations Officer attracting swathes of new members with his fanciful tales. The Freshers' ObsNight, delayed both by weather and malfunctioning technology in the Northumberland, was extraordinarily well-attended once again, delivered by Aniruddha's capable hands and wealth of astronomical knowledge. Committee meetings received an upgrade to their usual location under the dome, moving to the warmer and more elegant Library Room A of the IoA, under the inspiring gaze of Chandrasekhar, Einstein, and Eddington – who once lived in the building. Evening sessions fuelled by Cadbury Heroes were productive and enjoyable and drew out many a guffaw at the antics of the Neptune editor. The usual Freshers' Pub Quiz – a staple of the CUAS calendar – was substituted for one hosted by the combined science societies at BrewDog, continuing the year's trend of collaboration. In a similar fashion, Lent term began explosively with a thrilling talk, hosted jointly with the Sedgwick Club, by Professor John Bridges on Martian geology. A more diverse set of talks followed this, with topics including asteroseismology, dark matter, and instrumentation in astronomy. This year has shown, once again, that interest in astronomy is alive and well in Cambridge. Increased collaboration with other societies has proved to be a very important part of the society, attracting new members, and expanding the possibilities for the future.

The success this year can only be attributed to a small group of people – the committee. Without their continuous hard work alongside demanding and time-consuming degrees, there would be no CUAS. Many of them have taken on multiple responsibilities, some unexpectedly during the year. In particular, I would like to extend my thanks to Jessica, whose contributions this year and last year cannot be understated. Ever-present at talks, a continuous source of wisdom, and more than happy to chastise me when necessary, she has done so much more than being the society's secretary. To next year's committee, I wish the best of luck. The future of CUAS, like Sirius, is bright.

A. Blake-Martín

SOME WORDS FROM THE OBSERVATION SECRETARIES

Aniruddha Aramanekoppa, Mahdeia Hidary, Guang Liang Yeo

It has been a busy year for the ObSecs this year. Even with two new ObsSecs, we managed to host over 100 members in our first ObsNight in Michaelmas and 92 new people for their (and our) first ObsDemo! Started by our previous ObsSecs, Ralph Battle and Joseph Thornton, we continued their tradition of providing ObsNight snacks - which I'm sure you'd agree remains very popular among the hungry observers.

At our freshers ObsNight, it was great seeing familiar and new faces among the stargazing crowd. We spent a night observing Saturn, Jupiter, the Double Cluster, the Andromeda galaxy and other deep-sky objects among gaps in the clouds. It is always great how morale at ObsNights remains high throughout the night, despite the cold and clouds - we owe it to our members for the friendly and welcoming atmosphere that greets everyone at these events. We even had help from our newly minted and trained members to help with the telescope (with supervision of course!).

A very different event that we ran in 2023 was an ObsNight at Emmanuel College May ball. We set up a stall with our Celestron SCT and newly purchased binoculars. We experienced cloudy skies and a light drizzle for a large part of the night, making it challenging to observe any of the heavenly bodies. However, we did manage to entertain our guests with some cool views through the telescope, when the skies cleared later in the night. It was very fun to see people's excitement when they saw anything through the telescope - even if it was a boring blue dot. This was unfortunately our very last event with our sorely missed Ralph Battle, and we wish him the very best in his future endeavours.

This year has not been one without its challenges. The Northumberland Telescope faced some technical issues in Michaelmas Term, forcing us to pause our observing activities. These were eventually fixed, and we were finally able to resume observations towards the end of term. We realised that we were still novices with the GoTo system on the Celestron SCT in our Freshers ObsNight - we tried many times to align the telescope but, in the end, it still works just great as a manual telescope! We very much prefer the old way of using a finderscope and taking our time enjoying the journey through the night sky until you reach your starry destination.

Adding one more year to the history of CUAS and the Northumberland itself, we hope to see our incoming committee continue sharing the joy and excitement of discovering the cosmos with our eager participants.

Aniruddha A. Mahdeia

Taken through the Northumberland Telescope with a phone camera (Motorola G5 Plus): ISO 100, 1/60 sec exposure, f/1.7.

This photograph shows a double solar eclipse in progress on Jupiter. Two of Jupiter's moons can be seen in the frame, Ganymede (left) and Europa (right). The two black spots on Jupiter's surface are the shadows cast by Europa and Ganymede (from left to right). This picture was taken a month after Jupiter's opposition with the Earth. Jupiter was at a distance of 4.09 AU from the Earth, shining brightly at a magnitude of -2.68 and appearing at a size of 47.11 arcseconds.

Aniruddha Aramanekoppa

CUAS 80th ANNIVERSARY ANNUAL DINNER: RECOLLECTIONS BY JAMES LANCASHIRE

16th March, 2023.

Chair, committee, current members and alumni, it is truly a pleasure to attend CUAS for this 80th anniversary.

I note, as this is divisible by four, this makes a 'leap year' celebration! Another significant milestone is the Observatory which marks 200 years since its opening in 1823, of which more memories in due course.

As an introduction to current members, I was Obs Sec in 1990 and Chair in 1991. There were two CUAS milestones in my period, plus a significant observing incident, of which more later.

At a comprehensive school in Stockport I had been inspired by 'Sky At Night' on TV and had used my mum's small garden binoculars to start looking round the sky at night. A physics teacher in my sixth form had a home-made refractor with an objective lens around 8-10 cm, mounted in a suitable length of drainpipe, and somehow had attached an eyepiece. So finally I could see moons of Jupiter, rings of Saturn, fine details on the Moon and some fainter Messier objects.

I also visited Jodrell Bank where it happened there was a demonstration of an inflatable planetarium dome, around 3m high. After crawling inside, I realised someone else was making an assessment of the projector's capability. When we emerged into daylight this older man asked what I thought of the dome - and I said it was a good experience depending on the price. He asked about me and I said I was in the sixth form and heading to Cambridge. He told me he was the Astronomer Royal! It was Francis Graham Smith, the radio astronomer, and I note it will be his 100th birthday next month!

My school was very large and as a prefect I knew almost all the 1600 pupils and 100 or so staff. So I wanted to be at a large college and also to enjoy the full range of Cambridge offerings outside Trinity and lectures. So I sought out various societies including CUAS. The Chair was at Sidney Sussex so it is a pleasant return here for me tonight. I also note the current Plumian Professor of Astronomy, Chris Reynolds, is now a fellow here. He was in my year at Trinity and was one of the high flyers academically. I recall many discussions with him at meals in hall and also during observing evenings together at the telescopes. Again more later.

The opening speaker was Sir Patrick Moore of 'The Sky At Night' and the large Lensfield Road chemistry lecture theatre was packed. The following year opened with Professor Stephen Hawking; again the queue was phenomenal and by then as a committee member there was a lot of organising to do at the event! I think that most professors, researchers, astronomers royal, astrophotographers and science writers have given talks to CUAS over the years. Plus astronauts, the odd astrologer and a healthy tradition of flat-earth proponents!

I loved the social aspects of CUAS with Sunday coffee mornings followed by a pub lunch, where students from other colleges and other subjects could mix. I remember one member insisted on eating his way through a whole packet of biscuits every Sunday so as to get full value from his membership! There were also naughty pranks like putting teabags into a kettle and pouring freshly boiled tea directly into mugs!

So I have always found astronomers to be friendly and supportive with a broad range of interests. If you look through the long list of CUAS committees, I think you find every college and probably every subject represented. It strikes me that with undergraduates being at Cambridge for 3 or maybe 4 years these days, the CUAS 80th birthday remarkably represents many, many 'generations' of students. I remember good mixes of men & women members and committee. The immediate Chair before me was a female materials scientist who loved a good social time!

As well as a wide range of distinguished speakers, CUAS is particularly fortunate to have use of telescopes at the Observatory. As you know the 20cm Thorrowgood and 30cm Northumberland. In my time, the Northumberland had just celebrated its 150th birthday in 1988. However the third Duke of Northumberland had purchased the large lens from Cauchoix in Paris in 1833. So this year is this lens's 190th birthday! The original lens has been replaced twice I believe, with the current objective having been specified by Dr Roderick Willstrop of the IoA who was also an illustrious Chair in the 1950s.

I was amazed to find this historic equipment was not locked away in a museum but available for use by CUAS members. Likely due to insurance reasons, you need to attend two demonstrations of safe use and pass a test of competence, usually run by the Obs Sec and committee. So there was an early taste of responsibility, plus a great opportunity to meet experienced observers from CUAS and the IoA, some of whom were also active with the BAA and RAS. I was fortunate to be elected to both these national organisations just after graduating.

So in the middle of World War II, with blackouts and very dark skies, undergraduates were inspired to form an astronomical group. The first CUAS Chair was John Lewis from Pembroke in 1942. I was able to meet him at the 50th dinner in 1993 and I wrote an account of his recollections for the newsletter. He was hugely proud that CUAS had thrived. He had asked Sir Arthur Eddington, the very eminent theoretician, to be first President and who in fact gave the opening talk in Lent 1943. CUAS did pretty well as Eddington unfortunately passed away in 1944 but this definitely set our society off on a very solid footing.

This brings me on to a very long-standing later CUAS President, Professor Donald Lynden-Bell. He had gone up to Clare when Dr Willstrop was Chair and at our 75th dinner Dr Willstrop recalled DLB being the first new student to knock on his door to ask about CUAS membership! Occasionally DLB would also wander round to the telescopes for a look through the eyepiece, precisely in the tradition of Eddington I think. As CUAS President, DLB and his wife hosted a meal at their house in Storeys Way prior to the annual full committee meeting, and again we very much appreciated their hospitality - though DLB often couldn't work a corkscrew!

A very long-serving senior treasurer was Dr David Dewhirst who was Librarian at the IoA, as well as being an early CUAS Chair. He had so many stories about astronomers that you felt he had probably known Galileo and possibly Ptolomey as well! He was invaluable in finding a speaker on an obscure topic, or persuading someone visiting the IoA to step in if there was a last-minute cancellation. I arranged a dinner to mark his 30th anniversary as Senior Treasurer which was well-attended, which also functioned as a dry-run for the CUAS 50th birthday dinner the following year. The society archives will hold full records of these.

It is the Chair's pleasant duty to arrange the weekly speakers and instead of a theme based on objects, I was inspired by the Royal Institution Christmas lectures given by Professor Malcolm Longair (of the Cavendish) and my basis was to include talks on all parts of the electromagnetic spectrum. There were exciting developments at that time, specific satellites were being launched and researchers had realised about the wealth of new insights by combining discoveries on an object across all wavelength observations of it.

Within our solar system, Voyager 2 was passing Uranus and Neptune and CUAS had bang up-to-date images with a talk from Garry Hunt the NASA project scientist. The discovery of the fluctuations in the cosmic microwave background made the national papers as well as a CUAS talk, and there was huge interest and excitement around astronomy at that time. Numbers of new members were over 100 each year from what I remember.

CUAS also organised joint meetings with the BAA which were well-attended but tricky to organise, especially getting a huge tea urn to boil in time for lunch! Other highlights were trips to Greenwich, Stonehenge and a quiz against Oxford. Plus fireworks, punting and the summer garden party. Again very social highlights and great ways to end each term.

In my final year before leaving Cambridge a certain comet Shoemaker-Levy 9 split and was due to impact on Jupiter. As the impact scars in the planet's atmosphere rotated into view they were literally breath-taking and some of my timings were published and agreed with minutes of those from the Hubble Space telescope! I made sunspot observations, saw eclipses (lunar and the 1999 solar on a return to Cambridge), all the planets of course, comets, meteor showers and many of the Messier objects. It is true that it takes take to 'get your eye in' but well worth developing your observing skills to see finer and fainter details.

I was also conscious in my time as a student that there was a transition from traditional film to digital imaging. It's remarkable progress indeed that there is now a high quality camera on every small mobile phone, and that these are enabled with reliable and cheap internet access.

A couple of years ago the greatest disruption came along with COVID and universities were affected the same as the whole world. However talks began broadcasting online and CUAS allowed links to alumni to keep updated. I think this proves the very good value of a lifetime membership!

And to sum up curiosity about our universe, Sir Isaac Newton remarked: "I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me."

So may I recommend enjoying your time with CUAS and your own discoveries on the 'astronomical beach'?!

Thank you for attending this wonderful meal, for listening and may I wish the health of our society in the traditional way: FLOREAT CUAS!

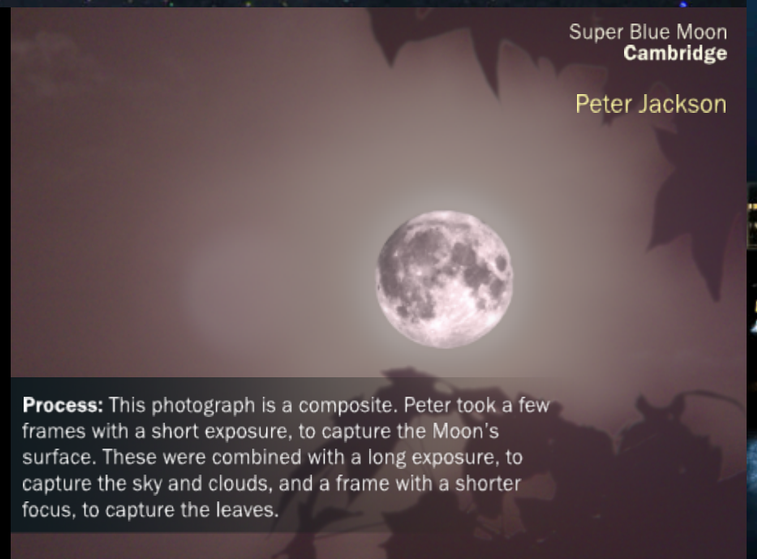
Speech *by* James Lancashire

A long exposure from the
Ngorongroro Crater, Tanzania

Kyrill Borzenko

Jupiter through the
Northumberland Telescope

Kyrill Borzenko



Super Blue Moon
Cambridge

Peter Jackson

Process: This photograph is a composite. Peter took a few frames with a short exposure, to capture the Moon's surface. These were combined with a long exposure, to capture the sky and clouds, and a frame with a shorter focus, to capture the leaves.

Messier 13
Northumberland Telescope

Edward Lancaster

The Ring Nebula through the
Northumberland Telescope

Edward Lancaster

The Moon above the River Itchen
Southampton

Yuting Shang

MEMBERS' PHOTOS

The Moon

Andrew Strong

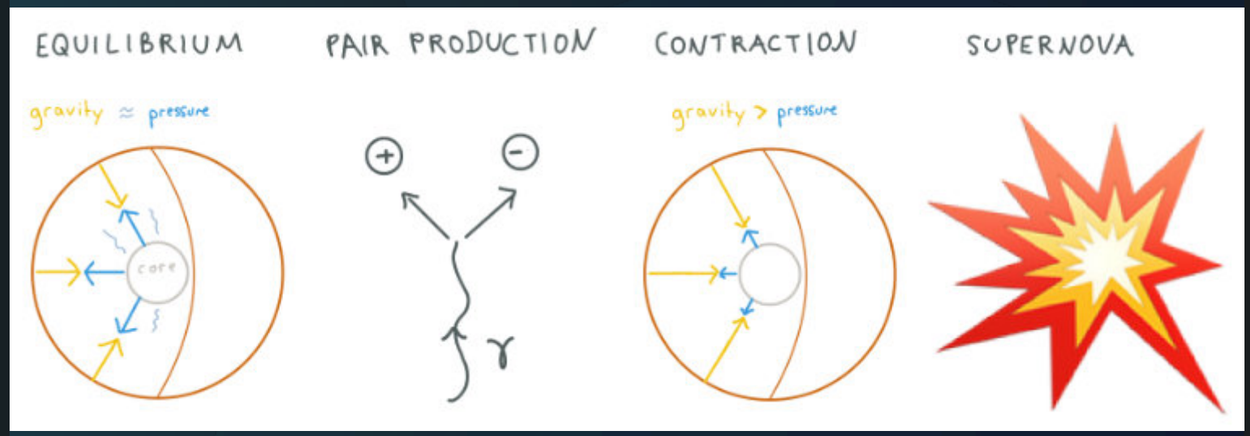
AN INTERNSHIP AT THE INSTITUTE OF ASTRONOMY

Throughout July and August, I was lucky enough to spend my summer working at the Institute of Astronomy in Cambridge on a funded summer internship exploring theoretical models of early universe stars and their supernovae.

The previous January had been somewhat stressful as I spent much of it writing and sending off internship applications, however once it got to summer and I was cycling into the Institute for my first day at work, it was all worthwhile given how much fun I had doing research. The first thing I saw when I came into the Observatory building (above), where I spent most of my time working, was a series of posters dedicated to past and present women in astronomy. Jocelyn Bell Burnell, who worked at Cambridge as a young postgraduate student in the 60s and was fundamental in the discovery of rotating neutron stars but was not awarded a Nobel prize (which went to her thesis supervisors instead), was on one such poster. She has since become a trailblazer for women in astrophysics and an inspiration to many. Another poster showed Caroline Crawford, an emeritus member of the Institute who has done a huge amount for astronomy both in research and outreach, and I regularly listen to her talking about stars and planets on the radio.

My project revolved around theoretical models of early universe stars, how they evolve and how they eventually die in spectacular explosions called supernovae. The first stars in the universe around 13 billion years ago that formed from primordial gas after the Big Bang were very different to 'modern' stars formed more recently. The first stars, known as Population III stars, could have enormous masses potentially up to a hundred or even a thousand times that of the Sun. Their chemical compositions were very different too as they were made mainly of hydrogen and helium. Modern stars are more chemically enriched and contain elements such as metals because these are the recycled products of previous generations of stars, which burnt light elements and fused them into heavier ones. Life as we know it could not exist without metals, which in astrophysics language means anything other than hydrogen and helium. Even the air we breathe is the result of elements made from past generations of stars. Because of their unique properties, it is thought that Population III stars may be able to explode in a rare and hypothetical supernova called a Pair Instability Supernova (PISNe). These can occur when a massive star undergoes a thermonuclear explosion. At the high temperatures and densities present in supermassive stellar cores, energetic photons collide with atomic nuclei resulting in the photon splitting to form an electron-positron pair. The star remains stable for as long as the outward radiation pressure from photons escaping the burning stellar core balances with inward gravitational pressure. However, when electron-positron pair production occurs the reduction in the number of photons present reduces the outward pressure, and the core rapidly contracts as the inward gravitational force begins to dominate and culminates in an enormous, bright explosion. When the core collapses it ignites explosive silicon and oxygen burning which blows the star apart and leaves no remnant behind, not even a black hole, which is unusual. This process is shown in a sketch I made below. Early universe stars have not yet been directly observed, but it is hoped that they may be indirectly observed through their explosions as PISNe, which is challenging due to their suspected rarity, but may be possible.

My job was to replicate some stellar evolution models, and then calculate how many PISNe could be seen per year for each model. Each model had a different distribution for the masses of the stars in a hypothetical population. For PISNe to occur, progenitor stars are thought to need a mass of 140-260 solar masses, so models that produce more stars in this mass range will also result in more PISNe.This is helpful because in a scenario where, say a telescope has been observing an area of sky for 1 year and found no PISNe (as is currently the case), we can calculate which models are most likely to have caused this outcome, which in turn constrains what we know about the stars that have evolved in such a model. This reverse statistical inference process is one used by many astronomers hoping to find rare supernovae and use them to uncover the secrets of the first stars.



Most of my work was quite mathematical and theoretical, but there were other interns on the summer programme working on observational astronomy and on topics as varied as white dwarf stars, exoplanet atmospheres and black holes. Everyone was very friendly and it was exciting to be in an environment with so many other astrophysics enthusiasts, with the highlight being a talk on space travel by the Astronomer Royal, Lord Martin Rees, which was very inspiring. Occasionally I would potter around the historic site, and I found some lovely old libraries with a treasure trove of astronomy magazines and books. One such room had an old astrophysics department photo from 1973, and peering closely I saw the famous Stephen Hawking on the front row. Next to that photo was a bust of another noteworthy Cambridge alumnus the Indian astrophysicist Subrahmanyan Chandrasekhar, who famously worked out the maximum mass of a white dwarf star before it explodes while on a long boat voyage in the 1930s. Seeing such famous names and important history about the scientists who worked here was very motivating. All in all, it was lovely to be part of the inspiring Institute of Astronomy community for two months and I learnt a great deal about astrophysics. I would like to thank the Summer Research Programme for funding my project and Dr. Fialkov and Mr. Gessey-Jones for supervising me over this time.

Article and Images *by* Almudena Visser Velez

VANDENBERG'S DARK SKIES OF AUSTRALIA

Lunar Eclipse (Blood Moon)
Newcastle, NSW, Australia

Tom Vandenberg

Two Photos of a solar eclipse
Exmouth, WA, Australia

Tom Vandenberg

Canon EOS 600D, EF-S 250mm lens, single exposures 1/60s, ISO 200

'From my observation point, the solar eclipse 'totality' only lasted for about 1 (spectacular) minute; you can see the sun beginning to re-emerge from behind the moon near the top of the circle in the second of the two solar eclipse pictures.'

Solar Eclipse: observation site during partial solar eclipse.
Exmouth, WA, Australia

Tom Vandenberg

Jupiter
Newcastle, NSW, Australia

Tom Vandenberg

Saturn
Newcastle, NSW, Australia

Tom Vandenberg

Telescope	Sky Watcher Newtonian - primary mirror diameter 10inch, 1.2m focal length (Dobsonian mount)
Camera	ASI 224MC camera + 2x Barlow
Software	Processed in AutoStakkert!3.
	Jupiter: 6313 frames (4.2ms each), best 20%. Saturn: 1811 frames (5.8ms each), best 50%

THE IMPASSABLE CHASM OF XENOLINGUISTICS

Meaningful communication with extraterrestrial entities has long been a subject of fascination and speculation. Numerous books and motion pictures have explored this captivating concept, with science fiction enthusiasts eagerly envisioning a universe teeming with interconnected civilisations. In a more scientific endeavour, researchers have already expounded certain initial cogitations within the novel field of Xenolinguistics.

However, it is important to approach this topic with a firm grip on reality, acknowledging the Herculean task demanded by the very concept of Communication with Extraterrestrial Intelligence (CETI). This short essay posits that the problem of decoding an alien language is not only intractable but utterly insolvable.

The film 'Arrival' (Paramount Pictures, 2016)[1] has been lauded as a compelling and thought-provoking case in question. In it, ETs ('heptapods') in spacecrafts touch down at key points across the Earth, leaving international governments mystified. The heroine, a linguist, is recruited to decipher the unreservedly outlandish written script of the aliens and establish their intentions. It is entertainment of course, so it only takes a quick montage cut or two before she attains fluency.

For the purpose of expediency, let us imagine a hypothetical scenario based on the parameters presented by 'Arrival':

1. ETI exists (rather uncertain);

2. It is biological (implausible, more likely it would be Artificial Intelligence);

3. The contact takes place tête-à-tête (the heptapods are physically visiting Earth; relatively improbable);

4. Both parties are willing to interact, setting aside many of the darker explanations of the Fermi Paradox (odds for this are indeterminate).

The film employs an intriguing setup, nonetheless -based on our current understanding- any interchange with the heptapods would prove insurmountably difficult in reality.

There are three overarching reasons for this:

A) Biological constraints: All known life-forms utilise biological mechanisms evolved on their native planet. However, the conditions that gave rise to us differ radically from other worlds. Without shared biochemistry or sensory modalities, finding a common framework for interaction poses a staggering challenge, perhaps an insuperable one. (as it would be for example with the "the superintelligent shades of the colour blue" - per Douglas Adams).

Terran life, including humans, utilises biological mechanisms that have developed on this planet. The building blocks of life, DNA, RNA, and proteins, are unique and have evolved over billions of years to adapt to the planet's habitat. Similarly, the sensory modalities utilised to perceive the world around us are also specific to Earth's environment.

If interspecies communication with animals which have the same genetic makeup and a similar sensory system to homo sapiens (think about primates, dolphins, canines) remains unreachable, one can only imagine how problematic this might be with creatures that have evolved on a different planet. ETI would possess different brains (if it uses such organs at all) and therefore might conceptualise the universe in ways that shall remain forever enigmatic to us—or to any other alien species- and exhibit agency that is utterly unfathomable.[2]

B) Temporal disparities: The timescales of existence may diverge radically in developmental processes, lifecycles, and cognitive architectures, which may create vast discrepancies in perceived and actual time and confound any attempt at correlation. (ET may need months -or picoseconds- to think, convey and process what we describe as one 'sentence').

Interestingly, this disparity is directly tackled in the film, where the heptapods' dissimilar perception of time comprises a major plot point. They are able to assimilate all of the past and future simultaneously rather than in a linear fashion, thus transcending the constraints of the present in a way that is incomprehensible to mankind. Whilst a gripping narrative device, this also serves as a reminder of the impasse we would face in attempting to converse with such entities.

C) Semantic obstacles: Communication necessitates congruence between symbols and their semantic import across individuals. Yet reaching beyond our planet, common referents and modes of abstraction may bear no resemblance whatsoever. Mapping each other's cognitive constructs onto an alternate frame of reference could well prove nonsensical.

For instance, in the film the protagonist holds a sign with the word 'human' (in Latin characters) before her and repeats it verbally, subsequently attempting to teach the hapless heptapods that herself is called 'Louise'. This is a procedure which may validly be utilised amongst foreign human cultures but would be most doubtful of any value when confronting an ETI. If anything, it is one of the very scenes that succinctly exposes the innumerable communication pitfalls of even such a prima facie simple act: Would heptapods understand the concept that every individual earthling has a defining call-sign? Why would they ever connect the vocalisation with the inscribed tokens? Why should 'human' signify an organism and not the appellation of the planet, a greeting/threat, or the term for 'sign'? Would the aliens be able to perceive the letters as intentional rather than accidental smudges? Would they be able to visually distinguish them at all?

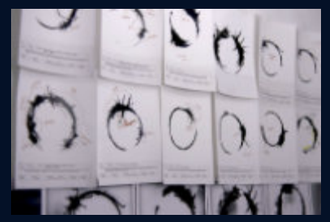
The fictional visitors confer through visual logograms, a set of mysterious inky and circular gaseous emissions that the tentacled creatures can expel into the air. The non-linear temporal

perception is reflected in their language, as the symbols represent entire ideas rather than individual phrases. The circularity presumably is meant to epitomise the holistic awareness of time.

One of the apparent assumptions of xenolinguistics is that any extraterrestrial civilisation would be sighted and they may communicate through space by the electromagnetic spectrum. But equally, their medium could be chemical or gravitational fluctuations and their long-distance signals based on quantum entanglement.

Employing mathematics as a common fundamental lingua franca is an idea elaborated in CETI studies for decades. Such exchanges could of course be used both over astronomical distances as well as in a close encounter. It may possibly constitute the one item that we could impart to each other, but even this conjecture may not be infallible. For one, an alien race might start with a different geometry and derive its laws of motion in that system; or their comprehension of their place in the universe might be divergent from ours. But even if these obstacles do not exist (or could be somehow overcome) it is hard to imagine how one could progress from astute mathematical banter ("we know of a higher prime number than you do...") to a meaningful discussion of any other topic.

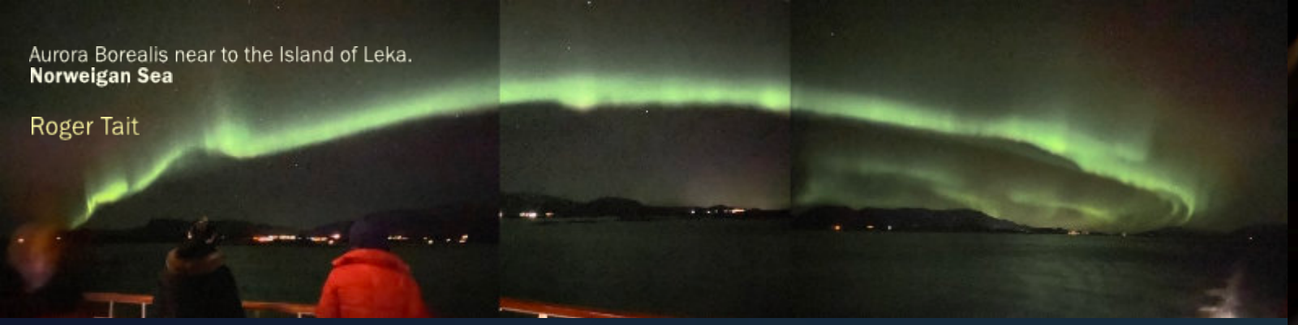
The above thoughts suggest that contact with an extraterrestrial intelligence able to bridge such disparate trajectories may simply exceed our capabilities. Absent providential serendipity, the chasm to interfacing with ETI from space appears impassable. Alas, it may be that in the immensity between stars, understanding threatens to remain perpetually and maddeningly alien.




Essay *by* Demetrius A. Floudas

Demetrius A. Floudas is Adj. Professor at IKBFU and the Senior Adviser of Cambridge Existential Risks Initiative. He is proud possessor of a Campo del Cielo bolide fragment and remains a stalwart member of CUAS since JD 2448556.26.

1. Copyright holder to accompanying photographs.
2. Cf. Stanislaw Lem, His Master's Voice, 1968; and Solaris, 1961.

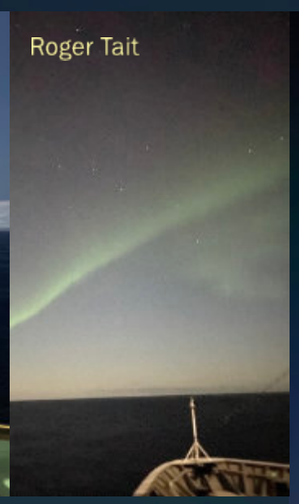


Aurora Borealis near to the Island of Leka.
Norweigan Sea

Roger Tait

TAIT'S ADVENTURES IN NORWAY

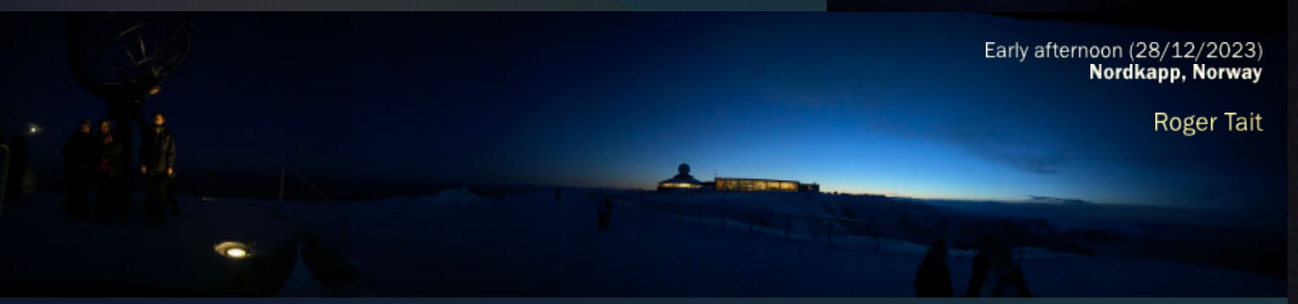
Roger Tait



Roger Tait

Roger Tait

Left 28/12/2023 • Moon shining on the sea near to Honningsvåg Norway.
Centre 29/12/2023 • Aurora Borealis near to Båtsfjord in the Norwegian Sea.
Right 29/12/2023 • Aurora Borealis near to Båtsfjord in the Norwegian Sea II.



Early afternoon (28/12/2023)
Nordkapp, Norway

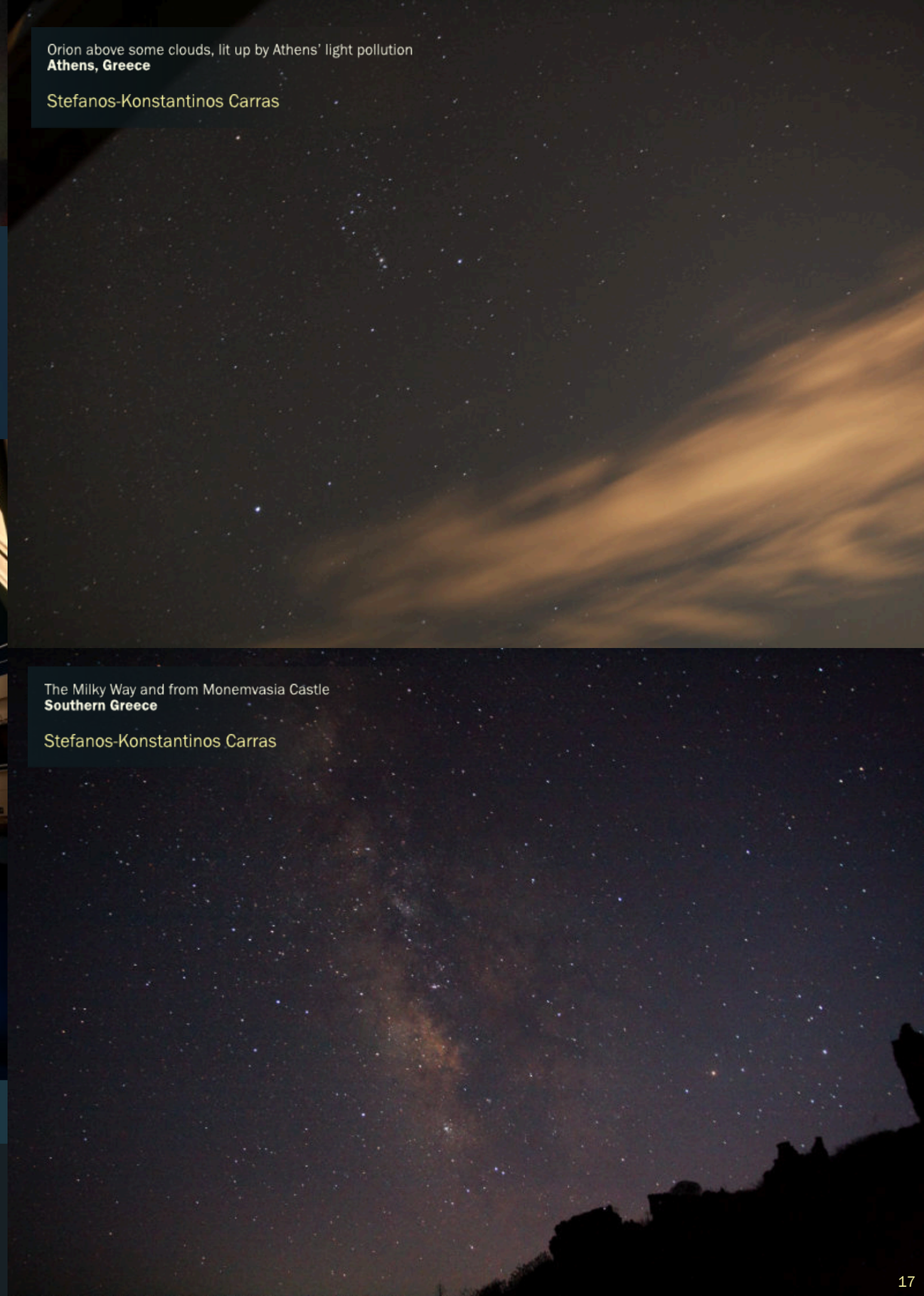
Roger Tait

'The sun does not come above the horizon at this time of the year but creates the blue light shown. The moon can be seen to the far left next to my wife and children who are standing next to the Nordkapp Globe.'

Andrew Strong's (Chair 1970-71) Reminiscences

'As chairman I had by tradition to give a talk in my room, and chose nucleosynthesis, which always fascinated me.'

'Cycling out to the Obs (as we called it); valiant searches for objects of interest (before the days of computer control); and climbing back into college in the early hours.'



Orion above some clouds, lit up by Athens' light pollution
Athens, Greece

Stefanos-Konstantinos Carras

The Milky Way and from Monemvasia Castle
Southern Greece

Stefanos-Konstantinos Carras

THE MULLARD OBSERVATORY

All four images *by* Juan Paulo Lorenzo Gerardos Barrios

Observatory Building
Cambridge

David Purchase

'The roof of the original IoA building, looking due east, with Churchill College just visible through the trees.

In a sense it is quite appropriate for this issue of Neptune, because the University Observatory was founded in 1824. Of course the roof will have been repaired, retiled and upgraded many times since then!'

SPACE PROJECT (AL37) - SPACE EXPLORATION PROGRAMME, IMAGES FROM DEEP INTO SPACE

In 2019, A. Lazarou created Ansas L37 (AL37) an advanced space project and the 'Communi Intellectu Theory' to conduct a search for unidentified aerial phenomena (UAP) and physical objects and to investigate electromagnetic wave transmission from large deep-space communication facilities. Space Program AL37 is inspired by astronomy, particularly the scientific research of extraterrestrial life and the scale of different types of universal intelligences. By using telescopes, camera, and computerised systems to gather data from outer space, she detects signals and laser pulses originated in our solar system. We share a small part of our data with non-scientists. The goal of the Space Program (AL37) is to search for extraterrestrial techno-signatures and to provide a continuous flow of outer space data and discovery of signals through powerful lasers and intense electromagnetic pulses. The type of signals that could prove the existence of alien life.

Words and Images *by* Anastasia Lazarou

Anastasia Lazarou is a Modelling Program volunteer, supporting with collected data of the Galileo Project founded by Dr Avi Loeb at Harvard University and the Department of Astronomy. In addition, Anastasia is a life member of Cambridge University Astronomical Society (CUAS).

Anastasia Lazarou has completed her master's in politics at Queen Mary University of London. This year she plans to start her PhD which is related to space domain and its astropolitical environment for the exploration and exploitation of space.

WHITAKER'S UNIVERSE

Justin Whitaker
Crescent Nebula

Frames

Lights	x 160 (180s)
Flats	x 40
Bias	x 100
Total Integration	8 Hours

Equipment

Camera	Canon 1100D (Full spectrum modified)
Mount	EQ6-R
Scope	Ian King 80ED Doublet
Guide Camera	QHY-5II-c
Captured with	Ekos
Processed in	Pixinsight

M45
PLEIADES

Justin Whitaker

Frames

Lights	x 180 (180s)
Flats	x 60
Bias	x 100
Total Integration	9 Hours

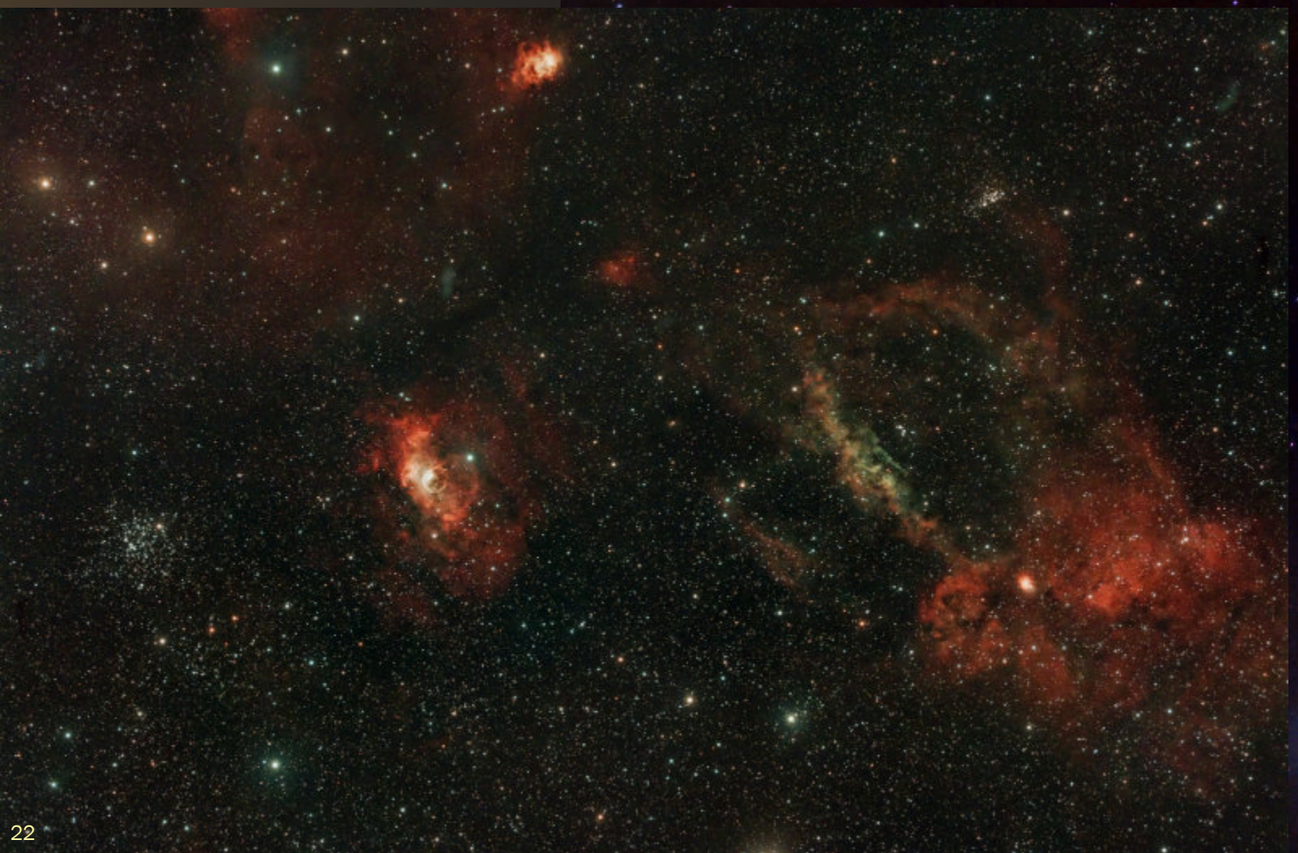
Equipment

Camera	Canon 80D
Mount	EQ6-R
Scope	Ian King 80ED Doublet
Guide Camera	QHY-5II-c
Captured with	*Ekos*
Processed in	Pixinsight

BUBBLE & LOBSTER CLAW NEBULAE

Justin Whitaker

Light Frames	x 170 (180s)
Total Integration	8.5 Hours



Justin Whitaker
Flaming Star and Tadpoles Nebulae

Light Frames	x 300 (180s)
Total Integration	15 Hours

DARK SHARK NEBULA

Justin Whitaker

Light Frames x 120 (300s)
Total Integration 10.5 Hours

ANDROMEDA

Justin Whitaker

Light Frames x 180 (180s)
Total Integration 9 Hours

TWO TELESCOPES; COMPARING IMAGES OF JUPITER

I

I wanted to compare images taken of Jupiter with a modern refractor and the Northumberland telescope.

I personally own and use a SkyWatcher Esprit 120ED APO refractor. Since this Esprit works at F7 (focal length 840mm and diameter 120mm) I use a x2.5 Televue barlow to increase the F number to 17.5 thereby giving me a larger image. I also use an IR cut filter to prevent my CCD camera from being swamped by the longer wavelengths.

The camera is a ZWO 294MC Pro one-shot colour camera and I use ZWO's ASICap to capture video images of Jupiter. I ran videos of 60 seconds in length. At opposition this would mean that Jupiter's mid-position could have moved by about 0.25" (arc seconds) due to it's axial rotation in this time period. The Dawes' limit of my scope is about 1" (arc second) under perfect conditions and that of the Northumberland telescope is slightly better than 0.5" (arc seconds). The blurring due to the exposure time is small. There is software (WinJUPOS) that can be used to deal with this but it was not used in this comparison.

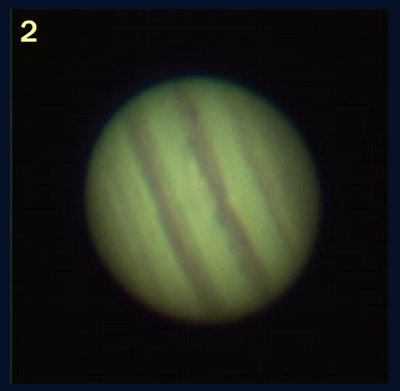
On three separate occasions (estimated at Bortle 4 by FLO Clear Outside App), I took videos using my ZWO 294MC Pro camera and IR cut filter. The Televue x2.5 barlow was used with the Esprit (F17.5) but not when using the Northumberland telescope (F20).

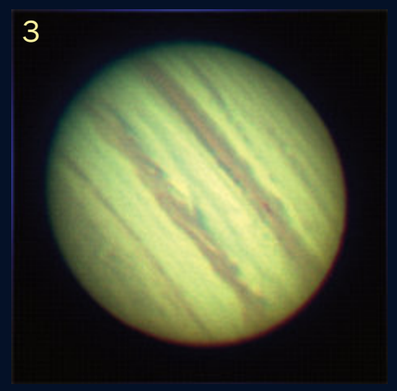
On the first occasion I used the Esprit and the Northumberland telescope on the 2 subsequent occasions.

Focusing with the Esprit was done by focusing on a star first and producing a 'V' curve to attain precise focus. Videos (16 in all) were then taken of Jupiter and processed using the following software:

Pipp	DeBayer, crop and centre.
AutoStakkert!	analyse, select best 50% of images and stack.
Registax	wavelet enhance and adjust colour balance.

The same method, except focusing , was carried out using the Northumberland Telescope. Since the Northumberland doesn't have electronic focusing control, on the first occasion I estimated the best focus position by eye but on the final occasion I used a Bahtinov mask with the Northumberland to obtain a more precise focus.



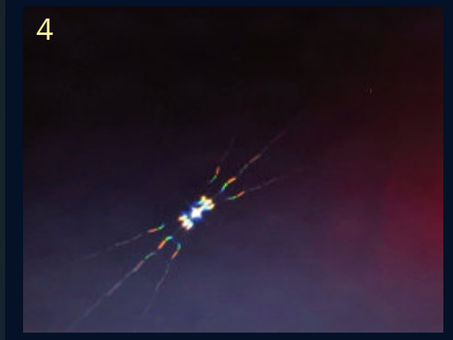


1 This is the best image I got from the Esprit. Io (the moon shown in the bottom left) is about to transit.

2 Compare this with the best Northumberland image ('guessing' focus by eye).

3 Northumberland image focusing using a Bahtinov mask .

The 120mm refractor image is considerably clearer and more detailed than either of the Northumberland images. The Northumberland image created by focusing using a Bahtinov mask is superior to the one created by 'guessing' the correct focus point.



The refractor is an apochromatic telescope whilst the Northumberland is only an achromatic lens and so there will be more chromatic aberration with the Northumberland. Since I am using a one shot colour camera, chromatic aberration could affect the quality of the final image.

The chromatic aberration effect can clearly be seen in the following photo I took of the computer screen when the Bahtinov mask was attached to the Northumberland (when focus is achieved the horizontal line should be in the middle of the X when using a Bahtinov mask, *Image 4*).

I would like to repeat the above exercise using a colour filter or a monochrome camera and see whether the difference in quality between the images produced by the two telescopes is reduced. If there is still a significant difference in quality then perhaps one of the following reasons might explain the loss of clarity with the Northumberland compared with the Esprit: collimation errors, dirty objective lens, inferior quality objective.

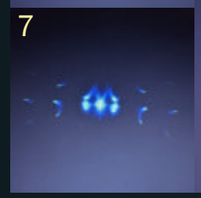
II

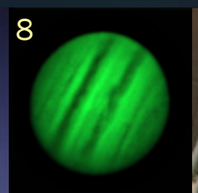
I managed to do one more session imaging Jupiter, but this time I used a filter wheel with RGB (red, green, blue) filters.

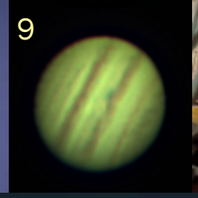
I focused the telescope using a Bahtinov mask with the green filter (since green is in the middle of the spectrum). I then recorded images of the Bahtinov mask for all RGB filters (*Images 5, 6 and 7*). Whilst the green image displays the horizontal line centred, the red image shows the horizontal line slightly above centre and, conversely, the blue image shows the horizontal line slightly below centre. This shows the limitations of an achromatic lens and its ability to only approximately bring the RGB light rays to the same focus.

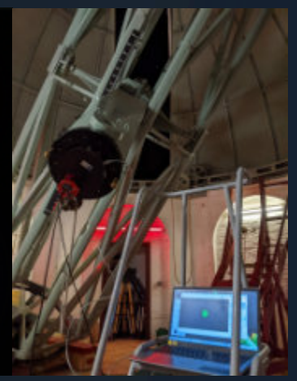
I then took and processed images of Jupiter using the green filter (which should in theory be perfectly focused) and also with no filter for comparison purposes (*Images 8 and 9*).

Whilst these images are probably better than my previous images using the Northumberland they still do not match up to those taken with the Skywatcher Esprit 120ED APO. Granted they were taken almost 3 months after opposition, I still was hoping for a better result. Perhaps the optical quality of a modern apochromatic refractor, albeit of only 120mm diameter, is better than the forty something year old achromatic optics of the Northumberland telescope? Perhaps I'll try again next year when Jupiter spins around to us.









Nearest Left

Working with the Northumberland Telescope.

Words and Images *by* Kevin Reid

JACKSON'S NEBULAE

Peter Jackson

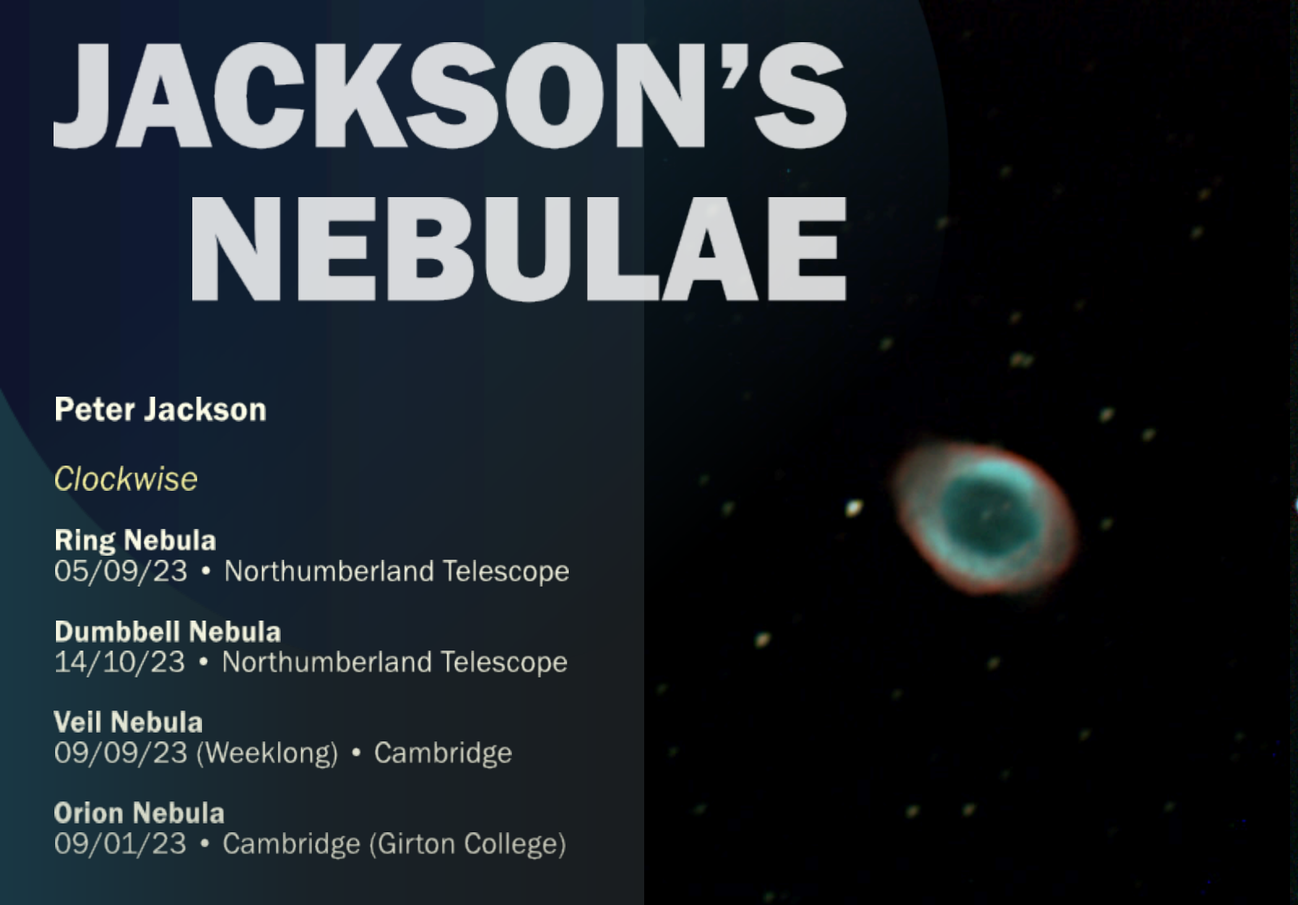
Clockwise

Ring Nebula
05/09/23 • Northumberland Telescope

Dumbbell Nebula
14/10/23 • Northumberland Telescope

Veil Nebula
09/09/23 (Weeklong) • Cambridge

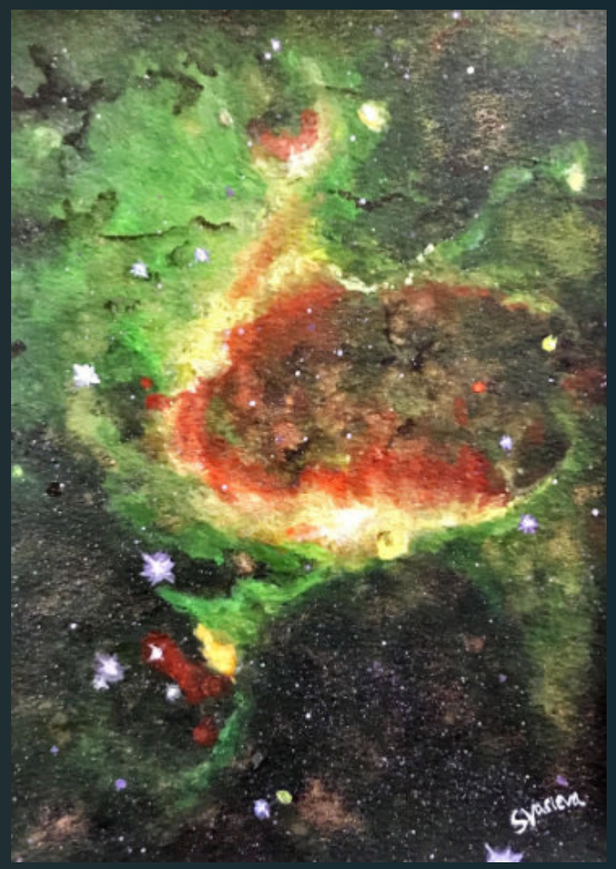
Orion Nebula
09/01/23 • Cambridge (Girton College)



Camera	Modified Canon 600D
Mount	Homemade
Frames	x 93 (15s) Unfiltered RGB (23.15 minutes)
Processed in	DSS and GIMP

Camera	Modified Canon 600D
Frames	x 45 (60s) UHC Filter
Processed in	DSS and GIMP

Camera	Modified Canon 600D
Frames	x 200 (30s) RGB, x 120 (30s) Ha
Processed in	DSS and GIMP

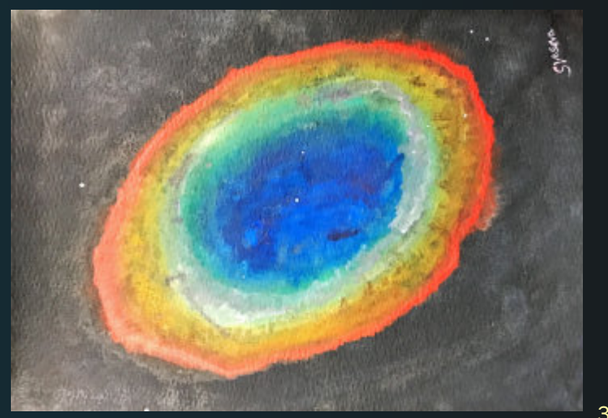


WATERCOLOURS

Four Paintings *by* Sofia Vasieva

Find Sofia on Instagram @rays.escaping

Furthest Left	Eagle Nebula
Above	Crab Nebula
Below	Ring Nebula



INTO THE MULTIVERSE

Poems *by* Ziyou Lu, Leo Tan and Joshua Teo

Cosmic Microwave Background radiation waves. It is not bird poop.

Levi-Civita connection, for curved surfaces' description, where we have to resort to parallel transport, and get the geodesic equation.

Born-Oppenheimer Method. In 1904 Oppenheimer Born.

ged rotating black hole, Surprising closed form.

.

et their energies deplete. We get gravitational waves.

e than we had forecast. We need dark matter to explain it better, in the universe oh so vast!

Point of infinite density, expanded exponentially. Thanks to inflation, there's an explanation, to the universe's homogeneity.

Kerr-Newnham Metric. A charged rota

Galaxies spinning too fast, much more than we had forecast. We need dark matter to explain it better, in the universe oh so vast!

Remnants of a collapsing star, that white dwarves and neutron stars are. Which is the result? We have to consult: the limit of Chandrasekhar.

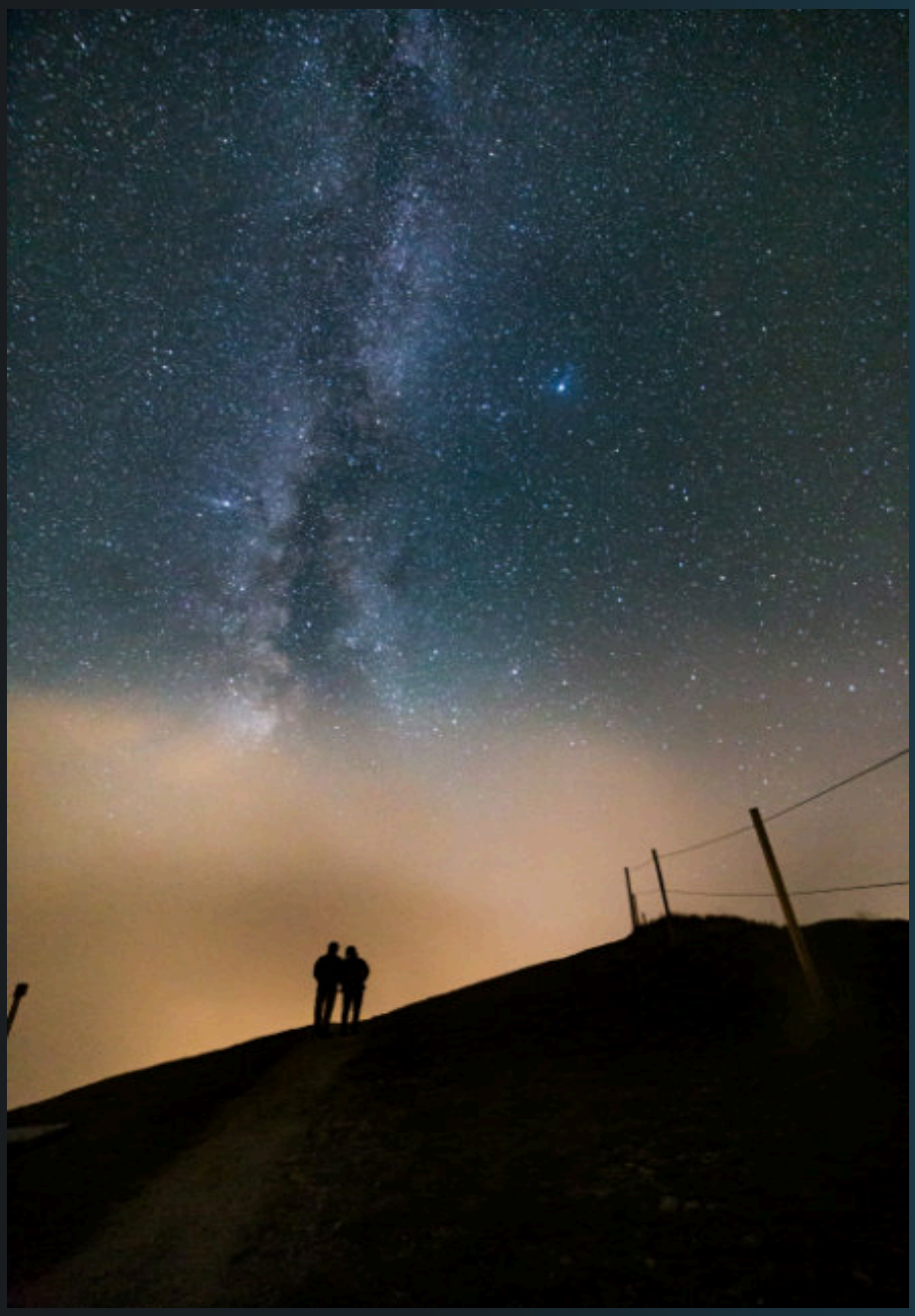
On Earth we measure from afar: regular bursts from a pulsar. Turns out the suspect, that we least expect, is actually a neutron star.

Near black holes GR replaces Newton's theory in most cases. Your time is frozen at event horizon, then your space and time swap places.

Ripples in spacetime so brave, due to a planetary rave! When two black holes meet their end.

Explain this singularity? The answer's quantum gravity! The problem with these incomplete theories: Renormalisability.

CAMBRIDGE UNIVERSITY ASTRONOMICAL SOCIETY



Cover Image *by* Haozhe Zhu — Seceda, Italy

NEPTUNE is the annual publication of the Cambridge University Astronomical Society. It is comprised of works produced by members of the society.