

Current Notes

Cassini Legacy Special
September 2018



Introduction

After two decades in space, NASA's Cassini spacecraft reached the end of its remarkable journey of exploration.

Having expended almost every bit of the rocket propellant Cassini carried to Saturn, operators deliberately plunged the spacecraft into the planet to ensure Saturn's moons will remain pristine for future exploration in particular, the ice-covered, ocean-bearing moon Enceladus, but also Titan, with its intriguing pre-biotic chemistry.

Beginning in 2010, Cassini began a seven-year mission extension in which it completed many moon flybys while observing seasonal changes on Saturn and Titan. The plan for this phase of the mission was to expend all of the spacecraft's propellant while exploring Saturn, ending with a plunge into the planet's atmosphere.

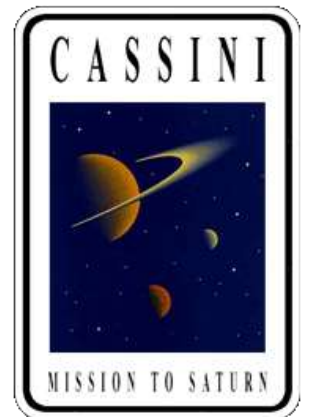
In April 2017, operators placed Cassini on an impact course that unfolded over five months of daring dives with a series of 22 orbits that each passed between the planet and its rings. Called the Grand Finale, this final phase of the mission brought unparalleled observations of the planet and its rings from closer than ever before.

On 15th September 2017, the spacecraft made its final approach to the giant planet Saturn. But this encounter was like no other. This time, Cassini dived into the planet's atmosphere, sending science data for as long as its small thrusters could keep the spacecraft's antenna pointed at Earth. Soon after, Cassini burned up and disintegrated like a meteor.



To its very end, Cassini was a mission of thrilling exploration. Launched on 15th October 1997, the spacecraft entered orbit around Saturn on 30th June 2004, carrying the European Huygens probe. After its four-year prime mission, Cassini's tour was extended twice. Its key discoveries included the global ocean with indications of hydrothermal activity within Enceladus, and liquid methane season Titan.

And although the spacecraft may be gone, its enormous collection of data about Saturn the giant planet itself, its magnetosphere, rings and moons will continue to yield new discoveries for decades.





With Cassini's exploration of Saturn coming to a dashing end in a few months, the mission team scheduled an "All Cassini Plus Alumni" group photo on Wednesday, June 21st 2017 to commemorate the event.



The Cassini program is an international cooperative effort involving NASA, the European Space Agency (ESA) and the Italian space agency, Agenzia Spaziale Italiana (ASI), as well as several separate European academic and industrial contributors. The Cassini partnership represents an undertaking whose scope and cost could not likely be borne by any single nation, and is made possible through shared investment and participation.

Through the mission, about 260 scientists from 17 countries hope to gain a better understanding of the Saturn, its rings, moons and magnetosphere.





CASSINI

MISSION OVERVIEW



Cassini had several objectives, including:

- Determining the three-dimensional structure and dynamic behaviour of the rings of Saturn.
- Determining the composition of the satellite surfaces and the geological history of each object.
- Determining the nature and origin of the dark material on Iapetus's leading hemisphere.
- Measuring the three-dimensional structure and dynamic behaviour of the magnetosphere.
- Studying the dynamic behaviour of Saturn's atmosphere at cloud level.
- Studying the time variability of Titan's clouds and hazes.
- Characterizing Titan's surface on a regional scale.

Cassini–Huygens was launched on October 15th 1997, from Cape Canaveral Air Force Station's Space Launch Complex 40 using a U.S. Air Force Titan IVB/Centaur rocket. The complete launcher was made up of a two-stage Titan IV booster rocket, two strap-on solid rocket motors, the Centaur upper stage, and a payload enclosure, or fairing.

The total cost of this scientific exploration mission was about US\$3.26 billion, including \$1.4 billion for pre-launch development, \$704 million for mission operations, \$54 million for tracking and \$422 million for the launch vehicle. The United States contributed \$2.6 billion (80%), the ESA \$500 million (15%), and the ASI \$160 million (5%). However, these figures are from the press kit which was prepared in October 2000. They do not include inflation over the course of a very long mission, nor do they include the cost of the extended missions.



The primary mission for Cassini was completed on July 30th 2008. The mission was extended to June 2010 (Cassini Equinox Mission). This studied the Saturn system in detail during the planet's equinox, which happened in August 2009.

On February 3rd, 2010, NASA announced another extension for Cassini, lasting 6.5 years until 2017, ending at the time of summer solstice in Saturn's northern hemisphere (Cassini Solstice Mission). The extension enabled another 155 revolutions around the planet, 54 flybys of Titan and 11 flybys of Enceladus. In 2017, an encounter with Titan changed its orbit in such a way that, at closest approach to Saturn, it was only 3,000 km above the planet's cloud tops, below the inner edge of the D ring. This sequence of "proximal orbits" ended when its final encounter with Titan sent the probe into Saturn's atmosphere to be destroyed.



1. The Huygens probe makes first landing on a moon in the outer solar system (Titan).
 - Huygens's historic 2005 landing on Titan was the most distant in our solar system to date. The probe's 2-hour and 27-minute descent revealed Titan to be remarkably like Earth before life evolved, with methane rain, erosion and drainage channels and dry lake beds. A soup of complex hydrocarbons, including benzene, was found in Titan's atmosphere. Huygens also provided the first on-site measurements of the atmospheric temperature.
2. Discovery of active, icy plumes on the Saturnian moon Enceladus.
 - The discovery of Enceladus's massive plume was such a surprise that mission designers completely reshaped the mission to get a better look. The discovery became even more important when Cassini found evidence of water-based ice in the plume. Life as we know it relies on water, so the search for life suddenly extended to this small, bright moon. The recent discovery of signs of an subsurface ocean makes Enceladus one of the most exciting science destinations in our solar system.
3. Saturn's rings revealed as active and dynamic -- a laboratory for how planets form.
 - Cassini's decade-long mission made it possible to watch changes in Saturn's dynamic ring system. The spacecraft discovered propeller-like formations, witnessed the possible birth of a new moon and observed what may be one of the most active, chaotic rings in our solar system (Saturn's F ring).
4. Titan revealed as Earth-like world with rain, rivers, lakes and seas.
 - Imaging with radar, and both visible and infrared wavelengths shows that Titan has many geologic processes similar to that of the Earth. These processes generate methane rains, which build river channels and form lakes and seas containing liquid methane and ethane that don't immediately evaporate.



5. Studies of the great northern storm of 2010-2011.

- Late in 2010, Saturn's relatively tranquil atmosphere erupted with a storm of gigantic proportions. Typically a 30-year storm, this one arrived 10 years early, giving Cassini a front-row seat. Within months, this storm grew to encircle the planet with a swirling band. The largest temperature increases ever recorded for any planet were measured. Molecules never before seen in Saturn's upper atmosphere were detected. The storm diminished shortly after its head collided with its tail, a little less than a year after it began.

6. Radio-wave patterns shown not to be tied to Saturn's interior rotation as previously thought.

- Saturn emits radio waves known as Saturn Kilometric Radiation. A similar radio wave pattern was measured at Jupiter to deduce the length of that planet's day, but Saturn's daily rotation rate turned out to be much more complicated. Recent data from the radio and plasma wave instrument show that the variation in radio waves controlled by the planet's rotation is different in the northern and southern hemispheres. The northern and southern rotational variations also appear to change with the Saturnian seasons and the hemispheres have actually swapped rates. Saturn's length of day is still not known.

7. Vertical structures in the rings imaged for the first time.

- Once about every 15 years, the Sun shines on the edge of the ring plane and northern and southern sides of the rings receive little sunlight. Cassini measured the thick, long shadows from this rare event to determine the heights of structures within the rings.

8. Study of prebiotic chemistry on Titan.

- Titan's atmosphere is a zoo teeming with a variety of molecules -- the most chemically complex in the solar system. Beginning with sunlight and methane, ever more complex molecules form until they become large enough to form the smog that covers the giant moon. Nearer the surface, methane, ethane, and other organics condense and fall to the surface where likely other prebiotic chemistry can take place.

9. Mystery of the dual bright-dark surface of the moon Iapetus solved.

- The origin of Iapetus's two-faced surface has been a mystery for more than 300 years. The Cassini spacecraft solved the puzzle. Dark, reddish dust in Iapetus's orbital path is swept up and lands on the leading face of the moon. The dark areas absorb energy and become warmer, while uncontaminated areas remain cooler. The moon's long rotation period contributes to the yin-yang effect.

10. First complete view of the north polar hexagon and discovery of giant hurricanes at both of Saturn's poles.

- Saturn's Polar Regions have surprised scientists with the presence of a long-lived hexagonal-shaped jet stream in the north and two hurricane-like storms at both poles. The driving forces of each remain a mystery.

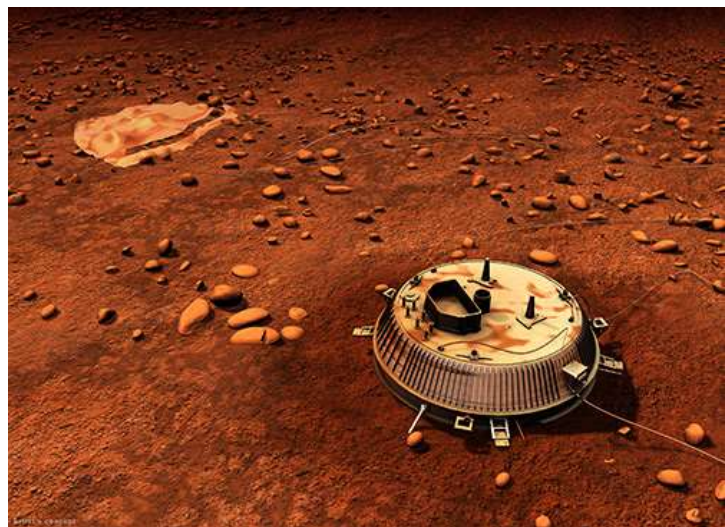
Huygens Probe

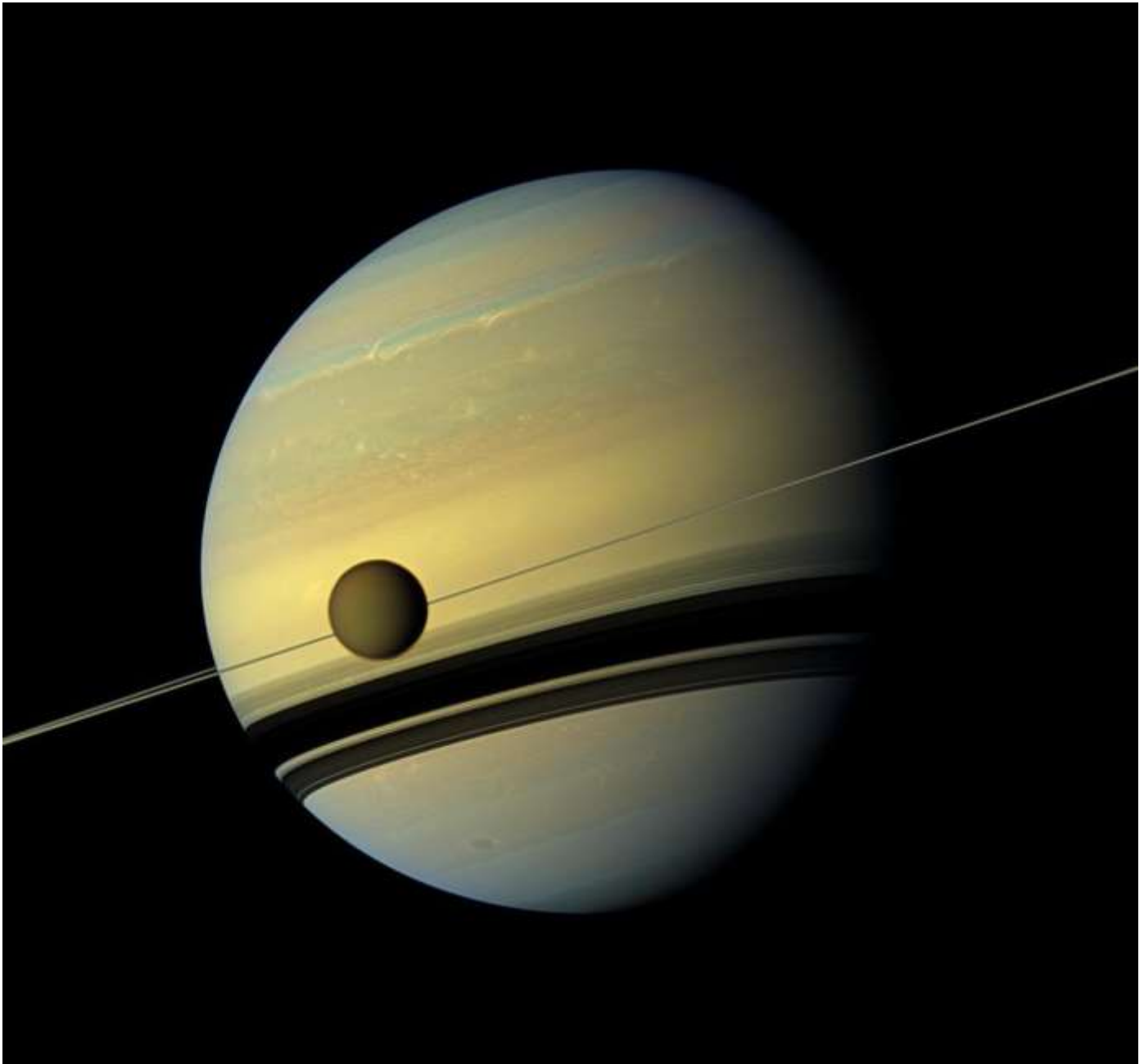
Huygens was an atmospheric entry probe that landed successfully on Saturn's moon Titan in 2005. Built and operated by the European Space Agency (ESA), it was part of the Cassini–Huygens mission and became the first spacecraft ever to land on Titan and the farthest landing from Earth a spacecraft has ever made. The probe was named after the Dutch 17th-century astronomer Christiaan Huygens, who discovered Titan in 1655.

The combined Cassini–Huygens spacecraft was launched from Earth on October 15, 1997. Huygens separated from the Cassini orbiter on December 25, 2004, and landed on Titan on January 14, 2005 near the Adiri region. This is the only landing accomplished in the outer Solar System. It was also the first landing on a moon other than our own. It touched down on land, although the possibility that it would touch down in an ocean was also taken into account in its design. The probe was designed to gather data for a few hours in the atmosphere, and possibly a short time at the surface. It continued to send data for about 90 minutes after touchdown. It remains the most distant landing of any human-made craft.



In situ image of Titan's surface from Huygens—the first images from a non-Earth planetary surface beyond Mars and Venus. Globules (probably made of water ice) 10–15 cm in size lie above darker, finer-grained substrate in a variable spatial distribution. Brightening of the upper left side of several rocks suggests solar illumination from that direction, implying a southerly view, which agrees with preliminary evidence from other data sets. A region with a relatively low number of rocks lies between clusters of rocks in the foreground and the background and matches the general orientation of channel-like features in the low-altitude images taken from under 7km altitude.





Many lessons learned during Cassini's mission are being applied to planning NASA's Europa Clipper mission, planned for launch in the 2020s. Europa Clipper will fly by the icy ocean moon dozens of times to investigate its potential habitability, using an orbital tour design derived from the way Cassini has explored Saturn. The Europa Clipper mission will orbit the giant planet -- Jupiter in this case -- using gravitational assists from its large moons to manoeuvre the spacecraft into repeated close encounters with Europa. This is similar to the way Cassini's tour designers used the gravity of Saturn's moon Titan to continually shape their spacecraft's course.

In the decades following Cassini, scientists hope to return to the Saturn system to follow up on the mission's many discoveries. Mission concepts under consideration include spacecraft to drift on the methane seas of Titan and fly through the Enceladus plume to collect and analyse samples for signs of biology.

The Cassini-Huygens mission is a cooperative project of NASA, ESA (European Space Agency) and the Italian Space Agency. NASA's Jet Propulsion Laboratory, a division of Caltech in Pasadena, manages the mission for NASA's Science Mission Directorate, Washington. JPL designed, developed and assembled the Cassini orbiter.

Rebuilding the KMO Moon Machine.

Kevin J Kilburn

In 1990 Manchester Astronomical Society got a new member, Dame Kathleen Mary Ollerenshaw DBE, OStJ, MA, Dphil, Hon.LLD, CNA, Hon. LLD Manchester, Hon. DSc Salford. Kathleen was also former Lord Mayor of Manchester, Oxford don and mathematician. She was a keen educationalist, especially for girl's schools in the northwest and was a member of Margaret Thatcher's committee when she was Minister for Education.

In 1990, then age 78, Kathleen had been driving up the M6 from her Manchester home in Pine Road, Didsbury, to her Lakeland retreat at Hodge Close when she decided to do something about a long-time interest in astronomy; she would buy a telescope and learn more about the stars.

Never doing anything by halves, Kathleen phoned the then Astronomer Royal, director of Jodrell Bank, Sir Francis Graham Smith, about where to buy a suitable telescope. Within days she bought an 8-inch Celestron Schmidt-Cassegrain (SCT) from a telescope dealer in Liverpool...and never looked back. Joining Manchester AS was the next step. She arrived one Thursday evening, liked what she saw and the people she met and demanded to be taught how to navigate the heavens...on one condition...she must ALWAYS be referred to as Dame Kathleen. That lasted about a month before she was just Kathleen to everyone present.

We hit it off from the start and became great friends. Although her knowledge of astronomy was initially limited, she was a fast learner and was soon photographing the sky with an old Minolta SLR and slide film so that she could learn and memorize the constellations. The 8-inch Celestron being deemed too small, she bought an 11-inch Celestron SCT and took up photography of the moon and planets. Deep sky objects were however too difficult for her to find, so the C11 was quickly replaced by one of the first fork-mounted GOTO Meade LX200 series 10-inch SCTs with which she began imaging galaxies and star clusters with a Starlight Express CCD camera. *(The C11 was subsequently given to Lancaster University as the seed of the Kathleen Ollerenshaw observatory)*

The telescope was mounted in a substantial run-off roof observatory, Lovell II, (Lovell is the name of the 200ft radio telescope at Jodrell Bank) under the dark skies at Hodge Close, Cumbria. *(Her first observatory was a disused outdoor toilet that she christened Lovell I.)*



The Observatory, front view, 1994.

The fruits of her labours were documented in the 1996 Year Book of Astronomy, edited by Patrick Moore; some of her images being featured on Sky at Night. From the start, Kathleen acknowledged that she was a beginner in astronomy but always made contacts at the highest levels. Patrick Moore was a frequent house guest at Pine Road and I was usually roped in to act as 'interpreter' between Kathleen and Patrick...Kathleen was profoundly deaf from birth and with Patrick it was sometimes difficult to get a word in edgeways but as I'd first met him in 1967, the three of us got along marvellously. I recall one late Sunday evening sitting between Kathleen and Patrick sipping a glass of port and watching Sky at Night...he recorded them in one take and never watched before the programme was aired.

One evening Patrick gave a xylophone recital at Owens College. I was their chauffeur that evening, in my old company issue Vauxhall Cavalier. It had a small stone chip in the windscreen and as we went past streetlights a little shadow ran across the dash, much to Kathleen's annoyance as she thought it was a fly! After her many attempts to swat it, Patrick, in the back seat, asked, 'What's the matter?' Kathleen was stone deaf so Patrick shouted again, but louder. Kathleen shouted back; it was bedlam with me trying to drive and the two of them now ganging up and determined to get that pesky fly. (*Reiterated in Martin Moberly's follow-up biography of Patrick Moore, 'Return to the Far Side of Planet Moore'. Springer 2015.*)



KMO and Patrick at the opening of the Ollerenshaw observatory, Lancaster University 2008)

On another occasion, Kathleen invited me to Jodrell Bank where Astronomer Royal, Sir Arnold Wolfendale, was giving a talk to a children's group under the auspices of Manchester's Literary and Philosophical Society of which she was a patron. It was a pleasant summer evening as we arrived at the venue, the now-demolished planetarium, where we found an elderly gentleman hammering at the door trying to get in...it was Sir Bernard Lovell. He was trying to enter via a fire escape door and no-one would let him in! After the talk, I was privileged to accompany Kathleen to Stanneylands Hotel at Wilmslow where we joined Sir Bernard, Sir Arnold Wolfendale, Sir Francis Graham Smith and Prof Andrew Lyne for a very enjoyable dinner.

By the time Kathleen was in her early nineties, degenerative macular disease had affected her eyesight. She couldn't use the telescopes and wasn't able to drive herself up to Hodge Close. The LX200 was given to Denis Buczinski, a very keen lunar and deep sky observer at his Conder Brow observatory near Lancaster where Denis was proprietor of a butcher's shop. He and Kathleen once attended a lecture at Lancaster University where the Duchess of Kent was in attendance. The Duchess and Denis were introduced and got on like a house on fire; the next morning, enroute home, the Duchess popped into his shop for a pound or two of his best sausages!

In 2006, shortly before his retirement to Scotland, Denis returned the LX200 to Pine Rd. The telescope had been well used for over fifteen years but the original 12v handset controller was damaged. It was replaced at

Stockport Binocular and Telescope Centre. Kathleen then asked me to look after the instrument with the informal agreement that when I had no further use for it, it would become the property of MAS. (*Denis and I were executors of Kathleen's astronomical equipment in her Will although, by the time of her death aged nearly 102 in 2014, most of it had already been given away.*)

After I moved from Bollington to New Mills in 2007, the telescope was set up on its original fork mounting on tracks so that it could be wheeled in and out of a purposely modified shed... the Low Leighton Cuckoo Clock observatory.



The setup worked well until it fell foul of the Meade's Achilles heel. One afternoon I was checking the GOTO when the lead from the handset to the telescope drive became accidentally unplugged. Without thinking I plugged it back in...and 'fried' the handset circuitry: NEVER, EVER, reconnect a computerized hand controller without first switching off the power. The GOTO facility, slewing and most of the other functions had gone for good but fortunately the RA drive still worked and for the next three years I used the scope for lunar imaging and as a platform for carrying a SkyWatcher ED80 refractor for semi-wide, deep sky pictures



I moved from New Mills to Cheddleton in the Staffordshire Moorlands in August 2012, after taking early retirement. Nearly a year passed before I could re-mount the LX200, again on wheels so it could be run in and out of an annex to my 'shed', actually a rather substantial workshop built by a previous owner who was a map maker and who used it as his drawing office. I spent many months re-mounting the telescope on a moveable pier only to find that when I switched it on for the first time in late 2013 the drive motor was dead. This time the Meade fork mounting couldn't be revived or easily replaced. Remounting the telescope on a heavy duty tangent arm drive didn't work either; the stepper motor drive was too coarse for long exposure imaging.

I officially retired in January 2015 but some months before then made access to my 'pension pot', accrued for over 35 years. In December 2014 I bought a SkyWatcher NEQ6 Pro heavy duty GOTO mounting for the 10-inch SCT which by then had been dismantled from its original and now useless fork. A meeting with another amateur astronomer and blacksmith in Cheadle, Staffordshire, about 6 miles from my home resulted in Jim Plant making me a moveable T-shaped support for the NEQ6 mounting. Jim is an honorary member of the British Astronomical Association, having joined in 1963, and his domed observatory in the centre of Cheadle houses a massive 15-inch fork-mounted Newtonian reflector that he built over 40yrs ago for lunar and planetary observing.

The 'T-trolley' that Jim made for me is of simple construction; a T-frame of butt-welded rectangular steel section drilled at each extremity to accommodate the spikes of the NEQ6 tripod. The central screwed rod that fastens the tripod legs onto the equatorial head was replaced by $\frac{1}{2}$ " stainless steel threaded rod extended down to the T-trolley to tension the whole mounting into a rigid tetrahedron. As no visual observations were ever intended, the tripod legs are fully retracted to give maximum stability and the lowest profile. The T-trolley is supported on 60mm diameter V-grooved wheels that run on 10mm diameter steel rods welded to three 40x40mm angle iron tracks each 2.4m long. (*Supplied by the Rolling Centre, Leeds, as heavy duty sliding-warehouse door wheels.*)

With a bit of external levelling, to bring the outside path up to the level of the shed's concrete floor, the tracks were laid, Rawl-bolted to the concrete and pointed-in with sloppy cement to give a solid foundation. The T-trolley was designed to pass through the 33-inch wide door frame but this had to be cut away at its base to allow freer access.



The T-trolley

The NEQ6 heavy-duty mounting is a monster, the equatorial itself weighing in at around 25kg and capable of carrying my 26kg telescope plus balancing counterweights for visual use. Its load capacity is 23kg for long exposure auto-guided photography but as I'm using it for less critical video imaging where some small drift is allowable, my setup, which includes nearly 30kg of counterweight is still well within its capability. The set-up is deliberately slightly east-side heavy to ensure that the drive takes up any backlash in the gearing and to allow for accessories fitted to the telescope.



Although the mounting and the telescope weigh upwards of 125kg, the smoothly-running T-trolley can be pushed in and out of the shed literally with one finger: that's important to me, I don't want to struggle to set up a big telescope as I get older. Setting up quickly and ready to go is fundamental to astronomical productivity. A permanent dome is a luxury that few of us can afford or find garden space for but a fixed mounting and a run-off roof observatory like Kathleen had at Hodge Close is an alternative solution; mine is another practical approach in achieving the same end.



The 10-inch Meade SCT optical tube assembly is all that remains of the original LX200. Although hardly necessary, even after more than two decades of use, its 1991 OTA was re-collimated in 2016 by Dr Mark Hadley of Macclesfield AS using a state of the art SCT collimator. Although the original, rather shaky Meade fork mounting had to be scrapped when the drive packed up, the new assembly based around the NEQ6 mounting is off-the-shelf and as good as it gets, now specifically for lunar and planetary imaging. It's far more solid and stable than the original fork, even in high winds. I may yet use the GOTO capabilities to find planets and other visual objects but my setup still needs accurate polar alignment before even considering 2 or 3 star synchronization with the sky. As with the original agreement with Kathleen Ollerenshaw, the telescope and its new replacement mounting, together with ancillary bits 'n' bobs will be bequeathed to MAS when I've finished using it.

So far, so good, but anyone who's tried to understand the clear-as-mud handbook to the SkyWatcher NEQ6 or the smaller EQ5 Pro GOTO mountings will appreciate that even setting the tracking speed, sidereal, lunar or solar, necessitates wading through several pages of instructions. However I have now managed it and can wheel the telescope out on its rails, set the drive rate and attach the video camera via the laptop computer on its little wheeled computer trolley ready for lunar or planetary imaging within 10 minutes. First light was in June 2017 when Saturn at opposition was tentatively imaged low in the summer sky but first moonlight wasn't until January 2018, by which time the T-trolley rails had been extended to give more freedom at the back end of the telescope and when, for the first time since 2012, lunar imaging recommenced.

Members of Manchester AS are very welcome to come down to my home in Staffordshire to see and to use the instrument but in the meantime recent lunar images are attached to this article.

Both the 10-inch SCT and the NEQ6 mounting will be bequeathed to Manchester AS either when I get too old to use them or in my Will.

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Montes Alps,
Caucasus
and Apennines



10-inch LX200 SCT
DBK21AU618

Four panel panorama

KJKilburn ST13

2018 02 26 1802-1806UT

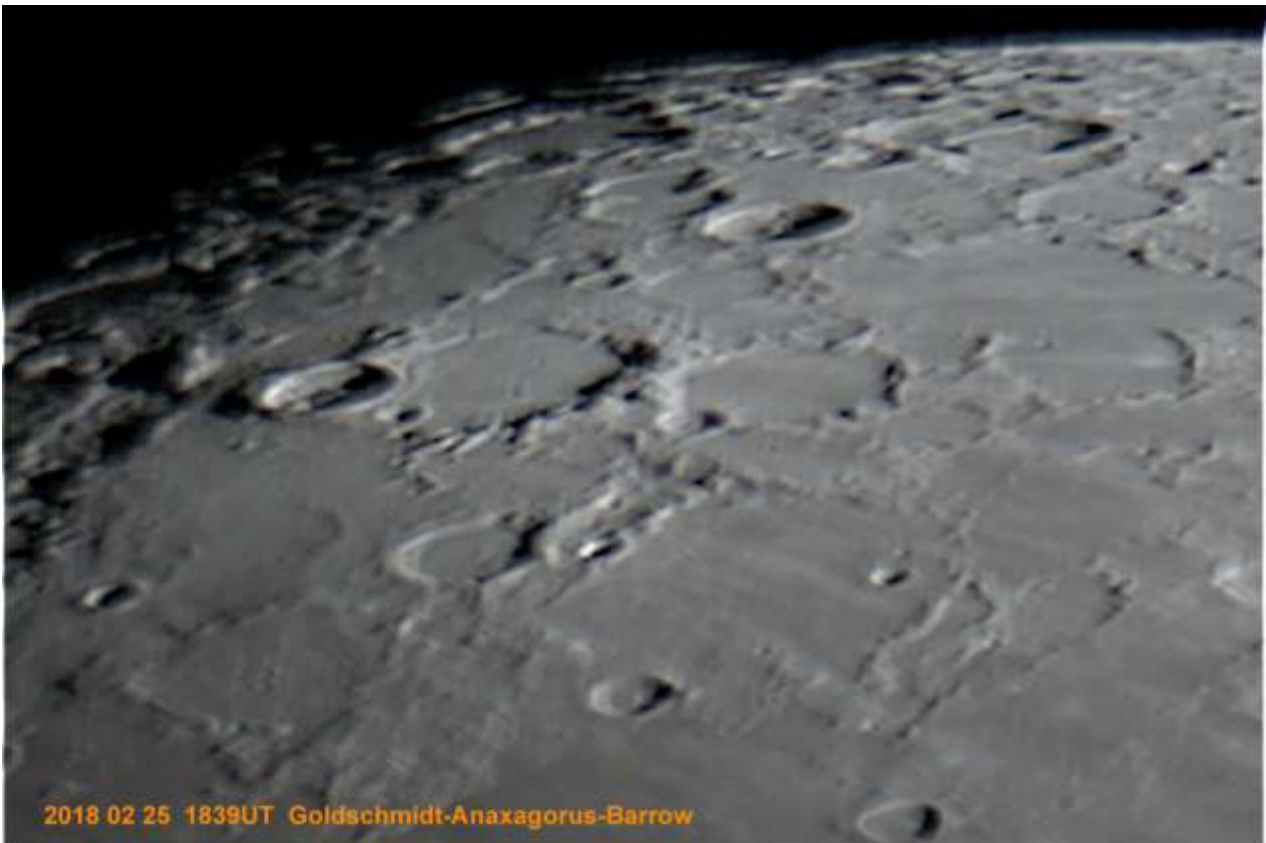
Straight Range and S. Iridum
down to Aristarchus plateau and
Harbinger mountains



10" LX200 SCT DBK21AU618

Four panel mosaic +15 colour enhanced
Seeing fair, some cloud passing Moon

KJKilburn ST13



Outreach

Manchester Astronomical Society at the Manchester Museum of Science and Industry 9th January 2016 with a Lunt solar telescope funded by The Big Lottery Fund.

As a 2016 introduction to Manchester AS's public outreach and in advance of BBC2 TV StarGazing Live, past-presidents, Dr Barry Henshall, Anthony Cross and Kevin Kilburn spent a day at the Museum of Science and Industry sharing our interest in astronomy with visitors to our stand. We had nearly 200 adults and about 80 youngsters asking the most probing of questions. Nearby, our colleagues, the students of The University of Manchester's School of Physics and Astronomy gave a similar but more physics-related presentation, particularly oriented to hands-on experimentation.

Throughout the day, triple video screens overlooking the main hall of the warehouse building showed deep sky objects, the sun, moon and planets and other astro- meteorological images taken by our members that attracted interest from a whole host of visitors to the museum from a wide audience in northern England and visitors from as far afield as China, India, Poland and Australia.

We were proud to exhibit the Lottery-funded Lunt LS80PT solar telescope although inclement weather prevented its live views of the solar disc.



Society member Kevin Kilburn with members of the Public who visited our display



Lunt Solar Telescope and Equatorial Mounting funded by the Big Lottery Fund.

On the 4th April 2016, at very short notice, Tony Cross was contacted by the University of Manchester Film Unit to see if he could open up the Godlee Observatory. The team were in the process of making a film about bringing the young generation into the world of the University of Manchester and the many rewards that can be had in the future for them.

The film is a short story line linking both Jodrell Bank Observatory and the Godlee Observatory.

It looks like all the bridge building Tony has been carrying out at every opportunity with the University is finally getting the Godlee Observatory the exposure it so rightly deserves as a place of Scientific/Heritage standing in our City.

The film was posted on the UoM site, as well as being shown on the big screens at the Trafford Centre



Perhaps, tongue-in-cheek, Tony suggested that a short film taken using a drone would really make the Godlee look impressive, they are looking into getting clearance/license.



Our Journey into Astronomy by June & Harry Blackburn

Our journey began around 6 years ago as we were nearing retirement. We have many hobbies and interests but decided we wanted one that we could both enjoy together, so we decided on Astronomy.

Having no knowledge of Astronomy, we took ourselves off to Opticstar in Sale. They were extremely helpful, finding out what we wanted from astronomy. At that time it was for observing the night sky. After a lot of help and a couple of hours later, we enthusiastically left for home with our telescope and accessories.

Our first scope was a Celestron NexStar 4SE Telescope, 102mm (4") f13 on a computerised mount. It was a lovely scope but we quickly decided we wanted a larger scope so we bought the Celestron CPC800 with GPS -200mm (8") f10. This was a scope which served our purpose well, the only drawback being the weight. We were both enjoying our astronomy and the thrill we got seeing Jupiter and Saturn for the first time, which we will always remember. We made the decision then to expand our knowledge. We enrolled on a year-long course that shows you how to navigate the night sky, find and see planets and deep-sky objects and understand a little of the science behind what you see in the night sky. At the same time we joined the Manchester Astronomy Society, one of our better decisions. It is a great society and everyone was very welcoming and friendly and so it has been ever since, with knowledgeable members, weekly meetings, public lectures, library and useful links on the website - NASA, Jodrell Bank and much more.

Astronomy doesn't stand still and neither do we. So after meeting members and discussing different aspects of Astronomy and seeing such amazing images that members had taken, astrophotography became the next step on our journey. Our special thanks to Mike Oakes for his help with Deep Sky imaging and to Kevin Kilburn and Tony Cross for all the knowledge they gave us about the Sun and the Moon. The Moon is also a particular favourite of Harry's.

The drawback for all astronomers is our English weather but more so for astrophotography. We found by the time we had set up all the equipment the cloud would arrive. After a couple of years of having to setup and dismantle outside in the cold we decided to have an Observatory.

Our observatory is 10' x 7'. The main advantage is you don't have to keep setting up and dismantling which is what you need with our unpredictable British weather. Was it all worth it, definitely! Is it any warmer, no, especially when the roof is rolled back. Perhaps we might make a warm room one day. Another project!!

We did all the ground work ourselves as we wanted to make sure we got exactly what we wanted. Starting in late October 2014 it took us a few months to complete the foundations but it was all worth it.

Stage 1. of the build was to decide where would be best for viewing the sky and positioning of the telescope, followed by Stage 2 - Checking with the council for building regulation.



Stage 3. of the build was to dig out for the pier which was 2ft x 2ft x 3ft deep, using rebar for reinforcement in readiness for pouring the concrete.



Stage 4 & 5. consisted of digging out for the armoured cable for the electrics and alarm cable from our garage, followed by preparing the base with hard-core, DMP and reinforced Mesh ready for laying the concrete base, leaving a 5mm gap around the pier base to be filled with expansion foam to eliminate any vibration once completed.



Stage 6. The concreting was completed but of course our English weather never fails and the rain came down just after we finished so we had to cover the concrete to ensure it dried, which took most of the week.



Due to the inclement weather we decided it would be quicker to have the observatory made to our own specifications by a company in Norfolk who erect on site and which only takes two days, far quicker than we could have achieved doing it ourselves. The whole project was completed in February 2015.

Our specification consisted of Extremal cladding - 22mm treated Lap log, Base/Frame – 4 x 2" machined and treated – 4" run off posts - Internal lining with waterproof membrane between the frame and external cladding with a 25mm cavity for air flow and lined with eastern ply. The Roof construction is of lightweight steel trusses with membrane and black plastic roof tiles and ridges. We opted for a roll off roof rather than drop down sides.



Our current equipment consists of:

- Current scope - William Optic FLT 110 Triplet refractor with flattener reducer 1V – Focal length 770mm.
- Guide scope – Opticstar AR 80 refractor - Focal length 400mm Camera
- Starlight Express Trius SX694C CCD camera and UHC filter.
- Guide Camera – Starlight Express Lodestar x2
- Mount – Skywatcher AZ-EQ6 GT
- DSLR Camera – Canon EOS 7D mark 2
- Lens – Canon EF 70-300mm f/1-5.6 L IS USM Lens - Canon EF 24-105mm f/4L IS USM
- Camera tripod - SILK Tripod Pro 700 DX.

Below are of the few Images we have taken from our observatory



M31 Andromeda



M16 Eagle Nebula

Our Beautiful Noctilucent Clouds



We couldn't finish without mentioning our two exciting events with the MAS.

A memorable day at Stargazing Live Tatton Park 2013 with members from the MAS, after watching the first Stargazing live on the BBC in January 2011, we could not have guessed that we would be part of it in 2013

MAS STAND



MAS TEAM



CERN in Geneva another memorable day with members of the MAS.



Our most recent exciting Astronomical events since starting astronomy are:

Solar Eclipse March 2015



Lunar Eclipse September 2015



Mercury Transit 9th May 2016



The Hills Observatory by Michael Oates

It's now three years since I took the plunge and bought my first telescope, yes my first, even though I have been a member of the MAS for over 30 years. I could say that I was taking my time to decide on which telescope to buy, but in reality I realized early on that I would not be able to get the results I really wanted with limited equipment and the poor skies of Prestwich, just north of the Manchester city centre. But more recently I decided that due to the advances in telescope design, control equipment, mounts, CCD cameras and software, now was a good time to take the plunge as all those technologies had only in recent years come together to allow the amateur to get results that only a few years ago was limited to professional observatories.

I first started taking astronomical images at the time of Halley's Comets return in 1985, those were humble beginnings with just a film camera and telephoto lens, but it got me hooked on imaging. I built my own equatorial drive out of steel pipe and fittings, large bearings and it was driven on both axis with small synchronous motors that I could speed up or slow down with buttons on a hand control. This was a very heavy mount and although the pier it was fitted to was left out when not in use (the top doubled as a bird table!) I had to dismantle and carry inside the rest of it to protect it from the weather.

There were many times that I would spend an hour or more getting set up, only to be clouded out once it was ready for use. Setting up included putting old curtains on washing lines to try and block out street lights and also lights from the neighbours. Over time, this got more of an issue and I really had to be motivated to even bother. Oh if I only had an observatory, probably what most amateur astronomers would say and dream of.

After a few years and a move of house, the mount and pier were thrown out. What followed was about 20 years of not really taking many astrophotos apart from making use of the Godlee refractor on the few clear Thursdays evenings we had and I also had a small battery driven tracker that fitted on a standard camera tripod which allowed me to take wider constellation shots and it also kept the Sun in the field of view so I could do some white light photography of the Sun with a mylar solar filter.

Digital cameras started to replace film cameras and I was a very early adopter of these new cameras, and plenty of images were taken of the Moon and Sun, but deep sky imaging was not suited to these cameras as most had restricted long exposures lengths of 15 or 30 seconds. Deep sky imaging really had to wait for the arrival of the DSLR.

With my purchase of a Canon 500D DSLR I could now see deep sky imaging becoming a reality, but I really needed a driven mount to use with telephoto lenses or a telescope. A SkyWatcher EQ5 Pro mount was bought plus all the other bits needed such as guidescope, guide camera, fittings cables etc. I started to take deep sky images with my 500D and a 300mm telephoto lens and I was absolutely blown away with the results, even from my garden in Prestwich.

So within a few months in 2013 just prior the Astrofest meeting in London that February, a discussion took place in the Godlee which led me to tell Tony Cross what my ideal telescope would be as I had been admiring recent images taken by other amateurs. I said a Takahashi FSQ106 ED as the results I was seeing were amazing. Of course there is more to making a great image than just the telescope, but it was the start. But as I was not going to Astrofest so I said to Tony, as there are often some bargains to be had at that event, that if there was one at a good price to let me know. Well a few days later and a few phone calls, I was the owner of a 530mm f5 refracting telescope and anyone that knows Tony will realise that he got me a really good price!

As this telescope was rather heavy I upgraded my mount to a AZ-EQ6 GT mount, plus other fittings needed to mount the new telescope. The equipment looked very impressive, but it was also very heavy and I was back in the position I was nearly 30 years ago that it was taking me ages to set up and strip down after a session. It typically took 1.5 to 2hrs set up and 1/2 hour to pack away. The motivation I now got was the fantastic images I was taking, but so many times the weather would change and I was saying to myself again, if only I had an observatory!

At the end of 2014 I decided an observatory just had to be built. The question was how, do I buy one and have it erected, or do I build my own. A quick look at prices of ready built observatories make be think, oh that's expensive, I am sure I could build one myself for about the same price and it would have the advantage that it would be made how I wanted. I will say right now, that if anyone is thinking of building an observatory because you think it will be cheaper, think again!!

The construction was to be done in three stages:

Stage 1 Get a pier made to support the AZ-EQ6 GT mount, plus make the base for the pier to sit on.

Stage 2: Make the observatory concrete base. Stage 3: Make the observatory.

Stage 1: You can buy piers, but as I had contacts at work, I knew I could have one made to a far higher spec for less money. In the mean time the base for the pier had to be made. Prior to taking shovel to soil (note I use the word 'soil' here very loosely!), I had to settle on the site for the observatory. I choose a position that would not dominate the garden and it had to be where I could maximise the amount of night sky I could see. No place was ideal, in fact building in this part of the country is not ideal, so it was all a matter of compromise.

Digging that first hole was really difficult, most of the 'soil' was clay and very water logged, as soon as I started to dig it filled in with water and it remained like that for a few weeks while I continued the dig. The pier needed a solid base that would not move over time as this would mean re-polar aligning. Make it too heavy and the weight alone could cause it to slowly sink, too light and it may be prone to vibrations.



Pier foundation ready for concrete

The result was approx 1 meter cube of reinforced concrete with threaded rods embedded in the concrete to hold the pier down with. All work was done by myself including mixing and pouring the concrete. Once the concrete had set, the pier was bolted on and the ground around made good so that I could start to use it. I fitted the AZ- EQ6 GT mount to the pier which was then left out but I did cover it over and used large desiccant bags to take up the moisture to prevent the mount getting damaged by moisture.

Once the mount was polar aligned, this meant that even though I still had to set up quite a bit of equipment, I did not have to polar align each time, and it was the polar alignment that took most of the time. Now I could spend the winter of 2014/15 imaging.

Stage2: Early spring, the base for the observatory was started, again hard work digging, but at least I did not have to go too deep this time. After shutting was fitted taking care to leave a gap between the observatory floor and the pier base. This gap reduces vibrations passing to the telescope by walking about in the observatory. Hardcore laid, plastic sheet fitted followed by reinforcing bars then the concrete. This time as the volume was far greater I decided to get the concrete delivered and barrowed in.



Once the concrete had set, I was able again to use the pier to continue imaging, in fact my plan was to keep the pier accessible as much as possible throughout the build. However that proved a little difficult at times.

Concrete base for the observatory.



Wooden framework, the observatory is taking shape.

I took a week off work with the aim of getting most of the framework done in that time. Well, that proved to be a little optimistic but a good start was made. Construction consisted of a 3x2 wooden frame work with lots of bracing. Shiplap wood is used for the outer skin, plywood on the inside and insulation in between. There is also a layer of breathable membrane behind the shiplap for additional water proofing. I decided to insulate well in order to reduce extremes of temperature, i.e. not too hot in summer and not too cold in the winter. The roof and under floor is also insulated. That decision to insulate now I have used it for about 8 months was spot on.

The walls had to build really well as a normal shed construction relies a great deal on the roof to hold the walls together. With an observatory, where the roof runs off, the roof plays no part at all in keeping the building stable. I chose a run-off roof as this is a relatively easy design for an amateur to construct compared to a dome. Plus a run-off shed looks more like a shed and blends in with the surroundings better.



Proud of my handy work



Finished observatory showing the roof closed



Observatory with the roof rolled back

The roof runs on a steel track, with the track on top of the walls and a set of eight metal wheels are fitted to the roof. These wheels are normally used for sliding steel gates and are very robust and very smooth in operation. In my design, the roof does not completely run off and a third remains covered. That is the warm room, the place where I would sit and operate the mount and telescope from a laptop. The name 'warm room' does literally mean warm. I was very surprised at just how warm it gets once the laptop is in use plus the power supplies for the equipment. Although no heater is used, the temperature is typically 10 deg C warmer than outside, plus there is no wind. So I highly recommend the use of a separate room to control from. I do however have to ensure I don't open the sliding door to the telescope room during imaging as the heat escaping through the door causes the air to become turbulent, possibly affecting the image.

The roof is finished in shingles which look like tiles and have a typical life of 20-25 years, rather longer than a normal shed roof covered in roof felt. Guttering is also used to reduce the amount of water hitting the ground next to the walls shortening the life expectancy of the wood. As the roof moves, a lot of thought had to go into how the guttering would feed into the downspouts! Clamps and bolts are used to hold the roof in place when closed. I decided not to motorise the roof, so I open and close it by hand. At about 400 kg it takes a little effort to start the roof going, but it rolls along smoothly after that. I also have the top section of two of the walls drop down on hinges to allow the telescope to reach lower altitudes when needed. In practice these are hardly used as the light pollution is much worse near the horizon. But it's good to have the option there.

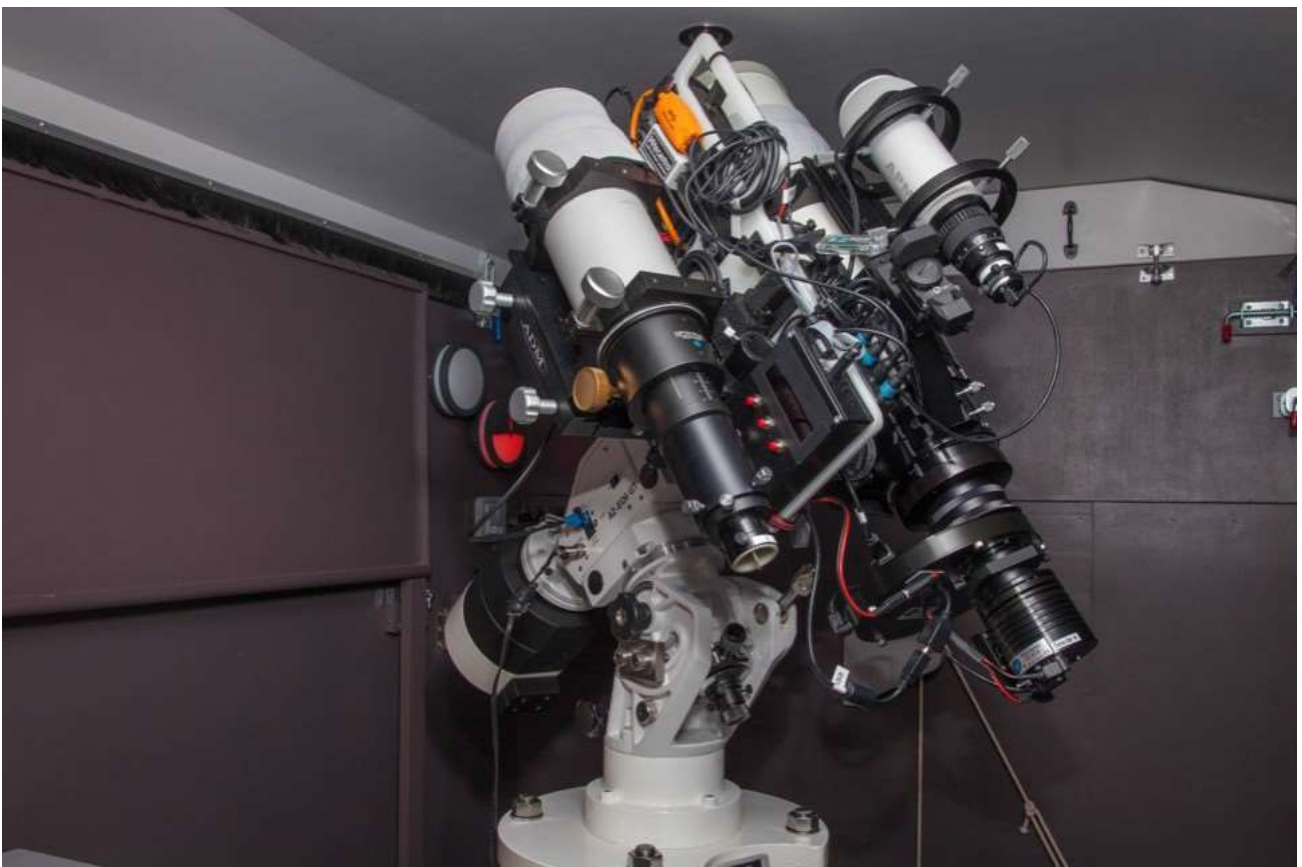
Before the inner plywood skin and floor was fitted the electrics were added, and this was one job I left to the professionals. Power come from the main house breaker box and armoured cable was used which was buried under the ground. Having electricity in the observatory means I no longer have to use large & heavy batteries. Instead I use a couple of 12V power supplies that power the mount, telescope and all the other equipment. I also have a dehumidifier in the observatory which is set at it's lowest power setting, this is of course turned off before imaging. Reading about other peoples observatories, many use a dehumidifier to ensure that the optics, mechanics and electronics don't suffer from damp, which can prove very costly.

The result I am very, very happy with and every time I use it I say to my self, oh this is good, real good. Now I can be imaging in about 10-15 mins, ideally I should open up the roof an hour or more before I intend to use it, just so the temperature stabilises other wise the seeing may be poor. Being so much faster means I can take advantage of small windows between the clouds, which means more imaging.



With a WiFi connection to the PC in the house I can also connect to the laptop in the observatory and operate it from inside the house if I want using a free program called Team Viewer. However I never intended it to be operated remotely as I still need to be there to make balance adjustments to the mount, be ready to cover the scope to stop an airplane passing through the field, fit a light panel for flat frames etc. Also to be ready to close the roof if it looks like rain and that's happened on a few occasions.

View from the control room (warm room)



The telescope and mount, it might look a bit complicated, and you would be right!

You may have gathered that this is an imaging observatory. It was built purely for imaging using a computer. All the mount positioning, image capture, focusing, filter changing is all controlled by a program called Sequence Generator Pro. Once it has been set going, in theory it can take a whole series of images of different objects which are then stored on the computer for processing later. As the observatory is built for imaging there is not a lot of room around the scope, indeed you would struggle to see through it even if I took off the camera and fitted an eyepiece, as it's too low.



View of the telescope room with the side panels lowered

Any society member is welcome to visit I will be happy to show you round, just contact me at a Manchester Astronomical Society meeting.



SH2-155 'The Cave Nebula' in Cepheus. This was the first light image from the completed observatory. Image By Mike Oates



IC410 a nebula in Auriga. Also known as the Tadpoles taken with narrow band filters. Image By Mike Oates



Comet C/2013 US10 (Catalina)
Imaged with a blue filter. The
image shows the dust tail, the
broad tail pointing down and
the ion tail going off to the
right. Image By Mike Oates



IC 63, IC59 Nebulae and the
star Gamma Cassiopeiae.
Image By Mike Oates



The Globular Cluster M13
in Hercules.
Image By Mike Oates.



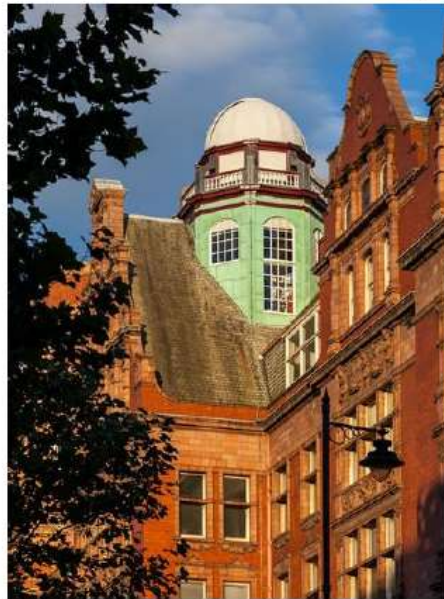
Two galaxies in Ursa
Major M82 (top) and
M81.
Image By Mike Oates.



The moon, bicolour Almost full Moon.

Image By Mike Oates.

Manchester Astronomical Society



Manchester Astronomical Society

Founded in 1892 as the North-Western Branch of the British Astronomical Association. The Manchester Astronomical Society became independent in 1903 and is one of the oldest astronomical societies in the country.

Our aim is to encourage the study of astronomy for both the newcomer and seasoned observer alike.

Group visits to the MAS are especially welcomed and can be arranged for evenings other than Thursday by prior arrangement.

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