TRANSIT

The Newsletter of

Cleveland & Darlington Astronomical Society

05 June2007

Saturn Occultation

On May 22, 2007, Johannes Schedler shot this stunning mosaic of Saturn hiding behind the Moon from Wildon, Austria, using his 16-inch Cassegrain telescope.

Editorial

Last meeting : 11 May 2007 – CaDAS President Jack Youdale presented a follow-on from his last yea's tour de force on David Sinden who worked in Grubb Parsons before setting up his own company

His talk this time included a lot more information about Grubb Parsons themselves. This engineering firm was the very epitome of British precision engineering at a time when we truly led the world in engineering achievements and everybody in the North East was proud to host such a fine company. Jack has obtained some excellent photographs showing the operations of the optical workshops in action.

The various large telescopes still in existence around the world bear witness to the skills of those engineers working on such a huge instruments and producing both mountings and optics to specifications measured in microns. A stirring tale delivered in Jack's usual flamboyant style.

Next meeting : 8 June 2007 –Keith Johnson will speak on "Astrophotography". Location, Wynyard Planetarium.

Letters to the Editor :

*Any new observations, any comments on local or international astronomy, **anything** you want to share with your fellow members?*

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The old ones are always the best :-

Two spiral galaxies walk into a pub. The first one goes up to the bar and asks for two beers, one for him and one for his friend. The barman looks suspiciously at the second spiral galaxy and says "I'm sorry but I can't serve your friend, he'll have to go!

The first spiral galaxy complains "why can't you serve him?" The barman replies "Because he is barred."

The Lonely Mountain

From Rob Peeling

Have you looked at the mountains on the Moon and wondered what it would be like to be there? How would they compare to mountains on Earth? Would they look as impressive? Would they be as tall?

Believe it or not the answer to the last question at least is within your reach. You can measure the height of the mountains of the Moon from your back garden. You don't require a multi-billion dollar budget or a spacesuit, just a small telescope, a lunar ephemeris, a map of the moon and a calculator. The mountain you choose needs to be near the terminator so that you observe close to lunar dawn or sunset to ensure that there are long shadows to see. Gallileo was the first to try this and publish his results.

Mons Piton is perhaps the real Lonely Mountain (c.f. The Hobbit, J.R.R. Tolkien). Mons Piton being the peak of a pre-existing mountain whose base was drowned when the Imbrium basin flooded with basalt to form the present Mare Imbrium perhaps explains its loneliness. Tolkien never explained the existence of his Lonely Mountain. His maps suggest geology wasn't really his thing – a great storyteller though. The time to look for Mons Piton is just after 1st Quarter.

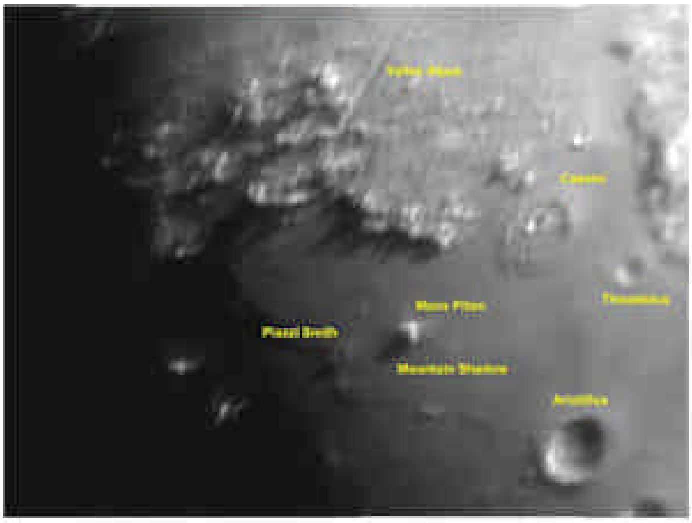


Figure 1 Mons Piton (from lunar orbit)

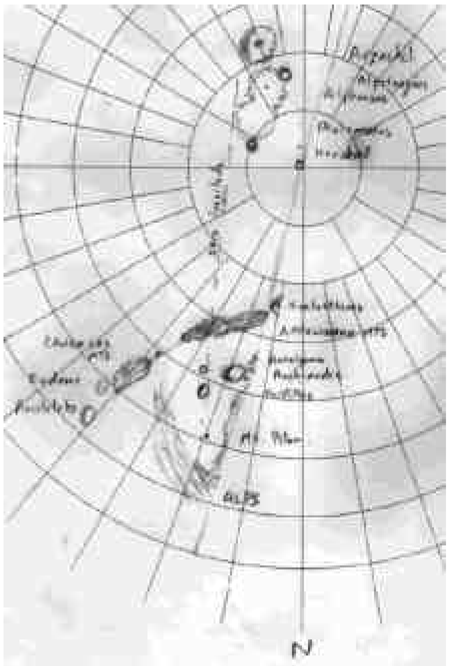


Figure 2 Sketch of the Moon on 9th Feb 2003

I will describe two attempts I have made to measure the height of Mons Piton, which is found in the northeast of Mare Imbrium in the region of the three large craters Archimedes, Aristillus and Autolycus.

The trick is to measure the length of the shadow of the mountain accurately. Knowing the angle of illumination at the time of observation and the longitude of the mountain on the Moon you can calculate the height by application of some trigonometry.

My first attempt was back in February 2003. I used my 6" Newtonian and at the time I hadn't fitted a drive to the mount. I did have a Celestron Microguide eyepiece with a focal length of about 12 mm that has an illuminated reticule with a laser etched linear scale. Using this with a 2x Barlow I was able to see a little mountain with a long dark shadow coming out of it.

I made a sketch of the area to enable me to identify the mountain later and estimated the length of the shadow using the scale. I also measured the diameter of the Moon's disc using the scale.

I used the diameter of the moon, 3476 km against the eyepiece scale to determine that the shadow observed was 25 km long. The sketch shows roughly the position of the terminator and the main objects visible near to it. The grid was a (totally misguided) idea to improve the quality of my sketch.

Later I used a lunar atlas to check the identity of the mountain and find its lunar longitude, which is 0.7 degrees west i.e. slightly to the left of the central meridian of the Moon directly facing Earth. For this article I have been using the excellent and completely free Virtual Moon Atlas downloaded from the Internet. I'll come back to the calculations later.

It would have worked just as well to estimate the length of the shadow in comparison to the size of any suitable crater you can identify on the map – ideally choose a crater that is not too much bigger than the shadow. You must however note down the date and time of your observation.

For my second attempt, in March 2007, I tried a more sophisticated approach. I used a webcam and x4 Imagemate (with the same 6" telescope now upgraded with a drive) and took three 60 second video clips of the Mons Piton region. These videos were then processed using Registax (Keith is the society's expert on this technique).

The resulting pictures gave me a nice big shadow to work with and plenty of craters to compare it too.

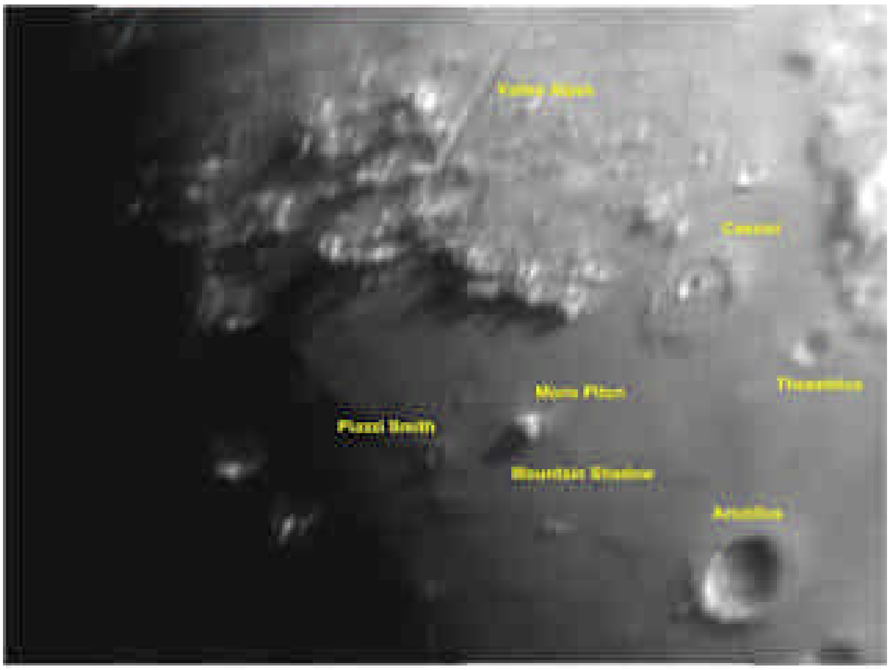


Figure 3 The Lonely Mountain, 26th March 2007 20:27 BST - my image

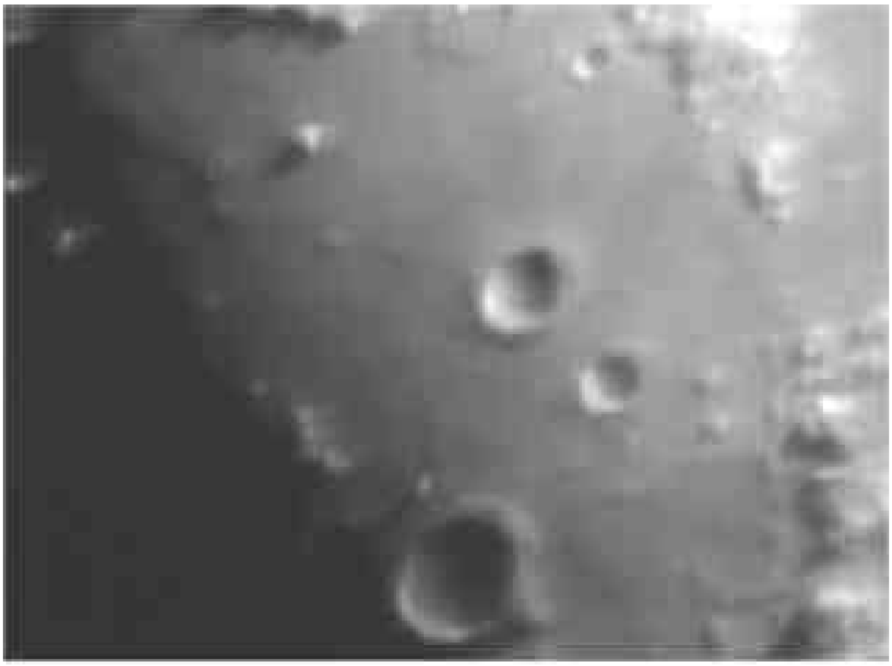
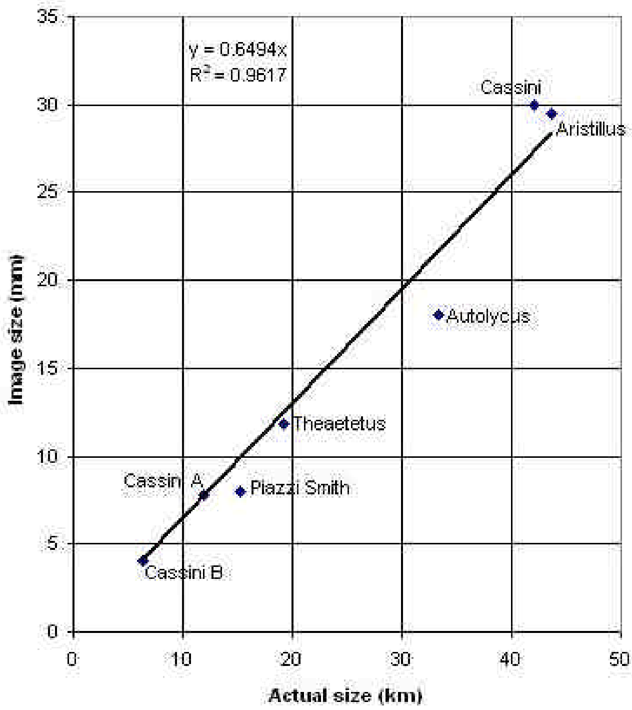


Figure 4 26th March 2007 20:29 BST

Figure 5 26th March 2007 21:03 BST

For the webcam images the scale is established by measuring the diameter of the identifiable craters. A range of sizes from large to small should be used. Plot a graph of the size measured in the image against the actual size in km from the lunar atlas. Draw a straight line to join up the points as best as possible with a line going through the origin and the slope of the line gives the scale. Now measure the shadow and use the scale to determine its length.

Figure 6 Image Scale Calibration Chart



The calculation method I have used is described on the internet at http://stupendous.rit.edu/classes/phys236/moon_mount/moon_mount.html - location. The trigonometric formulae required are all there. I'll restrict myself to describing the steps without the mathematics here.

The first problem to deal with in the calculation is that because the moon is spherical, the observed size of any object on it is distorted by the fact that we see it tilted. The effect is only zero near the centre of the moon's disc but is quite important at the latitude of Mons Piton. The size of the shadow we have just measured is therefore only about 70% of the true value. The effect of libration has to be taken into account as so the time of the observation must be considered as well as the location on the moon's surface.

The next step is to determine the angle of the Sun over the mountain at the time of the observation. From lunar ephemeredes, determine the point on the moon's surface where the Sun is directly overhead (referred to scientifically as the sub-solar point). Using the latitude and longitude of Mons Piton, applying the correct formula then spits out the angle of the Sun. So long as the calculated angle, ?, is between zero and 15 degrees all is probably well.

The final step is to work out the height of the mountain from the angle of the Sun, ?, and the corrected length of the shadow, L. This is GCSE trigonometry

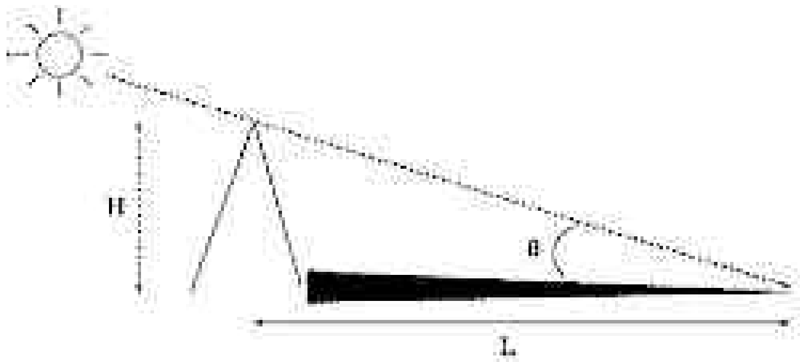


Figure 7 Height of Mountain - from web site cited in text

The Virtual Moon Atlas gives a height of 2490 metres for Mons Piton. How did my results compare?

9th February 2003 2920 metres

26th March 2007

19:27 UT	2820 metres
19:29 UT	2720 metres
20:03 UT	2440 metres
Average	2660 metres

That's within 10% of the value in the atlas.

The Reverend Thomas Espin, The Stargazer of Tow Law

from Bob Mullen

The Reverend Espin was a fine example of the gifted 19th Century amateur scientist. At a time when excellent optical and mechanical engineers in the UK were coming to their peak these amateurs were able to bring to astronomy an intense interest and dedication of many nights on a telescope followed by the leisure of committing their findings to print for the benefit of others.

The Reverend Thomas Henry Espinell Compton Espin or T. H. E. C. Espin (May 28, 1858 – December 2, 1934), a self-trained astronomer, developed a world reputation as an observer of double stars. He was also a Priest, a Musician, an Inventor, a Radiographer, a Microscopist, a Botanist and Geologist. He was indeed the personification of a Natural Philosopher ,skilled in so many arts and sciences. His family originated in an area between present day Holland and Belgium, with a recorded history back to the early 1600s. Religious tensions in Europe caused the family to moved to the Fen district in England . Thomas Espin was born in Birmingham in 1858. His father was at the time Rector of Hadleigh. Thomas was educated at an East India school in Haileybury, Herts where his interest in astronomy sprang from the interest of one of his masters, the Rev Frederick Hall. His passion was finally ignited with the sighting of Comet Coggia on 17th April, 1874. His original optics were a pair of opera glasses, followed by a one inch Dolland refractor then a three inch achromatic refractor made by Large.

His first essays were published in the “English Mechanic”. His literary skills attracted the attention of T.W. Webb, an eminent astronomer who requested the

17 year old Espin to collaborate in compiling his book “Webbs Celestial Objects for Common Telescopes”. This book, reprinted in 1917, is still an excellent source for beginning amateurs. He finished his education in France, at the same time becoming a skilled musician, especially on the piano and pipe organ.

In 1878 when he moved to Oxford to study Theology he continued his astronomy using a 13 inch De la Rue telescope belonging to the University. He repaid this use by helping his fellow students with their astronomical studies. He graduated from Oxford in 1881 with a BA and was appointed as Curate at West Kirby on the Wirral in Cheshire. It is worth noting Espin’s father was, at that time, was involved in training and selecting prospective clerics in the Bishopric of Chester – coincidence?

Whilst at West Kirby Espin was gifted a Tully 5 inch refractor by one of his father’s friends. He also purchased a 4.5 inch stellar camera made by Grubb.

As Espin’s father reached 60 he moved to an easier living as Vicar in Wolsingham, Thomas Espin followed as one of the Curates. He built an observatory and purchased a Calver 17 ¼” Newtonian and a 4 ½” equatorial refractor. He charted up to 3,800 red stars, many nebulae and more than 30 variables and, using a spectroscope of his own design, observed more than 100,000 stars down to magnitude 9. A truly astronomical workload.

In early 1887 he was elected as President of Liverpool Astronomical Society but moving to Wolsingham had reduced his direct involvement. He resigned on 30th December 1887. In 1888 he was promoted to become the Perpetual Curate of Tow Law, not as Vicar which is often reported. He relocated his observatory to Tow Law and continued his heavy workload. He fell out with the Liverpool Astronomical Society who only wanted a local membership – quite a few members at the time lived a long way from Liverpool. An aggrieved Espin contacted other eminent astronomers and they formed “The British Astronomical Association” in 1890.

He was elected director of the Spectroscopic and Photographic section. He also edited Proctor’s Star Atlas and submitted many papers to the Royal Astronomical Society on a variety of subjects (in excess of 1,000 papers). At this time he involved himself in the new science of X-ray radiography and conducted a number of X-ray examinations including looking for swallowed coins in children.

In 1899 he started his double star search up to primary magnitude 9.5. In 1904 he was elected President of Newcastle Astronomical Society. On 30th November 1910 he discovered a new star, named Nova Lacertae. As a result of this discovery “Vicar” Espin became a regular ‘star’ himself in the newspapers, both local and national.

In 1915 he aquired 24" reflector for his observatory and continued his search for double stars in tandem with his gifted assistant William Milburn who used the old 17 ¼" telescope. Espin also invented illuminated spun glass cross wires, a variable power eyepiece, a stellar camera and a diffracting eyepiece for spectroscopic viewing. He was also a considerable traveller around Europe, often taking Millburn as his companion – Espin was a dyed-in-the-wool misogyinist, he wouldn't even allow women in his church choir! Towards the end of his life Espin had recorded and measured 2,575 new stars and, with Milburn, had made a total of 912 recorded sightings of double stars (some sources say 2.500 sightings?).

In 1933 he retired to North View where he built two observatories and continued observing, often in freezing conditions well known by astronomers in the North East. He finally passed away after a short illness on 2nd December 1934, aged 76. After his death his various equipment was distributed around his various friends and colleagues. It is interesting to note his Calver 1914 24" reflector with clockwork drive was recovered from under years of hen droppings in the Tow Law observatory by Mr David Sinden who restored and modified it then presented to Newcastle University for use in their Close Hall observatory.

"Vicar" Espin has been memorialised by naming a mountain on the far side of the Moon, the lunar peak – Mount Espin.

(details of Thomas Espin's astronomical life were from "The Stargazer of Tow Law" by the Tow Law History Group with many thanks).

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Astronomical Colleagues

Astronomer Fritz Zwicky (1989 – 1974), both brilliant and irascible, often referred to his colleagues as "spherical bastards". Spherical, because they appeared to be bastards no matter from which direction you looked at them.

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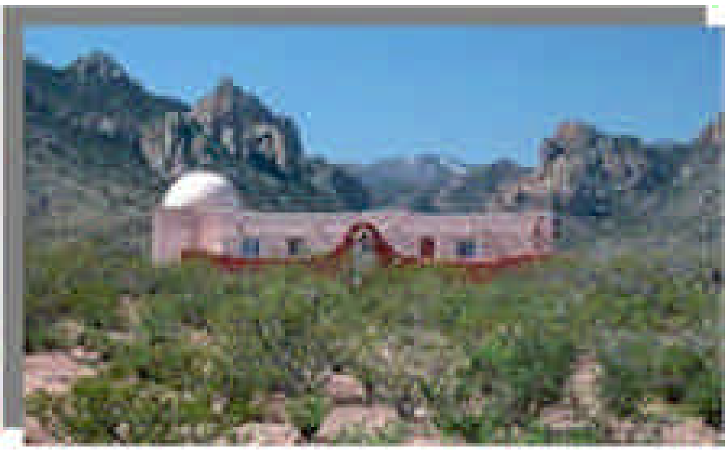
Astro-ramblings in Arizona

from Bob Mullen

Arizona, land of clear skies and comfortable observing temperatures.

Our annual pilgrimage brings us to the very northern edge of Phoenix , a city in the US renowned for its light pollution – actually, it doesn't hold a candle to the yellow peril of Teesside! A faint glow on the southern horizon across the city from our backyard is all we see, the east, north and west looks over the wild lands of the desert. The developer of our estate is a dedicated astronomer and has fitted all street lights with maximum cutoff shades. Sky watching Heaven!

At least I thought so until we visited the Arizona Sky Village near Portal, Arizona, three hundred miles to the east and on the Arizona-New Mexico border. We were invited to visit the home of our Planetarium colleagues, Gil Clark and Mary Craggs. Together they organise the TIE foundation (Telescopes in Education) that allows the WWP Planetarium and schools world-wide to have Internet live access to their remote telescopes in Chile, Australia and previously Mount Wilson, California (soon to be relocated in Arizona). With California becoming so light polluted they decided to move home to the Arizona Sky Village.



Jack Newton's house and Observatory
(photo Jack Newton)

The Sky Village is a concept devised by two astronomers, Jack Newton and Eugene Turner, who searched some of the darkest deep-sky sites in North America and came up with this wonderful stretch of desert amongst the Chiricahua Mountains. They set up a residential community for dedicated skywatchers. Each home (or hacienda) has four acres of land on which they can build a suitably designed home and an observatory (usually fitted out with huge reflector telescopes). Utilities are provided by the community although you do have to drill your own water well.

The community has strict rules on light pollution – how sensible ! There is a community centre/observatory for socialising which also offers a 30 inch Skymaster telescope, fully fitted with CCD imaging equipment. Some of the properties including observatories and telescopes are available for short-term rental. For more information :- http://www.arizonaskyvillage.com/index.html

A night sky view across the Sky Village house and observatory of Jack Newton. Zodiacal Light and the Milky Way.

(photo Jack Newton)

Gil and Mary elected to live just outside the Sky Village perimeter in a property which boasts a 4,000 foot runway and a huge aircraft hanger - very handy. Gil is deeply involved in helping Sky Villagers to professionally erect their observatories and fit them out with adequate optics. When night fell the thought of using a telescope goes out of your head, the naked eye view of the night sky itself was overwhelming. The 4,600 foot elevation of the desert floor goes a long way to a clear, steady sky and the total lack of any visible artificial light almost brought tears to the eyes – as it turned out the tears were mainly due to the rapidly decreasing temperatures at this height.

Gil had recently bought 40 acres on top of close-by North Peak. He intends to build an observatory on the peak and a VIP lodge to cater for the Foundation subscribers (includes me now).

Returning to Phoenix showed us how annoying the city light pollution to the south really is.

Amongst our regular trips around the State is visiting the Lowell Observatory in Flagstaff, about 130 miles further north and into a fir-clad mountainous area – was Lowell (of the Mars canals fame) really mad siting his observatory up here? This year the poor night-weather record of the Observatory held true, not a clear night on any of our visits. In previous years we have had crystal clear nights but at ridiculously low temperatures,

At the other end of the State is the 7,000 foot Kitt Peak Observatory outside Tucson, almost guaranteed to offer clear night viewing.

Kitt Peak Observatory

7,000 feet above sea level

As well as hosting over 20 professional telescopes the Observatory offers two levels of observing for visitors. A relatively inexpensive introductory group session led by an enthusiastic and knowledgeable sky guide and a one-on- one night-long session with a Kitt Peak professional astronomer. Both sessions offer the use of their 16” telescopes with plenty of attached gadgets for those into astroimaging.

Transit of Mercury day, Kitt Peak

As proved this year you now have to book the night-long session well, well ahead, I was the number two standby behind a California couple who finally turned up just before they closed off the mountain at 4pm. All other visitors not on observing programmes have to be off the mountain by this witching hour. Last year I obtained my first ever view of Pluto through the 16”, at least I think I did, I should have opted for the CCD kit on the telescope for confirmation, however, the professional astronomer assured me the faint blur in the eyepiece was Pluto. (I’m still not convinced).

We visited Kitt Peak the following week to view the Transit of Mercury on 8 November, unfortunately it was not visible in UK at the time.

The Peak was covered in telescopes with solar filters and various solarscopes, all manned by enthusiastic amateurs and all willing to talk your ears off in that wonderful friendly American way. I tootled along to the McMath Pierce Solar Telescope (above right) to view the Transit through their equipment. The main beam was being used for ongoing experiments but they had the Transit showing on one of the auxilliary beams – most impressive.

To show how small a world it is, when I stood on the heliostat observation platform I found myself next to the only other observer at the time – Charles Hunter, a renowned English amateur eclipse hunter from Wakefield.

Also impressive was the number of telescopes outside homes in the town of Tucson and by the roadside during the transit. The average Arizonan takes astronomy very seriously – and with their almost permanently clear skies who can blame them, lucky beggars.

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Spacecraft speed records

from John Crowther

The subject of spacecraft speed records is complicated because there are so many ways in which they can be measured.

When Apollo 10 – a final rehearsal for the Moon landing – arrived back on Earth on May 26, 1969, its re-entry speed was 24,790 mph, a record for manned space flight.

The fastest atmospheric entry of all, however, belongs to the Galileo probe which spent eight years studying Jupiter and its moons before ending its mission by purposely diving into that planet's atmosphere. During its suicide plunge on December 21, 2003, Galileo reached a top speed of about 108,000mph.

Recent reports erroneously stated that New Horizons probe, launched on January 19, 2006, to take a close look at Pluto and its moon Charon, would become the fastest craft ever. New Horizons is to be accelerated by a gravity-assist manoeuvre when it passes Jupiter. This will accelerate it to 52,000 mph which is far short of the 107,500 mph record planetary flyby achieved by Pioneer 11 when it flew by Jupiter on December 2, 1974.

New Horizons does boast one record, though it was travelling faster as it left Earth's orbit than any previous vehicle launched into interplanetary space with an escape velocity of 35,800 mph. The probe reached the Moon in nine hours (compared to three days for the Apollo missions) and should reach Jupiter in 13 months.

Honourable mentions go to Voyager 1, which is the fastest interstellar spacecraft, exiting our solar system at a rate of 38,60 mph and Stardust, a sample capsule designed to collect space dust particles, which achieved the fastest Earth atmospheric entry on January 15, 2006, travelling at 29,000 mph.

The fastest spacecraft though is Helios 2. Helios 1 and 2 were launched in the mid-Seventies to study the Sun. Both probes were developed through co-operation between the US and West Germany. Helios 1 was launched in December, 1974 and Helios 2 in January 1976, both reaching the Sun within three months. The craft made incredibly close passes to the Sun, resulting in very high orbital speeds of around 150,000 mph.

Helios 2 was slightly faster and holds the speed record as not only the fastest spacecraft but also the fastest man-made object in history.

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Astro-imaging with Photoshop tweeks

For all you budding astro-imagers Keith Johnson has provided an excellent website which introduces you to using Photoshop in improving your images.

http://www.waid-observatory.com/articles.html

14th Century Chaucerian Astrolabe Quadrant

from John and Martin Crowther

A 14th century scientific tool, dubbed the "pocket calculator" of its age, sold for a "world record" price today.

The astrolabe quadrant, which has been dated to 1388, the period when Geoffrey Chaucer began to write The Canterbury Tales, fetched £138,000 including buyer's premium at an auction at Bonhams in London today.it exceeded its estimated price of £100,000, and was sold to an anonymous telephone bidder.

"This is an extremely rare piece," said Bonhams auctioneer Jon Baddeley.

"Prior to its discovery in 2005, there were only seven others known about. In its area it's gone for a world record price," he said.

The brass instrument, made in England, was used for telling the time, surveying, mapping the stars and calculating the height of buildings.

The instrument was discovered in 2005 underneath a clay floor during excavation work to extend a restaurant.

The restaurant stands on a site known as the House of Agnes, a 17th century inn on the main road to London, just outside Canterbury.

Experts said the discovery of the quadrant after so many years was of great significance for the study of ancient scientific instruments.

Additional information is supplied by Martin Crowther, a Museum Curator in Canterbury and previous CaDAS member.

The quadrant was actually found in amedieval rubbish pit. In the grounds of the House of Agnes, Canterbury.

Was it a piece of outdated 14th Century technology which was discarded as being too small to melt down or had it just been lost.

No one knows but it was sold in March 2007 to an American collector for a huge amount of money.

Is the term “Easter moons” marked on the astrolabe used to mean any new moon or just the date which marks the start of the Jewish Passover – the Easter of the Christian church?

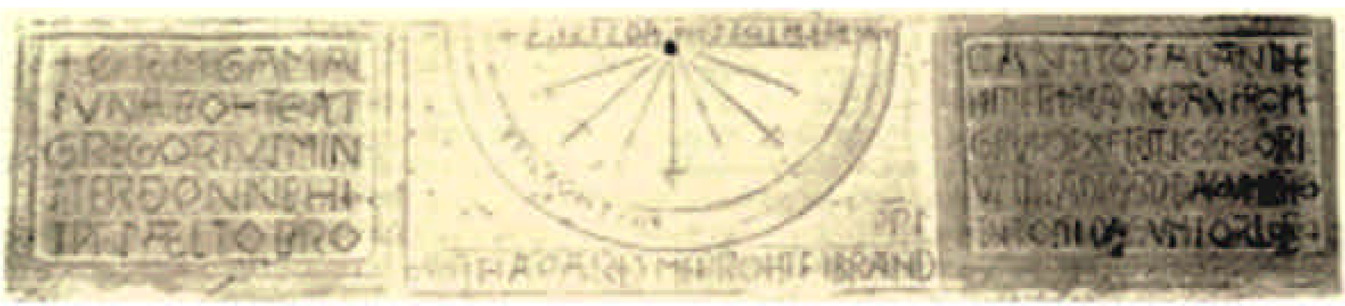
More from John Crowther on sundials :

- The cover on a previous Transit showed the refurbished Market Cross sundial in Guisborough.

It was around such Market Crosses that farm hands were hired for a year at the time of St Martin’s Day. These Martinmass Hirings, held annually around 3rd November when men were hired and promised a certain wage along with their board and lodgings.

No doubt much haggling took place as the men were looked over by the farmers and the amount of their pay and the quality of their lodgings were decided upon by those offering their services.

- The Saxon sundial at Kirkdale is protected by the porch of St Gregory’s Minster



It incorporates the longest inscription in stone Sundial on the wall of St Gregory's Minster. (cast in the Science Museum, London). The inscription reads: "This is the day's sun-marking at every hour. And Hawaro made me, and Brand, priest" . The lines with cross bars correspond to 6am, 9am, noon, 3pm and 6pm. The uncrossed lines divide time into one and a half hour periods. The line with a cross on it on the lefthand side of the dial denotes 7.30am which marked the beginning of "daytime".

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A Visit to Jodrell Bank

from Pat and Paul Duggan

As members of the Society of Popular Astronomy, Paul and I got to go along to a "behind the scenes" visit to Jodrell Bank. We sent off for tickets as soon as it was advertised but were contacted on the phone by Barry Turvey, who said it was very over subscribed – but – could we manage another date? We took the offer of May 12 and travelled down (taking advantage of a Travel Lodge "cheapie") on the Friday, hoping for a tourist look at the Peak District around Buxton en-route. It rained. However the Museum and Art Gallery in Buxton, the architecture and the general interest of the town made it a pleasant stop-off for the afternoon.

Saturday morning we travelled the short distance from the Travel Lodge at Crewe, Bartholomley to Jodrell Bank. We really enjoyed the grounds which included an arboretum with azaleas and rhododendrons out in bloom. There was an outdoor, "Whispering Ear" set up to focus sound. The "Space Café" provided us with a good meal. The Visitors Centre had information and "hands – on" items for all age visitors. We really would encourage schools to take the long trip there, our son's school had to depart from Yarm about 5.30am, it really is worth the effort. There was a 3D show for £1 extra and loads of written information and TV screens to watch. They are planning to extend the Visitor Centre soon and are asking for ideas. Walkways and information boards are set up all around the fenced perimeter of the huge telescopes, MK1 and MK2 and there is an outdoor picnic area.

The planned visit began at 1.30pm and we were met by Ian Morison of Jodrell Bank, himself an SPA Past President. We were taken beyond the visitors area and shown the original extent of the grounds as they were, when Bernard Lovell was first commissioned to search for cosmic rays, after the war had ended in 1945. He took his ex-army radar system to the university's horticultural land at the village of Jodrell Bank - the centre of Manchester was not suitable because of interference from the tramcar network. The older buildings are still in use including one changed into a "Clean Room" for the preparation of instruments for inclusion in Plank. There is a GP Receiver and a Dish System for receiving information from other telescopes in the MERLIN array. An accurate time signal to keep these telescopes in unison is also sent from there. A 218ft parabolic reflector was built there to scan the sky directly overhead in 1947, alas no cosmic rays were detected. However it was soon noted that some astronomical objects were emitting radio waves, the most notable discovery was that the Andromeda Galaxy was not a part of our own Milky Way Galaxy.

In the lecture theatre Ian Morison explained that Lovell was not content with the area of sky he could scan and joined forces with Charles Husband, a bridge engineer, in 1950. They planned an impressive, moveable 250ft telescope of a mesh design. The weight of the structure if covered with ice and the new prospect of searching the sky, after 1951, for 21cm wavelength emissions of the hydrogen atom, decisively changed their plans and increased production costs enormously. A benefactor was found in Lord Nuffield of Morris Cars, and the "Mark 1" was finally completed in 1957, just in time to track the carrier rocket of the Russian Sputnik 1. At that time it was the only powerful enough instrument in the West that could do so. Later, and with the co-operation of the Express Newspaper Group, a de-coder was provided to bring the World the first pictures ever taken from the surface of the Moon. This was a blow to the Russians who had actually landed the craft and planned to be the first to show them to the World. The main work of the telescope was to collect data on what were noticed to be unusual stars. The improved detail then possible was to lead to the discovery of Quasars, or "quasi-stars".

The discovery of Pulsars at Cambridge in 1967 was refined by the Mark 1- that had fortunately just been equipped with a computer based data acquisition system timed into an atomic clock. The search for new and most distant pulsars is a major part of its work today. The recent remarkable and continuing study of a double pulsar system, where two pulsars are seen to orbit one another every 2.4 hours, is now hailed as the most important chance of detecting the proof of Einstein's prediction about gravitational ripples.

We were taken to the Control Room where the weather conditions are extremely carefully monitored and dictate which areas of sky can be searched at any given time. The minimum movement pattern is also a factor affecting use schedules as re-positioning of this enormous instrument can take up to 10 minutes. We were shown pictures of the ageing reflector surface and the installation of a fine new bowl. Engineering improvements have been made over the years to stabilise the structure which was fortunate to escape disaster in a storm during January 1976. Below the Control Room the atom cooling system unit is housed for the reduction of "noise". It is monitored there and is vital for the quality of data gathered.

We were taken to the room where all the data from the other MERLIN telescopes arrives and shown the new storage system that is so much less bulky than the last but, never the less, is now needing a storage room all of its own. The 217 kilometre MERLIN array can provide a resolution of 1/20th of a second of arc which is comparable to those images received from the Hubble telescope. In another site operation room there is data storage on a system of hard disks and a huge back up bank. The price of replacement computing systems is surprisingly high but as technology advances apace overall there is a lower increase than we would have expected.

Back in the Lecture Theatre Professor Morison told us that the future would be with an "e-Merlin". At present there is a great deal of investigative work being done - looking to the future in providing optical fibre transmission of data. Cost and practicalities are nearly overcome. The Fibre-optic laboratory at the Observatory is now able to receive three "colours" of infra red – each carrying 10GBits of data per second from each of the other telescopes in the array. The Observatory Website provides further information: http://www.jb.man.ac.uk

As we were leaving a nuthatch flew across the doors. Ian Morison pointed out a magpie nest in the support structure of the MK2 right next to us, and told us of a pair of gyr falcons that lived happily up in the big MK1 and "kept the pigeons down" both pairs oblivious of, and quite capable of building a nest to stay the right way up whatever the motion of, the telescopes!

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Every Planet a filling station

From Bob Mullen

At present travelling through the solar system is relatively slow process. Years can pass between the launch of a probe to the arrival at its eventual destination. In fifty years of spce travel things haven't improved all that much.

One of the problems spacecraft journey designers is the constant motion of everything out there. Thanks to the huge gravitational effect of the Sun Planets in the inner solar system orbit at extremely rapid rates, the gas giant orbit at slower rates, whatever, they still are in motion relative to one another.

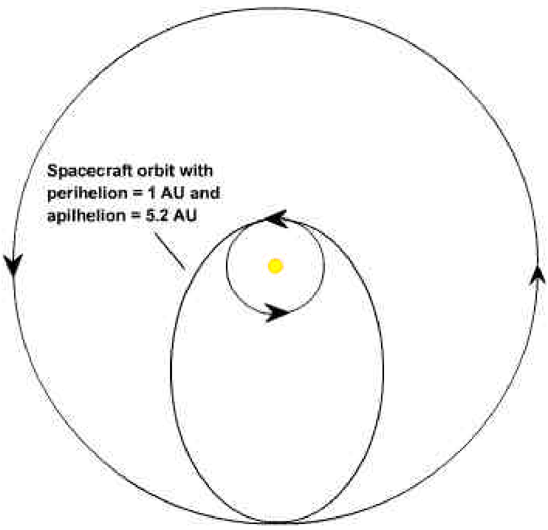
Another problem is the vast distances involved in reaching other planets, in fact so large they tend not to use miles or kilometres, far too many zero, and in a business already prone to very expensive errors one missing zero can be very costly. Instead they used the distance from the Earth to the Sun as a fundamental unit; 1 astronomical unit = 1 AU = 150 million kilometres.

Average distances from the Sun in AU:

Mercury	0.4	
Venus	0.7	
Earth	1.0	
Mars	1.5	
Jupiter	5.3	
Saturn	9.5	
Uranus	19.6	
Neptune	30.0	
Pluto	39.5	(oops! not a planet any more)

Modern spacecraft engines are still not sufficiently powerful to easily overcome these two problems. The ideal trip between, say, Earth and Jupiter would be to blast off from Cape Kennedy at full throttle and proceed to half way between the two planets, then decelerate until it is slow enough to land on Jupiter. Unfortunately at present we do not have a rocket engine with enough energy to lift off with the weight of fuel necessary to reach this half way point, also such an engine is not possible in the foreseeable future or least many decades to come.

So, instead of blasting their way directly to a planet, modern rockets have only enough energy to lift the spacecraft into a very elliptical orbit round the Sun.
This orbit is calculated to pass very, very close to their target planet. The spacecraft travels for many months to years, coasting through inter-planetary space in a big lazy arc using its own orbital speed without any engine assistance except for occasional course corrections when required. The path is very slow but steady. This method is known as the Hohmann transfer orbit.



Left : the Hohmann transfer orbit

When it is near enough its target planet the rocket engine will fire sufficiently to slow the craft (a retro-braking function) into an orbital injection path around the planet. Depending on its instrumented task the craft will continue to orbit the planet or perhaps descend to the surface. Present rocket motors are just powerful enough to lift enough fuel to feed the planned burns, both to achieve escape velocity from the Earth and retro-brake the craft at the distant planet but they do have a payload weight limitation as we shall see with the Cassini mission.

Typical coasting orbital journey times from Earth:

Mercury	3.5 months
Venus	4.8 months
Mars	8.5 months
Jupiter	2 years 8.8 months
Saturn	6 years 1 month
Uranus	16 years 1 month
Neptune	31 years 4 months
Pluto	46 years

The timing of launches has to be extremely precise so when the spacecraft reaches the other end of its trip the planet is there to meet it. Remember all the planets are moving relative to each other - a difficult bit of maths by the journey designers but they seem to get it right every time, well, most times. The precise timings are called launch windows, for instance, opportunities to reach Mars is every 780 days and the windows only occur for very short times.

Another method of reaching the target planet has been devised by the journey designers. This is the gravity assist method, using the gravity of other planets to increase the speed of the spacecraft.

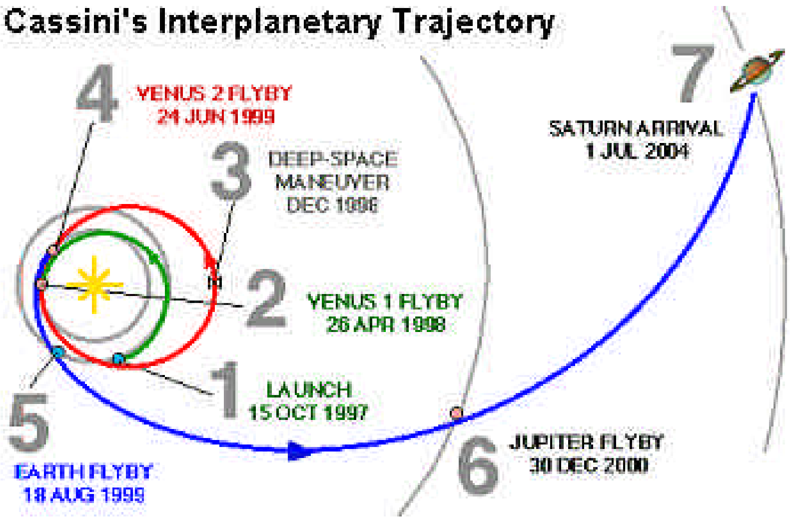
As a spacecraft is launched towards its target planet, it first follows an orbital path around the Sun. When the spacecraft approaches another planet, the gravity of that planet takes over, pulling the spacecraft in and altering its speed.

The amount by which the spacecraft speeds up or slows down is determined by the direction of approach, whether passing behind or in front of the planet. To gain spacecraft speed there is a downside for the planet, it loses the same amount of momentum the spacecraft gains and its rotation is actually slowed down accordingly.

Of course the trick is to pass the spacecraft close enough to the planet to use the gravity assist and not have it too close to the planet that its gravity pulls it down to the surface - another very difficult bit of maths.

When the spacecraft leaves the gravitational influence of the planet it once again follows an orbit around the Sun, but a different one from before, either on course for the original target or heading for another planetary fly-by. Of course any gain of speed is relative to the Sun and not to the planet itself.

This method of cleverly employing Newtonian physics has been used on a number of spacecraft journeys. For example the Cassini mission to Saturn employed four planetary flybys as seen on the below image. Although the travel time for the simpler Hohmann transfer orbit from Earth to Saturn has been calculated as 6 years and 1 month, the gravity assist method actually took 6 years 8.5 months, there was obviously no benefit in transit time but there was a very good reason for using the gravity assist method.



above: the gravity assist orbit

This is because the Cassini –Huygens spacecraft itself weighs in at 5,712 kilograms (12,593 pounds) and is so massive that no existing launch rocket could produce enough energy to directly fly the distance at which Saturn orbits the Sun. However, the launch vehicle was powerful enough to lift itself towards Venus for its first gravity assist flyby. From then on it just became “simple” orbital mechanics flying via other planets to eventually reach Saturn at minimum energy expenditure.

Effectively this means that by using gravity assist orbital techniques we can regard all planets in the solar systems as potential filling stations, this may even be the case when in the distant future man travels beyond the solar system and uses other celestial bodies to refuel the necessary energy to travel onwards.

In the meantime another type of solar system filling station has been proposed by NASA who recently tested a methane-fuelled rocket engine. Imagine a methane powered spacecraft being propelled on a trip to Saturn by gravity assist but not having enough fuel to return with Saturnian atmospheric samples. No problem, just divert to Titan and pick up a few thousand kilos of methane, compress it into the fuel tanks and head for home. Science fiction?

A Life Under the Stars part II

from David Blenkinson

What does an astronomer on a bright sunny day?

Yours truly gets my small refractor out of the shed to see it there are any sunspots. The truth is I am compelled to do it, I have to. I have a look every sunny day.

The small refractor is made from a 17 inch PVC tube and a 50mm lens with 80mm focal length – two inches and fourteen inches in old money. I use an ordinary 1 ¼ " eyepiece to project the image. I have not seen any sunspots since 21st January.

We are now in the time of Venus observing. I got my six inch telescope out and put it on the wooden fork mount. In the March 2007 "Astronomy Now" it has the positions for the Sun and Venus. So I made a pencil mark on the RA plywood disk for the Sun and another mark for Venus. I did not find Venus straight away but a bit of sweeping soon found it. That was at 3:30pm on March 25th.

At 8:00pm that evening I had a look at the Moon with the ten inch Dobsonian. Then Huygens Rille and crater Hyginus were seen very nicely. In the crater Ptolemeus some smaller craters were seen, they were just past the terminator. The shadow of the west wall of Archimedes was cutting right down the middle of the crater and was seen to be very jagged, I had not seen this before.

The Moon near Castor in Gemini produced a lovely sharp image. I looked at Saturn next, it was wonderful.

I had been looking at some close double stars in April. I was able to split 49 Leo with the six inch telescope, I had tried it before without success. Also XI Ursa Major was resolved with the six inch and iota Leo at X 210 and gamma Virgo was split with the ten

Transit Tailpieces

Articles : Please send contributions for the newsletter to Bob Mullen, 18 Chandlers Ridge, Nunthorpe, Middlesbrough, TS7 0JL, 01642 324939 (b2mullen@hotmail.com) Copy deadline date is the 20th of each month.