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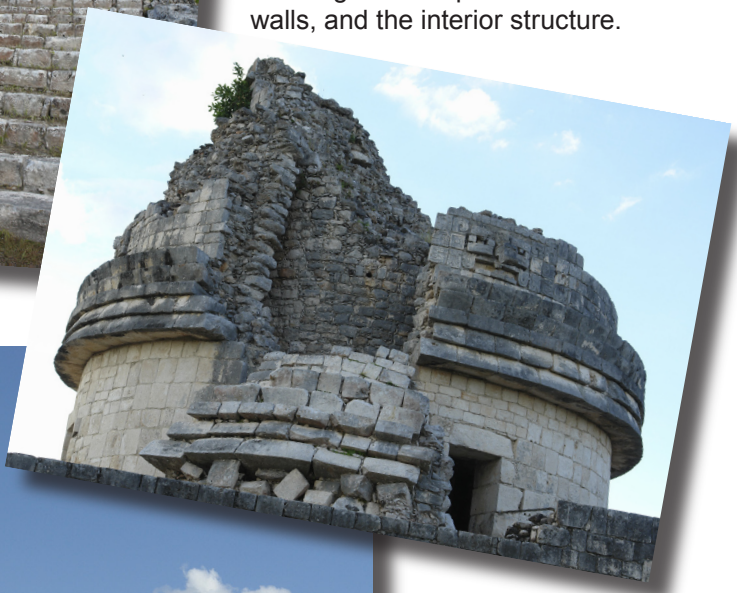
Postcards from Chichen Itza, Yucatan peninsula, Mexico

Top three pictures show the Observatory, or Caracol of Chichen Itza. Originally, in the tenth century, it was a straight sided tower with horizontal shafts in the turret and perpendicular lines to the base aligned with the planet Venus extremes.

The view below is from the rear showing the collapsed roof and walls, and the interior structure.



The Mayan Chichen Itza pyramid is in the Mexican State of Yucatan. It is about 30 meters high and has 91 steps on four sides leading to the top platform, 364 plus the top step = 365 = days in a year. It is forbidden to climb the pyramid now to preserve the stonework.

CONTENTS

Page 2	The Editors Bit, a visit to Chichen Itza, a Mayan site.
Page 3	*Nathaniel Nye* By Mike Frost
Page 9	*Astronomy in Chicagoland* By Mike Frost

Last year my wife and I spent a couple of weeks in the Mexican resort of Cancun on the Yucatán peninsula. Cancun is a completely man-made holiday resort, the oldest hotels are only just over 30 years old and are now being ripped down to be replaced with shiny new ones. The only fly in the jam jar is that it lies in the path of the odd hurricane or two and can be hit with one. There was a near miss with Hurricane Dean a couple of months ago.

While we were there we made a couple of trips to two Mayan sites, the best was Chichen Itza. A coach took us the 150 km from Cancun to the site vie a tourist shop / loo stop and a visit to one of the many wells in the Yucatán peninsula. This whole area is completely flat covered with small trees about 30/40 feet high. The locals call it the jungle, but its not very dense or high. All of this area was flattened 65 million years ago in the asteroid strike at Chicxulub.

The well we stopped off at was just off the main road and, you've guessed it, a tourist stop! But it was amazing, the opening to the well in the ground was about 50 or more feet across and a series of steps led down to a ledge just above the clear fresh water about 150 feet down. All along one side roots and creepers trailed off the plants above into the water. Some brave souls went for a swim in the cold water. The water is part of an underground network of rivers cutting through the limestone rock which I believe all connect up and run into the Gulf of Mexico around the rim of the invisible Chicxulub crater. This was just one of many wells in the region, some of which are still covered with a thin roof of limestone.

Just around the corner, a short hop away was what I had come to see, Chichen Itza. Dominating the centre of the site is the Temple of Kukulcan or El Castillo, the main Chichen Itza pyramid. It is classed as a step pyramid and is in a very good state of repair, but it is forbidden to climb the pyramid now to preserve the stonework, and after a tourist was killed falling down the steep steps in 2006. It is about 30 meters high and much wider at the base, it tapers up in 9 large steps with a wide ramp on each side leading to the top. These ramps have 91 steps on each of the four sides leading to the top platform, 91x4=364 plus the top step = 365 = days in a year.

The age is not certain, but the best estimate is it was started around 650 - 800AD. The 9 large steps are covered in Mayan symbols. On the day of the spring and autumn equinoxes, at the rising and setting of the sun, the corner of the structure casts a shadow in the shape of a plumed serpent - Kukulcan, or Quetzalcoatl - along the side of the North staircase. On these two days, the shadows from the corner tiers slither down the northern side of the pyramid with the sun's movement.

The movement of the Sun, Moon, Venus, Mars and Jupiter seem to have been especially important to the Mayan people. Located to the south west of the pyramid is the Observatory, or as it's called in Spanish, El Caracol, (Spanish for snail). The Observatory was dedicated to the study of the movement of the stars and planets and is one of the most beautiful accomplishments of the Mayan in Yucatán.

The Observatory, which consists of a round tower built on two rectangular platforms, was built during different periods. These platforms are above the tree line giving a unrestricted view of the horizon all round. The staircase that marks the front faces 27.5º north of west, out of line with all other buildings but an almost perfect match for the most northerly position of Venus in the sky. Also a diagonal formed by the northeast and southwest corners of the building aligns with both summer solstice sunrise and winter solstice sunset. The tower itself is more recent than the platforms. Inside the tower there are a number of small windows which were used to study the movements of Venus which had a tremendous significance for them. The small windows aline with both northern and southern extremes of Venus rising above the surronding flat horizon The unusual stairway, resembling a snail shell, leads to the highest part of the tower. The tower is about 13 meters in height and the observatory measures 22.5 meters high. Above the doorways in the observation tower there are carvings of the rain god, Chaac to whom some believe the building may have been dedicated.

Why the Mayan were so keen on following Venus is a mystery. Even though the Mayan wrote many books, only 4 have made it to our time, the rest was burnt by the Spanish as works of the devil! One, the Dresden Codex, has 5 pages devoted to the Venus Table listing the number of days between morning and evening risings. This is accurate to 1 day in five centures! They knew about the cycles of Venus and how the planet returns to the same position after 584 days and the length of the year 365 days a ratio of 5 : 8. So after 8 years it returns to the same position. Also in the Dresden Codex is an lunar eclipse table which seems to be able to predict future eclipses of the sun and moon.

The Maya's deep interest in astronomy and calendars helped the Mayas to establish the cycle for sowing crops and other activities which were important to the economic and social life of the city.

All this without any instruments or telescopes. How many years must it took of careful record keeping to be able to construct buildings and tables of the sky that are accurate still?

Ivor Clarke

Nathaniel Nye

By Mike Frost

In my article, *"Samuel Foster and his Observations from Distant Places'"*, which appeared in the last edition of MIRA (see MIRA 79, Summer 2007), I told you about a remarkable group of astronomers who were active around Coventry during the late 1630's, shortly before the Civil War. The leader of this group was Samuel Foster. Two others who are mentioned in Foster's writings are John Palmer, rector of Ecton, to the east of Northampton; and John Twysden, originally of Kent, whose sister married the owner of New House, Coventry, from where Foster, Palmer and Twysden made observations.

However, as I read books about science in the seventeenth century, another name kept cropping up - Nathaniel Nye, the subject of this article. Several of my sources assured me that he was an astronomer on the periphery of Samuel Foster's circle. Yet he is best known for something else altogether.

According to the Dictionary of National Biography, Nathaniel Nye was baptised in Birmingham on 18th April 1624. Nathaniel may have been the son of Allen Nye, whose name later appears as a governor of King Edward VI's school, Birmingham. Nathaniel Nye is most famous for his 1647 book *"The Art of Gunnery"*, a practical guide to the deployment of artillery. The rather sinister portrait accompanying this article, by Wenceslaus Holler, is the frontispiece of this book. During the Civil War Nathaniel Nye was the master gunner of Worcester, which he successfully defended for parliament against the Royalists. Nye also mentions in passing that he had drawn up plans for the defence of both Birmingham and Coventry, although neither of these plans now survives.

"The Art of Gunnery" is still in print! The Pike and Shot Society reprinted the original edition in 2004. It's a popular book amongst students of military history because it gives a vivid insight into the practical difficulties of being a gunner during the English civil war. I have read the book, both in its original edition and in its more recent imprint - I particularly enjoyed the section on *"Fireworks for Warre and Recreation"*. Unfortunately I found nothing at all of astronomical significance. From an astronomical point of view, Nye's most interesting works were written earlier in his career: a series of almanacs for the city of Birmingham, for the years 1642, 1643 and two for the year 1645. In these almanacs Nye describes himself as a mathematician and astronomer. After publication of *"The Art of Gunnery"* we know nothing more of the life of Nathaniel Nye.

The entry for Nye in Professor D.G.R. Taylor's *"The Mathematical Practitioners of Tudor and Stuart England"* claims that Nye observed a solar eclipse from Coventry in 1640. From this Taylor inferred that Nye was one of Samuel Foster's students. If Nye's baptism followed shortly after his birth, Nye would have only been 16 or 17 at the time.

However, there are some problems with this. First of all, Samuel Foster does not mention Nye in any of his eclipse descriptions, or indeed anywhere else, to my knowledge (for that matter, Nye doesn't mention Foster anywhere either). Moreover, although there were two solar eclipses between January 1st 1640 and March 25th 1641 (the end of the year 1640-41, by the convention of the time), neither was visible from England. I asked Sheridan Williams, author of *"UK eclipses from Year 1"* to confirm that England had no eclipses in 1640. He was able to do so, and made the ingenious suggestion that Nye might have been aboard an H.M.S. Coventry elsewhere in the world in 1640. There is alas no evidence for this.

The true Effigies of Nathaniell Nye Mathematician.

An Internet search threw up another baffling discrepancy. Although Nye is mentioned on a

number of web-sites, mostly concerned with the history of artillery or the English Civil War, there is only one internet site which refers to Nye's astronomical beliefs. This is `www.skyscript.co.uk/almanac.html`, and is written by one Derek Parker. It's an astrological website. Mr. Parker reproduced an article from The Traditional Astrologer Magazine, discussing the almanacs produced during the seventeenth century by Nathaniel Nye and many others, the forerunners of Old Moore's almanac. These almanacs included a bewildering jumble of information on many subjects, and in keeping with the context of the times, mixing up astrological and astronomical predictions was commonplace.

The article is entertainingly written and well presented, and shows every sign of having been thoroughly researched. But Mr. Parker's comments on Nathaniel Nye's almanacs surprised me. Mr. Parker tells us that *"Nathaniel Nye, a supporter of Copernicus, nevertheless taught that the Moon was larger than the Earth"*.

Why is this so surprising? Because it is very easy to disprove. Compare the relative sizes of the shadows during a lunar eclipse and a solar eclipse. The Earth's shadow on the Moon is much bigger than the Moon, and covers it completely. Yet the Moon's shadow barely reaches the Earth, the zone of totality being only a few tens of miles across at best during a solar eclipse. So the Earth MUST be comfortably bigger than the Moon.

This was hardly news during Nye's time - the argument was well known to the ancient Greeks. One of them, Aristarchus of Samos, had extended the argument to deduce that the Earth must be around 3 to 4 times the size of the Earth. Moreover, Samuel Foster produced his own calculations, based on his observations during eclipses, to refine Aristarchus's calculations. These appear in his mathematical lucubrations, *"An epitome of Aristarchus Samii, Proposition XVII"*. The result of the calculations is that the Moon's diameter is 20/57th (0.351) that of the Earth. The actual ratio is 0.272.

So, to summarise - Nathaniel Nye of Birmingham is taken to be a student of Samuel Foster, even though Foster never mentions him. Nye is claimed to have observed, from Coventry, an eclipse of the Sun, which didn't happen, and to have believed that the Moon was bigger than the Earth, a fact which his so-called teacher, Foster, comprehensively disproved.

There was only one way to resolve these discrepancies. I returned to Cambridge University Library (CUL) to see what Nye had actually said in his almanacs.

The orginals of the almanacs are held in the British Library, however Cambridge holds copies on microfiche and digitally (the librarian took pity on me after I'd struggled with the microfiche for half an hour, and told me there was also a digital copy). The 1642 almanac is only on microfiche.

Each almanac contains a list of predictions of planetary positions for the year, for astrological usage (the 1643 almanac styles these *"The Caracters of the Seven Planets and their Aspects"*), a catalogue of stellar positions, and a prognostication of eclipses for the upcoming year. The year is deemed to begin in January, so presumably the almanacs were printed at the end of the previous year. Other common tables are *"A necessary and Perfect Table to know the beginning and end of every term"* and *"A short description of the four quarters of the year"*. For variety, individual almanacs contain sections such as *"A Chronology of Memorable Things"*, *"A brief description of the naturall causes of watery Meteors, as Snow, Hale, Raine etc."* and *"Observations for Husbandmen"*. Additionally, the 1645 almanac contains a long and detailed commentary on the progress of the civil was to date. Not surprisingly, Nathaniel Nye was passionately interested in the tumultuous events of the time.

However, *"a new almanacke and prognostication for the year of our Lord God, 1643, being the third from the leap year, calculated exactly for the town of Birmicham [Birmingham] in Warwickshire..."* by *"Nathaniel Nye, Mathematitian and Practitioner of Astronomy"* is the only one to record Nye's astronomical observations.

There are several sections of interest. First of all *"Certaine Observations and new discoveries made in the Celestial Regions"* establishes Nye's credentials as a serious astronomer. Nye asserts that Jupiter possesses four Moons, that Venus shows phases, and that there are mountains and other features on the Moon. Clearly he has read and understands Galileo's observations from 1608 onwards. The Sun has spots; the Earth rotates around the Sun.

Others of Nye's claims are less valid but reflected general belief at the time - for example, *"The Sea is caused to ebb and flow by the Earth's motion about the Sun"*. This reflects Galileo's erroneous ideas on how the tides were created. Isaac Newton was the first person to come up with a theory of Tides close to modern explanations, in Principia Mathematica, published in 1687.

Finally we get to the relative sizes of astronomical objects. *"...no planet is bigger than the Earth (the Sun excepted) but lesser many hund. [hundred?] times, and this is easily proved, the Moon must then be bigger than any of the other planets, being but less than the Earth 42 times "*. Nye does NOT say that the Moon is bigger than the Earth! Mr. Parker, the astrologer, has mis-quoted Nye's statement of belief. Nye does say the Moon was bigger than the other planets, but again this was in line with the beliefs of the time - the solar system beyond the Moon was thought to be much smaller in size than we now know it to be. As Edmund Halley pointed out, Transits of Venus offered a method of determining the size of the solar system.

Nye then goes on to describe *"Certain Observations made by me and others of my friends, in the place of the Planets"*. His account begins: -

"Because those that hath astronomical tables may calculate the places of the Planets for these times, as I have observed, which I know will be to their content, however it cannot be amisse to set down such observations which I have faithfully observed.

1640 upon the 8 of August Jupiter in the 10 deg:36 min:?? the lati. of Jupiter about one min and a half fourth, just at eight at night.

1639 upon the 22 of May the eclipse of the Sun began at the City of Coventry just 2 min after 4 after noone the greatest obscurity just at 5 a'clock and 9 min; and the end most exactly at 6 & 5 min: the whole duration was 2 hour and 3 min; & the quantity obscured was 9 dig & 23 min;..."

The first observation is routine. The second resolves the discrepancy in Professor Taylor's book. Prof. Taylor was mistaken - the eclipse observed by Nye occurred not in 1640 but in the previous year, 1639. I mentioned this eclipse in my article on Samuel Foster. Foster and John Twysden saw the eclipse of May 22nd 1639 from 'Old Bayly, London'. Jeremiah Horrocks saw the eclipse from Much Hoole, and William Crabtree from Broughton, Manchester, and they all compared observations (the Sun was around 70% eclipsed from England, and the eclipse was annular over Scandinavia). In this context, Nye's observations make a great deal more sense. If Nye was in Coventry, Foster would not mention him in his London report. It's still possible that Nye may have known Foster. In 1639 Nye was perhaps only 15, and Foster may have not considered him a serious observer; perhaps Nye had attended the November 1638 observation of a lunar eclipse.

You might think that, having resolved these discrepancies, finding both Prof. Taylor and Mr. Parker wrong, I would be feeling more than a little smug. Actually, I was shaking like a leaf. This was because I had just read the lines that immediately follow the eclipse account (without even a carriage return) in the catalogue of Nye's observations. This is what comes next:

"1639 upon the 23 of Novem Venus came just under the Sun at 3 aclock and 30 min; & continued upon the Sun half an hour the true place of the Sun; Venus were in Sagittarius 10 deg; and 19 min. This observation doth not agree with Landberg's table, but the eclipse of the Sun commeth somewhat nearer the truth, for [by these tables?] the Sun was Eclipsed 8 dig & 50 min; for the time of the beginning and ending, he differs much from observation. Upon the 26 of March 1640 just at 9 aclock at night I observed Moon's Placce to be in the 8 deg of Libra & 32 min; & in this observation I considered the Paralax, Refraction & Lati[tude]"

Again, the 1640 observation of the Moon is routine - but the description preceding it is sensational. Nye is claiming to have seen the 1639 Transit of Venus!

Can we possibly add Nathaniel Nye, perhaps only 15 years of age, to Jeremiah Horrocks and William Crabtree as the first people in history to view the a Transit of Venus? It barely seems credible. Samuel Foster, Nye's supposed teacher, left no record of having viewed the event. Capable astronomers such as Pierre Gassendi, first person to observe a Transit of Mercury, left no record of having seen the Venus Transit (Galileo didn't see it either, but he was in his declining years). Yet here is an upstart "mathematitian and astronomer" of Birmingham cheerfully including an observation of the Transit among the list of *"such observations which I have faithfully observed"*.

You might recall me saying in my previous article (written before I saw Nye's alamancks) that "if I was any use as a historian, I would produce a previously unknown document detailing Samuel Foster's observations of the 1639 Transit of Venus, preferably from in front of Coventry Cathedral". Well, I didn't find any observations of the Transit by Foster - but here was one by Nathaniel Nye! And although Nye didn't state where he made this observation, it followed on immediately from one made in Coventry. You can imagine why my hands were shaking!

Elsewhere in the 1643 almanac, in a separate section entitled *"Of the Eclipses"*, Nathaniel Nye says a little more about Transit observations. *"And in the Year of our Lord 1639 upon the 23 of Novem the planet Venus came just under the Sun at halfe an hour after 3 noone and went of about 4. The like will happen upon the 12 of November 1643 about 11 before noon for at the instant Mercury comes just under the Sun and about 2 after noon lies nearer the center of the Sun and goes off the Sun about Sun setting ... let me entreat all those who affect these arts to observe it"*. Nye then wrote down a detailed method for *"How to behold an Eclipse of the Sun or when Venus and Mercury come under the Sun"*, which involved projecting the Sun's image onto a screen in a darkened room, just as Horrocks and Crabtree had done.

So, not only did Nye describe how to observe a Transit, he also made further predictions of when the next Transit (of Mercury) was going to occur. How could the history of science have managed to miss this remarkable astronomer?

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In most branches of astronomy, time is of the essence. In the history of astronomy, the evidence will still be there after lunch. To calm myself down, I had a cup of tea in the CUL's excellent tea-rooms. I then went for a stroll along the Backs and polished off an ice cream. By the time I returned to the reading

rooms an hour later Nye's observations didn't seem quite so impressive. Here's why:

There are several worrying errors in Nye's account. First, and most important - the 1639 Transit was NOT on November 23rd, but the next day, November 24th 1639. The timings of the Transit are suspicious - Jeremiah Horrocks reported that when he was first able to observe the Sun, Venus was already on it, at 3:15pm, and Horrocks then observed until sunset at Much Hoole, at 3:50pm. These times are nominally inconsistent with Nye's report; however, in 1639 all times were local (there was no such thing as Greenwich Mean Time; in fact, no such thing as Greenwich Observatory) so Nye's reported hours may be reconcilable with Horrocks's account. More worrying is the assertion that Venus *"came of[f] the Sun"* at 4pm. In reality, the transit continued for several hours, but couldn't be observed from England because the Sun had set, with Venus still crossing it.

So, if Nathaniel Nye really did observe the 1639 Transit, his account of it is not very impressive - the three lines contain at least two errors. You'd have thought he'd at least get the date right!

Much though I'd like to claim discovery of a new account of the 1639 Transit, I'm not sure Nye really saw the event. The errors in the detail need to be explained away. Perhaps, for example, Nye observed the Transit in 1639 but didn't understand what he had seen until he came to compute details of Transits for the 1643 almanac. This would account for the vagueness of detail and additionally explain why there was no mention in the 1642 almanac. Unfortunately there is no evidence to back this explanation and I have to regard it as rather contrived.

I think there's a better explanation. I think he's borrowing someone else's account - perhaps this is what he meant by *"observations by me and others of my friends"*. I would go further, and suggest that the observation appears to be a garbled version of Jeremiah Horrocks's account, written as *Venus in Sole Visa* in 1640.

Why do I think this? Because Nye's account is largely consistent with a misreading of Horrocks's account. Horrocks began observing on November 23rd, just in case, although he expected the transit to occur on the 24th. Horrocks observed from 3:15 to 3:50, although he neither saw second or third contact. The mention of Landberg (Philip Landberg, Belgian astronomer) is also telling, as Horrocks discusses at length the shortcomings in Landberg's tables of solar and planetary positions.

Most significantly, I think, the contrast in the quality of Horrocks's and Nye's accounts is marked. *Venus in Sole Visa* is a seventy page document, tightly argued, showing how Horrocks came to predict the Transit of Venus and what conclusions he drew from his observations (there's also polemic and some bad poetry). Nye simply (and incorrectly) reports the bald facts of his supposed observations, without any attempt at context or interpretation. It is this lack of supporting detail that fails to convince me.

And how about Nye's prediction of a forthcoming Transit of Mercury? If Nye had successfully forecast a Transit of Mercury in November 1643 I would have been a lot more inclined to accept his Venus Transit report at face value. However, he was wrong - there was no Transit of Mercury in 1643, although there was one in November 1644 (see Appendix 1). Nye knew enough about the orbital motion of Mercury to know that a Transit was possible in November (they can only occur in May or November), but his calculations were not good enough to forecast the next one accurately.

If I'm right - if Nye was simply reproducing Jeremiah Horrocks's account of the 1639 Transit - this is still of some interest. The route to publication of *Venus in Sole Visa* was tortuously slow. Horrocks died in January 1641. William Crabtree managed to secure many of his papers, but Crabtree himself died in 1644. Horrocks's brother Jonas also had some of Jeremiah's papers, bit it isn't certain what happened to these. Crabtree's papers, including *Venus in Sole Visa*, passed to Christopher Towneley of Burnley, and Towneley's student Jeremy Shakerly was the first to publish Horrocks's work on gravity (Shakerly later travelled to India to see the Mercury Transit of 1651, the first Englishman to view a Mercury Transit). John Worthington, who had known Horrocks at Emmanuel, was next to take ownership of Horrock's papers. He passed them to Christian Huygens, who gave them to Johannes Hevelius of Danzig. Hevelius was the first person to publish *Venus in Sole Visa*, as an appendix to his own observations of the Mercury Transit of 1661.

Finally, later in 1661, John Worthington persuaded the Royal Society to publish Horrocks's most important work. In his preface to *Venus in Sole Visa*, John Wallis (who knew both Samuel Foster and Jeremiah Horrocks) says

"I cannot help being displeased that this valuable observation, purchasable by no money, elegantly described, and prepared for the press, should have laid hid for two-and-twenty years, and that no one should have been found to take charge of so fair an offspring at its father's death, to bring to light a treatise of such importance to astronomy, and to preserve a work for our country's credit and the advantage of mankind"

When I first read this, I interpreted it to mean that, according to the Royal Society, the knowledge of the 1639 Transit of Venus had been hidden from view for 22 years. Yet for most of this time it had been common knowledge on the streets of Birmingham! I wrote a paper for the Journal of the Society for the History of Astronomy on Samuel Foster, to which I appended my findings on Nathaniel Nye. I argued that, even though it was unlikely that Nye observed the 1639 Transit; it was still of huge interest that

he knew of Horrocks's work, which was unknown outside the north-west of England.

The referee disagreed somewhat with my conclusions. And as my referee was Dr. Allan Chapman, I had to listen to his comments! Dr. Chapman's interpretation is that Horrocks's papers did circulate quite widely after his death, even though this is not the impression you gain from popular accounts of his life (for example, Peter Aughton's biography). Cambridge University Library has three hand-written copies of *Venus in Sole Visa* (which I saw when I was researching Horrocks's life three years ago) and Allan tells me that there are several references to these copies in correspondence of the time. John Wallis, it would appear, was simply displeased that the work took such long time to come to print in Britain.

Nonetheless, Wallis was presumably unaware that a brief summary of Horrocks's work had already been published by Nye. I think that the Birmingham almanac for 1643 is the earliest published account of a Transit of Venus. It's just a pity that the details are wrong.

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It's hard to draw a conclusion from all this research. I started my investigations into Samuel Foster with the faint hope that I might find someone else, other than Jeremiah Horrocks and William Crabtree, who had observed 1639's Transit of Venus. I thought that person might be Foster, but I'm now sure that he didn't, because he would surely have included such an observation in his detailed observing notes. Instead I found Nathaniel Nye, in many ways a shadowy figure, who made the extraordinary claim of a Transit observation, in a very offhand and throwaway manner.

I've resolved several annoying discrepancies on the published details on Nye's life, but in doing so I immediately set up some bigger questions. Nye's relationship to Samuel Foster is still a mystery to me. Clearly both were making astronomical observations from Coventry around 1638/39, yet neither mentions the other, and Nye doesn't seem to have told the Gresham Professor of Astronomy of an event he would have surely wanted to know about.

And, much though I would love to announce the discovery of a third, independent, observer of the 1639 Transit, who lived in Coventry, I think that I have to say that the discovery is flawed.

Probably.

Appendix 1 - 17th century transits of Mercury

NASA / Fred Espenak's catalogue of Mercury transits is at
`http://sunearth.gsfc.nasa.gov/eclipse/transit/catalog/MercuryCatalog.html`

Mercury transits are far more common than Venus transits. The following are calculated to have occurred between 1631 and 1677 (new style dates):-

1631 Nov 07 - observed by Gassendi and others (the first ever observed Mercury Transit)

1644 Nov 09 - not observed

1651 Nov 03 - observed by Jeremy Shakerley (from India)

1661 May 03 - observed by Huygens and Hevelius

1664 Nov 04 - not observed

1674 May 07 - not observed

1677 Nov 07 - observed by Edmond Halley (from St. Helena)

Sources:

Dictionary of National Biography entry for Nathaniel Nye

"The Art of Gunnery", Nathaniel Nye (first edition 1647, re-printed by the Pike & Shot Society, 2004)

"The Mathematical Practitioners of Tudor and Stuart England", pp 221-222, D.G.R. Taylor (C.U.P. 1954)

"The Rise and Fall of the Astrological Almanac", D.Parker, (The Traditional Astrologer, Issues 10 and 11)

"A new almanacke and prognostication for the year of our Lord God, 1643, being the third from the leap year, calculated exactly for the town of Birmicham [Birmingham] in Warwickshire..." by *"Nathaniel Nye, Mathematitian and Practitioner of Astronomy"* (1643). Held digitally and on microfiche in Cambridge University Library, classmark WING/B125:2.9, reel 1517:21

"Miscellanies, or mathematical lucubrations" Samuel Foster, ed. John Twysden (London, 1659) - St John's College library, by kind permission of the Master and Fellows of St John's College, Cambridge.

"Venus in Sole visa (Venus seen upon the Sun)", Jeremiah Horrocks (1640).

"The Transit of Venus - The Brief, Brilliant Life of Jeremiah Horrocks, Father of British Astronomy", Peter Aughton (Weidenfeld & Nicolson, 2004)

Appendix 2

The proof by Aristarchos of Samos that the diameter of the Earth is 3 times that of the Moon.

Aristarchos knew that:

(a) The umbra of the Moon's shadow just touches the Earth's surface (as observed during a solar eclipse)

(b) The umbra of the Earth's shadow is twice as wide as the Moon (as observed during a lunar eclipse)

Aristarchos also assumed (correctly) that the Sun was much further away from the Earth than the Moon.

Let x be the distance from the Earth to the Moon.

Let y be the distance from the Earth to the Sun.

Let z be the length of the Moon's umbra (from (a), the length of the Moon's umbra is x)

Let m be the Moon's diameter, e the Earth's diameter, s the Sun's diameter.

Diagram (1 top) shows a solar eclipse.

From it we can see that $s/y = m/x$ (1)

Diagram (2 bottom) shows a lunar eclipse

From it we can see that $e/z = 2m/(z-x)$ (2)

Rearranging (2) gives $z = Ex / (E-2m)$ (3)

From diagram (2) we can also see that $s/(y+z) = E/z$ (4)

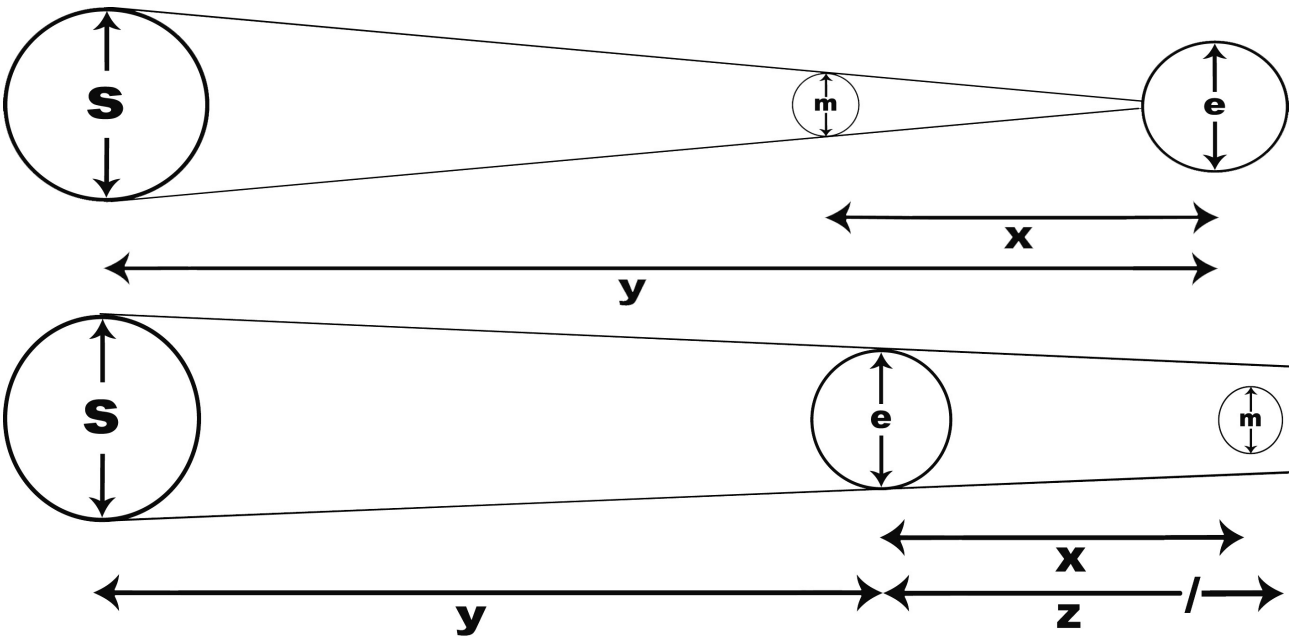
Because the Sun is much further away than the Moon, y is much bigger than z and so we can approximate s/(y+z) by s/y (the error is only 1 part in 400)

So $s/y = E/z = E (E-2m) / Ex = (E-2m) / x$ (5)

Substituting (1) gives $m/x = (E-2m)/x$ (6)

Or $E = 3m$ QED

Samuel Foster attempted to refine the calculation of Aristarchos by making his own estimate of how big the Earth's shadow is compared with the Moon (using the observations he had made from New House,



Astronomy in Chicagoland

By Mike Frost

I spent Christmas 2006 and the first few weeks of 2007 in the United States, commissioning a computer control system at Beta Steel, a small steel works situated in the Port of Indiana, at the southern end of Lake Michigan. The Port of Indiana is a rather grandiose name for a small and sleepy complex, which in any case shuts down as a harbour during the winter when the lake freezes over. The whole of the southern end of the lake, one of the largest bodies of freshwater in the world, is lined with a string of steel works; some of the largest are located within the city of Gary, founded in 1906 by Elmert H Gary, chairman of US Steel. The highway from Gary to the Port of Indiana, which I travelled on every day, was named "The Frank Borman expressway", after one of Gary's more famous sons, the astronaut who orbited the Moon in Apollo 8. Michael Jackson also comes from Gary, but they don't have any expressways named after him.

Just to the west of my steel works is a nature reserve containing a public beach and many of the impressively large dunes which have formed at the windswept end of the lake. From the beach you can see across the lake, which is far too wide to see to the other side. Except at an angle of forty five degrees. If you look to the north-west, when the air is clear, you can see the skyscrapers of Chicago rising straight out of the lake like distant castles. The city at ground-level is not visible - a clear proof that the Earth is round, so that only the highest buildings peek above the horizon, as viewed from thirty miles away.

Chicago is in the state of Illinois, and my steel works, plus Merrillville, the town where my hotel was located, are both in Indiana. However the way in which American cities sprawl means that the north-west corner of Indiana has become part of Greater Chicago, or "Chicagoland", as Chicagoans style it. Merrillville is pretty much the last big town on the south-east route out of Chicago; to the south, the state rapidly becomes agricultural rather than industrial. I get the impression that Hoosiers (as Indiana residents style themselves) don't really think of the Chicagoland bit of Indiana as a proper part of the state - in fact it's even in a different time zone.

So, even though I spent my time living in Indiana, I felt that I was actually in the suburbs of the city of Chicago. I had no objection to this, as Chicago is one of America's great cities. On my days off, I often caught the train into the city centre to explore the city, see the sites and visit Chicago's excellent museums.

From an astronomical point of view, there were several places worth visiting. The Field Museum of Natural History has an extensive collection of meteorites, including the Benld meteorite, a 1771g rock from space which, in 1938, ended up embedded in the back seat of Ed McCain's Pontiac Coupe. The car was parked in Mr. McCain's garage at the time and there are also pictures of the holes in the garage roof and the roof of the car.

Better still is the excellent Museum of Science and Industry, to the south of downtown, close to the University of Chicago, and not far from the squash court under which Enrico Fermi built the first ever nuclear reactor in 1942. I visited the Science and Industry museum twice, as there was so much to see. The Henry Crown Space Centre, situated next to the IMAX theatre, contained the Apollo 8 Command Module and Aurora 7 Mercury capsule, a space shuttle mimic, and many memorabilia such as space suits.

Best of all, however, was the Adler planetarium, which I visited with my work colleagues on Christmas Eve. The Adler is situated on an artificial promontory built jutting out into Lake Michigan, and from it you have some of the best views in Chicago. To the south is Soldier Field, home of the Chicago Bears NFL American football team, and a venue for "real" football during the 1994 World Cup. To the north there is an uninterrupted view over downtown Chicago - the Sears Building (largest skyscraper in the USA west of New York) and the Hancock Building; the Navy Pier and the harbour. It's a breathtaking view.

Of course, you don't go to a planetarium to enjoy the view outside (though it's a bonus to be able to enjoy such a view from the tea room!) The Adler features not one but three planetaria, representing the evolution of the discipline over more than a century. Oldest is the Atwood Sphere, now just a curiosity but in its heyday a wonder. It is literally a metal sphere, fifteen feet in diameter, into which 692 holes have been carefully punched, so that external light appears to come from the stars of the sky. You sit on the inside and the sphere rotates to show how the sky changes through the course of the night. The Atwood Sphere was built in 1913, and had fallen into disrepair, but has been renovated in recent years.

We didn't see the Sky Theater Zeiss planetarium, but we did attend a show in the most modern arena, the "virtual reality" StarRider Theater, where a digital projector gives a state-of-the-art presentation on the history and future of astronomy. Perhaps the most entertaining part was where the audience had to manouevre a probe around the canyons of Mars, taking care not to collide with any of the rock outcrops (we failed). It's all very high-tech, but personally I feel something has been lost when a

planetarium presentation no longer features the night sky.

The best part of the Adler is the galleries that surround the planetaria. There was an excellent display on the history of astronomy in cultures throughout the world. Another gallery showcased NASA's many missions around the solar system, including full scale models of the Mars Rovers which are currently doing such sterling work on the red planet. Our favourite gallery, however, was "Shoot for the Moon", a display dedicated to the life and achievements of Chicago resident Jim Lovell, astronaut on Gemini 7 (with Frank Borman) and Gemini12, Apollo 8 (with Frank Borman) and the ill-fated Apollo 13. Lovell had provided many personal memorabilia, plus insights on what motivated him to become an astronaut, and what it's like to be in space.

By contrast with Chicago, Merrillville, where our hotel was located, was a rather soulless town dedicated to shopping malls. Somewhat to our surprise, however, we discovered that the local middle school had its own planetarium, which offered public shows every Friday.

The setup is most impressive. As you enter Clifford Pierce Middle school, above your head is suspended a one-tenth sized model of the space shuttle Endeavour, built by a local cub-scout group. The planetarium is in a dedicated suite of rooms, including a teaching area and a small shop. The show was booked out, which was a pity because we hadn't booked in advance; fortunately not everyone turned up and so everyone on the reserve list managed to get in.

When the show starts the audience is let into the planetarium proper, which is an ordinary "rectangular" room with a thirty-foot diameter dome inside, into which we all filed. There are sixty-four reclining seats, with a computer control desk at the centre. Greg Williams, the planetarium director, explained to us that the school had recently installed a new digital system, and we were among the first audiences to see the new show. My heart sank - were we going to get another "whiz-bang" program, strong on special effects but weak on astronomy? Fortunately not - as the lights dimmed we had the familiar view of the night sky above us.

The presentation was excellent - in my mind a near-perfect example of how to use new planetarium technology. Our guide showed us the constellations of the night sky and the positions of the planets. He took us on a guided tour of the highlights - the Pleiades, Orion Nebula and so on, and the digital technology allowed him to magnify and expand on items of interest as he reached them. He showed how the celestial sphere changed through the night, and through the seasons, and then took us to the North Pole to demonstrate how the whole sky became circumpolar there. Then we left the Earth altogether, to look back at our home planet, before paying a rapid visit to Jupiter and Saturn. At the end of the show the volunteers from the school, who had helped with the presentation, were introduced to the audience and took a bow.

So I was very impressed with the Merrillville planetarium; designed for use by the school, manned by volunteers from the school, and used for the education of the pupils and the community. I was hoping that the planetarium program was going to followed, as advertised, by a star viewing session from the school roof; unfortunately the weather was at its coldest, around zero degrees Fahrenheit, or minus 18 centigrade, and so the steps and walkways were frozen and at risk to the public. It was so cold that any public viewing session wouldn't have lasted very long anyway.

I was hoping to pay a visit to another observatory, at the University of Valparaiso, which is fifteen miles to the east of Merillville, in more rural Indiana. Valpo, as everyone calls it, feels much more like small-town America than Merrillville; the town hall square, we reckoned, was straight out of "Back to the Future". The University advertised a viewing night at the physics department's campus observatory, featuring a 16-inch computer-controlled reflector. Unfortunately my work got in the way, and I had to fly to Pittsburgh to visit another steel mill in Pennsylvania; so I left the observing night to my work colleagues. It was a bit of a disappointment, I'm told. The students didn't know how to control their electronics, and apparently the observatory dome was out of control and spent much of the session rotating to its own whim. They did manage to view Saturn eventually, but the observing session was greatly curtailed.

As for proper observing, opportunities were greatly limited by the sky light of Chicago and its suburbs, and above all by the extremely cold weather. At one point the TV advised us not to venture outside at all, even during daytime, as the windchill meant that all exposed flesh was in danger of frostbite. My observing was limited to a vain attempt to spot Comet McNaught between the clouds in the early evening sky; but an unexpectedly clear view over several nights, of Venus and Mercury together in the twilight. I have rarely seen Mercury, outside of transits and solar eclipses, so I was surprised and delighted when I realized that the tiny point of light beneath the much brighter evening star was in fact the elusive innermost planet.

To sum up: Chicagoland is a great place to learn about astronomy - but not such a great place to do astronomy from!

Sources/ Further Information

www.adlerplanetarium.org
www.msichicago.org
www.mcpstars.org
www.physics.valpo.edu