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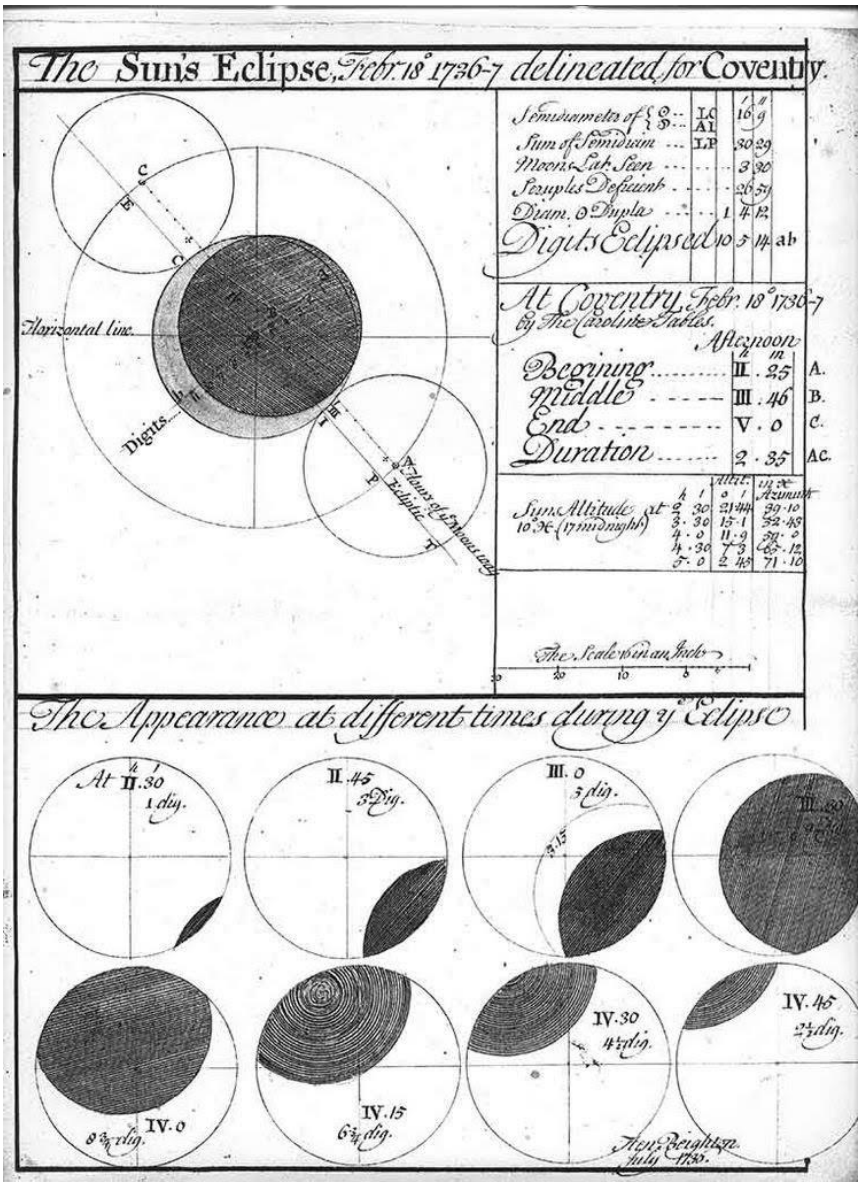


Contents

Editors Bit	Ivor Clark
T-Day	Mike Frost
A Warwickshire Eclipse	Mike Frost

Editors Bit

For this years main holiday, my wife and I headed for Pafos on the west coast of Cyprus. The time was the second week of June and the transit of Venus was due on June 8th. Cyprus was blessed with clear skies and warm weather and as it is situated two hours ahead of UK, made it an early breakfast for the start at around 8.20am local time for the beginning of the transit. We had arrived on the Saturday evening before the Tuesday's event and the first clouds we saw! You've guessed it! Tuesday morning!!!

If we had been there to do a transit timing of the beginning of the second contact (when Venus is just inside the Sun's surface and shows a complete round sphere) we would not have seen it! The clouds soon cleared however and there was a small black dot on the surface of the Sun. I was using an old telescope balanced on the edge of one of the hotel's poolside tables to project the image of the Sun onto a piece of white card. Sunbathing and astronomy all at once. Even with this crude setup Venus was easy to see.

On of the hotel guests walked past and said "Mines bigger than that." For a second I wasn't sure what he was talking about, well he was a German. He fished out of his bag a small black 80mm Vixen refractor mounted on a small photographic tripod. He set it up at the other end of the pool area, it had a home-made disc support on to which was projected the Suns image of about 6" diameter behind a cardboard screen. The image was excellent, sharp and nice and contrasty through a Plossls eyepiece.

So the morning passed, with a glance at the Sun now and then through the 1999 eclipse glasses and a few shots with the digital camera through a sun filter. Every few minutes it was necessary to move the telescope to keep the Sun in the field of view. Now and then other hotel guests came and had a look and chat, most of them it must be said couldn't care less about seeing the transit.

It is not every day you can see something moving in the night or day sky, apart from a meteor that is. All things move at a different scale to human existence. Of cause many objects are moving at many miles per second but from our perspective of several tens of millions of miles, they don't seem to be rushing across the sky. The Sun and Moon can only be seen moving when they are touching objects near the horizon, when high in the sky they appear to be stationary and several minutes must pass before any movement is noticeable. With the planets, they appear to move across the sky in small night by night jumps. Only looking through a telescope can you watch the Moon move past a star near its edge or disappear and reappear again. This is because the Moon is only 239,000 miles away and moving at 2,300mph (0.63miles per second).

But in the case of a transit of Venus what you are watching is *the difference in orbital speed of the two planets.* Venus is in a 225 day orbit at 108 million km from the Sun and our Earth is in a 365 day orbit at 150 million km from the Sun; its orbit is larger and so its speed is slower than Venus. Earth's orbital speed is just under 30 kilometres per second and Venus is just over 35 kps, so as you observe the transit you can see the true speed difference in the orbits of the two bodies. In this case a little over 5 kps. Over 6 hours to cross less than 1/2° of sky, or in this case, the Sun.

As the morning wore on and lunch time approached Venus was getting close to its exit point. When Captain Cook sailed half way round the world to observe the 1769 transit it was to time the exact moment the disc of Venus entered and exited the Sun's disc. As Venus is covered in a thick atmosphere which bends the light of the Sun, combined with less than

perfect optics, into a teardrop shape at the edge of the Sun, the exact moment was not timed to within 10 seconds. At least they could see the start and end, we didn't. As it was at the start with cloud so our end was clouded out, just as Venus got to the edge, so the Sun went behind a cloud! I could not believe our luck at both occasions of the transit. The Sun came out again soon but Venus was already at the limb, and slowly disappeared from view by 2.20pm. Time for another beer, thirsty work transit watching.

Transits of Venus are rear and one as good as this will not be visible from our part of the world for about 250 years! The object of the timings was to work out the distance to the Sun and the size of the solar system. The best early estimates got within 2.5% of the modern day value of 149,597,870.66 kilometres for the AU, as measured with radar.

Ivor Clarke Ed.

T-Day

By Mike Frost

Ever since I was a child, I have been waiting for a series of momentous astronomical events, clustered around the turn of the millennium. The return of Halley's Comet in 1986, the English total eclipse of August 1999, the Leonid meteor storms in the years around 1999, the Scottish annular eclipse of May 2003 — and finally the Transit of Venus across the Sun on June 8th 2004.

Well, we have now reached the end of the list. I saw Halley's comet through the Cooke refractor formerly on top of Coventry technical college. I was clouded out for both the British central eclipses (but never mind, there are plenty more eclipses, just not visible from the U.K.). And I had the pleasure of seeing two of the Leonid storms, although I wasn't in England for either.

For the Transit of Venus, I gave serious consideration to joining the Explorers Tours expedition to Sharm-el-Sheikh, on Egypt's Red Sea coast. I saw the 1999 Leonid meteor storm from a Bedouin encampment in the Sinai desert, inland from Sharm, and this remains my favourite ever nighttime observing experience. Additionally, the scuba diving in the Red Sea is wonderful.

However, as with the two solar eclipses, I had sentimental reasons for remaining in Britain to see the Transit. I had connections with Jeremiah Horrocks, the first man to predict and see a transit of Venus, in 1639. Jeremiah and I both grew up in Lancashire, and we both attended Emmanuel College in Cambridge, although we never met.

From 2001 onwards, I carried out a considerable amount of research on the history of Jeremiah Horrocks. On trips home to Lancashire I visited Much Hoole, from where Horrocks made his celebrated observations; Liverpool museum, where there's a famous portrait of Horrocks by Eyre Crowe, and Manchester Town Hall, where Ford Maddox Brown painted the impressive mural of William Crabtree, Horrocks' friend and the only other person to observe the 1639 transit. In Cambridge I spent time in the Emmanuel College archives, where I saw the entry register to Emmanuel that Jeremiah Horrocks signed on May 18th 1632, the very first day in his life where we know his precise location. And finally I spent time in the RGO archives in Cambridge University Library, examining three hand-written

copies of Horrocks' masterpiece "Venus in Sole Visa" (Venus seen on the Sun). One or more of these is probably in Horrocks' own hand.

I wrote an article for Mira about the "curious astronomer", and submitted a similar version to the Emmanuel College magazine in mid-2003. The college didn't seem very interested initially, and the 2003 Emmanuel magazine didn't feature my article. However, things began to happen earlier this year. Roger Cowley, an ex-Emmanuel man who is now Professor of Physics at Rutgers University in New Jersey, informed the college that he was intending to visit England to see the Transit - and what were the college going to do to mark the event?

Emmanuel decided to celebrate the day by inviting old members to an event at the Institute of Astronomy on Transit Day. Dr Roderick Willstrop, an Emmanuel man who showed Coventry & Warwickshire AS round the Institute of Astronomy when we visited a few years ago, was happy to organise a meeting in the Institute on the afternoon after the Transit. Now, of course, they needed speakers — and fortunately they remembered the chap who had written the article on Horrocks.

So, I had a date for Transit Day. I put together a PowerPoint presentation on the story of Jeremiah Horrocks, which I fine-tuned in talks to Birmingham University AS, the Astronomy Centre in Todmorden, and as a lunchtime lecture at work.

Meanwhile, the Lancashire side of my investigations was also beginning to bear fruit. I was in correspondence with the University of Central Lancashire, based in Preston, about their distance-learning courses. I helped out Dr Paul Marston of UCL with his booklet on Jeremiah Horrocks, providing him with Cambridge-based information on Horrocks. He, in turn, tipped me off about a pre-Transit course that UCL were organising on the weekend before the transit.

So, on Friday June 4th I set off north up the M6, listening to Tim Henman's epic semi-final match in the French Open on my way. As Guillermo Coria completed his victory over poor Tim, I pulled into UCL's study centre at Alston Hall, five miles east of Preston, an old house set in beautiful grounds overlooking the Ribble Valley, and next door to the UCL's Alston Observatory. There were around 25 people on the course, mostly students from the UCL distance-learning programme.

We started off with an entertaining history of transits given informally, in the bar, by Professor Don Kurtz of UCL. I tackled Professor Kurtz with a series of questions (why did we need a transit to measure the parallax of Venus? How did Kepler know the distances to the planets in terms of the distance to the Earth?), which he was happy to answer on the back of an envelope over a pint. Paul Marston completed the evening with a talk on the religious climate at the time of Jeremiah Horrocks.

On Saturday morning, we took a convoy of cars around Preston to the village of Much Hoole, ten miles to the southwest of town on the Ormskirk road. At St Michael's Church, Much Hoole, celebrations were in full swing to mark one of the most anticipated days in Much Hoole's history. A whole week of events was planned, beginning with the church's flower festival. St Michael's was a riot of colour, with every floral display having a Horrocks theme. A giant silver Moon in the font commemorated Horrocks' pioneering theory of Lunar motion; each of the planets had its own display, from ringed Saturn to ruddy Mars; and in the lych-gate, a hanging basket full of bright yellow flowers contained a single black bloom, signifying Venus, and a blue flower on a long stem, signifying Earth.

After St Michael's we drove the short distance to Carr House. Local legend has it that this was where Horrocks made his observations from. This lovely old house is now privately owned, but the owners got on well with UCL, and let the course members wander round the

outside of the house, taking photographs. On Transit Day, two coach loads of astronomers from the International Astronomical Union were allowed to visit the master bedroom, to observe the transit from the same window that Horrocks used, three hundred and sixty four years earlier.

On Saturday afternoon, we had two further talks. Robert Walsh talked to us about the SOHO and TRACE missions to observe the Sun and then Paul Marston gave a second, thought provoking, lecture on cosmology and mystery. Then in the evening, a highlight — Dr Alan Chapman, of course, lecturing on Victorian amateur astronomers. It was the start of a busy week for Dr Chapman, who was scheduled to give talks about Horrocks in Hoole, Preston, Whitby and Manchester. After Alan's talk, we toured the Alston observatory. The skies were cloudy, but Jupiter popped in and out of gaps in the cloud, letting us observe it sporadically. Pretty soon we retired to the bar, to sup Black Sheep ale and watch England wallop Iceland in a football friendly.

The course concluded on Sunday morning with two further lectures — Dr Mary Bruck, of Edinburgh University, talking about James Ferguson, the first Scottish astronomer royal, and then about the 1874 transit and the observations from St Helena. Finally Dr Wayne Orchiston spoke about the 1882 transit and the American expedition to Tasmania. Dr Orchiston had located the remains of the observing base and also one of the few remaining pictures taken by the expedition.

The UCL course was excellent — I've now signed up for their course on the History of Astronomy. From Preston, I drove to Rochdale to visit my parents, and then back to Rugby on Monday morning. On Monday afternoon I did an interview for Rugby FM radio, and made final adjustments to my Horrocks presentation, including photos from Much Hoole.

On Tuesday June 8th I woke early — who didn't? — and was ready in my back garden as 6:18 AM approached. There were wisps of cloud in the sky but nothing to be too worried about. If you were watching for first contact on the 8th, you will understand the thrill I felt when I spotted the nibble in the disk of the Sun caused by the first encroachment of Venus. I imagined Jeremiah Horrocks and William Crabtree watching over my shoulder — 'a most agreeable sight', Jeremiah observed and I concurred with him.

Jeremiah Horrocks would have spent six hours making detailed measurements. After second contact, I had my breakfast and went back to bed for an hour — I had a long day ahead of me! Once I woke up, I spent twenty minutes showing the transit to my neighbours. Then I set off for Cambridge.

I spent a frustrating half hour sat in a traffic jam on the A14 (122 years, and then I found a traffic jam!), before arriving at the Institute of Astronomy in Cambridge at 10:45 AM. Immediately on arrival I bumped into an old friend from my student days, Richard Gymer. It was a beautiful warm cloudless summer day. The Institute was open to the public and was swarming with people. There were telescopes everywhere — the Institute's own permanent 'scopes, the telescopes used by the Cambridge University Astronomy Society, and perhaps a dozen or more portables. Two of the larger telescopes had video feeds to the main lecture theatre. There was an exhibition of modern sculpture in the Institute grounds, although my favourite statue, of Fred Hoyle, was a permanent fixture. There was what looked like a model of Beagle 2 in the Institute foyer — it was actually the working spare for the mission. The Astronomer Royal, Martin Rees, could be seen darting around the exhibits.

At regular intervals, one of the Institute staff, Dr Carolin Crawford, gave a short presentation on transits and the planet Venus. Carolin was a fellow student when I studied at Cambridge and a fellow member of the University Astronomy Society, CUAS. The talk was entertaining

and given in difficult circumstances — one member of the audience took a call on his mobile and held an extended conversation during the lecture!

I watched third contact from the lecture theatre — I figured this was the best view I was going to get. There was little sign of the famous black drop on either of the two video feeds. Nonetheless, when the audience voted afterwards as to the exact time of third contact, there was a disagreement of over twenty seconds in the estimated time. Considering that Captain Cook, Mason & Dixon, LeGentil and all the rest hoped to measure contact time to the nearest second, the difficulty of their task became very apparent.

Between third and fourth contact I toured the telescopes again. I talked to the astronomers operating one of the video feed scopes (a large portable reflector). He was playing with the contrast on the feed, trying to see the atmosphere of Venus, which ought to appear as a ring around the planet, easiest to see when the disk of Venus crossed the disk of the Sun. Lomonosov reckoned he saw this in 1761, but we couldn't spot any sign of it.

I watched the fourth contact on a portable scope run by CUAS, projecting onto a piece of cardboard sat on a chair. As the final segment of Venus slipped away from the Sun there was a round of applause. "Next performance, 2012", the students announced.

The Emmanuel party took a coach back to the college for lunch. I was pleased to see that Dr Sarah Bendall, the overall organiser, had taken up two of my suggestions. The college register for 1632 was on display, with Horrocks' signature highlighted. And the Master of Emmanuel, Lord Wilson (formerly Richard Wilson, cabinet secretary), dropped by to propose a toast to Jeremiah Horrocks. I was also pleased to talk to a guest - Peter Aughton, author of a biography of Jeremiah Horrocks that had just come out. I had managed to acquire an advance copy and I was pleased to recommend it to my audience later on in the day.

After lunch, we returned to the Institute for the lectures. I was supposed to be first on, but it was clear that there was a problem with the digital projector and everyone who knew what to do had gone home! We ended up swapping round the speakers. So first on was Anthony Cheke, from Oxford. He spoke about the 1769 transit expeditions to Mauritius, Reunion, and Rodrigues in the Indian Ocean. Whilst these expeditions contributed to the refinement of the Astronomical Unit, they also helped destroy the native flora and fauna, from the dodo and solitaire and tortoises, to unique species of trees and grasses. It was a sobering account, given by someone who clearly cared for both the ecology and the astronomy.

During the tea break, we sorted out the projector. I was able to finish off the afternoon with a shameless piece of playing to the galleries, telling the story of Jeremiah Horrocks with reference to his fellow Emmanuel pioneers of the seventeenth century — pioneers to the New World such as John Harvard, founder of Harvard University and William Blackstone, first settler in Rhode Island; pioneers of philosophy like John Worthington and Ralph Cudworth, the Cambridge Platonists; pioneers of mathematics like John Wallis; even Lemuel Gulliver, fictional pioneer and Emmanuel student (read Gulliver's Travels!). But I finished off hailing, ". . . the greatest pioneer of them all, the father of English astronomy — his name was Jeremiah Horrocks and — HE — WAS — AN — EMMANUEL — MAN". How could the audience fail to applaud that?!

In the evening, I returned to the college for dinner with Sarah Bendall, Anthony Cheke, Roderick Willstrop and Roger Cowley. Despite the early evening heat, I donned a college gown, spurning the offer to forego it for old times' sake. We dined on high table in front of several tables of rowdy post-exam students, before retiring to the parlour, where we consumed port and cheese and proposed a further toast to Jeremiah Horrocks. Toasts proposed in the college parlour are entered in the parlour book, which goes back two

centuries through several volumes. There is a wager, for example, on whether or not Thomas Young, fellow of the college, was correct in proposing a wave theory of light. Young, of course, is now recognized as the originator of the wave theory - but he still lost the wager! Dr Bendall later checked the volumes for previous Transit Days, but this appears to be the first time Jeremiah had been toasted.

Transit Day was a momentous day and memorable day for me. The clouds held off in Rugby, and we could not have had better weather in Cambridge. I felt honoured to be able to return to my old college and celebrate one of our most illustrious alumni. But most of all, I was proud to have been able to commemorate the achievements of Jeremiah Horrocks. In his own time he was virtually unknown; until a few months ago he was largely forgotten outside the astronomical community. But for this one glorious day in June he was the centre of attention the world over. His name was Jeremiah Horrocks, he was the father of English astronomy, and he was an Emmanuel man.

As always, I took a keen interest in the media coverage of Transit Day. In the weekend beforehand, the main historical commemoration was of course of the sixtieth anniversary of D-Day. However, from Monday evening onwards, there was strong and generally accurate coverage of T-Day. I was particularly impressed with the programmes shown at intervals during the day by the Open University, based at Greenwich but with visits to Much Hoole, Patrick Moore at Selsey, and to Sharm-el-Sheikh. The BBC crew at Sharm managed to miss filming the start of the Transit because they assumed that the point of ingress onto the Sun was at the same position angle as from Britain. There were also historical reconstructions of Horrocks' and Captain Cook's transits — I was particularly taken with Jeremiah's scouse accent. The coverage in the newspapers was a little patchy. *The Sun*, who seemed to have written their entire article in advance, and expectation of cloudy weather, talked of "Venus envy" in Britain over the much better observing conditions elsewhere (where?!) in the world. *The Times* had a leader in which they analysed the astrological implications of the Transit — proof that Murdoch's Thunderer is no longer a serious newspaper. But there were much better accounts — the *Telegraph* had an excellent report, headlined "Britain captivated by Venus's heavenly body". Best cartoon was by Mac in the *Mail* — a group of sunbathers has a family of little green monsters on the end. *"If you think it's hot here"*, says one Alien to his neighbour, *"imagine what it's like on Venus right now"*. The astronomy was dodgy but I liked the joke.

But the best account, by far, appeared on the front page of *The Guardian.* Their columnist Simon Hoggart had traveled up to Preston to join the IAU conference. Along with 92 astronomers from around the world, he watched the start of the Transit from Alston Observatory, before traveling to Much Hoole to view the latter stages and admire the floral displays. Mr. Hoggart produced an affectionate and entertaining account of astronomers having the time of their lives, and I can do little better than to close with his words:

". . . it is the unity between our own past and the immensity of the universe which is skin-tingling. Just after the last transit, in 1882, Robert Ball wrote: 'The next time people will see it is when the flowers are in bloom, in June 2004'. It was good to be there with the flowers."

Mentioned in the article

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

A very readable account of Horrocks' life, good at teasing out what we know about Horrocks' family tree, and very clear on the explanation of his scientific work.

"Jeremiah Horrocks, young genius & first Venus transit observer", Paul Marston (University of Central Lancashire, 2004).

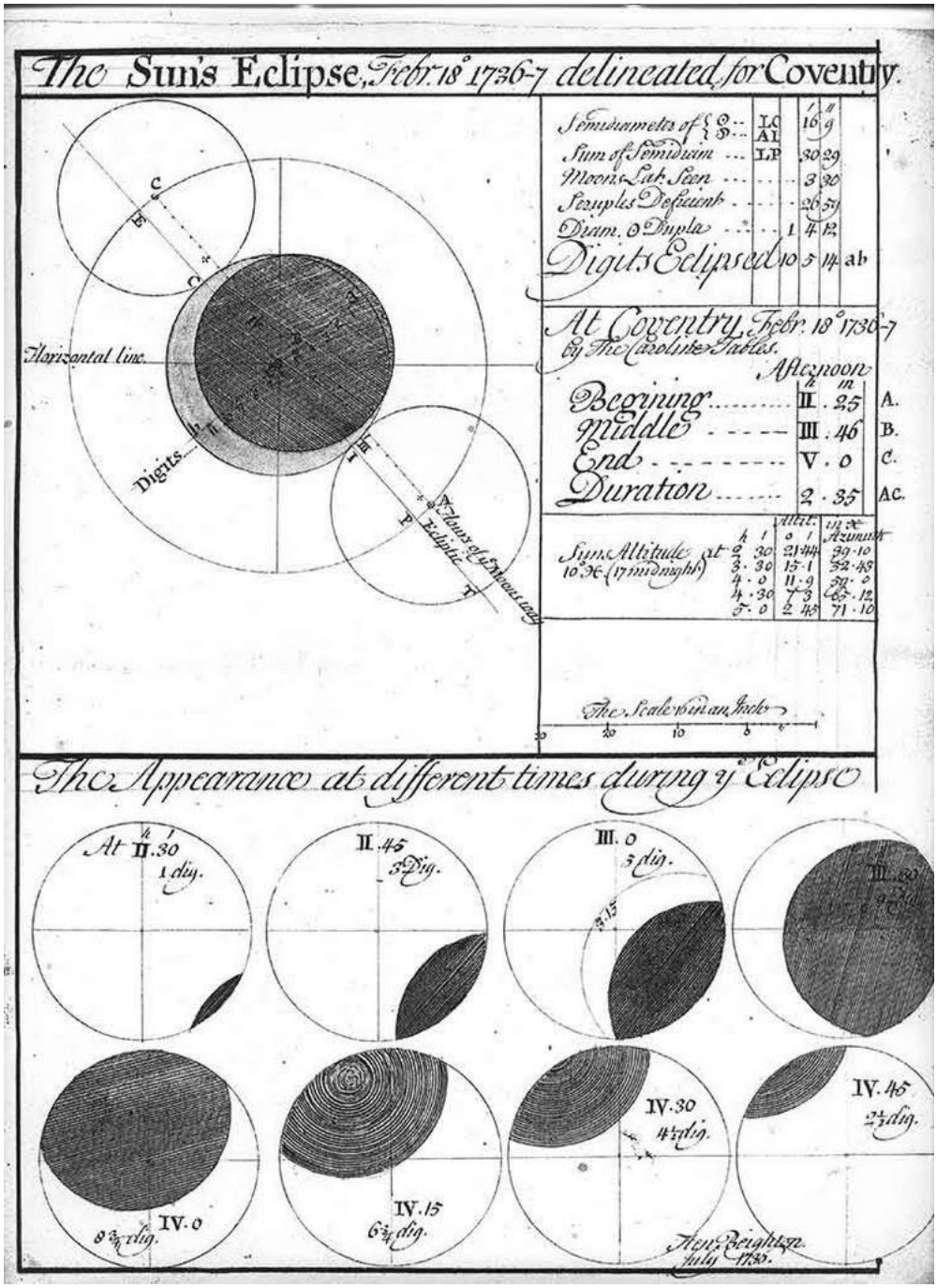
Jeremiah Horrocks is studied as part of the UCL *"Great Astronomers of History"* course. Paul Marston also specialises in the interaction between science and religion, so the pamphlet is strong on Horrocks' Christian beliefs and the religious climate of the time.

A Warwickshire Eclipse

By Mike Frost

During the Easter holidays I paid a visit to the Warwickshire County Record Office, at Priory Park in Warwick. I was hoping to find out information about the Rugby Literary and Scientific Institution, founded in the 1830's. The early members included Matthew Arnold, the famous headmaster of Rugby School and Joseph Hooley Lockyer, father of Rugby's eminent astronomer, Joseph Norman Lockyer. The biographies of Norman Lockyer make mention of the minute books from the meetings of the Literary and Scientific Institution, and I was hoping to find these in the Record Office.

I didn't succeed. The only relevant document I could find was an (uninspiring) accounts book dating from the 1850's, some time after the Lockyer family had departed Rugby. There was also a note, signed by Norman Lockyer, apologising for being unable to attend some function (I couldn't decipher what). However, my visit to Priory Park was by no means wasted, as I made several other serendipitous discoveries. For example, there was an almanac for the year 1665, owned by one William Gosnall, and filled with his daily scribbles. On the 3rd April 1665, he records seeing, at 4am, a comet which *"hath been seen by many persons in & abought this city of London"*



Best of all, however, was the beautiful eclipse map that accompanies this article — *"The Sun's Eclipse, Febr 18th 1736-7, delineated for Coventry"*. Please take a moment to look at the map (above) — it repays study. The original, rather larger than A4 size, is in ink and watercolour (which adds to the appeal). In the top left hand corner, the path of the Moon across the Sun is shown. Where the two are superimposed, the Moon is darker shaded. It is clear that, first, the Moon's apparent size is less than the Sun's — so this was not a total eclipse. Moreover, from Coventry the eclipse was not central — there was never a point in time at which the Moon was completely super-imposed on the Sun. We'll see later on that the eclipse was central when viewed from further north, producing an annular eclipse.

In the top right hand corner are various elements of the calculation. The Sun was predicted to have a radius of 16 minutes and 9 seconds of arc; Sun and Moon together 30' 29"; however the path of the Moon was offset by 3' 30" from the Sun's centre. The upshot was that, if the Sun's diameter were divided into twelve digits, just over ten-and-a-half of these would be obscured by the Moon at the time of maximum eclipse.

Next come the local times for observing from Coventry, and the Sun's altitude and azimuth at these times. This was an afternoon eclipse, beginning at 2:25 pm and ending at 5:00 pm, a duration of 2 hours 35 minutes. The date also deserves comment. First of all, it is prior to the change from Julian to Gregorian calendar in 1752, so 11 days have to be added to give a date in the new (current) style, of March 1st, which is when the eclipse is recorded in some reference books. Note also that the year is described as 1736-7, as the new year was considered to begin on March 25th (this is why our tax year still begins on April 5th, 11 days on from March 25th).

Finally, at the bottom of the map is *"The appearance at different times during ye eclipse"*, showing the slow progress of the Moon across the solar disk. Hidden in amongst these is the signature of (I presume) the map's author, Hen. Beighton, July 1736. So this was a predictive map, produced beforehand to show the expected path of the eclipse, rather than a description of what happened after the event.

In the Record Office, I pored over the map for some time, struck as much by its beauty as a document as by the astronomy it features. But of course the map suggests many questions. Who was Mr. Henry Beighton? Who did he produce the map for? Was the map accurate? And was the eclipse observed, from Coventry or anywhere else?

Arbury Hall, Nuneaton

I can answer one question with some certainty. The map is in the papers of Sir Roger Newdigate, of Arbury Hall, Nuneaton. I'm sure many of you will have visited this lovely

stately home, situated to the south west of Nuneaton. It features a stable with a frontage designed by Sir Christopher Wren in 1674, one of his few commissions outside London. However, Arbury Hall as we know it today was mostly modelled by Sir Roger Newdigate during the eighteenth century. He inherited Arbury Hall at the age of 14 in 1734, only 3 years before the eclipse.

Other papers in the Newdigate collection, presumably produced by Newdigate himself, show that he struggled to grasp the fundamentals of astronomy. There are pages of exercises in his papers, showing the solar system and reproducing basic propositions from Isaac Newton's Principia Mathematica, for example the parabolic motion of a projectile under gravity, or the tidal bulge caused by the attraction of the Moon. From a viewpoint three centuries on, these are very straightforward calculations, the kind of thing you would find in any physics textbook. But don't forget that Principia had been published less than sixty years previously, and so the details of the theory of gravity would be as unfamiliar to people then as, say, relativity or quantum mechanics are to us today.

In the early part of the eighteenth century, astronomy was a hot topic. The scientists of the previous century, from Galileo and Kepler, through Jeremiah Horrocks and culminating with Isaac Newton, had solved the theory of planetary motion pretty much comprehensively (it would be another 180 years before Einstein came up with a better theory, which mopped up the tiny residual errors in the motion of Mercury). The importance of astronomical calculations to marine navigation had led to the establishment of the Greenwich Observatory and the appointment of John Flamsteed as the first Astronomer Royal in 1675.

Added to these momentous events was an extraordinary co-incidence. In the first quarter of the eighteenth century, southern England enjoyed not one but two total solar eclipses within the space of ten years, in April 1715 and May 1724. To understand how rare this is, consider that England has had only two total eclipses in the succeeding three centuries — in 1927 and in 1999. In many ways, the timing could not have been more fortuitous. A century before, these eclipses might have been predicted approximately (the Saros cycle, where eclipses approximately repeat every 54 years, had been known for millennia). But now mathematicians had the means to predict the path of these two eclipses with unprecedented accuracy.

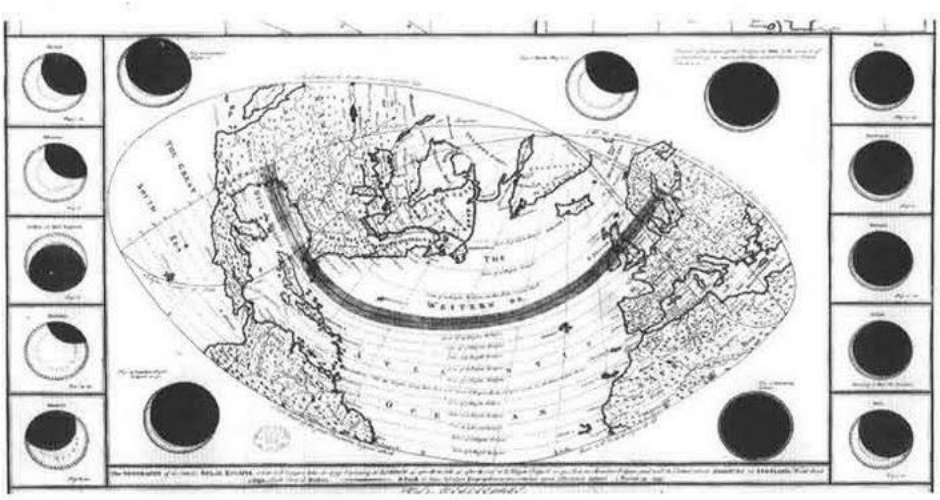
Halley's English eclipse map of 1715, this was one of the first accurate maps made of the track of the Moon's shadow across the country, later he checked with different towns to see what had been their experience of the eclipse which took place on a clear sunny day.

A number of astronomers took up the challenge, but the most successful attempt was by Edmund Halley, who produced a famous map predicting the track of totality, across southern England, including London. April 22nd 1715 was a clear day, and the total eclipse was widely observed. Halley described the solar corona, *"a luminous ring, of a pale whiteness, or rather pearl colour, a little tinged with the colours of the Iris, and concentric with the Moon"*. After the eclipse, Halley collected accounts of the eclipse and produced a more accurate map of the eclipse track. The 1715 revised map is the most accurate path of a total eclipse track prior to the twentieth century (the next step in accuracy occurred in 1925 when the path of totality crossed over Manhattan, enabling the totality track to be narrowed down to individual blocks in the city), and is of great use to scientists who want to estimate how much the Earth's rotation period has changed by during the last three centuries.

The 1724 eclipse was not total over London (the track crossed South Wales and the south-west of England) and was not as well observed as the 1715 eclipse. Dr Stukeley, the noted antiquary, observed it from Haraden Hill, near Salisbury, and reported that the spectacle was *"beyond all that he had ever seen or could picture to his imagination the most solemn".*

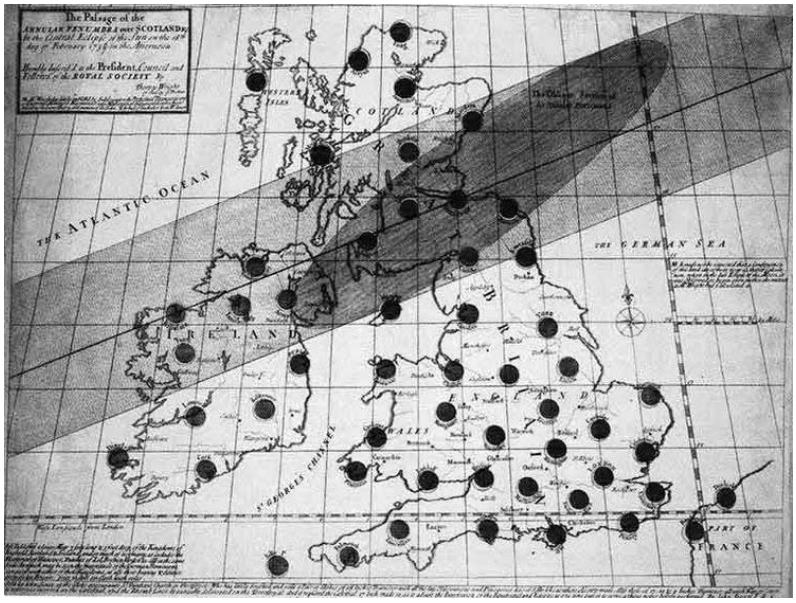
Halley was by no means the only astronomer to produce eclipse maps. I've reproduced several illustrations from Geoff Armitage's lovely book on eclipse maps, which I reviewed for *Astronomy Now* a few years ago (I liked it!).

Path of the 1737 eclipse drawn by John Haynes.



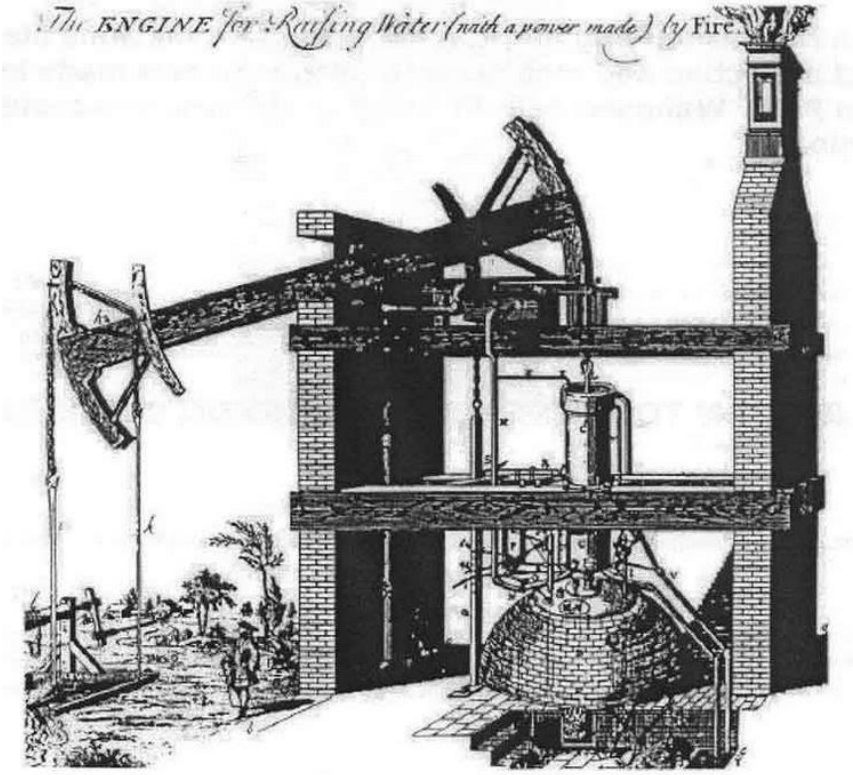
One of the early eclipse maps, this one drawn by a Mr George Smith of York, showing the track of the 1737 eclipse.

The maps fall in to two general types — eclipse track maps, such as Halley's, which show all the locations where an eclipse will be total or annular, and maps such as Beighton's showing the view to be seen at a particular location. Both types of map were produced for the 1737 eclipse. George Smith, of York, produced a rather wonky map showing the entire track of the eclipse across the Atlantic and into Europe. John Haynes and Thomas Wright produced rather less ambitious but more precise maps showing the track across Britain. Both Haynes and Wright predicted that the 1737 eclipse would be annular over the far north of England and lowland Scotland. It is clear that Henry Beighton's predictions of a deep partial eclipse were accurate. So, Henry Beighton was one of several mathematicians to predict the circumstances of the annular eclipse of 1737. Do we know anything more about him? I hadn't heard of him prior to researching this article, but he turns out to be a remarkable and versatile man. He was born on 20th August 1687 (some authors say 1686) in Chilvers Coton, a hamlet to the south of Nuneaton. His family were yeomen, holders of land in Griff, between Bedworth and Nuneaton. So Beighton was a landowner, but not of substantial estates. Fortunately he was able to supplement his less than impressive estate income with an impressive variety of other accomplishments.



This map is by Thomas Wright of the 18th February 1737 eclipse. It is astonishing that the path of the Moon's shadow could be worked out so accurately without the aid of computers and calculating machines, the time required for such an undertaking takes the breath away today.

In 1713, Beighton took over the editorship of *The Ladies' Diary* on the death of his friend John Tipper, a Coventry schoolmaster. *The Ladies' Diary* was a journal that featured a variety of mathematical features and puzzles, often set by Beighton himself. Beighton, who edited the magazine anonymously for many years, was determined to produce a journal of more substance than the almanacs of the day, which were more Old Moore's than Whittaker's in tone. Under Beighton's editorship *The Ladies' Diary* became one of the leading mathematical journals of the day. Beighton's skills were not just theoretical. In 1711, he suggested that the new technology of the steam engine could be used in local collieries to pump water out of the mines. In April 1714, three Midlands entrepreneurs, Richard and Stonier Parrott and George Sparrow, employed Thomas Newcomen, builder of the first industrial steam engine, to build his second steam engine for the Griff colliery, on land in the Newdigate estates. Henry Beighton may well have been involved in this project; certainly in 1717 Beighton himself built a Newcomen steam engine at Oxclose Colliery, Washington Fell, in County Durham. A picture of this engine, drawn by Beighton, still exists, entitled *"The Engine for Raising Water (with a power made) by Fire"*. It is the earliest known drawing of a steam engine. Also in 1717, Beighton made calculations on the diameter of pump barrel and steam cylinder needed to pump water from different depths. These were published in *The Ladies' Diary.* In 1720 Henry Beighton was elected to a Fellowship of the Royal Society. Between 1722 and 1725, Beighton surveyed the county of Warwickshire in unprecedented detail, to draw one of the first county maps produced in England, and certainly the most accurate to that time. Beighton used trigonometrical surveying techniques, common in France, but new to England. In the pages of *The Ladies' Journal*, he advertised his map for several years, hoping to finance his surveying and printing costs by advance orders — the map was finally published in 1729.



Henry Beighton's drawing of an early beam engine pump.

Around this time, Beighton began a business relationship with Sir Richard Newdigate, Roger Newdigate's father. It isn't clear to me exactly what this entailed — one source (Rolt & Allen) suggests that Henry Beighton, in partnership with his mother, leased collieries from Newdigate senior; another author (White) cites a report from Beighton to Lady Newdigate suggesting that collieries should be closed down. However, it does appear that Beighton acted as friend and advisor to Newdigate senior.

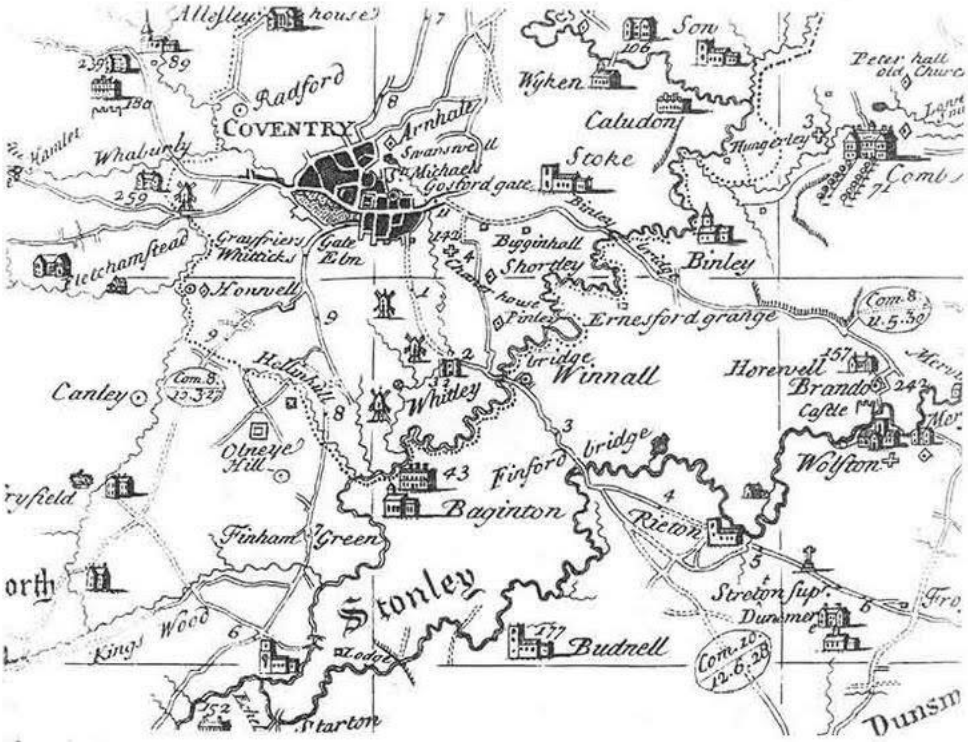
So, we know that Henry Beighton was an accomplished surveyor and engineer. In the Newdigate papers, there are also a ground plan and a prospect (both in poor condition) of Arbury Hall, drawn by Beighton in 1708. Additionally, there are notes by Beighton on *The Use of the Moon's Instrument* and *The Use of the Quadrant* — both practical instructions for surveying the heavens. So perhaps it's no surprise that Beighton should turn his hand to mapping the eclipse for Roger, the son of his late friend Richard Newdigate.

At the time of the 1737 eclipse Henry Beighton was forty-nine years of age, a self-educated man who had risen from relatively low social standing to achieve business success, engineering brilliance, editorship of a respected mathematical journal, and a reputation as the finest surveyor in the country. Roger Newdigate was sixteen years old, recently installed as the lord of Arbury Hall, a precocious (one suspects) young man with big ideas and the world at his feet. One can imagine Beighton securing the gratitude of his aristocratic young friend with the gift of a map to trace the forthcoming eclipse.

Roger Newdigate went on to study at Oxford and make a Grand Tour of Europe, before becoming a Member of Parliament. Despite representing Middlesex, he spent all but three months of each year in Arbury Hall, his pride and joy and in later years was increasingly

reluctant to leave the estate. He was lord of the manor at Arbury for seventy-two years, and completely remodelled the hall, room by room, producing one of the finest examples of Gothic architecture in Britain.

Henry Beighton, on the other hand, died only six years after the eclipse, in 1743, and was buried at Chilvers Coton.



One final question remains — what was the weather like on eclipse day? The annular eclipse was certainly seen from Scotland. The Scottish mathematician Colin Maclaurin reported that *"A little before the annulus was complete, a remarkable point or speck of pale light appeared near the middle part of the Moon's circumference that was not yet come upon the disc of the Sun. . . During the appearance of the annulus the direct light of the Sun was still very considerable, but the places that were shaded from this light appeared gloomy. There was a dusk in the atmosphere, especially towards the north and east. In those chambers that had not their lights westwards the obscurity was considerable. Venus appeared plainly, and continued visible long after the annulus was dissolved, and I am told that other stars were seen by some".*

Alas, I have no idea what happened from Warwickshire! I made a second visit to the County Record Office when I spotted that among the Newdigate papers, there is also a diary covering the period 1736-1743. Unfortunately, this diary turns out to be a very perfunctory record of the period, with no entries at all for February 1737. It would appear that Newdigate was at Arbury Hall during this time; the entry for March 1st 1737 records a move from Arbury to Astley, a nearby manor.

There is no clue as to whether Newdigate or Beighton attempted to observe the eclipse, or if the weather helped or hindered them. But I hope Henry Beighton and Roger Newdigate saw their eclipse!

Acknowledgements:

The descendants of the Newdigates who kindly gave permission to reproduce the eclipse map from the family archives.

The staff of the Warwickshire Record Office for their assistance.

Chris Hicks of Rugby Local History Group (a colleague at work) who educated me on the many accomplishments of Henry Beighton.

Sources / Further Reading

Henry Beighton's eclipse map has classification CR136/B2551 in the Warwickshire Records; the prospect of Arbury Hall is CR1199/70, the ground plan is CR270/7, and Beighton's notes on Lunar and Quadrant measurements are CR136/B3026. Newdigate's diary is CR136/B3015/1, and William Gosnall's journal has classification CR2133/1.

All other eclipse maps appear in *"The shadow of the moon (British solar eclipse mapping in the eighteenth century)"* — Geoff Armitage (Map Collector Publications, 1997)

Beighton's picture of the early steam engine is reproduced from *"The Steam Engine of Thomas Newcomen"* — L.T.C.Rolt & J.S.Allen (Moorland, 1997)

The story of the Griff colliery appears in *"Men and Mines in Warwickshire"* — A.W.A.White (Coventry Branch of the Historical Association, 1970)

The detail from Beighton's Warwickshire map appears from *"Maps and Plans for the Local Historian and Collector"* — David Smith (Batsford)

An account of Beighton's attempts to sell his map is given in *"Marketing Mathematics in Early Eighteenth-Century England: Henry Beighton, Certainty, and the Public Sphere"* — Shelley Costa (History of Science xl, 2002)

The Halley, Stukeley and Maclaurin quotes are taken from *"UK Solar Eclipses from Year 1"* — Sheridan Williams (Clock Tower Press, 1996)

There is a concise history of Arbury Hall at
`www.heritage.me.uk/houses/arbury.htm`