The 2012 solar transit of Venus

Richard McKim

A report of the Mercury & Venus Section. Director: R. J. McKim

Results from the 2012 June solar transit of Venus are illustrated and discussed, and make an interesting comparison with our recent report on the 2016 transit of Mercury.[1-4] As in previous years, observers were able to time the contacts, to see the 'Black Drop' effect (caused by inadequate resolution, but often enhanced by turbulence) and to record the ring of light around the unilluminated limb at both ingress and egress. This will be the last transit of Venus until 2109 Dec 13, unless we include the event of 2020 Jun 3, when the planet will be silhouetted against the solar corona.

Introduction

The 2004 transit of Venus was very well observed from the UK, as was the 2016 transit of Mercury. However, the UK weather was most unkind to observers of the 2012 Jun 5–6 transit of Venus, with the result that few observers succeeded in viewing both transits of the planet, eight years apart. Only the end of the event was visible from the UK, but we have received a number of reports from overseas observers who could view the start of the event or the entire spectacle. In the USA in particular many interesting observations were secured: it will be recalled that US observers could not see the 2004 event. Observers of the 2012 transit are listed in Table 1.

Transits of Mercury go unnoticed with the naked eye, but those of Venus can be seen without optical aid if the Sun is sufficiently dimmed by cloud. The latter therefore excite much more widespread interest than those of Mercury, even from unexpected quarters.[1] Peter Macdonald usefully summarised the circumstances of the 2012 event,[2] and a BAA Transit webpage was set up to allow our members to post images online.[3] Details also appeared in the BAA

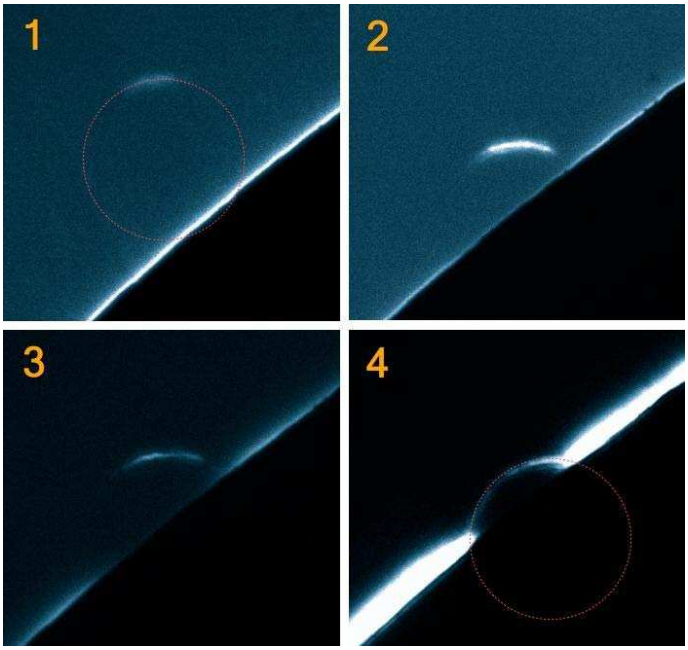

Figure 1. Coronograph ingress images from the Lowell Observatory, USA, 2012 Jun 5. The dotted lines indicate the contour of the unseen disk of Venus. *P. Tanga* (Venus Twilight Experiment, Laboratoire Lagrange, Observatoire de la Côte d'Azur). The solar disk is occulted by a black disk. *Note:* All figures have naked eye orientation with north at top.

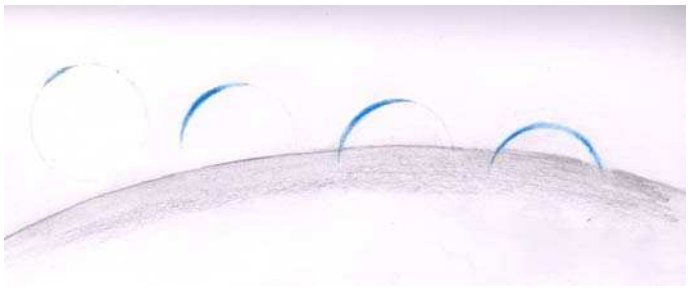

Figure 2. Coronograph ingress drawings from the Lowell Observatory, USA, 2012 Jun 5. *W. P. Sheehan.* Compare with Figure 1.

Handbook. An interim report was published by the Director,[4] many observations appeared in popular magazines,[5] and Paul Abel described the observations made with Sir Patrick Moore at Selsey.[6] Another transit website was set up by Steven van Roode,[7] while NASA and the Keck Observatory offered live video of the event.[8]

The observations

The UK weather on transit day in 2012 was generally dismal, and the majority of BAA members were clouded out. There were small pockets of clear sky over southern England, and although few UK members saw much, some could snatch useful images from the few minutes allowed to them. Fortunately we received numerous reports from abroad. See Table 1.

In 2004 the observations sent to us were limited to white light or Hydrogen alpha views. In 2012 some observers were also able to obtain excellent images in the wavelength of Calcium K. Figures 1–15 present some results.

Solar activity

The Solar Section counted seven Active Areas on Jun 5 and 6, all being small sunspot groups or individual spots: a typical level of activity for 2012.[9]

Ingress

The most interesting work came from P. Tanga and colleagues at the Lowell Observatory, where by means of a focal coronograph they obtained an excellent series of images (and drawings) showing the ring of light visible around the planet just before 1st contact and until 2nd contact. In particular a brighter and wider part near the N. pole was noted (Figures 1–2).

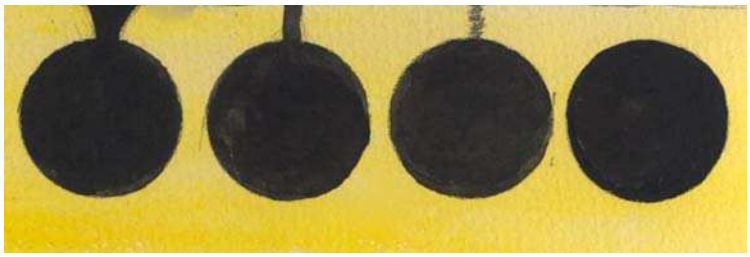

Figure 3. White light ingress drawings with 76mm OG, 2012 Jun 5, *W. P. Sheehan*. Note the Black Drop, often more pronounced with a relatively small aperture.

The Black Drop effect was not a particular problem to those making timings. As we explained in 2004[10,11] this is due more to inadequate resolution than to poor seeing, though unsteady air can exacerbate it. It can be seen at ingress in Figures 3 and 4.

Figure 4. White light ingress image with 76mm MKT, 2012 Jun 5. *R. Hill*. Note the Black Drop, again rendered more apparent with a relatively small aperture, and exacerbated by unsteady seeing.

Mid-transit

As in 2004 and earlier events, the presence of the dense atmosphere of the planet led to a slightly lighter area around the sharply defined black disk of the planet against the solar photosphere, which brightened up appreciably when closer to the darker limb of the Sun. The highest resolution images show it well, being just a few pixels wide where the solar granulation was blurred and distorted (Figure 11). Over-sharpened images showed a spurious white ring near mid-transit.

As mentioned earlier, Venus was visible to the naked eye with suitable filtration.

Egress

At last there was a chance of some observations from the UK and Europe: our observers were able to catch the last moments of the event, often through cloud. The events at ingress were repeated in reverse order.

Frassati was able to obtain a good sequence of egress drawings in both 2004 and 2012. See Figure 10 for the 2012 series. Colombo at 04:45:48 UT, between 3rd and 4th contact, could also see the whole disk of the planet faintly outlined, betraying the presence of the atmospheric ring.

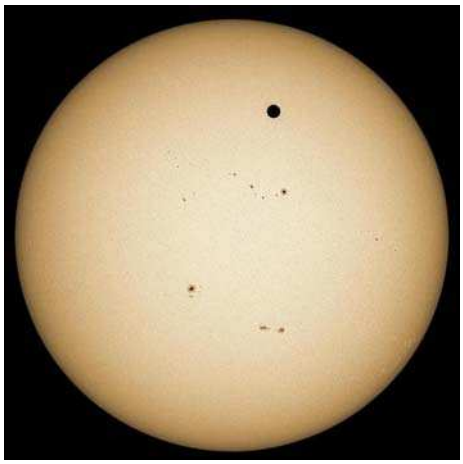

Figure 5. 2012 Jun 6, 01:35UT, mid-transit image with 80mm OG, Celestron solar filter and Astronomik green filter, QHY5 colour camera. *Ray Johnson*.

Timings

A number of observers obtained timings, and the more precise ones we gather in Table 2. All timings were made in white light unless otherwise stated. As usual the event was longer when viewed in H-alpha owing to the extra thickness of the chromosphere.

Observers' comments and notes

Gianluigi Adamoli, Verona, Italy

'All sunspots were far lesser in size than the planet and quite fuzzier.' A much longer extract of Gianluigi's observations featured in the interim report.[4]

Tomio Akutsu, Cebu City, Philippines

Akutsu obtained the clearest close-up image of the planet upon mid-disk, given here in Figure 11, and had a good series of third

Table 1. Observers

Observer	*Location (UK unless otherwise stated)*
P. Abel, J. Cooper & D. A. Peach (with Sir P. A. Moore & numerous others)	Selsey, W. Sussex
G.-L. Adamoli	Verona, Italy
T. Akutsu	Cebu City, Philippines
K. Al-Jamaan	Kuwait
A. Arishi & Y. Dagriri	Saudi Arabia
R. Buckley	Flottskar, Vaddo, Sweden
M. Charron	Gallows Down, Berkshire
E. Colombo	Gambarana, f. Cambio' (PV), Italy
P. Curtis	East coast, USA
S. Dean	Ryde, Isle of Wight
P. Edwards	Horsham, W. Sussex
C. Fattinnanzi	Montecassiano, Italy
M. Frassati	Crescentino, Italy
M. Frost, J. Jarvis, D. Morris & other members of Rugby	Mollington, Oxon. & District AS
M. V. Gavin	Worcester Park, Surrey
S. Ghomizadeh	Roudehen, Iran
P. T. Grego, J. Spittle & P. Stephens	Long Marston, Warwicks.
B. Halls	Lancing, W. Sussex
C. Henshaw	Amman, Jordan
R. & D. Hill	Mt Bigelow, Tucson, AZ, USA
N. Howes	Tucson, AZ, USA
T. Ikemura	Nagoya City, Japan
Ron Johnson	Burgh Heath, Surrey
Ray Johnson	Lyrup, S. Australia
M. Kardasis	Anavra, Greece
P. Lawrence	Spitsbergen, Svalbard, Norway
M. Leventhal	Sydney, Australia
S. Mahato	Binnaguri, West Bengal, India
J. McCue	Doha, Qatar
S. S. Massey	Hervey Bay, Queensland, Australia
J. Melka	Chesterfield, MO, USA
E. Morales Rivera	Aguadilla, Puerto Rico
D. Niechoy	Göttingen, Germany
J. O'Neill	Lake Champlain, Vermont, USA
G. Privett	Fovant, Wilts.
M. Ratcliffe	Wichita, KS, USA
M. Scott	Stratford upon Avon, Warwicks.
D. Self	Aylesbury, Bucks.
W. P. Sheehan, K. Brasch & P. Tanga	Lowell Obsy., Flagstaff, AZ, USA
P. C. Sherrod *et al.*	Arkansas Sky Obsy., Petit Jean Mtn, USA
G. Deep Singh	Udaipur, India
A. Stevenson	Lerwick, Shetland
J. Sussenbach	Kiris, Turkey
H. Wheeler	Brenchley, Kent
F. Ventura	Malta
A. Vincent & Worthing AS	Findon, W. Sussex
L. Wadle	Honolulu, Hawaii, USA
G. White	Wellow, Somerset
K. Yunoki	Sakai City, Osaka, Japan

Formal negative (clouded) reports came from L. Aerts (Heist-op-den-Berg, Belgium), M. Foulkes, A. W. Heath, P. Macdonald, H. W. McGee, S. Macsymowicz (Ecquevilly, France), F. J. Melillo (NY, USA), P. W. Parish, L. Smith, J. Vetterlein, P. B. Withers and the Director.

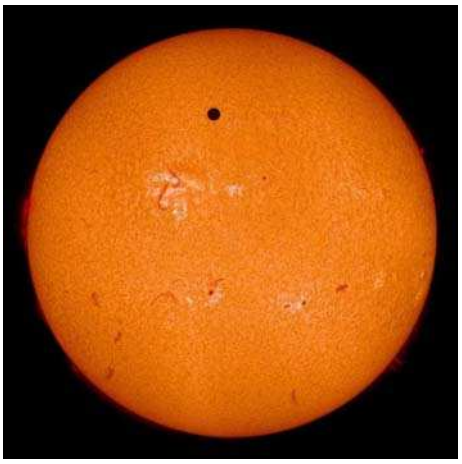

Figure 6. 2012 Jun 5, 23:00UT (approx.), mid-transit hydrogen alpha image with Solarscope SV50. *N. Howes*.

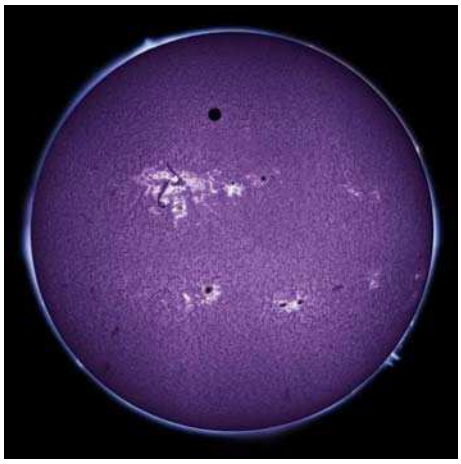

Figure 7. 2012 Jun 5, 23:00UT (approx.), mid-transit Calcium K image with Solarscope SV50 and Lumenera Skynyx 2-1 camera. *N. Howes*.

contact images. He also imaged a very weak atmospheric ring, visible at just after 3rd contact.

Richard Buckley, Sweden

'The site was at Flottskar, Vaddo, Sweden... The clouds added to the atmosphere and a few were of the one-eyed-monster type with Venus visible in a narrow strip on the solar disk.[4] At one point a swan flew in for a territorial fight with two others, and in the woods there was a cuckoo calling. I just missed a shot at the beginning with the low Sun + Venus reflected in the glass-like sea inlet before the clouds interfered and the wind got up. Unforgettable.'

Mario Frassati, Crescentino, Italy

A sequence of egress drawings appears in Figure 10. The white atmospheric ring was pronounced, and showed interesting changes as egress continued.

Mike Frost, Mollington, Oxon.

'For sentimental reasons, I decided to stay in England for the June 6 transit. If 40 minutes of transit, ending at sunset, was good enough for Jeremiah Horrocks, then 80 minutes of transit, starting at dawn, was going to be good enough for me.' After a night in a tent and a cloudy dawn: 'The glow brightened, brightened... and then the Sun burst through! Almost taken by surprise, we turned the scopes to catch the rays. 5:43 a.m., and the projected disk of the Sun had a tiny nibble at about 4 o'clock on the edge. We were way past 3rd contact – but there was Venus, still clinging to the solar disk by its fingertips.'

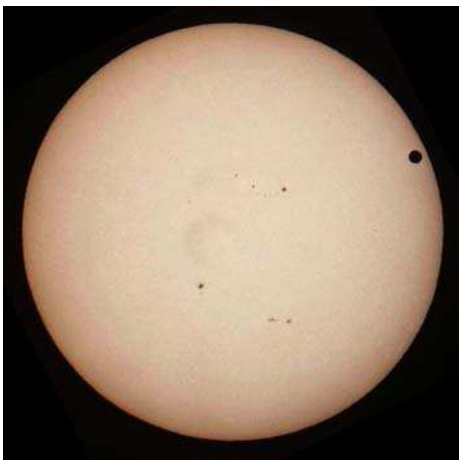

Figure 8. 2012 Jun 6, just prior to third contact. Digital camera image with 125mm SCT stopped to 105mm. *F. Ventura*.

Maurice Gavin, Worcester Park, Surrey

'Got lucky in the last few moments of transit with just one decent pic via PST CaK.' We show this image in Figure 15.

Peter Grego, Long Marston, Warwicks.

'Through the 100mm MKT we watched as Venus made its way to the edge and cleared the disk. There was intermittent cloud, but some really great, clear views of the whole Sun were had at times. I noticed (very subtle) refraction effects around the dark Venusian limb, initially with two 'horns' projecting, but the complete ring was just about seen by me.' Grego's egress sequence is given here (Figure 9).

Rik Hill, Tucson, Arizona

Rik (with a Questar 3.5) observed a very marked Black Drop effect (Figure 4), doubtless due to high temperature and turbulence at his site north of Tucson, and the effect is always exacerbated with a smaller aperture. He submitted an excellent video.

Nick Howes, Tucson, Arizona

From Tucson, Nick obtained excellent, nearly simultaneous images in CaK and H-alpha which we show here (Figures 6 & 7).

Toshihiko Ikemura, Nagoya City, Japan

Toshihiko obtained a very sharp egress series (Figure 12), in which there is no sign of the Black Drop even when the intervening photosphere was reduced to the merest sliver.

Ray Johnson, South Australia

Ray, a new BAA member resident in South Australia obtained a superb image which is shown here (Figure 5).

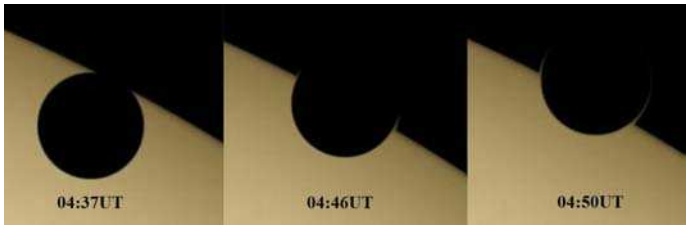

Figure 9. 2012 Jun 6. Drawings from Long Marston, Stratford-upon-Avon, showing third contact with 100mm MKT, ×70. *P. T. Grego*. The atmospheric ring is partly visible at each cusp, 04:46–04:50UT.

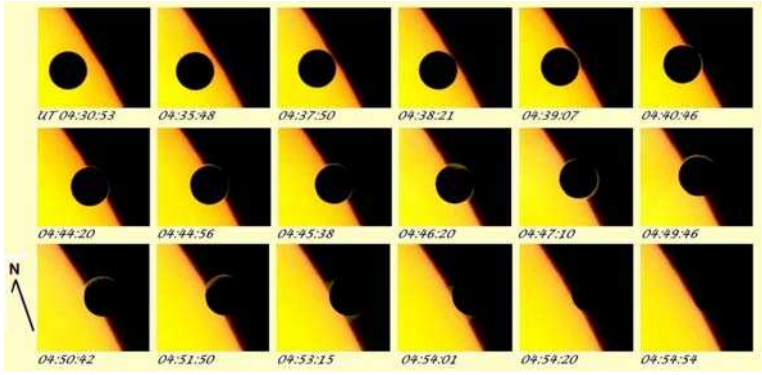

Figure 10. 2012 Jun 6 04:30–04:55UT. Egress series of drawings with 203mm SCT, ×133, and full aperture solar filter. *M. Frassati*.

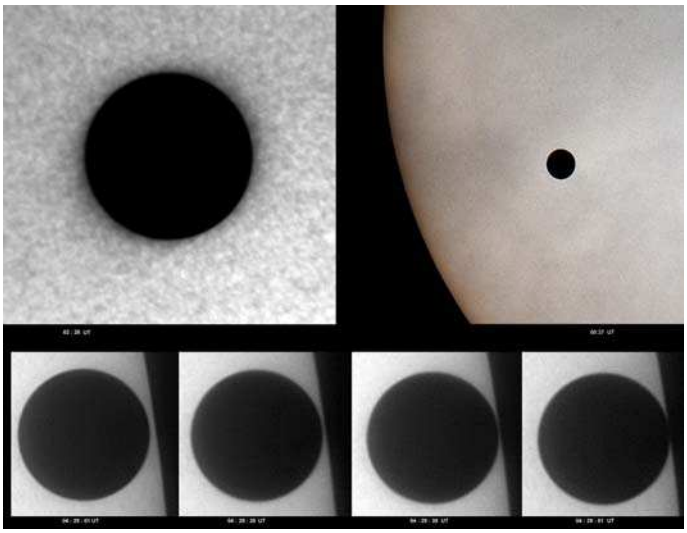

Figure 11. Mid-transit and egress imaged from the Philippines with a 356mm SCT, Baader AstroSolar filter and DMK21AU618AS camera. *T. Akutsu. Top left:* Enlarged mid-transit image at 02:28UT. *Top right:* Image at 00:37UT. *Bottom:* third contact series at 04:29:01UT, 04:29:25UT, 04:29:39UT and 04:29:51UT. Note in the close-up mid-transit image the blurring of the surrounding photosphere by the atmosphere of Venus, and the very faint aureole upon egress. Note also the complete absence of any Black Drop.

Manos Kardasis, Anavra, Greece

From Anavra Manos was able to capture the white atmospheric ring at 3rd contact. This superb image is given here as Figure 13.

Pete Lawrence, Svalbard, Norway

This observer had an excellent view at Spitzbergen, published earlier in our interim report.[4]

John McCue, Doha, Qatar

Combining his work with an observer in New Zealand, John was able to measure the solar parallax to derive a value of 36±7". The Black Drop was seen.

Richard McKim, Peterborough, Northants.

After a cloudy dawn vigil the Sun came out shortly after 4th contact, and he was able to get a good H-alpha disk drawing: but with Venus no longer present!

Peter Parish, Rainham, Kent

'By 5.30 a.m. three-quarters of the sky was now clear but still the Sun was hidden by a massive cloud bank. At 5.55 a.m. a tiny chink of Sun showed, then at 5.59 a.m., the Sun suddenly came right out allowing us an uninterrupted view for the first time. We were all bathed in sunshine but the transit was over!'

Grant Privett, Fovant, Wilts.

A quote to accompany his 3rd contact image: 'A lovely morning, I waited through the cloudy bits listening and watching as three larks ascended.'

Martin Ratcliffe, Wichita, Kansas

An image of the event was previously published.[4] Around 2nd contact he saw 'a pair of pincer-like extensions leading away from the solar limb along the curve of the Venusian disk. They were extremely fine, very short...' See the drawings by Frassati and Grego (Figures 9 & 10).

Figure 12. Third contact imaged from Japan with 380mm refl. stopped to 180mm and DFK51AU02 camera. *T. Ikemura*. From left to right, the results of 12 fps 3 second avi movies at 04:29:41UT, 04:29:46UT, 04:29:52UT, 04:29:57UT and 04:30:03UT. Note the complete absence of any Black Drop.

Bill Sheehan & Paolo Tanga, Lowell Observatory, Arizona

Sheehan contributed a series of ingress sketches showing the Black Drop (279mm SCT with 75mm stop, Figure 3), and of the aureole made with a coronograph (Figure 2). Tanga obtained CCD images of the aureole which he was able to record some 3 minutes before 1st contact, by means of a second coronograph (Figure 1). Tanga's experiment is described online.[12]

Sheehan, just prior to 1st contact adds: 'I now noted with astonishment the small polar spot, shining brilliantly in the blackness of space just over a minute of arc from the solar limb. As I continued to observe, it began to turn slightly peaked or crescentic, and gradually widened into a bright, asymmetric arc, in the manner shown in the drawings (Figure 2). The arc continued to remain visible and even brilliant – growing ever brighter and more asymmetric – right up to second contact, which occurred at 15:23:26.4UT, when it seemed to swirl around and mix together with the Black Drop forming at the limb of the Sun and then disappeared. After second contact, I switched from the coronagraph to the off-axis 3-inch aperture on the Mylar filter, and observed the well-developed thunderhead of a Black Drop (Figure 3) as it elongated and faded and finally dissipated... I could no longer make out the aureole but there was a faint bright ring due to contrast, or perhaps this corresponded to the outline of the real image of Venus into which light from the photosphere was bleeding to produce the apparently smaller image.'

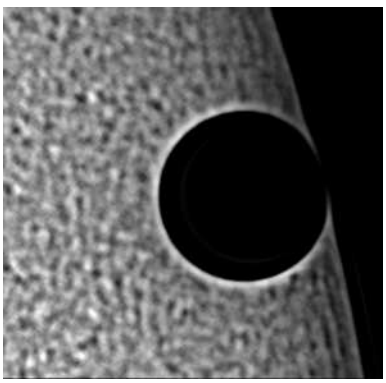

Figure 13. 2012 Jun 6, 04:37:45UT. Third contact imaged from Greece with 279mm SCT and DMK21AU618 camera with IR742 filter. *M. Kardasis*.

Figure 14. Third contact imaged through clouds at 04:41UT from Brenchley, Kent with a PST H-alpha telescope and a Panasonic TZ20 digital camera. *H. Wheeler*.

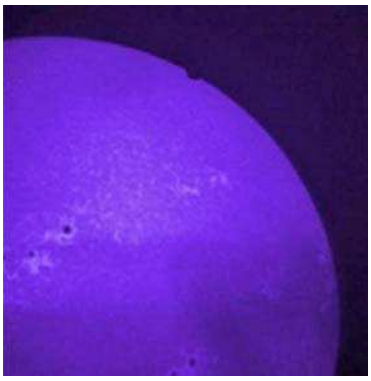

Figure 15. The final stages of the event imaged from Surrey with a Calcium K filter. *M. V. Gavin.*

John Sussenbach, Kiris, Turkey

Under excellent seeing conditions no Black Drop was detectable. At and just following 3rd contact the bright atmospheric ring was detected beyond the limb after careful enhancement of the images. He then compared his precise value of 3rd contact (obtained by careful measurement and extrapolation) with that of Tomio Akutsu to get the distance of the Earth from the Sun: 'Using the Delisle method[13] I got a value of 149,599,986km, whereas the official value is 149,597,870km. An excellent result!!'

Frank Ventura, Malta

Frank obtained images (Figure 8) and some excellent egress timings.

Alex Vincent, Findon, West Sussex

'We observed the Black Drop and some of the partial phases as Venus left the Sun.'

Larry Wadle, Honolulu, Hawaii

Combining his times with those of a New Zealand observer he obtained a value of the Earth–Sun distance via Delisle's method with an error of only 3%: a remarkable result using only a pair of small binoculars!

Honor Wheeler, Brenchley, Kent

Honor contributed a good H-alpha image taken through cloud, which we reproduce here (Figure 14). 'Eleven of the Crayford Society's members travelled to Joss Bay, Broadstairs and unfortunately they got greatly rained upon! Only thanks to a member who lives in Paddock Wood did some of us observe in Brenchley. We waited until 05:39 BST to see the any sign of the Sun and were lucky enough for 18 minutes worth of hazy, white light and H-alpha glory!'

Observations from Selsey, West Sussex

Sir Patrick Moore (Director of the Section, 1956–1963) was able to view the 2004 transit, but it seemed unlikely he would be able to witness the 2012 event. Remarkably the sky cleared for a few moments enabling him and a group of friends to enjoy the event. Figure 16 shows local scenes.

Paul Abel writes: 'The transit of Venus came at an awkward time: with my PhD close to submission it was unfeasible to travel far. Shortly before the event, Sir Patrick inquired from where I would be observing it. I had considered the northeast, but the weather conditions looked poor so fellow BAA member Dr Matthew Forman and I decided to join the transit party in Selsey. On the train we were joined by amateur astronomer and impersonator Jon Culshaw, and actress Nicola Bryant.

The weather conditions seemed to deteriorate the further south we travelled. The fine conditions in Leicester were gradually replaced by low-level cloud. In Selsey, conditions were much worse with high winds and heavy rain: it did not look promising. Although our chances seemed remote, Jon remained optimistic that we would see some part of the transit the following morning. We were joined at 'Farthings' by Damian Peach, Ninian Boyle, Jamie Cooper, Robin Flegg, Chris Newsome and reporter Sarah Cruddas. Ninian set up a projector and we were able to view the start of the transit on the NASA TV stream.

We assembled the following morning at 4 a.m. and made our way to East Beach: sunrise would be relatively unobstructed. Conditions had now improved with large holes in the sky in evidence. Unfortunately sunrise was obstructed by cloud cover, but eventually the Sun reached a large gap in the clouds and we quickly took turns to observe the transit through the solar telescope. Everyone managed to glimpse the unmistakable tiny black disk of Venus,

Figure 16. *Top left and right:* Observers (including Patrick Moore & Paul Abel) waiting for the cloud to clear on the beach at Selsey, Sussex. *Middle, left:* Part of the group in Patrick Moore's study watching a NASA TV stream showing the start of the event. Clockwise from top left: Ninian Boyle, Nicola Bryant (from *Dr Who*), Jon Culshaw, Patrick Moore, Paul Abel & Matthew Forman. *Middle, right:* the transit cake. *Lower left:* Cake-cutting at the post-transit party. At left, Patrick Moore & Sarah Cruddas (BBC); photos from website of *D. A. Peach*. *Lower right:* Approaching third contact, taken from Selsey beach. *J. Cooper*.

Table 2. Timings (UT) of the 2012 Solar Transit

All timings are in white light except where stated.

Observer	*I*	*II*	*III*	*IV*
G. Adamoli N 45° 27' 05" E 11° 02' 04" (125mm MKT)			04:37:50	04:55:30±10
T. Akutsu N 10° 18' 56" E 123° 53' 07" (356mm SCT)			04:29:51	
E. Colombo N 45° 01' 57.0" E 8° 47' 13.4" (90mm MKT)			04:37:55	04:55:16
M. Frassati N 45° 11' 31" E 8° 06' 10" (203mm SCT)			04:38:21	~04:54:54
T. Ikemura N 35° 07' 22" E 136° 58' 30" (180mm SCT)			~04:30:03	
M. Kardasis N 39° 04' 22" E 22° 33' 05" (279mm SCT)			04:37:45	
E. Morales Rivera N 18° 25' 39" E 67° 09' 15" (310mm SCT)	*white light* *H-alpha*	~22:22:15 ~22:19:24		
J. Sussenbach N 36° 33' 52" E 30° 34' 36" (125mm SCT)			04:37:54±3	
F. J. Ventura N 35° 54' 21.8" E 14° 25' 41.8" (125mm SCT)			04:38:20	04:55:24
L. Wadle N 21° 16' 12" W 157° 49' 12" (8x23 binoculars)	22:10:30	22:28:05	04:26:30	04:42:20
K. Yunoki N 34° 34' 24" E 135° 28' 59" (102mm OG)			~04:30:22	
For comparison:				
London *(predicted)*	**——— not visible ———**		**04:37**	**04:55**
Geocentric *(predicted)*	**22:09:41**	**22:27:29**	**04:31:32**	**04:49:30**

The ~ symbol denotes an approximate time inferred by the Director from an image or drawing.

which by this point was close to the limb. Peach and Cooper were able to obtain images, but given the time constraint I was content simply to observe visually.

The gap in the clouds did not last long, but at least we had seen the transit. We returned to 'Farthings' for some well-earned champagne and a slice of the transit cake which Robin Flegg had made. Patrick Moore passed away later that year, and this was the last astronomical event he would observe. An account by the author was published in the *Sky at Night* Magazine, 2012.'[6]

Damian Peach concludes: 'It was a really miraculous morning at Selsey Beach. The sky was totally overcast and only a brief clearing of a few minutes occurred just prior to the end of the transit that allowed a nice view through the clouds.'

Mercury's recent solar transit: a comparison

The disk of Mercury is much smaller than that of Venus, and the planet has no sensible atmosphere to create interesting effects at ingress and egress, but transits of Mercury are still of much interest to watch. We have reported the BAA observations of the 2016 event earlier,[14] and these make for an interesting comparison with Venus in 2012.

The next transits of Venus

Alex Vincent reminds us that the next event will actually be a coronal transit on 2020 Jun 3.[15] Venus will pass only 13 arcminutes north of the Sun, so a coronograph will be needed to see her. But to watch Venus again in transit against the photosphere, we must wait till 2109 Dec 13 and 2117 Dec 11, nearly a century from the present day.

Conclusion

The 2012 transit did not add much to our scientific knowledge, though photometric observations of the event were taken by professional astronomers to inform their research on extrasolar planet transits. The transits of Venus were formerly used as a yardstick for measuring the solar system, but today we can simply enjoy them for the amazing celestial spectacles that they are. Doubtless the events of 2109 and 2117 will be just as eagerly awaited by our successors.

Acknowledgment

I thank Paul Abel for specially writing a longer account of the Selsey observations.

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Notes & references

1 Even Parson James Woodforde, the famous diarist and gourmet – after noting how he had dined that day – mentions the transit of 1769 June 3: 'The transit of Venus over the face of the Sun I saw this Evening between seven & eight o'clock at Dr Clarkes. It appeared as a black-Patch upon a fair Lady's Face. It will not appear again they say till in the Year 1874. We should have seen it much plainer had not little Sam Clarke broke the window Glass of the Telescope Yesterday, I could however perceive it with my naked Eye but very little...' *The Diary of a Country Parson:* The Revd. James Woodforde, Folio Society, London, 1992, p.70.

2 P. Macdonald, *J. Brit. Astron. Assoc.*, **121**(3), 135–142 (2011)
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8 The following websites are of most relevance: **http://keckobservatory.org/news/venus_transit_live_keck_observatory; http://eclipse.gsfc.nasa.gov/transit/venus0412.html; http://sunearthday.nasa.gov/transitofvenus/ http://eclipse.gsfc.nasa.gov/transit/venus/Map2012-2.GIF**
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