The elongations of Mercury 2007–2016, and the 2016 solar transit

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

In this paper we review telescopic observational data of Mercury from 2007 November to 2016 October inclusive, and describe the results of the 2016 solar transit. A gradual improvement in imaging technique has enabled observers to record albedo features upon Mercury's surface as well as many bright patches corresponding to the ejecta regions of bright craters. An albedo chart and a *Messenger* map are presented for comparison. At the solar transit, observers obtained images in white light as well as in the wavelengths of Hydrogen alpha and Calcium K, timed the various contacts, and re-observed certain optical effects, comparing the results with those obtained at previous events.

Introduction

In early 2008[1] we summarised the best BAA Mercury observations for the 1978–2007 period, with collages of the highest resolution images and drawings available from our files. This paper acknowledges more recent efforts and summarises the period from late 2007 to the end of 2016. It would not have been worthwhile to analyse a shorter time period. The improvement in resolution since 2007 is sometimes noticeable in the submitted data. Ironically, with the completion of the mapping process by the *Messenger* spacecraft, we now receive fewer observations than in the past. Nevertheless, it is worth putting on record what the amateur astronomer can now resolve upon the little disk of Mercury.

Figure 1. Wide angle photographs of Mercury. **(A)** Mercury above the towers of Crescentino, Italy, 2012 Feb 26, 18:05UT, Canon EOS 450D, 2.5s at f/5.6. *Mario Frassati.*

In this paper we also discuss and illustrate the solar transit of 2016. Even better amateur images of Mercury's albedo markings have been seen online from time to time, but in this paper we use only those contributed to the Section.

Only a few elongations of Mercury per year are relatively favourable for observation: the BAA *Handbook* always gives full details. It is suggested that the writer's previous Section note[1] should be read for some details about the planet's observational history. Since its publication, a number of other Section notes and relevant papers about telescopic observations of Mercury have appeared in the *Journal*.[2–8]

Observers

Many of the observers (Table 1) will be recognisable for their regular work for other BAA planetary Sections. Most appearances in this list represent the result of chance opportunities for an occasional view, for few observers concentrate upon the planet.

All observers provided images except those marked **V** (visual data only). Drawings and images were supplied by Adamoli, Bailey and Niechoy. An image by Boudreau was received via Melillo. Johnson contributed wide-angle sky photos and the other observers contributed telescopic observations at east or west elongations. We list the 2016 solar transit observers separately (Table 3).

Observations of Mercury's sunlit disk, 2007–2016

Observational circumstances

The difficulties in observing Mercury hardly need restating here: its small angular separation from the Sun coupled with its tiny angular diameter frustrate most observers' attempts even to locate it, while low altitude and consequent poor seeing often prevent any useful observation being made. Furthermore, the observable part of any elongation is brief. But for many observers a nice wide-angle photograph, perhaps of some conjunction involving Mercury, represents an achievable goal: see Figures 1A and 1B.

Figure 1. (B) Mercury's conjunction with Venus and the Moon from Terrigal Beach, NSW, Australia, 2008 Mar 6, Canon 350D. *Mike Salway.*

Elongation data

In Table 2 we list the greatest elongation (GE) dates from 2007 Nov to 2016 Oct. In his Section Reports, the late J. Hedley Robinson found it suitable to summarise Mercury observations every two calendar years. (F. J. Melillo, who is the current Mercury Recorder for the ALPO, reports upon the work of his contributors annually.) The sheer number of these elongations is immediately apparent from the table. (The BAA *Handbook* also gives the times of superior conjunction.) We also indicate the number of contributors.

We have shown the availability of observational material in **bold** type. Each **bold** entry is accompanied in brackets first by the number of visual observers, followed by the number of imaging observers (*e.g.*, (2/1)). A number of elongations, particularly the morning ones, went unobserved.

Observational results

It can readily be seen that most eastern elongations received observational coverage, but that an increasing number of western elongations were not observed. The majority of BAA work has always taken place at the more favourable Spring eastern elongation each year, although some observers such as Gray are obliged to concentrate upon western elongations due to local obstructions. The best-observed elongations in terms of volume of data were the eastern ones of 2008 May (bringing drawings from Adamoli, Frassati, Niechoy and Phelps, and images from the Ackermanns, Arditti, Kivits, Lomeli, Niechoy and Walker) and 2010 Apr (drawings by Adamoli, Bailey, Frassati, Grego and Niechoy, and images by the Ackermanns, Edwards, Ikemura, Kivits and Meredith). Understandably, some of the best quality images and drawings were obtained in the still morning air at western elongations.

For ease of reference we present the Camichel–Dollfus telescopic albedo map[9] in Figure 2. This lower resolution chart is more suitable in making comparisons with our results. It will be useful to give one of the final *Messenger* mosaics[10] to refer to for the higher resolution data: see Figure 3.

As in the previous report we display images in a single collage in order of central meridian longitude rather than by date: see Figure 4. This Figure includes some particularly fine work by the late Willem Kivits. It can be seen that several observers achieved a slightly higher resolution than the work published up to the end of 2007.[1] If we compare our current data with the previous collage, we can see that the results are complementary: longitudes imaged at crescent phase in one may be compared with nearly full phase ones at another. Even over nearly a decade we did not gather enough images to record every longitude at a high gibbous phase.

Some of the better drawings are given likewise in Figures 6A and 6B.

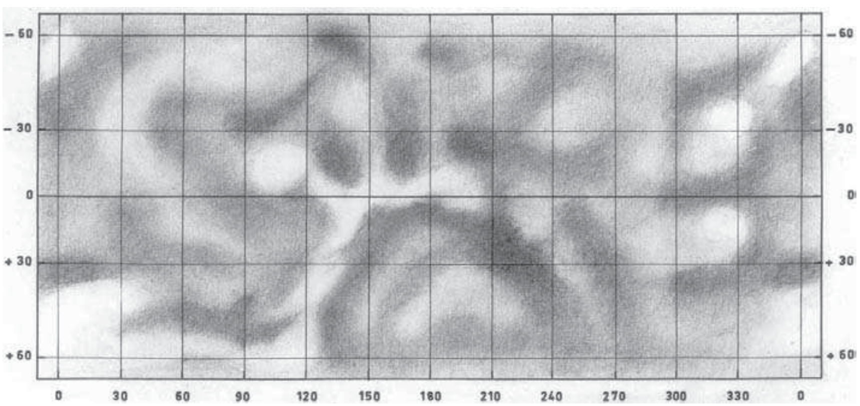

Figure 2. Albedo map of Mercury by H. Camichel and A. Dollfus, reproduced from their paper in *Icarus*, 8, 216–226 (1968). *Note:* In this map and all telescopic drawings and images, south is uppermost.

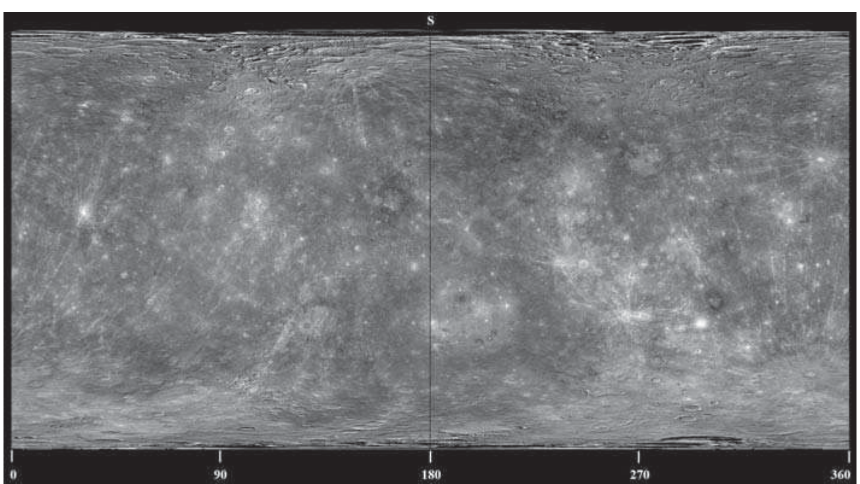

Figure 3. The *Messenger* Low Angle Incidence Mercury Mosaic: http://messenger.jhuapl.edu/Explore/Images.html#global-mosaics. 'This monochrome mosaic complements the morphology mosaic by using images that minimize shadows on the surface, and hence this ...mosaic highlights different reflectance properties of the materials on Mercury's surface. Projection: simple cylindrical, centered on 0° latitude and 0° longitude.' For reproduction here we have rearranged the mosaic to show longitude 180° at the centre, and south at the top.

The bright spots

Note that these spots, representing the ejecta from ray craters, are seen at their brightest under a vertical Sun. Thus if the phase is slightly gibbous they will be best seen towards the limb, which is where the subsolar point will be located. On the disk of the planet close to Full they may be bright near the centre. For example, witness Kuiper (–11°, 31.5°) as the bright spot near the *p.* limb under CM= 080 and 081° (Figure 4). At this longitude the Sun would be close to being directly overhead at the equator. On the image at CM= 028° in Figure 4, Kuiper is seen to be just *f.* the CM, and it is light but not bright. There are many examples of these bright spots on the images (and on several drawings).

Anomalous observations

At the 2010 April eastern elongation Frassati on Apr 1 and 5 (drawing; see Figure 6A, CM= 087°), and Edwards on Apr 5 (image) both showed the N. cusp protruding against a convex terminator. This may have been

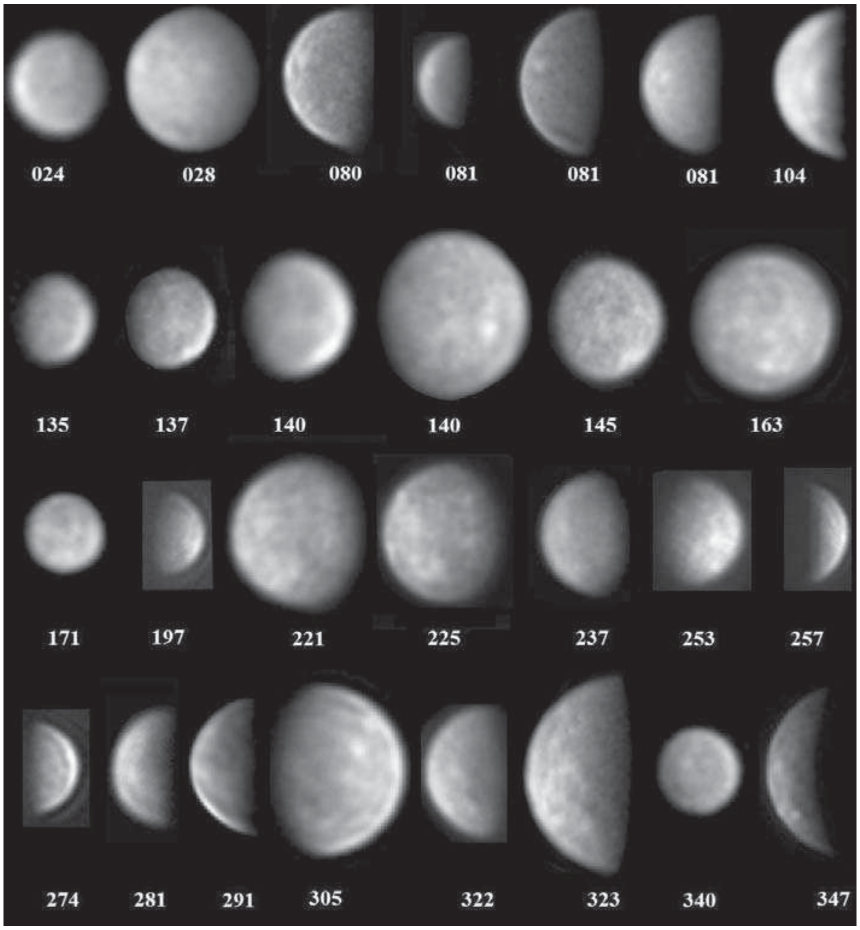

Figure 4. A selection of the best BAA images of Mercury, 2007–2016, using cameras with infrared pass filters, by Gabriele & Joerg Ackermann (DMK21AF04 camera); David Arditti (SkyNYX 2-0); John Bourdreau (DMK21AF04.AS); Daniele Gasparri (Lumenera LU075m); Chris Hooker (DMK21AU04.AS); Manos Kardasis (DMK21AU618); Willem Kivits (ATK 2HS & (2010–) DMK 21AU04.AS); Ed Lomeli (DMK21BF04); Paul Maxson (Lumenera SkyNyx); Tiziano Olivetti (Flea 3); John Sussenbach (Flea 3) and Sean Walker (DMK 21AU04.AS). The slow rotation rate of Mercury enables observers to employ long integration times. Given the very variable disk diameter of Mercury, no attempt was made to achieve a constant scale, but the better images have obviously been enlarged to a greater extent. All images have necessarily been considerably enhanced in contrast. In many instances this has resulted in a spurious grainy appearance due to amplified noise, which may well be visible upon the page.
Top row: CM= 024° (2016 Jul 13, Hooker), CM= 028° (2011 Mar 7, Kivits), CM= 080° (2008 May 5, Kivits), CM= 081° (2011 Mar 9, Arditti), CM= 081° (2008 May 5, Walker), CM= 081° (2011 Mar 19, Kivits), CM= 104° (2008 May 10, Ackermanns);
Second row: CM= 135° (2010 Jun 17, Hooker), CM= 137° (2011 Jun 2, Sussenbach), CM= 140° (2016 Oct 19, Hooker), CM= 140° (2012 May 17, Kivits), CM= 145° (2009 Jul 5, Kivits), CM= 163° (2010 Jun 24, Kivits);
Third row: CM= 171° (2010 Jun 26, Hooker), CM= 197° (2008 Mar 10, Lomeli), CM= 221° (2010 Jul 8, Kivits), CM= 225° (2010 Jul 9, Kivits), CM= 237° (2008 Jan 16, Boudreau), CM= 253° (2008 Mar 22, Lomeli), CM= 257° (2010 Sep 17, Maxson);
Bottom row: CM= 274° (2009 Oct 6, Maxson), CM= 281° (2013 Jun 4, Kardasis), CM= 291° (2013 Jun 6, Gasparri), CM= 305° (2014 Jul 26, Olivetti), CM= 322° (2009 Aug 15, Kivits), CM= 323° (2011 Jul 15, Kivits), CM= 340° (2016 Jul 2, Hooker), CM= 347° (2013 Jun 17, Gasparri).

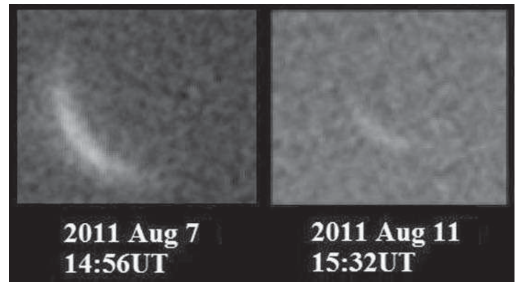

Figure 5. Mercury at very narrow phase, imaged in daylight by Willem Kivits (DMK 21AU04.AS camera) on 2011 Aug 7 & 11.

due to the presence of a large dark marking near the cusp. Indeed, if we look at the image by Walker under CM= 081° in Figure 4 we can see a very dark candidate marking near that cusp which could make the terminator appear to recess visually, or upon a processed image.

The smallest observable phase?

The Director has often wondered what is the smallest phase at which the crescent of Mercury can still be distinguished from the background sky. Rarely do we see drawings or images with a phase below about 0.25. We know it is possible to see the New Moon from a little under 16 hours old, corresponding to a theoretical phase of 0.005. But Mercury is so close to the Sun that few observers have ever viewed a really narrow crescent, when daytime viewing becomes essential. Moreover, being a rocky planet like the Moon, its magnitude drops off rapidly with decreasing phase.

Extracts from correspondence with Kivits show that Mercury was always invisible to the naked eye (and even on his CCD screen) in daylight at narrow phase. However, Kivits was able to extract the planet's feeble image from the background noise. His narrowest crescents were obtained in early to mid-afternoon on 2011 Aug 7 (0.114) and 11 (0.05). The planet's magnitudes were +2.3 and +3.4 respectively, and the corresponding latter image was obtained just six days prior to inferior conjunction. These remarkable images are given in Figure 5. Note the extreme faintness of the horns; indeed, they are not visible at all in the second image.

Adamoli is another frequent observer of the planet, and often takes up the same challenge from the visual point of view. During the 2010 April evening elongation he was able to follow Mercury on ten evenings in Mar–Apr, and found an apparent phase of 0.16 on Apr 18. But the record of Kivits – phase 0.05 – will be hard to beat.

Filters for visual daytime use

Gray (2012 Dec 2) wrote about his experiments with various Wratten filters: 'Usually the W22 [orange] copes well, with this planet in particular, but on this occasion it became fairly ill-contrasted against the sky background. So after some experimentation a W15 [yellow] stacked with a W13 [yellow-green] proved very effective… this combination rendering the sky much the colour of olive oil, with Mercury relatively more yellow.'

The 2016 solar transit

Circumstances

The event took place on 2016 May 9. The circumstances were reviewed by Macdonald[9] and the Director,[10,11] and also given in the 2016 BAA *Handbook*. Observers submitted their results to the writer, to the BAA Transit Website and to the Director of the Solar Section. Some images have already featured on the cover of the 2016 August *Journal*.[12]

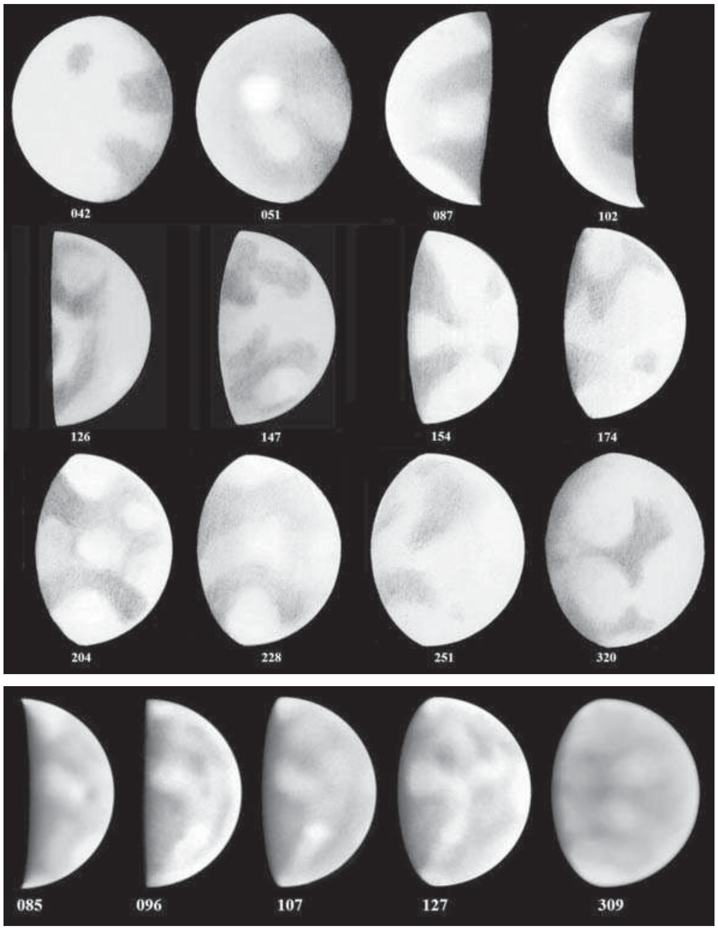

Figure 6. Collages of Mercury drawings, 2007–2016.

A *(top)*. Drawings by Mario Frassati, W21 or W23A filter, ×250. *Top row:* 2010 Mar 26 (CM= 042°), Mar 28 (CM= 051°), Apr 5 (CM= 087°) & Apr 8 (CM= 102°). *Middle row:* 2009 Feb 9 (CM= 126°), Feb 13 (CM= 147°); 2008 Mar 2 (CM= 154°) & Mar 6 (CM= 174°). *Bottom row:* 2008 Mar 12 (CM= 204°), Mar 17 (CM= 228°), Mar 22 (CM= 251°); 2009 Oct 16 (CM= 320°).

B *(bottom)*. Drawings by David Gray, W22 or W15+W13 combined filters, ×365. *From left to right:* 2012 Nov 30 (CM= 085°), Dec 2 (CM= 96°), Dec 4 (CM= 107°) & Dec 8 (CM= 127°); 2008 Oct 29 (CM= 309°).

Observers

A few observers went abroad to seek more reliable weather, but in the end the conditions in the UK proved to be good for many observers. The weather favoured observers in the Midlands and in the north, with those further south either having had a reasonable view only at the start, or been troubled by cloud all day. The 3rd and 4th contacts were only observed in the north. Many observers were able to view in hydrogen-alpha light. Most of the material sent in consisted of images of part of or the whole solar disk. Abel, Heath, McKim and Phelps also made drawings. The observers are listed in Table 3 and selected work illustrated in Figures 7–12.

Table 1. Observers of Mercury, 2007 Nov–2016 Oct

G. & J. Ackermann	Zaberfeld–Michelbach, Germany	180mm MK & 310mm DK Cass.
G. Adamoli	Verona, Italy	125mm MK & 235mm SCT
T. Akutsu	Cebu City, Philippines	355mm SCT
D. L. Arditti	Edgware, Middlesex	355mm SCT
K. N. L. Bailey	Swindon, Wilts.	127mm OG
J. Boudreau	Saugus, MA, USA	279mm SCT
C. Dole	Newbury, Berks.	180mm MK
P. Edwards	Horsham, West Sussex	279mm SCT
M. & L. Frassati **V**	Crescentino (VC), Italy	203mm SCT
M. H. Gaiger	Tolworth, Surrey	254mm refl.
D. Gasparri	Perugia, Italy	355mm SCT
M. Giuntoli **V**	Montecatini Terme, Italy	102mm OG
D. L. Graham **V**	Richmond, N. Yorks.	152mm OG
D. Gray **V**	Kirk Merrington, Co.Durham	415mm DK Cass.
P. T. Grego **V**	St Dennis, Cornwall	203mm SCT
C. J. Hooker	Didcot, Oxon.	254mm refl.
T. Ikemura	Nagoya, Japan	380mm refl.
R. Johnson	Ewell, Surrey	Digital camera
M. Kardasis	Athens, Greece	279mm SCT
W. Kivits	Siebengewald, Netherlands	355mm SCT
H–G. Lindberg	Skultuna, Sweden	180mm MK
E. Lomeli	Sacramento, CA, USA	235mm SCT
S. Macsymowicz **V**	Ecquevilly, France	102mm OG
G. McLeod	Bower, Wick	80mm OG
P. W. Maxson	Surprise, AZ, USA	254mm SCT
F. J. Melillo	Holtsville, NY, USA	254mm SCT
C. Meredith	Prestwich, Manchester	203mm SCT
D. Niechoy	Göttingen, Germany	203mm SCT
T. Olivetti	Bangkok, Thailand	410mm DK Cass.
I. S. Phelps	Warrington, Cheshire	152mm refl.
M. Salway	Central Coast, NSW, Australia	305mm refl.
J. Sussenbach	Houten, Netherlands	279mm SCT
J. Vetterlein	Rousay, Orkney	102mm OG
S. Walker	Manchester, NH, USA	317mm refl. & 355mm SCT

Abbreviations: Cass.= Cassegrain; DK= Dall–Kirkham; MK= Maksutov; OG= Refractor ('Object Glass'); Refl.= Reflector; SCT= Schmidt–Cassegrain. **V** *indicates visual data only supplied.*

Solar activity

Solar activity was low, with the last solar maximum well past. On the previous day, the Director (H-alpha and white light) had seen only a few small limb prominences, a number of small plages, and little evidence of flocculi.

The day of the transit was not dissimilar, and the small E. limb prominences provided a photogenic accompaniment to the entry of Mercury's small black disk. There were three small sunspot groups, the largest of which was west of the meridian and several times larger than Mercury in area. Mercury's transit track did not

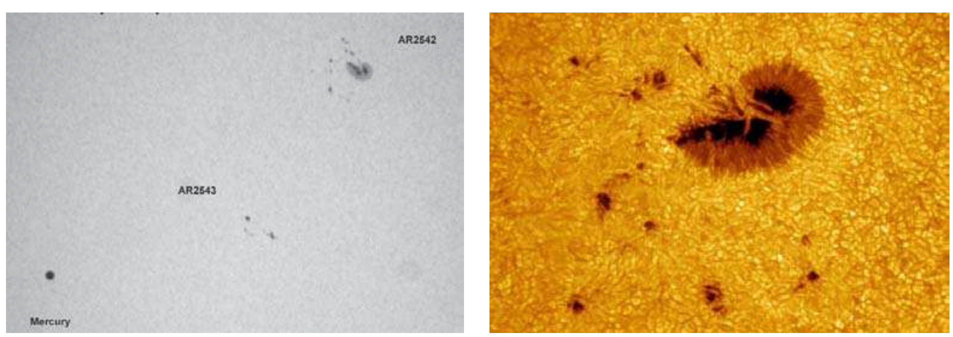

Figure 7. The solar transit, 2016 May 9. Sunspot activity.
A *(left)*. Mercury and sunspot groups at 13:50UT with 102mm OG with green filter and DMK21AU.04 monochrome camera by Ron Johnson.
B *(right)*. Enlargement of the largest sunspot group at 09:45UT with 178mm OG, Herschel wedge, ND + Baader solar continuum filter and ZWO ASI120MM-S camera by Dave Tyler. Note: All the solar transit images are oriented as the Sun would be viewed with the protected naked eye, with north uppermost.

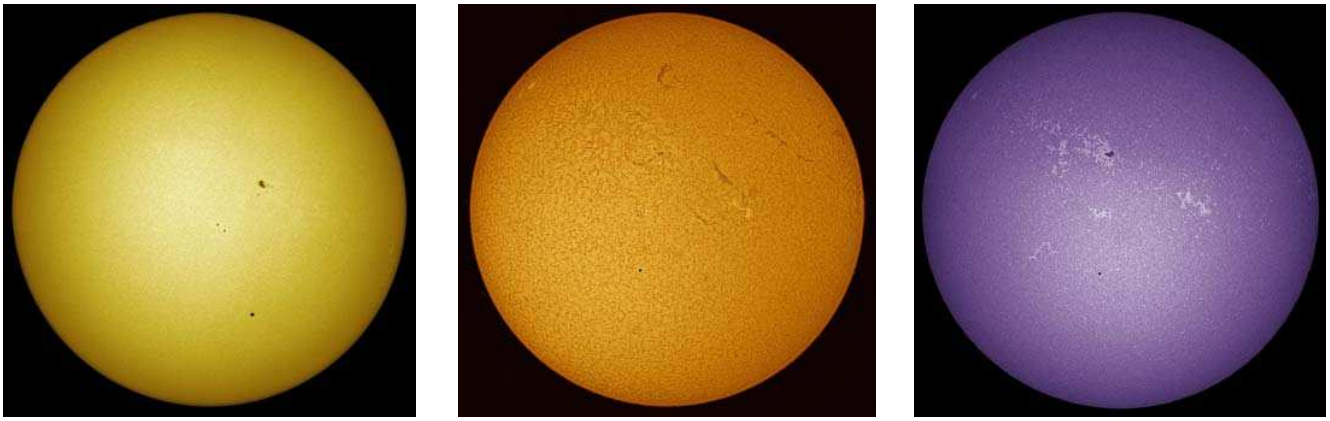

Figure 8. The 2016 solar transit. Comparing the view in white light with hydrogen alpha and calcium K.
A *(left)*. White light image at 13:05UT by Manos Kardasis with an 80mm OG, full aperture solar filter and DMK21AU618 camera.
B *(centre)*. Hydrogen alpha image at 14:55UT by Alan Tough with a 60mm Lunt LS60THa H-alpha telescope and DMK51AU02.AS camera.
C *(right)*. Calcium K image at 14:57:32 UT by Pete Lawrence with 40mm CaK PST and ZWOASI174MM camera. This was taken at the point of greatest transit.

bring it close to any spot. However, the changing aspect of the east limb prominences was interesting to follow as the day progressed. Figure 7 by Ron Johnson shows Mercury and two sunspot groups, and Figure 7B shows a close-up of the largest group by Dave Tyler.

Several observers took H-alpha images on the day of the transit, while Pete Lawrence and Sheri Lynn Karl[12] made Calcium K images too, which make fascinating comparison to the white light aspect. Compare Figures 8A, 8B and 8C, with mid-transit images by Manos Kardasis (white light), Alan Tough (H-alpha) and Lawrence (CaK).

Table 2. Greatest elongation (GE) and observational data, 2007 Nov to 2016 Oct

Date of GE East (evening)	*Date of inferior conjunction*	*Date of GE West (morning)*
– – –	2007 Oct 23	**2007 Nov 8 (1/1)**
2008 Jan 22 (2/2)	2008 Feb 6	**2008 Mar 3 (1/3)**
2008 May 14 (4/6)	2008 Jun 7	**2008 Jul 1 (0/1)**
2008 Sep 11 (1/1)	2008 Oct 6	**2008 Oct 22 (2/1)**
2009 Jan 4 (1/0)	2009 Jan 20	**2009 Feb 13 (1/1)**
2009 Apr 26 (4/0)	2009 May 18	2009 Jun 13
2009 Aug 24 (1/1)	2009 Sep 20	**2009 Oct 6 (2/2)**
2009 Dec 18 (1/0)	2010 Jan 4	2010 Jan 27
2010 Apr 8 (5/5)	2010 Apr 28	**2010 May 26 (0/3)**
2010 Aug 7 (1/1)	2010 Sep 3	**2010 Sep 19 (1/2)**
2010 Dec 1	2010 Dec 20	2011 Jan 9
2011 Mar 23 (2/4)	2011 Apr 9	**2011 May 7 (0/2)**
2011 Jul 20 (1/1)	2011 Aug 17	2011 Sep 3
2011 Nov 14	2011 Dec 4	2011 Dec 23
2012 Mar 5 (3/2)	2012 Mar 21	**2012 Apr 18 (0/1)**
2012 Jul 1	2012 Jul 28	**2012 Aug 16 (0/1)**
2012 Oct 26	2012 Nov 17	**2012 Dec 4 (2/1)**
2013 Feb 16 (1/1)	2013 Mar 4	2013 Mar 31
2013 Jun 1 (1/3)	2013 Jul 9	2013 Jul 30
2013 Oct 9	2013 Nov 1	2013 Nov 16
2014 Jan 31 (1/0)	2014 Feb 15	2014 Mar 14
2014 May 25 (1/0)	2014 Jun 19	**2014 Jul 12 (0/1)**
2014 Sep 21 (1/0)	2014 Oct 16	**2014 Nov 1 (0/1)**
2015 Jan 14 (1/0)	2015 Jan 30	2015 Feb 24
2015 May 7 (2/1)	2015 May 30	2015 Jun 24
2015 Sep 4 (1/0)	2015 Sep 30	2015 Oct 16
2015 Dec 29	2016 Jan 14	2016 Feb 7
2016 Apr 18 (2/2)	**2016 May 9 (transit)**	**2016 Jun 5 (0/1)**
2016 Aug 16 (1/1)	2016 Sep 12	**2016 Sep 28 (0/2)**

The availability of observational material is indicated in **bold** type. Each **bold** entry is accompanied in brackets first by the number of *visual* observers followed by the number of *imaging* observers [*e.g.*, **(2/1)**]. A number of Elongations, particularly the morning ones, went unobserved.

Ingress & egress and optical effects

At the 1973 Nov 10 transit, observing in the bright continuum adjacent to the H-alpha line, Harold Hill[13,14] had observed the planet's black disk projected upon the inner solar corona beyond the solar limb up to 1.5 minutes after 4th contact. In fact this was

Table 3. Observers of the 2016 May 9 solar transit

P. Abel & P. Lawrence (Leicester), G–L. Adamoli (Verona, Italy), R. M. Baum (Chester), K. W. & R. Blaxall (Colchester, Essex), G. Di Giovanni (Colle Leone Observatory, Italy), C. Fattinnanzi (Montecassiniano, Italy), C. Foster (Centurion, S. Africa), M. Foulkes (Grantham, Lincs.), M. Giuntoli (Montecatini Terme, Italy), R. Hartness (Barnard Castle, Teesdale), A. W. Heath (Long Eaton, Notts.), R. Hill (Tucson, AZ, USA), N. D. James (Chelmsford, Essex), R. W. Johnson (Ewell, Surrey), M. Kardasis (Athens, Greece), S. L. Karl (Aberdeen, Scotland), W. J. Leatherbarrow (Sheffield), P. Macdonald (Harrow, Middx.), R. J. McKim (Oundle & Upper Benefield, Northants.), P. Meadows (Crete, Greece), F. J. Melillo (New York, NY, USA), M. P. Mobberley (Bury St Edmunds, Suffolk), P. Mulligan (Sheffield), D. Niechoy (Göttingen, Germany), P. W. Parish & T. Cannon (Gillingham, Kent), I. Phelps (Warrington, Cheshire), A. Tough (Elgin, Moray, Scotland), D. B. V. Tyler (Flackwell Heath, Bucks.), A. Vandebergh (Wittem, Netherlands), A. G. Vargas (Cochabamba, Bolivia), T. Wakefield (Manchester) and S. Williams (Leighton Buzzard, Beds.).
Images by S. L. Karl and T. Wakefield were kindly contributed by the Solar Section Director, Lyn Smith.

Figure 9. The 2016 solar transit. Hydrogen alpha images at 11:12:16–11:12:26 UT showing the planet crossing the spicule layer at the edge of the chromosphere just prior to 1st chromospheric contact, with 102mm OG, Quark H-alpha filter and ZWOASI174MM camera, by Pete Lawrence.

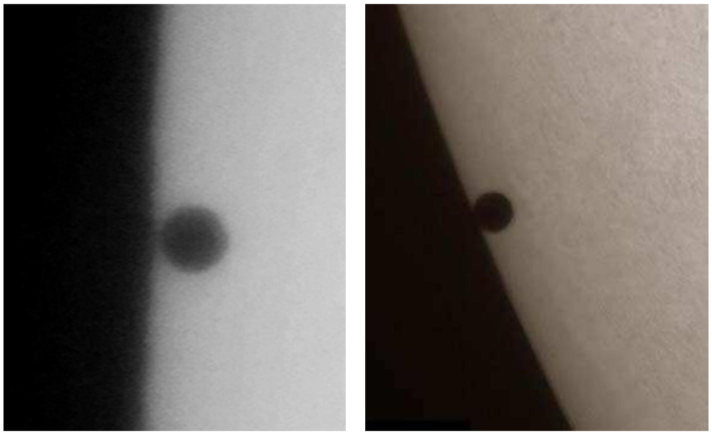

Figure 10. The 2016 solar transit. Second contact white light images showing how the appearance of the Black Drop was seeing-dependent.
A *(left)*. 11:15UT, 150mm OG and Sony TRV-740 video camera, *Ralf Vandebergh*. If this image taken in average seeing is viewed from a distance, a trace of the Black Drop effect – or at least a darkening of the surface between the Sun's limb and planet – is evident.
B *(right)*. 11:15:12 UT 178mm OG, Herschel wedge, ND + Baader solar continuum filter and ZWO ASI120MM-S camera, *Dave Tyler*. There is no trace of the Black Drop in this image taken in very good seeing, which was clearly obtained a few seconds before that in **(A)**.

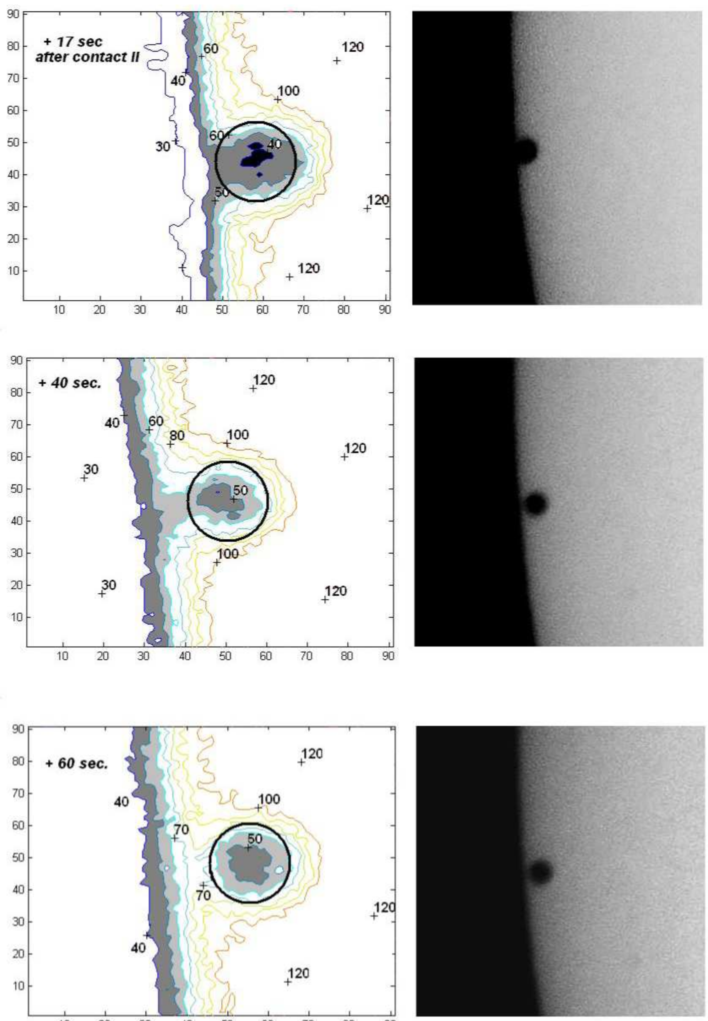

Figure 11. The 2016 solar transit. Images and photometric scans taken in fair seeing (Antoniadi III–IV) 17s, 40s and 60s after second contact with 150mm OG and Nikon D3000 camera by Giovanni Di Giovanni. The second of these pairs hints at the presence of the Black Drop. The images have been sharpened so that the position of the true limb has been lost.

another observation of a type previously made at several transits, dating back to the 19th century.[14] Just prior to first contact on 2016 May 9, Pete Lawrence experienced very good conditions and was able to make the same sort of observation before the transit began. Lawrence described his images as showing the planet silhouetted against the spicule (transition) layer before reaching the chromosphere proper: see Figure 9. Lawrence was able to observe that the transit began earlier in H-alpha than in white light, due to the extra depth of the chromosphere. This difference in time is known from previous events. Others attempted to see Mercury prior to 1st chromospheric contact but did not succeed due to the presence of cloud.

Seeing was very favourable for many observers, and those who were able to time the contacts mostly did not experience the once-dreaded Black Drop effect. The latter is now recognised to be more an effect of lack of resolution, which is exacerbated by bad seeing, rather than the result of bad seeing alone (as it was earlier believed to be). Little sign was seen of the light aureole around the planet either, though it can always be mimicked by over sharpening an image. The white spot in the centre of Mercury's disk (an effect of diffraction, reported at some past events) was also not observed. Ralf Vandebergh produced an image hinting at the Black Drop effect at 2nd contact, in fair seeing (Figure 10A). In contrast the image by Dave Tyler in better seeing at the same point shows only a sharp disk (Figure 10B). The ingress sequences of Alan Heath and Ian Phelps (Figures 12 and 15) may also be compared on this point.

Timings

Various predicted timings were given in the 2016 *Handbook*. Actual timings are given in Table 4 (I= 1st contact, etc.), with the geocentric ones for comparison.

Table 4. UT timings of the 2016 May 9 solar transit

All timings made in white light except where stated.

Observer	*I*	*II*	*III*	*IV*
Pete Lawrence: white light	11:12:33±4	11:15:40.7±1		–
H-alpha (102mm OG)	11:12:24±4	–	–	–
Manos Kardasis (279mm SCT)	–	11:15:03	–	–
Richard McKim* (254mm refl.)	11:12:30	11:15:40	–	–
Ian Phelps (152mm refl.)	–	11:15:32	–	–
R. Hartness (203mm SCT)	–	–	–	18:40:20
AlanTough (100 mm OG)	–	11:15:38	18:37:23	18:40:02
Sheridan Williams (98mm OG)	11:12:28	11:15:38	–	–
Geocentric (predicted)	**11:12:18**	**11:15:30**	**18:39:12**	**18:42:24**

*These measurements may generally be reliable to ±5s, but we quote the error estimates of Lawrence which are smaller due to better conditions. The first and second UK contact times differed little from the geocentric ones. A greater deviation can be seen with the third and fourth contacts. For Leicester (Lawrence) the predictions for the contacts were 11:12:19, 11:15:31, 18:39:14 and 18:42:26. Foster stated that for Pretoria (S. Africa) the time predicted for 2nd contact was 11:15:08. He confirmed that this had already occurred by 11:15:32, but did not obtain a precise timing.

Solar parallax

In principle we could compare the UK data with those from South Africa or South America in order to determine the solar parallax, as was done in the distant past.

Observers' comments (extracts)

Paul Abel & Pete Lawrence: 'We were able to follow the transit until the end, although by this point we were observing the Sun through gaps in the trees!'

Gianluigi Adamoli: 'Around 15:30 UT there was a temporary thinning of the clouds. Mercury was a perfectly round spot, absolutely black, with very definite edge. I've been lucky that this transit was a very long affair, so allowing me to take advantage of a limited opportunity window, during an otherwise very bad day, quite rare for May, in Italy.'

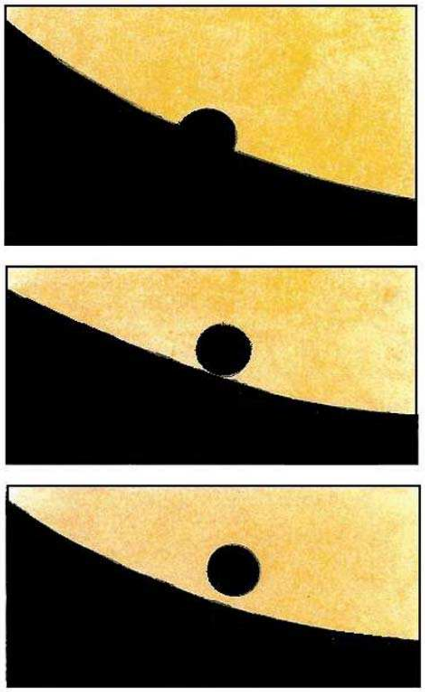

Figure 12. The 2016 solar transit. Drawings at ingress by projection with 75mm OG, ×90, by Alan Heath.

Richard Baum: 'Cloud and haze proved a nuisance, but we had good moments. Both ingress and egress were lost to cloud but in the time it was possible to have a decent sight of the event it was fascinating. Thinking back to June 2004 and Venus, Mercury seemed more like a full stop! Of course there was no comparison with the observations made during the transit of 1973 when after a morning of exceedingly heavy rain the cloud abruptly cleared with remarkable rapidity, and rushing home from work, I was able to catch egress very well. At that time I was much taken with historical reports of white spots and haloes round the planet. Artefacts obviously, yet I did catch a glimpse of whiteness around the planet.'

Giovanni Di Giovanni: 'These results [with 150mm Cass. in seeing Antoniadi III–IV] show a slight Black Drop effect at ingress, less prominent than had been expected.' The observer submitted photometric scans of the ingress image series (Figure 11).

Clyde Foster: 'As Ingress time approached, weather conditions were very uncertain, although definitely better than forecast… There were substantial breaks in the cloud… All in all, an eventful day, not least of all that it started at about 02:00 a.m. with me up early for some Mars imaging.'

Mike Foulkes: 'The forecast indicated it would be very clear north of Peterborough but with some thin cloud around first/second contact, but very clear into Lincolnshire. I decided to travel north up the A1 and ended up in a lay-by on the A46 to the east of the A1. As I headed north it was cloudy but slowly blue skies appeared. I did think of stopping near Grantham but there was a bit of thin cloud around, so went further north in line with the forecast. I set up my trusty 70mm refractor with an imaging camera. I did get a few funny looks from other people parked in the lay-by throughout the time I was there. Then Mr Spode appeared. A couple of minutes before first contact my drive stopped. By the time I changed the batteries and checked the connection and got the drive going again and slewed back to the east limb, first contact had taken place. But I managed to see second contact with the webcam going. I had to leave around 15:00 BST to get back to Stevenage.'

Alan Heath: 'No Black Drop seen [at ingress; 75mm OG]. The planet was completely black and well seen and darker than the umbra of a sunspot.' Alan's ingress drawings are given in Figure 12.

Bill Leatherbarrow: 'I did try to replicate Harold Hill's famous observation of Mercury before transit, silhouetted against the solar corona, but without success either visually or imaging.' Bill rightly considers that the slight whiteness around Mercury in transit was an effect of processing: however, this is hardly visible in Figure 13.

Richard McKim: 'The transit was shown to many pupils and staff at Oundle School using a 254mm Newtonian to project the image. There was a distinct gap between Mercury and the Sun's limb by 11:16:00 UT, and at 11:17:45 UT I noted that any light aureole around Mercury was barely visible upon the projection screen in good seeing, and any such appearance was regarded as illusory. Images were also made with a 60mm Coronado H-alpha telescope (Figure 14). Conditions were quite good until 18:20 UT, less than 20 minutes before 3rd contact, when cloud cover gradually increased to 100%.'

Peter Meadows: 'The transit was observed using telescopes set up by the Crete Astronomy Friends Club in the picturesque Venetian Harbour in Chania. I observed the transit at around 15:50 UT (18:50 EEST local time). Both the telescopes showed that Mercury was darker than the umbra of the few sunspots that were visible.'

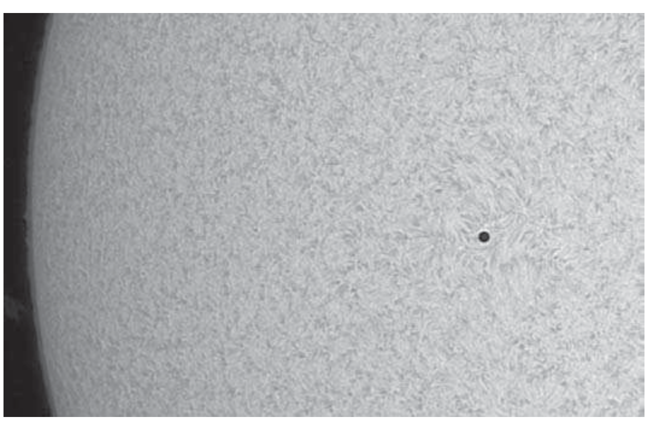

Figure 13. The 2016 solar transit. H-alpha image at 13:36:51 UT with Solarscope SV50 (50mm aperture) and DMK21AU04.AS camera by Bill Leatherbarrow. Notice the very slight whiteness around the planet; an effect of image-processing.

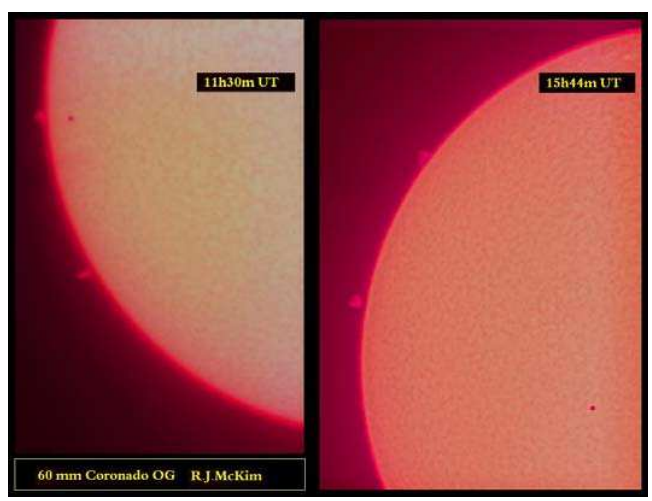

Figure 14. The 2016 solar transit. Two H-alpha images at 11:30 & 15:44UT with 60mm Coronado solar telescope and Phillips ToUCam camera by Richard McKim.

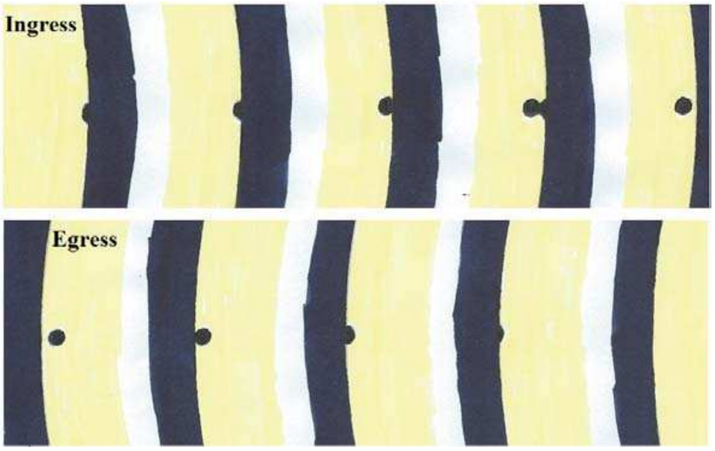

Figure 15. The 2016 solar transit. Ingress and egress sequences with 152mm refl. ×45 and full aperture ND5 Baader solar filter, drawn with direct vision by Ian Phelps.

Peter Parish: 'The weather forecast for Sunday May 8 had been for unbroken sunshine all day and they were right, but for Monday the 9th it said that cloud and rain was coming up from the south. This cloud was forecast to appear during the morning. At around 11 a.m. BST despite the weather forecast, the Sun in Rainham was shining off and on… as second contact approached I could not see any sign of the Sun stretching around Mercury as I saw in hydrogen alpha with Venus in 2004… by 15:00 BST the cloud had built up to such an extent that it prevented any further observation. I discovered later how lucky I was even to see this event from Rainham in Kent. My sister who was in Eastbourne, on the Sussex coast on May 9, told me that whilst the Sun was shining at 08:30, by 12:00 BST it was very overcast. The cloud was thick and unbroken during that afternoon and for the whole duration of the transit.'

Ian Phelps: 'Although having clear skies throughout was an ultimate advantage, I did have to contend with some gusty wind and episodes of poor seeing.' The Black Drop was very marked in poor seeing at 11:14 UT, but the 'thread' was timed to break at 11:15:32 UT, and this can be taken as 2nd contact. Better conditions were experienced at 3rd and 4th contacts and the Black Drop was not seen then. (See Figure 15.)

Alan Tough: 'I took the day off work on Monday to see the entire Transit of Mercury (my first one). Conditions were, generally, very good here in Elgin, with a clear blue sky and just a few wispy, high-altitude clouds.' See Figure 7B. Alan was the only observer to report accurate timings of 3rd and 4th contacts.

Figure 16. The 2016 solar transit. White light image at 13:41:52 UT with 98mm OG and Canon EOS 60Da camera by Sheridan Williams.

Gonzalo Vargas: Setting up his telescopes in a public area together with his wife Cristina and sons Alioth and Arturo, he noted: 'Two scopes were used. A Meade 10-inch [203mm] with a solar filter for direct observation and a homemade 8-inch [216mm] for projection… More than one hundred persons of all ages came to visit us.' The visitors included a local journalist and some local TV crews.

Sheridan Williams: 'I saw the first four hours of the transit but clouds got very annoying after that.' Figure 16 shows mid-event with a little of that cloud.

Conclusions

Nearly a decade of Mercury work has produced relatively meagre imaging results, but we have at least shown how improved technique coupled with persistence can generate excellent daytime images that show recognisable Mercurian features, even from the UK. Although the features of Mercury are static, and have been completely mapped by *Messenger*, any telescopic sighting of this elusive little world is always satisfying. We have shown that the visibility of the bright spots on the surface – regions of ejecta from ray craters – is always brightest under a high Sun, as is seen to be the case with our Moon.

Data from the transit of Mercury confirm earlier findings concerning optical effects. The white ring around the planet is purely an artefact, produced by image processing, and can be replicated visually by a combination of small aperture and bad seeing. The famous Black Drop effect is also primarily an effect of inadequate resolution, but it too is exaggerated by bad seeing.

We invite observers with good images or drawings of Mercury to continue to send them to the Section.

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Received 2016 November 5; accepted 2016 October 10