Report on the Transit of Mercury, May 2016.

Paul G. Abel and Pete Lawrence.

Abstract

Presented here is a preliminary report which covers the observations made by the authors of the transit of Mercury which occurred on 2016 May 09. The event was observed from Leicester UK where the skies were largely clear (although somewhat hazy at times). During the transit, many images and drawings were obtained in a variety of wavelengths. These are presented here along with some analysis of the results.

1 Observation Details

Date: 2016 May 09th Monday Start: 1002UT Finish: 1843UT

Observing Site: Knighton Observatory, Leicester UK.

Seeing Conditions: Variable- between AIII-AIV, thin cloud at times. Windy conditions.

Predicted Start time: 11:12:19UT Predicted Finish: 18:42:26UT Greatest: 14:57:26UT

Separation: -318.5" Position Angle: 153.80 Duration of Transit: 7h 30m.

2 Instrumentation

(i) Pete Lawrence:

- Station 1 (LS1) [set up for timelapse]
  - Vixen FL102S apochromatic refractor (f/9) with Baader Astrosolar film filter,
  - Camera used with this telescope was a ZWO ASI120MM monochrome high frame rate planetary camera fitted with an Astronomik OIII filter to enhance solar granulation.
  - S1 mount was a SkyWatcher AZ EQ6-GT which had a Hutech Hinode Solar Autogider fitted.

- Station 2 (LS2) [used for experimental imaging]
  - Vixen FL102S apochromatic refractor (identical to that used at S1) fitted with a variety of filters: Quark (chromosphere) h-alpha filter, a Solarscope SF-70 single-stacked H-alpha filter and a second Baader Astrosolar Film full aperture filter.
  - Coronado Calcium-K PST.
  - S2 mount was a Vixen GP-DX.

- All imaging was done with a ZWO ASI174MM monochrome high frame rate planetary camera. An Astronomik Green filter was used to enhance appearance of granulation in white light imaging.

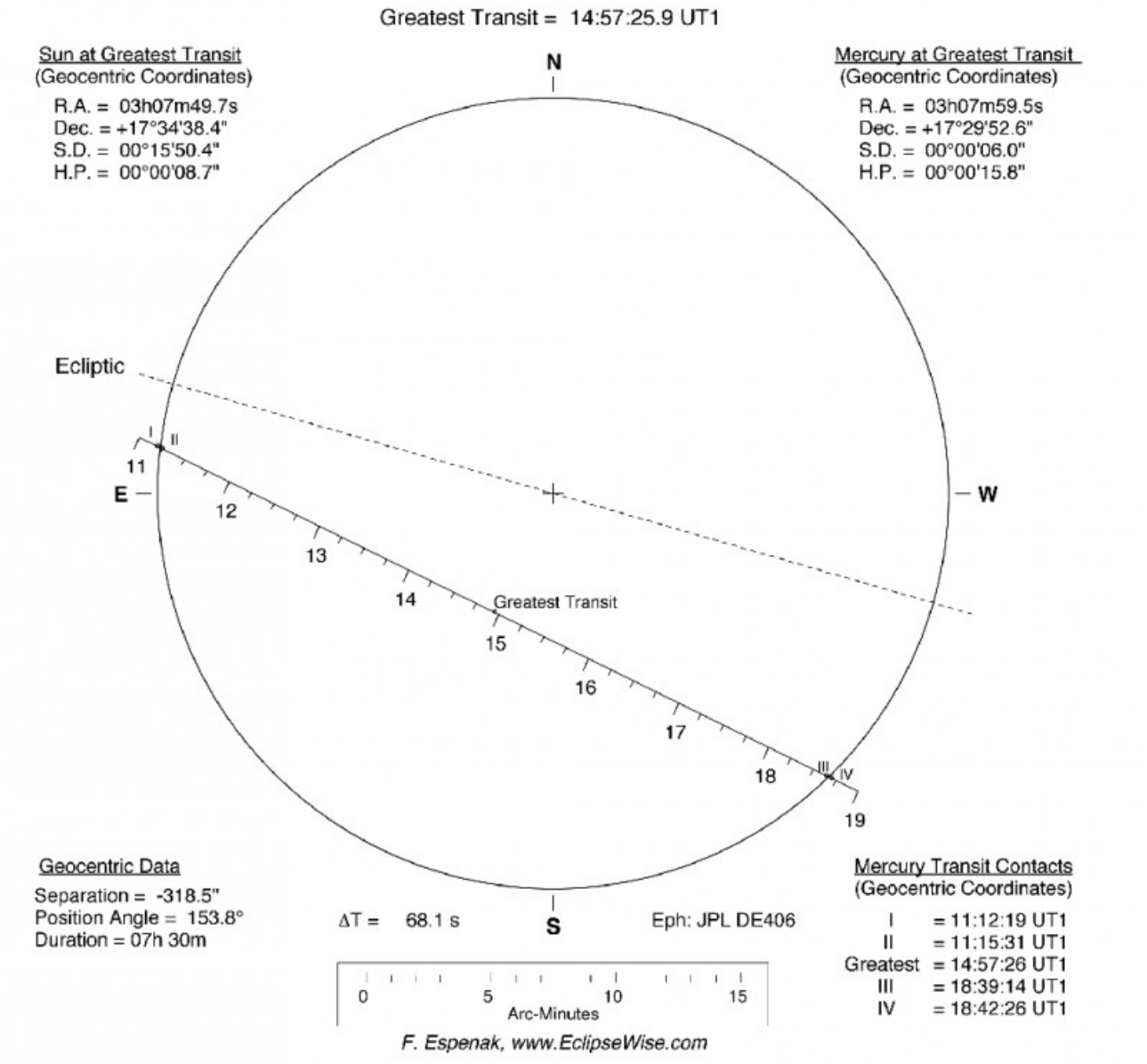
(ii) Paul G. Abel:

- Station 1 (AS1) [Observatory housing the main telescope]
  - 203mm Newtonian Reflector with Baader Astrosolar film filter on EQ5 mount
  - Filters used on Newtonian: W#47 (violet), W#25A (red) and W#11 (yellow)

- Station 2 (AS2) [H-alpha observations and white light projection]
- 40mm H-alpha PST telescope on alt-azimuth mount.
- 40mm Refractor on alt-azimuth mount.

3 Transit Details

The following fact sheet showing the full details of the transit was produced by Fred Espenak, and was made available from his website: www.EclipseWise.com



4 Diary of Events

With much of southern England predicted to be under thick cloud cover, the authors decided to observe the transit from Leicester. At the start of the day however, conditions did not look at all promising- at 0800UT thick cloud cover dominated the skies of Leicester. Pete Lawrence was driving north from Selsey and reported that the cloud front did seem to be breaking and by 0845UT there were substantial breaks in the cloud.

Initially we considered relocating further north: MET office predictions implied that much of the NE of England would be clear for most if not all of the transit and a number of alternative locations were considered. In particular, we thought seriously about relocating to Sheffield (Prof. Bill Leatherbarrow kindly agreed to host us if we decided to move).

A journey further north to a suitable location would have taken at least an hour, and when set up time was factored in, it seemed unfeasible to move- especially given that first contact was not far off. In the end we decided to remain at the Leicester location and spent some time getting the equipment set up in preparation for the transit.

The skies cleared sufficiently and we were able to observe the start of the transit, continuing all the way until 3rd contact (although this had to be viewed through the trees and a hazy sky as the sun was rather low by this point!) Light cloud drifted across at times making the conditions somewhat hazy, but overall we had a good view of the transit.

Observations and remarks were recorded in '*Field Observations, Vol* V'. The diary of events is as follows:

UT	**Event**
1030	Telescopes set up and ready.
1112	Abel estimates first contact using a 40mm H-alpha PST.
1116	Drawing of Mercury against the limb in IL (203mm Newt). Second contact somewhere between 1115-1116UT but very difficult to determine due to poor seeing. Probably occurred before 1116UT
1120	Observing with W47 (violet) filter on 203mm Newt.,- no perceptible difference in appearance of Mercury when compared to IL.
1123	Observing with a W11 (yellow) filter on 203mm Newt., again no difference from the white light view
1127	W25A (red) on 203mm Newt., no different from white light view.
1141	Drawing showing AR2542 and Mercury with transit well underway.
1152	Imaged the view through eyepiece on 203mm Newt., with Iphone- not a bad image but certainly it won't be the best one taken here today by any means!
1209	Drawing made using PST showing two nice proms and Mercury on disk.
1338	Full disk drawing made (IL, 203mm Newt.,) showing Mercury and AR2542

1400	Tried projecting the sun with 40mm refractor- unable to make out Mercury on the projected image however it is now rather windy which makes such observations difficult.
1457	Halfway point observed: Mercury now in mid transit.
1741	Final view of the transit with the 203mm Newt., as the sun is now descending into the trees and the wall of the observatory is starting to obscure the view.
1804	Now using just the 40mm PST. Mercury is now approaching the SW limb, but the sun is descending into the trees, so observations are somewhat difficult. Nonetheless, I am able to glimpse the planet through gaps in the trees.
1814	Mercury still visible, and continues to approach the limb.
1819	Mercury now on the SW limb low cloud now approaching making the image a little dim- having to move the PST about the garden to get views through the trees
1839	Final view of Mercury now very close to the edge of the sun's disk.
1842	Finish! Transit over! Both of us have managed to follow the transit from start to finish. Storm clouds now rolling in- heavy rain predicted to arrive within the next 30 minutes.

5 Observations

- On 1973 November 10 at 1318.5UT, the experienced Lunar and Solar observer Harold Hill observed a silhouette of Mercury's disk just off the hard edge of the solar limb in H-alpha light. PGA tried to repeat this observation with a 40mm PST but was unable to see Mercury until it appeared on the disk.

Figure 1: *PGA using his 203mm Newtonian to make white light observations of the transit. A filter made by Pete Lawrence for his 250mm Newtonian from Baader astrosolar film is being used for white light observations.*

Drawings (Paul G. Abel):

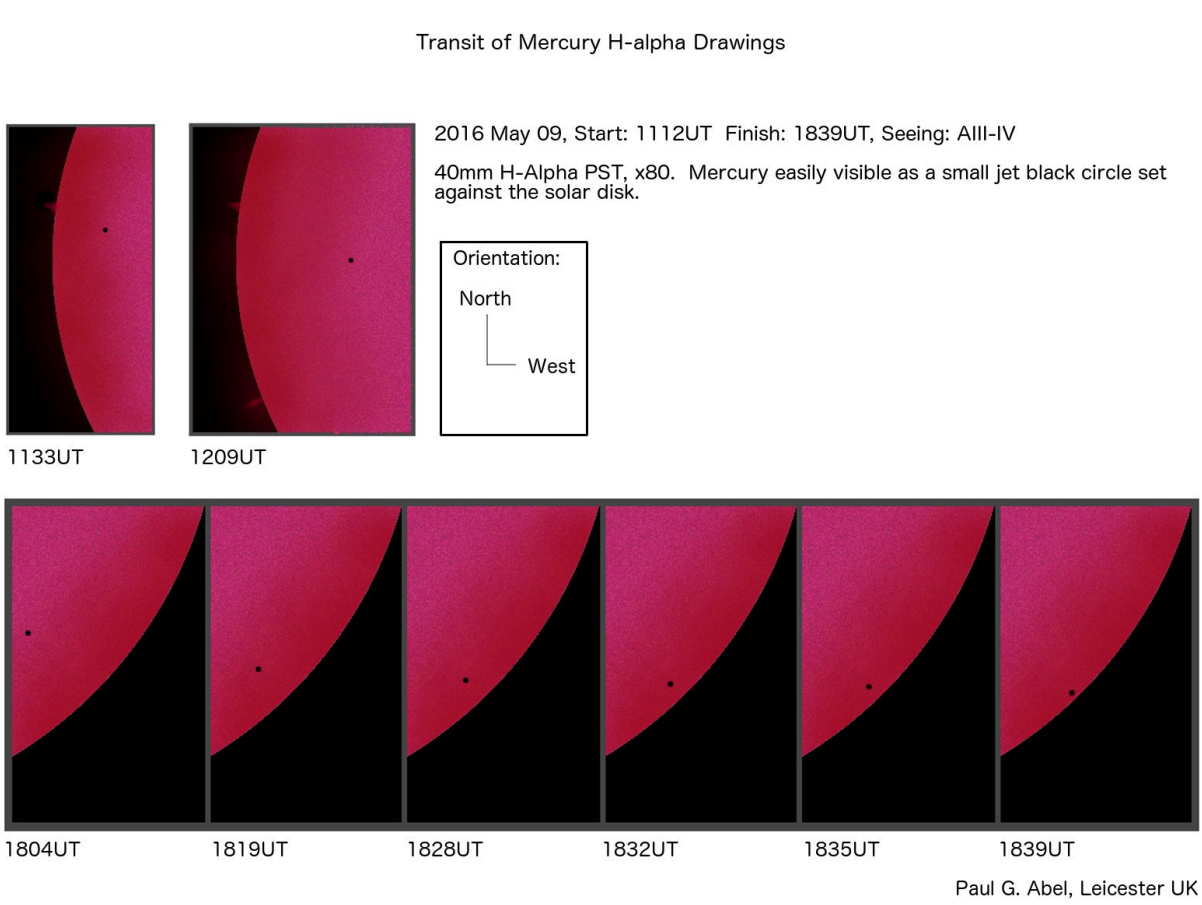


Figure 2: *A series of drawings made in H-alpha wavelengths. The upper two drawings were made not long after the start of the transit and show two prominences. The bottom sequence was made as the transit came to a close.*

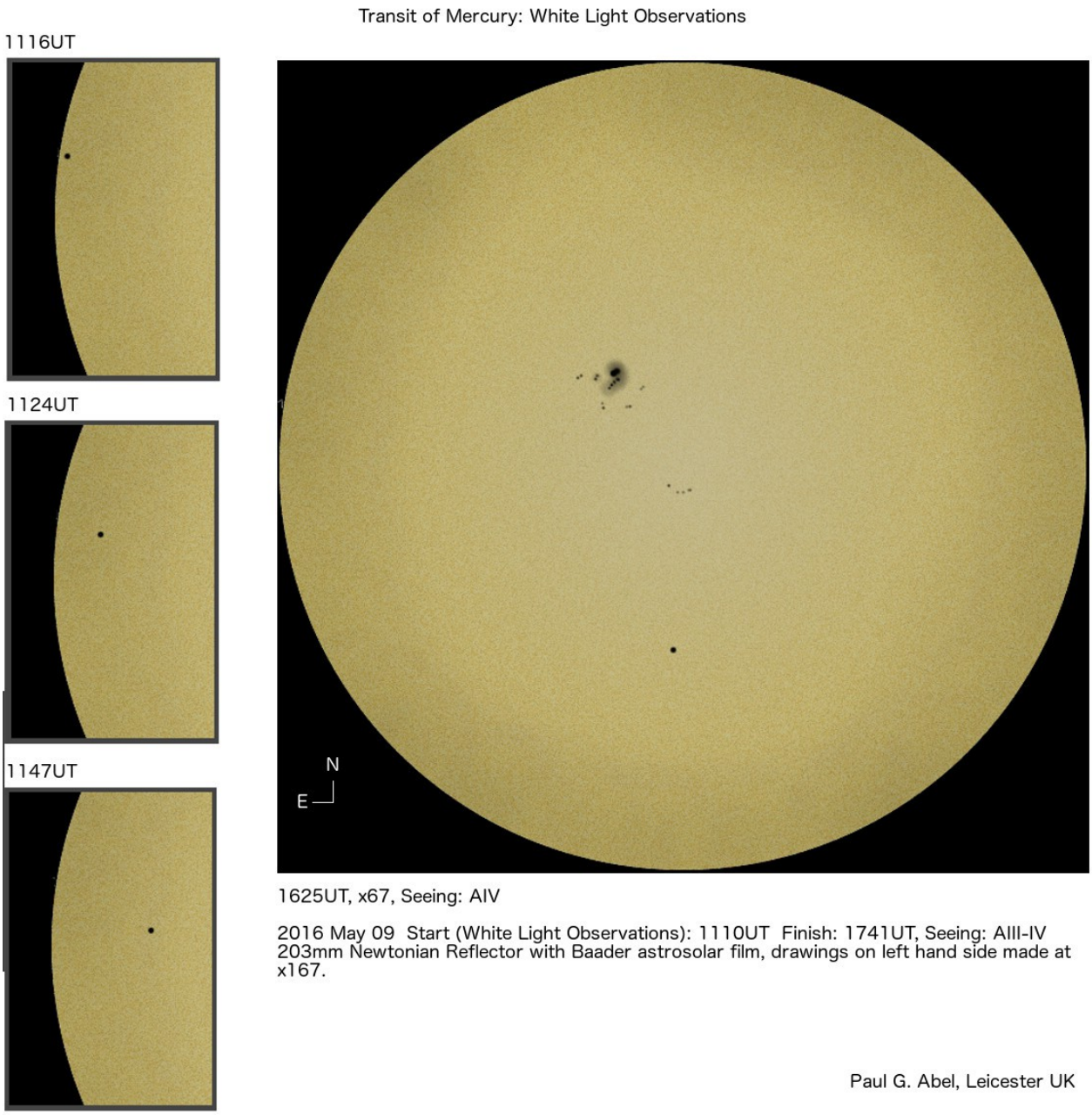


Figure 3. *White light drawings made with a 203mm Newtonian reflector. The sequence on the left shows Mercury's progress at the start of the transit. The large full disk drawing shows Mercury in transit and AR2542.*

Images (Pete Lawrence):

All images below were produced by Pete Lawrence, other images available at www.digistalsky.org.uk

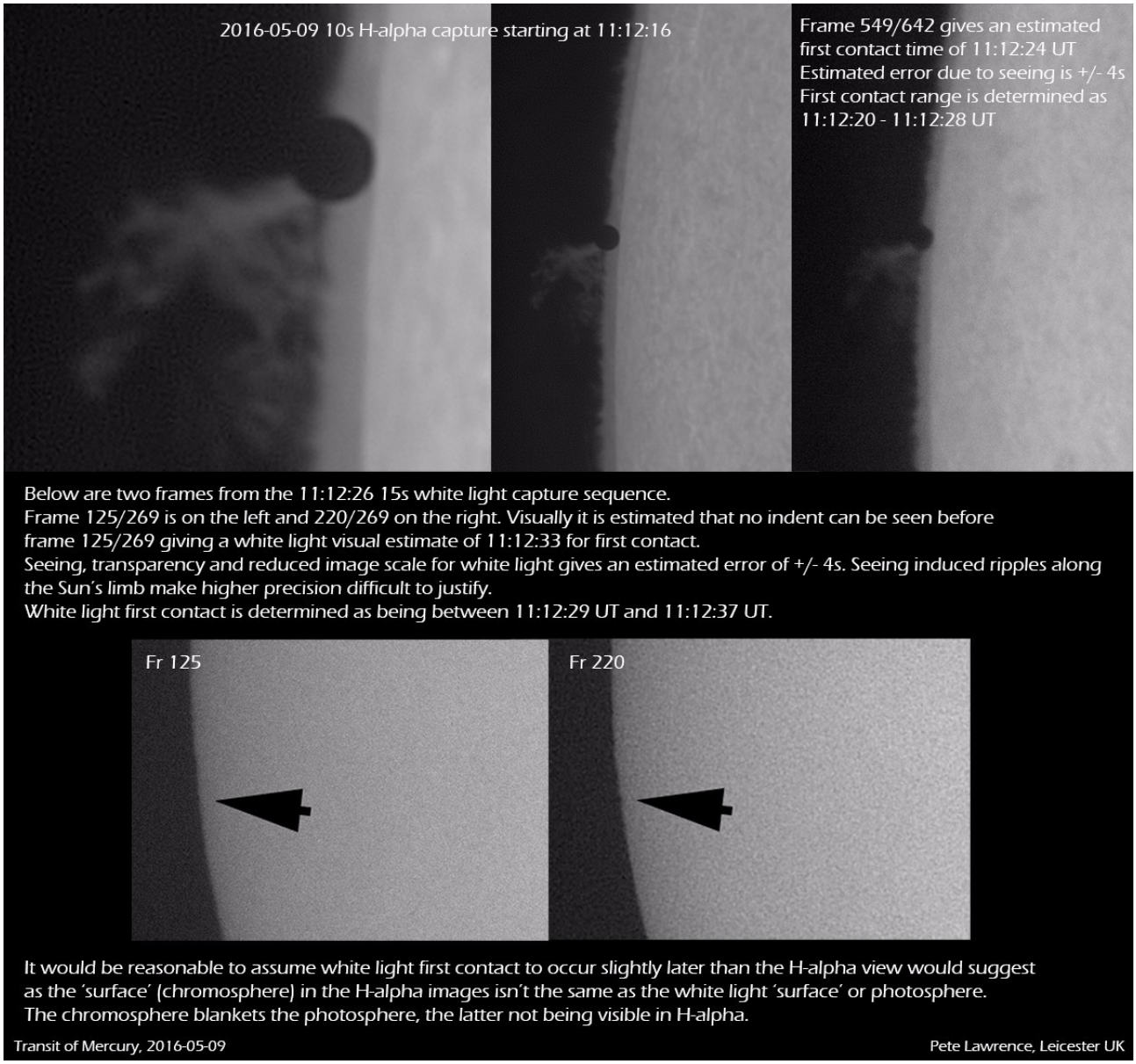


Figure 4: *Trying to determine a first contact time. In H-alpha Mercury crosses the spicule (transition) layer before reaching the chromosphere proper. The 'surface' observed in H-alpha is not the same as the surface observed in white light (photosphere). The chromosphere blankets the photosphere hiding it from view in H-alpha. Consequently, apparent first contact through a hydrogen alpha filter will be slightly earlier than first contact through a white light filter.*

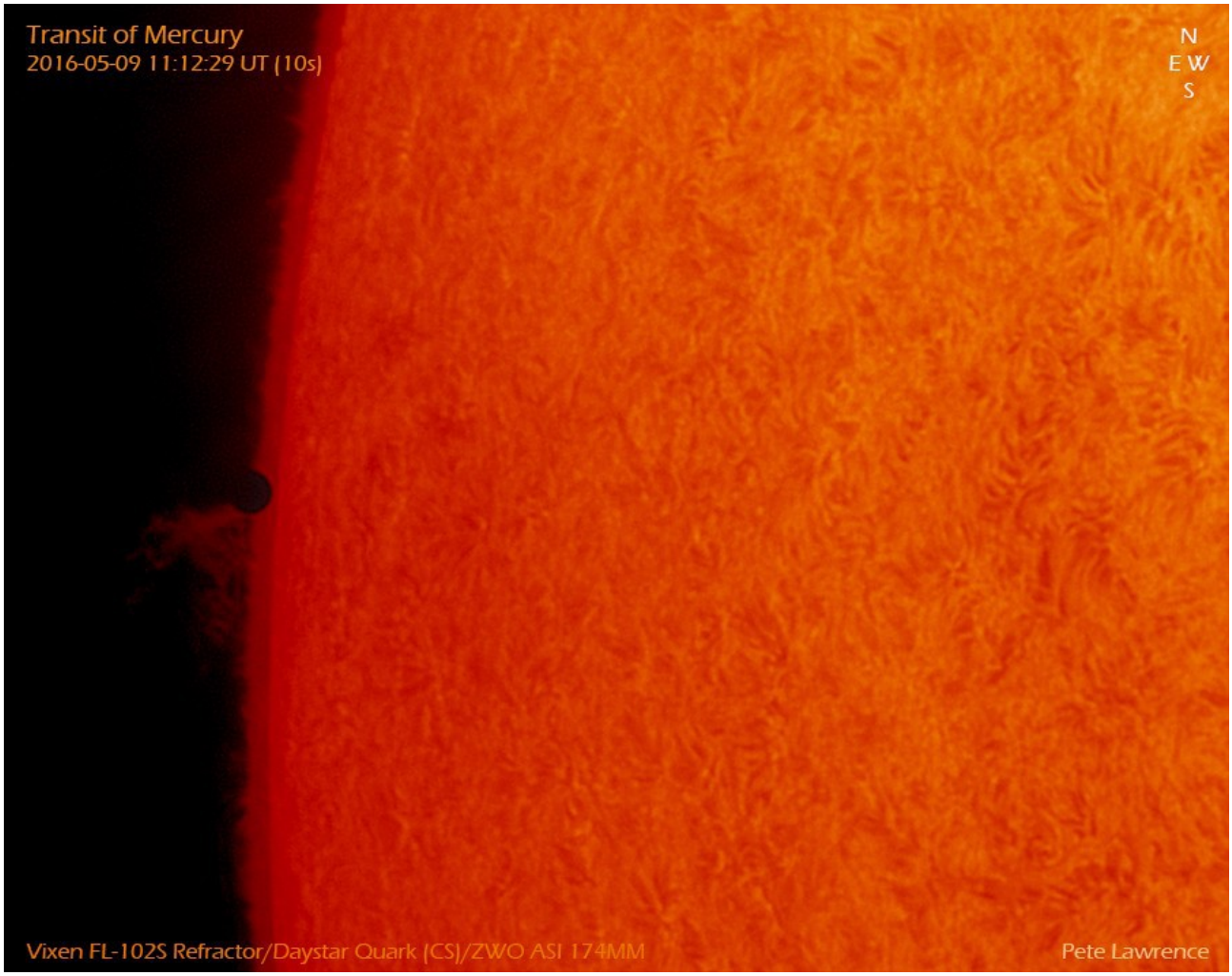


Figure 5. *H-alpha image of Mercury crossing the chromospheric layer at the limb of the Sun*

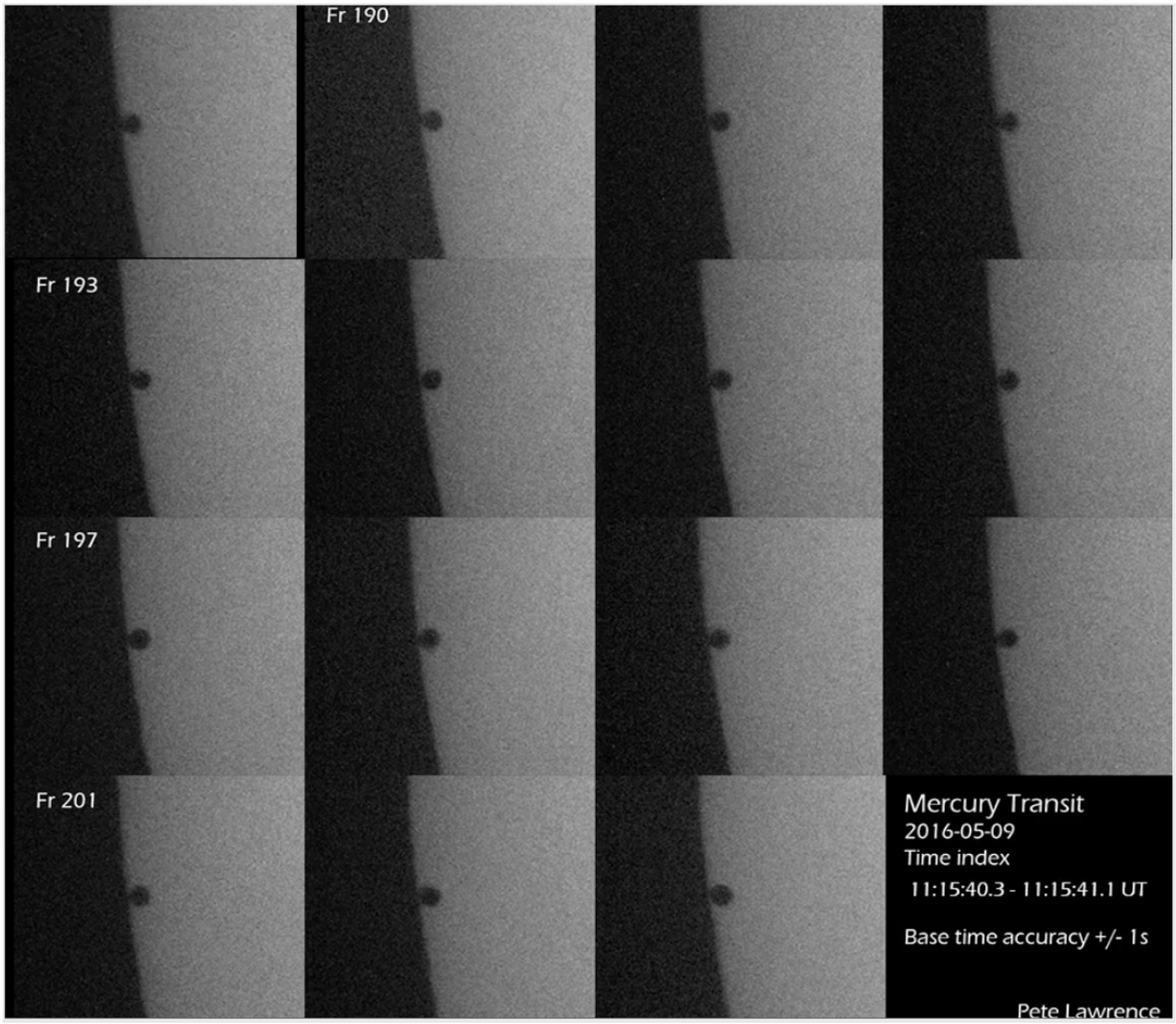


Figure 6. *Attempting to find second contact. This is a sequence of 14 white light frames from one of my capture files - a small sample of the total frame count in this file. The 14 frames which span a period 0.8s contain definite indications of the 'black drop' effect (see frame 200) caused by, in this case at least, high frequency atmospheric distortion.*

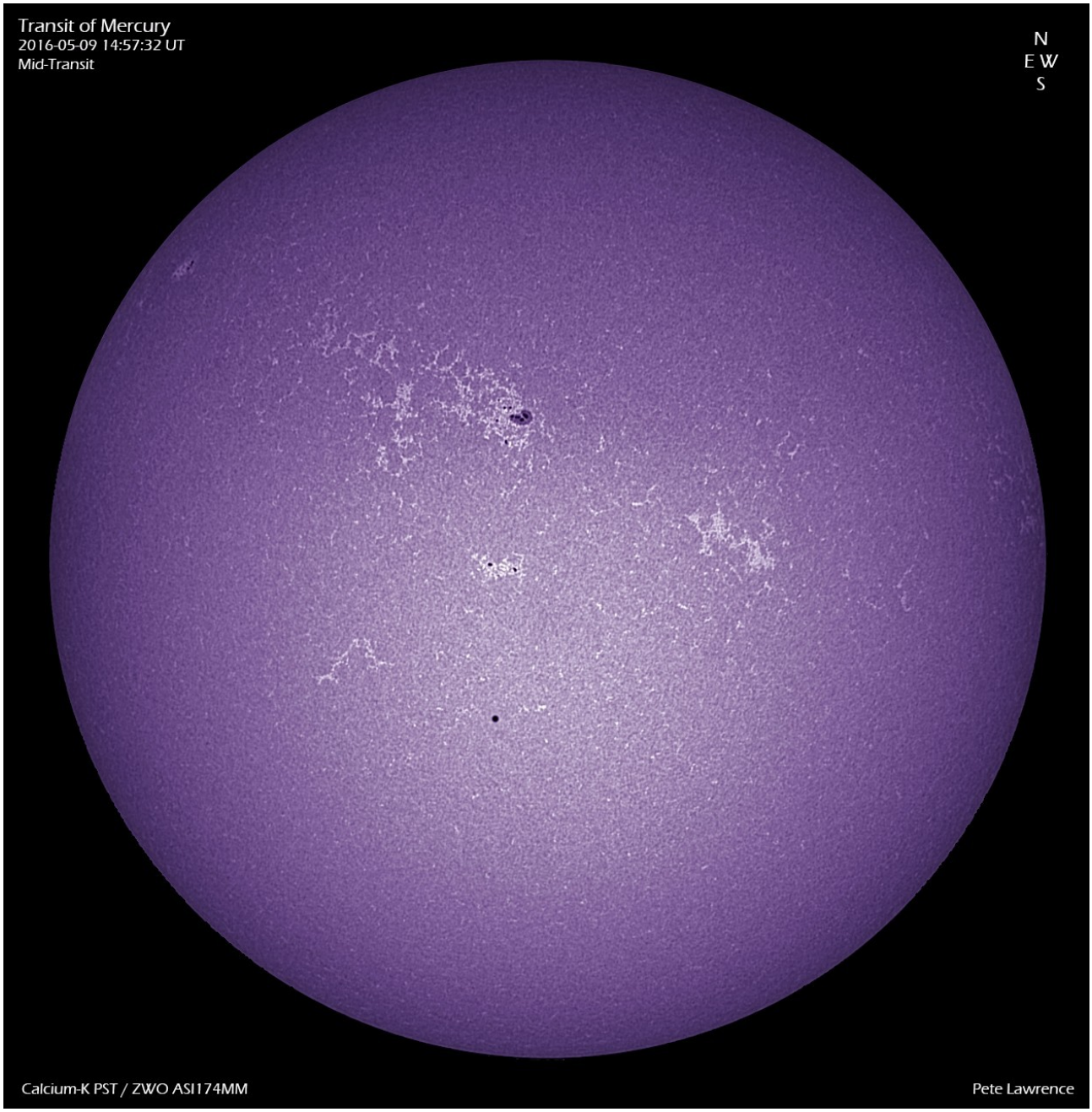


Figure 7. *An image taken through a 40mm Calcium-K PST during the time of greatest transit.*

Figure 8. *Cheers! Celebrating a successful transit.*

6 Some Preliminary Conclusions

Both authors secured many images and drawings during the transit, and the amount of material gathered means that our results here are only preliminary. In particular, Pete Lawrence took many images and videos during the event, and these will take some time to process, and will be presented at a later time. Thus far, we were able to conclude the following:

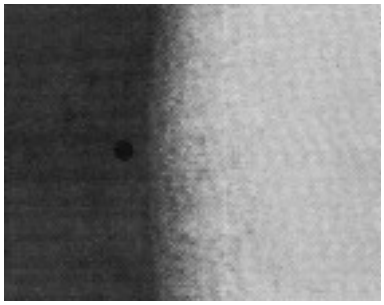


Figure 9. *Drawing made by Harold Hill on 1973 November 10 showing the silhouette of Mercury close to the Sun's limb. (Image from BAA Mercury and Venus website.)*

- On 1973 November 10, at 1318.5UT, Harold Hill observed Mercury off the solar disk, in H-alpha using a spectrohelioscope (figure 9). Abel attempted to repeat this observation using a 40mm H-alpha PST but was unable to see the planet until first contact.

- H-alpha 1st contact time (figure 4) is determined to have occurred at 11:12:24UT ±4s

- H-alpha 1st contact range (figure 4) is determined to be 11:12:20UT – 11:12:28UT±4s

- Abel using a 40mm PST estimated the time of first contact at 1112UT.

- White light 1st contact time (figure 4) is determined to have occurred at 11:12:33UT±4s. Note poor seeing introduced ripples along the solar limb which makes higher precision difficult to justify.

- White light 1st contact range is 11:12:29UT-11:12:37UT ±4s. First contact was slightly later in white light, when compared with H-alpha.

- Second contact in white light (figure 6) is estimated to have occurred within 11:15:40.3UT-11:15:41.1UT±1s.

- Visually Abel (using a 203mm Newtonian) determined second contact to be somewhere 1115UT-1116UT,however poor seeing made this somewhat difficult to judge and by 11:16:57UT it looked like second contact had occurred earlier as Mercury appeared fully on the disk.