The enigmatic Ashen Light of Venus: an overview

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The weak illumination of the dark side of Venus known as the Ashen Light represents one of the oldest unsolved mysteries in the observational history of the solar system, having first been reported in 1643 by the Jesuit professor of astronomy at Bologna, Giovanni Battista Riccioli.[1] Widely thought to be an observational artefact, the phenomenon is elusive and erratic in appearance, but the evidence as it is currently formed is too ambiguous, too circumstantial, and much too contradictory to furnish a satisfactory rationale.

Illusion or reality?

Riccioli's observation is of such an extraordinary character that it is perhaps more correct to credit William Derham, Canon of Windsor, with the first accurate description. His sighting is undated but seems to have been made prior to 1715.[2] In 1871 H. Vogel, using the large refractor at Bothkamp, saw the dark side of Venus partially lit by a secondary light on seven mornings in the period October 15 to November 12, but failed to detect it on five others.[3] A team project organised by D. Barbier (Marseilles Observatory) in 1935 yielded a similar result. Twenty-one observers participated, and in the period August 15 to October 1 examined Venus on each day but three; as many as eight reports being available for certain days. Three observers reported positive sightings of the entire disk, each on a different day, but each checked negative against reports from two to six other observers. Not surprisingly Barbier concluded, 'la lumière cendrée de Vènus est une légende.'[4]

The effect most often reported by the observers was a duskiness within the horns of the crescent. Visible in daylight or bright twilight, it gave the impression the dark side of Venus was darker than the surrounding sky. 'Might not a plausible explanation of it be given by referring it to the class of objects which are negatively visible?' queried François Arago.[5] Danjon attributed it to secondary spectrum. Others invoked a physiological origin. Heen ascribed it to projection on the solar corona or the zodiacal light. This however, involves obvious difficulties, not the least of which is light scatter in the Earth's atmosphere. So perhaps the simplest explanation is contrast? Careful study of earthshine may provide useful insights; for it has been the writer's experience that in bright twilight the region embraced by the horns of the thin crescent moon appears slightly darker than the adjoining sky.

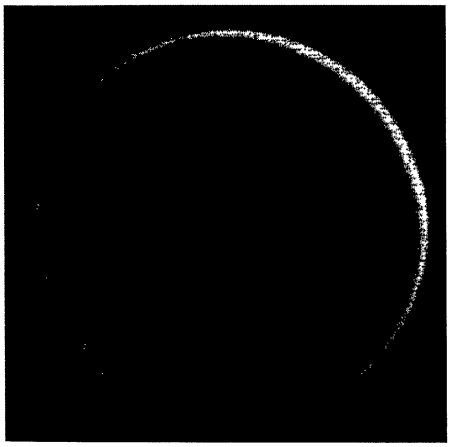

Figure 1. The Ashen Light of Venus, 1951 September 11, 05.45 UT. Excellent seeing and transparency. 7.62cm OG ×100. *R. M. Baum*

Interestingly, a series of observations during the favourable eastern elongation of 1952–1953 suggested to the writer that this so-called 'negative visibility' diminishes in intensity with the onset of twilight, disappearing entirely when the Sun is about 6° below the apparent horizon. As the sky continues to darken so a pale secondary light is seen to dissipate some of the gloom of the unlit hemisphere. This is the true *lumière cendrée*. It is always feeble and fugitive, and is best seen by averted vision when the illuminated crescent is out of the telescopic field. Of course the sequence is manifest in reverse at western elongation.[6] Independent confirmation of the observation was obtained by M. B. B. Heath and T. A. Cragg, then of the Mt Wilson and Palomar Observatories. Even so, this scarcely justifies confidence in the result since the observations themselves do not furnish materials of sufficient precision to enable us to decide in favour of any one hypothesis in preference to another.

But is 'illusion' a satisfactory response? In 1950 Walter H. Haas reported that C. B. Stephenson, graduate student in the Yerkes observatory and Recorder of the Mercury Section of ALPO (Association of Lunar and Planetary Observers), had informed him of an observation in which the interior of the crescent had actually been photographed as darker than the sky. The photograph was taken near inferior conjunction in June 1940, by the well-known investigator A. B. Meinel. He used a 15cm reflecting telescope, to the optical system of which a lens had been added to increase the focal length of the instrument.[7] It is a matter of some regret that so far as is known this observation was not published, and that in spite of efforts to trace it the photograph, like the originals of the famous UV series taken

by F. E. Ross in 1927,[8] which for the first time positively revealed detail of cloud structure in the upper atmosphere of the planet, is now presumed lost.

Haas cites the Meinel episode in his important 'La Visibilidad del Hemisferio Oscuro de Venus' (1950) where he also discloses that during the 1942 inferior conjunction he was, 'unable to distinguish the least difference in colour or brightness between the obscure face and the sky adjoining the planet.' Yet, he continues, 'it was a curious fact that I continued to receive reports from correspondents confirming the visibility of the dark face, including one from Mr. Robert Barker in England.' Haas then describes his own conversion from scepticism to belief. 'My first personal positive verification of the phenomenon,' he writes, 'was made on June 6th, 1948, at 2hr. 35min. UT. Sunset occurred at 2hr. 17 min. and the angle Sun–Venus–Earth was 143°.' His notes of that time are cited as generally representative: 'I have seen the ashen light, the curious illumination of the dark side, for the first time! It is not surprising, I would have seen it without seeking to do so; in all, I think that there is little chance of it being an illusion. It is very like the ashen light of the Moon, in particular the edge of the dark face is brighter than the central part (contrast effect?) and the circle of the illuminated crescent appears larger than that of the dark face (irradiation) ... I cannot see any colour (in the dark side) except possibly a grey-reddish hue.'[9]

Haas also notes that prior to inferior conjunction on 1950 January 31, 'the obscure face was repeatedly seen by members of the ALPO, so often in fact that it no longer seems possible to doubt the objective reality of this phenomenon. ... At least sixteen people saw the obscure face during December [1949] and January [1950], seemingly a much greater number than during any similar period previously.' Observations on December 15 'between 1hr 10min and 3hrs 25min., UT,' by D. L. Bellot, F. E. Brinckman, Jr., and T. R. Cave, Jr., at Long Beach, California, were of particular interest. With telescopes of from 15 to 20cm aperture they each independently affirmed, 'that the dark face glowed over an area in the form of a biconvex lens, with one surface along the terminator and the other some way within the dark limb. This lens, ... occupied about one third of the projected area of the whole disc, considered as circular.' Haas judges the observation 'of major importance and ... preferable as evidence to many individual and unconfirmed reports.'[10]

In the same period, on December 29 and 30, L. E. Armfield, Elyria, Ohio, found the dark side 'completely visible as if it were faintly luminous. Its aspect was identical with that presented by the ashen light of the moon seen through a small glass at low magnification when the moon is two days old, not so bright of course, but all the same clearly visible.'[11]

M. B. B. Heath, a leading British planetary observer who from 1951 to 1963 served as Director of the Saturn Section, also observed during this period and saw 'the ashen light ... on several occasions during the month of January as well as obscurity between the horns.'[12] Hestin in France had the same experience on January 23 and 26. He described the colour of the unlit side as bluish.[13]

Of course all this contrasts sharply with earlier assumptions. Alexander von Humboldt for instance knew of only three observations of the dark side. François Arago listed five, Johann Maedler but two, while A. Winnecke thought his daylight observations of 1871 were the first since 1759.[14] Early editions of Webb's *Celestial Objects* were no more informative. A. Schafarik of Prague, however, tells us he was aware of 'more observations ... than is ordinarily supposed,' and following a personal sighting in July 1868, undertook to collect all observations known to him. His paper lists twenty-two instances starting with Derham, and summarizes the various hypotheses advanced to explain the appearance. It was first printed in the notices of the Bohemian Academy of Sciences for July 18 1873,[15] abridged by Winnecke,[16] and published complete in the 1873 volume of proceedings of the British Association for the Advancement of Science which in that year convened in Bradford.[17] In 1883 C. V. Zenger drew attention to Riccioli's observation, thus predating Derham's sighting.[18] Members of the BAA were greatly agitated in 1895 judging from the numerous communications in the sixth volume of the *Journal*. Over the years observers continued to report sightings many of which were published in diverse places, some more accessible than others. The Barbier project followed in 1936,[19] and in 1950 Walter H. Haas published his invaluable summary.[20] Seven years later, the writer produced a descriptive list of forty-four of the more interesting sightings, commencing with Riccioli's admittedly curious observation of 1643 through to 1900.[21] Research has since uncovered the existence of many unreported observations.

In 1988 Professor C. T. Russell, University of California, and Dr John Phillips, Los Alamos National Laboratory, repeated Barbier's experiment, targeting Venus at it passed through inferior conjunction on June 13. The investigation involved 70 observers in six countries, and provided over 2000 separate observations. Telescopes varied in type and design, and ranged from 5.08 to 91.5cm in aperture. An initial step in analysis was to limit the observations to night and twilight, discounting those made during daylight. Another step was to consolidate each sequence of multiple observations by a single astronomer at a single sitting into a single report. The resulting data set contains 700 observations spanning 120 days, before and after inferior conjunction.[22]

Significantly, 190 positive sightings were registered. Of these the most credible were from BAA members Robert W. Middleton, Massimo Giuntoli, Gerald North and Alan Carey. North and Carey observed together at the Royal Greenwich Observatory, using 17.8, 76.2 and 91.5cm telescopes.[23] Their observation is well known.

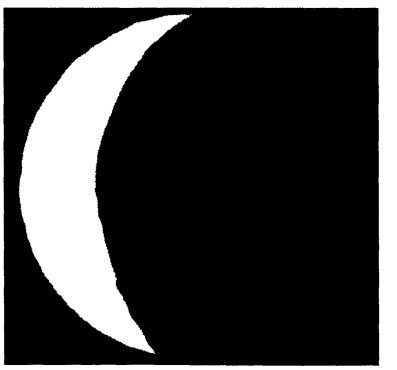

Figure 2. The Ashen Light observed and drawn by R. W. Middleton at Brightlingsea, 1988 May 12, 19.30 hrs UT. 12.7cm OG ×150, Wratten filter 44A (Blue). *R. W. Middleton*

Less so is what Mr Middleton

saw through his 12.7cm refractor on May 12 1988. Cloud thwarted active response to his telephone alert that evening. The next day he reported to the writer, 'I commenced observing Venus 1930 UT. 12/5/88. I use Wratten filters 25 (red), 58 (green), 15 (yellow) and 44a (blue). When I used the Blue I was astonished to see the dark side very faintly lit, I went through the filters again, it was not seen with the Yellow, Green or Red. I checked a couple more times then I rang yourself. I don't know if it was ashen light, I have seen nothing like it before. I estimated the phase as 0.22.'[24] There things might have remained, but for the fact that as Mr Middleton logged his observation, the German astronomer Bernd Flach–Wilken imaged Venus in ultraviolet. His photograph shows a faint gleam on the dark side, not unlike that seen visually by Middleton.[25]

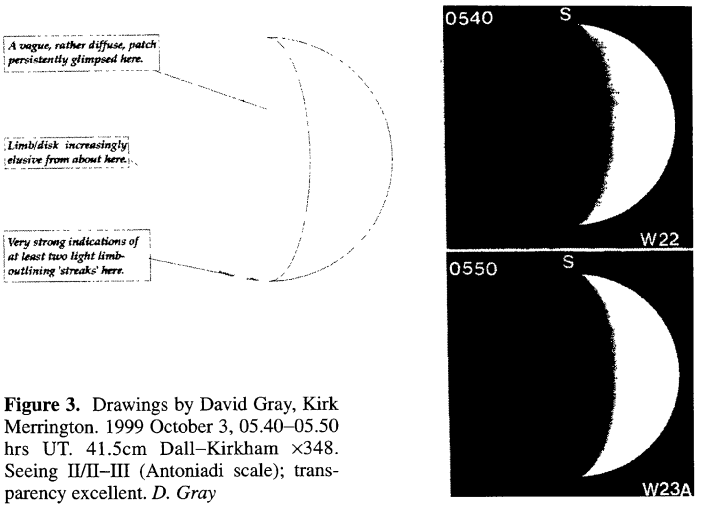

Figure 3. Drawings by David Gray, Kirk Merrington. 1999 October 3, 05.40–05.50 hrs UT. 41.5cm Dall–Kirkham ×348. Seeing II/II–III (Antoniadi scale); transparency excellent. *D. Gray*

Coincidence or confirmation? Whatever the answer, the observational data tells us here is something in need of close investigation. Something that has properties one expects of a phenomenon intrinsic to the planet; a fact Phillips and Russell recognised when they urged astronomers 'to continue efforts to solve this centuries-old riddle.'[26]

Against this background a review of recent observations of more than ordinary interest submitted to the Mercury and Venus Section is not without relevance.

Recent Section observations

In 1996 inferior conjunction occurred on June 10. Two weeks earlier, on May 2, using the 20cm Thorrowgood refractor at Cambridge, Jonathan Shanklin wrote, 'Strong impression of ashen light, but probably psychological. ... impression of faint continuous ring of light [twilight arc outlining the dark limb]. With the 30cm Northumberland refractor on May 30 he had an 'Impression of ashen light which disappeared when the bright limb was out of the field.' His sighting with the Thorrowgood, of June 4, phase 0.02, is more positive; 'Razor thin crescent. Cusps elongated to 200–240 deg. A[shen] L[ight] suspected even when bright crescent occulted.'

Popular texts often allege it is at this phase, when the crescent is no more than a thready wisp of light shimmering uncertainly in unsteady air, that the Ashen Light makes its appearance; this makes sense since the dark side is then almost entirely turned in our direction. Yet the truth is otherwise. From a study of 125 visual sightings made between 1954 and 1962, J. L. Levine found that only 15 observations or 12% of all the observations were made at this time; 31 observations or 25% of the total were actually made at a reference angle of 21 to 30° (here inferior conjunction corresponds to 0°, superior conjunction to 180°).[27]

Laurence H. Field, University of Canterbury, Christchurch, New Zealand, found the dark side brightly illuminated before sunrise on 1998 April 17, some three months after inferior conjunction. Dr Field was at an elevation of 1000ft at Port Hills, the remains of a volcanic caldera above a large natural harbour, south of Christchurch, some 5km from the edge of the city suburbs. Venus was about 25° high above the Southern Ocean and half full. 'The sky was still dark before sunrise,' he writes. 'I looked at Venus with the Questar [3.5in Maksutov, ×160, Konig EP plus Barlow], and noticed ... it clearly looked like the Moon with ... earthglow.' The appearance was quite distinct, and defined the disk of the planet. Seeing conditions were superb.

Another observation followed prior to inferior conjunction on 1999 August 20. Dr. Field observed at 1830 on July 6 from Christchurch, at an elevation of 200ft, with a 17.8cm Maksutov, 12mm Brandon EP (×212 and ×424 with Barlow). He says; 'Venus was above the neighbor's house, about 30 deg. altitude in the northwest evening sky. Weather had been clear all day (warm nor'wester, high pressure zone). I set up the Questar for a quick look at Venus, which was about 1/4 crescent phase. Although the seeing was poor, every so often I could see light extensions of the two cusps into a partially circular outline [twilight arc, which did not completely encircle the disk]. Along with this phenomenon, I could occasionally make out the very pale shadow side enclosed by the cusp extensions.' Kevin Barker from South Island, New Zealand, independently confirmed the observation with a Zeiss APQ 100/1000 fluorite refractor. Three weeks or so earlier, at 20.33hrs. on June 18, a similar appearance was evident to C. E. R. Brook, Plymouth, England.

Although Barker, Brook and Field each describe the phenomenon in terms of uniformity, *viz.* an undifferentiated illumination at once subtle and illusive, others speak of structure, of patchiness, irregular contrasts, even of a filmy granular look, such as was evident to the writer in 1953.[28]

David Graham suspected structure when he used a 15.2cm, f/13 refractor to inspect the planet on 1988 May 16. In a bright sky at 18.35 hrs UT, the dark side looked normal in integrated light. Fifteen minutes later with W15 (yellow) irregularity was suspected, and at 19.00 hrs in W25 (red) he noted 'something funny with unilluminated portion of disk,' but strong impression of 'very elusive mottling remains.' At 19.15 hrs, with W44A (blue), no trace of the

anomaly could be found. By 19.30 hrs, with W58 (green), it was again faintly visible, but less so than in the red.

Structure was visible at 21.15 hrs in W25 (red), W44A (blue), and W58 (green), but vanished once the bright crescent was occulted. No trace visible in integrated light, or W15 at 18.35 hrs. At 21.50 hrs, ×166 and ×222, and W25, Graham thought the whole of the unilluminated side brighter than the sky. A feeble trace showed in integrated light.

What confronted David Gray at Kirk Merrington on the morning of 1999 October 3 was even more striking. 'Whilst scrutinising the image with a W22 filter,' he says, 'and although highly suspicious of it most of the time, I started to believe that the dark hemisphere was lighter than the sky. Changing to integrated light seemed to indicate the area to be of a tawny-grey hue. Suspecting some effect from the apodiser, this was removed but the impression remained – possibly more so! Returning to W22 it was all made the more convincing in that it stood out more clearly during the better moments with some discrete structure(s) glimpsed. Also at these times it was apparent that not the whole of the disk was outlined. The main illumination being more toward the north and rather tapering off toward the mid-south terminator side. Here being an irregular lighter patch; but most definite of all were two, or more, light 'extensions' running from the north cusp, apparently along the limb. The effect was weaker and featureless tho' pear-shaped with the W23A and doubtful with W25. W15 showed it, very doubtfully, and the blue filters not at all – even W80A. Though the latter investigations were done in an ever brightening sky – even then, a last look with W22 still rather suggested something there!'

Could the W22 be flawed? 'As far as I know,' Gray writes, 'it performs as well as other filters in the collection. I have often used [it] on the moon to good effect; had I noticed any 'over-spill' of light into, for instance, craters with shadowed floors, this would soon have offended, as I enjoy good clean crisp views! I can say that I checked the Venus phenomenon by using the filter both in front of and behind the eyepiece; and also tipped and rotated the filter to be satisfied that there was no defect.'

He further notes: 'Secondary spiders have been blamed for causing the Ashen Light effect.' But the Dall–Kirkham has the secondary affixed to the optical window, so as Gray remarks, 'no vanes.' Of course the optical window itself might come under suspicion, and Gray admits there 'is a slight ghost from this, but displaced a few arc minutes from the source.' I think,' he continues, 'this is due to it being not exactly square on but have left it that way so as not to interfere with faint objects near bright planets!'

A riddle wrapped in an enigma

Like many others before, Larry Field drew a comparison with earthshine. Ostensibly the Ashen Light of Venus is analogous to earthshine. But Rheinauer in 1861 calculated that if earthlight were indeed the cause, the ashy light should equal a star of magnitude 14. 'That this explanation is insufficient,' remarked Schafarik, 'is so clear as to need no further proof.'[29] Nor can we invoke light reflected from a satellite; Venus is moonless. The *Künstliche Feuer* of Gruithuisen is sheer fantasy. J. Lamp proposed that the feeble gleam visible to him at Bothkamp on 1887 October 21 and 26, might result from electrical activity in the planet's atmosphere.[30] Certainly airglow and other processes connected with the planet's meteorology are possibilities, though attempts to correlate *Pioneer Venus Orbiter* data with the many corroborated sightings obtained during the 1988 global campaign, produced no evidence of interaction with solar emissions.[31] Vulcanism as a cause has also been suggested, while lightning in the clouds of Venus – which may explain electromagnetic signals picked up by all four *Venera* landers – was proposed by Meinel and Hoxie (1962),[32] and Russell (1991)[33] and others. Another possibility emerged in 1983 when David A. Allen and John W. Crawford imaged the planet in infrared and found cloud patterns on its night side. These clouds have a retrograde rotation period of 5.4 ± 0.1 days and are thought to be at a lower level than the UV features, and may be sufficiently lit by radiation scattered from the day side to occasionally become visible in integrated light.[34]

Of course, speculation of this nature presupposes a phenomenon of predictable characteristics. This is certainly not the case. So with what are we faced? A fabulous fiction, or hard reality? History dictates caution when dealing with phenomena at or near the limits of visibility. We need only remind ourselves of Mars and its canals, of Neptune and its phantom ring, of the lost moons of Mercury, Venus, Saturn and Uranus, and so on, to realise how skilled and experienced observers can be easily deluded. But even if the evidence is circumstantial, there is about it a quality that leaves us with intimations of something as yet to be recognized; the sense of a riddle wrapped up in an enigma.

More observations needed

It is acknowledged that the amateur community is the main source of observational information about the Ashen Light. Dedicated and enthusiastic, often with limited means, its members nevertheless produce results that are scientifically useful. However as amateurs they are constrained by domestic pressures, *viz.* the need to earn a living, and the responsibilities of family life, and often have to observe under less than ideal conditions. Hence their observations are perceived not as continuous records but as snapshots. That is not to say they lack substance, rather that the problem demands a different strategy. Collaboration between amateur and professional offers a more rewarding approach. It is not the purpose of this note to assign a distinct set of observational procedures, or to announce a specific campaign, but to put recent observations of note into historical context, and to alert observers of Venus to the opportunity afforded during its passage through inferior conjunction in 2001.

In the meantime observers should adopt a more consistent observational strategy. There is no doubt about the great

difficulty of detecting the phenomenon. In some respects its visibility in the telescope can be compared to how earthshine appears to the naked eye or with but slight optical aid; there is one significant difference however, we are conscious of the nature of earthshine. Still it is not easy to recognize earthshine in fading daylight or in a bright twilight sky. Indeed, as mentioned earlier, it is hard to decide whether the unlit parts of the Moon are brighter or darker than the sky under those conditions. Also, earthshine is difficult to detect when the Moon is more than three or four days old. This suggests any true brightening of the unilluminated hemisphere of Venus is likely to be detected by the visual telescopic observer only when the planet is a narrow crescent, and is viewed in a comparatively dark sky. The two requirements are somewhat exclusive. When Venus is observed in a dark sky it is bound to be near the horizon. Image quality therefore suffers from the vagaries of bad seeing, poor transparency and atmospheric dispersion. Obviously an occulting bar is essential to block out the illuminated part of the planet. Even so, the observer must remain vigilant of contrast-induced illusions close to the planet.

Experimentation with a range of techniques including the use of a CCD recorder of appropriate sensitivity and dynamic range, is also suggested. Further studies of the night side emission spectrum are also required. Professionals are not readily able to make this observation (scarce telescope time, and the difficulty of accessing the planet against a dark sky because of zenithal-angle limitations). A direct-vision spectrograph on a low power eyepiece, is perhaps the best tool. If the Ashen Light is an airglow phenomenon, there is a reasonable possibility that much of the radiation would be a single line. A continuum source would probably be smeared and diffused below the threshold of sensitivity.

What then are we to make of the phenomenon? How do we explain the considerable ambiguity of filter observations? In fact are filters a hindrance or an asset? Why is it visible to one observer, but not to another, yet simultaneously seen by independent observers many kilometres apart? It is reported then lost; reappears only to vanish again. It is a haunted, and haunting phenomenon; as elusive and illusive as *Gran Quivira*, the legendary place where Francisco Vazquez Coronado sought the Seven Cities of Cibola. Still his quest ended in a sort of truth, the dwellings of the Zuni Indians; so perhaps a vestige of truth invests the story of the Ashen Light.

Only a careful and persistent search by well equipped observers over a long period of time, will resolve the mystery.

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