The 2019–’20 eastern elongation of Venus, Part II: Observations of the nightside

Paul G. Abel

A report of the Mercury & Venus Section. Director: P. G. Abel

Presented here is an analysis and discussion of observations made of the nocturnal hemisphere during the 2019–’20 eastern elongation of Venus. These observations of the infrared thermal emission are crucial to the Section’s aim of investigating active volcanism on the planet. We also discuss research by professional astronomers at the Swiss Federal Institute of Technology, supporting the idea of active volcanism, and how the results obtained by Section members thus far support this conjecture.

Introduction

This is the second part of a paper presenting the analysis and conclusions of amateur observations of the planet Venus during the 2019–’20 eastern elongation. In Part I we examined observations made of the sunlit hemisphere during this time.[1] In this instalment, we examine observations made of the nocturnal hemisphere (nightside) of Venus.

To observers confined to visual and ultraviolet wavelengths, the planet is covered by a never-ending ocean of clouds. These clouds, although both striking and dynamic at short wavelengths, do nevertheless permanently obscure our view of the Cytherean surface. Prior to the 21st century, much of our information about the surface had to be established by spacecraft such as the NASA *Magellan* probe, which used radar to penetrate the clouds and provide a detailed map of the topography beneath.

In more recent times, advances in amateur astronomy have allowed observers to finally investigate the surface of Venus for themselves. This is done by capturing the infrared thermal emission (IRTE) of the nightside. The average surface temperature is about 737K (464°C),[2] which means that the surface of the planet emits infrared (IR) radiation. The lower regions are hotter than the mountain peaks and therefore the lowlands appear brighter in IR images, while more elevated regions appear darker.

In longer wavelengths of the range $\lambda \sim$ 780–2,500nm, the atmosphere of Venus is somewhat transparent, allowing hot glowing surface features to be imaged. An increasing number of amateurs have been involved in this work, and their results can be found in the report covering the elongations during 2007–’17.[3]

It has become increasingly clear over the last few years that Venus is likely to be a volcanically active world. Evidence to support this conclusion has been slowly gathering, but the results presented by Anna Gülcher *et al.* in *Nature Geoscience*, published in 2020 July, are particularly noteworthy.[4] In this work, the authors used simulations to produce high-resolution images showing how volcanoes could form on the surface. Furthermore, these images predicted what active volcanic features would look like. By comparing the simulated imagery with *Magellan* data, the researchers found at least 37 sites which were likely to be volcanically active.

Recently, the Section has been involved in collecting and analysing amateur observations, with the aim of capturing active

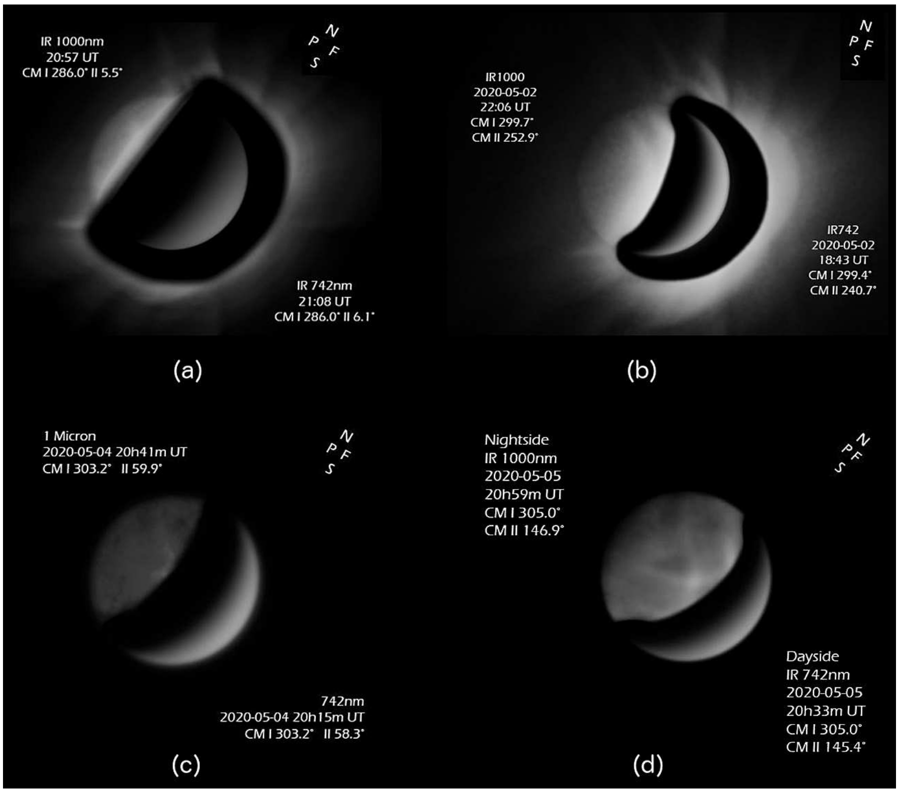

Figure 1. A sequence of IR images taken by Pete Lawrence using a 356mm SCT. The nightside was captured using an ASI 224MC at 1,000nm, while the illuminated crescent was captured using an ASI 174MM at 742nm. The two images were then combined to give a single image, showing the nightside and a crescent which is not over-exposed. Images (c) and (d) were processed with artefact reduction and masked to remove stray light patterns. Dates for each image are as follows: **(a)** 2020 Apr 25, **(b)** 2020 May 2, **(c)** 2020 May 4 and **(d)** 2020 May 5.

Figure 2. A sequence of contrast-enhanced IR images taken by Martin Lewis using a 444mm Newtonian and an Edmund Optics 1,000nm filter. Surface features are illustrated by means of an arrow.

volcanism on the surface. These observations are made by imaging Venus, typically using IR filters with a passband of around 740nm to 1μm (one micron). This work has already produced a number of tantalising results: the bright features recorded by Wesley and Miles which were discussed by McKim (2019),[3] and the extraordinary wave-like feature observed by Kardasis and others,[5] can all be argued as supporting evidence for recent volcanic activity.

This has become one of the primary aims of the Section, and the Director strongly feels that it will be a fruitful line of scientific investigation. Amateur astronomers now have the technology to monitor the surface of Venus for long periods of time and provide greater coverage than a single space mission. If the volcanoes of Venus are indeed active, it is reasonable to suppose that it will be amateurs who provide conclusive proof and long-term monitoring. Members who are interested in pursuing this line of work can consult the Section newsletter *Messenger*, in which Martin Lewis has written an excellent introduction on how to observe Venus in the IR.[6]

The observations

Observations of the IRTE from the nightside of Venus can be made when the phase of the planet is below 30%. The smaller the phase, the more of the nightside is visible. One of the primary problems with this kind of work is in getting the exposure times correct and dealing with the brilliant crescent.

During the 2019–'20 eastern elongation, IRTE images were received from David Arditti, Frank J. Melillo, Pete Lawrence and Martin Lewis. Details of these observers can be found in Table 1, given in Part I of this paper.[1]

Lawrence obtained a series of nightside images at the end of April and early May, which are given in Figure 1. By uploading the images into *WinJUPOS*, the longitude in CM1 (that of the surface) can be determined and some of the features visible in the images can be identified when compared to a map of the planet.[7] In Figures 1c & d, the central bright spot is *Undine Planitia*, while the two bright features heading diagonally away from *Undine* towards the preceding limb are *Beta Regio* and *Phoebe Regio*. The darker region between them is *Hinemoa Planitia*. By imaging the planet at 1μm and 742nm, the nightside and the crescent have been captured and combined into a single image.

Martin Lewis successfully obtained the BAA Harold Ridley Grant in 2020 April to purchase a 1,000nm filter, which is particularly well suited to this work. As can be seen in Figure 2, Lewis obtained a number of images showing surface features. Lewis used *WinJUPOS* to construct a map; this can be compared to the *Magellan* radar height map to enable features to be identified, as shown in Figure 3. Not surprisingly, Lewis seems to have recorded the same features as Lawrence. Both of these sets of images can be used for future reference, if subsequent imagery indicates changes to these features in later elongations. The region was also imaged by Gasparri and his map, given by McKim (2019),[3] can be compared to Figure 3 (although the resolution of Lewis' image is higher, making direct comparisons somewhat difficult).

The observer Frank J. Melillo, based in New York, also managed to obtain IR images using a 1,000nm filter – even though the seeing conditions were poor, the nightside can still be clearly seen in three of his images, presented in Figure 4.

Observations of the Ashen Light

The Ashen Light is the name given to that elusive glow whereby the nightside of the planet appears to become visible to observers at visual wavelengths. At the time of writing, there is no definitive proof that the phenomenon exists, although it should also be noted that a number of distinguished observers have reported seeing the Ashen Light over the last 100 years.

The Ashen Light can only be observed when Venus is viewed in a dark sky. Some observers have reported seeing the dark side of Venus when they have observed the planet in twilight – this is an illusion; for the Ashen Light to be visible then, it would have to be brighter than the background sky. During the 2019–'20 eastern elongation, the Director received no reports of sightings in a dark sky, and it seems the phenomenon was absent during this period.

Conclusions

Imaging the nightside of Venus is a challenging task which requires filters in the 740–1,000nm range and a phase below 30%. At this time in the orbit, the planet has moved closer to the Sun in the sky and so there is a balance to be struck when attempting to make such observations: the sky needs to be fairly dark, but the planet must not be too close to the horizon.

Although these circumstances make capturing the IRTE of Venus difficult, thankfully this has not stopped some of the Section's advanced amateurs from making such observations. The Director hopes that we can continue to build on this work and increase the number of observers in the Section capable of imaging the nightside of the planet.

Although a number of interesting surface features were recorded in the elongation, it seems there were no bright spots observed of a similar nature to those recorded by Wesley and Miles.[3] The fact that no apparent activity was recorded should not be seen as a failure however; a negative report is just as valuable as a positive one. If observers of future elongations do record activity, we shall have these observations as a useful reference, allowing us to determine the frequency of activity within the resolving powers of amateur telescopes.

It should also be pointed out that it is not possible to compare the regions imaged by Wesley and Miles in 2017, as their observations were made during a western elongation. Those regions, however, were visible during June and July of 2020, so if any IRTE observations were made in this period, they will be of interest.

The 2019–'20 eastern elongation of Venus was a splendid one; a good number of Section members contributed regular observations and most were of an excellent quality. As yet, we have not seen the 'smoking gun' in amateur observations, but the Director remains convinced that if active volcanism continues to shape the surface of the planet, then its detection will likely be made by amateur astronomers engaged in the kind of pioneering work undertaken by our members capturing the nightside IRTE.

Address: School of Physics & Astronomy, University of Leicester, University Road, Leicester LE1 7RH *[paul.abel@yahoo.co.uk]*

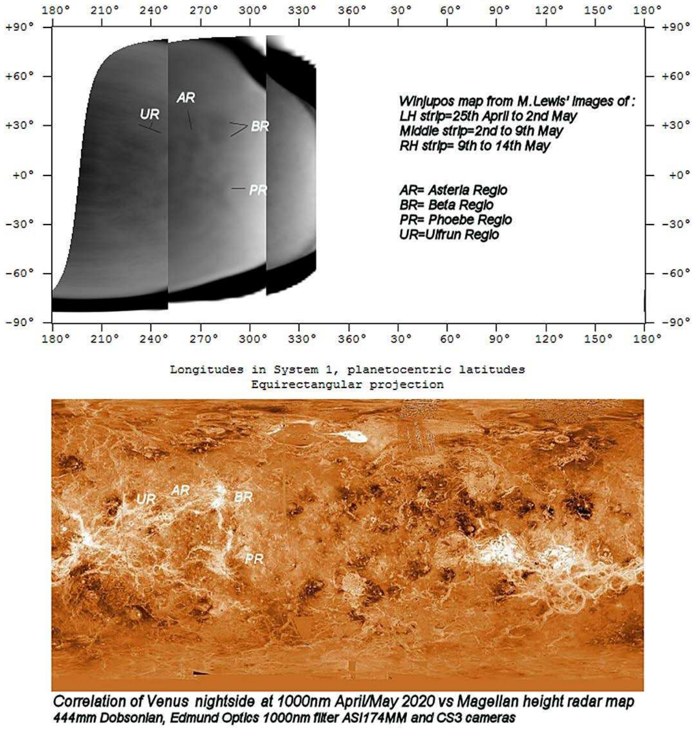

Figure 3. A map of the nightside of Venus by Martin Lewis, using IR images he obtained during 2020 April and May. A number of surface features are identified and correlated with a *Magellan* height radar map.

References

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7 Map of Venus: **www.runspect.com/examples/I-2476_Aphrodite_Terra.htm**

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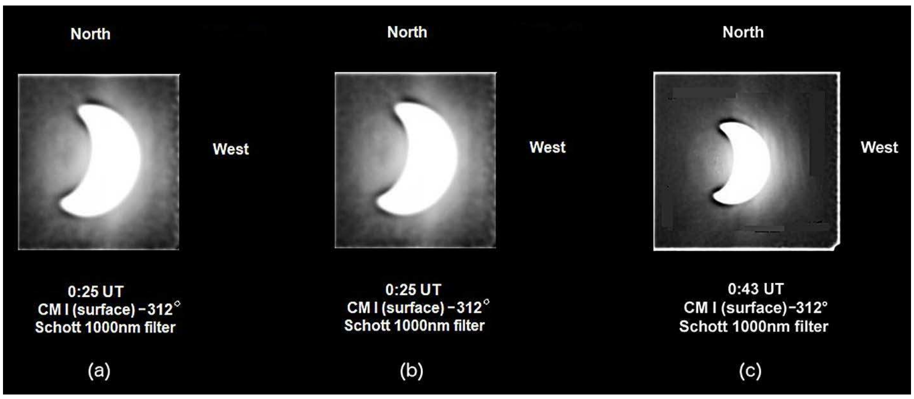

Figure 4. The nightside captured by Frank J. Melillo, using a 250mm SCT and a Schott 1,000nm filter. The dates for the images are as follows: **(a)** 2020 May 10, **(b)** 2020 May 12 and **(c)** 2020 May 13.