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Amateur studies of Venus in the near IR and UV

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Abstract

Cameras and filters now available to amateurs allow them to usefully study Venus with telescopes in the range 0.2m-0.5m in the near-UV and near-IR. At low phase angles, studies in UV between 300 and 400nm allow the rotation of the upper atmosphere to be measured, from measurement of the permanent dark cloud markings, and allow other changes to be monitored, for example the changing brightness of the polar hoods. At high phase angles, imaging in the IR at around 1000nm allows the thermal emission from the surface and lower clouds of the night side of the planet to be recorded. New results obtained by Wesley and Miles are tentatively reported, which appear to show an unexplained hot-spot in the thermal emission in a lowland area of *Eistla Regio* in 2017 April-May.

1.Introduction

Venus is a problematic planet to study from the Earth primarily because its general proximity to the Sun in the sky means it must be studied either in full daylight, or when it is quite low, both conditions leading to typically turbulent seeing and poor resolution. In addition, as the angular diameter grows, the phase shrinks, mitigating against detailed global coverage of the cloud patterns.

However, recently, the increased sensitivity in the ultraviolet and infrared bands of fast frame rate CCD and CMOS cameras inexpensively available to amateurs has made practical shorter exposures, and improved the quality of images in these non-visible bands obtained using standard lucky imaging techniques of quality selection from large image statistics, stacking and sharpening.

2.The cloud-tops in UV

In the visible and UV the cloud tops of Venus are seen, but the contrast is highest in the UV. Successively longer wavelengths probe lower levels of the cloud-deck. Most of the best amateur images of the cloud patterns are taken using filters with peak transmission at 300-400nm, such as the Astrodon UVenus filter. Care is needed to use a filter, or combination of filters, that completely blocks the IR signal, or this easily overwhelms the UV.

The planet-scale albedo features observed in UV are of the nature of permanent waves, and often called the Y-horizontal, C-reversed, and ψ-horizontal features [1]. Under particularly good conditions, finer transient features comprising banding and mottling can be observed. There are also bright polar caps of variable size or intensity seen in UV.

Images of the clouds can be combined into cylindrical projection maps, though it is typically difficult to assemble enough of these covering the whole planet in a short enough period to be valuable. A rotation period known as System 2 has been defined for the cloud tops of one revolution in 4.2 days. This 4.2 day period is built in to the *WinJUPOS* software commonly used by amateurs to reduce planetary observations. However, recent work by McKim [2] has shown this is not appropriate, and that the average rotation period of the cloud-tops, as measured from the main violet-UV albedo features over an 8-year period, is actually 4.0 days.

3.The atmosphere in IR

Features may also be imaged in the IR between 725 and 950nm, but these are finer and lower in contrast than he UV features, hence more rarely imaged by amateurs. They correspond to the cloud morphology at the base of the upper cloud, altitude 60km [1].

4.The night-time surface in IR

There are three fairly transparent windows in the atmosphere between 1000 and 1020nm, and amateur imagers (as well as the Venus Monitoring Camera of *Venus Express*) have been able to use this band to record thermal emission from the night side, though amateurs' detectors are typically only about 10% efficient in this band. The images can only be obtained when Venus presents a narrow illuminated crescent, otherwise leakage from the sunlit side dominates the signal. The signal normally correlates with the *Magellan* radar altimetry, higher areas of the surface cooling faster at night and so appearing

darker in the IR images, though it can also be modulated by low-level clouds [3]. Amateurs have normally used a filter that transmits all radiation beyond 1000nm.

In 2017 April-May Anthony Wesley and Phil Miles made a series of observations with a 508mm Newtonian using a new method, utilising the 1000nm+ filter in combination with one covering 850-1020nm, to isolate the 1000-1020nm band and reduce scatter from the bright crescent. As well as the normal topographic features, a distinct bright spot was observed in a lowland area south of *Eistla Regio*. This spot was observed on 4 successive days, and was seen to rotate with the topographic features. While it is speculative to apply any particular interpretation to this spot, it appears real but temporary, and it has not been seen in previous comparable amateur images. Possibilities are that it is a cloud thinning, a hot spot on the surface caused by ongoing vulcanism, or a volcanic plume.

5.Conclusions

1) Mapping of the upper clouds of Venus in UV light needs to take into account the new measurement of the cloud-top rotation rate of 4.0 days.

2) Further monitoring of the planet at crescent phase beyond 1000nm is needed to determine if temporary hot spots occur that might be related to vulcanism.

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References

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Figure 1 (below): A comparison of the bright feature imaged by Wesley & Miles on 2017 May 1 with *Magellan* altimetry