Observing Venus with the ALPO

By: Julius L. Benton, Jr.
Coordinator
ALPO Venus Section

E-Mail: jlbaina@msn.com
Website: http://www.alpo-astronomy.org/
Venus eGroup: http://tech.groups.yahoo.com/group/Venus-ALPO/

Value of Amateur Planetary Observations

- Complete freedom to observe whenever desired for extended periods of time.
- Standardized systematic observations provide long-term continuous records for further study by professional astronomers.
- Earth-based monitoring by amateurs of changing atmospheric features on Venus often help professionals select targets for high-resolution spacecraft imaging.
- Skilled observers routinely produce excellent digital images at various wavelengths that are useful to professional astronomers.
- The ALPO serves *to encourage and coordinate regular, systematic investigations of the Sun, principal planets, and other members of our solar system with instrumentation readily available to amateur astronomers*.

Suggested Instrumentation for Observing Venus

- Telescopes with good, well-aligned optics with minimum apertures such as:
  - 7.5cm (3.0in) or greater for refractors.
  - 10.2 cm (4.0 in) for Newtonians and Catadioptrics
- Sturdy equatorial mount with slow-motion controls and a clock-drive.
- Color filters of known wavelength transmission are useful, for example:
  - *Low-transmission filters improve contrast while limiting effects of irradiation.*
  - *Blue (W38A) & violet (W47) filters enhance views of low-contrast detail of yellowish atmospheric clouds of Venus.*
  - *Variable-density polarizers improve visibility of faint markings by reducing glare when Venus is seen against a dark sky.*
- For achromatic refractors, utilize a “fringe” filter to suppress the secondary spectrum.
- *Astronomical Almanac* or similar printed or electronic ephemeris.
- Digital imaging equipment (IR blocking filters are suggested).
- Laptop (PC or Mac) with software for capturing and processing of images.

Keys to Meaningful Results

- Start observing each apparition when Venus first becomes visible before sunrise or just after sunset & keep watching through greatest elongation until inferior or superior conjunction.

- Use ALPO observing forms for recording data and submit images & drawings regularly.

- The high albedo of Venus causes excessive glare against a dark background sky, so low-contrast atmospheric features are often very hard to detect visually.
  - *Employ color filters & variable-density polarizers to enhance contrast & reduce irradiation.*

- Because atmospheric features on Venus are so elusive, *simultaneous observations* are very important to confirm results, especially for visual work.

- If possible, try to observe Venus during twilight or daylight hours because:
  - *Most of the prevailing glare associated with the planet is minimized.*
  - *When Venus is higher in the sky atmospheric effects causing poor seeing can be reduced.*
  - *Contrast conditions usually improve when Venus is seen against a light background sky.*

ALPO Venus Observing Programs

- Visual numerical relative intensity estimates of atmospheric features.
- Disk drawings of atmospheric phenomena seen or suspected on Venus.
- Routine digital imaging of Venus at visual, ultraviolet (UV), and infrared (IR) wavelengths.
- Observation of cusps, cusp-caps, cusp-bands, and cusp extensions.
- Monitoring the extent and visibility of the Bright Limb Band.
- Systematic patrol of the dark hemisphere of Venus for the elusive Ashen Light.
- Observation of terminator geometry (monitoring for any irregularities).
- Documenting Schröter's Effect (i.e., difference between predicted vs. observed date of dichotomy).
- Routine *simultaneous observations* using visual and digital imaging methods.
- Active participation in on-going *Professional-Amateur (Pro-Am)* work:
  - ESA's *Venus Express (VEX) Mission* (which ran from 2006-2015)
  - Japan's (JAXA) *Akatsuki Mission* (began April 2016).

Standard ALPO Venus Observing Form

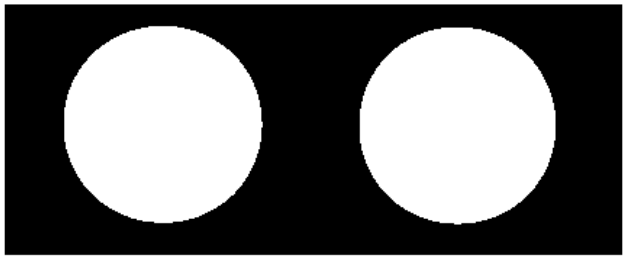
Although regular imaging of Venus is extremely worthwhile, observers should not neglect to make careful drawings of Venus and visual numerical relative intensity estimates of any suspected atmospheric features.

Association of Lunar and Planetary Observers (A.L.P.O.): Venus Section

A.L.P.O. Visual Observation of Venus

Drawing Blank — S

Intensity Estimates Blank — S



N (*all coordinates are IAU*) N

Observer_____ Location_____

UT Date _____ UT Start _____ UT End _____ D = _____" k_{m} = _____ k_{0} = _____

m_v = _____ Instrument _____ Magnification(s) _____ x_{min} _____ x_{max}

Filter(s) IL/none) _____ f_1 _____ f_2 _____ f_3 _____ Seeing _____ Transparency _____

Sky Illumination (*check one*): [ ] Daylight [ ] Twilight [ ] Moonlight [ ] Dark Sky

Dark Hemisphere (*check one*): [ ] No dark hemisphere illumination [ ] Dark hemisphere illumination suspected [ ] Dark hemisphere illumination [ ] Dark hemisphere darker than sky

Bright Limb Band (*check one*): [ ] Limb Band not visible [ ] Limb Band visible (complete cusp to cusp) [ ] Limb Band visible (incomplete cusp to cusp)

Terminator (*check one*): [ ] Terminator geometrically regular (no deformations visible) [ ] Terminator geometrically irregular (deformations visible)

Terminator Shading (*check one*): [ ] Terminator shading not visible [ ] Terminator shading visible

Atmospheric Features (*check, as applicable*): [ ] No markings seen or suspected [ ] Radial dusky markings visible [ ] Amorphous dusky markings visible [ ] Banded dusky markings visible [ ] Irregular dusky markings visible [ ] Bright spots or regions visible (exclusive of cusp regions)

Cusp-Caps and Cusp-Bands (*check, as applicable*): [ ] Neither N or S Cusp-Cap visible [ ] N and S Cusp-Caps both visible [ ] N Cusp-Cap alone visible [ ] S Cusp-Cap alone visible [ ] N and S Cusp-Caps equally bright [ ] N and S Cusp-Caps equal size [ ] N Cusp-Cap brighter [ ] N Cusp-Cap larger [ ] S Cusp-Cap brighter [ ] S Cusp-Cap larger [ ] Neither N or S Cusp-Band visible [ ] N and S Cusp-Bands both visible [ ] N Cusp-Band alone visible [ ] S Cusp-Band alone visible

Cusp Extensions (*check, as applicable*): [ ] No Cusp extensions visible [ ] N Cusp extended (angle = _____°) [ ] S Cusp extended (angle = _____°)

Conspicuousness of Atmospheric Features (*check one*): [ ] 0.0 (nothing seen or suspected) [ ] 3.0 (indefinite, vague detail) [ ] 5.0 (suspected detail, but indefinite) [ ] 7.0 (detail strongly suspected) [ ] 10.0 (detail definitely visible)

IMPORTANT: Depict morphology of atmospheric detail, as well as the intensity of features, on the appropriate blanks at the tops of this form. Attach to this form all supporting descriptive information, and please do not write on the back of this sheet. The intensity scale is the *Standard A.L.P.O. Intensity Scale*, where 0.0 = completely black => 10.0 = very brightest features, and intermediate values are assigned along the scale to account for observed intensity of features.

The Elusive Atmospheric Features of Venus

- Analysis of visual observations over many years suggests rough categories for atmospheric features on Venus (also seen on images at different wavelengths, especially UV):
  - *Banded Dusky Markings*: Parallel dusky streaks across the illuminated disk of the planet, perpendicular to the line of the cusps.
  - *Radial Dusky Markings*: Curious "spoke" pattern or horizontal V, Y, or ψ (psi) shaped dusky clouds (especially noticeable on UV images).
  - *Irregular Dusky Markings*: Elongated or roughly linear dusky streaks having no specific orientation.
  - *Amorphous Dusky Markings*: Shaded features that exhibit no form, definitive shape, or pattern.
  - *Bright Spots or Regions*: Exclusive of cusp regions, areas that appear much brighter than the surrounding illuminated disk.
- The contrast of dusky markings on Venus is typically wavelength dependent:
  - *Contrast drops off rapidly at 380nm (near lower limit of the average human eye).*
  - *Observers have varying wavelength & contrast sensitivity thresholds.*
  - *Contrast conditions are often improved when observing Venus against a light background sky.*

Geocentric Phenomena in Universal Time (UT)

Current 2016-17 Eastern (Evening) Apparition

Superior Conjunction	2016	Jun 06 (angular diameter = 9.7″)
Greatest Elongation East	2017	Jan 12 (Venus will be 47º East of the Sun)
Predicted Dichotomy (k = 0.500)		Jan 14.56^d (theoretical half phase)
Greatest Brilliancy		Feb 18 (–4.8m_v)
Inferior Conjunction		Mar 25 (angular diameter = 59.8″)

- Venus is an inferior planet exhibiting phases like the Moon, attaining a maximum elongation from the Sun of ~47° during any given apparition.

- For the current 2016-17 Eastern (Evening) Apparition the following circumstances exist:
  - *Venus is visible in the Western sky after Sunset (East of the Sun).*
  - *Progression is from Superior Conjunction → Greatest Elongation East → Inferior Conjunction.*
  - *Angular diameter increases continuously from 9.7" to 59.8".*
  - *Brilliancy of Venus (visual magnitude) slowly increases (becomes – 4.8m_v).*
  - *Observers are witnessing waning phases (100% illuminated → Dichotomy → 0% illuminated).*
  - *Venus loses altitude on any given night following sunset against a darkening sky.*

On-Going Professional-Amateur (Pro-Am) Colloboration

- **ESA's *Venus Express (VEX)* mission (2006-2015)**
  - Began remote sensing of Venus at UV, visible (IL) and IR wavelengths in May 2006.
  - ALPO Observers regularly submitted digital images taken at UV & IR wavelengths from 2006 until the end of the mission in late 2015.
  - Although the actual mission has concluded, data analysis in continuing, so *observers may still submit images to the ALPO Venus Section as well as to the VEX website for further study at*:

    http://sci.esa.int/science-/www/object/index.cfm?fobjectid=38833&fbodylongid=1856

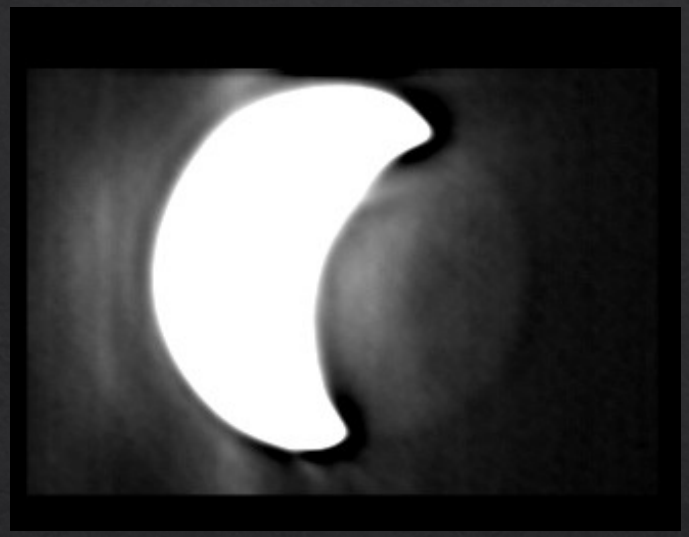
- **Japan's JAXA Mission to Venus: *Akatsuki Venus Climate Orbiter* (began April 2016)**
  - Observers need to start registering immediately their instrumental capabilities by contacting:

    coordinatewithakatsuki@gmail.com
  - The *Alatsuki* team will advise observers how to cover relevant gaps in the mission's dataset.
  - Images taken with filters not included in the spacecraft payload are of great value to the mission (specific details will be conveyed to observers who register).
  - The ALPO Venus Section will help coordinate exchange of data to the *Alatsuki* team.

A Quick Tour of Some Notable ALPO Venus Observations from 2004 to 2016

Dark Hemisphere of Venus Imaged in the near-IR in 2004

2004 May 12 20:04-20:43UT
35.6 cm (14.0 in) SCT
ATK-1HS Camera @ 1000nm IR
C. Pellier (France)

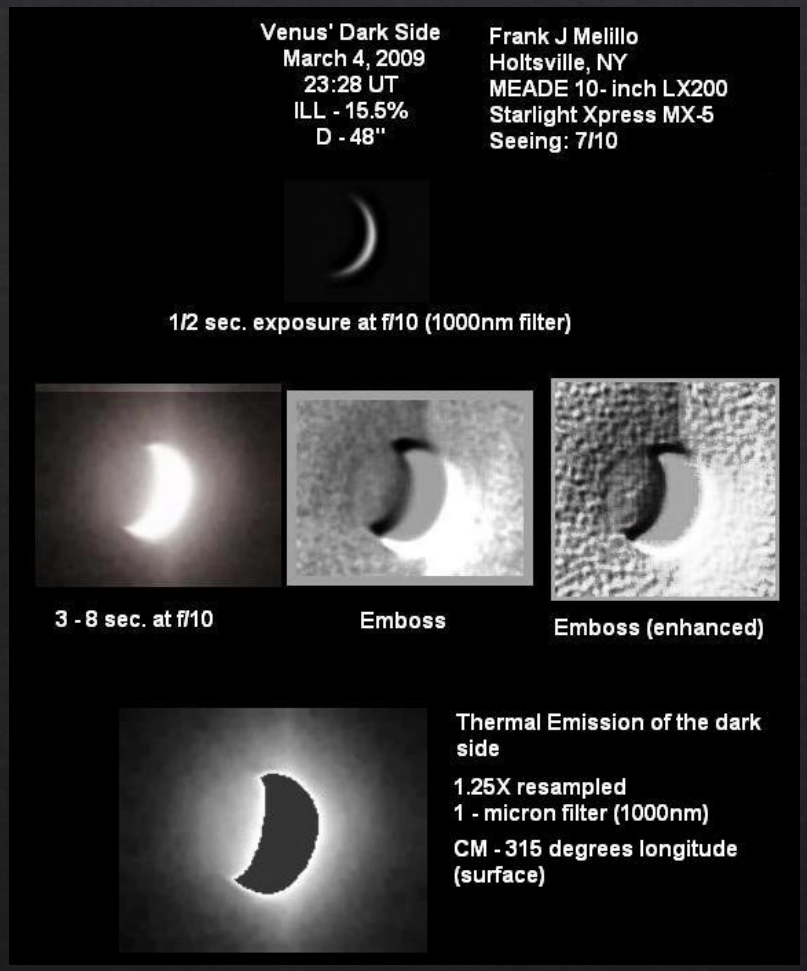


2004 May 18 20:22UT
35.6 cm (14.0 in) SCT
ATK-1HS Camera @ 1000nm IR
C. Pellier (France)

Above are the unprecedented Pellier 2004 amateur images of Venus' illuminated dark hemisphere!

- *Thermal emission from the surface of Venus in the near-IR (1000nm) penetrating the dense atmosphere.*
- *Subtle mottlings in the images are not atmospheric features; they are warm surface areas emitting in the 1000nm near-IR band.*
- *Because instrumentation Pellier used was rather uncomplicated, Venus observers have been attempting similar imaging work in more recent apparitions (near inferior conjunction).*

Images of the Dark Hemisphere of Venus in near-IR in 2009



Ever since Pellier's IR images in 2004 Venus observers have routinely tried to image Venus in the near IR.

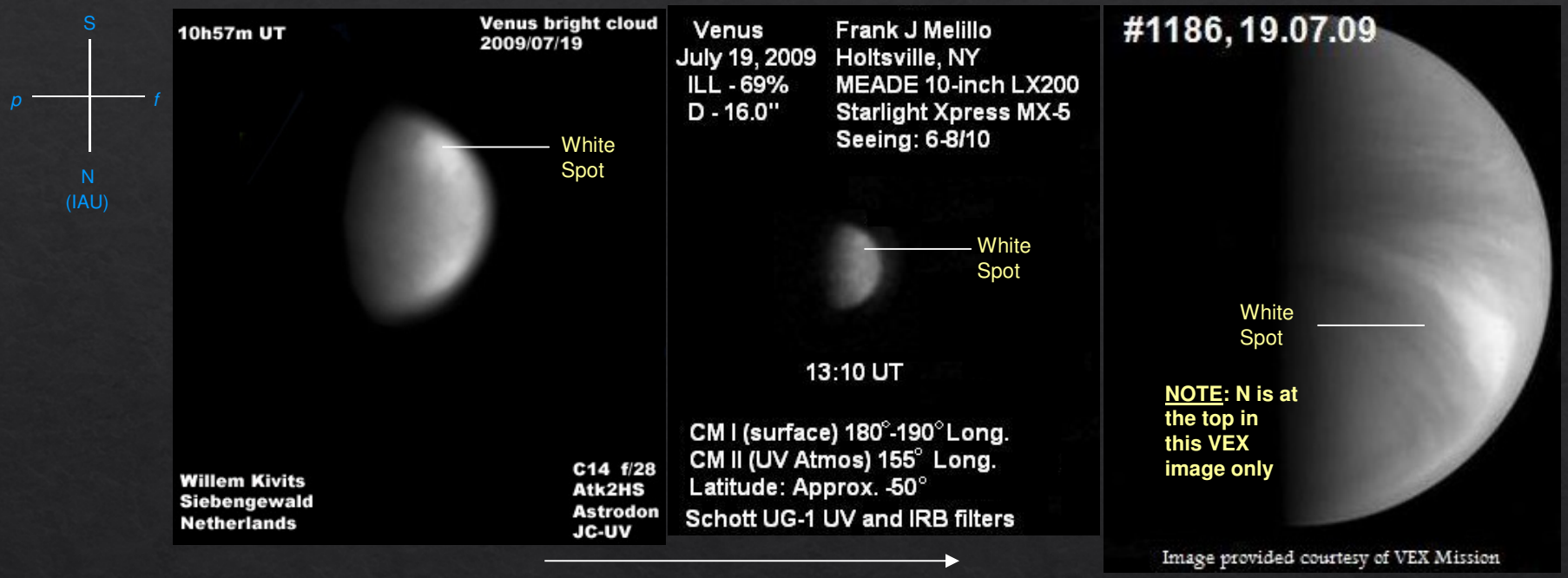
A 2009-10 Example of Estimating Schröter's Phase Effect

- The *predicted phase* of Venus, ***k***, found in an ephemeris, does not always correspond with the *observed phase* on the date of observation.
- This is particularly the case at the time of *dichotomy* (half phase, when the terminator is exactly straight from pole to pole, such that k = 0.500 or 50%). This discrepancy is known as *Schröter's Effect* after the scientist who first recognized it.
- The observed date of dichotomy varies from the predicted date by an average of about 7 to 8 days. A fully convincing explanation as to its real cause is yet to be found.

Observed vs. Predicted Dichotomy of Venus: 2009-10 Western (Morning) Apparition			
QUANTITY	**OBSERVERS**		
	D. Niechoy	**J. Benton**	
Observed (O)	2009 Jun 05.31^{d}	2009 Jun 07.75^{d}	(***k*** = 0.500)
Predicted (P)	2009 Jun 06.61	2009 Jun 06.61	(***k*** = 0.500)
Difference (O-P)	–01.30^{d}	+1.14^{d}	

A Notable VEX Pro-Am Simultaneous Observation in 2009-10

Compare the images by Kivits and Melillo in these two near simultaneous observations during 2009-10

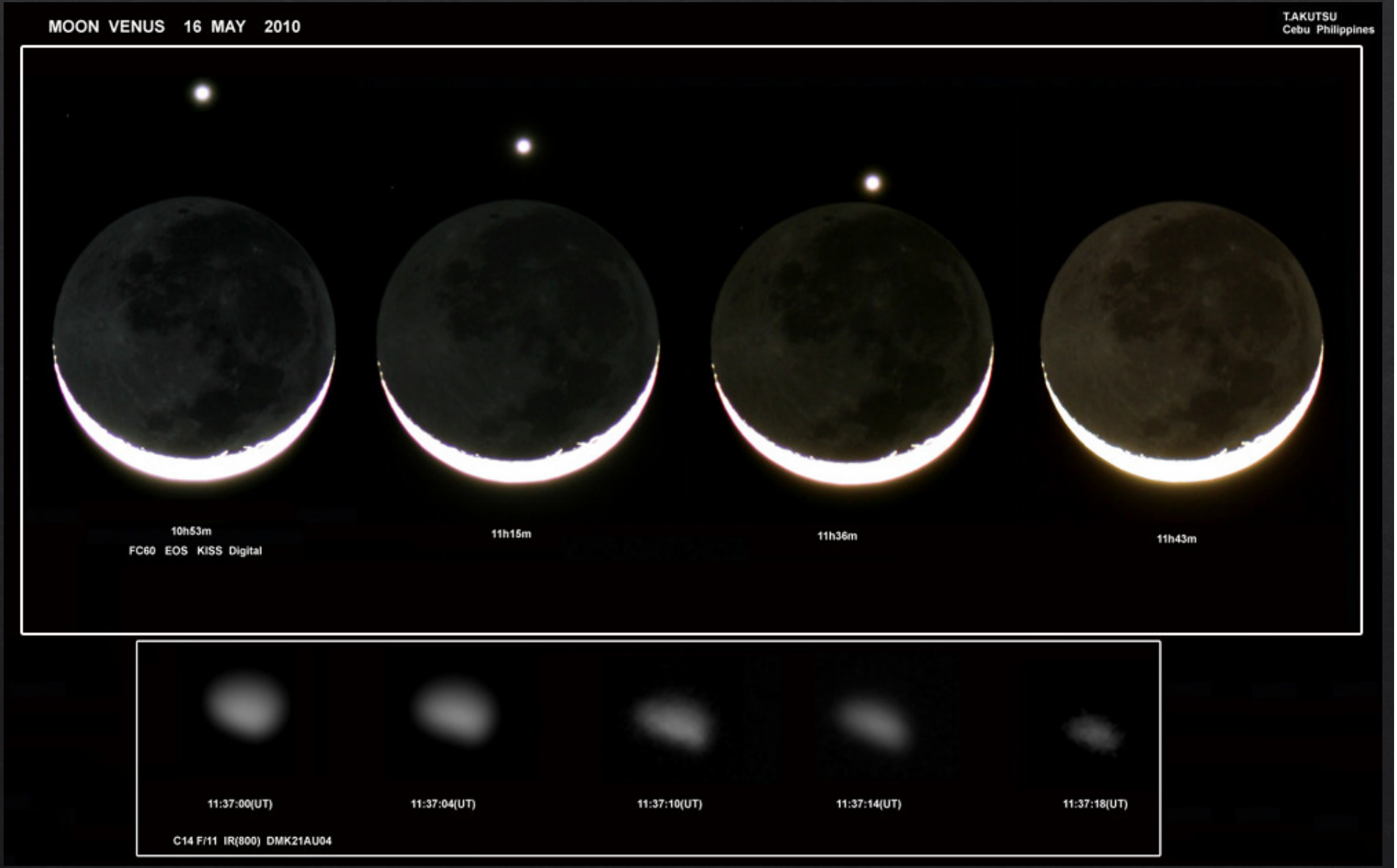


Direction of Rotation (retrograde)

The remarkable bright White Spot of the 2009-10 Western (Morning) Apparition

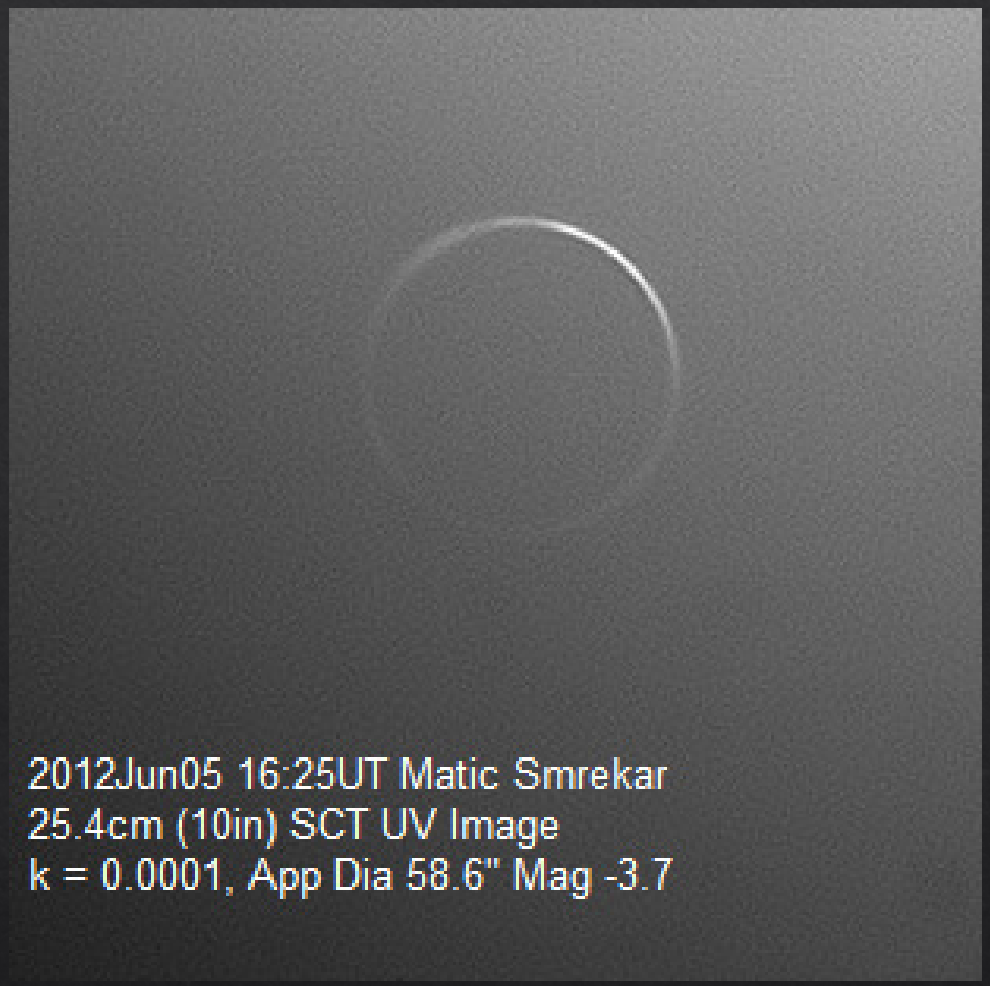
- *It was first reported by Kivits and Melillo on July 19, 2009 (this was not the first such brightening ever recorded on Venus).*
- *Venus Express (VEX) imaged the bright spot in the planet's southern hemisphere 4 days before Kivits and Melillo imaged it.*
- *The bright spot spread out with time, rapidly stretched out by the high-velocity winds of Venus' dense atmosphere.*
- *Although cloud properties somehow changed, the cause of the spot remains a mystery.*
- *Venus Express (VEX) scientists have so far not linked the feature to any volcanic activity on the planet.*

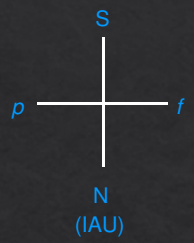
A Memorable Occultation of Venus on May 16, 2010



A Remarkable Cusp Extension in 2012

This image was taken roughly a day prior to the Transit of Venus





When Venus approaches inferior conjunction, the cusps can often extend dramatically into a beautiful halo encircling the dark portion of the planet's disk.

This effect is caused by sunlight reflecting through the planet's atmosphere forming a ring of light as it appears to us in our telescopes on Earth.

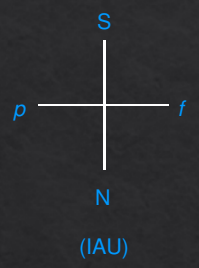
A Truly Memorable Transit of Venus in 2012

Image courtesy of Rik and Dolores Hill of the Transit of Venus near sunset on June 6, 2012 north of Tucson, AZ using a Questar 3.5”

The last transit of Venus occurred on June 6, 2012.

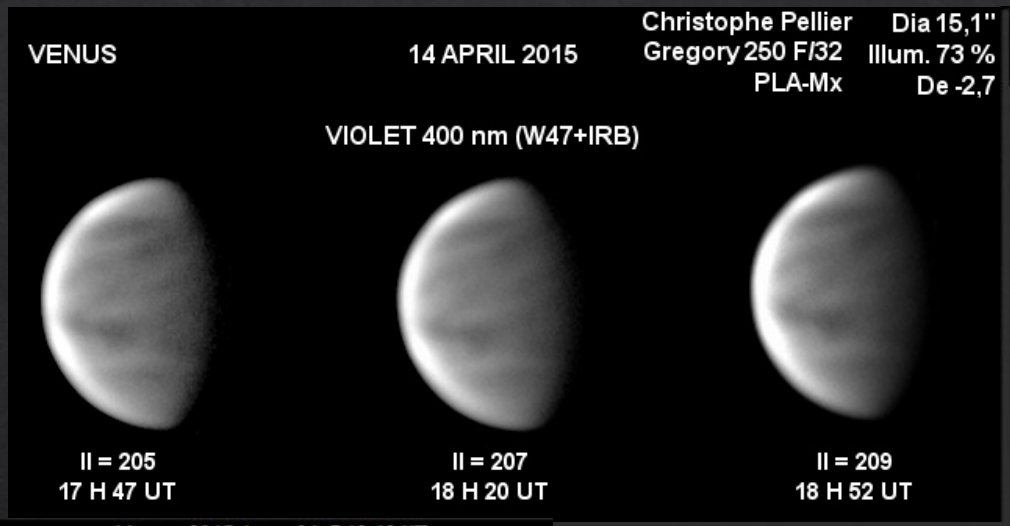
As a testament to the rarity of such events, the next transit won’t occur until December 11, 2117.

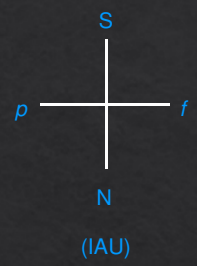
Venus Observations: 2013-14 Eastern (Evening) Apparition

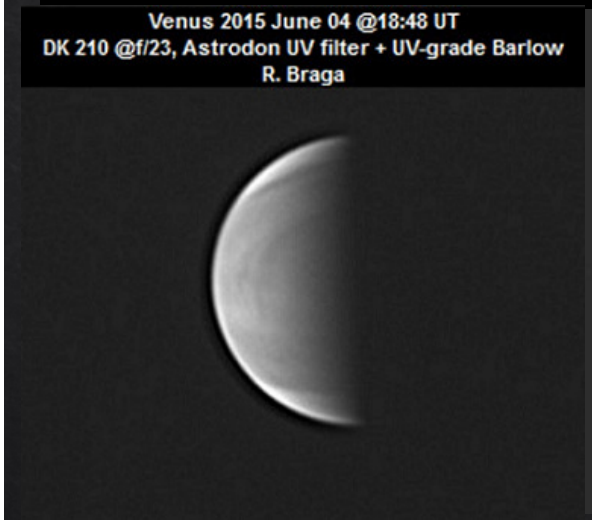


- Ashen Light was claimed to be definitely observed visually in these two drawings made three days apart.
- Observers are urged to try to image the elusive Ashen Light in a simultaneous observing program when it is reported by visual observers.
- The cause of the phenomenon has been a mystery for over 400 years since it was first reported in 1643.
  - *Some say it's due to CO_2 in the atmosphere of Venus being split by UV radiation, emitting a greenish glow.*
  - *Others attribute it to lightning storms in the atmosphere of the planet.*
  - *Still others say it's merely an illusion, since no spacecraft has conclusively detected the Ashen Light.*

Recent Venus Images: 2014-15 Eastern (Evening) Apparition





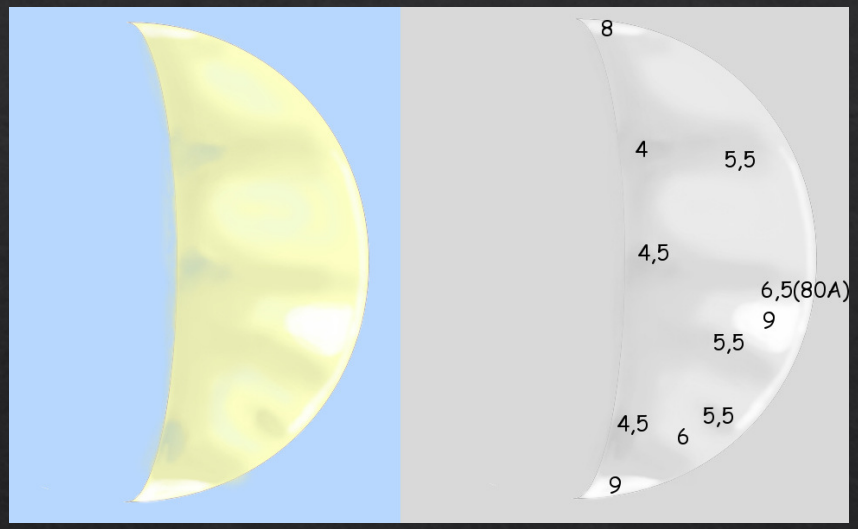


In these W47 (violet) and UV images, horizontal V, Y, or ψ (psi) shaped dusky clouds are distinct as well as banded dusky markings, cusp caps, cusp bands, and the bright limb band.

Direction of Rotation (retrograde)

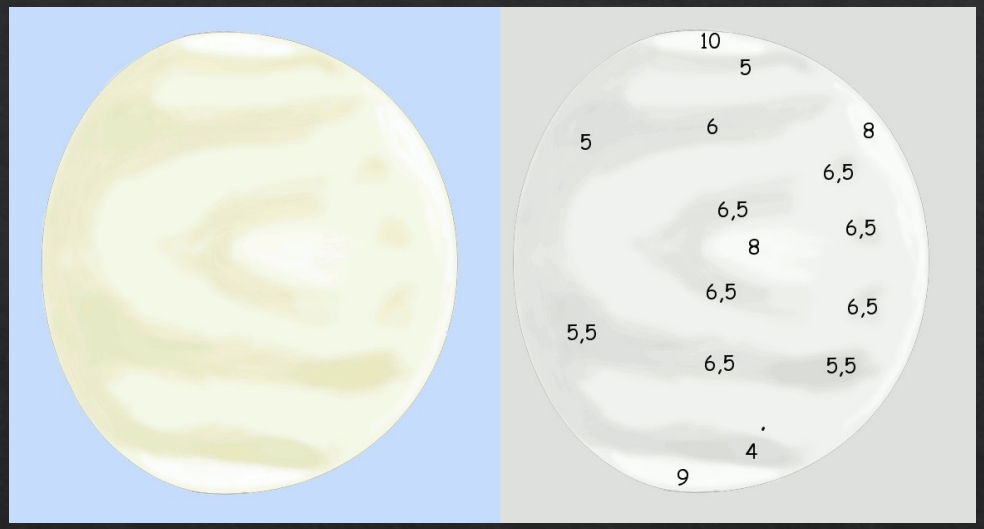
Recent Venus Drawings: 2015-16 Western (Morning) Apparition

Intensity Estimates



Michel Legrand of La Baule-Escoublac, France
2015 September 01 at 09:52UT in Integrated Light (no filter) and W80A (light blue) filter; 21.0 cm (8.3 in) Newtonian at 251X
Apparent diameter of Venus is 51.7", phase (k) 0.094 (9.4% illuminated) and visual magnitude -4.3.

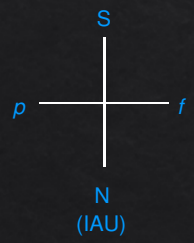
Intensity Estimates



Michel Legrand of La Baule-Escoublac, France
2016 February 25 at 10:40UT in Integrated Light (no filter)
W80A and W38A (light blue) filters 21.0 cm (8.3 in) Newtonian at 251X; Apparent diameter of Venus is 11.4", phase (k) 0.901 (90.1% illuminated) and visual magnitude -3.7.

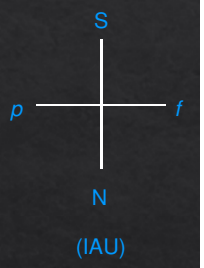
Drawings and images by experienced observers are vital to our observing programs.

Banded Dusky Markings, Bright Spots, Cusp Caps and Cusp Bands are depicted in these excellent colorful drawings at visual wavelengths.



Direction of Rotation (retrograde)

Recent Venus Images: 2015-16 Western (Morning) Apparition

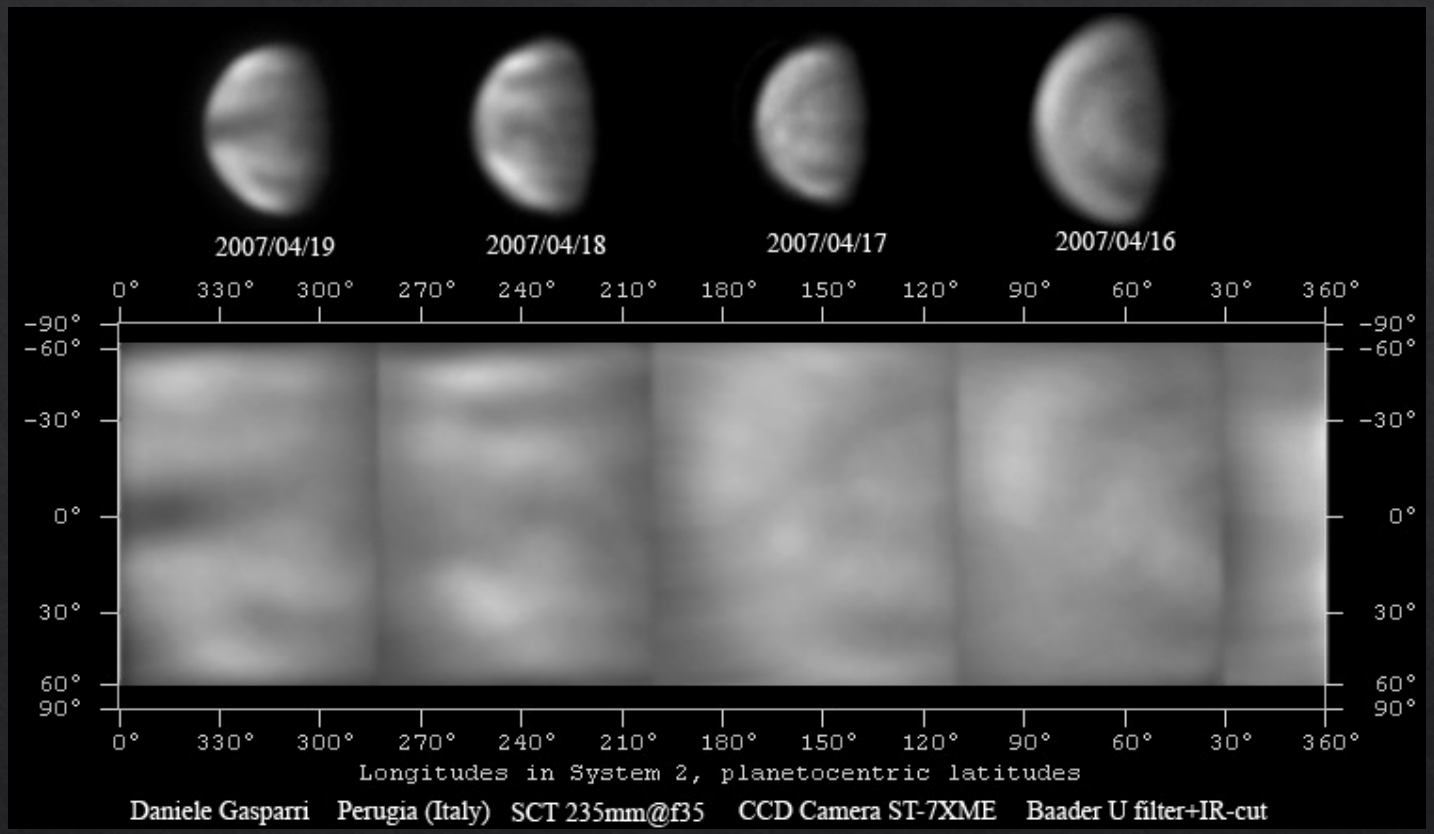


Notice the varying phase of Venus and forms of dusky markings revealed in these images using W47 (violet), UV, & IR filters

Direction of Rotation (retrograde)

Some Gleanings from Long-term UV Imaging of Venus

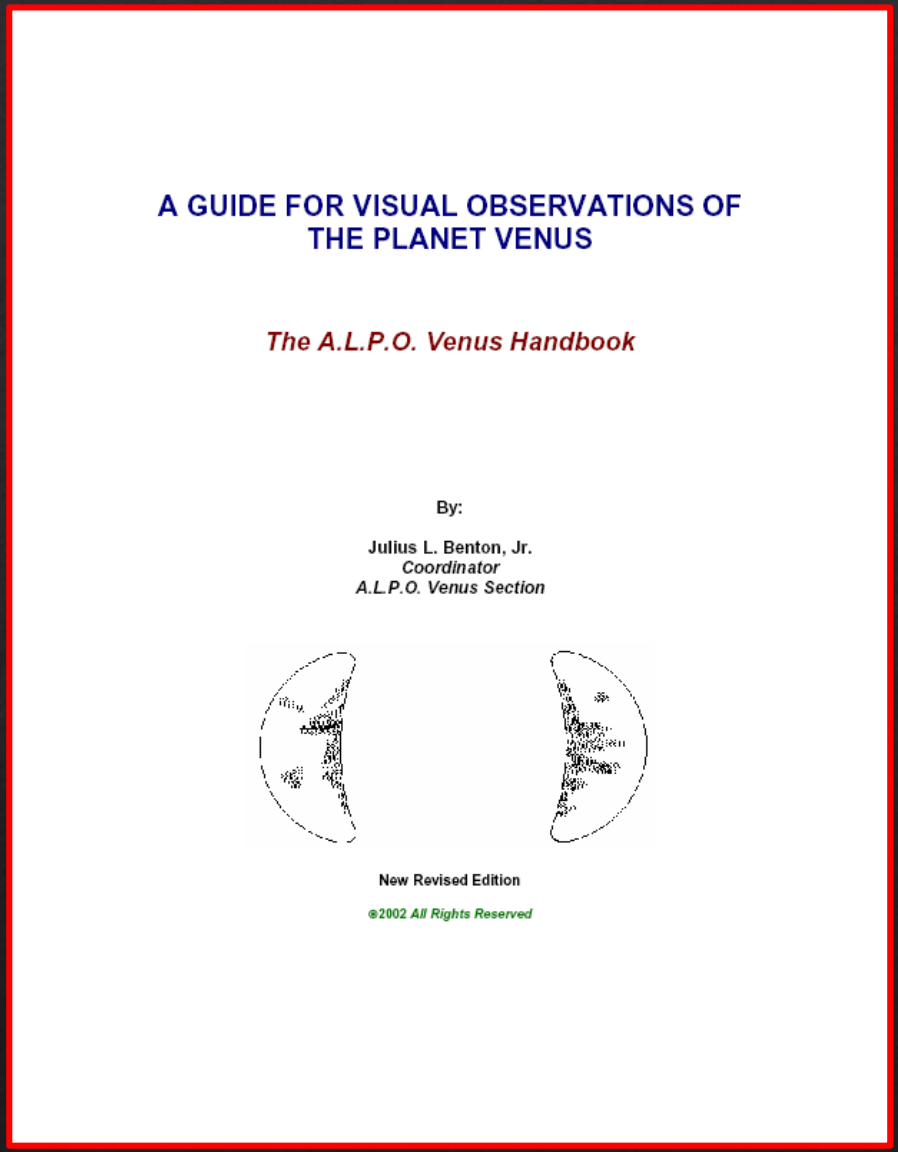
Sample map of UV features images on Venus 4^d during the 2006-07 Eastern (Evening) Apparition



- UV images taken over nearly three decades show horizontal *V, Y, or Ψ (psi) shaped dusky clouds* usually aligned along the planet's equator & moving W at 110m s^{-1} in a planetary-wide rotation.
- The more intense & distinctly *V-shaped features* last several weeks, but smaller-scale cloud patterns can change substantially after each successive rotation in 4^d around the planet.
- Over several years, the polar areas are sometimes covered by whitish clouds, typically lasting only a few weeks or months, evolving independently for the two poles.

More About Observing Venus

Those who wish to learn more about how to observe Venus and record useful data are encouraged to get a copy of the *ALPO Venus Handbook* from the ALPO Venus Section. It is available in printed form or as a *.pdf file.



A GUIDE FOR VISUAL OBSERVATIONS OF THE PLANET VENUS

The A.L.P.O. Venus Handbook

By:

Julius L. Benton, Jr.
Coordinator
A.L.P.O. Venus Section

New Revised Edition

©2002 All Rights Reserved