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Schroeter's Effect:

An Analysis of the Phase Anomaly of Planet Venus

A. A. Faraj
a_a_faraj@hotmail.com

Abstract:

In the following survey, the observations of the phase anomaly of the planet Venus are discussed. And the various theoretical interpretations of this long-standing anomaly, on the basis of optical, atmospheric, and kinematic considerations, are presented and analyzed in detail.

Keywords:

Schroeter's effect; phase anomaly; theoretical dichotomy; light aberration; Venusian atmosphere; twilight model; Doppler effect; absolute velocity of the solar system.

Introduction:

In 1793, J. H. Schroeter reported, for the first time, observing the southern limb of the planet Venus remaining concave up to about eight days before or after its conjunction with the Sun, according to his best estimate [***Ref. #8***].

Just like the Moon, Venus goes through various phases, at different times, as seen from Earth.

However, the phases of Venus differ from the phases of the Moon in three important respects:

I. Historically, the phases of Venus played a crucial role in the downfall of the geocentric model and the ascendancy of the heliocentric model of the solar system.

II. The cycle of the phases of the planet Venus takes *583.92* days from start to finish.

III. And the observed times and the calculated times of the phases of the planet Venus show persistently significant deviations and anomalous differences.

It is often the case that observations of the planet Venus, at the time of theoretical dichotomy (*e.g. theoretical half phase*), show a terminator straight at the center of the disc, but curved at the poles.

In general, the time difference between the time of theoretical dichotomy and the time of observed dichotomy is about four to six days.

Since the Venusian phase dichotomy is defined in terms of a straight terminator along the whole of its length, the above-mentioned difference between the observed and calculated times of dichotomy has been deemed anomalous and labeled accordingly as '*Schroeter's effect*'.

Nonetheless, the phase anomaly of Venus is much wider than the Schroeter's effect, and can produce differences of ± *0.10* for all phases from near *0.1* Phase to *0.9* Phase; and not just at *0.5* Phase alone.

Furthermore, images of the Moon and the planet Mercury, recorded on photographic plates, show a similar, though to a lesser degree, discrepancies between these two celestial bodies' observed and calculated phases [***Ref. #5.a***].

As for the planet Venus, its observed dichotomy is always later than its calculated dichotomy in western elongations, and earlier in eastern ones; but on average the deviation from theoretical calculations varies from about *3-1* to *2-4* days.

As shown in the illustration below, the straight line joining the inferior conjunction and the superior conjunction always divides the synodic curve of Venus to Western elongation, in which Venus is west of the Sun and rises in the morning in the east ahead of the it before sunrise; and to Eastern elongation, in which it is east of the Sun in the evening and appears in the west after sunset.

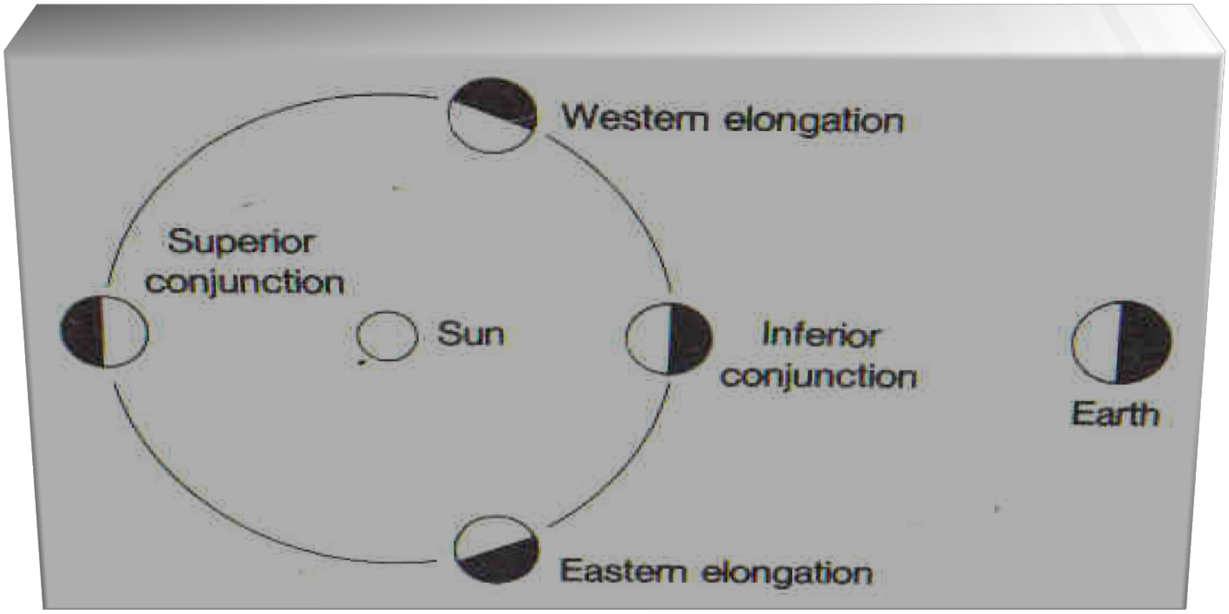


Figure #1: Phases of Venus — [Ref. #10]

Also, it should be noted that, in its Eastern elongation, the planet Venus, as observed from the moving reference frame of the earth, is always approaching the earth's observer; while, during its Western elongation, Venus is always receding from Earth.

According to Michelson and Petrov, the crescent of Venus appears larger than expected, while its gibbous appears smaller. But, according to H. McEwen, the observed angular size of Venus is always smaller than its theoretical angular size, except in near conjunctions [***Ref. 5.a & 5.b***].

Several observers reported that the retardation of the half phase in western elongations is greater than its acceleration in eastern elongations. However, in his *1961* review, M. Rushton, concluded that published observations indicate a relatively constant rate of change during the gibbous phase of the planet Venus with the maximum deviations occurring near the time of dichotomy [***Ref. 5.b***].

As will be discussed, in the following sections, there is a number of potentially viable theoretical interpretations that can be suggested in connection with the phase anomaly of Venus; but none of which has been, so far, demonstrably confirmed or completely ruled out by the published observations.

Theoretical Interpretations of the Phase Anomaly of Venus:

The phase anomaly of the planet Venus has long been a well-known and established observational fact.

Among its most prominent aspects that require satisfactory explanations in any theoretical attempt, within this context, are the constant retardation of the half phase in the morning apparitions and its acceleration during the evening apparitions of the planet Venus.

Why does the planet Venus reach its half phase earlier than predicted, when it is located east of the Sun, and later than expected, when it is located west of the Sun?

That is not, by any means, an easy question to answer; otherwise, J. H. Schroeter himself could have come up with a satisfactory answer to it in *1793*. And even now, the space probes that circled the planet Venus a number of times in the recent past offered little or no clues at all for solving this long-lasting riddle.

Notwithstanding the apparent lack of clues and informing leads, several interpretations of the phase anomaly of the planet Venus have been proposed and made available in the published literature; and several other potential interpretations of it can be advanced or put forward, in this regard, as well.

1. The Optical Interpretation:

This interpretation is one of oldest proposed explanations of the phase anomaly of the planet Venus, and based entirely upon the optical mechanism of irradiation and scattering of sunlight off clouds located at the top of the Venusian atmosphere.

As M. Rushton pointed out, however, irradiation and various other factors affecting micrometric observations would tend, in general, to increase the apparent angular size of the planet Venus, in stark contradiction with the observational evidence at hand [***Ref.*** ***#5.b***].

And the same applies to the old suggestion that the whole Venusian phase anomaly is an optical illusion related to telescopes, binoculars, and similar instruments: Firstly, because of the clear regularity of the phenomenon, under discussion. And secondly, because it is dependent on neither the aperture, nor the field of the orientation, nor the magnification of the telescope [***Ref.*** *#7*].

It's possible, however, that the discovery of super-rotating clouds, in the hight atmosphere of the planet Venus, with a rotational period of about four days, may well, in the end, make this optical hypothesis a viable interpretation of the Venusian phase anomaly once again.

2. The Atmospheric Interpretation:

According to this interpretation of the anomalous dichotomy of Venus, a sloping cloud surface along the terminator is the primary cause behind the deficiency of illumination in the Venusian atmosphere, and the half-phase anomaly.

However, the immediate objection to this hypothesis is that a sloping cloud surface along the terminator would require a greater temperature difference between the day and night Venusian hemispheres than actually exists [***Ref. #5.b***].

To avoid the aforementioned objection, the so-called '*twilight model*' is constructed, in order to explain away the anomalous Venusian dichotomy [*Ref. #3.b*].

This twilight model for the Venusian middle atmosphere is built upon the exponential decrease of air density with altitude.

The variations of atmospheric density with height should lead to similar variations in pressure and optical depth, which, in turn, can be used to qualitatively explain away the observed characteristics of the phase anomaly of the planet Venus.

3. The Light-Travel-Time Interpretation:

The interpretation of the phase anomaly of Venus, presented here, is based upon the spherical shape of the planet and the transverse component of its orbital velocity, across the line of sight, at the time of theoretical dichotomy, as observed from Earth .

Let r denote the radius of the planet Venus; and let v denote its transverse orbital velocity, across the line of sight, around the time of half phase, as observed in the moving reference frame of the earth.

And therefore, on the basis of the assumption of constant speed of light, light, reflected from the largest circle of the visible Venusian disc, must take an interval of time t longer than that of light reflected from the center of the disc, to reach an observer on Earth:

$$t = \frac{r}{c} \qquad 3.1$$

where c is the speed of light in vacuum.

And accordingly, due to the transverse component of its orbital velocity, the planet Venus, during this computed interval of time, travels, across the observer's line of sight, a distance d:

$$d = vt = v\left(\frac{r}{c}\right) \qquad 3.2$$

where d is the maximum displacement of the center of the Venusian disc, during the interval of time t, with respect to its periphery, as observed from Earth.

Similarly, on the assumption of ballistic speed of light, light, reflected from the greatest circle of the visible Venusian disc, must take, in the case of direct approach, an interval of time t longer than that of light reflected from the center of the disc, to reach an observer on Earth:

$$t = \frac{r}{c+2v} \qquad 3.3$$

and in the case of direct recession:

$$t = \frac{r}{c-2v} \qquad 3.4$$

and in the general case:

$$t = \frac{r}{c'} \qquad 3.5$$

where c' is defined in accordance with this equation:

$$c' = c\sqrt{1 - \left(\frac{2v}{c}\sin\theta\right)^2} + 2v\cos\theta \qquad 3.6$$

in which θ is the angle between the observer's line of sight and the orbital velocity vector of the planet Venus.

On the assumption of ballistic speed of light, therefore, the planet Venus, during the above interval of time, travels, across the observer's line of sight, a distance d:

$$d = vt = v\left(\frac{r}{c'}\right) \qquad 3.7$$

where c' is given by Equation *#3.6*.

Every other point on the disk of the planet Venus must cover, during the same interval of time t, an intermediate displacement whose length lies between the *maximum* length of the center's displacement and the *zero*-length displacement of the periphery of the visible Venusian disk.

And as a result, on the assumption of constant speed of light and on the assumption of ballistic speed of light as well, the straight Venusian terminator, at the time of computed dichotomy, must curve inward, if the illuminated part of the Venusian disk is leading; and it must curve outward, if the same illuminated part is trailing the dark part of the Venusian disk.

The primary objection to the light-travel-time interpretation of the phase anomaly of Venus is that the traveled distance vt, as calculated by using Equation *#3.2* on the assumption of constant speed of light, or Equation *#3.7* on the assumption of ballistic speed of light, is too short to be observed here on Earth, because the travel time of light across the radius of the planet Venus, as computed from Equation *#3.1*, or from Equation *#3.5*, is too small.

Nevertheless, if the travel-time interpretation is successfully worked out within the framework of the twilight model mentioned earlier in Section *#2*, then the travel time of light across the radius of the planet Venus can be made longer, through the process of refraction; and hence, this hypothesis may, well, be able to account for a substantial part of the anomalous Venusian dichotomy.

4. The Aberration-of-Light Interpretation:

The light-aberration interpretation is based upon dividing the visible disc of the planet Venus to small and equal sections that correspond as closely as possible to ideal point sources of light; and then applying the law of light aberration to those constructed point sources, in order to calculate the shifted position, due to the transverse component of the orbital velocity of the earth around the barycenter of the solar, for each and every one of the point sources located along the Venusian terminator.

Let β stand for the observed angle between the center of the Venusian disc and the orbital velocity vector of the earth v around the gravitational center of the solar system.

According to the law of light aberration, on the assumption of constant speed of light, therefore:

$$\sin \Delta\beta = \frac{v}{c} \sin \beta \qquad 4.1$$

where Equation *#4.1* is the standard equation for computing the shift in the position of the light source caused by light aberration due to the motion of the observer.

And in the same way, on the assumption of ballistic speed of light:

$$\sin \Delta\beta = \frac{v}{c'} \sin \beta \qquad 4.2$$

where c' is obtained, in this particular case of reflection, by using the following equation:

$$c' = c\sqrt{1 - \left(\frac{2v_V}{c}\sin\theta\right)^2} + 2v_V\cos\theta \qquad 4.3$$

where v_V is the orbital velocity of Venus; and θ is the angle that its orbital velocity vector makes with the observer's line of sight.

Since the calculated half phase of the planet Venus is defined in terms of a straight terminator along the entirety of its length, points sources of light strung along the terminator, at the time of theoretical dichotomy, must undergo shifting in their positions due to light aberration in accordance with the initial positional angle β' made by each of which with respect to the orbital velocity vector of the earth.

And because the initial angle β' made by each of the point sources along the terminator is defined by this equation:

$$\beta' = \beta + \Delta\beta \qquad 4.4$$

and since the value of β' varies with the position of each point source along the terminator, it's clear that the actual straight terminator of the planet Venus, at the time of theoretical dichotomy, would appear to observers on Earth to be curved either inward or outward depending on the position of the optical image of the planet Venus with respect to the orbital velocity vector of the earth, and on whether the dark part is leading or trailing the illuminated part of the visible disk of the planet Venus.

And so, from the standpoint of all physical theories, it is not a question of whether or not light aberration can curve the straight terminator of the planet of Venus; but rather a question of: Do really terrestrial astronomers have enough acute vision to spot slight twists and curves caused by light aberration on the tiny disk of Venus?

5. The Doppler-Effect Interpretation:

The Doppler-effect interpretation is based upon the apparent changes in the travel time of a physical object, to cover the same radial displacement, depending on whether that object is traveling towards or away from the stationary or moving observer in question.

If, for instance, a physical object travels from Point A to Point B at a speed of v, then, on the basis of the assumption of constant speed of light, its apparent travel time, in the case of receding directly from a stationary observer, is t'_R:

$$t'_R = \frac{AB}{v} + \frac{AB}{c} \qquad 5.1$$

where c is the speed of light.

By contrast, if the same physical object travels from Point B to Point A at the same speed of v, then its apparent travel time, in the case of approaching directly the stationary observer, is t'_A:

$$t'_A = \frac{BA}{v} - \frac{BA}{c} \qquad 5.2$$

in accordance with the assumption of constant speed of light.

Likewise, on the basis of the assumption of ballistic speed of light, if an emitting object travels from Point A to Point B at a speed of v, then its apparent travel time is t'_R:

$$t'_R = \frac{AB}{v} + \frac{AB}{c-v} \qquad 5.3$$

in the case of direct recession from the stationary observer; and:

$$t'_A = \frac{BA}{v} - \frac{BA}{c+v} \qquad 5.4$$

in the case of direct approach with respect to the same stationary observer.

And alternately, for reflecting objects:

$$t'_R = \frac{AB}{v} + \frac{AB}{c-2v} \qquad 5.3.A$$

in the case of direct recession;

and in the case of direct approach:

$$t'_A = \frac{BA}{v} - \frac{BA}{c+2v} \qquad 5.4.B$$

in the two cases, respectively, for reflecting objects approaching or receding directly with respect to the same stationary observer, on the basis of the assumption of ballistic speed of light.

Now, how does exactly the above procedure apply to the phase dichotomy of the planet Venus?

Since the orbit of Venus around the Sun is a closed curve, the two equations above, for linear displacements, have to be modified and worked out in detail, in the stationary reference frame of the solar system and in the moving reference frame of the earth, respectively.

Let R denote the average orbital radius of Venus; and let v denote its average orbital velocity around the barycenter of the solar system.

A. In the Reference Frame of the Solar System:

From any fixed point of the stationary reference frame of the solar system located anywhere along the orbit of the earth around the Sun, the time taken by the planet Venus to start and to return to the same point of its orbit is equal to its sidereal period P_{sid} in its orbit.

As seen from that stationary point of the earth's orbit, the straight line between the point of inferior conjunction, at which the planet Venus is at the shortest distance from the fixed point, and the point of superior conjunction, at which the planet Venus is at the longest distance from the same fixed point, divides the orbit of the planet Venus to two equals halves:

1. The western half of the orbit, from the point of inferior conjunction to the point of superior conjunction, in which Venus is always receding from the fixed point of observation.

2. And the eastern half of the orbit, from the point of superior conjunction to the point of inferior conjunction, in which Venus is always approaching the fixed point of observation.

It's, immediately, clear, based upon the above considerations of linear displacement, that from this fixed point of observation, the planet Venus should appear to spend more time of its sidereal orbital period in the western half of its orbit, and less time of its sidereal orbital period in the eastern half of its orbit.

And, therefore, the important question, here, is this:

By how much exactly is the apparent orbital time of the western half longer than the apparent orbital time of the eastern half of the orbit of the planet Venus, as measured in the stationary reference frame of the solar system from the above-mentioned point along the earth's orbit?

The answer to this question, on the assumption of constant speed of light, is quantitatively quite easy and simple.

The apparent orbital time of the western half P'_w is simply:

$$P'_w = \frac{1}{2} P_{sid} + \frac{2R}{c} \qquad 5.5$$

where R is the average orbital radius of Venus; and P_{sid} is its sidereal orbital period.

And the apparent orbital time of the eastern half P'_e is:

$$P'_e = \frac{1}{2} P_{sid} - \frac{2R}{c} \qquad 5.6$$

And hence, the time difference is:

$$P'_w - P'_e = \frac{4R}{c} \qquad 5.7$$

where c is the speed of light.

On the assumption of ballistic speed of light, however, the answer to the above question requires the calculation of the radial component of the average tangential orbital velocity of the planet Venus, which varies with the angle θ between its tangential velocity vector and the line of sight, as $v*cos(\theta)$, from 0 to $+v$ to 0, in the western half; and from 0 to $-v$ to 0, in the eastern half of the Venus' orbit.

For the Western Half of Venus' Orbit:

Since this orbital half, by definition, consists of the two quadrants: The 270^o-360^o Quadrant and the 0^o-90^o Quadrant; and since the average cosine value, throughout these two quadrants, approaches 0.5 as the number of the infinitesimal divisions of the two quadrants approaches infinity, it follows that the average ballistic velocity resultant of light c'_w must be:

$$c'_w = c - \frac{1}{2} v \qquad 5.8$$

in the case of emission from a light source

And in the case of reflection from a moving reflecting celestial body like the planet Venus:

$$c'_r = c - v \qquad 5.9$$

where c'_r is the average ballistic velocity resultant of light, in the case of recession.

Accordingly, the apparent orbital time of the western half of Venus' orbit P'_w is

$$P'_w = \frac{1}{2} p_{sid} + \frac{2R}{c - v} \qquad 5.10$$

where P_{sid} is the sidereal orbital period of the planet Venus, as measured from any stationary point on the orbit of the earth.

For the Eastern Half of Venus' Orbit:

Since this orbital half, by definition, consists of the two quadrants: The 90^o-180^o Quadrant and the 180^o-270^o Quadrant; and since the average cosine value, in these two quadrants, approaches *0.5* as the number of the infinitesimal divisions of the two quadrants approaches infinity, it follows that the average ballistic velocity resultant of light c'_e has to be:

$$c'_e = c + \frac{1}{2}v \qquad 5.11$$

in the case of emission from a moving light source; and:

$$c'_r = c + v \qquad 5.12$$

where c'_r is the average ballistic velocity resultant of light, in the case of reflection from a moving reflecting surface like the planet Venus, in the case of approach.

Accordingly, the apparent orbital time of the eastern half of Venus' orbit P'_e is

$$P'_e = \frac{1}{2}P_{sid} - \frac{2R}{c+v} \qquad 5.13$$

where P_{sid} is the sidereal orbital period of the planet Venus, as measured from any stationary point on the orbit of the earth;

And therefore, the time difference is:

$$P'_w - P'_e = \frac{4R}{c}\left(1 - v^2/c^2\right)^{-1} \qquad 5.14$$

where c is the speed of light; and v is the tangential orbital velocity of the planet Venus.

<u>B. In the Reference Frame of the Moving Earth:</u>

As observed from the moving reference frame of the earth, the time taken by the planet Venus to start and to return to the same point, with respect to the earth and the Sun, is equal to its synodic period P_{syn} which is, for an inner planet like the planet Venus, quantitatively defined by the following equation:

$$\frac{1}{P_{syn}} = \frac{1}{P_{sid}} - \frac{1}{P_{sid\_E}} \qquad 5.15$$

where P_{sid} is the sidereal orbital period of Venus; and P_{sid_E} is the sidereal orbital period of Earth.

As seen from the moving reference frame of the earth, the straight line between the point of inferior conjunction, at which the planet Venus is at the shortest distance from the earth, and the point of superior conjunction, at which the planet Venus is at the longest distance from the earth, divides the synodic curve of the planet Venus to two equals halves:

I. The western half of the synodic curve, from the point of inferior conjunction to the point of superior conjunction, in which the planet Venus is always receding from the earth.

II. And the eastern half of the synodic curve, from the point of superior conjunction to the point of inferior conjunction, in which the planet Venus is always approaching the observer on Earth.

And so, it should be noticed, at once, that the effective radial displacement *D* covered by Venus with respect to an observer on Earth, during one synodic period, is much longer than the effective radial displacement of *2R* that Venus travels, during its sidereal period, with respect to a stationary observer at a fixed point on the earth's orbit; as shown by the following equation:

$$D = 2R\left(\frac{P_{syn}}{P_{sid}}\right) \qquad 5.16$$

where P_{syn} is the synodic period; P_{sid} is the sidereal period; and D is the synodic radial displacement.

It follows, therefore, that the apparent synodic time of the planet Venus P'_{syn_w} in the western half of its synodic curve, on the basis of the assumption of ballistic speed of light, is equal to:

$$P'_{syn\_w} = \frac{1}{2}P_{syn} + \frac{2R}{c-v}\left(\frac{P_{syn}}{P_{sid}}\right) \qquad 5.17$$

where R is the average orbital radius; and v is the tangential orbital velocity.

And likewise, the apparent synodic time of the planet Venus P'_{syn_e} in the eastern half of its synodic curve, is equal to:

$$P'_{syn\_e} = \frac{1}{2}P_{syn} - \frac{2R}{c+v}\left(\frac{P_{syn}}{P_{sid}}\right) \qquad 5.18$$

based upon the assumption of ballistic speed of light.

By subtracting Equation #*5.18* from Equation #*517*, therefore, we obtain:

$$\Delta P'_{syn} = P'_{syn\_w} - P'_{syn\_e} = \frac{4R}{c}\left(\frac{P_{syn}}{P_{sid}}\right)\left(1-\frac{v^2}{c^2}\right)^{-1} \qquad 5.19$$

where $\Delta P'_{syn}$ is the difference between the two apparent synodic times in the western half and the eastern half of the synodic curve of the planet Venus, respectively.

It can be demonstrated, as well, that the synodic time difference $\Delta P'_{syn\_C}$, on the assumption of constant speed of light, is equal to the above synodic time difference, as computed on the assumption of ballistic speed of light; but without the ballistic boosting factor:

$$\left(1-\frac{v^2}{c^2}\right)^{-1}$$

or more precisely, $\Delta P'_{syn\_C}$ is:

$$\Delta P'_{syn\_C} = P'_{syn\_w} - P'_{syn\_e} = \frac{4R}{c}\left(\frac{P_{syn}}{P_{sid}}\right) \qquad 5.20$$

in accordance with the assumption of constant speed of light.

By inserting the numerical values of the average orbital radius, the orbital sidereal period, and the synodic period of planet Venus, along with the canonical value of the speed of light, into Equation *#5.20*, and neglecting the small eccentricity of the Venusian orbit and its inclination relative to the earth's orbit, along with the ballistic boosting factor, we obtain an average numerical value of the time difference between the apparent synodic time of the western half and the apparent synodic time of the eastern half of the synodic curve of the planet Venus, $\Delta P'_{syn}$, due to Doppler effect, in each and every synodic period, with an amount of about:

$$\Delta P'_{syn} \approx 1.036 \text{ hrs}$$

as calculated on the basis of the assumption of constant speed of light, and the assumption of ballistic speed of light as well.

We conclude, therefore, that the Doppler-effect interpretation can, in principle, explain away the observed phase anomaly of the planet Venus; but if and only if the planetary ephemeris, from which theoretical dichotomies are being deduced, is calculated, in advance, for *50* years or more, in order for the above computed amount of Doppler effect to accumulate and to account for the observed deviations between observed and theoretical dichotomies of the planet of Venus.

6. The Absolute-Velocity Interpretation:

The absolute-velocity interpretation of the phase anomaly of the planet Venus is based primarily upon the assumption of ballistic speed of light within the framework of ballistic and emission theories of light; although, from theoretical standpoint, it's quite possible to work out the details of this interpretation, in a consistent manner, on the assumption of constant speed of light within the context of the classical wave theory as well.

The theoretical phases of the planet Venus are defined in terms of positional configurations for the Sun, Venus, and Earth, throughout the Venusian synodic period, as perceived by observers situated in the reference frame of the moving earth.

For example, the Venusian half phase happens only when the extended straight line form the optical position of the planet Venus makes right angles with the straight line joining the instantaneous position of the earth and the optical position of the Sun.

Clearly, for observers on the earth, the perceived position of the earth, at anytime, coincides always with its instantaneous and true position, as deduced from dynamical and gravitational considerations.

However, as seen from the reference frame of the earth, the optical position of the Sun and the optical position of the planet Venus do not, necessarily, coincide with their dynamical positions, due to the combined effect of the light travel time and the space motion of the solar system.

Modern astronomy finds no trouble whatsoever in taking care of differences in optical and true positions of celestial bodies due to their relative motion.

Nevertheless, current astronomers have absolutely no way, within its present paradigm, for correcting or taking care of differences in optical and instantaneous positions of astronomical bodies, caused by their velocities relative to free space, which are continued to be labeled, theoretically, on the basis of its current theories, as impractical and impossible to exist in the first place.

And as a result, any effects of motion, relative to absolute space, are either explained away, within the theoretical framework of conventional astronomy, by resorting to available alternatives; or they're ultimately labeled or classified as anomalies and filed and stored away for an indefinite period of time.

However, from the standpoint of kinematics, all of the potential effects of absolute velocity, in the case under investigation, are exactly the same as those effects due to the collective motion of observers and light sources with the same speed in the same direction relative to some external point of reference.

In other words, uniform motion with respect to absolute space, in this regard, is an integral part of uniform motion in general and without having any fundamentally different characteristics of its own.

Moreover, even thought, the space motion of any physical body can have potentially an infinite number of components in an infinite number of directions, it can only, at any instant of time, have one instantaneous velocity resultant in only one direction.

In any case, the basic notion of absolute velocity, within the framework of physical theories based upon the assumption of ballistic speed of light, is kinematically meaningful; and, therefore, the only remaining question, here, is this:

How, exactly, can the collective uniform motion of the solar system, with respect to absolute space, be employed, in the current investigation, to explain away the aforementioned phase anomaly of the planet Venus?

As mentioned earlier, the Venusian phases vary with the values of the angle that the optical position of Venus makes with the optical position of the Sun and the instantaneous position of the earth, as measured in the reference frame of the moving earth.

Accordingly, if the absolute velocity vector of the solar system is at right angles to the ecliptic pole, then the displacement made by the earth, due to its absolute motion, during the travel time of light from Venus to Earth, must increase or decrease the above positional angle, depending on its direction.

And by contrast, if the absolute velocity vector of the solar system is exactly parallel to the ecliptic pole, then the displacement made by Venus, due to its absolute motion, during the light travel time from the Sun to Venus, must increase or decrease the above positional angle, depending on its direction.

Let's assume, for instance, that the absolute velocity vector of the solar system is exactly at right angles to the ecliptic pole.

And let the Earth-Venus line make an angle of β with the absolute velocity vector of Earth; and an angle θ with the absolute velocity vector of Venus.

Since both Venus and Earth are moving with the same collective speed in the same direction, the above two angles are always supplementary; i.e.,

$$\beta + \theta = 180^o$$

And subsequently, the displacement, d_E, that Earth makes, in the interval of time t_E, during the flight of light from Venus to Earth, which can be calculated by using this equation:

$$d_E = v_A t_E \qquad 6.1$$

must decrease the angle θ, by an amount $\Delta\theta$, if Venus is waning; and it must increase it by the same amount, if Venus waxing; and hence:

$$\sin\Delta\theta = \frac{v_A}{c'}\sin\theta \qquad 6.2$$

where θ is the angle between the line of sight and the absolute velocity vector of Venus; and $\Delta\theta$ is the amount of parallactic shift in the direction of the Earth-Venus line with respect to the absolute velocity vector of Venus, due to the displacement d_E made by the earth.

At the same time, the above displacement must increase, in the case of waning, and decrease, in the case of waxing, the angle β by an amount $\Delta\beta$ in the these two cases respectively; and therefore:

$$\sin\Delta\beta = \frac{v_A}{c'}\sin\beta \qquad 6.3$$

where $\Delta\beta$ is the amount of light aberration caused by the absolute motion of the earth; and c' is the ballistic velocity resultant of light:

$$c' = c\sqrt{1-\left(\frac{2v_A}{c}\sin\theta'\right)^2} + 2v_A\cos\theta' \qquad 6.4$$

and where the angle θ' is equal to:

$$\theta' = \theta \pm \Delta\theta$$

depending on the observed optical position of Venus with respect to the absolute-velocity vector of the earth.

In addition, the displacement, d_E, that Earth makes, during the time t_E, during the travel of light from Venus to Earth, must increase the Venus-Sun-Earth angle α, by an amount $\Delta\alpha$:

$$\sin\Delta\alpha = \frac{v_A}{c'}\sin\alpha \qquad 6.5$$

if Venus is waning; and it must decrease it by the same amount, if Venus is waxing.

The numerical values of the angle of parallax $\Delta\alpha$ and the angle of light aberration $\Delta\beta$, caused by the absolute velocity of the solar system, are always equal; but their effects on the optical positions of the celestial bodies, under investigation, are diametrically opposed.

While the parallax always shifts optical positions by an amount of $\Delta\alpha$ in the backward direction of the absolute velocity vector, light aberration, by contrast, always shifts the optical positions, shifted previously by the parallax, by an equal amount of $\Delta\beta$ in the forward direction of the same absolute velocity vector of the solar system.

But more importantly, within the current context, light aberration does not change the shifted phase angle of parallactically shifted optical positions.

For instance, light aberration transfers the optical position of the planet Venus, shifted earlier by the parallax, to its same optical position, before the parallax; but it does not change the ratio between the illuminated part and the dark part of the shifted Venusian image caused by the parallax.

In principle, therefore, the absolute-velocity interpretation can qualitatively explain away the phase anomaly along with the phase acceleration in eastern elongations and the phase retardation in western elongations of the planet Venus.

But, can the absolute-velocity interpretation produce the right numerical magnitudes of the above phase anomaly, as observed in these two cases respectively as well?

If it's assumed, for example, that the solar system travels, at right angles to the ecliptic pole, at an absolute velocity v_A:

$$v_A = 400 \quad \text{kms}^{-1}$$

and this numerical value of v_A is inserted into Equations *#6.2*, *#6.3*, and *#6.5*, in the case of half phase for instance; i.e., in the case of:

$$\alpha = 90^o$$

then the absolute-velocity interpretation can produce a numerical value for the time difference between the Venusian phase acceleration and phase retardation, ΔP_{syn} of an amount equal to:

$$\Delta P_{syn} = 0.124 \quad \text{days}$$

in each and every synodic period of the planet Venus.

It follows, therefore, that the planetary ephemeris, upon which the theoretical dichotomy of Venus is based, has to be constructed, in this particular case of the above assumed velocity value, for, at least, *30 years* in advance, in order for the absolute-velocity interpretation to account for an observed difference of about *2 days* between theoretical and observed dichotomies of the planet Venus.

The basic objection to the absolute-velocity interpretation of the phase anomaly of the planet Venus is that the magnitude and the direction of the solar system's absolute velocity, with respect to free space, is unknown. And therefore, unless the absolute velocity of the solar system is obtained by an independent method, the absolute-velocity interpretation of the phase anomaly of the planet Venus will, in practice, just remain inconclusive and keep going, in circle the other way around; i.e., practically, using the observed deviations to obtain the numerical value of the solar system's absolute velocity, instead of using the numerical value of its absolute velocity to explain away the observed deviations between the observed and theoretical dichotomies of the planet Venus.

7. Concluding Remarks:

It should be clear that no two interpretations of the above Venusian phase anomaly are mutually exclusive; and hence, there is always a real possibility that most or all of the aforementioned interpretations of the phase dichotomy of Venus may, well, be simultaneously at work, and each of which contributing a small part to the total magnitude of the observed anomaly.

Nonetheless, there is a number of observational tests that can be carried out for the main purpose of verifying, putting constraints on, or ruling out altogether some of the preceding interpretations of the phase anomaly of the planet Venus.

Concerning the above Doppler-effect interpretation, any crucial observational tests that can be suggested, in this regard, should include the following steps:

- Determining, by the means of direct observation, the exact time of observed eastern dichotomy during a specific synodic period of the planet Venus.
- Determining, by the means of direct observation, the exact time of observed western dichotomy during the same synodic period of the planet Venus.
- Using the time of observed eastern dichotomy, during this synodic period, as a basis for computing the theoretical eastern dichotomy for the next synodic period of the planet Venus.
- Using the time of observed western dichotomy, during the same synodic period, as a basis for computing the theoretical western dichotomy for the next synodic period of the planet Venus.

- Determining, by the means of direct observation, the exact time of observed eastern dichotomy during this second synodic period of the planet Venus.

- Determining, by the means of direct observation, the exact time of observed western dichotomy during the same second synodic period of the planet Venus.

- Determining the deviations of observed dichotomies, in the latter synodic period, from theoretical dichotomies, computed on the basis of observational data obtained during the former synodic period, for the eastern and western elongations of the planet Venus.

Accordingly, if the average numerical value of the time difference between the apparent synodic time of the western half and the apparent synodic time of the eastern half of the synodic curve of the planet Venus, $\Delta P'_{syn}$, is significantly greater than the predicted Doppler-effect deviation of an amount of about:

$$\Delta P'_{syn} \approx 1.036 \text{ hrs}$$

as computed earlier based upon the assumption of constant speed of light, as well as on the assumption of ballistic speed of light, then the Doppler-effect interpretation of the phase dichotomy of the planet Venus, alone and by itself, cannot explain away the observed anomaly; and hence, it must be ruled out as a viable interpretation of phase anomaly of the planet Venus.

However, observational testing of the absolute-velocity interpretation of the phase anomaly of the planet Venus, by contrast, is much more difficult to carry out in practice or to quickly reach a definitive conclusion either way.

And that is because, as pointed out earlier, the numerical value of the absolute velocity of the solar system is unknown; and in reality, it can have any numerical value between zero and infinity; and hence; it can formally explain away any deviations obtained in any observational test, by simply turning those deviations the other way around and deducing, instead, the magnitude and the direction of the solar system's absolute velocity from the observational data, in the case under investigation.

Nevertheless, by repeating the process of observational testing many times, it's possible to find out discrepancies and inconsistencies in the deduced results more telling and significant enough to rule out the absolute-velocity interpretation of the phase anomaly of the planet Venus; this is one one hand.

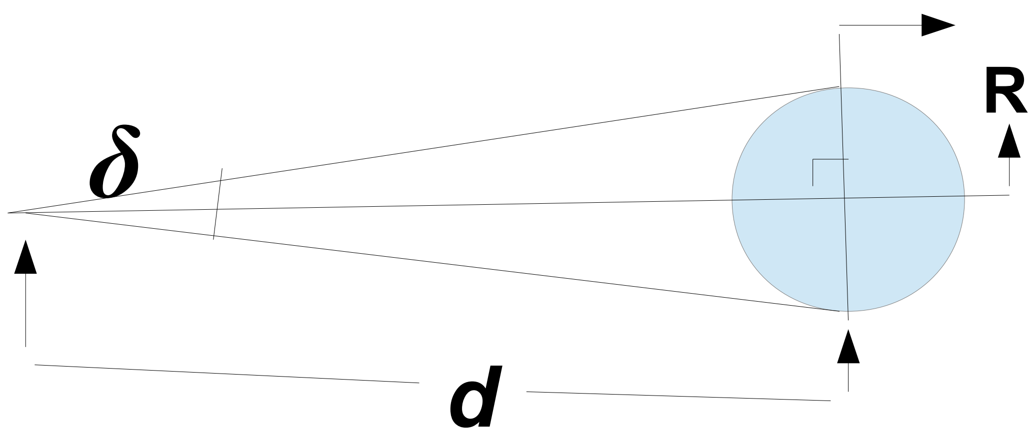
On the other hand, the same repeated process of observational testing can lead to robust and consistent results that show that the absolute-velocity interpretation is the correct and the valid interpretation of the observed phase anomaly of the planet Venus.

There is one more important aspect of uniform motion in general, and uniform absolute velocity relative to free space in particular, which has to be clarified and investigated, here, in more detail:

If an observer and emitting extended light source move with the same uniform speed in the same direction, then the angular size of the optical image of the extended light source must vary with the change in the optical position of the extended light source with respect to the velocity vector of the moving observer.

That is because the distance, between the observer and the optical image of the extended light source, in the case of collective uniform motion in general, is necessarily variable; and its actual value is dependent on whether the observer is leading or trailing the extended light source, in question.

Let's assume that d is the distance between the observer and the optical image of the extended light source, when the two are rest; i.e., their collective uniform velocity is equal to *zero*.



<u>Figure #2: Angular Size</u>

And therefore, in the stationary case, if the actual radius of the extended light source is R, the angular size of its optical image δ, as measured in the observer's frame of reference, can be computed by using the following standard equation:

$$\delta = 2\arctan\left(\frac{R}{d}\right) \qquad 7.1$$

where δ is the angular diameter of the optical image of the extended light source.

Now, if the extended light source and the observer move collectively with a uniform velocity v either with respect to absolute space or relative to some external point of reference, then, when the observer is directly trailing the extended light source, the distance d, between the observer and the optical image of the extended light source, will change to d', in accordance with this equation:

$$d' = d\left(1 - \frac{v}{c}\right) \qquad 7.2$$

And subsequently, the angular size of the optical image of the extended light source must change from δ to δ' as well:

$$\delta' = 2\arctan\left(\frac{R}{d\left(1 - \frac{v}{c}\right)}\right) \qquad 7.3$$

where δ' is the angular diameter of the extended light source.

And therefore, in this particular case, the angular size of optical image of the extended light δ', due to the collective uniform motion, is larger than the angular size of its stationary optical image δ.

In a like manner, when the observer is directly moving ahead of the extended light source, the distance d, between the observer and the optical image of the extended light source, changes to d':

$$d' = d\left(1 + \frac{v}{c}\right) \qquad 7.4$$

And as a result, the angular size of the optical image of the extended light source changes from δ to δ' as well:

$$\delta' = 2\arctan\left(\frac{R}{d\left(1 + \frac{v}{c}\right)}\right) \qquad 7.5$$

where δ' is the angular diameter of the optical image of the extended light source, in the case of uniform motion.

And hence, in this special case, the angular size of the optical image of the extended light δ' is smaller than its stationary angular size δ, because of the increased distance between the observer and the optical image of the extended light due to the collective uniform motion of the whole system..

It can be demonstrated that, in every other case between these two simple cases, the angular size of an extended light source, in collective uniform motion along with the observer, must have numerical values that lie between the numerical value given by Equation *#7.3* and the numerical value obtained from Equation *#7.5*.

And so finally, in this regard, here's the most important question, from any practical standpoint:

Can a uniformly moving observer notice or measure the aforementioned changes in the numerical values of the angular size of the optical image of the extended light source caused by the collective uniform motion of the entire system?

The answer to this question is, unequivocally, no.

The uniformly moving observer can neither notice nor measure the above changing numerical values of the angular size of optical image of the extended light source, due to the collective uniform motion of the entire system neither relative to free space nor with respect to any external point of reference.

The primary reason behind the moving observer's inability to notice those changes in the angular size of any uniformly moving extended light source, is that light aberration, due to the uniform motion of the same observer, has always numerical values that vary with the position of the optical image of the extended light source, and which always work in the opposite direction and counteract the effect of varying distances on the angular size of the uniformly moving extended light source.

In uniform motion generally, light aberration takes each half of the angular size's angle δ' as input and restores the whole angular size of the extended light source to a value equal to or extremely close to its stationary numerical value, either by shifting the periphery of the angular size towards its center, if it's larger; or by shifting the periphery away from its center, if the angular size of the moving extended light source is smaller than its stationary angular size, in accordance with this equation:

$$\frac{1}{2}\left(\delta' - \delta\right) = \arcsin\left(\frac{v_A}{c'}\sin\left(\frac{1}{2}\delta\right)\right) \qquad 7.6$$

where v_A is the uniform absolute velocity of the observer and the extended light source; and c' is the velocity resultant of light as calculated, in the case of emission, by using the following equation:

$$c' = c\sqrt{1-\left(\frac{v_A}{c}\sin\theta\right)^2} + v_A\cos\theta \qquad 7.7$$

where θ is the angle between the observer's line of sight and the absolute velocity vector of the extended light source.

It follows, therefore, that an observer, moving with the same velocity as that of the extended light source, cannot measure, in any directly practical way, any of the changes in the angular size of the optical image of the extended light source as predicted by Equation *#7.3* and Equation *#7.5*.

Nonetheless, the above predicted changes, in the angular size of the extended light source, can have, in a specific number of cases, observable consequences.

For example, if both the observer and the extended light source are moving relative to a second light source in the background, then, because of the above changes in the angular size of the extended source, the optical image of this second light source may appear to the observer, during an occultation by the extended light source, for instance, to be projected on the angular size of the latter, as a foreground object.

In addition, light aberration, under certain conditions — in particular and especially, if the numerical value of the collective uniform velocity, in question, is very high or close to the canonical value of the speed of light *c* — does not restore the shifted angular size of the optical image of the extended light source to its exact stationary angular size.

And hence, a very small but observable difference between the two angular sizes of the extended light source may, well, be noticed and measured by the uniformly moving observer, even in the extreme case of observers and extended light sources moving with the same speed in the same direction relative to absolute space.

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