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Observation of a star's orbit based on the emission and propagation of light as mechanical phenomena

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Abstract: The hypothesis that the velocity of light depends on the motion of the light source was rejected by astronomers' observations of binary stars and by the result of the experiment performed at CERN, Geneva, in 1964. Opposingly, the study of the emission, propagation, and reflection of light as mechanical phenomena concludes that the velocity of light depends on the velocity of the light source. The human eye sees the orbit of a star larger than its actual size, and the light from the star on the observed orbit travels to the observer's eyes at the emitted velocity c; therefore, there are no time irregularities. This paper exposes visual irregularities predicted by the hypothesis that the velocity of light is independent of the velocity of the light source.

Key words: Geometrical Optics; Emission of Light; Propagation of Light; Velocity of Light; Observation of Binary Stars.

I. INTRODUCTION

The ballistic theory of W. Ritz[1] and other physicists was based on the hypothesis that the velocity of light depends on the velocity of the source. The astronomers' observations of binary stars, and especially W. de Sitter,[2,3] rejected this hypothesis.

The study of the emission, propagation, and reflection of light as mechanical phenomena in inertial frames[4] concludes that the velocity of light depends on the velocity of the source. This study explains the result of the experiment performed at CERN[5] that does not contradict the ballistic theory. Here, it is reveals that there are no time irregularities as predicted by W. de Sitter.

In the empty space of the frame at absolute rest, light from a source at rest or in motion is emitted at the speed c which is of electromagnetic nature. If the source is in motion with the constant velocity v which is of mechanical nature, then the velocity v drags the velocity c and the propagation velocity of light is the vector sum of the velocities c and v. The dragging of the emitted velocity c does not affect its direction. The human eye is sensitive to the direction of light, of electromagnetic nature, emitted by the source. Therefore, the light coming to the human eye is perceived as having the direction of the emitted velocity c that is different from the direction of the propagation velocity. Because of this, the orbit of a star is seen larger than its actual size and the light from the observed orbit travels to the eyes of the observer with the emitted velocity c.

Section II presents how the star's orbit is perceived larger than the actual orbit by the human eye, then derives the time the light travels from the star on the actual orbit and on the observed orbit to the observer, and finally obtains the data of the observed orbit. Section III lays out a procedure for obtaining the real orbit data from the observed orbit data.

The observation of a star is studied in the empty space of the frame at absolute rest called here the absolute frame.

II. OBSERVATION OF A STAR'S ORBIT WITHIN THE PLANE OF THE ORBIT BASED ON THE EMISSION AND PROPAGATION OF LIGHT AS MECHANICAL PHENOMENA

A. Emission, propagation, and observation of light from a star

Figure 1 illustrates a star that travels at the velocity v on its orbit with the radius R and an observer at rest at point O in the plane of the star's orbit. There is a wavefront of light emitted by the star at point E of its orbit that reaches the observer.

The velocity of light depends on the velocity of the source. Therefore, the wavefront emitted from the star at point E has a direction such that the velocity vector v at point E drags this wavefront from direction EE' to direction EO.

The wavefront from point E is emitted in the direction EE' with the velocity c. The wavefront is dragged from direction EE' to direction EO by the velocity v at point E and arrives at the observer at point O. The wavefront travels the distance EO with the propagation velocity c_{EO}, in time t. Thus, the distance $EE' = ct$ and $E'O = vt$. The figure $EE'OE''$ is a parallelogram.

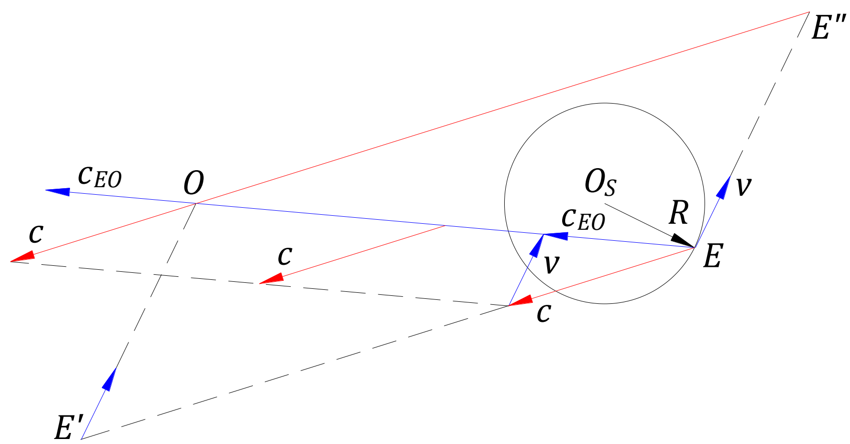

FIG. 1. Emission, propagation, and observation of light from a star.

The velocity v that is of mechanical nature does not change the emitted direction EE' of the velocity c of electromagnetic nature nor its magnitude of 3×10^8 m/s of the wavefront. Thus, the wavefront of light along the propagation direction EO has the emitted direction EE'. The velocity c_{EO} is the vector sum of velocities c and v.

The wavefront in the observer's eye is in the direction EE', has the speed c, and the observer sees the wavefront traveling from E'' with the emitted speed c, in time t, not from E at the speed c_{EO}, in time t.

B. Derivation of time in which the light travels from a star on its actual orbit and on its observed orbit to an observer

Figure 2 depicts an observer and a star in the absolute frame. The observer is at rest, and the star revolves with a velocity v counterclockwise in a circular orbit with a radius R and center at O_S.

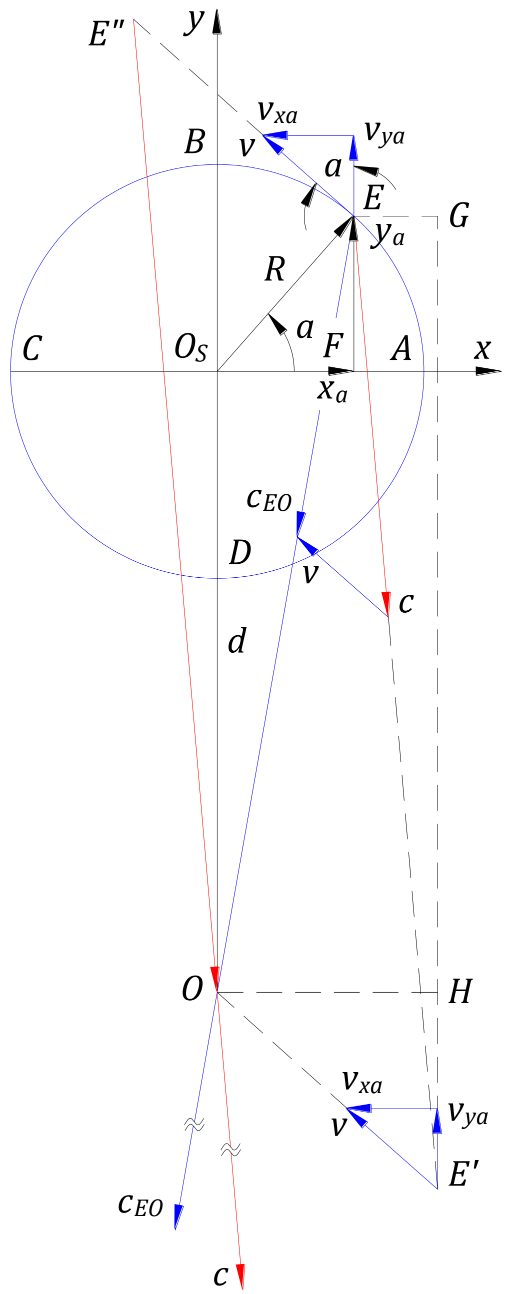

FIG. 2. Derivation of time in which the light travels from a star on its actual orbit and on its observed orbit to an observer.

The observer at point O is in the plane of the star's orbit. The distance from O to O_S,

$OO_S = d$, is perpendicular to the diameter AC of the orbit. Point A is at the initial position of the star at zero radians. The radius R to the star located at point E makes an angle a measured from the coordinate $O_S x$.

At point E, there is a wavefront of light sent towards point E' with the emitted velocity c that is dragged with velocity v from point E and, as a result of the two velocities, the wavefront travels from star along the path EO with the propagation velocity c_{EO}, in time t_{sa} calculated as follows:

From Fig. 2, $x_a = R\cos a$, $y_a = R\sin a$, $v_{xa} = v\sin a$, and $v_{ya} = v\cos a$.

$EE'^2 = E'G^2 + EG^2 = (OO_S + FE + E'H)^2 + (OH - O_S F)^2 \Rightarrow$

$c^2 t_{sa}^2 = (d + y_a + v_{ya} t_{sa})^2 + (v_{xa} t_{sa} - x_a)^2 \Rightarrow$

$c^2 t_{sa}^2 = (d + R\sin a + v t_{sa}\cos a)^2 + (v t_{sa}\sin a - R\cos a)^2 \Rightarrow$

$c^2 t_{sa}^2 = d^2 + R^2 \sin^2 a + v^2 t_{sa}^2 \cos^2 a + 2dR\sin a + 2dv t_{sa}\cos a + 2Rv t_{sa}\sin a\cos a +$
$v^2 t_{sa}^2 \sin^2 a - 2Rv t_{sa}\sin a\cos a + R^2\cos^2 a$. This expression yields the equation

$$\left(c^2 - v^2\right)t_{sa}^2 - 2dv t_{sa}\cos a - \left(d^2 + 2dR\sin a + R^2\right) = 0. \quad (1)$$

The convenient solution of Eq. (1) is

$$t_{sa} = \frac{\sqrt{d^2 v^2 \cos^2 a + \left(d^2 + 2dR\sin a + R^2\right)\left(c^2 - v^2\right)} + dv\cos a}{c^2 - v^2}.$$

The propagation direction of velocity c_{EO} is not aligned to that of emitted velocity c of the wavefront. Therefore, the wavefront in the observer's eye is in the direction EE', and the observer sees the wavefront traveling from E'' with the emitted speed c, in time t_{sa}, not from E at the speed c_{EO}, in time t_{sa}.

C. Observation of a star's orbit with the star on its observed orbit

In Fig. 2, the velocity v changes the path of the wavefront from EE' to EO but does not change the direction EE' of the emitted wavefront. The wavefront from E travels to observer O with the propagation velocity c_{EO}, in time t_{sa}, but the observer O sees this wavefront traveling from point E'' with the emitted velocity c, in the same time t_{sa}. Knowing the time t_{sa}, the observer calculates the distance $EE' = E''O = ct_{sa}$. Figure $OE''EE'$ is a parallelogram with the side $EE'' = E'O = vt_{sa}$ called here the deviation of the orbital point at the angle a, $DOP_a = vt_{sa}$.

The observed orbit of the star can be plotted by the calculation of $DOP_a = vt_{sa}$ for different angles a. Times t_{sa} and the distances $DOP_a = vt_{sa}$ of Fig. 3 are calculated for radius $R = 4$ m, $d = 12$ m, $v = 1$ m/s, and $c = \sqrt{10} = 3.162$ m/s. The deviation of the orbital points DOP_a is calculated in steps of $45°$ starting from the initial position of point A and presented in Table I.

TABLE I. Deviation of the orbital points DOP_a calculated in steps of $45°$.

a (°)	0°	45°	90°	135°	180°	225°	270°	315°	360°
t_{sa} (s)	5.755	6.062	5.333	4.177	3.089	2.392	2.667	4.278	5.755
DOP_a (m)	5.755	6.062	5.333	4.177	3.089	2.392	2.667	4.278	5.755

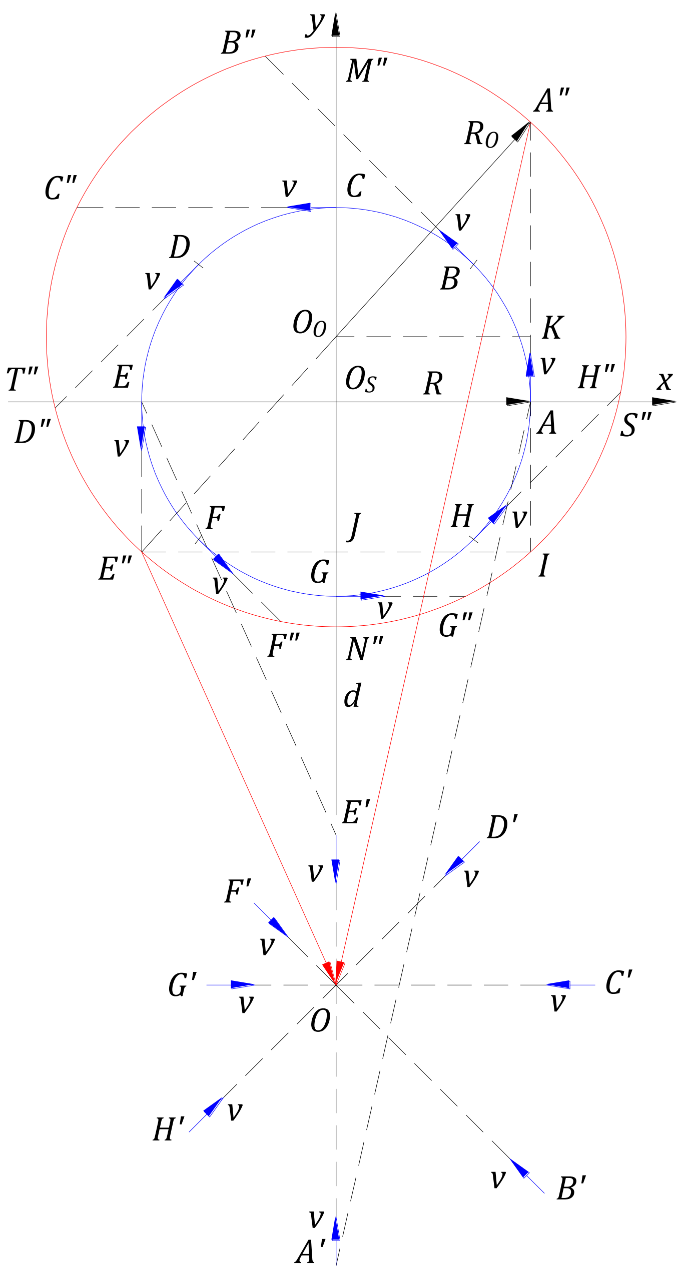

FIG. 3. The star on the actual orbit containing points A, B, C, D, E, F, G, and H, and on the observed orbit containing points A'', B'', C'', D'', E'', F'', G'', and H''

The observed orbit is a circle, or close to a circle, with its center at O_O achieved with the deviation of the orbital points from Table 1. The velocity of light from any point of the observed orbit to the observer is the emitted velocity c. Thus, no time irregularities as predicted by W. de Sitter.[2,3]

From Fig. 3, points A'' and E'' belong to the diameter $A''E''$ of the observed orbit. The center deviation of the observed orbit O_SO_O can be obtained.From triangle $A''E''I$, the distance $A''K = IK \Rightarrow DOP_{a=0°} - O_SO_O = DOP_{a=180°} + O_SO_O \Rightarrow O_SO_O = \left(DOP_{a=0°} - DOP_{a=180°}\right)/2$.

The distance from the observer to the center of the observed orbit $d_O = d + O_SO_O$.

In triangle $A''E''I$ the distances $A''I = DOP_{a=0°} + DOP_{a=180°}$ and $E''I = 2R$, then the radius $R_0 = \sqrt{\left(DOP_{a=0°} + DOP_{a=180°}\right)^2 + 4R^2}\,/\,2$.

For the real orbit, the angular speed with respect to O_S and the speed v are constants, but for the observed orbit, for the same constant angular speed with respect to O_S, the speed v_O is variable. The variable speed v_O can be derived for any angle a. Taking an infinitesimal angle and rotating it at point O_S then aligning it with its bisector along O_SS'', O_SM'', O_ST'', and O_SN'', the maximum and minimum of v_O can be derived graphically: v_O is at a maximum, $v_{O\max}$, at point M'' and at a minimum, $v_{O\min}$, at point N''. At points S'' and T'', $v_O = \left(v_{O\max} + v_{O\min}\right)/2$.

III. DERIVATION OF DATA OF THE ACTUAL ORBIT FROM THE DATA OF THE OBSERVED ORBIT

The example employed in this section is the binary star Algol B or β Persei Aa2, mentioned by W. de Sitter,[2,3] with the approximation that the orbit of the star and observer are in the same plane and the star travels counterclockwise as in Fig. 2.

Data with an index o is dedicated to the observed orbit, and data without an index is dedicated to the actual orbit. The data of a binary star offered by astronomers is the data of the observed orbit. Thus, the data of the binary star Algol B is the distance in light-years from the observer to the star $d_O = 90$ly, the period in days $P_O = 2.867328$d, the semi-major axis $a_O = 0.00215''$, and the eccentricity $e_O = 0$.

The data used in the calculation is transformed into SI base units as follow:

- The period of one year on the Earth in seconds $P_E = 365\,\text{d} \times 24\,\text{h} \times 60\,\text{min.} \times 60\,\text{s} = 3.153600 \times 10^7$ s.
- The speed of light from a source at rest in the absolute frame $c = 3 \times 10^8$ m/s, and then one light-year in meters $1\text{ly} = c \times P_E = 9.460800 \times 10^{15}$ m.
- The distance $d_O = 90\text{ly} \times 1\text{ly} = 8.514720 \times 10^{17}$ m.
- The period $P_O = 2.867328$d is the same for observed and actual orbit, $P_O = P = 2.867328$ d $\times$ 24 h $\times$ 60 min. $\times$ 60 s $= 2.477371 \times 10^5$ s.
- The semi-major axis $a_O = \left(0.00215''/3600''\right)° \times \pi\,\text{rad}/180° = 1.042349 \times 10^{-8}$ rad.
- The eccentricity $e_O = 0$. Thus, the semi-minor axis $b_O = a_O$, and the observed orbit is a circle.

- The radius of the orbit $R_O = d_O \times \sin a_O \cong d_O \times a_O = 8.87531340565652 \times 10^9$ m.
- It is assumed that the speed of the star on its orbit $v_O \cong 2\pi R_O / P_O = 2.250984 \times 10^5$ m/s.

Giving a guess value to the unknown actual radius R, the velocity $v = 2\pi R / P$. It is considered that the distance $d \cong d_O$. With known R, v, and d, the time t_{sa} can be calculated for any angle a with the solution of Eq. (1). The distances $DOP_{a=0°} = vt_{sa=0°}$ and $DOP_{a=180°} = vt_{sa=180°}$ can be calculated, then $O_S O_O = \left(DOP_{a=0°} - DOP_{a=180°}\right)/2$ and $R_O = A''E''/2 = \sqrt{\left(DOP_{a=0°} + DOP_{a=180°}\right)^2 + 4R^2}\,/2$.

By trial and error, different values are given to R. For $R = 1.232951040 \times 10^5$ m, the radius $R_O = 8.87531340579308 \times 10^9$ m is obtained that is close to the known radius $R_O = 8.87531340565652 \times 10^9$ m. The calculations were performed in a spreadsheet.

As a result of the above calculation, the actual orbit that yields the observed orbit of the binary star Algol B, has the following data:

- Comparing the center deviation of the observed orbit $O_S O_O \cong 92.5118$m to $d_O = 8.514720 \times 10^{17}$ m, it can be concluded that $d = d_O - O_S O_O \cong d_O = 8.514720 \times 10^{17}$ m as considered above. The orbits are approximately concentric and velocity v_O is approximately constant as assumed above.
- The radius $R \cong 1.232951040 \times 10^5$ m.
- The circular orbit speed $v \cong 2\pi R / P = 3.12705$m/s. The ratio of velocities is equal to the ratio of radii $v_O / v = R_O / R = 7.19843 \times 10^4$.

IV. CONCLUSIONS

According to the emission and propagation of light as mechanical phenomena, the orbit of a star is observed larger than its actual size. This phenomenon is more evident when the distance $OO_S = d$ is perpendicular to the star's orbit that implies O_S coincides with O_O and the orbits are concentric.

For the same size of the actual orbit, the ratio R_O / R increases with increasing observation distance.

In Fig. 1, let's consider that the star from point E travels with the speed v to point E'', and the observer from point O travels with the same speed v in the direction of $E'O$ the path OO'' equal and parallel to EE''. The imaginary figure $OEE''O''$ is a parallelogram. In the frame at absolute rest, the star at E emits a wavefront of light towards O with the emitted speed c, the velocity v drags the wavefront on the path EO'', and the observer at O'' sees the light coming from E'', as if the observer and star are in an inertial frame.[4]

If the velocity of light would be independent of the velocity of the source, the star at E emits a wavefront of light with the speed c that intercepts the observer at a point O' which can be before or after O'' depending on the shape of the parallelogram $OEE''O''$. The observer at O' sees the wavefront coming from E, which is not the right position of the star at the time of observation. This means that an observer on Earth, which also has the velocity of the Sun in the Universe, sees in the sky the positions of the celestial bodies from a few light-years to millions of light-years ago depending on the distance of observation, and the real celestial bodies in the sky are not seen.

The celestial bodies are moving in space on large spirals. In Fig. 1, let's consider that the star from point E travels on its spiral path to a point which is more or less close to E'', with the same speed v, at the same time as for path EE''. Therefore, the observer sees the star on a spiral path more or less close to the real spiral path.

Appendix: Irregularities of time predicted for the light coming from the star on the observed orbit if the velocity of light would depend on the velocity of the source

In Fig. 2, the star travels its orbit in period $P = 2\pi R / v$. The time in which the star travels from A to E is given by equation

$$t_{ra} = aR / v. \tag{2}$$

The time in which the wavefront from E arrives at the observer, measured from the initial position, is given by solutions of Eqs. (1) and (2), $t_a = t_{ra} + t_{sa}$, applicable for any other point of the orbit.

Time t_a applied to the observed orbit of Algol B with the data as in Subsection III (R_O, v_O, and d_O), considering that the observer perceives the propagation velocity c_{EO} and not emission velocity c, offers time irregularities mention by W. de Sitter.[2,3] Time t_a for different angles a is given in Table II and graphical illustration in Fig. 4.

TABLE II. Time t_a applied to the observed orbit for angle a from $0°$ to $360°$ in steps of $45°$.

a (°)	0	45	90	135
t_a (d)	0	-6.86	-23.94	-41.01

180	225	270	315	360
-47.86	-40.29	-22.51	-4.71	2.87

In Fig. 4, what the observer would see at point O is unfolded on the Line of Observation equal to the observed diameter AC of the orbit. The time from the star on any point of the orbit is given in days from the instance when the light from point A of the orbit arrives at the observer. Multiple periods of the star observation are shown in light lines.

Algol B would be seen as one star, or double stars, or multiple stars depending on the distance d and the angle between the plane of the orbit and the distance d. When this angle is zero, the irregularities are at a maximum. When d is perpendicular to the star’s orbit, no time irregularities are predicted for any distance d.

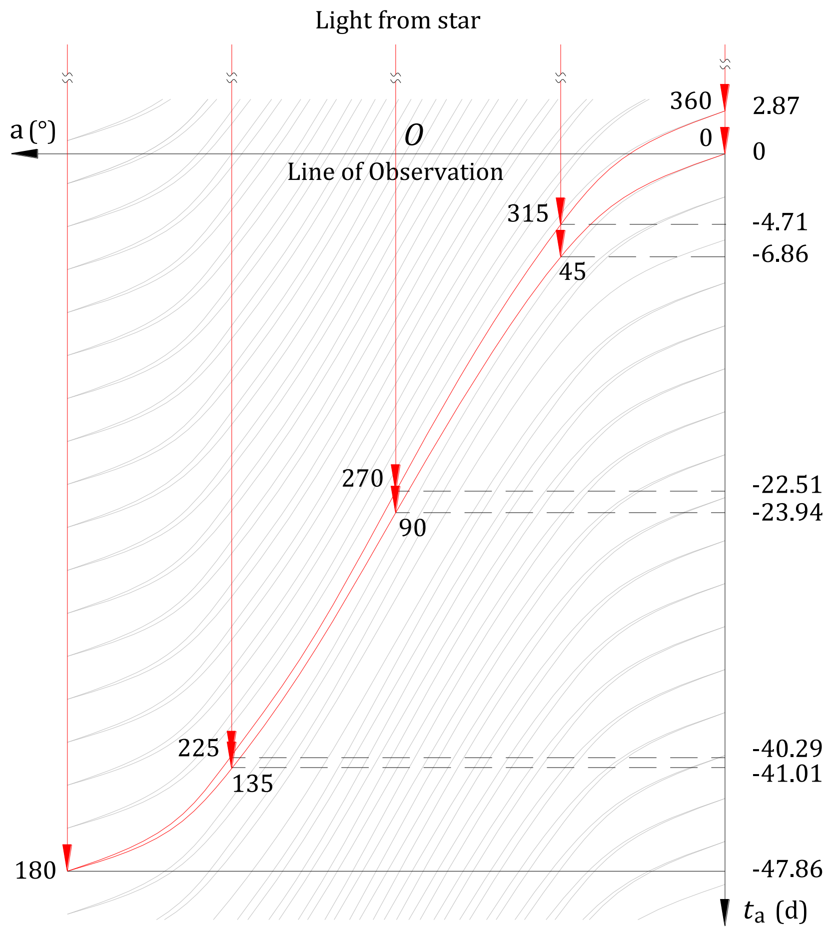

FIG. 4. Time t_a applied to the observed orbit for angle a from $0°$ to $360°$ in steps of $45°$.

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