Review Article

ISSN 2767-3901

International Journal of Theoretical & Computational Physics

Time, Eigenvelocity, and Propulsion of Celestial Bodies - On Barnard's Star

Liang Shiduo

Wenzhou Institute of Navigation, Zhejiang, Wenzhou, China

***Correspondence author**
Liang Shiduo
Wenzhou Institute of Navigation
Zhejiang
Wenzhou
China

Submitted : 28 Apr 2022 ; Published :12 May 2022

Citation: Liang Shiduo. Time, Eigenvelocity, and Propulsion of Celestial Bodies - On Barnard's Star. I J T C Physcics, 2022; 3(2): 1-6.

Summary

The measured time interval of celestial events is t, and t is only Earth time, not the original time t of celestial events. , the Earth time t must be converted into the original time t of the celestial event.

Measure the radial velocity u of a celestial body, it is not the eigenvelocity of the celestial body, the eigenvelocity is constant, but the apparent velocity changes, the celestial body moving towards the solar system is the blue-shifting celestial body, and the apparent velocity of the blue-shifting celestial body, year-on-year ratio One year slow.

Barnard's Star is a blue-shifting celestial body, which is an example. The apparent velocity is slowing down every year. The apparent velocity of the first measurement is 110.8km/s, (ARICNS: 1916), and the apparent velocity of the second measurement is 110.8km/s. It is 106.8km/s (SIMBAD: 2000). From this paper, it is calculated that the intrinsic velocity of Barnard's Star is 959.332km/s, and the apparent velocity in 2022 is 105.751km/s.

Keywords: apparent component angle, apparent velocity, blue, redshift critical point, Barnard's star. CLC number: F.P129 Document identification code: A

Prefaces

Apparent component angle: the angle between the celestial body's motion direction line and the celestial body's line of sight to the observer, see Figure 1

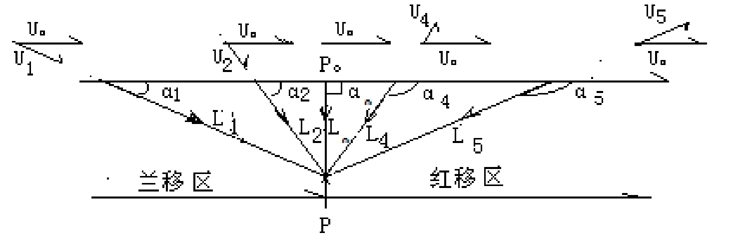
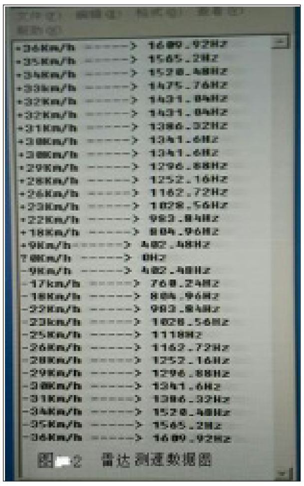


图1 视分量角与视速率图

It can be seen from the figure that the apparent component angles are gradually increasing in the process of moving close to the solar system (blue shift) to moving away from the solar system (red shift). $\alpha_1<\alpha_2<\alpha_0<\alpha_4<\alpha_5$.

Apparent velocity: the speed of the moving celestial body to the direction of the observer's line of sight. The apparent velocity of the moving celestial body gradually slows down to the critical point P0, the apparent velocity is 0_0 after the critical point, the shift from blue to red shifts, and the apparent velocity gradually becomes faster. The motion nature of the inter-cosmos motion source is common, which also includes the speed measurement of the car by the radar speedometer.

The author used Orenfu flat-panel PSD-3 radar speedometer (K wave: f. = 2.413209697 × Hz), aiming at the traveling car (36km/h) on the straight road, as shown in the experiment in Figure 1, the data is shown in Figure 2 [1].



When the trolley approaches the surveyor (Lan shift area), the apparent velocity (+ sign) gradually decreases and reaches P0 (positive and horizontal), the apparent velocity is zero and exceeds P_0 Point, when driving away from the observer (red-shift area), the apparent velocity (-sign) gradually increases, P_0 are the blue and red shift critical points.

Observe the initial frequency $f_1 = f_0$ +1609Hz, to P0 point, the observation frequency $f_3 = f_0 + 0$, the last observed frequency $f_5 = f_0$ -1609Hz.

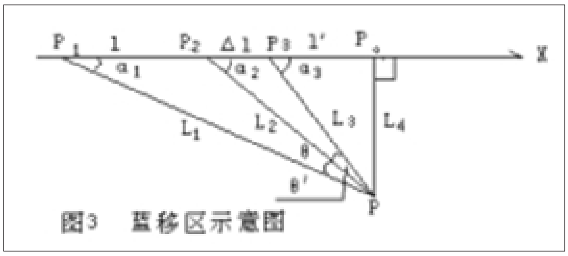
The observation frequency gradually decreases from high to low; $f_1 > f_3 > f_5$, the observation period is gradually slowing down [2], because the viewing component angles are gradually increasing.

The above state is a general observation law, and can also adapt to the general moving celestial bodies. In order to obtain astronomical measured examples, it is necessary to find a celestial body with a large annual self-propelled value to prove this theory.

Barnard Star

Most celestial bodies have an annual proper value of less than 1 arcsecond, while Barnard's star has a large annual proper value. Barnard's star [3] is close to the motion of the solar system (Lan shift star), which was discovered by American astronomer Edward Emeron Barnard (1875-1923) in 1916.

The annual proper value is 10.3 arc seconds, the ARICNS apparent velocity (U_1) is 110.8 km/s (1916), while the SIMBAD annual proper value is 10.31 arc seconds, and the apparent velocity (U_2) is 106.8 km/s (2000). See Figure 3



Let the Eigen speed of Barnard's star be U_0,
Apparent rate $U_1 = U_0 \cos \alpha_1$, apparent velocity $U_2 = U_0 \cos \alpha_2$, $U_0 = U_1/\cos \alpha_1 = U_2/\cos \alpha_2 = U_2/\cos(\alpha_1+\theta) = U_2/(\cos \alpha_1 \cos_\theta - \sin \alpha_1 \sin\theta)$
Sorting: $U_2/U_1 = (\cos \alpha_1 \cos_\theta - \sin \alpha_1 \sin\theta)/\cos \alpha_1, = \cos\theta - \mathrm{tg}\, \alpha_1 \sin\theta$
Obtain: find the angle of view component:

$$\mathrm{tg}\, \alpha_1 = (\cos \theta - U_2/U_1)/\sin\theta \qquad [1]$$

From 1916 to 2000, for 84 years, Barnard's Star traveled in total by $\theta = [(10''.3+10''.31)\div 2\times 84]$ $\theta = 0°14'25.62''$

Substitute $\theta = 0°14'25.62''$ U_1=110.8km/s U_2 = 106.8km/s into formula [1]
Obtained: $\mathrm{tg}\,\alpha_1 = 8.600296206$ $\alpha_1 = 83°22'3.76''$ $\alpha_2 = 83°36'29.38''$

Barnard's star motion Eigen speed
$U_0 = U_1/\cos \alpha_1 = 959.3328316$km/s
$U_0 = U_2/\cos \alpha_2 = 959.3328316$km/s

From 2000 to 2022, counting t'=22 years, Barnard's Star has moved in motion $\theta' = 10.31''\times 22 = 0°3'46.82''$,
The apparent component angle of Barnard's Star in 2022
$\alpha_3 = \alpha_2 + \theta' = 83°40'16.2''$,

The apparent velocity of Barnard's star in 2022 is
$U_3 = \cos \alpha_3 U_0$ =105.751km/s!
Converting Earth Time (t) to Barnard Star Time (t.),
When the viewing component angle is α_2:

$$t_0 2 = t'/(1-\mathrm{Cos}\, \alpha_2\, U_0/C_0) \qquad [2]$$

Will: t'=22 years α_2 = 83°36'29.38'' U_0 = 959.3328316km/s C_0=299792.458km/s
Substitute into formula [2] to get: $t_0 2$ = 22.00784022
Substitute: t'=22 years a_3 = 83°40'16.2'' U_0 C_0 into formula [2]

Got: $t_0 3$ = 22.00776322 years
$t_0 = (t_0 2 + t_0 3) / 2$ = 22.00780172 years
Barnard star in t_0 (22.00780172) time traveled Δl distance,
$\Delta l = t_0 U_0 / C_0$ = 0.07042474278 light years

$$L_3 = \Delta l \mathrm{Sin}\, \alpha_2/\mathrm{Sin}\theta' \qquad [3]$$

Substitute: Δl =0.07042474278 light-years α_2=83°36'29.38'' θ'=0°3'46.82'' into formula [3]
Get: L_3=63.64452522 light years t_3 =63.64452522 years.

$$L_2 = \Delta l \mathrm{Sin}\, \alpha_3/\mathrm{Sin}\theta' \qquad [4]$$

Substitute: $\alpha_3 = 83°40'16.2''$, Δl, θ', etc. into formula [4]
Get: $L_2 = 63.65232694$ light years $t_2 = 63.65232694$ years.

Verification; two spaceships ②, ③ start from the point P_2 on the X axis at the same time, the spaceship ② flies to the point P at the speed of light, reaches the point P after t_2 time, waits at the point P, and the spacecraft ③ travels along the X axis to U_0 speed of flight, through t. When the time reaches the point P_3, it flies to the point P at the speed of light instantaneously, and reaches the point P after t_3 time. At this moment, the spacecraft ② has waited for the time interval t. Spaceship ② and spaceship ③ have the same timing, except that spaceship ② arrives at time interval t earlier at point P,
Therefore:

$$t_2 + t = t_0 + t_3 = T \qquad [5]$$

Substitute the above data into formula [5]: 63.65232694 years + 22 years = 22.00780172 years + 63.64452522 years
$t_2 + t = 85.65232694$ years $= T$
$t_3 + t_0 = 85.65232694$years $= T$ See Figure 3-1

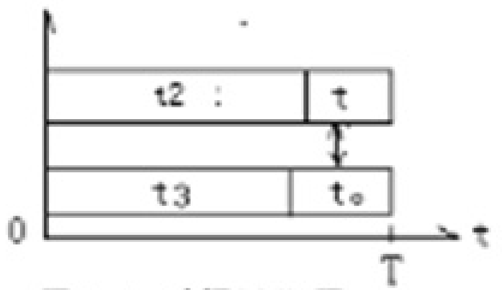


图3-1 时间转换图

$$l' = L_3 \cos \alpha_3 \qquad [6]$$

Substitute: $L_3 = 63.64452522$ light-years $\alpha_3 = 83°40'16.2''$ into formula [6], we get: l'=7.0158 light-years
Convert Barnard Star Time 2192.4 years ($t''0 = l'\ C_0/U_0$) to Earth Time (t'')

$$t''_0 + t_4 = t'' + t_3 \qquad [7]$$

Enter t''_0 = 2192.4 years t_4 = 63.25560958 years t_3 = 63.64452522 years into formula [7]
Got: t''=2192 years,
Barnard's star will be closest to the solar system in 4214 AD, reaching the zenith of the earth (P_0), when Barnard's star is: apparent component angle $\pi/2$, apparent velocity is 0_0

By 4 formula: $L_2 = \Delta l Sin\ \alpha_3/\mathrm{Sin}\theta'$

$L_2 = \Delta l Sin\ (a_2+\theta')/\ \mathrm{Sin}\theta' = \Delta l(\mathrm{Sin}\ a_2\ \mathrm{Cos}\ \theta' + \mathrm{Cos}\ a_2\ \mathrm{Sin}\ \theta')/\mathrm{Sin}\ \theta'$

$L_2/\Delta l = \mathrm{Sin}\ a_2/\mathrm{tg}\ \theta' + \mathrm{Cos}\ a_2$

Arranged:

$$\mathrm{tg}\ \theta' = \mathrm{Sin}\ a_2/(\ L_2/\Delta l - \mathrm{Cos}\ a_2\ ) \qquad [8]$$

[8] type; celestial body self-propelled type, become universal type

$$\mathrm{tg}\ \theta = \mathrm{Sin}\ a_n\ /(Ln/\Delta l\ n - \mathrm{Cos}\ an\ ) \qquad [8]$$

Discussion

The light source is U. The speed moves along the X-axis of the S system, and the Doppler effect occurs, as shown in Figure 3-2 A. At this time, there are five stationary testers who measure the speed of the light source at five positions.

1. The tester is in the direction of the light source movement. The visual component angle is 0 degrees,
2. the observer's visual component angle is α_2,
3. the observer's visual component angle is α_3 (90 degrees),
4. the side visual component angle is α_4, and
5. the observer's visual component angle is α_5 (180 degrees).

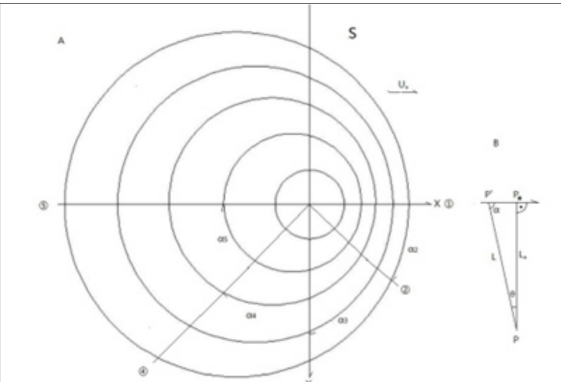


图3-2 A多普勒效应图

For the **subject 1**, the light source is blue-shifted, and the apparent velocity is the intrinsic velocity U_0 0
For **subject 2**, the light source is blue-shifted, and the speed of vision is U_2 ($U_2 = U_0$ Cos α_2).
For the **subject 4**, the light source is redshifted, and the speed of vision is U_4 ($U_4 = U_0$ Cos α_4).
For **subject 5**, the light source is redshifted, and the apparent velocity is the intrinsic velocity U_0 0
For **subject 3**, the visual velocity is 0, as if the light source is stationary relative to the subject, because the optical paths of the light waves from the light source to the subject are the same, the visual velocity measured by the subject is 0, as shown in Figure 3-2 B; the light source moves to close to P. At the P' point, the distance from the observer is L optical path, the visual component angle is α ($\alpha = \alpha_3$-θ or $\alpha = \alpha_3$+θ), and the optical path $L = L_0\ /\sin\alpha = L_0\ /\sin\ (\alpha_3 \pm \theta)$

$$L = L_0/\cos\ \theta \qquad [9]$$

It can be known from the formula [9] that when the angle θ becomes smaller than 2 arcseconds ($\cos\ \theta = 1$), $L = L_0$, the optical path of the light wave from the light source to the tester, which is equivalent to L_0, the light source measured at this time is equivalent to being stationary relative to the tester. Formula [9] is equivalent to the description that when the light source is stationary relative to the observer, the light wave reaches the observer with the same optical path, and the apparent velocity $U = U_0$ Cosα, directly describes the apparent velocity U and the intrinsic velocity U_0 - Changes with the change of the apparent component angle α. During the observation, the apparent component angle has been gradually increasing, from 0 to $\pi/2$, and gradually to π_0.

For a celestial body with an annual self-propelled value of 1 arcsecond, the apparent velocity is 0 for four years when it crosses the zenith of the Earth, and for a celestial body with an annual self-propelled value of 0.5 arcseconds, the apparent velocity is 0_0 for eight years when it crosses the Earth's zenith.

Viewing component angle a (°)	0	30	60	90
	180	150	120	
visual rate u (km/s)	±959.332	±830.805	±479.666	0
Line of sight Ln (l.y)	1.3×10^{10}	126.51	73.04	63.255
Celestial time t_0 (day)	366.171	366.014	365.584	365 day/year
	363.853	363.991	364.416	
celestial body Δln (l.y)	3.21×10^{-3}	3.208×10^{-3}	3.205×10^{-3}	3.199×10^{-3}
	3.189×10^{-3}	3.191×10^{-3}	3.194×10^{-3}	
Celestial body's proper motion θ	0	2.62"	7.84"	10.44"
	0	2.6"	7.81"	

Table 1: Data before and after Barnard Star

From the data in Table 1, it can be seen that Barnard's star moves in a straight line at a uniform speed (without the action of external force) relative to the solar system, and the initial (apparent angle is 0) apparent velocity is the intrinsic velocity, and when it gradually moves to the zenith of the earth (P_0), the apparent velocity gradually changes from the Eigen speed to 0, and then moves to the end (the component angle is 180), and the apparent velocity gradually changes from 0 to the eigenvelocity.

Earth's time is 365 days a year (rounded by an integer), while Barnard's star is relative to the earth, from the initial 366.171 days, when it moves to the zenith of the earth, it is 365 days, which is the same as the earth's year and day, and then moves to the end, Barna The days of Dexing continue to shorten and become 363.853 days. Barnard's star is opposite to the earth. From the beginning to the end, the changes of Barnard's star's years and days are from 366.171 days to 365 days to 363.853 days.

Has the Barnard's star date changed, see Figure 3-3

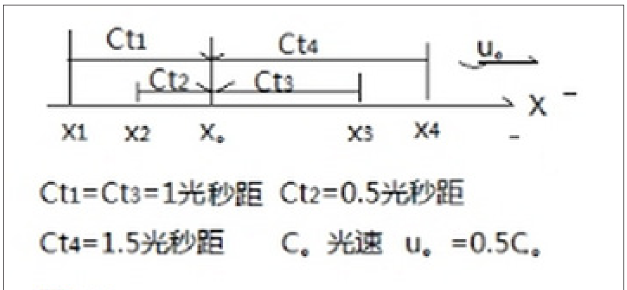


图3-3

A light source moves along the x-axis at a speed of 0.5 light, and at the moment at x_1, it emits a light signal ①, and after one second, it emits a light signal at x_2, and at this moment, the signal ① reaches x_0 After 0.5 seconds, the observer recorded ② optical signal, measured ① ② optical signal observation time interval is 0.5 seconds, and the light source emits ① ② optical signal time interval is one second.

The light source does indeed emit ① ② optical signals at intervals of one second, and the subject does indeed receive ① ② optical signals at 0.5 second intervals, because the optical signals ① and ② reach the subject with different optical distances.

The light source moves to x_3 to emit ③ optical signal, and after one second reaches x_4 to emit ④ optical signal, at this moment ③ signal reaches x_0 The tester, the tester starts timing, at this moment, the light source is reaching x_4, and emits the ④ light signal, and the light signal ④ reaches x after 1.5 seconds. , the time interval for the tester to record the signals ③ and ④ is 1.5 seconds.

The light source transmits ① ② and ③ ④ optical signals at the same one-second interval, but the subject receives ① ② and ③ ④ optical signals at 0.5 second and 1.5 second intervals, because the ① ② and ③ ④ signals reach the subject with different optical distances, and there is a time effect!

[2] The formula is the time effect formula, the earth's year and day is a constant quantity, and the year and day of the celestial Barnard's star is a variable!

The time of the celestial body in the formula [2] is t. 2(t_0) is set as a constant quantity, and t'(t) in Earth time becomes a variable,
The formula [2] is as follows;

$$t = t_0\,(1-\cos aU_0/C_0) \qquad [9]$$

As shown in Figure 3-2, the light source moves at a speed $U_0 = 0.5C_0$, the pulsed light signal is emitted ①, ②, ③… period $t_0 = 1$ second, the initial movement towards the tester, the visual component angle a = 0, the tester's measurement period t = 0.5 seconds, the light source moves relative to the tester, the form is shown in Figure 1, and the light source pulse period measured by the tester is shown in Table 2;

Viewing component angle a (°)	0	15	30	45	60	75	90
	182	165	150	135	120	105	
Observation period t (seconds)	0.5	0.517	0.566	0.646	0.75	0.870	1.0
	1.5	1.482	1.433	1.353	1.25	1.129	

Table 2: Transmit period t_0 = 1 second

It can be known from Table 2 that the observation period is gradually slowing down.
From the formula [8], the θ item of celestial motion in Table 1 is obtained; when the apparent component angle a is 0° and 180°, the annual proper motion value is 0°. When Barnard's star moves to the zenith of the earth (P_0), the apparent velocity is 0, and the annual self-value is at most 10.44″.

In 2022, the viewing angle a = 83°40′16.2″, the viewing distance L = 63.642 light-years, the Barnard star time t_0 = 365.128 days, the self-travel *Δl* n = 0.00320 light-years, and the above data are substituted into [8] formula, the annual self-propelled value θ = 10.31″.

It is known from Table 1 that when Barnard's star moves to the zenith of the earth, its annual proper value is the largest (10.44") and the zenith distance is 63.255 light-years. For example, at a farther zenith distance, what is its annual proper value, see Table 1. 3;

Zenith distance L_0 (l.y)	1.0×10^3	1.0×10^4	1.0×10^5	1.0×10^6	1.0×10^7	1.0×10^8
959.332km/s (Barnard Star)	0.66"	0.07"	0.01"	0.0"		
0.5 speed of light		10.31"	1.03"	0.1"	0.01"	0.0"
speed of light			2.06"	0.21"	0.02"	0.0"

Table 3: Relationship between celestial body's intrinsic velocity, zenith distance and annual proper value

From Table 3, when the zenith of Barnard's star is 1,000 light-years away, its annual proper value is 0.66", and when it is 100,000 light-years, its annual proper value is 0.01".

For a celestial body that reaches the speed of light, its zenith distance is 10 million light-years, and its annual proper value is only 0.02". When it reaches 100 million light-years, its annual proper value is 0, and its proper motion cannot be measured.

Verification

Verification (1): Barnard's star to the zenith of the earth P. It will take more than 2,000 years, the apparent velocity is 0, and the annual proper value is the largest (10.44"), and the apparent velocity is increased year by year after one year of observation. The younger the year, the bigger the year itself is.

Verification (II): From Table 1, it is known that the celestial body moves to the zenith of the earth (P_0), its apparent velocity is 0, and its annual proper value is the largest. A celestial body, the apparent velocity U_1 = 20km/s, the annual self-value is 1.0″, after 4 years, the self-propelled θ = 4.0″, the apparent velocity U_2 = 19.8km/s, the blue-shifted celestial body, and the above data is substituted into [1] Formula, the apparent component angle a = 89°53′20″, the Eigen speed U of the celestial body.

U_0 = 10313.259km/s,

4-year self-travel Δl n = 0.137605 light-years.
Substitute θ, a, Δl n into formula [3];

Obtained: the viewing distance L=7095.770 light-years.

If the apparent velocity observed in the first year is U_1 = 19.8km/s, and the observed velocity in the fourth year is U_2 = 20km/s, the red-shifted celestial body will still have its proper motion in four years.

θ = 4.0″, substitute the above data into formula [1]

The apparent component angle a = -89°53′24″
get the intrinsic velocity U_0 =10313.259km/s
A 4-year journey Δl n = 0.137605 light-years
Substitute θ, a, Δl n into formula [3];

Obtained: the viewing distance L = -7095.772 light-years.

Substitute the celestial body's annual motion value of 0.5″, 4-year motion θ = 2.0″ U_1 = 20km/s U_2 = 19.8km/s into formula [1]

The apparent component angle a = 89°56′40″
get the intrinsic velocity U_0 = 20626.490km/s
A 4-year journey Δl n = 0.27521 light-years
Substitute θ, a, Δln into formula [3];

Obtained: the viewing distance L = 28383.082 light-years.

Verification (III): All celestial bodies that have their own motion, the blue-shifted ones, their apparent velocity is slowing down, and the red-shifted ones, their apparent velocity is getting faster [4], and the future astronomical observations will be verified.

References

1. Liang Shiduo (2018). Time-frequency effect experiment and verification of mathematical relationship, *Journal of Zhejiang Jiaotong Vocational College*, 3, 47-50.
2. Liang Shiduo (1995). Time Effect, Journal of Wenzhou Normal University, *Natural Science Edition*, 6, 51-55.
3. Asimov, L. (1984). Universe [M]. Beijing: *Science Press*, 35-37.
4. 2016 Chinese Astronomical Calendar, edited by Purple Mountain Observatory, Chinese Academy of Sciences [G], Beijing, *Science Press*, 202-445.