# THE RITZ EFFECT AS A CAUSE OF VARIATIONS IN THE ORBITAL PERIOD

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The paper considers the hypothetical Ritz effect, which follows from the ballistic theory of light and manifests itself in a change in the time scale of the observed events with a parallel change in the frequency of light. The effect elementarily explains the significant variations in the period of X-ray pulsars, in particular, the period of pulsations GX 1 + 4 and quasiperiodic oscillations IGR J17480-2446, short periods of these and radio pulsars. The effect also explains the anomalies, inconsistencies in the radial velocity plots and light curves of binary pulsars or any other binary stars. Based on the predicted super-frequency modulation (HFM) effect, the anomalously fast motions of stars around the galactic center in Sgr A * and the activity of galactic nuclei are explained without the hypothesis of supermassive black holes.

*Key words:* orbital elements, Ritz effect, pulsars, binary stars, the center of the Galaxy, supermassive black holes.

## INTRODUCTION

To date, a number of space objects have been discovered in which the orbital period is rapidly changing. As a rule, these variations are interpreted according to the Doppler effect as a result of variations in the orbital radial velocity of bodies entering the system. A striking example is the satellites of Jupiter, whose orbital period change was discovered in the 17th century, long before the Doppler effect was discovered [1]. But in rare cases, the change is so large that it cannot be explained by the Doppler effect at typical velocities $V << c$. In addition, extremely short orbital periods are often observed, which are orders of magnitude shorter than theoretically possible. Next, we will consider this phenomenon from the point of view of alternative effects of the period change, for example, from the standpoint of the Ritz effect, a hypothetical effect predicted in 1908 by Ritz on the basis of ballistic theory [2, 3] and substantiated in the 21st century by the example of a number of astronomical effects, including anomalies of redshift in the spectra of galaxies and quasars [3–5] and regularities of the Barr effect [6].

### The Ritz effect

The essence of the effect is as follows. Consider a source emitting light signals at a short time interval $dt$ and remote from the receiver at a distance $r$. The light from the source emitted at time $t$ will reach the receiver at time $t' = t + r/c'$, where $c'$ is the speed of light in vacuum. The time $dt'$ between the reception of two light signals is found by differentiating $t'$ with respect to $t$:

$$dt' = \left(1 + \frac{\partial r}{\partial t} \cdot \frac{1}{c'} - \frac{r}{c'^2} \cdot \frac{\partial c'}{\partial t}\right) dt \quad (1)$$

Here the general case is considered, when the speed of light $c'$ plays the role not of a constant $c$ (as in STR), but as a variable, as in general theory of relativity (GR) and Ritz's theory [2, 7]. The second term in (1) characterizes the Doppler effect $dt' = (1 + V_r/c')dt$, since $\partial r/\partial t = V_r$ is the radial velocity of the source relative to the receiver, and the third term characterizes the change in signal duration due to variations in the speed of light. This effect

$$dt' = \left(1 - \frac{r}{c'^2} \cdot \frac{\partial c'}{\partial t}\right) dt, \quad (2)$$

follows from the ballistic principle $\mathbf{c'} = \mathbf{c} + \mathbf{V}$ (classical addition of velocities [1, 7]), according to which the speed of light $\mathbf{c'}$ changes from the addition of the velocity $\mathbf{V}$ of the source (as opposed to SRT, where in vacuum always $c' = c$). Note that at the moment there are no experiments (including De Sitter's analysis and the experiment of EB Aleksandrov), which unequivocally proved the fallacy of the ballistic principle [3, 5, 8]. On the contrary, there are a number of astronomical observations, effects, and patterns that testify in favor of the Ritz theory [3, 6, 8–10]. From the ballistic principle in the direction of the receiver, the speed of light is $c' = c - V_r$, where $V_r$ is the radial velocity of the source (the projection of $\mathbf{V}$ onto the line of sight is the radius vector $\mathbf{r}$ of the source). Differentiating $\partial c'/\partial t = -\partial V_r/\partial t = -a_r$ (where $a_r$ is the radial acceleration of the source - the projection of the vector $\mathbf{a}$ onto $\mathbf{r}$) and substituting in (2), for $V_r << c$, we find

$$dt' = \left(1 + \frac{r a_r}{c^2}\right) dt. \quad (3)$$

The nature of the effect is obvious: according to ballistic theory, an accelerated source at each subsequent moment imparts a new speed to the light, and successive signals (or fronts of light waves) emitted at different speeds catch up with each other (shortening the wavelength λ), or diverge (increasing λ) coming to the receiver more or less often. From the transformation of the intervals $dt$ (3), the period $T$ of light oscillations $T' = Tdt'/dt$ and the law of conservation of light energy, we find for the change in the initial wavelength $\lambda' = cT'$, light frequency $f' = 1/T'$, pulse duration $\Delta t'$, and its intensity $I'$ (compared to the intensity $I$ of light from the same, but stationary source), the transformed parameters (*shaded*) compared to static (*unshaded*) in the same system:

$$\lambda' = \lambda\left(1+\frac{ra_r}{c^2}\right),\quad f' = f\left(1+\frac{ra_r}{c^2}\right)^{-1},\quad \Delta t' = \Delta t\left(1+\frac{ra_r}{c^2}\right),\quad I' = I\left(1+\frac{ra_r}{c^2}\right)^{-1}. \tag{4}$$

Effects (3) and (4), complementing the Doppler effect, will hereinafter be called the Ritz effect, since formula (3) was derived by the Swiss physicist W. Ritz in 1908 [2, p. 251]. A possible confirmation of the effect is the redshift $z = (\lambda' - \lambda)/\lambda$ in the spectra of galaxies, which is also proportional to the distance $r$ of galaxies, with a corresponding extension of the duration of processes in galaxies [3–5]. From (1) at $V_r << c$ follows the transformation in the sum of the Doppler and Ritz effects

$$dt' = \left(1+\frac{V_r}{c}+\frac{ra_r}{c^2}\right)dt,\quad \lambda' = \left(1+\frac{V_r}{c}+\frac{ra_r}{c^2}\right)\lambda. \tag{5}$$

The Doppler effect $dt' = (1 + V_r/c)dt$ is easily recorded in the laboratory, and the Ritz effect (3) is much more difficult to detect, due to the smallness of $ra_r/c^2 << 1$. But at cosmic distances $r$ of the order of a light year, small accelerations $a_r \sim c^2/r \approx 9.5$ m/s$^2$ can change the apparent duration of the processes and the wavelength at times. This, in particular, can explain short frequent bursts of pulsars, which can be ordinary binary stars, which significantly change the frequency $f'(t)$ and radiation intensity $I'(t)$ according to the Ritz effect (4) with variations in the radial acceleration $a_r(t)$ [4, 10, 14].

If effect (4) takes place, and the apparent motion of stars is distorted, then, in addition to the noted distortion, there will be an additional shift of the spectral lines to the Doppler effect according to law (4). The total change in the period and wavelength of the spectral line is given by formula (5). Thus, the redshift $z$ is represented by the sum of the displacements according to the Doppler effect and according to the Ritz effect:

$$z = \frac{\Delta\lambda}{\lambda} = \frac{V_r}{c} + \frac{ra_r}{c^2}. \tag{6}$$

Interpreting this displacement as purely Doppler, the calculated radial velocity value that does not coincide with the true $V_r$ is obtained in spectral measurements

$$V_r' = c\frac{\Delta\lambda}{\lambda} = V_r + \frac{ra_r}{c} = V_r + V_r^*. \tag{7}$$

where $V_r^*$ is the additional imaginary radial velocity due to the Ritz effect.

## Orbital phase shift and period variations

For radial velocity plots of stars moving in a circular orbit, the Ritz effect will lead to a change in the orbital phase of the star. The true radial velocity of the star is given by the expression $V_r = -K\sin(2\pi t/P)$. Taking into account the acceleration $a_r = dV_r/dt = -(2\pi K/P)\cos(2\pi t/P)$, the additional imaginary (apparent) velocity introduced by the Ritz effect will be $V_r^* = ra_r/c$ or $V_r^* = la_r/c$ (in the case of re-radiation light by interstellar gas at a length $l$ [3, 8]). From here we find that the design speed is given by the expression

$$V_r' = V_r + V_r^* = -K\sin\left(\frac{2\pi t}{P}\right) - \frac{2\pi lK}{Pc}\cos\left(\frac{2\pi t}{P}\right) = -K'\sin\left(\frac{2\pi t}{P} + \varphi\right), \tag{8}$$

where the phase shift $\varphi = \mathrm{arctg}(2\pi l/Pc)$, and the calculated radial velocity amplitude

$$K' = K\sqrt{1+\left(\frac{2\pi l}{Pc}\right)^2} \approx K\left(1+2e'^2\frac{c^2}{K^2}\right), \tag{9}$$

in the approximation of the parameter $e' = \pi lK/Pc^2 << 1$. In addition, the observed radial velocity graph $V_r'(t')$ will be distorted if the time is taken not the time $t$ in the source system, but the time $t'$ in the terrestrial observer's system. Then the graph of the line-of-sight velocities $V_r'(t')$ will correspond not to a circular, but to an approximately elliptical orbit with an eccentricity $e'$ (see more details about the parameter $e'$ in [6]).

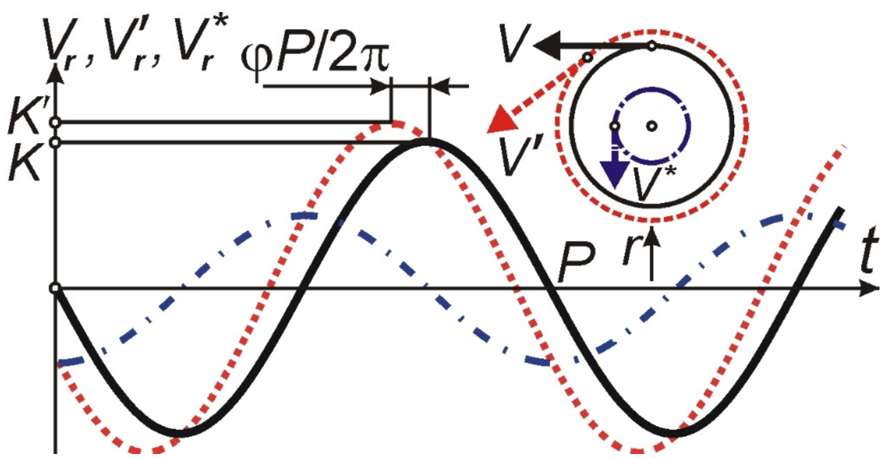


*Fig. 1. Diagram of the distortion of the Doppler radial-velocity curve $V_r(t)$ (solid line) from the additional frequency shift according to the Ritz effect in the form of the imaginary radial-velocity curve $V_r^*(t) = la_r/c$ (dash-dotted line) and the corresponding circular orbits. The resulting spectral offset curve (dotted line) gives the false Doppler velocity $V_r'(t) = V_r(t) + V_r^*(t)$.*

The phase shift of the radial-velocity graph $V_r'(t)$ (Fig. 1) will be noticeable for spectroscopic binaries observed simultaneously as eclipsing binaries. Theoretically, an eclipse of a star with a circular orbit would be observed at the moment of its greatest distance in the phase of the radial-velocity curve 0. If the curve is shifted by the Ritz effect, the eclipse will occur with a delay by the phase difference $\varphi$ reaching $\pi/2$ (or in the orbital phase $\Phi = \varphi/2\pi = 0.25$ in astronomical notation), in the limiting case when the spectrum shift is mainly due to the Ritz effect. Phase mismatches between the light curves and the radial velocity are actually discovered, for example, for υ Andromeda [11], as well as for a number of close binary stars, which is usually interpreted according to the hypothesis of an inhomogeneous distribution of brightness over the stellar surface. The effect was also found for the binary pulsar PSR 1957 + 20, in which the eclipse occurs in the orbital phase $\Phi = 0.25$ [12], which coincides with the limiting value of $\Phi$, at which the pulsar period variations are almost entirely due to the Ritz effect.

If a pair of stars in a multiple system moves with a general acceleration $a_r$ in the gravitational field of a third star, then, in accordance with (4), the observed orbital period $P'$ of the system will change in comparison with the true $P$. But, unlike the Doppler effect (for example, for satellites Jupiter), the reduction of the measured period $P'$ according to the Ritz effect will be significant when $a_r$ reaches the critical value $|a_r| \sim a_0 = c^2/r$. Moreover, the period $P'$ can decrease by orders of magnitude and change rapidly for $a_r \approx -a_0$ and small variations of $a_r$ near $-a_0$ as

$$P' = P\left(1 + \frac{ra_r}{c^2}\right) = P/g ,$$

where $g$ is the compression ratio, time scale compression.

A similar effect was observed for the X-ray pulsar GX 1 + 4, the period $P_1'$ of pulsations of which decreased for 15 years until, in 1985, having reached a minimum, it began to grow just as rapidly (Fig. 2). To explain these variations in $P_1'$, it was formally assumed that the magnetic fields and friction of the rotating gas ring, which accelerated the rotation of the star, began to slow down its rotation [13]. But until now, the reasons for the change in direction while maintaining the magnitude of the moment of friction forces, which is huge, have not been clarified. in 10 years it doubled the giant rotational energy of the pulsar, and then just as quickly slowed down the rotation. The Ritz effect elementarily explains these variations as illusory [14], if we assume that a pulsar with a period $P_1$ enters a multiple system moving around the main star with a large orbital period $P_2 = 2\pi/\omega$ and orbital radial acceleration $a_{2r}$. First, during the orbital motion of the star (approximately in a circular orbit), the acceleration of the pulsar $a_{2r} = a_2\cos(\omega t)$ approached $-a_0$, shortening the recorded period $P_1' = P_1 + P_0\cos(\omega t)$, and then began to move away from $-a_0$, increasing $P_1'$, where $P_0 = P_1 r a_2/c^2$. The time scale $dt' = dt/g$ is compressed in proportion to the compression ratio $g$, whence $t' = t + P_0\sin(\omega t)/\omega P_1$. Thus the graph of the observed variations $P_1'(t')$ represents a trochoid (shortened cycloid). Near the minimum (tip of the trochoid) $P_1'$ changes almost linearly, as in GX 1 + 4 [15]. Similar variations were observed for the pulsar 4U0900-40 [16, p. 594]. Small deviations of points from the trochoid are probably associated with small variations of $a_r$ in the gravitational field of satellites, respectively changing $P_1'$ (this is how an additional regular variation of $P_1'$ is observed with a period of 304 days [18], corresponding to the orbital period of a hypothetical satellite), as well as that the true motion of the pulsar occurs not in a circular but in an elliptical orbit. For exact alignment of the theoretical and experimental curves $P'(t')$ and determination of the parameters of the pulsar orbit, it is necessary to enumerate the parameters $e$, $a$, $\omega$ of the orbit, minimizing the sum of squares of deviations of the experimental points from the theoretical curve, or represent the dependence $a_{2r}(t)$ in the form polynomial, series, choosing the coefficients according to the method [17]. With a minimum period $P_1' \approx$ 100 s, the star stopped emitting X-rays. In the framework of the ballistic theory, this is a consequence of the increased degree of compression $g$, which transforms the optical radiation of the star into the gamma-range rather than in the X-ray range. But at that time, the star was not studied in gamma rays, and its gamma variability remains in question.

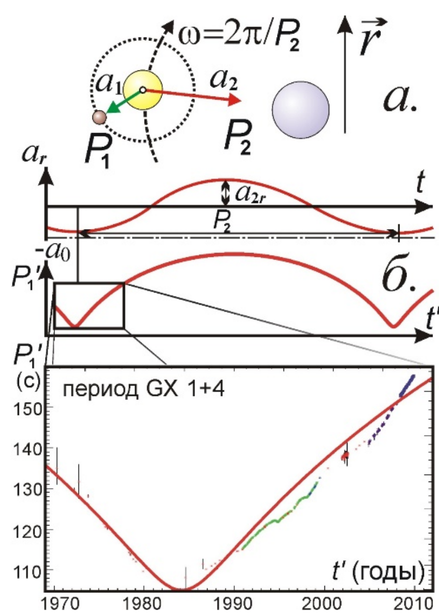


*Figure: 2. Possible structure of the pulsar GX 1 + 4 (a) and variations of its period $P_1'$ due to the acceleration of the star and the Ritz effect (b). The solid line $P_1'(t')$ is a theoretical curve (modeling by the Ritz effect), points with error intervals are the result of period measurements [13, 15].*

The flares themselves (variations in $I'(t)$) are obviously caused by the regular compression of the binary star light according to the Ritz effect (4). This is confirmed by the example of the pulsar GX 5-1, in which the power of flares increases in proportion to the integral luminosity of the star, as in a number of other pulsars and variable stars [14]. Oscillations of radial acceleration can be associated either with the orbital motion of binary stars, or with the pulsation of their surface. For example, in stars of the β Canis Major, β Cephei, and peculiar Ap stars of the main sequence, in which brightness oscillations with a period of 5–20 minutes are discovered, the variability mechanism can be combined. Thus, brightness varies due to small pulsations of the stellar atmosphere and due to the Ritz effect, which enhances small brightness oscillations $I'$. So, in the atmosphere of the Sun, five-minute oscillations are discovered [16, p. 301]. By themselves, such rapid fluctuations are not able to lead to a noticeable change in the radius, temperature and true brightness of the star, and fluctuations in brightness cannot be explained within the framework of the theory of pulsations. But the modulation of the radial velocity of the stellar atmosphere (with an amplitude of 100–200 m/s) leads, according to the Ritz effect, to noticeable variations in brightness, as shown by S. Devasia [19]. Such short-period brightness oscillations with a period of several minutes are actually observed in a number of stars, for example, in V391 Pegasus, in white dwarfs [16, p. 142]. Because the amplitude of the brightness oscillations is high; their most probable cause is the Ritz effect. In pulsars moving around the main star with acceleration $a_r \approx -a_0$, the orbital period ($P \sim 1$ day) or pulsation period ($P \sim 1$ min) is compressed to $P'$ according to the Ritz effect (4), decreasing by a factor of millions ($g \sim 10^6$). This also explains the bimodality in the distribution of the periods $P'$ of pulsars, i.e. grouping periods around values of the order of seconds and milliseconds.

Another example is the T5X2 object (pulsar IGR J17480-2446 in the Terzan 5 cluster), which also exhibits brightness variability in X-rays: in addition to ordinary pulsations with a frequency of 11 Hz, quasiperiodic oscillations (QPO) with a frequency of the order of MHz are observed [20]. Within one month, for T5X2, the period of quasiperiodic oscillations decreased from 1000 to 200 s, and then increased again to 1000 s (Fig. 3). An increase in the brightness oscillation frequency by a factor of 5 (from 1 MHz to 5 MHz) was accompanied by a proportional increase in the average X-ray brightness by a factor of 5. As seen from Fig. 3, the maximum X-ray brightness corresponds exactly to the maximum brightness oscillation frequency. It is natural to interpret this as a manifestation of the Ritz effect (4): the approach of the acceleration of the system to the critical one (as in Fig. 2) is accompanied by a proportional increase in the frequency of brightness and intensity oscillations by a factor of 4–5, according to ф -le (4). Apparently, the proximity of the acceleration $a_r$ to the critical $-a_0$ makes T5X2 an X-ray source, converting the light of the main sequence star into the X-ray range.

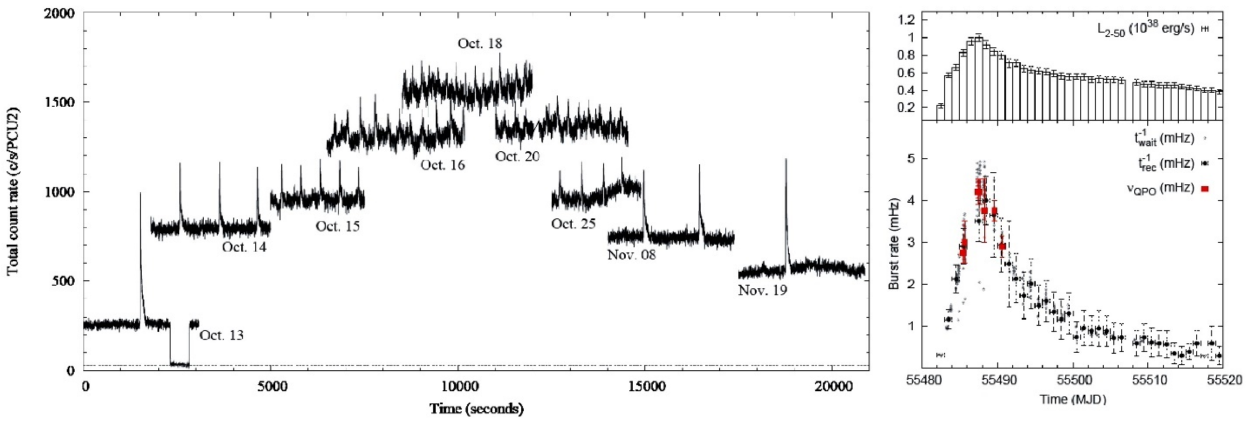


*Figure: 3. Left - a graph of fluctuations in the X-ray brightness of the object T5X2 (IGR J17480-2446) in 2010. On the right - graphs of fluctuations in the average X-ray brightness and frequency QPO of brightness variations [20].*

A parallel increase in the intensity and color temperature (frequency of the spectral maximum) of X-ray radiation was also found in the IGR J18245-2452 pulsar [21]. Note that its X-ray brightness pulsations have the form of almost perfect sinusoids. This testifies to oscillations caused by the motion of the star in a circular orbit with radial acceleration $a_r$, varying according to a harmonic law. According to the Ritz effect, at a small modulation depth $a_r(t)$ relative to the $-a_0$ ($m << 1$) level, this leads to brightness fluctuations according to the harmonic law [14].

## Frequency overmodulation effect in Sgr A*

A similar illusory acceleration of processes is probably observed in the case of other anomalously fast motions or anomalously fast changes, for example, in the center of our Galaxy [10, 22]. In particular, in the region of the galactic center - the radio source Sgr A*, anomalously fast motions of stars are observed near a hypothetical supermassive black hole with a mass $M' \sim 4\times10^6 M_\odot$. It is believed that it is the supermassive black hole that creates the gravitational forces sufficient to hold fast stars in wide orbits. Moreover, the giant velocities of stars are established both by the apparent motion and by the spectrally measured radial-velocity curve, which quite accurately corresponds to the observed motion of the stars [23, 24]. However, it is possible to consider other explanations for anomalously fast motions in the center of the Galaxy, especially since other facts contradict the existence of a supermassive black hole there. The absence of supermassive bodies in the center of our and other galaxies confirms the emission spectrum of these areas, which corresponds to an extremely rarefied gas, judging by the presence of forbidden lines in the spectrum [25, p. 374]. The presence of supermassive black holes caused by accretion of interstellar gas on them, i.e. increasing its concentration and temperature. In addition, no relativistic precession is observed - the displacement of the periastrons of the orbits, which in a giant gravitational field occurred much faster than that of Mercury.

Thus, the ultrafast motions of stars in the center of the Galaxy are unlikely to be caused by the gravity of a supermassive black hole. It is more natural to assume that there is an illusory increase in the velocity of the apparent motion of stars due to the motion of the stellar system with radial acceleration $a_c$ close to the critical one $a_c \approx -a_0$. For example, if a star system with a massive central star moves with acceleration $a_c \approx -a_0$ in the gravitational field of another massive star or star cluster.

Let us solve the problem strictly and calculate how many times the apparent motion of the star is accelerated if $(1 + ra_c/c^2) = b << 1$, i.e. the compression ratio $g$, showing how many times the apparent motion is accelerated in comparison with the true one, will be equal to $g = dt/dt' = 1/b >> 1$. In the case of the extreme approach of acceleration with the critical $-a_0$, the effect of frequency overmodulation (FM) will be observed , when small modulations of the speed of light with $c' = c - V_r$, caused by the proper motions of stars with a radial velocity $V_r$, lead to giant frequency variations. In the general case, from (5), if we take into account $c' \neq c$ and assume that the proper orbital accelerations of stars are small (i.e., their resulting radial acceleration $a_r \approx a_c$), the period of light oscillations is transformed as

$$T' = \left(1 + \frac{V_r}{c'} + \frac{ra_r}{c'^2}\right)T \approx \left(1 + \frac{V_r}{c'} + \frac{b-1}{(1 - V_r/c)^2}\right)T \approx \left(b + \frac{V_r}{c} - 2\frac{V_r}{c}\right)T = \left(1 - \frac{V_r}{cb}\right)bT \quad . \tag{10}$$

Thus, the motion of the stars looks accelerated by a factor of $g = 1/b$, so that the measured astrometrically transverse velocity of the stars is $V_t'(t) = V_tT/T' = V_t(t)/b$. And the measured spectroscopically radial velocity, if we study the relative displacements of the lines from their mean positions, will be $V_r'(t) = -V_r(t)/b$. Thus, in both cases, there is an illusory increase in speed by a factor of $g = 1/b$, but in the second case, the calculated direction of the speed is reversed. It would seem that this would lead to a discrepancy between the observed astrometrically motion and the measured spectroscopically motion of the stars. However, in fact, from the ambiguity of the angle $i = i_0$ of the orbital inclination, since only the projection of the orbit and apparent motion onto the plane of the sky is observed (Fig. 4), they may correspond to two astrometrically indistinguishable variants of the orbit arrangement $i = i_0$ and $i = -i_0$. Accordingly, each position of the star will correspond to two possible values of the radial velocity $V_r' = V_r0$ and $V_r' = -V_r0$. Thus, in the orbital elements, determined astrometrically and spectroscopically, there will be no contradictions, but instead of the true angle $i = i_0$ we get a false, opposite value $i = -i_0$, which corresponds to the opposite in sign value of the radial velocity $-V_r0$.

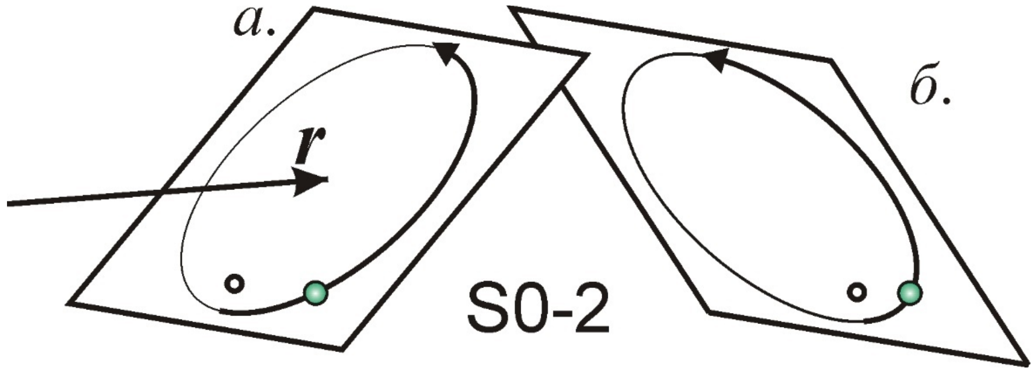


*Figure: 4. Two variants of the location of the S0-2 orbit (a and b) in relation to the line of sight* **r**, *corresponding to the same apparent motion of the star S0-2 on the plane of the sky, but with opposite sign of the radial velocity curves $V_r(t)$.*

Nevertheless, the discrepancy can be revealed by examining the spectrum of the star, in which it is possible to clearly distinguish the absorption and emission spectrum of interstellar gas [24]. If for a true orbit with $i = i_0$ the most distant point ($V_r = 0$ and decreases) corresponds to the most intense absorption spectrum of interstellar gas, then for a false orbit with $i = -i_0$ the same motion of the star on the plane of the sky corresponds to the closest position of the star and the least intense gas absorption spectrum. Thus, if the picture of the absorption spectrum variations is inverse to the expected one, or if some stars have eclipses by the central star at off-calculated times, this will mean that $i$ is determined incorrectly and the radial velocity is reversed. In addition, if you focus not on the relative displacement of the spectral lines, but on the absolute one, it will also be possible to detect a discrepancy, since from formula (10) at $g \sim 10^3$ by the Doppler effect we obtain the imaginary radial velocity $V_r' \sim -c$. Thus, a huge shift of spectral lines is observed, which is not detected solely from the incorrect identification of spectral lines. Apparently, the recorded spectral lines of helium and bromine in fact correspond to low-frequency radiation of the far-IR range and radio lines of hydrogen and helium, shifted by the Ritz effect to the near-IR range.

If the measured astrometrically and spectroscopically motions of stars near the galactic center are illusory accelerated by the Ritz effect by a factor of $g = 1/b \sim 400$, then the true velocities will turn out to be much less, and the orbital periods are much longer than the calculated ones. For example, for the star S0-2, instead of the measured speed $V_r' \sim 4000$ km/s, we find that the true speed is $V_r \sim 10$ km/s, and the orbital period is not $P' = 15$ years, but $P = 6000$ years. Accordingly, the mass of the central star will be not $M' \sim 4 \cdot 10^6 M_\odot$, but $M = M'/g^2 \sim 25 M_\odot$, i.e. a magnitude typical of O and B main sequence stars. In this case, the characteristic masses of the companion stars whose motions are observed will amount to about $0.1 M_\odot$, which is typical for red dwarfs. For a star system to move during such a time $P \sim 6000$ years with a radial acceleration close to the critical $a_c \approx -a_0$, it must fly in the gravitational field of a globular cluster located at a distance of $R \sim 100{,}000$ AU from the star. and having a mass $M \sim 10^7 M_\odot$. Such a cluster may consist of $10^6$ stars with a mass of $\sim 10 M_\odot$. In this case, a globular cluster can have a size of ~ 10,000 AU and will lead to the motion of the central star with a period of $P \sim 10{,}000$ years. Thus, there is no need for a central black hole, and the observed phenomena can be explained by the movement of an ordinary star system in an orbit around a large star cluster.

Such massive dense clusters are just typical of the central region of the Galaxy - the core in which the concentration of stars is maximum. And the center itself serves as a center of gravity, capable of providing a critical acceleration $a_c \approx -a_0$. Indeed, according to the known mass distribution in the core [16, p. 197], a ball of radius $R$ centered at the center of the Galaxy has a mass $M(R) = kR$, where $k \approx 10^7 M_\odot$ pc$^{-1}$. Hence, the critical distance $R_c$ is found from the acceleration on the surface of a ball of such radius equal to the critical distance $a_0 = GM/R_c^2$. Whence $R_c = Gkr/c^2 = 1.5\times10^{14}$ m = 1000 AU. This $R_c$ value is within one order of magnitude correlated with the measured semiaxes of the orbits of S0-2 and other stars moving around the central object [23, 24]. Thus, inside a sphere of such a radius at the center of the galaxy, many objects flying around the center will have an acceleration of the order of the critical $a_0$. As a result, the effect of supermodulation of frequency makes it possible to elementarily interpret the activity of galactic centers in the form of flares and other rapid variability of brightness and spectrum in the entire range of electromagnetic waves, and also makes it possible to explain abnormally fast motions in the center of our (Sgr A*) and other galaxies.

## CONCLUSION

It is shown that the hypothetical Ritz effect, which follows from the classical transformations for the speed of light from a moving source, explains a number of effects, including the redshift of galaxies, rapid changes in the frequency of light of stars, distortion of the shape of the radial velocity graph and the apparent motion of binary stars and exoplanets, as well as fast changes in their periods. The effect elementarily explains the observed anomalies in the radial velocity plots and light curves for binary stars, pulsars and exoplanets. The effect of supermodulation of the frequency of light, predicted on the basis of Ritz's theory, elementarily explains the anomalously fast motions of stars in the center of the Galaxy, near a hypothetical supermassive black hole. Also, the effect of overmodulation of frequency naturally explains the activity of galactic nuclei - the rapid variability of the brightness and spectrum of nuclei, including in the radio, X-ray and gamma ranges.

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