Answering Laplace's Problem

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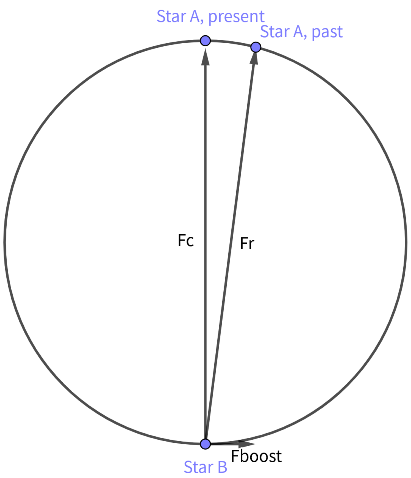
Abstract

I discovered a thorough explanation addressing the issue raised by Laplace, in the book "Celestial Mechanics" in 1805. He had contended that it was impossible to sustain a stable orbit for a celestial body with a force transmitted at a finite speed. This part had been roughly guessed after Purcell's formula for electromagnetic fields appeared, but it was a part that could not be handled accurately with Purcell's formula, which could not handle acceleration. Therefore, the essential aspects of the phenomenon were completely inaccessible. I solved this problem by using Maxwelian gravity and converting Feynman's formula into a more practical form. $\vec{E} = \frac{q}{4\pi\varepsilon_0 r^2 (1 + \frac{\dot{r}}{c})^3} \left(\left(1 - \frac{v^2}{c^2} + \frac{\vec{a} \cdot \vec{r}}{c^2} \right) \left(\hat{r} - \frac{\vec{v}}{c} \right) - \left(1 + \frac{\dot{r}}{c} \right) \frac{r\,\vec{a}}{c^2} \right)$ Consequently, I discovered that the force transmitted at a finite speed of light produces a subtle resistance component. The energy loss attributed to this resistance component consistently remains smaller than the loss incurred due to the wave resulting from force-induced acceleration, thereby being overshadowed by the greater loss. Given that the energy loss from wave loss energy due to general relativity is significantly smaller compared to the loss stemming from Maxwellian gravity, this serves as compelling evidence against the validity of general relativity.

1 Intoduction

In his 1805 book "Celestial Mechanics", Laplace showed that the Moon's orbit could not be stabilized under the assumption of a finite gravitational transfer speed. Laplace showed that if gravity's transmission speed were finite, the Moon would gradually lose energy in its orbit around the Earth and eventually collide with the Earth. Thus, he concluded that the speed of gravity must be at least 7 million times greater than the speed of light. Laplace found it necessary to offer an empirical interpretation for this problem, and he conducted calculations for the Moon orbiting the Earth. In contrast, aiming to provide insight, I dealt with a simpler scenario, a binary star system engaged in circular motion with each other.



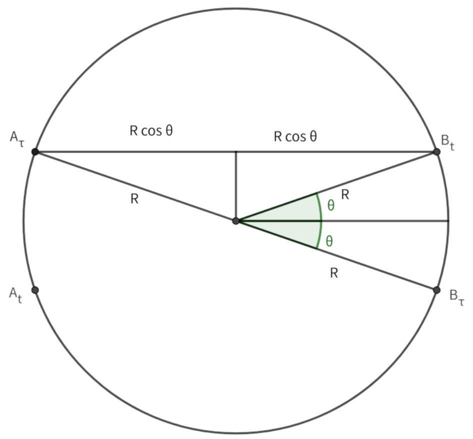
Upon the introduction of Purcell's formula, it was revealed that the direction of the electric field induced by a source in constant motion points towards the present position of the electric field source, rather than its point of origin. Building on this observation, it was hypothesized that the field's direction would approximately be directed towards the center of the circle. However, due to the mathematical impossibility of precisely pinpointing the center of a circle using an algebraic function, it was evident that this solution could not provide a comprehensive resolution. Consequently, the issue persisted as one that could not be entirely elucidated.

Purcell's formula $\vec{E} = \frac{q}{4\,\pi\,\varepsilon_0\,r_p^2}\,\frac{1-\beta^2}{(1-\beta^2\sin^2\theta)^{3/2}}\,\hat{r}_p$ was inadequate for solving this problem. Instead, I resolved it by transforming Feynman's formula $\vec{E} = \frac{q}{4\pi\varepsilon_0}\left[\frac{e_r'}{r'^2} + \frac{r'}{c}\frac{d}{\mathrm{dt}}\left(\frac{e_r'}{r'^2}\right) + \frac{1}{c^2}\frac{d^2}{\mathrm{dt}^2}e_r'\right]$ into a practical form.

$$\vec{E} = \frac{q}{4\pi\varepsilon_0\,r^2\left(1+\frac{\dot{r}}{c}\right)^3}\left(\left(1-\frac{v^2}{c^2}+\frac{\vec{a}\cdot\vec{r}}{c^2}\right)\left(\hat{r}-\frac{\vec{v}}{c}\right)-\left(1+\frac{\dot{r}}{c}\right)\frac{r\,\vec{a}}{c^2}\right)$$

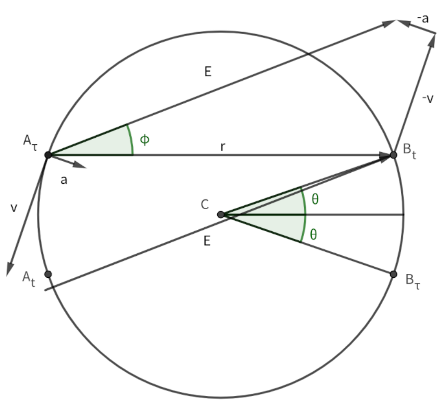
2 Analysis and Assumptions

The basic definitions used in the analysis are shown in the following figure.



In a binary star system composed of stars of the same mass, A and B, even if there are other disturbance factors such as gravitational wave emission, it is safe to say that the two stars are orbiting in exactly opposite positions with the center of the orbit circle as the symmetry point. In this case, if the gravity of star A, which departed at time τ in the past, arrives at star B at time t, which is the present time, B moves from Bτ to Bt in the meantime.

Based on the picture above and considering the Feynman formula for the electric field, the following guesses/results can be confirmed.



If I explain the direction of the force in the binary star system shown in the diagram and give the calculation result in advance. When one star is at Aτ and the other star is at Bτ in the binary star system, the field generated at Aτ affects the B star at Bt along the r path. The field is E, the sum of the r-direction component plus the component in the opposite direction of the velocity v at Aτ and the opposite direction of the acceleration 'a' at Aτ. When this field is felt at Bτ, it points slightly ahead of the center of the orbit or the current position of the A star which is the direction that slightly decelerates the B star. That is $\theta < \phi$.

In this context, two factors contribute to the reduction of energy in a B star. The first involves the decrease in energy resulting from the electromagnetic waves emitted as Star B accelerates, while the second is an energy reduction effect contingent on the direction of force. However, the energy reduction effect based on the direction of force appears to challenge the principle of energy conservation since it is not evidently linked to other effects. In light of this, I made an assumption. I posited that if the energy reduction effect based on the direction of force consistently remains smaller than the reduction effect due to electromagnetic waves, the energy reduction effect from that phenomenon is overshadowed by the impact of electromagnetic wave emission. By attributing the orbital energy reduction to electromagnetic wave emission, it was believed that these two phenomena could be effectively combined. furthermore, it is evident that the two effects cannot be precisely identical because expressing the direction of the center of the circle requires a transcendental function, making it impossible to accurately represent it as the resistance expressed by an algebraic function.

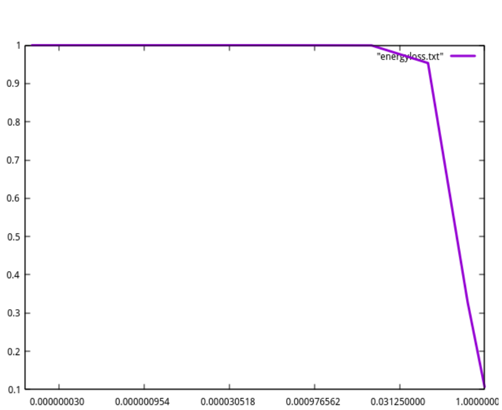
3 Computations and Result

The value of ϑ was determined through numerical computation by solving the equation $\frac{v}{c} = \frac{\theta}{\cos\theta}$, while φ was computed by solving $\tan\phi = \frac{E_y}{E_x} = \frac{\left(1+\frac{v^2}{c^2}+2\,\frac{v}{c}\sin\theta\right)\frac{v}{c}\cos\theta}{\left(1-\frac{v^2}{c^2}\right)\left(1+\frac{v\sin\theta}{c}\right)}$. Furthermore, I applied the relativistic Larmor formula for electromagnetic wave radiation, $\frac{a^2\,q^2\,\gamma^6}{6\,c^3\,\pi\,\varepsilon_0}\left(1-\frac{v^2}{c^2}\,(\hat{a}\times\hat{v})^2\right) = \frac{a^2\,q^2\,\gamma^4}{6\,c^3\,\pi\,\varepsilon_0}$.

And, I got the following results,

$\frac{v}{c}$	$\frac{E_{\text{friction}}}{E_{\text{radiation}}}$
0.9999	0.1071093790662159823 E-7
0.5	0.3294690940692090954
0.1	0.9533805048443296396
0.01	0.9995201416767165202
0.0001	0.9999999520000014171
0.00000001	0.9999999999999995200

Table 1.



When the speed is high enough to be comparable to the speed of light, the loss due to wave radiation is overwhelmingly large. However, the difference starts to decrease rapidly, and the difference decreases to about the same unit around half the speed of light, and as the speed slows down, it can be seen that the two values become very similar from around 0.1c. However, the energy loss due to wave radiation is always slightly large.

This is a surprising result. It coincides too well to be an unrelated coincidence. To claim there is a connection, this is a comparison of the computational result of a transcendental function with that of an algebraic function, and the relation cannot be expressed by a finite polynomial. The calculation started with the expectation that the loss due to wave radiation would cover the loss term due to resistivity, but I couldn't expect that it would cover this very slightly. When the speed is very slow, it is practically the same. I think this is an example that shows that nature is never completely mathematical, but it is as mathematical as possible.

4 Conclusion

Through these calculations, I have shown that, in a binary star system sustained by electromagnetic forces, the motion resulting from those forces transmitted at a finite speed can comply with the principle of energy conservation without any violation.

This explanation is based on electromagnetic force rather than gravity, so if Maxwellian gravity is not correct, another explanation must be found. However, even in that case, this solution still has importance because the Laplas problem must be solved for any type of force.

This approach is not compatible with general relativity. The formula for calculating gravitational wave emission in the binary star system PSR B1913+16, as per general relativity, was $\frac{64\,G^4\,m^5}{5\,c^5\,r^5}$, and it is insufficient to account for the resistance component based on the field direction. Consequently, this outcome strongly implies that the fundamental nature of gravity aligns more with Maxwellian gravity, where gravity is described by Maxwell's equations, rather than general relativity.

Bibliography

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