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A Tentative View on Relativistic Effect in GPS Measurement

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ABSTRACT

Concerning the issue of light speed, the test to the uniqueness and correctness of the relativity effect in Global Positioning System, leads to the conclusion that the “principle of constancy of light velocity” is not essentially about “different distances to different time” but about “same distance to same time”. According to this principle, is proposed based on using higher-order high-dimensional space of the concept of distance intersection method can make the orbit determination of satellite positioning don't have to consider the earth's rotation, many body problems, and relativistic effects factors like observation ground static target could be achieved with measurement results.

INTRODUCTION

Concerning the issue of the velocity of light, both Newton’s classical mechanics and Einstein’s relativity presuppose a premise that the spatial distance covered by a light when an optical pulse is emitted from one place to another seems different to different observers. On this basis, the difference is derived from Newton’s theory that claims different observers’ agreement on the time that the lights spend makes the velocity of light different to different observers; however, the relativity claims, based on Michelson’s interferometer experiment, that different observers have different views on the time the light spends while asserting the premise of a constant light velocity [1-4]. However, the problem is the fundamental difference between transmission of light and particle movement lies in that the light covers a high order and high dimensional spatial distance rather than a three-dimensional one! This distance has nothing to do with the selection of coordinate system although it varies with time, and thus it cannot be calculated with the conventional three-dimensional coordinate system. In other words, the spatial distance covered by the light and the time it spends should be actually the same for different observers or reference systems.

METHODS

Take navigation by satellite timing and ranging/global positioning system as an example and assume that a rectangular coordinate system is established with the earth as an absolute reference frame and follows the ground time standards. When the satellite transmits a signal, it is located at A; when the ground observation station at C receives the signal, the satellite is at B. In this way, the three-dimensional coordinates of the point A released by the two-line orbital element is calculated as the starting point of the transmission distance during the period of time to consider the relativity effect on the point C during positioning, according to the international practice. As such, a question will inevitably arise: if the measurement results generated after amending the relativity effect are acceptable, considering the relativity effect may not be the only solution and not even the best solution! The reason is that considering the relativity effect actually makes the solution more complicated. In other words, the spatial distance covered by the satellite signal during the time should be the distance from the point B where the satellite is to the point C where the ground observation station, no matter for the ground observation station, the satellite itself, or for any other frame of reference! This distance is actually a high order and high dimensional space that changes real time and it consists of two parts: the three-dimensional spatial distance from the point A in the absolute frame when the satellite signal is passing to the observation point C, and the super space distance between the absolute three-dimensional space where the point A is when the satellite signal is emitted to the motion three-dimensional super space where the satellite is; in other words, when the satellite passes over the point A to transmit the signal, the satellite is not at the point A in the three-dimensional space but at a certain point of the orbit in a high order and high dimensional space, the point that has the clear orbit coordinates in three axes at the point A. These orbit coordinates depend on the spatial orders of the orbit point where the satellite is rather than the mass, size or shape of the satellite; specifically, assume a satellite M is in an orbit that has 50 spatial orders, the 50 partial derivatives of the satellite in the three axes from time will actually constants, that is

$$\frac{\partial^{50}x}{\partial t^{50}}=C_x,\frac{\partial^{50}y}{\partial t^{50}}=C_y,\frac{\partial^{50}z}{\partial t^{50}}=C_z \quad (1)$$

It means that, if the satellite M meets the following initial conditions, that is: its position coordinates when it passes a coordinate point (assumed as A) above the earth at $t_\circ=0$ and its orbit coordinates when it is at the three coordinate axes of the 50th (represented by n) order orbit coordinate under different order velocities, accelerations and variable accelerations are $(x_M,y_M,z_M,x_M^{(1)},y_M^{(1)},z_M^{(1)},...,x_M^{(n)},y_M^{(n)},z_M^{(n)})_{t_\circ}$, and if M's position coordinates and order orbit coordinates when it reaches another coordinate point (assumed as B) above the earth at $t_j(j=1,2,3,...)$ are $(x_M,y_M,z_M,x_M^{(1)},y_M^{(1)},z_M^{(1)},...,x_M^{(n)},y_M^{(n)},z_M^{(n)})_{t_j}$, the orbit state for M to move freely in space can be described by an analytic expression similar to Taylor series as follows:

$$\begin{cases}\begin{pmatrix}x_M\\y_M\\z_M\end{pmatrix}_t=\begin{pmatrix}x_M\\y_M\\z_M\end{pmatrix}_{t_\circ}+\begin{pmatrix}x_M^{(1)}\\y_M^{(1)}\\z_M^{(1)}\end{pmatrix}_{t_\circ}t+\frac{1}{2}\begin{pmatrix}x_M^{(2)}\\y_M^{(2)}\\z_M^{(2)}\end{pmatrix}_{t_\circ}t^2+...+\frac{1}{n!}\begin{pmatrix}x_M^{(n)}\\y_M^{(n)}\\z_M^{(n)}\end{pmatrix}_{t_\circ}t^n\\ \begin{pmatrix}x_M^{(k)}\\y_M^{(k)}\\z_M^{(k)}\end{pmatrix}_t=\begin{pmatrix}x_M^{(k)}\\y_M^{(k)}\\z_M^{(k)}\end{pmatrix}_{t_\circ}+\sum_{i=1}^{n-k}\frac{1}{i!}\begin{pmatrix}x_M^{(i+k)}\\y_M^{(i+k)}\\z_M^{(i+k)}\end{pmatrix}_{t_\circ}t^i \qquad (k=1\sim n)\end{cases} \quad (2)$$

Based on this orbit equation of M, if $t_j(j=1,2,...,153)$ fixed points are selected on the ground to receive the signal at $t_j(j=1,2,...,153)$ sent by M at $t_\circ$, regardless of the spatial orders (M's gravitational pull on external objects in the surrounding space) of M, the distance intersecting method (although this intersecting is not in the conventional three-dimensional sense but a high order and high dimensional sense with four or more dimensions) can be used to measure the coordinate values of M in the three-dimensional spatial position at $t_\circ$ and its 50-order orbit coordinates at three axes according to the fact that these position coordinates in the three-dimensional space and 50-order positions do not vary and the result that the measured spatial distance of M transmitted to the observation points at t_j is "$s_j=ct_j$", that is

$$\begin{cases}\sqrt{\left[(x_{t_0}-x_1)+\sum_{i=1}^{n}\frac{1}{i!}x_{t_0}^{(i)}t_1^i\right]^2+\left[(y_{t_0}-y_1)+\sum_{i=1}^{n}\frac{1}{i!}y_{t_0}^{(i)}t_1^i\right]^2+\left[(z_{t_0}-z_1)+\sum_{i=1}^{n}\frac{1}{i!}z_{t_0}^{(i)}t_1^i\right]^2}=ct_1\\ \sqrt{\left[(x_{t_0}-x_2)+\sum_{i=1}^{n}\frac{1}{i!}x_{t_0}^{(i)}t_2^i\right]^2+\left[(y_{t_0}-y_2)+\sum_{i=1}^{n}\frac{1}{i!}y_{t_0}^{(i)}t_2^i\right]^2+\left[(z_{t_0}-z_2)+\sum_{i=1}^{n}\frac{1}{i!}z_{t_0}^{(i)}t_2^i\right]^2}=ct_2\\ \cdots\cdots\quad\cdots\cdots\quad\cdots\cdots\quad\cdots\cdots\quad\cdots\cdots\quad\cdots\cdots\quad\cdots\cdots\quad\cdots\cdots\quad\cdots\cdots\quad\cdots\cdots\\ \sqrt{\left[(x_{t_0}-x_{3n+3})+\sum_{i=1}^{n}\frac{1}{i!}x_{t_0}^{(i)}t_{3n+3}^i\right]^2+\left[(y_{t_0}-y_{3n+3})+\sum_{i=1}^{n}\frac{1}{i!}y_{t_0}^{(i)}t_{3n+3}^i\right]^2+\left[(z_{t_0}-z_{3n+3})+\sum_{i=1}^{n}\frac{1}{i!}z_{t_0}^{(i)}t_{3n+3}^i\right]^2}=ct_{3n+3}\end{cases} \quad (3)$$

According to the initial conditions of M, we can directly calculate the spatial position coordinates and orbit coordinates of M at any time, without considering the relativity effect or such factors as Earth's rotation and many body problems. We can also back calculate the time it takes for M to move from the initial coordinate position to the position released by the ephemeris according to three-dimensional spatial position coordinates that the ground receiver receives from M's ephemeris at one time; then, the calculated time can be used to further calculate the order orbit coordinates of M in the coordinate positions released by the ephemeris; based on the coordinate positions released by the ephemeris and the corresponding order orbit coordinates, as well as the time to receive M's signal, the coordinate values of the actual starting point (e.g., the point B) for the distance covered by M's signal can be calculated. These values are replaced with the coordinate values (e.g., the point A) released by the ephemeris before. Clearly, the results generated by replacing the coordinate values released by the ephemeris with those of the actual starting point are more accurate than the results generated by amending the relativity effect, because the latter is at least unable to completely exclude the accuracy loss caused by the many body problem that remains unsolved in the world today.

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DISCUSSION

Indeed, we can also explore whether the issue of light velocity can be solved by the internationally recognized relativity effect or by the coordinate values of starting point through the principle of GPS measurement. Assume the 153 observation points are distributed in a ring on the ground and their three-dimensional spatial position coordinates are measured accurately by precision electronic total station and level, when a dual-frequency Geodetic GPS receiver (L1/L2 type) is used to statically observe three or more satellites with the same ephemeris under a high-precision and synchronization mode at every observation point with the coordinate values released by the ephemeris as the starting points of the measured distance, as the internationally accepted practice suggests, the coordinates of the points in the terrestrial network and in the satellite network after surveying adjustment are gained. Since the GPS satellites is more than 20,000 km from the ground and maintains a relative velocity of the earth at 3.87 km/s, and since the time difference between satellite clock and ground clock is about 0.45ms per second according to Einstein's relatively effect[1][2], with the measurement accuracy guaranteed and other interference excluded, if the three-dimensional coordinates released by the satellite ephemeris is correct and the experiment is conducted in the USA to exclude the precision loss from conversion in coordinates between two different ellipsoids such as WGS-84 and Beijing-54, the two coordinate values of 153 observation points in the same ellipsoid are measured by the conventional measurement system and the GPS positioning system, respectively. If affected by the relativity effect, their difference (e.g., the coordinate error at the point C $x'_C - x_C, y'_C - y_C, z'_C - z_C$) will be basically from the equivalent range error d_s generated from the spatial distance measurement of the satellite under normal circumstances, that is

$$\begin{aligned} c(t_2 - t_1) &= \sqrt{(x_A - x'_C)^2 + (y_A - y'_C)^2 + (z_A - z'_C)^2} \\ &= \sqrt{(x_A - x_C)^2 + (y_A - y_C)^2 + (z_A - z_C)^2} + d_s \end{aligned} \quad (4)$$

Thus, the measured 153 coordinate differences should be distributed normally without direction on the three axes, that is

$$\sum \Delta x \to 0, \quad \sum \Delta y \to 0, \quad \sum \Delta z \to 0$$

However, if a mistake is made as the point A is used to calculate the spatial distance covered by the signal while its actual starting point is B, these coordinate differences should be basically from the equivalent range errors $\Delta x_a, \Delta y_a, \Delta z_a$ in the three axes, that is

$$\begin{aligned} c(t_2 - t_1) &= \sqrt{(x_A - x'_C)^2 + (y_A - y'_C)^2 + (z_A - z'_C)^2} \\ &= \sqrt{(x_B - x_C)^2 + (y_B - y_C)^2 + (z_B - z_C)^2} \\ &= \sqrt{[(x_A + \Delta x_a) - x_C]^2 + [(y_A + \Delta y_a) - y_C]^2 + [(z_A + \Delta z_a) - z_C]^2} \end{aligned} \quad (5)$$

Thus, some of the measured 153 coordinate differences will be significantly larger in a certain direction and this deflection is obviously associated with the three axis directions, that is

$$\sum \Delta x \to C_x, \quad \sum \Delta y \to C_y, \quad \sum \Delta z \to C_z$$

SUMMARY

The test to the uniqueness and correctness of the relativity effect by the GPS principle shows that the "principle of constancy of light velocity" is not essentially about "different distances to different time" but about "same distance to same time", unless the basic surveying adjustment principle is problematic. Thus, the relativity effect is not essentially "relativity of time" but "absoluteness of spatial distance"! This also shows the conflicts and incompatibility between Michelson's interferometer experiment and the time paradox issue following the establishment of the relativity theory, and between the quantum theory built on the relativity theory and the later string theory. All of this, in the final analysis, is basically derived from a common-sense illusion of the presupposition.

REFERENCES

1. Einstein A. Relativity. New York: Crown, 1961.
2. Einstein A. The Meaning of Relativity. Princeton: Princeton University Press, 1988.
3. Hawking S. A Brief History of Time. New York: Bantam Books, 1988.
4. Thorne K. Black Holes and Time Warps. New York: Norton, 1994.