Counterexample and example of the principle of relativity

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Counterexample and Example of the Principle of Relativity

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In the earth-centered locally inertial coordinate system, the Principle of Relativity was denied using the experimental data of the global positioning system. The clocks in the global positioning system satellites tick off time more slowly by the velocity v_G = 4 km/s after elimination of the gravitational effects. Between two local gravity fields the Principle of Relativity is satisfied.

Key words: Principle of relativity, reference frame, earth-centered locally inertial coordinate system, global positioning system

1. Introduction

In 1904, Poincaré[1] noted that "The principle of relativity, according to which the laws of physical phenomena should be the same, whether for an observer fixed, or for an observer carried along in a uniform movement of translation;" (English translation) In 1905, Einstein[2] noted the "Principle of Relativity" that "the same laws of electrodynamics and optics will be valid for all for which the equations of mechanics hold good." Thereafter, "The laws by which the states of physical systems undergo change are not affected, whether these changes of state be referred to the one or the other of two systems of co-ordinates in uniform translatory motion." (English translation)

In 1916, Einstein[3] described that "Special principle of relativity: If a system of coordinates K is chosen so that, in relation to it, physical laws hold good in their simplest form, the same laws hold good in relation to any other system of coordinates K' moving in uniform translation relatively to K." (English translation)

In 2016, Phipps[4] first showed a counterexample of the Principle of Relativity noted that "Thus we see that in the real world the relativity principle cannot be valid for timekeeping. Proper time clocks having different accelerational histories really do run at different rates and yield different measurement results when at rest in different inertial systems." Phipps noted the global positioning system (GPS) evidence for clock rate asymmetry; that is, only the GPS clocks suffer time dilation. That is, in the earth-centered locally inertial (ECI) coordinate system, the Principle of Relativity was denied using the experimental data of the GPS. Proper time clocks are atomic clocks. (In this report, time is proper time.) Moving atomic clocks tick off time more slowly than that of stationary. This is a counterexample of the Principle of Relativity. A paradigm shift in relativity has begun.

In this report, we show counterexample and example of the principle of relativity.

2. Reference frame

In the previous papers, the reference frames were not clearly defined. Poincaré noted as observers in a uniform movement of translation. Einstein described as a system of coordinates K' moving in uniform translation relatively to K. They noted uniform movement of translation, and uniform translation. Poincaré noted that "we have not and could not have any means of discerning whether or not we are carried along in such a motion."

In these days, the GPS are carried along in uniform movement of translation, between the GPS satellite and the station on the earth. **Figure 1** shows the reference frames, that is, the GPS satellite[5] moves (v_G = 4 km/s) in the ECI coordinate system which is moving in the solar system at v_R = 30 km/s. It is considered a hierarchy structure[6] of locally inertial coordinate systems that the ECI coordinate system moving in the solar system as shown in **Fig. 1.** The ECI coordinate system is the gravitational field of earth-centered and nonrotating with regard to the galaxy. The solar system is the gravitational field of the sun which is nonrotating with regard to the galaxy. We can also define, for example, the Mars-centered locally inertial coordinate system. A GPS satellite frame itself is a locally inertial system, but not a local gravity field.

We make the definition of "a system of coordinates K" clear. The Principle of Relativity is correct between two local gravity fields. The speed of light in each local inertial coordinate system is c. That is, the speed of light is c both in the ECI coordinate system and the solar system; therefore the clocks tick off time equally.

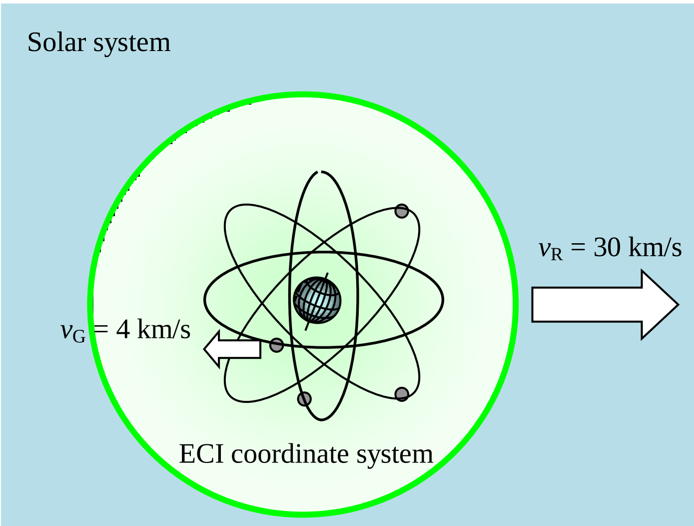

Fig. 1 Reference frames: the solar system, the ECI coordinate system and the GPS satellite

3. Counterexample and example

In this section, we discuss not only the counterexample but also the example of the principle of relativity.

Phipps[4] first discussed a counterexample of the Principle of Relativity. He described that "The factual point to be retained (facts before theory) is that when a clock is accelerated its running rate is slowed." We rewrite: when a clock moves faster in the ECI coordinate system, its running rate is slowed. **Figure 2** shows a counterexample between two frames in the ECI coordinate system. A system of coordinates K is set on the earth, another system of coordinates K' is set in the GPS satellite. The number of GPS satellites is around 70, we represent all GPS satellites using K'. The systems of coordinates represented as K' have the relative velocity with regard to the earth. The velocity of the GPS satellite v_G is 4 km/s. All clocks in every GPS satellites run 1/γ times slower, where $\gamma = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}}$ is the Lorentz factor, v is the velocity defined in the ECI coordinate system, and c is the speed of light. Asymmetry in clock run appears between the earth and the GPS satellites. The experimental data of the GPS shows that the clocks in the global positioning system satellites tick off time more slowly (7.1 μs every day) by the velocity[5]. There are no asymmetries among the GPS satellites. That is, times are equal in every GPS satellites[5].

Feynman's[7] light clocks are also shown. Time dilation is only caused by the velocity v_G = 4 km/s. There are relativistic Doppler shifts observed between the earth and the GPS satellites.

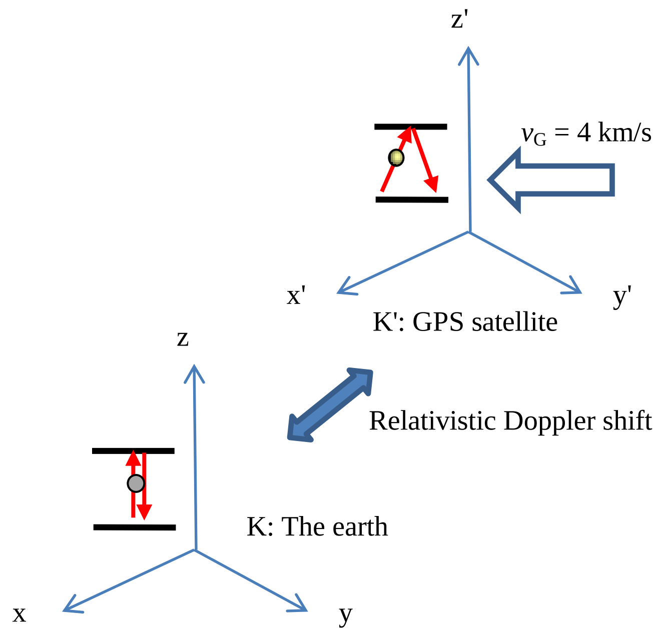

Fig. 2 Counterexample of the principle of relativity

Figure 3 shows the example of the Principle of Relativity. Two systems are local gravity coordinate systems. A system of coordinates K'' is set in the solar system, the revolution velocity v_R is 30 km/s, however there is no time dilation by the revolution velocity v_R, the clock ticks off time equally both in the solar system and the ECI coordinate system. The revolution velocity v_R 30 km/s does not cause any time dilation. Feynman's light clocks equally work both in the ECI coordinate system and the solar system. Between the solar system and the ECI coordinate system the Principle of Relativity is satisfied. There is the classical Doppler shift caused by the velocity of 30 km/s between the ECI coordinate system and the solar system.

Let us summarize. Case 1: Principle of relativity does not hold between two systems in the ECI coordinate system (between the earth and the GPS satellites). Case 2: Principle of relativity will hold between two local gravity fields (between the ECI coordinate system and the solar system).

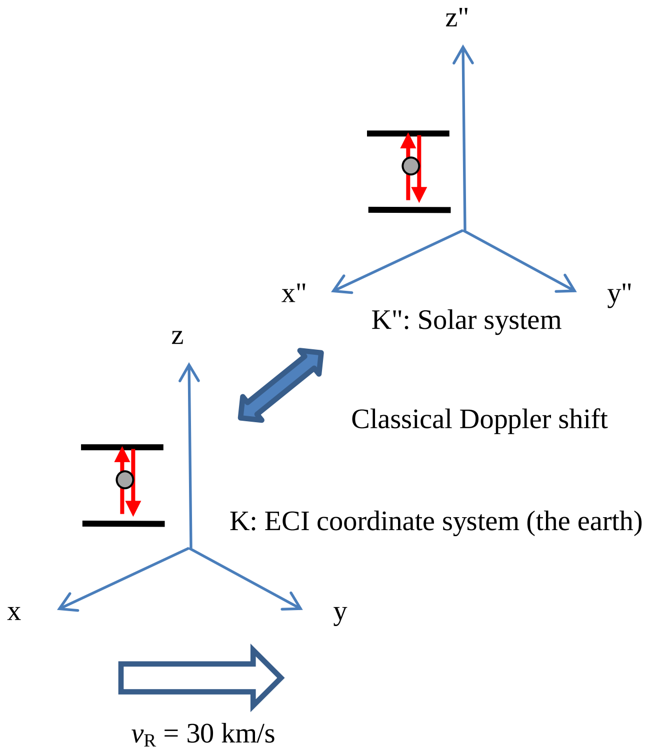

Fig. 3 Example of the principle of relativity

4. Conclusion

We showed a counterexample and an example of the principle of relativity. In the GPS satellite, we can confirm that the advance of the clock is slow comparing with the clock on the earth. This indicates that the progress of the physical phenomenon is slow in uniform translation. This is a counterexample of the principle of relativity. Between two local gravity fields, the Principle of relativity holds.

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