On the Relativity of Simultaneity

Xu Shaozhi and Xu Xiangqun
Beijing Control Device Research Institute
PO Box 3913, Beijing 100854, P.R. China

This paper re-examines the well-known topic of "relativity of simultaneity." The latter is shown to be a false proposition due to an error in logic and confusion in fundamental concepts and epistemology by Einstein.

1. Introduction

This paper scrutinizes a basic proposition of the Special Relativity Theory (SRT), the "epochal" topic of the "relativity of simultaneity" (ROS).

The ROS is the conceptual foundation of the SRT, from which the relativistic space-time ideas were poured by Einstein into the Lorentz transformation (LT), leading, as it has been said, to a "great revolution" in man's space-time ideas, despite the fact that the expression for the LT retains the

same form before and after Einstein. It has been hailed as one of the greatest theoretical discoveries in science of this century, and is cited by almost every work on the SRT (*cf.* Pauli 1958, Bohm 1965, Møller 1955, Rindler 1977, Miller 1981). Hence, it is of great significance to analyze it in depth.

This paper will show that the ROS is a false proposition, because Einstein committed errors in logic and used confused concepts and epistemology.

2. Two questions concerning the ROS

To expound his views about the ROS, Einstein supposed a train traveling along a railway (surrounding *in vacuo*) with a constant speed v in the direction shown in Figure 1a, and asked (Einstein 1936): "Are two events (*e.g.* the two strokes of lightning A and B) which are simultaneous *with reference to the railway embankment also simultaneous relative to the train*?" And then he answered the question, "we shall show directly that the answer must be in negative".

Why must the answer be "in the negative"? The reason in his direct proof is: "Just when the flashes of lightning occur" at points A and B on the rails, the midpoint M' of $A-B$ on the moving train coincides precisely with the midpoint M of $A-B$ on the rails. An observer M' sitting at point M' "is hastening towards the beam of light coming from B, whilst he is riding on ahead of the beam of light coming from A. Hence the observer will see the beam of light emitted from B earlier than he will see that emitted from A."

What is the meaning of this? Einstein concluded, "Observers who take the railway train as their reference-body must therefore come to the conclusion that the lightning flash B *took place* earlier than the lightning flash A". (our italics)

There are two questions which need to be made clear:

(1) Is Einstein's argument compatible with the two postulates of SRT, the principle of invariance of the velocity of light (PIVL) and the principle of relativity?
(2) Could the observers at the train come to the conclusion that "the lightning flash B *took place* earlier..." (our italics) only because observer M' "*sees* the beam of light emitted from B earlier than [the light] from A"?

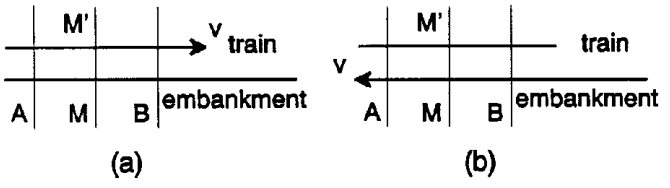

Figure 1

We can show that both answers "must be in the negative".

3. A logical error in Einstein's argument

It is evident that the diagram in Figure 1b is entirely equivalent to that in Figure 1a, because, according to the principle of relativity, the motion of the train toward the right relative to the rails is equivalent to motion of the rails toward the left relative to the train. For Figure 1b, where the train is immobile (even if it is mobile as shown in Figure 1a the argument below remains valid), if the PIVL were valid, both the velocities of light of from A and B with respect to the train should also be the same and equal to c, so that the observer at midpoint M' *should also see the two beams simultaneously.*

But then, where is the ROS? How different our argument is from Einstein's! Thus, which is correct, Einstein's or ours ? It is clear from the above that our argument has done nothing but follow the two postulates of SRT, and its validity is therefore unquestionable. But Einstein's *direct* proof has disregarded the PIVL set forth by himself: his comment that the observer M' "hastening towards... will see the beam of light emitted from B earlier..." is nothing but introducing on the sly an influence of speed v on the velocity of light. We must, therefore, conclude that Einstein's argument *has violated* at least one of the two postulates—the PIVL.

We come to the unavoidable dilemma that either the two beams of light will arrive simultaneously at point M', as at point M, or the PIVL must be invalid; and so the ROS must be false.

Here Einstein committed a logical error, which is real and not "only apparent" as claimed by Einstein. In his 1905 paper (Einstein 1936), Einstein wrote:

> *taking into consideration the principle of the constancy of the velocity of light we find that*

$$t_B - t_A = \frac{r_{AB}}{c-v} \tag{1}$$

and

$$t'_B - t_A = \frac{r_{AB}}{c+v}. \tag{2}$$

This statement is self-contradictory; explicitly, $(c-v)$ and $(c+v)$ are the difference and the sum of speed v and the velocity of light c, respectively, and they are irreconcilable with the PIVL. There are thus serious grounds for doubt that Einstein was "taking into consideration" the PIVL!

In fact, as we have pointed out before (Shaozhi and Xiangqun 1992a), there is no truth to the claim that the PIVL has been confirmed experimentally. On the contrary, there are disproofs of the PIVL (*e.g.*, see Shaozhi and Xiangqun 1992b). Moreover, Einstein *never* put his PIVL into practice.

For example, in deducing the LT in his 1905 paper (Einstein 1936), he took various values for the light velocity, such as $(c-v)$, $(c+v)$, and $\sqrt{c^2-v^2}$ *etc.*

4. Equivalence of inertial systems not infallible

The fact that for one and the same pair of events, observer M' has an observational result different from what observer M has, shows directly that:

(a) A statement about the velocity of propagation of light has no direct physical meaning without a definition of the source of light.
(b) The observational effects corresponding to the two (inertial) systems *differ* from each other, and this automatically refutes Einstein's myth that the equivalence between inertial systems is infallible. In fact, the observed radial Doppler shift, which roughly corresponds to what happens in Figure 1, is one of the best disproofs of the infallible equivalence of inertial frames, since one and the same light source gives different observational results for different observers having different speeds relative to the source.
(c) Indeed, the alleged "Principle of Relativity" has been misinterpreted by Einstein and needs to be clarified and corrected, which will be dealt with separately later.

5. ROS is only an apparent effect

We now proceed to the second question, which is not quite as simple a question as it seemed to Einstein, since it involves a profound epistemological problem.

Epistemology tells us that: what an event (or an object) is observed to be is one thing; and what it is in reality is another, though there is a relation between the two. For instance, the Sun looks like a small disk, but in reality it is quite large. Similarly, whether the two flashes of lightning are observed simultaneously is one thing; and whether they take place simultaneously is another.

Even according to the SRT, if the two strokes of lightning strike at the train instead of the rails, the result should be opposite: It is observer M' (*not* M) who will see the two beams simultaneously; while observer M must note the beam coming from A (no longer B, in this case) earlier than that coming from B.

Thus, it follows that:

(a) The simultaneity of two lightning flashes with respect to the system in which the two strokes of lightning strike is uniquely determined. Hence, we may *not* deny the fact that real simultaneity exists in this sense in the SRT. This might be termed *proper simultaneity*.
(b) The alleged "relativity of simultaneity" is an apparent effect, which we may call *image simultaneity*.
(c) The law of propagation of light, which Einstein always identifies with the PIVL, has nothing to do with the PIVL;
(d) There is no physical or real reason for the observers at the train "to come to the conclusion that the lightning flash B took place earlier...", even though observer M' sees the lightning flash at B earlier than the flash at A.

6. Conclusions

To sum up, this discussion has shown that

(1) The ROS is a false proposition (Phipps 1991), in which Einstein had made serious mistakes of two kinds: he overlooked a logical flaw in his inference; he confused the concept of "taking place" with that of "seeing" and took apparent effects of events for events themselves.
(2) The principle of relativity and the law of light propagation have nothing to do with the PIVL; they have been distorted by Einstein and the others and need to be corrected.
(3) The equivalence between different inertial frames is not infallible. The Doppler effect is the best disproof of the equivalence of inertial frames, since one and the same light source gives different observational results for different inertial frames.
(4) The "relativity of simultaneity" is only an apparent observational effect; and it cannot preclude the existence of real simultaneity.
(5) Since the ROS is invalid, it provides no premise for Einstein to conclude that "every reference-body (coordinates system) has its own particular time". Thus the SRT and the relativistic space-time theory are built on a false foundation.

Acknowledgments

We should like to thank Prof. Wu Jimin of the Institute of High Energy Physics, Academia Sinica, Senior-Engineer Cheng Jianmin at the Ministry of Aeronautics and Astronautics, and our colleagues Sun Yimin, Wang Yufang, Zhang Chunjing and Bo Yongan for their kind help. We are also grateful to Drs. T.E. Phipps Jr. and W.V. Coon for their helpful discussions, and to Prof. H.E. Wilhelm for his comments and suggestions.

References

Bohm, D., 1965, *The Special Theory of Relativity*, Benjamin Inc., p. 55.

Einstein, A., 1936, *Relativity, The Special and the General Theory*, Methuen, 7th ed., p. 25.

Einstein, A., *et al.*, 1923, *The Principle of Relativity*, Methuen, p. 42.

Miller, A.I., 1981, *Albert Einstein's Special Theory of Relativity*,

Addison-Wesley Pub., p. 204.

Møller, C., 1955, *The Theory of Relativity*, Oxford University Press, p. 33.

Pauli, W., 1958, *Theory of Relativity*, Pergamon Press, p. 9.

Phipps, T.E., Jr., 1986, *Heretical Verities*, Classic Non-Fiction Library, p.63.

Phipps, T.E., Jr., 1991, *Foundations of Physics* 21:1071.

Rindler, W., 1977, *Essential Relativity*, Springer-Verlag, 2nd ed., p. 28.

Shaozhi, Xu and Xiangqun, Xu, 1992a, A reexamination of the Lorentz Transformation, *Galilean Electrodynamics* 3:60.

Shaozhi, Xu and Xiangqun, Xu, 1992b, A crucial experimental proof of light velocity invariance, preprint.