

## **Proof of Simultaneity Preservation at Relative Inertial Motion**

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### **Abstract**

Based on the proof of universal validity of identity of the moment when any event happens in two inertial reference frames in mutual motion and on logical transitivity there is proven the simultaneity preservation at relative inertial motion.

**Key words:** simultaneity preservation, relative inertial motion

### **Theorem**

It is universally valid that any event happens in two inertial reference frames in mutual motion at identical moment.

### **Proof**

Let any couple of points of coinciding horizontal axes of mutually moving inertial reference frames  $S$  and  $S'$  coincides at some moment for the rest observer of  $S$  located at the related point of this couple. In the reference frame  $S$  this observer starts at this moment the uniform acceleration in the direction of motion of  $S'$  and after some time he (between these before coinciding points) becomes the rest observer located at some point of horizontal axis of  $S'$ .

Theoretically the uniform acceleration can be unlimitedly high, so the time interval starting for the observer in  $S$  with the event of coincidence of the given couple of points and finishing for this observer in  $S'$  at the moment when he is already the rest observer of this inertial reference frame can be unlimitedly short. If this interval is more and more close to zero, so for the observer in  $S'$  the moment of finishing of the acceleration (when he is already the rest observer of this inertial reference frame) is more and more close to be identical with the moment when for this observer in  $S$  the given couple of points coincides, and the points of the given couple are for him in  $S'$  more and more close to coincidence (also with him). It clearly

means that if the observer was (what is certainly impossible) the rest observer of  $S'$  at the moment of the event of coincidence of the given couple of points, so the moment of this event would be for him in  $S'$  identical with the moment of this event for him in  $S$ .

### **Logical Transitivity**

Let us have in  $S'$  two simultaneous distant events (event A and event B) of coincidence of two couples of points of coinciding horizontal axes of  $S$  and  $S'$ . According to the proven theorem and according to the logical transitivity: A happened in  $S$ , when simultaneously A happened in  $S'$ , when simultaneously B happened in  $S'$ , when simultaneously B happened in  $S$ . So consequently, A happened in  $S$ , when simultaneously B happened in  $S$ . It means that A and B are simultaneous events also in  $S$ .

### **Conclusion**

If some in the direction of mutual motion distant events are in some inertial reference frame simultaneous, so these events have to be simultaneous in the other inertial reference frame as well.