The Return of Absolute Simultaneity?
A New Way of Synchronizing Clocks Across Reference Frames

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Abstract

This paper introduces a new way to synchronize clocks distanced apart and a way to synchronize clocks between reference frames. Based on a simple synchronization thought experiment, we claim that relativity of simultaneity must be incomplete. Einstein's special relativity theory predicts relativity of simultaneity and that two events that happen simultaneously in one reference frame will not happen simultaneously as observed from another reference frame. Relativity of simultaneity is directly linked to a particular way of synchronizing clocks (Einstein-Poincaré synchronization) that again assumes that the one-way speed of light is isotropic and identical with the well-tested round-trip speed of light. In the new thought experiment introduced here, there is reason to believe that two distant events can happen simultaneously in both frames[1]. Still, we agree that these events will not happen simultaneously as measured with Einstein synchronized clocks. The claim here is that Einstein synchronized clocks lead to apparent relativity of simultaneity due to a clock synchronization error rooted in the assumption of isotropic one-way speed of light.

Keywords: Absolute of simultaneity, relativity of simultaneity, Einstein synchronization, new clock synchronization, special relativity theory.

1 Introduction

Before describing our new thought experiment on synchronizing clocks, let us briefly refresh our memory on how Einstein's special relativity theory was born. FitzGerald (1889) introduced the idea of length contraction when trying to explain the null result of the Michelson and Morley (1887) experiment. Lorentz (1892) mathematically formalized length contraction, suggesting that any type of matter that travels against the ether has to contract by $\sqrt{1-\frac{v^2}{c^2}}$, where v is the object's speed against the ether and c is the well-known, experimentally tested speed of light[2]. Bear in mind that the FitzGerald and Lorentz length contraction is different than the Einstein length contraction; see for example Patheria (1974).

Larmor (1900) added time dilation[3] to the FitzGerald and Lorentz length contraction and was the first to develop a mathematical theory which is fully consistent with the experiment's null result Michelson and Morley (1887). Recall that FitzGerald, Lorentz, and Larmor all still assumed an ether, and they originally introduced length contraction and time dilation to save the ether. Even the famous mathematician and physicist Henry Poincaré believed in the ether's existence. Still, in 1905 Poincaré concluded with the impossibility of detecting the earth's motion against the ether. Poincaré therefore suggested synchronizing when the clocks are distanced apart, using the assumption that the one-way speed of light for synchronization purposes was the same as the well-tested round-trip speed of light. To measure the one-way speed of light, we need to synchronize two clocks, and to synchronize two clocks we need to know the one-way speed of light. We end up with a circular problem. This is the reason Poincaré assumed the inability to ever measure the one-way speed of light and thereby the impossibility of detecting motion against the ether. If one could actually measure the true one-way speed of light and find it to be

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[1]At least as long as we assume isotropic one-way speed of light, as does Einstein.

[2]More precisely the well-tested round-trip speed of light.

[3]Time dilation has been proven in a series of experiments; see for example Haefele (1970), Haefele and Keating (1971b,a) and Bailey and et al. (1977).

anisotropic, then this would be strong evidence of the laboratory frame's (the earth) motion through the ether.

Einstein (1905) instead abandoned the ether and assumed that the true one-way speed of light was the same as the round-trip speed of light, and he used this assumption to synchronize his clocks. Based on this, Einstein proved that under his theory there could be no absolute simultaneity, only relativity of simultaneity. Actually, the inability to detect absolute simultaneity is strongly related to the inability to detect the true one-way speed of light, which again is related to detecting motion against the ether.

If Henry Poincarè was right – that we can never detect the true one-way speed of light or motion against the ether and thereby never detect absolute simultaneity – then Einstein's special relativity theory would indeed be the simplest theory for explaining all experiments in space and time (inside flat space-time).

To synchronize clocks by assuming that the one-way time of light is half of the well-tested round-trip time of light is what is known as Einstein synchronization, or what some like to call Einstein-Poincarè synchronization.

The assumption that the one-way speed of light is isotropic leads to relativity of simultaneity. Furthermore, the assumption that the one-way speed of light is isotropic is rooted in that measuring the one-way spend of light requires synchronizing two clocks when distanced apart. To synchronize two clocks that are distanced apart, we need to know the one-way speed of light. In other words, based on this it is not possible to detect the true one-way speed of light, or motion against the ether, and we can then just as well abandon the ether and assume that the one-way speed of light is isotropic. The idea of slow clock transportation synchronization was for a moment thought to circumvent this problem i.e. – to get around Einstein synchronization. However, as first proven by Eddington (1924) slow clock transportation synchronization gives the same synchronization as Einstein-Poincaré synchronization[4]. This is based on the clock being moved at a velocity of close to zero relative to the clock with which it is synchronized.

2 A Brief on Relativity of Simultaneity

Relativity of simultaneity is a cornerstone prediction in Einstein's theory of special relativity . This basically predicts that two distant events that happen simultaneously in one reference frame cannot happen simultaneously as observed from another reference frame. In other words, under special relativity theory there is no absolute simultaneity.

Assume two reference frames, for example the embankment (frame one) and a train (frame two), where the train is moving relative to the embankment. Assume that the train's velocity relative to the embankment is v as measured with Einstein synchronized clocks from the embankment. This also means that the embankment's velocity relative to the train is v as measured with Einstein synchronized clocks from the train. In special relativity theory the velocity between two frames is the same no matter the frame from which the velocity is measured. This velocity is reciprocal. Furthermore, assume that two Einstein synchronized clocks are on board the train, one at the front and one at the back, with a distance L apart. The two clocks emit a laser signal simultaneously, as measured via Einstein synchronized clocks on board the train. This means that the two laser beams will reach the train's midpoint at the same time, as measured from the train. From the train frame the laser signals were emitted simultaneously, and the signals will arrive simultaneously at the midpoint between clocks. As observed from the embankment, the two signals must have been emitted with a time difference of

$$\Delta t = \frac{Lv}{c^2\sqrt{1-\frac{v^2}{c^2}}} \tag{1}$$

Equation 1 can be derived directly from the Lorentz transformation and is well known from a series of sources in the special relativity theory literature; see for example Comstock (1910), Carmichael (1913), Bohem (1965), Shadowitz (1969), and Krane (2012)[5]. Again according to Einstein's special relativity theory two distant events that happen simultaneously in one frame cannot happen simultaneously as observed from another frame. This is indeed true as observed from Einstein synchronized clocks. However we will in this paper introduce a thought experiment where based on logic, two distant events happen simultaneously as observed from both frames. While we do not at all dispute the mathematics of Einstein's special relativity theory, we do claim that special relativity theory must be incomplete. As measured with Einstein-Poincaré synchronized clocks, we will indeed observe relativity of simultaneity even under our thought experiment.

[4]This has also been proven under a set of other conditions and alternative relativity theories; see Mansouri and Sexl (1976), Lévy (2003) and Haug (2014a).

[5]In Krane (2012) there is clearly a typo in the derivation, but the end result he obtained is correct.

3 New Thought Experiment on Synchronizing Clocks

Assume two reference frames. Reference frame one is the embankment, while reference frame two is a train moving relative to the embankment. We do not even need to know the exact velocity of the two frames relative to each other to illustrate the thought experiment's main points. It is enough to know that the relative velocity between the reference frames is greater than zero.

The train contains two clocks – again, one in the front and one in the back – with a distance $L > 0$ apart, as measured from the train. These clocks are stopwatches that have not yet been started. The clocks begin timing when the start pin, which is hanging from each clock, is touched.[6] In the embankment frame, a long series of clocks lay side by side along the train track. These clocks are also stopwatches that have not yet been started. Each clock along the train track has a touchscreen. Each clock is immediately started when the screen is touched by a start pin from a clock on the train. The two clocks on the train and all the clocks along the train track are all set to the same start time, but none of the clocks have started to run yet.

The two clocks on the train are mounted to a bar that can be dropped by removing a safety pin at the midpoint of the bar (see figure 1). When removing the safety pin the bar will fall towards the embankment. The bar is beforehand adjusted so that it will stop falling exactly when the start pins on the downside of each clock on the bar contact the touchscreen clocks on the embankment. The two clocks on the train will then start running, as will the two clocks on the ground. The start pins then break off. Two clocks on the ground and the two clocks on the train will be affected by two distant events: the start pins of the train clocks contacting the embankment clocks. Two clocks on the embankment and two clocks on the train must start simultaneously as defined by common sense and logic. We assume the distance between the bar and the ground is exactly the same for both the front clock and the back clock.

As gravity works uniformly on the drop bar, the front and back clock start pins must contact the ground (touchscreen clocks) simultaneously – not only simultaneously from the train frame but also simultaneously from the embankment frame. Event one is the back clock start pin on the train contacting one of the touchscreen clocks on the embankment, while event two is the front clock start pin contacting another clock on the ground. Still, based on Einstein's special relativity theory the two distant events cannot happen simultaneously in both reference frames. Actually if we had Einstein synchronize the clocks in each frame beforehand, then these two simultaneous events would not happen simultaneously in any of the two reference frames as observed via Einstein synchronized clocks. We fully agree that absolute simultaneity cannot be observed with Einstein synchronized clocks. Furthermore, both the train observer and the embankment observer would, based on Minkowski (1908), also agree on the space-time interval if using Einstein synchronized clocks. The Minikowski space-time theory is naturally consistent with Einstein's special relativity theory, as both are based on Einstein synchronized clocks; this we do not dispute. What we are questioning here is the deeper logic and common sense aspect of special relativity theory.

We claim that Einstein's relativity of simultaneity is an apparent effect (that one will observe) due to a clock's synchronization procedure that is based on the assumption that the one-way speed of light is the same as the well-tested round-trip speed of light. Einstein's theory is indirectly based on Poincarè's hypothesis that we need light to synchronize two distant clocks and that we cannot detect the true one-way speed of light. If this were true, then Einstein's theory would be complete. However, this new clock synchronization thought experiment indicates that distant clocks can be synchronized in other ways – ones that could render Einstein's special relativity theory incomplete.

Next, if we use the clocks, as synchronized in the way described above, to measure the one-way speed of light, we will detect that the one-way speed of light is anisotropic and is different in every reference frame (see figure 2). Furthermore, if this is the case, then the midpoint between the two clocks will not simultaneously receive the two simultaneously emitted light signals (as measured from our absolute synchronized clocks), as the one-way speed of light must be anisotropic. The same holds true on the embankment: the midpoint cannot receive two light signals simultaneously if sent out simultaneously from two absolute synchronized clocks.

4 More in Depth Discussion

One could argue that if the true one-way speed of light (electromagnetic forces) is anisotropic, then when removing the safety pin in the middle of the bar, the force holding the bar up (counteracting the gravitational force) would use more time to travel in one direction along the bar than in the other direction. If that were the case[7], then the start pins for the back and front clocks would not contact the

[6]We could make this start pin as short as we wanted, so we can realistically assume the clocks starts instantaneously at touch of the clock pin.

[7]And this is likely the case in our view

Figure 1: Thought experiment on new way of synchronizing clocks across distances and reference frames.

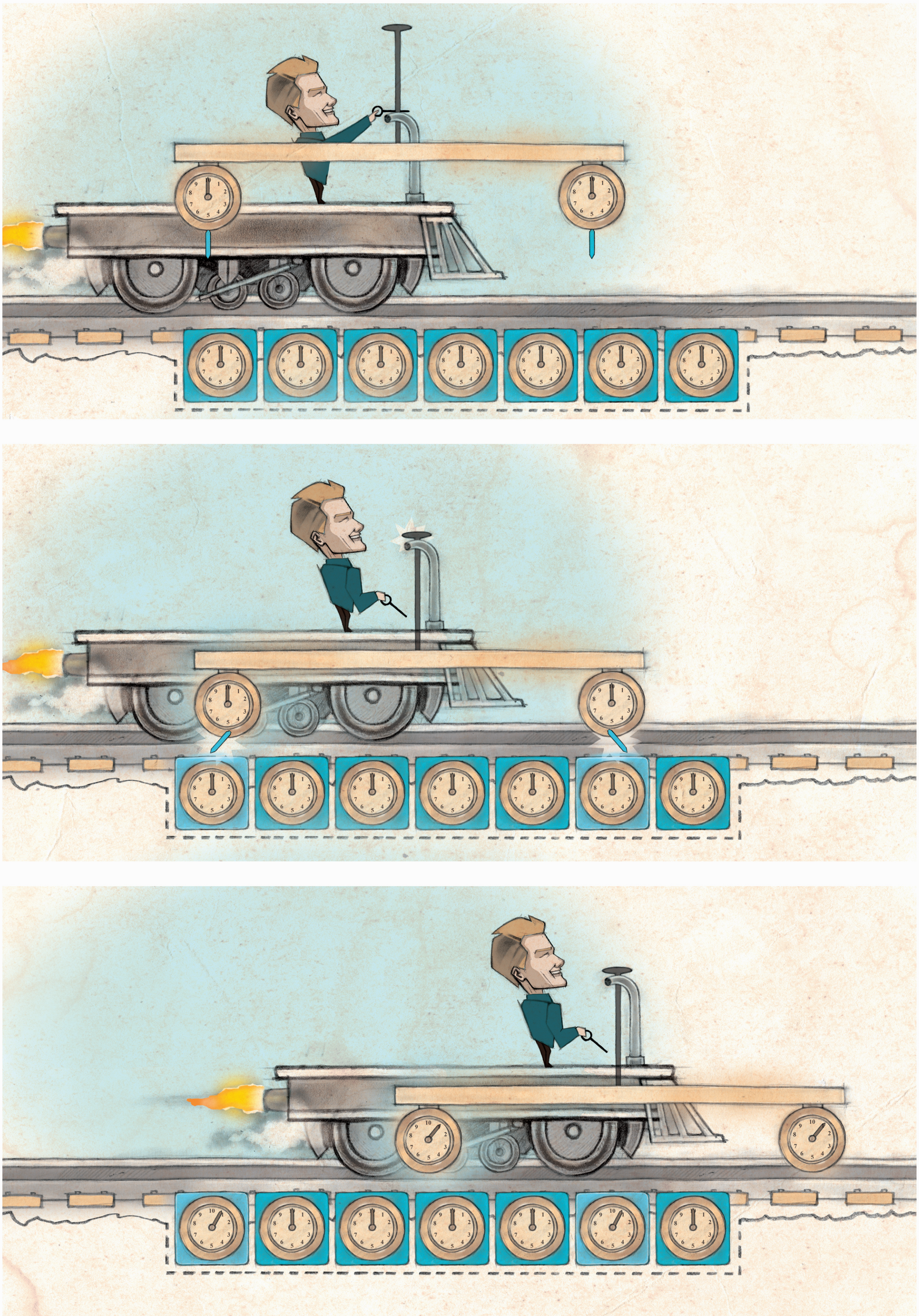
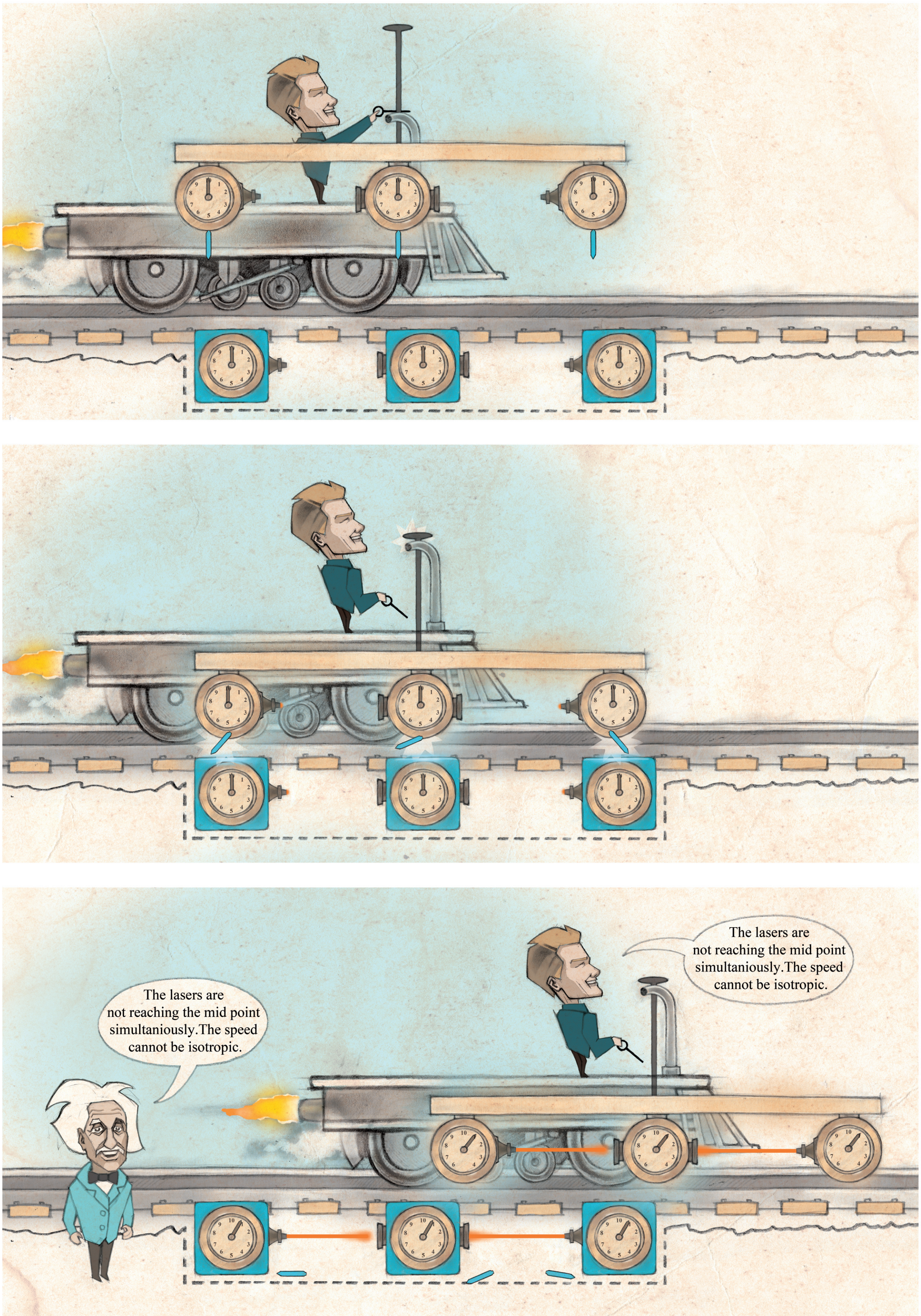


Figure 2: Thought experiment on new way of synchronizing clocks across distances and reference frames. The clocks are then used to detect anisotropy in the one-way speed of light.



embankment clocks simultaneously. This is so even if the distance between the start pins on the back and front clocks relative to the embankment clocks was the same before we released the drop bar. In this case our clock synchronization procedure would not give absolute synchronized clocks (at least not without understanding the cause of why we did not observe absolute simultaneity). Hence, the two distant events do not happen simultaneously, neither from the train frame nor from the embankment. This would be consistent with the main conclusion from Einstein synchronized clocks, namely that these two events could not happen simultaneously in both frames. Still, to get the back clock and front clock start pins to contact the embankment clocks at different times, one would need to accept anisotropic one-way speed of light. Einstein's theory seems to be inconsistent with this thought experiment, because if we accept isotropic one-way speed of light then the two events must happen simultaneously (based on logic) in both frames. And if they do not happen simultaneously, then the one-way speed of light must be anisotropic.

Since gravity causes the bar to drop, some physicists will perhaps try arguing that the paradox would be resolved by accounting for some complex general relativity effects. However, we could have arranged a similar experiment in a zero gravity environment: the train could be moving at a uniform velocity relative to the embankment, and the drop bar could at the same time be moving at a uniform velocity towards the embankment. This would involve no acceleration and no gravity theory, and no rotation. So, general relativity theory is unlikely to solve the paradox introduced in this paper.

The drop bar clock synchronization paradox is, on the other hand, fully consistent with the indivisible relativity theory introduced by Haug (2014a) and also by the theory introduced by Lévy (2003), but not with special relativity theory alone. Again, there is nothing mathematically incorrect with special relativity theory; it's just that special relativity theory seems incomplete. In our view, the postulates of special relativity theory do not hold in reality, while the mathematics of special relativity theory holds as long as we use Einstein synchronized clocks or slow clock transportation synchronization, but not when using the clock synchronization procedure introduced here. It would likely be very difficult to perform such an experiment in practice, as it would require extremely accurate distance measurements and laboratory equipment. Still, the thought experiment alone very strongly points towards an incomplete special relativity theory.

A fully developed mathematical theory of absolute simultaneity is derived by Lévy (2003) and Haug (2014a, 2016). Relativity of simultaneity is a real effect that one indeed will observe with Einstein synchronized clocks. Still, Haug (2016) and indirectly Lévy (2003); **?** show that Einstein's relativity of simultaneity is fully consistent with anisotropic one-way speed of light when using Einstein synchronized clocks, but that it also contains a synchronization error. The new thought experiment introduced in this paper strongly indicates that Einstein's special relativity theory is incomplete and that we need to move to the more generalized indivisible relativity theory, where the results of special relativity are special cases for Einstein synchronized clocks.

5 Conclusion

We have introduced a new clock synchronization thought experiment that seems to conflict with Einstein's relativity of simultaneity. We claim relativity of simultaneity holds true under Einstein synchronized clocks, but that relativity of simultaneity is an apparent effect due to a clock synchronization error. We claim that the thought experiment introduced in this paper cannot be explained away inside special relativity theory or its extensions, like in Minkowski (1908) space-time. Still, we look forward to a discussion around this topic. Is it time to return to absolute simultaneity and anisotropic one-way speed of light?

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