Title: An Accelerated Array of Clocks in Special Relativity: A Meaningful "NOW-at-a-Distance"

(Revised Edition)

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Abstract:

Einstein showed us how an array of unaccelerated synchronized clocks could be set up, extending throughout all space, with a fixed spacing between adjacent clocks. To accomplish that, we only need to assume that the speed of light is exactly the same in all inertial (unaccelerated) reference frames: 186,000 miles per second (which is the fundamental assumption of special relativity). That establishes a meaningful "NOW-at-a-distance", at each instant in that particular inertial reference frame. It allows the question to be asked and answered (by the people stationary in that reference frame): "How old is that particular distant person, RIGHT NOW? That answer MUST be MEANINGFUL to them. If it ISN'T meaningful to them, then the speed of light in that inertial frame can't be 186,000 miles per second (which is the only thing that the synchronization was based on). So if that answer ISN'T meaningful to them, then special relativity can't be correct. Assuming that special relativity IS correct (which I certainly believe is the case), the NOW-at-a-distance given by the array of unaccelerated clocks MUST be considered to be meaningful by the people stationary in that inertial reference frame.

But how about an array of clocks, with a fixed spacing between adjacent clocks, which are all equally ACCELERATED? Can they establish a meaningful NOW-at-a-distance for a person who is stationary with respect to that array of accelerating clocks (and co-located with one of them)? The answer is YES! Those clocks can't be synchronized: they run at different rates. But if they are synchronized at the instant that they all start the acceleration, then a person (he), stationary with one of the clocks, can CALCULATE the current time on each of the other clocks, at each instant of his life during the acceleration. THAT effectively establishes a NOW-at-a-distance for him: it allows him to determine the current age of any particular distant person (her), according to him. And he MUST consider that answer to be fully MEANINGFUL to himself.

Section 1. Some Additional Terminology

To "flesh out" the second paragraph in the above abstract, some additional terminology is needed.

It will help if we imagine that each of the accelerated clocks has a co-located human with it. We choose one of those humans to be the human whose "perspective", or "point of view", about simultaneity-at-a-distance we desire. I call that human the "Interested Observer", abbreviated as the "IO". For example, he is "interested" in what the current age of the distant "home twin" is (because he is the traveling twin in the twin paradox).

The human co-located with each of the other clocks in the array is called a “Helper Friend”, abbreviated as an “HF” (and sometimes ending in a suffix when I need more than one helper friend, like HF1 and HF2). Suppose the IO (he) wants to know the current age of a particular distant person … say, the home twin (she) in the twin paradox scenario, when the IO is accelerating back toward her. To get that answer, all the IO needs to do is ask the PARTICULAR HF, who happens to be momentarily co-located with her then, what her age is right then. That HF can determine the answer just by looking at her, or asking her what her age is right then. Because the IO can compute the current age of each of the HF’s at each instant of his life, that effectively establishes a “NOW” instant for the IO that extends throughout all space.

It should be mentioned that each of the HF’s don’t agree with the IO about the relationship between their current age and the current age of the IO. But that’s OK … we are only interested in the IO’s “Now-at-a-distance” … no one else’s.

Section 2. How Does the IO compute each of the HF’s Current Age?

The relationship between the IO’s current ageing rate and the ageing rate of each of the HF’s, according to the IO, is given in my previous paper entitled “A New Gravitational Time Dilation Equation”, on viXra at https://vixra.org/abs/2201.0015 . The IO says that the ratio of the HF’s current ageing rate, relative to the IO’s ageing rate, is:

$$R(A,t) = [\, 1 + L\, A\, \text{sech\_sqrd}\{\, \text{theta}(t) \,\} \,],$$

where “L” is the distance between the IO and the HF (positive when the HF is leading the IO, and negative when the HF is trailing the IO). “A” is the acceleration, and “theta” is the “rapidity”, which has a one-to-one relationship with the velocity v. Theta can be arbitrarily large, but the magnitude of the velocity can’t exceed or equal the speed of light.
The velocity v is equal to tanh(theta). In the above equation for R(A, t), the function “sech_sqrd” is the square of the hyperbolic secant function. The hyperbolic secant is the reciprocal of the hyperbolic cosine.

To get the current age of the HF (for the case where they are each zero years old at the instant t = 0 when the acceleration begins), R(A,t) must be integrated, from t = 0 to t = tau, where tau is the IO’s age when we want to compute the HF’s age. The result is the “age change equation”:

$$AC(tau) = tau + L * \tanh(A\, tau) ,$$

where “tau” is the current age of the IO, and AC is the current age of the HF.

When the above results are used to determine what happens when the IO instantaneously changes his velocity, it gives exactly the same answer as given by the well known co-moving-inertial-frames (“CMIF”) simultaneity method. That’s fortunate, because the CMIF simultaneity method is easy to compute. The value of the accelerated array of clocks results that I have given ISN’T in its ability to get the answer to twin-paradox-type scenarios … the CMIF method can do that easily, and the accelerated array of clocks definitely doesn’t give the answer easily. The value of the accelerating array of clocks is that it GUARANTEES that the CMIF results are fully MEANINGFUL and “real”, and that the CMIF simultaneity method is the ONLY correct simultaneity method.

Section 3. Conclusions

Many (maybe most) physicists consider special relativity to be a finished, closed theory. But it is NOT, for several reasons. First of all, I've previously shown (on viXra at https://vixra.org/abs/2109.0076) that the special relativity version of the exponential gravitational time dilation equation is incorrect. And I've shown in this paper that the CMIF simultaneity method is the ONLY correct simultaneity method. So special relativity certainly wasn't finished before I came along. And it is STILL not finished, because physicists still disagree about special relativity. Beneath the surface, there are significant differences in the way different physicists INTERPRET the various results of special relativity.

For example, consider the fact that different INERTIAL reference frames (moving relative to one another) DISAGREE about the current age of some distant person (like the home twin in the twin paradox). Given that, many physicists conclude that the whole idea of simultaneity-at-a-distance is MEANINGLESS, and should be ignored. Some recommend omitting the twin paradox from the physics curriculum entirely. The instantaneous ageing of the home twin (she), according to the traveling twin (he), when he instantaneously reverses his velocity at his turnaround, is troubling to many physicists. And her negative ageing (i.e., her getting YOUNGER), if he accelerates AWAY FROM her, is even much more troubling to them. Those physicists generally prefer to explain special relativity by talking about more abstract concepts, like path lengths through spacetime. But the results that I've obtained for the accelerating array of clocks REQUIRE that the CMIF results MUST be considered to be fully MEANINGFUL, and that the CMIF method is the ONLY correct simultaneity method. There really isn't any "wiggle room", anymore, on that issue.