Extended Space-Propertime Diagrams

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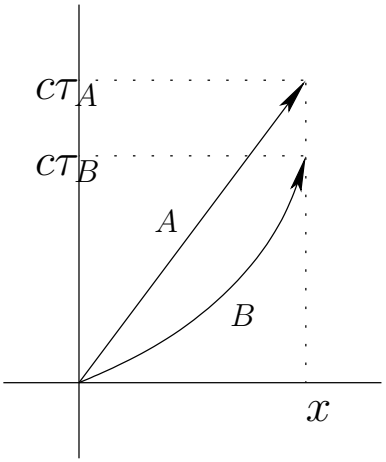
Benefits of using space-propertime diagrams are demonstrated by giving a new visual and geometrical derivation of the Lorentz transformations. With a space-propertime diagram we mean a diagram with the usual three spatial dimensions x,y and z and the proper time times c ($c\tau$) as the fourth dimension. By extended we mean that we also use the negative proper time direction to represent anti-particles. Note that this is not possible in Minkowski spacetime diagrams, so these diagrams can represent more. Now we introduce the following axiom:

1) In at least one frame everything moves with the velocity of light (c) through space-propertime.

Mathematically this can be expressed as $c^2dT^2 = c^2d\tau^2 + dx^2 + dy^2 + dz^2$ with T representing the time of a stationary clock in that frame. Note that if we rewrite this we see it is equivalent to the line-element of special relativity: $c^2d\tau^2 = c^2dT^2 - dx^2 - dy^2 - dz^2$. In a space-propertime diagram T is the length of the worldline of any particle, and the propertime can be directly seen on the new axis. So if twins A and B, of which only B accelerated, meet again after a time T (so the lengths of their worldlines must be equal) at location x, it is easy to see that the proper time of the accelerated person must be less, so B is younger. This visually solves the twin-paradox.



It is also easy to derive the time-dilatation factor γ by using purely geometrical arguments. The angle depends on the velocity. To visualize and geometrically derive length contraction we use can use the following axiom:

2) The three dimensional space (x,y,z) corresponding to each individual reference frame is orthogonal to the direction of motion of that frame through the four-dimensional space-propertime.

By using the same angle to compare rulers, the scaled spatial transformation becomes $x' = \gamma\,(x - VT)$.

If an observer in any other inertial frame uses slow clock transport in its frame to synchronize clocks and to define simultaneity, we can then see that the transported clock (dotted wordline) will have a different proper time, even when the clock is moved infinitely slow. In that limit the worldlines can be seen as parallel and by using geometry that time difference can be derived.

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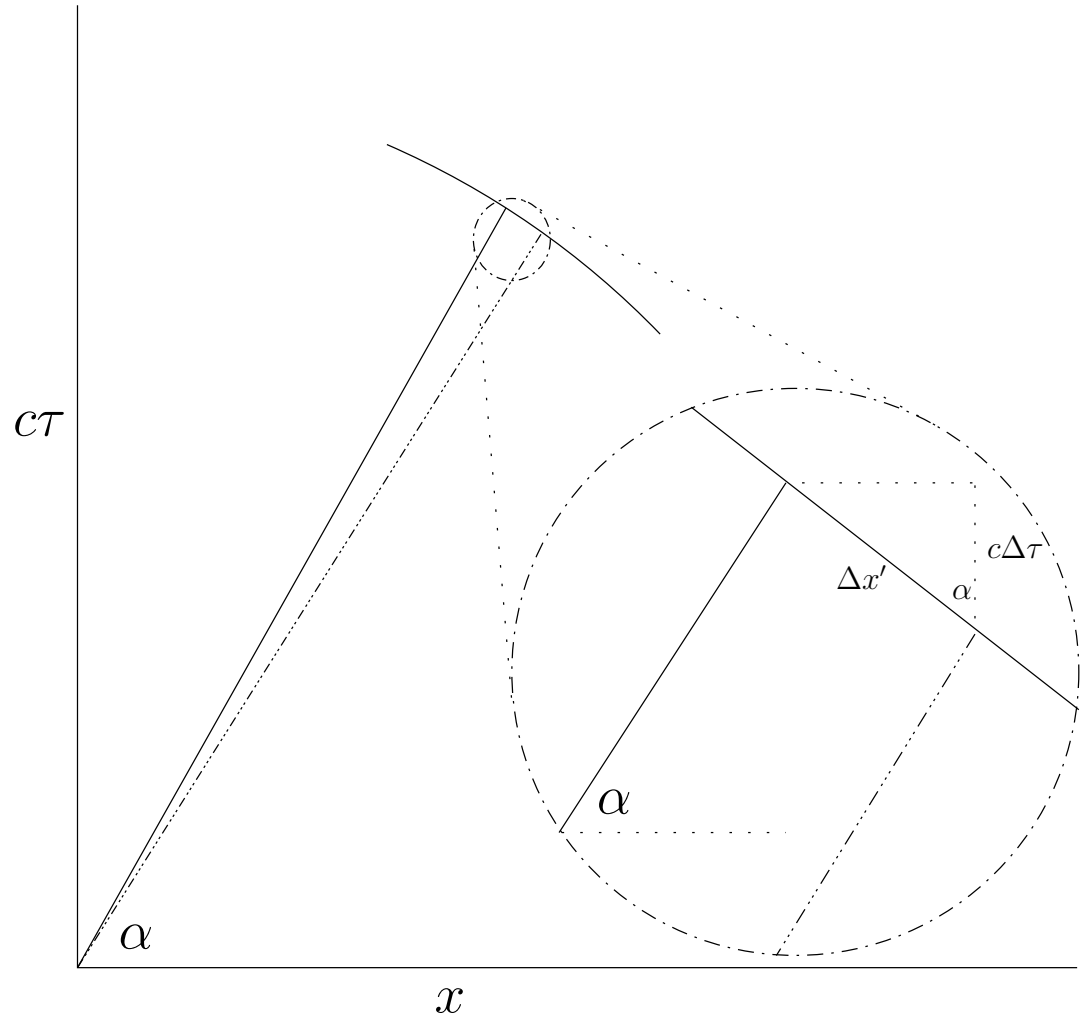

This leads to $t' = \frac{T}{\gamma} - \frac{V}{c^2}x' = \frac{T}{\gamma} - \frac{V}{c^2}\gamma\left(x - VT\right) = \gamma\left(T - \frac{V}{c^2}x\right)$. So here it is shown that using slow clock transport to define simultaneity leads to the Lorentz transformations and all its consequences. These geometric derivations and these axioms, that do not postulate relativity, are new according to the author. The author previously also proposed the following: The energy-momentum four-vector can be visualized in a similar diagram, by using the mass m as the extra dimension, and the energy as the length of the new vector. In the theory of the author and in these diagrams it is possible to move in a negative proper time direction and to have negative mass. The author interprets these as antiparticles. Usually the minus signs of the mass and proper time cancel, but not for the gravitational source tensor. So the author predicts that antimatter produces anti-gravitational fields and gravitationally repels one another and could cause effects such as dark energy and could be present at the Dipole Repeller, a region in the universe which seems to gravitationally repel everything. This could also help locating the missing antimatter in the universe. In this theory antimatter can't form stars, so it will be dark and distributed. It can also solve the vacuum energy problem, because the gravitational effects of the virtual particles and virtual antiparticles in the quantum vacuum would cancel each other in this theory. See [1, 2] for more details and references.

References

[1] A.A.J. van de Ven, A space-time formalism with negative mass, Second International Conference on the Ontology of Spacetime, Concordia University, Canada, June 9-11, 2006. http://www.spacetimesociety.org/conferences/2006/docs/vandeven.pdf

[2] A.A.J. van de Ven, A Space-Time Formalism with Negative Mass to describe Antimatter and Dark Energy, First International Conference on Logic and Relativity, Budapest, Sept. 2012. https://web.archive.org/web/20120814092650/http://www.renyi.hu/conferences/nemeti70/Ven.pdf