Debate: Einstein's Special Relativity Postulates: True or False?

1. First Step -- Pure Math

The Coordinate System can be introduced by:

a) Naming coordinates in an orderly fashion (ex. t,x,y,z or x^0,x^1,x^2,x^3).

b) Giving a span of coordinates (-inf. <x<+inf.)

c)Giving a metric tensor (we need one to know the norm of a vector:

$$| A^k | = \sqrt{g_{ab} A^a A^b}$$ **).**

POINT – is a mathematical object (carries identity) that becomes definite if its coordinates are given. The identity of a point SURVIVES the arbitrary coordinate transformation:

$x'^0=x'^0(x^0,x^1)$, $x'^1=x'^1(x^0,x^1)$

(we use 2 dimensions for simplicity) IF there exist the unique inverse transformation:

$x^0=x^0(x'^0,x'^1)$, $x^1=x^1(x'^0,x'^1)$.
All the points constitute a SPACE which therefore has objective meaning (remains the same does not matter what coordinate system is used).
VECTOR – is a mathematical object (carries identity) it becomes definite if its components are given. The identity of a vector survives the same coordinate transformation if the law of transformation of the vector's components is (a contravariant vector is assumed):

$$A'^k = \frac{\partial x'^k}{\partial x^a} A^a$$

TENSOR – is a mathematical object (carries identity) that becomes definite if its components are given. The identity of a tensor survives the coordinate transformation if its components undergo this transformation (a second rank covariant tensor (ex: metric tensor) is assumed):

$$g'_{ik} = \frac{\partial x^a}{\partial x'^i}\frac{\partial x^b}{\partial x'^k} g_{ab}$$

For practice let us consider LT and GT:

$$x'^0 = \gamma(x^0 - Vx^1); \quad x'^1 = \gamma(-Vx^0 + x^1) \quad inverse$$

$$x^0 = \gamma(x'^0 + Vx'^1); \quad x^1 = \gamma(Vx'^0 + x'^1) \quad (LT)$$

$$x'^0 = x^0; \quad x'^1 = -Vx^0 + x^1 \quad inverse$$

$$x^0 = x'^0; \quad x^1 = Vx'^0 + x'^1 \quad (GT)$$

Suppose that originally given metrics was Lorentz Metrics (LM) given in covariant components: $g_{00}=1$, $g_{01}=g_{10}=0$, $g_{11}=-1$. Using the law of transformation we find:

$$g'_{ik} = \frac{\partial x^a}{\partial x'^i}\frac{\partial x^b}{\partial x'^k} g_{ab} = \frac{\partial x^0}{\partial x'^i}\frac{\partial x^0}{\partial x'^k} - \frac{\partial x^1}{\partial x'^i}\frac{\partial x^1}{\partial x'^k}$$

$$g'_{00} = \frac{\partial x^0}{\partial x'^0}\frac{\partial x^0}{\partial x'^0} - \frac{\partial x^1}{\partial x'^0}\frac{\partial x^1}{\partial x'^0} =_{Lor} 1 =_{Gal} 1 - V^2$$

$$g'_{01} = \frac{\partial x^0}{\partial x'^0}\frac{\partial x^0}{\partial x'^1} - \frac{\partial x^1}{\partial x'^0}\frac{\partial x^1}{\partial x'^1} =_{Lor} 0 =_{Gal} -V$$

$$g'_{11} = \frac{\partial x^0}{\partial x'^1}\frac{\partial x^0}{\partial x'^1} - \frac{\partial x^1}{\partial x'^1}\frac{\partial x^1}{\partial x'^1} =_{Lor} -1 =_{Gal} -1$$

$$Inv.langth: \quad s^2 = g_{ab}(x_2^a - x_1^a)(x_2^b - x_1^b)$$

Ex: Suppose we have two points on the same axis so that the invariant distance between them is 1. The difference of coordinates of these points will be not 1 but $1/\sqrt{|g_{kk}|}$ where k is the index of the corresponding axis.

In the simplified algebra that we usually use in physics we do only those transformations that do not change the components of originally given metrics. Among these are: a)changing of the origin of coordinates (called translation; this does not change any metrics), b)a

rotation transformation of terrestrial coordinates (this one does not change the Euclidean Metrics of 3-subspace), or c) we can make a dependent of time transformation. If the original metrics is Lorentz then it will be invariant only to LT. Please remember, no coordinate system exist without Metrics Tensor (MT).

Classical ElectroDynamics (CED)

1. Einstein's SRT in its nature is a mathematical advance. All physical consequences come from Maxwell's equations and Newton's dynamics equation upon applying this improved math. This math improvement is not disputable. If you do not like SR you better make a claim to

2. Maxwell's equations:

$$div\vec{H} = 0, \quad div\vec{E} = \frac{4\pi}{c} j^0$$

$$\frac{1}{c}\dot{\vec{E}} = rot\vec{H} - \frac{4\pi}{c}\vec{j}, \quad \frac{1}{c}\dot{\vec{H}} = -rot\vec{E}$$

(the dot above vector denotes time derivative). This is a unique Partial Differential Equations (PDE) system in 4 independent variables t,x,y,z. Suppose that 4-vector of current density $j^0=c\rho$, j^x, j^y, j^z is given. We can give initial data at t=0 (the initial data have to satisfy the 1st and 2nd equations). From the 3rd and 4th equations we can find 6 time derivatives of 6 unknown functions of the E-M field meaning that we can predict the E-M field in future. The characteristics of this PDE system are wave fronts going with the speed of light. Please notice, that the constancy of the speed of light does not require 3-d ether (as thought Maxwell, Lorentz and many up to the present day) because it can have another explanation (demonstrated by

Einstein).

The normal introduction of SR would be like this:

1. **Maxwell's Equations are written in 4 independent coordinates t,x,y,z therefore it requires 4-d coordinate system.**
2. **Lorentz Metric follows from Maxwell's Equations.**
3. **Lorentz Transformations (LT) provide invariance of LM. Each moving coordinate system (obtained by LT) will have the privilege to have the same metric tensor (it is the consequence but Einstein turned it to the 1st postulate).**
4. **The 4-vector of velocity of any object is a unit vector (if c=1). The 4-vector of light velocity has all its components infinite (but still unit norm/speed). These exclusive properties of light make the coordinate speed of light (dx/dt) equal 1 in all so obtained coordinate systems (Einstein called**

them Inertial Frames (IF)). This consequence Einstein used as a 2nd postulate.

The Einstein's story is simple: he discovered that Lorentz was incorrect claiming physical time dilation and length contraction. Instead of saying truth – he confirmed Lorentz. He only stated mildly that 3-d ether does not exist. To turn his discovery from math improvement to new physical theory by Einstein he hid LM as much as possible, turned the consequences into the starting points (postulates), endowed the coordinate systems with frames and observers (to make mathematics look more like physics and to attend a positivistic look), and used LT wherever normally LM is needed. Note: to describe any physical situation or even the whole world only one coordinate system (with LM) is needed.

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On the second step one can assume that the mathematical OBJECTS of this coordinate system describe correctly the real physical world (or something of our particular interest in it). We do not know yet the numerical value of actual coordinates and components of vectors but we can consider identificators in their place (like in algebra). It is my opponents who do not realize that the real description in SR is absolute and independent of coordinate system.

We always consider the physical world unique and unchangeable by our description or observation. At the same time we have a certain freedom in introduction of a coordinate system. We can make a coordinate transformation without ever touching the real physical world.

Please note: a) since all these mathematical manipulations are done without ever disturbing the physical object its physical properties can not be

different in different coordinate systems. That means that "time dilation" and "length contraction" have no physical meaning (physical meaning is kept behind "proper time" and "proper length"), b) we had to use LM and we took it from Maxwell's equations,
c) Einstein used his postulates to derive LT, but LT follows from LM. From LT both postulates follow.

This misrepresentation is phenomenal. Still, SR remains a classical theory and a big discovery. If understood rightly, it sheds a great deal of light on the relation between physical reality and its numerical description in theoretical physics (see "Paradigm" at the end).

H. Ricker said: "The oxymoronic nature of relativity is certainly nothing new. This character of the theory arose almost as soon as the theory received publication. It is a mystery of science

history that deserves further study. How could a theory which contradicts common sense, that produces a flood of books and papers, which are critical of its conclusions and which demonstrate numerous contradictions to established physics, become scientific gospel?"

Well, what you sow (misrepresentation) the same you reap (misunderstanding). My opponents certainly did not understand the Einstein's basic idea and replaced it with their own basic ideas. This is why whole SR seems to them "false".

The mathematics used is n-dimensional vector and tensor algebra with n=4. It is a must to know for all who want to contest SR. It was used by Riemann in 1855, only for SR the curvature is zero. It widens the set of real numbers introducing n-d "points", n-d "vectors", n-d "tensors". These are the mathematical objects that preserve their unique identity (like real numbers

do) independently of coordinate system. Notice, that separate coordinates of a point (or separate components of a vector) do not carry any identity. Only the full set of them defines a point and the point carries identity (the same with vector or tensor) – this is why time dilation and x contraction in SR have no physical meaning (the physical system can be physically changed only by interaction with another physical system).

The Light Clock

Suppose now that we are in Maxwell's shoes – not considering any moving coordinate systems yet. We have 4 coordinates and we are free to think that 3-d space (x,y,z) is absolute, the time is independent and also absolute (since it does not interfere with Maxwell's equations).

Suppose a light signal is bouncing between 2 mirrors along the y-axis. The distance between mirrors is d and there

is a counter of bouncing attached to one of the mirrors. It takes $t_0=d/c$ for light to go between mirrors.

Suppose now the second clock is moving with the speed v in direction of x-axis. Now the time between reflections t_1 will be bigger because while light goes the distance d along y-axis the mirror moves the distance vt_1 along the x-axis. So light ends up going the hypotenuse ct_1 of the rectangle triangle. Solving the triangle we find:

$t_1 = d/(c\sqrt{1-v^2/c^2});\quad t_0/t_1 = \sqrt{1-v^2/c^2}$ **. The moving clock is ticking slower (from the point of view of coordinate time). We have two events: 1. clock showing 0sec at t=0, x=0 and 2. clock showing 1sec at**

$\Delta t = 1/\sqrt{1-v^2/c^2},\quad \Delta x = v/\sqrt{1-v^2/c^2}$ **.**

Lorentz said: The coordinate time is absolute and clock's slow down is a physical change due to its velocity with respect to the resting ether.

Einstein said: **Let us consider two events where the clock ticks 0 and 1 second. Can we ask a question: what is the distance between these points? They differ in time and space coordinates. In 3-d case we are calculating the length of a stick from the differences of its ends coordinates by Pythagoras's theorem (Euclidean metric). Should we expect some extension of Pythagoras's theorem to 4-d coordinate system? Yes, the proper time between above two events (proper distance between them) should be:**

$$\Delta\tau = \sqrt{\Delta t^2 - \Delta x^2 / c^2}$$ **(Which is equivalent to Lorentz Metric). In our case** $\Delta\tau = 1$**. Now we can say that the physical time of the moving clock does not change. In twin's situation the physical time is different because the straight way between two events is the longest way in LM (in EM the straight way is the shortest).**

From Einstein's approach it follows that 4-d space is absolute. Einstein denied the existence of 3-d ether and thought that ether does not exist at all. He used the term "space-time" and thought that it can be influenced by matter and physical fields (GR). My opinion is that 4-d space can be called 4-d ether. This 4-d ether is another (not perishable) physical category (it is not a substance). 4-d space/ether is absolute, described by Lorentz Metric and by all the points of 4-d space. It can not be influenced by the presence or absence of matter (this is the denial of GR).

The meaning of SR simplified.

Consider 2-d Euclidean space (normal sheet of paper) and a line AB of unit length is drawn in parallel to the top of the sheet. This line is a physical object. Let us give a numerical description to this line. Let point A has the coordinates $x=x_1$, $y=y_1$, so we write $A(x_1,y_1)$. The point B in its coordinates will be B

(x_2,y_2). The square of the distance AB (which is 1) in Euclidean metric can be calculated:

$$(x_2 - x_1)^2 + (y_2 - y_1)^2 = 1 \quad or$$

$$y_2 = y_1 + \sqrt{1 - (x_2 - x_1)^2}$$

(we took a positive sign for the square root). The 3 from 4 coordinates we can choose arbitrary and each particular choice defines different coordinate system. Let us take $x_1=y_1=0$, $x_2=\cos(\varphi)$. Then: $y_2=\sin(\varphi)$. We still can choose φ as we like. Let us take $\varphi=0$ then $x_2=1, y_2=0$. By this choice we aligned the x coordinate along the physical line and $x_2=1$. If we choose a different φ then $x_2=\cos(\varphi)<1$ – if we turn our attention only to x-axis and forget about y-axis then it looks like our physical line "contracted" - but actually it is not. This is the analogy to SR meaning: Lorentz noticed contraction (and thought it is physical), Einstein said – no, it is just

another coordinate system . And it is obvious that Einstein is right because we did not touched the physical object we just were adjusting the coordinate system – no reason at all for any physical change.

Let us now consider (t,x) plane. Suppose we have a resting physical clock that makes 1st tick at the event A (t_1,x_1) and second tick at the event B (t_2,x_2). By t_1, x_1, t_2, x_2 I mean just unknown real records (algebra) – the coordinates of yet unknown coordinate system. If we have 2 points (events) in any coordinate system we have to have a rule how to find a distance between these points. This distance has to be invariant (independent of the choice of coordinate system). For that we need to know the metric tensor. Suppose the metric is Lorentz. We have 1 second between events and in Lorentz metric we get:

$$(t_2 - t_1)^2 - (x_2 - x_1)^2 / c^2 = 1 \quad or$$

$$t_2 = t_1 + \sqrt{1 + (x_2 - x_1)^2 / c^2}$$

Again we can choose $t_1=x_1=0$, $x_2/c=sh(\psi)$ (hyperbolic sin here). Then $t_2=ch(\psi)$. If $\psi=0$ then $x_2=0$, $t_2=1$ – we introduced a coordinate system in which the clock rests. If ψ is different from zero then we introduced another (moving) coordinate system in which the clock is moving with the velocity $V=c.sh(\psi)/ch(\psi)$. With respect to me the clock still resting. In this case we can cry: the clock is dilated: $t_2=ch(\psi)>1$. But we did not touched the clock! Time dilation (as well as length contraction) is not physical – it is just another (4-dimensional with Lorentz metric) coordinate system. Notice also that I disconnected observer (myself) from the coordinate system.

PARADIGM

The paradigm of mathematics and

theoretical physics has definitely gotten astray. Mathematics and theoretical physics intermixed one with the other especially during the last 100 years. It is very important to keep mathematics (as well as linguistics) separate from the objects that they describe. The linguistics and mathematics are products of human society – they did not exist in nature before humans came. They work very simple, they come up with unique constructions (linguistics with words, mathematics with numbers or, more general, with mathematical objects) and we use these constructions to describe the physical reality. They are very important for communication between people and for gaining order (science).