A “cosmic billiard” paradox of Special Relativity

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We discovered an unexpected paradox of Special Relativity. If a relativistic impact is observed in both inertial frames it leads to a contradicting existing of two different event realities. When a feather and a glass vase do impact relativistically, then in one observation case the glass will be broken by a relativistically very heavy feather and in other observation it stays unbroken. It could not be explained neither in Special or General Relativity and we invite every one to find a solution of this problem. We refer to our solution too, which was in developing a new relativity theory.

Discovering a relativistic impact momentum direction paradox

In special relativity it is known that inertial frames IF can be threatened equally in both directions of observers changing moving and static IF's. This is the Relativity Principle of SRT and the base of it. Also we know, that events are invariant too, so the reality must be the same observed in each IF.

But now we discovered a *Gedankenexperiment* in the manner of SRT, that suddenly did show a two different event realities paradox if interpreted in Special Relativity. This is when we observe momentums and the relative moving directions of the IF's and of the impact partners by relativistic speeds before and after the impact in each of IF's.

Asymmetric relativistic momentum paradox in a “cosmic game of billiards”

For this we have come up with a be thought “cosmic game of billiards”.

First of all, we start from the classic momentum interactions of two colliding balls. If two balls of the same mass *m* do hit by classic low speeds, like billiard balls, one resting and one pushing, then the resting ball receives the entire momentum and the previously moving ball stops. They did exchanged the IF's. If the impacted ball has a larger mass, its momentum is divided into the previously stationary ball and a residual momentum moves the impact lighter ball further in the same direction faster then the pushing ball. This can be looked up in any standard mechanics physics book [1] how momenta are defined in impacts.

$$p = m\,V \qquad (1)$$

And the law of conserved sum of momenta will lead to a method to calculate elastic and inelastic impacts of two masses m_1 and m_2 with given speeds v_1 and v_2 using a *middle mass* or *centre-of-*

momentum frame concept.

Relativistically it is only to increase the masses with the Lorentz factor $p' = m' V = \gamma m V$. Then everything must work perfectly too as in classic case with constant masses.

If the impacting ball has a smaller mass, then it rebounds with a divided momentum and the resting ball receives a partial momentum. With the same momentums from 2 balls, they brag about the same momentums backwards, as if they had exchanged momenta and they did so. Let us now look at the whole thing in a *relativistic* way.

In particle accelerators such as at CERN, proton bundles are accelerated in opposite directions and collided with one another. The result is an explosive particle image of new short-lived particles accelerated symmetrically in both and in all directions. The energy sum is dependent on the energies of both impact partners. At the moment, the only important thing for us is what the directions of particles movements afterwards are. They are symmetrical in all directions, which is also logical, because none of the directions of movement is preferred.

There are also particle accelerators, where fast particles collide against a stationary *target*, for example in the form of a film, and particles are knocked out of its lattice atoms on the back, which receive momenta. Or, as was discovered by Rutherford, lighter particles of electrons bounce back from heavy nuclei because they bounce off heavy nuclei just like lighter balls bounce off heavier ones.

Gedankenexperiment 1

> If we would think us as observer in the CERN impact being with one of the two particles, then the own mass of particle is normal low mass and the moved particle now has the double speed and therefore is very relativistically heavy one and so it has a very big momentum $p' = \gamma m V$ against a momentum of zero of the resting particle in our IF. But this is like in the case of *stationary target* above and after impact we would get another image of new particles, which all will be in one direction only, not in all directions – and that direction would be that of the moved high energy particle and some angled directions with the main direction. So that is *another second event* reality. And if we change our observation IF to the another particle, everything would change and again be a third another reality. We would get three different realities.
>
> Is it a thought failure of us?

Gedankenexperiment 2

We set up a game in mind in figures 1 to 6 in which a fast spaceship A moves past a slow satellite B near the earth serving as static IF. Both will fly very exactly next to each other at a distance of 5 meters. Both have exposed next to each other an ideally elastic billiard ball of the same mass *m*, looking them in windows parallel with space ship and resting - which will collide exactly axially. What will these balls experience as momentums after the impact collision, if one presents different relativistic situations?

The earth satellite observer thinks that the fast ball has received a relatively high dynamic mass, $m' = m\,\gamma$. The Lorentz factor can be thought very large, e.g. $\gamma = 10.000$. That is why he thinks that his ball, which is at rest for him, will be shot away with a very large relativistic momentum and the fast foreign ball will only lose a little of its momentum and will continue to move in same direction after it. The earthly ball receives such a strong momentum that it noticeably overcomes earth's gravity and flies away, even faster than the spaceship and in its direction.

The astronaut in the fast spaceship thinks exactly the same: in his inertial frame he sees in window his own ball at rest, i.e. with the normal rest mass. And the earthly ball including the earth races towards him with $\gamma = 10.000$ very highly relativistically heavier.

That is why he thinks that the fast moved earthly ball, which is so relativistically heavier, will sweep his ball away. Then both balls will be moved in the direction opposite to the spaceship along the earths movement after the impact. The lighter spaceship ball receives a rapid gigantic partial momentum and will be moved faster than the relativistically heavy earthly ball *against* the *direction of* the spaceship's movement with the movement of earth. And the earthly ball receives a very small partial momentum, it tries to remain inertial with the earth and its satellite.

Both results are contradicting each other. The respective "lighter balls" flies in two opposite directions.

We thus have an undecidable decision to make as to what should be true. Intuitively and *ad hoc* we decide that the earthly ball will be shot away and the spaceship ball will continue to fly with the spaceship almost unchanged, only with a slightly reduced momentum. However, just like with the twin paradox with time dilation, this is a completely arbitrary decision that cannot be derived from the SRT and Lorentz transformations without some *ad hoc* effort. But with our new G-Level hypothesis we could.

We discuss therefore more constellations of the balls and inertial frame's.

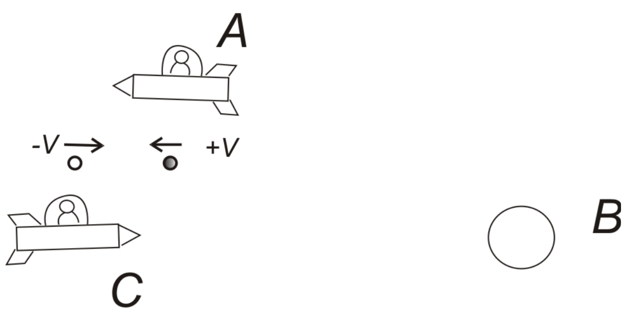

Fig. 1. Elastic joint impact before.

In Fig. 1, two space shuttles A and C move symmetrical antiparallel with + V and -V in relation to earth B and they leave a billiard ball of the same mass $m_A = m_C$ next to them with the same ±V, i.e. resting in their own inertial frame's in the space, which they can observe in the window as resting. They move so precisely that the two balls will meet symmetrically in the centre.

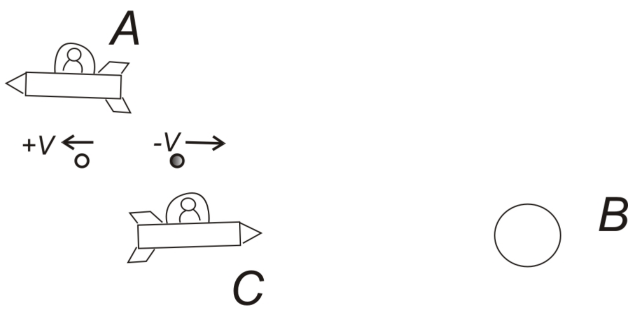

Fig. 2. Elastic joint impact afterwards

In Fig. 2 the joint has already been carried out. It was classically slow enough and the momentums were ideally exchanged elastically. Every spaceman therefore sees a ball in the window that is only offset by one diameter in space and has a different colour. In the relativistic case and ideally assumed elastic properties and infinite strength would be the same figure, since their momentums with respect to the earth are exactly the same. In reality however any material would crumble into pieces, as happens in accelerators when particles collide with particles.

If the two spaceships have a non-relativistic speed difference, then the two billiard balls behave classically. This means that each of the spacemen will see in the window that his or her resting ball is being pushed away and replaced by the foreign ball. Like the billiard balls described above. If you have these balls in different colours, you will recognize it particularly well. This shows the difference to the relativistic case.

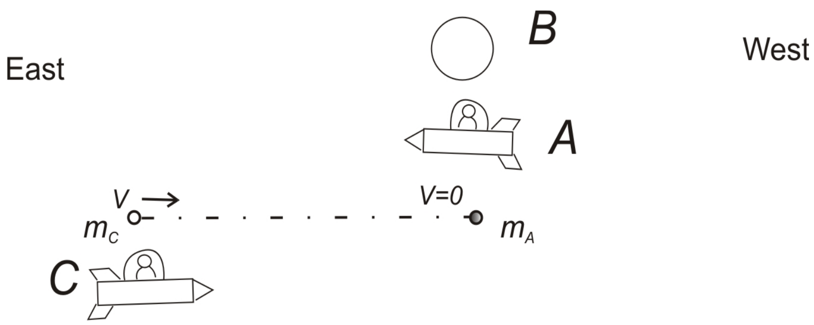

Fig. 3. Relativistic elastic impact in the inertial frame of the earth.

The earthly observer sees a spaceship C approaching with a relativistic high speed V with a Lorentz factor 10.000 and he has prepared a collision experiment A in earths orbit. There will be 2 billiard balls, a stationary one with m_A and a relativistic one with $m_C = m_A \cdot \gamma$, i.e. 10.000 times heavier. He calculates the following impact result and waits to see what will happen.

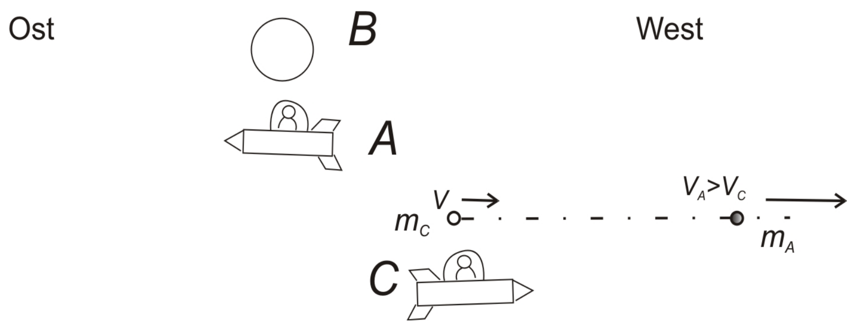

Fig. 4. After the collision from Fig. 3 in the inertial frame of the earth.

We have marked the spatial directions with "East" and "West" and have established that the terrestrial ball m_A hurries away in the direction of "west" at a higher speed than ball m_C. This is an event in space and must therefore be observed invariant in all inertial frame. The direction west in shuttle C direction. The ball m_C, however, receives only a very slight reduction in momentum and also remains moving westwards, it will only move backwards slowly in the viewing window and will eventually disappear out of sight.

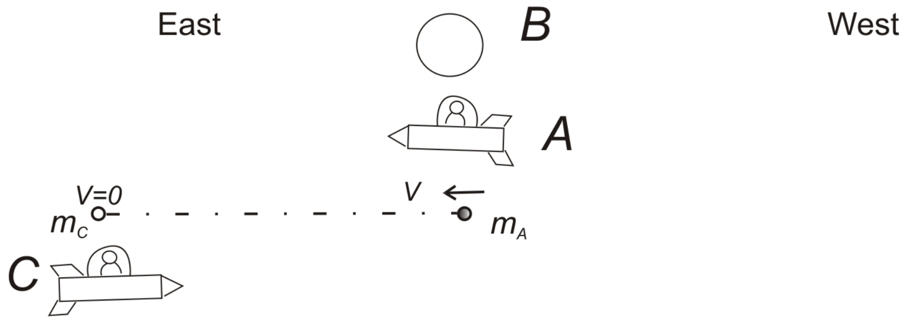

Fig. 5. Relativistic impact in the inertial frame of the spaceship, before.

Now let's think the same thing through from the perspective of spaceman C. In Fig. 5 a spaceman in C thinks, that the earth B to the orbit experiment A ball and m_A on it with relativistic velocity V_A race towards and he himself rests with V = 0. We ignore the difference in speed between Earth and the orbit experiment in shuttle A because of its relative insignificance in comparison with speed of light.

In Fig. 6, the spacemen has theoretically recorded and calculated the impact result in accurate SRT rules, as all inertial frame's are equal in relativistic laws.

In his opinion, in accordance with SRT interpretation, his resting and therefore lighter ball m_c with its rest mass will receive a very strong relativistic momentum *p* in the opposite direction from the earthly relativistically moving ball m_A, which is relativistically 10.000 times heavier, and therefore the ball m_c would quickly disappear from his viewing window. His ball m_c and spaceship C move then in <u>*different*</u> directions, he continues to move "west" and his ball to "east". This is also an event and must be observed in all inertial frames.

Paradox!

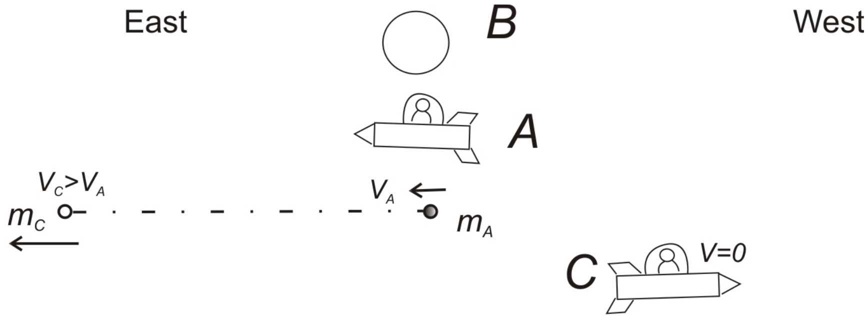

Fig. 6. Relativistic impact of Fig. 5 in the inertial frame of the spaceship, afterwards (gives the wrong contradicting paradox interpretation).

*Paradox: s*o the event in Fig.3 and 4 contradicts the event in Fig.5 and 6 producing a paradox of two different realities. And we cannot decide which is the true one.

This description in figures above doesn't need any calculation as we can see using a very large Lorentz factor in which *direction* the balls will be pushed after.

Gedankenexperiment 3

Another thought game like this: a policeman in bulletproof vest against a bullet

We can offer a similar dramatic thought game: in the present case, instead of 2 billiard balls, a bulletproof vest on a policeman and a pistol bullet as an impact partner should be used. In one case, the rapidly moving, relativistically heavy bullet protection vest will hold loosely against a lighter, stationary ball, and in the other, as it is at rest, it will be very easily penetrated by a relativistically heavy, fast bullet. The policeman dies or survives - there are again two mutually exclusive events, but with a fatal event difference.

Gedankenexperiment 4

A glass plate or a vase and a hair or a feather would work similar as glass of a gigantic relativistic mass will stand an impact calculated in one of the IF, but broken in the another, when the hair is relativistically heavy by a large Lorenz factor, which can be unlimited large.

This vividly examples do show didactically intuitive that the discovered impact momentum paradox of Special Relativity is being real.

Energy and momentum relation

The known general relation for energy and momentum doesn't show us the now discovered paradox problem. It is just a scalar relation and doesn't calculate all vectorial momentum directions possible by using squared values. It delivers just one true result and hides another untrue results. *V* could be in two directions.

$$E^2 = (pc)^2 + (mc^2)^2 = (mvc)^2 + (mc^2)^2 \quad (2)$$

Conservation of momenta

In classic mechanics the conservation of momenta does work if staying in one reference frame. The sum of momenta is then same before and after an impact. If we change the own resting reference frame the sum of momenta changes too. Even if the other speeds differences would work it qualitatively proportionally but masses can be any different ones producing another sum of momenta.

The same is in relativistic momenta applications and same if changing the inertial frames. And this is what we've done above in cosmic billiard games. We did it because it is usual in relativistic situation to do so. In classic samples no one did it and so it was a not recognized classic mechanics effect too as it can change the direction and the amount of a momenta summary.

An easy case of 2 masses, where one is n-times heavier.

$$\Sigma p = n\ m\ V\ -\ m\ (V=0) = n\ m\ V; \quad (3)$$

$$\Sigma p' = n\ m\ (V=0)\ -\ m\ V = -\ m\ V; \quad (4)$$

We just have changed the reference frames. Here the masses are constant classic and in relativistic case the relativistic mass changes are additionally to take into account.

Solution wanted

Any one is asked to find a theoretical solution, how to explain both discovered paradoxes. The discovered problem is an independent from a solution discovery and some solutions can be offered for same. There is maybe a very deep change to expect too as it was once the births of quantum mechanics.

We did it already and invite the reader to have an exclusive look at that [5]. This solution contradicts the SRT and its Relativity Principle and cannot be compatible with it. It is not less then an new Relativity Theory.

We also invite the reader to have a look at another two discovered paradoxes of the SRT [6, 7] and to solve them better.

*References *):*

[1] Berkeley, Physics Course, Volume 1, Mechanics, 4th Edition, 1986.

[2] Standard literature on Special Relativity Theory and optical Doppler of any choice.

[3] Wikipedia, Mass in special relativity, available at https://en.wikipedia.org/wiki/Mass_in_special_relativity

[4] Wikipedia, Energy–momentum relation, available at https://en.wikipedia.org/wiki/Energy–momentum_relation

[5] Schatz, V., Gravitational Doppler and Level Relativity Solved a Discovered Momentum Paradox and Identified the Cause of Relativity, preprint available at https://vixra.org/abs/2106.0017

[6] Schatz, V., A Discovered 2nd Triplet Paradox of Special Relativity, available at https://vixra.org/abs/2106.0156

[7] Schatz, V., An Atom-Photon Energy Paradox and a de Broglie Wave Length Energy Paradox of Special Relativity, available at https://vixra.org/abs/2106.0176

**) this references are absolute enough for all teaching presented*