Propulsion without propellant using four-momentum of photons in Euclidean special relativity

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An alternative method to accelerate particles or objects is described. It uses principles of 4D momentum that follow from Euclidean special relativity.

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In classical relativity, momentum $\mathbf{p}$ is part of the energy-momentum 4-vector $(E/c, \mathbf{p})$. The magnitude of this vector has invariant value m_0c under Lorentz transformations. This value however cannot be interpreted as a real physical momentum in the same sense of a 3D momentum. The components of 4-vectors are a mathematical concept with no direct association with physical entities [1]. This also shows from the 4-velocity vector $\gamma(c, \mathbf{v})$. Here, the spatial speed component is γv, while the real spatial speed obviously is v.

In the Euclidean interpretation of special relativity (ESR, [1] - [4]) the coordinate for the fourth spatial dimension in SO(4) is proper time τ. The 4-momentum vector is $(m_0\chi, m_0\mathbf{v})$, with $\chi = d\tau/dt$. It also has invariant magnitude m_0c but now this actually represents the constant physical 4D momentum of the object. An object that is in rest in space therefor has momentum m_0c in the proper time dimension. Acceleration in space corresponds to a rotation in 4D of the 4-momentum vector, yielding a growing momentum component m_0v in space, while the momentum in proper time $m_0\chi$ decreases (Fig. 1).

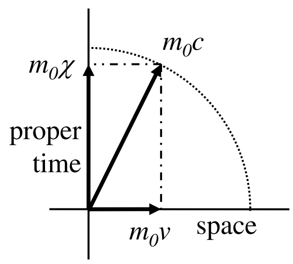

Figure 1: Four-momentum components in 4D Euclidean space-time.

Particle accelerators usually add spatial momentum in the form of photons from electromagnetic fields that are in rest, relative to the accelerator's frame of reference. The Euclidean 4-momentum of photons is $(0, E/c)$. The component in the proper time dimension is zero.

This momentum is orthogonal to the 4-momentum vector of particles in rest. When the particle begins accelerating, its momentum vector rotates towards space so that the momentum vector that is added by the electromagnetic field is no longer orthogonal. This decreases the efficiency of the particle's acceleration. After all, the total magnitude of the particle's 4-momentum vector remains m_0c at all times, so vectorially adding momentum can only be accomplished if the resulting momentum vector again has magnitude m_0c.

The added photon momentum must therefor be decomposed in components, of which only the component can be added that fits the requirement that the resulting momentum again is m_0c. Figure 2 shows an example. The result should yield another photon with rotated momentum vector in 4D, carrying the momentum component that could not be used for the acceleration. The momentum component in the proper time dimension is *not* zero.

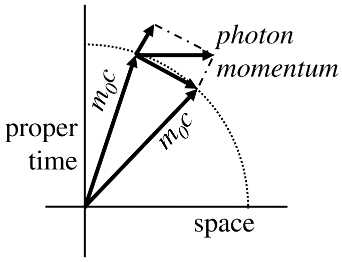

Figure 2: Decomposition of photon momentum to reach an allowed vector addition.

When the particle's speed reaches values near c, the acceleration becomes extremely inefficient. Only a very small fraction of the original photon momentum can be used to further rotate the particle's 4-momentum vector towards space (Fig. 3).

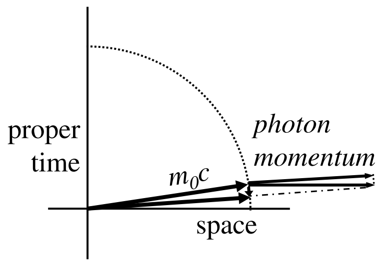

Figure 3: Momentum addition becoming inefficient at high particle speeds.

In this way it will therefor be impossible to accelerate the particle to exactly c. The photons momentum vector cannot be decomposed into components that are orthogonal to itself. The explanation from classical Minkoswki-based relativity is that the relativistic mass becomes near-infinite, making it impossible to accelerate it any further.

The particle could be accelerated more efficiently by using photons that have a momentum vector that is already (partly) rotated in 4D (Fig. 4).

In theory, such photons could accelerate a particle up to speed c. Photons that are (spontaneoulsy) emitted by electrically charged particles in motion must have such a rotated momentum vector. The emission leads to a slowdown or acceleration of the particle, changing the direction of the particle's 4D momentum vector (Fig. 5).

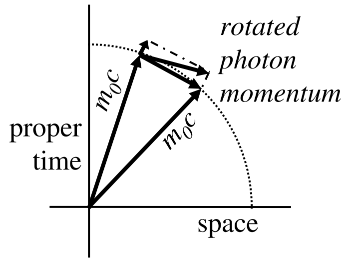

Figure 4: Addition using photon with rotated momentum vector.

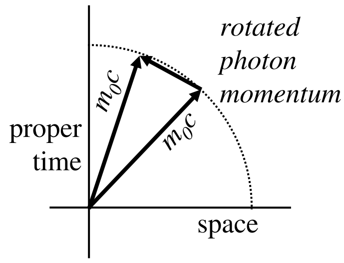

Figure 5: Emission of a photon with rotated momentum vector.

So basically, the devices that generate the electromagnetic fields in the particle accelerator should be moving themselves to reach a more efficient acceleration process. Alternatively, photons could be used that are produced in the particle accelerator itself, commonly observed as synchroton radiation. Such radiation could potentially be used to further accelerate other particles.

The setup of the controversial Podkletnov experiment [5] may also very well constitute the proper circumstances to produce such photons.

From ESR it follows that continuously accelerating the particle will not speed it up beyond c but will ultimately decrease its speed again (see also [2], Section 4). The resulting particle will however have a negative momentum in the proper time dimension.

This acceleration principle, if the interpretation from ESR is correct, potentially allows the propulsion or boost of any object without the use of propellant. The object must carry the device with it that generates the photons with rotated momentum vector. The acceleration of an electron in rest to light speed theoretically requires only a single photon, provided the photon's momentum vector is given an angle at exactly $^3/_4\ \pi$ in 4D to the original momentum vector of the electron and the length of this vector is exactly right (Fig. 6).

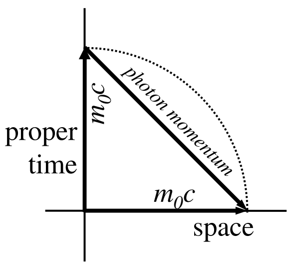

Figure 6: Acceleration to speed c with a single photon.

The biggest (apparent) gain in efficiency however comes from the difference in the magnitude of the resulting spatial momentum component of the particle according to Minkowski-based relativity versus ESR. Its 4D spatial momentum component according to ESR will be m_0v, but according to classical Minkowski relativity it will be $\gamma m_0 v$ and will go up to infinity.

Are we violating momentum conservation laws here? From a Minkowski perspective one would be tempted to say yes, consigning the whole idea to the waste bin. From a ESR perspective however all calculations match. According to ESR, the spatial component as given by the Minkowski 4-vector does not represent the real physical momentum but mathematically represents an enlarged projection of the 4D momentum towards 3D, much like the projected shadow of a stick can be longer than the stick itself (Figs. 7 and 8).

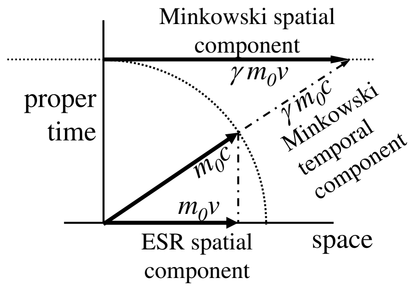

Figure 7: Minkowski versus ESR momentum components.

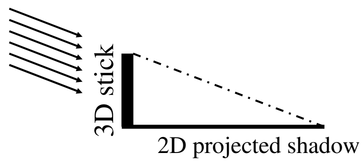

Figure 8: 2D projected shadow of a 3D stick.

References

[1] R.F.J. van Linden, "Minkowski versus Euclidean 4-vectors", available at www.euclideanrelativity.com (Feb 2006)

[2] R.F.J. van Linden, "Dimensions in Special Relativity Theory - A Euclidean Interpretation", Galilean Electrodynamics Vol 18 nr 1 (Jan/Feb 2007)

[3] H. Montanus, "Proper time formulation of relativistic dynamics", Foundations of Physics **31** (9) 1357-1400 (Sep 2001)

[4] A. Gersten, "Euclidean special relativity", Foundations of Physics **33** (8) 1237-1251 (Aug 2003)

[5] E.E. Podkletnov, "Weak gravitation shielding properties of composite bulk YBa_2Cu_3O_7-x superconductor below 70 K under e.m. field", arXiv:cond-mat/9701074v3 [cond-mat.supr-con] (Sep 1997)