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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Classical relativity defines momentum $\mathbf{p}$ as part of the energy-momentum 4-vector $(E/c, \mathbf{p})$. The magnitude of the vector is invariant m_0c under Lorentz transformations. The interpretation of its magnitude and components, as well as those of 4-vectors in general, differs from 3D interpretations due to the Minkowski $+ - --$ metric. Its 4D components are to be considered a mathematical concept without direct association with physical entities [1]. This shows for instance from the 4-velocity vector $\gamma(c, \mathbf{v})$. Here, the spatial speed component reads γv, while the actually measured spatial speed obviously is v.

Euclidean interpretations of special relativity (ESR, [1] - [4]) define proper time τ as the coordinate for the fourth spatial dimension in SO(4). Time t takes the role of the invariant. The 4-momentum vector is $(m_0\chi, m_0\mathbf{v})$, with $\chi = d\tau/dt$ and has invariant magnitude m_0c like the classical vector. However, in ESR it is more than just a mathematical concept; it represents the actual constant physical 4D momentum of the object. An object that is in rest in space therefor has a real momentum m_0c in the proper time dimension. In ESR, 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).

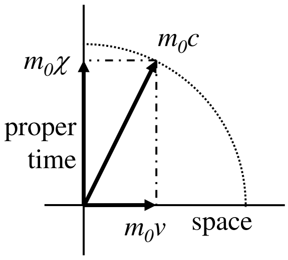

Figure 1: Four-momentum components in 4D Euclidean space-time.

Particle accelerators increase spatial momentum of the test particles by using photons from electromagnetic fields that are in rest, relative to the accelerator's frame of reference. The process of momentum transfer between the EM field and the test particles can henceforth be analysed according to the principles of ESR.

While accelerating, the test particle's momentum vector rotates towards space resulting in a situation where a subsequent addition of photon momentum become less efficient. Respecting the invariance of the particle's momentum m_0c demands a vector addition that again yields a total momentum 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 produce another photon, carrying the momentum component that could not be used for the acceleration.

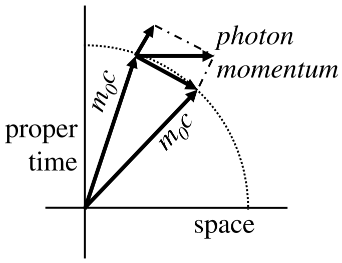

Figure 2: Decomposition of photon momentum to reach an allowed vector addition.

When the test 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 test particle's 4-momentum vector towards space (Fig. 3).

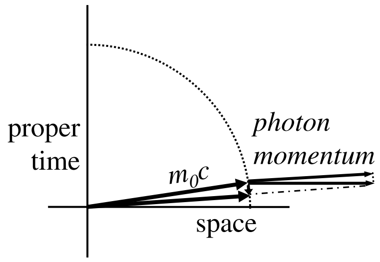

Figure 3: Momentum addition becoming inefficient at high test particle speeds.

In this way it will obviously be impossible to accelerate the test particle to exactly c. The photon momentum vector cannot be decomposed into components that are orthogonal to itself. Going back to classical Minkowski-based relativity, the explanation is that the relativistic mass of the test particle becomes near-infinite, making it impossible to accelerate it any further.

From this analysis it becomes clear that the test particle could be accelerated more efficiently by using photons that have a momentum vector that is already (partly) rotated in 4D (Fig. 4).

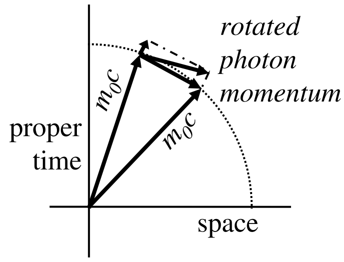

Figure 4: Addition using photon with rotated momentum vector.

In theory, such photons could accelerate a test particle up to speed c.

Photons that are emitted by electrically charged particles with relativistic speeds 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. Figure 5 shows an example.

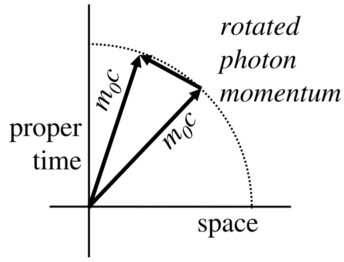

Figure 5: Emission of a photon with rotated momentum vector.

In essence, the source of the electromagnetic fields in the particle accelerator should be co-moving with the test particles 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, or those that were produced during the momentum transfer as shown in Fig. 2. 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 due to the high-speed rotation of the disk and it's constituting electrically charged particles.

Although not directly relevant to this analysis, it should be noted that from ESR it follows that continuously accelerating the test particle will not speed it up beyond c but will ultimately decrease its speed again (see also [2], Section 4). The test particle will then 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).

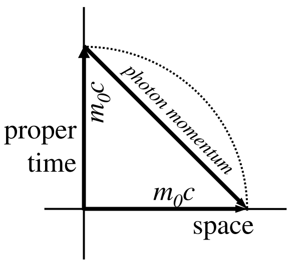

Figure 6: Acceleration to speed c with a single photon.

The gain in efficiency seems controversial at first sight. It is however purely based on a different mathematical interpretation of the momentum components of the particles in ESR. There is no change in physics involved. According to ESR, the 4D *real* spatial momentum component is m_0v and stays within manageable limits, but according to classical Minkowski relativity, where this component only reflects a *mathematical concept*, it will be $\gamma m_0 v$ and will go up to infinity. From the perspective of ESR the spatial component as given by the Minkowski 4-vector 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).

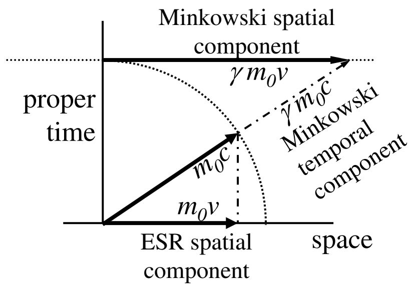

Figure 7: Minkowski versus ESR momentum components.

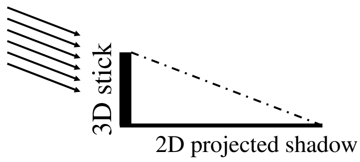

Figure 8: 2D projected shadow of a 3D stick.

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