Energy conditions in advanced SRT of fourth order

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Abstract

Discussed is the role of rest-mass and possible negative restenergy in SRT of fourth-order. Given is an action, and a Lagrangian for this case. Also the term of advanced kinetic energy and its possibility of negative form is mentioned resp. the corresponding Hamilton-function.

key-words: rest-mass-changing; SRT of fourth order;Lagrangian of fourth-order; negative kinetic energy; Hamiltonian of fourth-order; negative rest-energy

I. Changing of restenergy in SRT-theory of fourth order with analogy of damped, enforced oscillation

1. Introduction:

In the previous papers [2.],[8.],[9.],[10.], on advanced SRT of fourth order in analogy of damped oscillation-model the role of rest mass resp. restenergy or kinetic energy either in the advanced SRT was not really discussed. In detail, it seemed before, that restmass resp. rest-energy would be unchanged by the damping velocity factor a. But restenergy is changed either, not alone kinetic energy, it would be depend on velocity factor a of outer enforcing system what can be seen now below.
Since energy relations play an important role in many areas of physics [1.],[3.],[5.],[6.],[7.] terms of restenergy and kinetic energy of a moving particle in SRT of fourth order are developed in this paper.

2.Calculation:

If a linelement of local tangent Minkowski-spacetime is considered as of fourth order:

$$ds^4=(cdt^2-dx^2)^2+dx^2R^2 \quad , \qquad \text{and} \quad ds^4=cdt^{4\prime} \qquad (1.)$$

R taken as a constant length, maybe Planck-length,

then there is

$$dt' = \frac{ds}{c}=\frac{1}{c}\cdot\sqrt[4]{(1-\frac{v^2}{c^2})^2+\frac{na^2v^2}{c^4}} \quad . \qquad (2.)$$

Also there is the action as:

S= $-\alpha\int_a^b ds$ and with $ds=\frac{-L}{\alpha}dt$ and the Lagrangian as

$$\Rightarrow L=-\alpha c\cdot\sqrt[4]{(1-\frac{v^2}{c^2})^2+\frac{na^2v^2}{c^4}} \quad , \qquad (3.)$$

.

thererefore then results for the action:

$$S=\int_{t_1}^{t} L\,dt \qquad \Rightarrow S=-\alpha\cdot c\int_{t_1}^{t_2}\sqrt[4]{(1-\frac{v^2}{c^2})^2+\frac{na^2v^2}{c^4}}\,dt \qquad (4.)$$

$$\Rightarrow L=-\alpha c\cdot\sqrt[4]{(1-\frac{v^2}{c^2})^2+\frac{na^2v^2}{c^4}} \qquad (5.)$$

.

The Lagrangian of advanced lorentz-factor with damping-term-analogy is developed into a series in first order:

$$L=-\alpha\cdot c\cdot\sqrt[-4]{\left(1-\frac{v^2}{c^2}\right)^2+\frac{na^2v^2}{c^4}}=-\alpha c\cdot\left(1+\frac{1}{4}\cdot\left(\frac{2v^2}{c^2}-\frac{v^4}{c^4}-\frac{na^2v^2}{c^4}\right)\right)+O(n) \qquad (6a.)$$

Then there is:

$$L=-\alpha\cdot c-\frac{1}{2}\cdot\frac{v^2\cdot\alpha}{c}\cdot\left(1-\frac{na^2}{2c^2}\right) \quad \text{in first order.} \qquad (6b.)$$

With valid classical term for kinetic energy $E_{kin}=\frac{1}{2}\cdot m\cdot v^2$ there is

$$\alpha=\frac{-m_0\cdot c}{\left(1-\frac{na^2}{2c^2}\right)} \qquad (7.)$$

Therefore the result for rest-energy is:

$$E_0 = -\alpha \cdot c = \frac{m_0 \cdot c^2}{1 - \frac{na^2}{2c^2}} \tag{8a.}$$

This can be written also as:

$$E_0 = \frac{2m_0 \cdot c^4}{2c^2 - na^2} \tag{8b.}$$

So, what ever the damping-factor velocity a is interpreted as, it holds the relation:

$$a \neq c \cdot \sqrt{\frac{2}{n}} \tag{9.}$$

So, the advanced SRT-theory has no restriction of a singularity at $v = c$ but in the damping-factor of outer velocity a of the enforcing system.

<u>3.Result:</u>

a) For $a \equiv 0 \Rightarrow E_0 = m_0 \cdot c^2$; classical SRT (10a.)

b) for $a > \sqrt{\frac{2}{n}} \cdot c$ there is $E_0 < 0$ (10b.)

c) for $a < \sqrt{\frac{2}{n}} \cdot c$ there is $E_0 > 0$ (10c.)

<u>4. Conclusions:</u>

There are the action and the Lagrangian for SRT-theory of fourth-order (damping analogy) for a free particle:

$$S = \frac{-m_0 \cdot c}{1 - \frac{na^2}{2c^2}} \cdot \int_a^b ds = \frac{-2m_0 \cdot c^3}{2c^2 - na^2} \int_a^b ds \tag{11.}$$

For $a \equiv 0$ this leads to classical action of a free particle in SRT:

$$S = -m_0 \cdot c \int_a^b ds \qquad (11a.)$$

The Lagrange-function results to:

$$L = \frac{m_0 \cdot c^2}{1 - \frac{na^2}{2c^2}} \cdot \sqrt[4]{\left(1 - \frac{v^2}{c^2}\right)^2 + \frac{nv^2 a^2}{c^4}} \qquad (12.)$$

Always n=1 chosen but $n \in \mathbb{N}$ possible. More evidently, n=4 probable (see [8.],[10.]).

For $a \equiv 0$ this leads again to classical SRT-Lagrangian for a free particle of:

$$L = m_0 \cdot c^2 \cdot \sqrt{1 - \frac{v^2}{c^2}} \qquad (13.)$$

(and including inverse Feinberg-term for possible FTL-movement of classical tachyons)[4.].

5. Summary:

An Action and a Lagrangian can be constructed for a free particle in advanced SRT of fourth order with damping analogies of oscillation but there are restrictions in damping factor a.So the system has no singularity in v at $v = c$ but in a with $a \neq \sqrt{\frac{2}{n}} \cdot c$.

6. Numerical data for possible experimental measurement of rest-energy:

For $c = 1$; $m_0 = 1\,kg$; $n = 1$ there is with

$$E_0 = \frac{2 \cdot m_0 \cdot c^4}{2 \cdot c^2 - a^2} = \frac{2 \cdot c^2}{2 \cdot c^2 - a^2} \cdot m_0 \cdot c^2 \qquad (8a./8b)$$

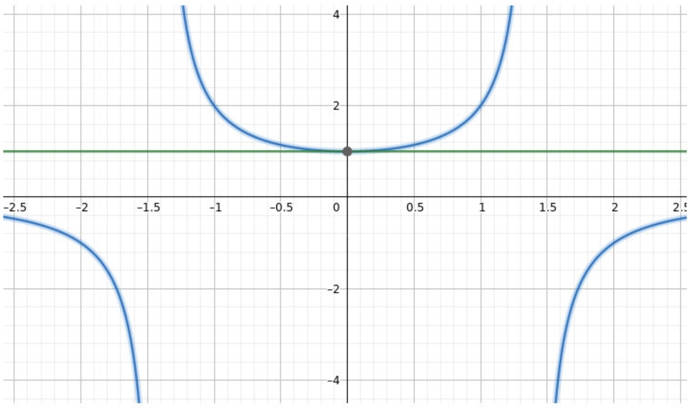
for

$$E_0\left(a = 10^{-4}\right) = 1{,}000\,000\,005 \cdot E_{0,SRT}$$

$$E_0\left(a = 10^{-3}\right) = 1{,}000\,000\,5 \cdot E_{0,SRT}$$

A term of $a = 10^{-4}$ means, if a is interpreted as a rotation velocity in terms of c there has to be a rotation velocity of $a = 30.000 \frac{m}{s}$ to get a sigificant measurement, that is with $r = 1\,m$, $N = 4777 \frac{1}{s}$ .Other data is possible, if experimental equipment will fulfill the requirement.

Seen is in Graph 1: this effect lest restenergy increase in contrary against the proposed result of decreasing in [2.]:



Graph 1: Terms of restenergy E_0 *over outer enforced velocity* a *for classical SRT (green constant graph) with* $a=0$ *and blue curves for advanced SRT of fourth order, when n=1 and singularity at* $a=\sqrt{2}\cdot c$ *for* $a\neq 0$

II. Changing of kinetic energy in SRT-theory of fourth order with analogy of damped, enforced oscillation

7. Discussion of kinetic energy-term:

There is the advanced term of kinetic energy in analogy to theory of classical special relativity:

$$E_{kin}=\frac{2c^4 m_0}{2c^2-na^2}\cdot\left(\frac{1}{\sqrt[4]{(1-\frac{v^2}{c^2})^2+\frac{na^2v^2}{c^4}}}-1\right) \qquad (14a.)$$

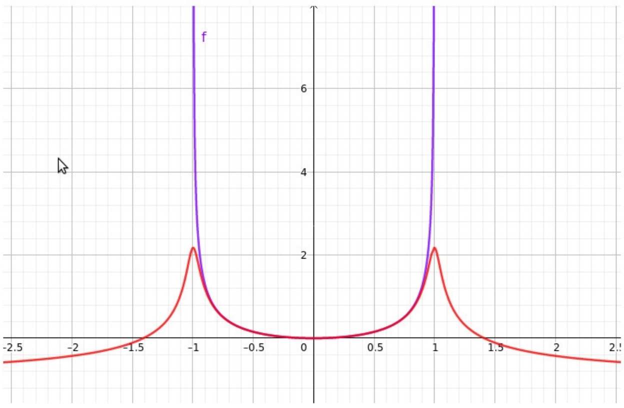
.

For $a\equiv 0$ the formula (14a.) goes into classical SRT-term for kinetic energy of a free particle of

$$E_{kin}=m_0\cdot c^2\cdot\left(\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}-1\right) \quad . \qquad (14b.)$$

The question now is:
<u>When is this new term of kinetic energy (14 a.) positive?</u>

Set $A:=\frac{2c^4 m_0}{2c^2-na^2}$ and $B:=\frac{1}{\sqrt[4]{(1-\frac{v^2}{c^2})^2+\frac{na^2v^2}{c^4}}}-1$ (14c.)



Graph 2: kinetic energy-term over v in classical SRT (blue curve) with $a\equiv 0$ *and in advanced SRT of fourth order (red curve) for special, qualitative, elected value of* $a\neq 0$ *.Indeed* $a=0.3$ *elected.*

The blue curve fit for open velocity- intervall of $v\in(-1;1)$ .It is plotted without the tachyon case for v>c [4.].The red curve fits for every value of v depending on outer velocity a of enforcing, damping system.

Then this problem is solved for conditions of:

$$(A>0\wedge B>0)\vee(A<0\wedge B<0). \qquad (15.)$$

Below is a table (7.1.) with all solutions to this question:

7.1.Solutions for Conditions of positive kinetic energy in advanced SRT of fourth order:

$A>0$	$\frac{2c^4\cdot m_0}{2c^2-na^2}>0$ (16 a.) : Since $2c^4 m_0>0$ obvious, it occurs. that $A>0$ for $a<\sqrt{\frac{2}{n}}\cdot c$ or $a>-\sqrt{\frac{2}{n}}\cdot c$. (16 b.)
$B>0$	This term is solved as a result for : a) $v^2<0\wedge v^2>2c^2-na^2$. This term fails because of $v^2<0$,this does mean that $v\notin\mathbb{R}$. (16 c.) b) $v^2>0\wedge v^2<2c^2-na^2$ .Herefore there are four solutions in v, two of them trivial, two of them restricted: I $v>0$ II $v<0$ both trivial and III $v\in(0;\sqrt{2c^2-na^2})$ IV $v\in(-\sqrt{2c^2-a^2};0)$ (16 d.) The roman third and fourth terms are open intervalls and restricted solutions for conditions of positive kinetic energy.

$A<0$	This term is solved for $a>c\cdot\sqrt{\frac{2}{n}}$ or $a<-c\cdot\sqrt{\frac{2}{n}}$ (16 e.)
$B<0$	This term is solved as a result for : a) $v^2<0 \wedge v^2<2c^2-na^2$. (16 f.) This term fails because of $v^2<0$,this does mean that $v\notin\mathbb{R}$. b) $v^2>0 \wedge v^2>2c^2-na^2$ .Herefore there are four solutions in v, two of them trivial, two of them restricted: I $v>0$ II $v<0$ both trivial and III $v>\sqrt{2c^2-na^2}$ IV $v<-\sqrt{2c^2.na^2}$ I and III gets: $v\in(\sqrt{2c^2-na^2};\infty)$ II and IV gets: $v\in(-\infty;\sqrt{2c^2-na})$ I and IV not solvable in $\Re$ II and III not solvable in $\Re$ (16 g.) The roman third and fourth terms are open intervalls and restricted solutions for condition of positive kinetic energy.

The possible measuring of this hypothetical postulated effect may be difficult because there may an overlapping by other, stronger, rotation-effects which has to be filtered out experimentally.

7.2.When is $E_{kin}=0$?

a) For $v\equiv 0$; that is obvious like in classical mechanics and in classical SRT.But there is a second zeroterm for kinetic energy in this theory-description of fourth-order here:

b) For $v(a)=\pm\sqrt{2c^2-na^2}$ kinetic energy is zero. Restriction of defintion: $a\neq\sqrt{\frac{2}{n}}\cdot c$ .With a=4 this leads to condition of $a\neq\sqrt{\frac{1}{2}}\cdot c$.

Conclusion:
So there are two zeropoints of kinetic-energy-term.One trivial at velocity being zero but the other as a variable function of $v(a)$ where v depends on the damping velocity a of outer enforcing system.

8.The Hamilton-function:

It results from velocity dependent partial derivation of Lagrangian to momentum:

$$\frac{\partial L}{\partial v}=p \qquad (17.)$$

and

$$E_{Ges}{}^2-(p\cdot c)^2=H^2 \qquad (18.)$$

There follows from

$$E_{Ges}=\frac{m_0\cdot c^2}{1-\frac{n\cdot a^2}{2\cdot c^2}}\cdot\frac{1}{\gamma} \qquad (19.)$$

and

$$L=\frac{m_0\cdot c^2}{1-\frac{n\cdot a^2}{2c^2}}\cdot\gamma \quad \text{with} \quad \gamma=\sqrt[4]{(1-\frac{v^2}{c^2})^2+\frac{n\cdot a^2\cdot v^2}{c4}} \qquad (20.a.b.)$$

the momentum p to:

$$p=\frac{m_0\cdot v}{1-\frac{n\cdot a^2}{2c^2}}\cdot[\frac{1}{\gamma^3}\cdot((1-\frac{v^2}{c^2})+\frac{n\cdot a^2}{2\cdot c^2})] \qquad (21.)$$

Therefore follows the correct Hamilton-function for the equation of movement to:

$$H=\sqrt{(p\cdot c)^2+\frac{m_0{}^2\cdot c^4}{1-\frac{n\cdot a^2}{2\cdot c^2}}\cdot\frac{1}{\gamma}{}^2\cdot[1-\frac{v^2}{c^2}\cdot\frac{1}{\gamma^4}\cdot[(1-\frac{v^2}{c^2})+\frac{n\cdot a^2}{2c^2}]^2]} \qquad (22a.)$$

which can be written shortened, in analogy to classical SRT-Hamiltonian if special variables are defined and established like:

$$\frac{1}{1-\frac{n\cdot a^2}{2\cdot c^2}}\cdot\frac{1}{\gamma}{}^2\cdot[1-\frac{v^2}{c^2}\cdot\frac{1}{\gamma^4}\cdot[(1-\frac{v^2}{c^2})+\frac{n\cdot a^2}{2c^2}]^2]=k \qquad (22b)$$

Then the result is:

$$H=\sqrt{(p\cdot c)^2+k\cdot m_0^2\cdot c^4} \qquad (22c.)$$

For $a\equiv 0$ there is the classical limited Hamilton-function of Special Relativity Theory (SRT) with

$$H=\sqrt{(p\cdot c)^2+m_0{}^2\cdot c^4} \qquad (23a.)$$

and $k=1$. (23b.)

9. Summary:

A Lagrange-function and a Hamilton-function can be constructed for advanced SRT of fourth order with any velocities v in local inertial system of Minkowski-tangent-space as a model of damped oscillation with enforced system. The problem of negativism occurs both for rest-energy and kinetic-energy under special conditions and circumstances, depending from outer velocity a of enforcing system.

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