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Eigenwertproblem of advanced Lorentz-Einstein-Factor

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Abstract:

The differential equation (DE) of second order for advanced Lorentz-Einstein-factor in fourth order can be written in a Sturm-Liouville form (STL). Therefore it can be formulated as an eigenwertproblem (eigenvalueproblem) for local flat spacetime-states. These eigenvalues are calculated.

Key-words: eigenwerte; Sturm-Liouville equation; differential equation of second order; Einstein-Lorentz-factor; model of damped resonance; eigenfunctions; ftl-velocity; eigenresonance of spacetime.

1. Introduction:

In the following paper there will be shown, that a second-order differential-equation can represent equations of eigenvalues („eigenwerte“) [5.] for advanced Lorentz-term of fourth order whose eigenvalues only exist under special conditions.

For the advanced SRT with ftl there can be written a Lorentz-Einstein -factor of fourth-order in root [1.].

$$\Gamma = \sqrt[4]{\left(1 - \frac{v^2}{c^2}\right)^2 + \frac{n \cdot v^2 \cdot a^2}{c^4}} \quad (1.)$$

For this term there exists a differential equation of second order which means, this DE is the generating equation for that factor [2.].

$$A \cdot \ddot{\psi} + AB \dot{\psi} + (A \cdot C - D) \cdot \psi = 0 \quad (2.)$$

The limiting cases to standard-SRT are fulfilled, because for $B \equiv 0$ follows $a \equiv 0$ and in this case there is generated by this DE the ordinary, common Lorentz-factor of [3.] and his counterpart of Feinberg for classical tachyons, see [4.] and Appendix:

$$\gamma = \sqrt{1 - \frac{v^2}{c^2}} \quad (3.)$$

This DE (2.) can be written in a Sturm-Liouville-form. This means, there is a description of an eigenwert-problem of this equation. This description follows now.

2.1. General Calculation:

The Sturm-Liouville-form of a DE can be formulated in its eigenform as:

$$-(p \cdot \dot{\psi})' + q \cdot \psi = \lambda_n \cdot \omega \cdot \psi \quad (4a.)$$

This means:

$$-p \cdot \ddot{\psi} - \dot{p} \cdot \dot{\psi} + q \cdot \psi = \lambda_n \cdot \omega \cdot \psi \quad (4b.)$$

Then can this equation be written as an eigenwertproblem:

$$L \cdot \psi = \lambda \cdot \psi \quad (4c.)$$

with the operator:

$$L = \frac{1}{\omega} \cdot ((-\ddot{p}) + q) \quad (4d.)$$

For the DE of advanced Einstein-Lorentz-factor (2.) this model can be written as:

$$-A \cdot \ddot{\psi} - A \cdot B \dot{\psi} + D \psi = A \cdot C \cdot \psi \quad (5a.)$$

with

$$\psi(r) = A \cdot e^{i \left(\frac{r}{r_{pl}} - \theta \right)} \quad (5b.)$$

(All dots above an variable or bracket are derivations after time in Newtonian notation).

Comparison of coefficients leads to:

$$\begin{aligned} A &= p \\ A \cdot B &= \dot{p} \\ D &= q \\ A \cdot C &= \lambda_n \cdot \omega \end{aligned} \quad (5c.)$$

Boundary condition after Sturm (BC) for this STL-system is the equation:

$$\psi(r) \cdot \sin(\theta) + \dot{\psi}(r) \cdot \cos(\theta) = 0 \quad (6.)$$

This leads especially to the BCs:

$$\psi(r_{pl}) \cdot \sin(0) + \dot{\psi}(r_{pl}) \cdot \cos(0) = 0 \quad (6a.)$$

$$\psi(r_{pl}) \cdot \sin(\pi) + \dot{\psi}(r_{pl}) \cdot \cos(\pi) = 0 \quad (6b.)$$

with

$$r \in [r_{pl}; n \cdot r_{pl}]; n \in \mathbb{N}; \theta \in [0; \pi] \quad (6c.)$$

Then the eigenwert-problem of a STL-equation can be written as:

$$\lambda_n = \pi^2 \cdot n^2 \cdot \left(\int_a^b \sqrt{\frac{\omega}{p}} dx \right)^{-2} \quad (7a.)$$

This leads in this case here to a selfreferential condition of:

$$\lambda_n = \pi^2 \cdot n^2 \cdot \left(\int_a^b \sqrt{\frac{C}{\lambda_n}} dr \right)^{-2} \quad (7b.)$$

After some boring calculations this formulation leads to an eigenwert-solution of:

$$\lambda_n = e^{2 \cdot \pi \cdot n \cdot \int \frac{1}{\sqrt{C}} d\omega + k} \quad (8a.)$$

Since $C = \omega^2_{PL}$, the integration has to be after the frequency ω of the oscillating system because of condition of absence of units of measurement in exponent of the value. Especially this integration leads to $\omega = \Omega$, the frequency of the modelled damping system, which is the only quantity which makes sense to use in these circumstances. Finally this equation leads to the expression of:

$$\lambda_n = e^{\frac{2 \cdot \pi \cdot n \cdot \Omega}{\omega_{PL}} + k}, \quad (8b.)$$

where k is an unknown, constant integration variable, which could be set to zero (or not).

2.2. Special calculation:

With

$$\Omega = \frac{a}{R} = \frac{1}{T}; R = m \cdot r_{pl}; m = const.; m \in \mathbb{N}; \omega_{PL} = \frac{1}{t_{PL}} = \frac{c}{r_{PL}} \quad (9.)$$

follows as a solution for the equation of eigenvalues:

$$\lambda_n = e^{2\pi \cdot \frac{n}{m} \cdot \frac{a}{c} + k}; \quad (10.)$$

The factor a is damping velocity of outer model- system, which reduces to $a \equiv 0$ for states of common, classical SRT.

$m = n; m, n \in \mathbb{N}$ possible.

So the equation for eigenfunction is finally:

$$\widehat{\psi}_n(t) = \lambda_n \cdot \psi(t) = \lambda_n \cdot A \cdot e^{i \left(\frac{v}{c} \cdot \frac{t}{t_{PL}} - \theta \right)} = \frac{e^{2\pi \cdot \frac{n}{m} \cdot \frac{a}{c} + k} \cdot e^{i \left(\frac{v}{c} \cdot \frac{t}{t_{PL}} - \theta \right)}}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)^2 + \frac{n \cdot a^2 \cdot v^2}{c^4}}} \quad (11.)$$

$k = \pm i \cdot \theta$ or $k = \pm \theta$ possible.

3. Conclusion:

There are calculated the eigenwerte for the DE of second order which represents in its solution the advanced Lorentz-Einstein-factor as an amplitude. They exist and are real e-functions.

Critical remark:

For $a \equiv 0$ this equation (8b.) leads to

$$\lambda_{(n)} = e^k. \quad (11.)$$

This formula doesn't depend from an n (see low brackets in lambda), so it could be reinterpreted as the classical form of SRT-Lorentz-factor because of $a \equiv 0$ – but on the other hand this form of a DE of second order can only be written as a STL-problem for constant value of p . Because p includes the velocity v of the inertial system (common classical Lorentz-factor), this velocity can only be supposed as a constant. So in this case acceleration in resp. of inertial systems can't be described.

Possibly k could be interpreted as constant supposed phaseangle $\pm i \cdot \theta$, but in case of classical SRT this phase-angle is identical equal to zero (or multiplies of Pi for classical tachyons), so the eigenwert will be reduced to a $|\lambda| = 1$ identity (see Appendix).

4. Summary:

The differential equation of second order for the advanced Lorentz-Einstein-factor in fourth order can be written as a Sturm-Liouville-problem. In this case the eigenvalue(s) can be calculated. They are real e-functions and depend from the velocity a of the outer model of a damping system. For $a \equiv 0$ the differential equation will reduce to the form for classical SRT-factor and possibly the eigenvalue be only the trivial case of $|\lambda| = 1$ or at least $\lambda = e^k; k = const.$

5. Appendix: Deduction of classical Lorentz-Einstein-factor from a DE

The aim is to determine the amplitude factor of A from the following DE of second order:

$$A \cdot \ddot{\psi}(t) + C \cdot (A - D) \cdot \psi(t) = 0 \quad (\text{A1.})$$

with:

$$C = \omega_{PL}^2; D = e^{i\theta} \quad (\text{A2.})$$

and the plane-wave function

$$\psi(r) = A \cdot e^{i \left(\frac{r}{r_{PL}} - \theta \right)} \quad (\text{A3.})$$

With the following common relations and the transition from r to t :

$$(r = v \cdot t; r_{PL} = c \cdot t_{PL}) \Rightarrow \psi(r) \rightarrow \psi(t) \quad (\text{A4.})$$

there is the function of a planewave depending only of time t :

$$\psi(t) = A \cdot e^{i \left(\frac{v}{c} \cdot \frac{t}{t_{PL}} - \theta \right)} \quad (\text{A5.})$$

with its derivations:

$$\dot{\psi}(t) = i \cdot A \cdot \left(\frac{\dot{v}}{c} \cdot \frac{t}{t_{PL}} + \frac{v}{c} \cdot \frac{1}{t_{PL}} \right) \cdot e^{i \left(\frac{v}{c} \cdot \frac{t}{t_{PL}} - \theta \right)} \quad (\text{A6.})$$

and

$$\ddot{\psi}(t) = A \cdot \left[i \left(\frac{\ddot{v}}{c} \cdot \frac{t}{t_{PL}} + 2 \cdot \frac{\dot{v}}{c} \cdot \frac{1}{t_{PL}} \right) - \left(\frac{\dot{v}}{c} \cdot \frac{t}{t_{PL}} + \frac{v}{c} \cdot \frac{1}{t_{PL}} \right)^2 \right] \cdot e^{i \left(\frac{v}{c} \cdot \frac{t}{t_{PL}} - \theta \right)} \quad (\text{A7.})$$

For $v = \text{const.}$ between inertial-systems of classical SRT, this relation of second derivation reduces to:

$$\ddot{\psi}(t) = -A \cdot \frac{v^2}{c^2} \cdot \frac{1}{t_{PL}^2} \cdot e^{i \left(\frac{v}{c} \cdot \frac{t}{t_{PL}} - \theta \right)} \quad (\text{A8.})$$

Setting $\psi(t) \wedge \ddot{\psi}(t)$ in the DE, this leads to calculation of amplitude A of the wave-function $\psi(t)$:

$$A = \frac{e^{i\theta}}{1 - \frac{v^2}{c^2}} \quad (\text{A9.})$$

Remark:

Since $e^{(i\theta)} = \cos(\theta) + i \cdot \sin(\theta)$ and comparison of coefficients in

$$e^{(i\theta)} = A \cdot \left(1 - \frac{v^2}{c^2}\right) \text{ leads to the conclusion for } i \cdot \sin(\theta) = 0$$

and the conditions for calculation of θ :

$$i \cdot \sin(\theta) = 0 \text{ for } \theta = k \cdot \pi; k \in \mathbb{Z} \text{ but}$$

$$\begin{aligned} I \cos(\theta) &= 1 \text{ for } k = 2 \cdot n; n \in \mathbb{Z}; \\ II \cos(\theta) &= -1 \text{ for } k = 2 \cdot n + 1; n \in \mathbb{Z} \end{aligned} \quad (\text{A10.})$$

I leads to square of Einstein-Lorentz-factor, II to square of Feinberg-factor of classical, common SRT.

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