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COMMENT

Can an anisotropic effect of the one-way velocity of light really be measured?

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Abstract. We briefly discuss the experimental test for detection of the anisotropic effect of the one-way velocity of light suggested recently by Chang. In our opinion Chang's proposition is rather inadequate to detect such phenomena.

Recently Chang (1980) has proposed the stellar aberration effect as a test for detection of the eventual anisotropy of the one-way light velocity. His proposition is based on the definition of some class of the inertial frames (IF) with the help of the so-called generalised Galilean transformation (GGT) (Tangherlini 1961, Mansouri and Sexl 1977, Chang 1979). However, in Rembieliński (1980) it was shown that the GGT form a subset of the nonlinear (with respect to three-velocity) Lorentz transformations: the IF connected by these transformations coincide with the special relativity (SR) ones via the formulae $\boldsymbol{x}_i = \boldsymbol{x}$ and $x_L^0 = x^0 - \boldsymbol{\sigma x}/c$, where x_L denote the SR coordinates and $\boldsymbol{\sigma}$ is interpreted as the velocity of IF Σ_σ with respect to the preferred frame Σ_0 (ether). The nonlinear Lorentz transformation from Σ_σ to $\Sigma_{\sigma'}$ has the form (Rembieliński 1980)

$$x^{0\prime} = \gamma_w^{-1}(1+\boldsymbol{\sigma w}/c^2)^{-1}x^0$$

$$\boldsymbol{x}' = \boldsymbol{x} - \frac{\boldsymbol{w}}{c}\gamma_w x^0 + \frac{\boldsymbol{w}}{c}\gamma_w\left(\frac{\boldsymbol{\sigma x}}{c} + \frac{\boldsymbol{wx}}{c}\gamma_w(1+\gamma_w)^{-1}\right) \tag{1a}$$

where $\boldsymbol{w}$ is defined by

$$\boldsymbol{\sigma}' = [\boldsymbol{w} + \boldsymbol{\sigma}\gamma_w^{-1} + \boldsymbol{w}(\boldsymbol{\sigma w}/c^2)\gamma_w(1+\gamma_w)^{-1}](1+\boldsymbol{\sigma w}/c^2)^{-1} \tag{1b}$$

and $\gamma_w = (1-w^2/c^2)^{-1/2}$.

The one-way light velocity is directional dependent (note however that the average value of $|\boldsymbol{c}|$ around closed paths is a constant equal to c),

$$\boldsymbol{c} = \frac{\boldsymbol{n}c}{1+\boldsymbol{\sigma n}/c}, \tag{2}$$

and as a consequence of equations (1) we have

$$\boldsymbol{c}' = \{\boldsymbol{c} - \gamma_w\boldsymbol{w}[1-\boldsymbol{\sigma c}/c^2 - \gamma_w(1+\gamma_w)^{-1}\boldsymbol{wc}/c^2]\}(1+\boldsymbol{\sigma n}/c) \tag{3}$$

i.e.

$$\boldsymbol{n}' = [\boldsymbol{n}\gamma_w^{-1} - \boldsymbol{w}/c + \gamma_w(1+\gamma_w)^{-1}\boldsymbol{w}(\boldsymbol{wn})/c^2](1-\boldsymbol{wn}/c)^{-1}. \tag{4}$$

Let us denote by Σ_σ and $\Sigma_{\sigma'}$ the solar and earth frame respectively and by $\boldsymbol{c}$ ($\boldsymbol{c}'$) the velocity of light from a fixed star observed in Σ_σ ($\Sigma_{\sigma'}$). Then equation (4) expresses the aberration effect for light emitted by the star. Because w is the relative velocity of Σ_σ and $\Sigma_{\sigma'}$ measured in standard (Einstein) synchronisation (Rembieliński 1980), the aberration effect is evidently synchronisation independent†, contrary to Chang's claim. The above result is not surprising because of the hidden Lorentz covariance of this ether theory (ET). As was mentioned in Rembieliński (1980), despite the physical interpretation of this ET, different from the usual one, it can be equivalent to special relativity at least on the classical level if dynamics does not mark the preferred frame.

Chang's equations of the electromagnetic field (Chang 1979) have the ordinary form in standard synchronisation, and consequently the expected ET effects are not really measurable in the framework of the light-geometric approach.

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† Equation (4) is the ordinary SR aberration formula.