Appendix T to:
A Theoretical Investigation to the Physical Constraints for Light Velocity in Empty Euclidian Space and first Consequences for Long-distance Physics.
Referred equations: (9), (12), (13), (14), (31), (34), (34a) (35)

Basic time transformation for force-free moving system

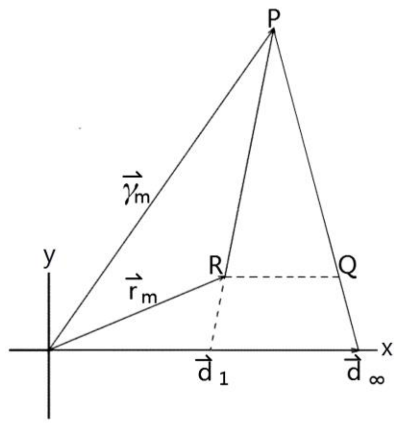
Again, a photon is considered travelling from then back to the origin of the now moving system, similar to equation (13) but now with different starting and ending locations:

$$\text{(T.1)}\qquad \begin{array}{ll} \vec{r}_{ph}(T_1) = \vec{d}_1 = \vec{d}(T_1) & \vec{r}^{*}_{ph}(T^{*}_1) = 0 \\ \vec{r}_{Ph}(T_m) = \vec{r}_m & \vec{r}^{*}_{ph}(T^{*}_m) = \vec{r}^{*}_m \\ \vec{r}_{ph}(T_2) = \vec{d}_2 = \vec{d}(T_2) & \vec{r}^{*}_{ph}(T^{*}_2) = 0 \end{array}$$

where $\vec{r}_m$ is the target location and the relations between T_m, T_1 and T_2 now are, from equations (9) and (34a) with corresponding $\vec{\gamma}_m$, $\vec{\gamma}_d$:

$$\text{(T.2)}\qquad \begin{array}{l} \vec{\gamma}_m - \vec{r}_m = (\vec{\gamma}_m - \vec{d}_\infty)\dfrac{T_1}{T_m} + \vec{d}_\infty \dfrac{T_{or}}{T_m} \\ \vec{\gamma}_d - \vec{r}_m = (\vec{\gamma}_d - \vec{d}_\infty)\dfrac{T_2}{T_m} + \vec{d}_\infty \dfrac{T_{or}}{T_m} \end{array}$$

However, these are implicit relationships because also the $\vec{\gamma}_m$, $\vec{\gamma}_d$ depend on T_1, T_2 respectively. Considering the top equation, travel from $\vec{d}_1$ to $\vec{r}_m$, towards $\vec{\gamma}_m$, the situation is depicted in the figure at the right. In the triangle PQR, the left side, PR, is the vector $\vec{\gamma}_m - \vec{r}_m$ and consequently the other sides must consist of the other vectors, according to their direction:



$$\text{(T.3)}\qquad PQ = (\vec{\gamma}_m - \vec{d}_\infty)\frac{T_1}{T_m} \qquad RQ = \vec{d}_\infty \frac{T_{or}}{T_m}$$

thus the point Q is:

$$\text{(T.4)}\qquad Q = \vec{r}_m + \vec{d}_\infty \frac{T_{or}}{T_m}$$

so that the line where the P, Q and $\vec{d}_\infty$ are located is described by:

$$\text{(T.5)}\qquad \vec{r} = \vec{d}_\infty + u\left\{\vec{r}_m - \vec{d}_\infty\left(1 - \frac{T_{or}}{T_m}\right)\right\} = \vec{d}_\infty + u\,(\vec{r}_m - \vec{d}_m)$$

where $\vec{r}$ is a point on the line, u is the corresponding location on the line and $\vec{d}_m = \vec{d}_\infty(1 - T_{or}/T_m)$. Q is reached for $u = 1$ and P will be reached for an u_e where $|\vec{r}|^2 = \gamma^2$:

$$\text{(T.6)}\qquad \gamma^2 = |\vec{d}_\infty + u_e(\vec{r}_m - \vec{d}_m)|^2 = d_\infty^2 + 2\,u_e\,\vec{d}_\infty \bullet (\vec{r}_m - \vec{d}_m) + u_e^2\,|\vec{r}_m - \vec{d}_m|^2$$

Note, that u_e is positive since $\vec{\gamma}_m$ and $\vec{r}_m$ are at the same side of the x-axis. This equation is rewritten as:

$$\text{(T.7)}\qquad (\gamma^2 - d_\infty^2)\left(\frac{1}{u_e}\right)^2 - \vec{d}_\infty \bullet (\vec{r}_m - \vec{d}_m)\frac{2}{u_e} - |\vec{r}_m - \vec{d}_m|^2 = 0$$

from which can be solved – note, that $\vec{d}_\infty \bullet \vec{r}_m = d_\infty x_m$ and $\vec{d}_\infty \bullet \vec{d}_m = d_\infty |d_m|$:

$$\text{(T.8)}\qquad \frac{1}{u_e}(\gamma^2 - d_\infty^2) = d_\infty(x_m - |d_m|) + \sqrt{\gamma^2\,|\vec{r}_m - \vec{d}_m|^2 - y_m^2\,d_\infty^2}$$

where the + sign of the square root pertains since u_e is positive. PQ can be expressed as a part $u_e - 1$ of the total line piece u_e:

$$\text{(T.9)}\qquad PQ = (\vec{\gamma}_m - \vec{d}_\infty)\frac{u_e - 1}{u_e}$$

so that combination with equation (T.3):

$$\text{(T.10)}\qquad \frac{T_1}{T_m} = \frac{u_e - 1}{u_e} = 1 - \frac{1}{u_e}$$

leads to, after some math:

$$\text{(T.11)}\qquad \frac{T_1}{T_m}(\gamma^2 - d_\infty^2) = \gamma^2 - x_m d_\infty - d_\infty^2\frac{T_{or}}{T_m} - \sqrt{\gamma^2\,|\vec{r}_m - \vec{d}_m|^2 - y_m^2\,d_\infty^2}$$

Following the same treatment for the back travel, we derive for T_2:

$$\text{(T.12)}\qquad \frac{T_2}{T_m}(\gamma^2 - d_\infty^2) = \gamma^2 - x_m d_\infty - d_\infty^2\frac{T_{or}}{T_m} + \sqrt{\gamma^2\,|\vec{r}_m - \vec{d}_m|^2 - y_m^2\,d_\infty^2}$$

so that:

(T.13) $$\frac{T_1 + T_2}{T_m}(\gamma^2 - d_\infty^{\;2}) = 2\left(\gamma^2 - x_m\, d_\infty - d_\infty^{\;2}\,\frac{T_{or}}{T_m}\right)$$

For the moving system, equation (14)

(14) $2\,T^*_m = T^*_1 + T^*_2$

remains valid – the right part of equation (T.1) is identical to that of equation (13) – so that combination with the universally valid equation (12):

(12) $T^*(x,y,T) = \Theta(x,y)\,T - \Delta t_{or}$

leads to – again, the parameters T_{or}, v_{or} are left out to improve readability:

(T.14) $$2\,\Theta(x_m,y_m)\,T_m = \Theta(d_1;0)\,T_1 + \Theta(d_2,0)\,T_2$$

According to Appendix M, the exact form of equation (31) is universally valid so that:

(T.15) $$2\,\Theta(x_m,y_m)\,T_m = \Theta(0,0)\left\{1 - \frac{d_1\, v_{or} T_{or}}{\gamma^2}\right\} T_1 + \Theta(0,0)\left\{1 - \frac{d_2\, v_{or} T_{or}}{\gamma^2}\right\} T_2$$

Applying equation (34) for $d_1 = d(T_1)$ and $d_2 = d(T_2)$ and replacing $v_{or}\,T_{or}$ by d_∞:

(T.16) $$2\,\Theta(x_m,y_m)\,T_m = \Theta(0,0)\left\{1 - \frac{d_\infty^{\;2}}{\gamma^2}\left(1 - \frac{T_{or}}{T_1}\right)\right\} T_1 + \Theta(0,0)\left\{1 - \frac{d_\infty^{\;2}}{\gamma^2}\left(1 - \frac{T_{or}}{T_2}\right)\right\} T_2$$

$$= \Theta(0,0)\left(1 - \frac{d_\infty^{\;2}}{\gamma^2}\right)(T_1 + T_2) + 2\,\Theta(0,0)\,\frac{d_\infty^{\;2}}{\gamma^2}\,T_{or}$$

so that combination with equation (T.13) gives:

(T.17) $$2\,\Theta(x_m,y_m)\,T_m = \Theta(0,0)\left(1 - \frac{d_\infty^{\;2}}{\gamma^2}\right) 2\,\frac{\gamma^2 - x_m\, d_\infty - d_\infty^{\;2}\,\frac{T_{or}}{T_m}}{\gamma^2 - d_\infty^{\;2}}\,T_m + 2\,\Theta(0,0)\,\frac{d_\infty^{\;2}}{\gamma^2}\,T_{or}$$

leading to – dropping the index m:

(T.18) $$\Theta(x,y) = \Theta(0,0)\,\frac{\gamma^2 - x\, d_\infty}{\gamma^2}$$

And equation (12) becomes, now expliciting the parameters T_{or}, d_∞:

(35) $T^*(T_{or},d_\infty;x,y,T) = \Theta_{or}\,(\gamma^2 - x\, d_\infty)\,T - \Delta t_{or}$

defining an adequate constant Θ_{or}.

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