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DETECTION OF RAYS IN MULTI-TIME WORLD

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A theory of multi-dimensional time was developed as an investigation of a further symmetrization of space-time properties [2 - 6] and as an attempt to bypass difficulties with superluminal Lorent transformations [5 - 8] inherent in all non-local generalizations [9,10]. A behaviors of bodies in such a theory is characterized by some interesting peculiarities. In one-time theories a luminous body is observed as long as its luminescence goes on, however in space with multi-dimensional time vectors the luminescence is seen only in a certain time interval and the body can become invisible long before a moment when its irradiation ceases. The question was considered in detail by E. A. B. Cole and I. M. Starr [1]. These authors did not use any restriction on time vector directions, i. e. in their model a signal can spread in any direction with respect to time axes t_i. It means that both outgoing and violating the causality incoming waves take part in interactions, therefore an influence of the future on the past, a creation of particles with negative energies and decays in which secondary particle mass exceeds mass of the decaying particle become possible.

The difficulties can be avoided if we demand that all signals should propagate along any time axis t_i only from the past to the future, i. e. all physically permissible trajectories ought to be disposed in t-subspace in that the projections of any time and energy vectors remain always positive [10]. From the cosmological point of view such a condition is equivalent to a supposition about an existence of some preferred ("relict") reference frame ("the time arrow" in one-time case) fixed by an event order which was set up at first moments after creation of our universe.

It should be emphasized that a moving along a trajectory $\hat{t}$ observer can describe events by means of the measured along this trajectory one-dimensional time t since the last one can be used as a parameter defining the vector function $\hat{t}(t)$ [1].

The goal of our paper is to show how taking the time irreversibility into account affects the detection of objects a time trajectory of which differs from the observer's one. In order not to complicate our consideration we shall confine oneself by a case when the trajectories of a luminous body and the observer are disposed on the same plane and the axis t_3 can not be mentioned.

As a simple example illustrating the peculiarities of the detection of signals in a multi-dimensional world, Cole and Starr considered a case when owing to the force of some circumstances a splitting of time trajectories of a motionless in x-subspace luminous body and the observer occurs suddenly (Fig.1). In the considered by these authors symmetrical with respect to every possible time directions variant of theory the light source losing little by little its lustre (displacing into infrared region) remains visible some time after the moment of the splitting. However, if the time-reverse motions are forbidden, we come to quite a different conclusion. Particularly, if the observer's time-trajectory coincides with the axis t_1 of relict reference frame, the luminous body becomes in a moment invisible because it occurs at once in the future with respect to the detector. The body can remain visible for some time after the splitting only if

[1]We mark off three-dimensional time vectors by a "hat".

the observer's trajectory has some inclination with respect to the relict time axes.

One can see from the Fig.1 that the duration of observing luminescence when the emitted light spreads in the plane (t_1, t_2) from the past to the future

$$T \equiv (t_f - t_c) = (t_f - t_p) - R/c = \frac{R}{c}\left(\frac{\sin(\varphi+\theta)}{\sin\varphi} - 1\right)$$

Here t_c is the time of the splitting, t_p is the observer's proper time when the light signal trajectory becomes parallel to the relict axes t_1. By $t > t_f$ the time light signal propagates backward in time t_2. R is the constant distance between the light source and the detector and φ is the angle between $\hat{t}$ and $\hat{\tau}$. BY θ the inclination of observer's trajectory with respect to the axis t_1 is denoted.

In more general case when the luminous body time trajectory *intersects* the observer's trajectory (at the moment $t = t_c$, see Fig.1) the detector holds fixed the luminescence in an interval from t_s when it fixes the ray emitted at right angle to the axis t_1 up to the moment of the last visible signal arrival t_f. For $t < t_s$ the body is too remote in the past and the connection to it is possible only with the help of subluminal signals ($\dot{v} < c$). The rays emitted at $t > t_f$ can not be observed owing to the causality principle. In that way, the duration of the visible luminescence expressed throughout the observer's proper time

$$T \equiv t_f - t_s = (t_f - t_c) + (t_c - t_s) = \frac{R}{c}\frac{\sin(\varphi+\theta)}{\sin\varphi}[1 + \cot(\varphi+\theta)]$$

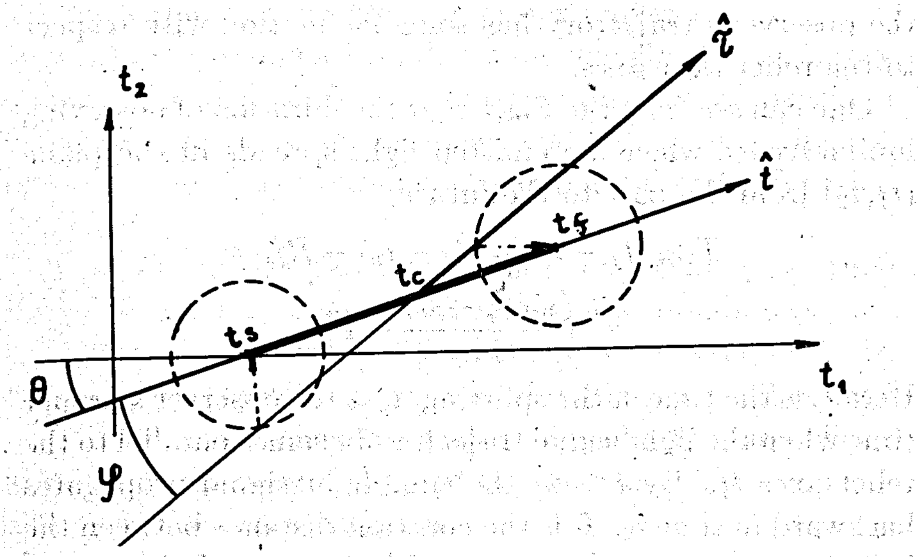

Figure 1: At an observer's proper time t_c the luminous body time trajectory $\hat{\tau}$ is splitted off from the observer's trajectory $\hat{t}$. The luminescence is seen in the interval $t_s \div t_f$. Light spheres $(\hat{t}-\hat{\tau})^2 = (R/c)^2$ from which at different times t the observer can receive signals are dotted. The dotted lines with arrow show the trajectories of the first and last visible signals.

As in the model considered by Cole and Starr [1], the value of T is significant only for remote cosmic objects. For example, if $R = 1$ m and $\varphi = \theta = 1', 1^o, 40^o$, it is equal, respectively, to $2.10^{-5}, 4.10^{-7}, 10^{-8}$ c. In a multi-time world there is a great number of invisible time displaced bodies around any observer. In this respect such a world is like a hypothetical world of tachyon theories [11,12]. One can think that an intersection of t-trajectories of bodies a space distance between which is smaller than their dimensions

must result in dramatic body destruction. Because such phenomena are not observed in a surrounding us part of universe, it proves that the time flow in this region is single-directed.

A duration of the visible luminescence of *a moving* in x-subspace light source depends on a value and a direction of its velocity, however qualitatively the picture remains the some as in the above considered static case. Particularly, if the observer's t-trajectory coincides with relict axis t_1 and the light source moves in x-subspace with zero impact parameter (a head-in-head collision), then the luminescence becomes visible from a moment

$$t_s = \frac{R_s}{c}\tan\varphi = \left(\frac{R_c}{c} + \beta t_s\right)\tan\varphi,$$

where $R_s = R(t_s)$ is the distance of the luminous body from the detector at the moment t_s, R_c is the respective distance at the moment when their t-trajectories intersect ($t = 0$), φ is the angle between these trajectories (Fig. 2A), $\beta = v/c$ is the relative velocity of the luminous body and the observer. Solving this equation we obtain

$$t_s = \frac{R_c/c}{\tan\varphi - \beta}.$$

If at $t = 0$ the source and the detector draw together and the velocity β is small ($\beta < \tan\varphi$, Fig.2A), then the luminescence is seen in an interval from t_s up to $t_f = R_c/c$:

$$T = \frac{R_c}{c}[1 + 1/(\tan\varphi + \beta)].$$

By increasing of the velocity ($\beta \geq \tan\varphi$) this interval stretches over all left half-axis from $t_s = -\infty$ up to t_f. In

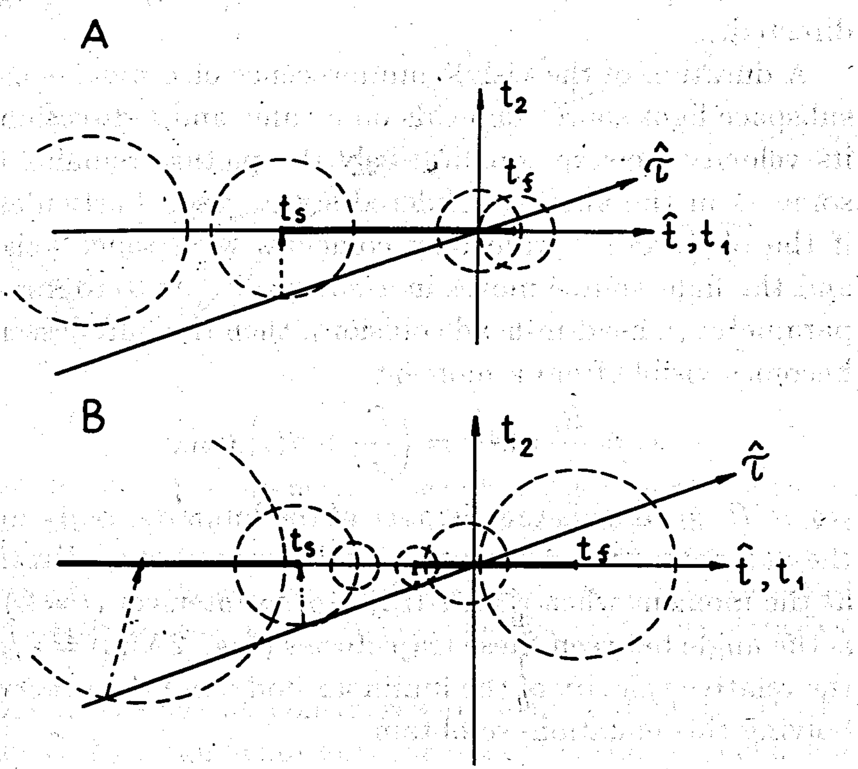

Figure 2: The bold tracks of the axis t_1 are the intervals of visible luminescence of a moving light source. The moment of time trajectories intersection is chosen as $t = 0$. The observer's light spheres are dotted. In case A the luminous body with velocity $\beta < \tan\varphi$ comes at time $t = 0$ near to the observer. In case B the luminous body with large velocity $\beta > \tan\varphi$ moves at $t = 0$ from the observer.

the case when at the moment $t = 0$ the light source moves off from the detector and its velocity $\beta < \tan\varphi$ the luminescence is observed, as before, in the interval from t_s up to t_f. However, by $\beta \geq \tan\varphi$ (Fig. 2B) one more interval of the visible luminescence beginning at $t_s = -\infty$ springs up.

The asymmetry of the cases of approaching and moving off light source is stipulated by the detector asymmetry with respect to signals from the past and the future.

As we see, the quantitative conclusions obtained in the papers /1/ are essentially changed if the time irrevesibility is taken into account.

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