The Structure of Time and the Wave Structure of Matter

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This paper presents a new concept of time called 'the SUPERTIME'. It is a time that is identical for all bodies, independent of their relative motion. The SUPERTIME, together with the 'Four-dimensional Euclidean Reality' model presented earlier, justifies in a simple way the wave structure of matter, and allows introduction of a new method of finding functions that describe particles as waves. The new approach also greatly extends the class of these functions.

Introduction

The nature of time is a problem that lies on the boundary between physics and philosophy, and it remains enigmatic to this day. On the one hand, time is perceived quite differently from space; on the other hand, when we use it in formulas, it behaves similarly to the space dimensions, which suggests that we are living in a four-dimensional reality. If we treat the time directly as the fourth dimension, analogous to the three space dimensions, we obtain a model of reality that is very complicated mathematically and conceptually. In order to simplify the description of reality, I proposed in [1] a model of Four-dimensional Euclidean Reality (FER), made of four identical dimensions. None of the dimensions was a pure space dimension or a pure time. We interpret three of the directions in FER as the space dimensions, and the fourth as the time-dimension, but those dimensions are not assigned in advance (as the time or space), but depend on the choice of a particular pair consisting of an observer and an observed body.

The FER model led to a significant simplification in the description of reality, and to the elimination of the singularities that appear in the Relativity Theory. On the other hand, the new model required careful definition of the observation process, which explained why the Euclidean reality without singularities is observed as the Lorentzian Space-Time (LST) with singularities. The singularities that occur in Relativity Theory are now the result of the manner of performing of observation, rather than the objective properties of reality.

In the proposed model [1], bodies 'move' in FER along their trajectories, and during this 'motion' they pass certain parts of the trajectories, and only these passed parts are perceived as time and measured by clocks in the bodies' frames. If we use the idea of 'motion', then we should introduce an additional 'time-like' dimension, in relation to which the 'motion' will be determined. This additional dimension will be called 'the SUPERTIME'. It is common for all bodies. Introducing the SUPERTIME will allow us to compare 'velocities' of bodies along their trajectories, *i.e.* the speeds of the time flow in the frames of these bodies.

Time and SUPRETIME

What properties should the SUPERTIME have? The following are proposed:

1) The main property of the SUPERTIME should be the ordering of events along the trajectory in FER. Successive positions on the trajectory should correspond to successive values of SUPERTIME. Because light quanta move along their trajectories similar to bodies, successive positions of quanta along their trajectories should also correspond to the successive values of SUPERTIME.

2) The SUPERTIME should 'flow' identically (*i.e.* with the same speed) for all quanta and bodies, independent of their relative motion.

3) The SUPERTIME must include the fact that the time in the bodies' frame depends on their relative motion, and the time in the frame of a light quantum must equal zero.

The above-mentioned properties of the SUPERTIME are fulfilled with the T -value determined by the formula:

$$dT^2 = \sum_{i=1}^{3} dx_i^2 + dt'^2 \tag{1}$$

where $i = 1,2,3$, x_i correspond to space coordinates x,y,z of the observer, and t' is the proper time of the moving body. (in FER $c = 1$) This means that the SUPERTIME is *not* an additional dimension in the well-known sense of the space-time dimensions. It is a value composed of both space and the time dimensions.

Such a definition of SUPERTIME changes the understanding of time flow. Up to now, a variability of events was related only to the changing of the body's position along the time dimension. Now the variability is determined by the change of its position in FER – along the time dimension (the proper time of the observed body) and along the space dimensions. For instance, for the observer's frame, where $\sum_{i=1}^{3} dx_i^2 = 0$, we have:

$$dT^2 = dt'^2 = dt^2 \tag{2}$$

i.e., the time measured by the observer is equal to the SUPERTIME, and the events of the observer are ordered only in relation to its position on its axis of time (trajectory).

For the observed body, moving with a certain velocity, the SUPERTIME is described with Eq. (1). This means that the events of the observed body are ordered in relation to its position along the trajectory of the body - t' - and along the space positions in the observer's frame- x_i.

For the frame bound with a light quantum, or with a hypothetical non-zero-mass body moving with the speed of light, (which corresponds to the body moving in FER along the trajectory perpendicular to the trajectory of the observer) we have $dt' = 0$; then

$$dT^2 = \sum_{i=1}^{3} dx_i^2 \tag{3}$$

In this case, the events of the quantum or of the body are ordered along its position on the direction (axis) that is perceived by the observer as the space dimension. We should notice that, with the help of the SUPERTIME, we are able to describe the non-zero mass body moving with the speed of light, while in LST that was impossible due to the singularities taking place for this speed.

For all the three cases mentioned above, the flow of the SUPERTIME – dT – was identical, but the proper times of those bodies were different.

We have to remember that, while in LST the notions of time- and the space-dimensions were separate ideas, in FER the notion of SUPERTIME is identical with the notion of distance passed by the body (in FER). During the SUPERTIME increment dT, each body passes the distance dS, and, using coordinates of the observed space- and time dimensions, dT can be written as follows:

$$dT^2 = dS^2 = \sum_{i=1}^{3} dx_i^2 + dt'^2 \tag{4}$$

Therefore, if we try to define the velocity – here the SUPER-VELOCITY – by analogy to the definition in LST, we can see that the SUPERVELOCITY of all particles in FER is the same, and equals to $V = dT / dS = 1$.

In FER all trajectories are allowed, so there can also exist bodies moving along trajectories aligned to the trajectory of the observer at an angle bigger than 90^0 and smaller than 270^0. From the observer's point of view, the time in frames of the bodies should flow 'backwards'. The situation described above is shown in the Fig. 1.

The SUPERTIME that would include all these trajectories can then be written in a complex form, and assuming that a time dimension is an imaginary one, it will take the following form:

$$T = r + r_0 + i(t' + t'_0) \tag{5}$$

Since r_0 and t'_0 are constant values, we can then make things simpler by conducting further considerations in the frame in which $r_0 = t'_0 = 0$ (with accuracy to a constant value). Then:

$$T = r + it' + = |T| \exp[i(\pi / 2 - \varphi)] \quad \text{where} \quad r = \sqrt{\sum_{i=1}^{3} x_i^2}, \tag{6}$$

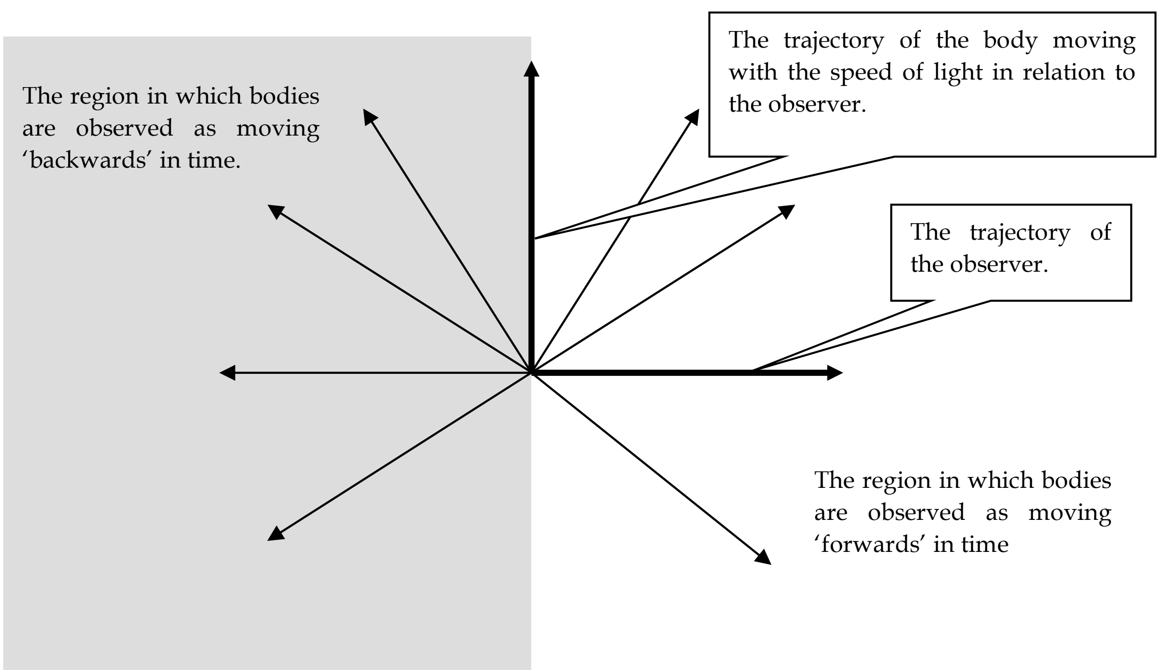

Figure 1. The trajectory of the observer and trajectories of other bodies. The trajectory perpendicular to the trajectory of the observer corresponds to a body moving with the speed of light. The trajectories inclined at angles >90^0 and <270^0 correspond to the bodies moving backwards in time in relation to the observer.

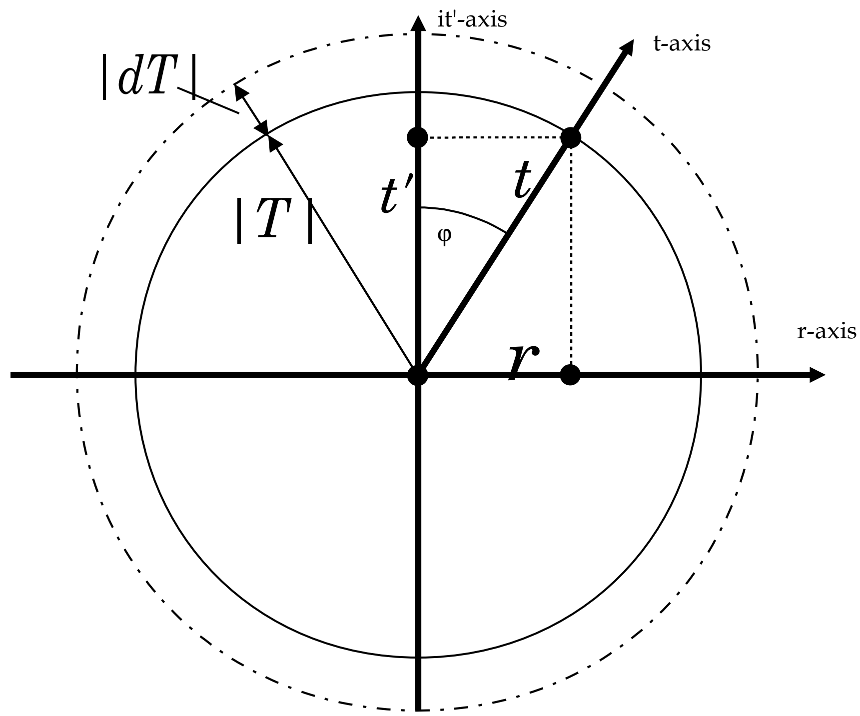

Figure 2. The idea of the complex SUPERTIME. The φ angle determines the relative inclination between the trajectory of the observer and the observed body. The $|dT|$ denotes the increment of the SUPERTIME T.

Because r and t' concern the observation of a body in the system of the particular observer, Eq. (6) can also be written as follows:

$$T = t\exp[i(\pi/2 - \varphi)] \tag{7}$$

where t is the time measured in the observer's frame, equal to $t^2 = r^2 + t'^2$. Such a definition of the complex SUPERTIME results from the earlier definition of the φ angle, which denotes the angle between the trajectory of the body and the observer – *i.e.* between the time axes of both coordinates systems; sinus of this angle denotes the relative velocity of the body [1,2].

The situation described above is shown in Fig. 2. The imaginary axis in Fig. 2. is chosen along the trajectory of the observed body, while the real axis denotes the *observed* distance r in space between the body and the observer. Neither of the dimensions is assigned *a priori* as the imaginary or the real one. The flow of the SUPERTIME consists only of the growth of $|T|$ - marked in Fig. 2 with the increment $|dT|$ - while it does not depend on the φ angle between the trajectories. This means that the flow of SUPERTIME is an absolute quantity.

Since the flow of time in the frame of the body – dt' – and the change of the distance – dr – treated separately are relative quantities and depend on the choice of the frame, then their composition, equal to $|dT|^2 = dt'^2 + dr^2$, is an absolute quantity, and does not depend on the choice of the frame. Hence, the SUPERTIME can characterize the body itself, independent of any observer.

The complex SUPERTIME T can be treated in FER both as the SUPERTIME and as the distance. If we treat the SUPERTIME as the distance, we can define the complex SUPREVELOCITY, which can be equal to:

$$V = dT/|dT| = \exp[i(\pi/2 - \varphi)] = \sin\varphi + i\cos\varphi \tag{8}$$

According to the definition of the observed velocity and the time dilation [1], we can see that the real part of such defined SUPERVELOCITY is equal to the observed velocity, while the imaginary part describes the *observed* velocity of the body's motion along its own trajectory, equivalent to the speed of the time flow in the observed frame.

Quantum Mechanics and the New Theory

The wave properties of matter have been known for almost a century, but the unification of the wave- and corpuscular properties of particles in a less abstract way than offered by quantum mechanics (QM) still presents a serious problem. The representation of a particle as a wave propagating in a medium such as space requires assuming the constant velocity of the wave. On the other hand, the particles-waves are moving in relation to one another, with various velocities, and in the frame of each particle, the time flows with different speed. The resolution of this problem is not simple, although possible –as proved in the recent paper [3].

Meanwhile, in the model presented in this paper and in [1,2], all particles are moving in FER with identical SUPERVELOCITY. Therefore, we have no more obstacles for representing the particle directly as waves in FER. We can express such a wave as a function of SUPERTIME in a most general way as follows:

$$\psi = f(T) \tag{9}$$

For instance, the simplest wave representing the particle can be expressed with the following formula:

$$\psi = \exp(-T\omega) = \exp(-r\omega)\exp(-it'\omega) \quad (10)$$

where $\omega = m_0 / \hbar$ for the described particle, and r is the distance from the maximum amplitude of the wave.

Next, in FER singularities do not exist, so t' for real bodies can be expressed as a continuous function $t'(t,r)$. For the case of the specified observer observing a specified body in a straight trajectory, the following formula should be fulfilled:

$$t' = t'\frac{dt'}{dt'} = \frac{1}{2}\frac{d(t')^2}{dt'} = \frac{1}{2}\frac{d(t^2 - r^2)}{dt'} = t\frac{dt}{dt'} - r\frac{dr}{dt'} \quad (11)$$

The rest mass of the particle is equal to $m_0 = \hbar\omega$ so Eq. (10) can be written as follows:

$$\begin{aligned}\psi &= \exp(-rm_0/\hbar)\exp[(-i/\hbar)(m_0 dt/dt't - m_0 dr/dt'r)] \\ &= \exp(-rm_0/\hbar)\exp[(-i/\hbar)(Et - pr)]\end{aligned} \quad (12)$$

Eq. (12) is the wave function well-known from QM.

Hence, the wave function that has been used for describing a particle in QM corresponds to the simple wave in FER. Therefore, it should be possible to describe all the quantum effects observed in our reality as a result of interactions of the waves in FER. The macroscopic motions should correspond to propagation of the waves in FER along differently inclined trajectories. Additionally, the factor $\exp(-rm_0/\hbar)$ appears here. This factor causes decrease of the wave's amplitude with increase of the distance from the particle. The effect of the existence of the particle would be felt, though attenuated, even at the very far distances from the particle. If the particles are disturbing space, and this disturbance extends to infinity, then the natural consequence of this disturbance will be action on the system of particles in order to decrease the global disturbance – *i.e.* the forces described until now as an effect of the existence of fields. If the disturbance described with the function $f(T)$ were complicated enough, consisting for instance of a several stretched and compressed regions of space, then we would expect that at different distances from the center of the wave, different mechanisms responsible for interaction between particles would dominate.

The Way to a Unified Field Theory

From the above consideration results the following scenario of constructing of the unified theory of field.

1) First, it is necessary to determine the action that corresponds to the disturbance of FER

2) Next, we should examine a set of functions of the SUPERTIME – $f(T)$ – describing various kinds of disturbance of FER and, using the principle of least action, we should determine forces acting on the system of particles.

3) Function $f(T)$, describing the shape of the space disturbance, should be chosen in a way that ensures the domination of different mechanisms for forces acting on the particles (or waves in FER), at different distances from the center of the wave. Those different mechanisms would be responsible for different kinds of interactions between particles.

Therefore, we should try to guess the right shape of the wave that correctly describes the particle in the FER. I believe that this is possible, and that finding such a function is only a matter of time.

If the theory given here is valid, the different kinds of interactions would be only an effect of the shape of the disturbance of space in FER, which is perceived in LST as the particle with the wave properties.

Conclusions

The idea presented in this paper, namely that the particle is a wave in space and the field is the result of disturbance of space, produced by a set of particles, and my conclusions from [1], namely that all particles of the Universe are somehow instantly connected to each other, are not new. Very similar conclusions were presented earlier in [3], so it could be said that the two papers – the present one and [1] – only confirm the ideas presented by Milo Wolff [3].

However, the presented paper is more then merely a justification of previous theories. The main advantage of this paper is the assumption that reality – FER – is constructed of dimensions different from the observed ones, and this greatly simplifies the description of reality. For instance, the function (12), describing a particle in LST, can be recast in FER in a much simpler form (10). Thus, the further description of particles should start from a function of the SUPERTIME describing the disturbance propagating through FER, and then, using the process of observation, it should be transformed into a more complicated function of the energy and momentum describing the particle in LST.

Of course we can try to guess the shape of the function in LST, and it is not difficult for the simplest cases described with functions similar to (9) – see [3]. However, in case of more complicated functions $f(T)$, it would probably be impossible. The wave structure of matter has already been proposed and described in [3], and the wave model of a particle was also proposed there. However, it is hard to believe that all particles of the Universe can be described with only one type of disturbance of the space. We know for instance from the physics fluids, that the disturbances of the medium can take different forms. Thus, the idea of the wave structure of matter [3] should, in my opinion, be extended for a wider class of functions. Introduction of the FER model allows one to find and examine a wide class of functions describing the particles, which should now be an effect of more or less complicated disturbances of space. I believe that it could give a final answer to the question of how the matter is constructed and how it interacts.

References

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