The physical nature of the basic concepts of physics

7. Extent, Velocity and Length Contraction [(i)]

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Abstract

Physics today has an ambiguous attitude towards 'velocity'. On the one hand relativistic physics considers it a "relative" characteristic of which the numerical value depends on the chosen reference frame, but on the other hand that same physics tells us that velocity causes a length contraction, a time dilation and a mass increase and that it has an absolute upper limit, which is equal to the invariable speed of light.
This duality is caused by the fact that the Lorentz transformations accomplish a mathematical bridging between a relative velocity at low speeds and an absolute velocity at the speed of light, but that it is not clear whether these equations describe observational or real physical phenomena. It is this vagueness that has led to the a number of internal contradictions, such as e.g. the "twin paradox" and the "pole an barn paradox".
In this paper I demonstrate that mass particles are 3-dimensional particle systems that consist of 2-dimensional massless particles and that their variable velocity is not so much distance divided by time, but that it is an emerging physical state of these a particle systems.
This physical nature of velocity leads in a self-evident way to the Lorentz contraction of moving particle systems in their direction of motion, which I demonstrate to be a real physical distortion.

1. The present concept of velocity

Physics has always had an ambiguous attitude towards 'velocity'.

- In 1687, Newton published his "Mathematical Principles of Natural Philosophy" in which all physical manifestations result from mechanical interactions between 'particles' and in which length and time are defined in an absolute way, so that velocity was intrinsically considered as an absolute physical characteristic. In a general way, Newtonian physics defines velocity as the change of distance per unit time. According to the International Systems of Units (SI):
  - The unit of 'length' or 'distance' is the meter (m), which was first defined as the distance between two scratches on a calibrated bar made of platinum-iridium. Since 1983, the meter is defined as the distance traveled by a light wave of a given laser in vacuum space, in a time interval of $1/299792458^{th}$ of a second.
  - The unit of 'time' is the second (s), which was first defined as a $1/24x60x60^{th}$ of a mean solar day. It is now replaced by the atomic standard of time, which corresponds

(i) Updated edition of the paper "Velocity, mass and time" May 1991 by the same author.

to 9192631770 vibrations of a cesium-133 atom.

- Besides Newton's 'mechanical world view', the leading theory for light became however the wave theory, developed by Christian Huygens in 1669 in his "Oeuvres Complètes". Huygens considered light as a wave that was propagating through the ether in a manner analogous to the propagation of sound through the air. Since that propagation is affected by the speed of the air, it was thought that the motion of the earth through the ether would equally affect the speed of light.

- James Clerk Maxwell at first attempted to explain the behavior of electric and magnetic fields in terms of a mechanical world view, according to which space was filled with a physical ether consisting of small rotating 'vortices' [(ii)]. Later on he abandoned this mechanical model and in 1873 he published his electromagnetic theory, in which 'charge' instead of 'mass' was the fundamental entity of matter and in which light was a form of electromagnetic radiation between charged particles. In that way Maxwell replaced the concept of the 'ether' by the concept of the electromagnetic 'field' that transmitted electromagnetic radiation and that was supposed to exist in its own right, without the need for an underlying ether [1]. In that way Maxwell's electro-magnetic field theory became the leading theory of light.

- In 1881 the 'Michelson-Morley experiment' definitely proved that the speed of light was not affected by the motion of Earth through space, which was the end of the ether drag theory and which not only meant that Maxwell's theory was right, but also that the speed of light was not consistent with the Galilean velocity addition law.

- In 1892, on the basis of the Michelson-Morley experiment, Hendrik A. Lorentz, who was one of the leading adherents of Maxwell's electromagnetic theory, published a modification of the Galilean transformation in which, in addition to the transformation equation for the space coordinate ($x' = x - v_0t$), he added a similar transformation equation for the time coordinate ($t' = t - v_0x/c^2$). In that equation he introduced a new variable 'c', which represents the invariable speed of light in empty space. This equation takes account of the ratio of the speed of the reference frame to the speed of light (v_0/c) and of the time required for the light to travel from the origin of the reference frame to the body (x/c).
In his dynamical theory, Lorentz explained that the electromagnetic interactions with the ether through which they move, modifies the internal structure of the fundamental units of matter (in the electromagnetic theory: electrons), squeezing them in their direction of motion, so that their form changes from spheres to ellipsoids, with the minor axis in the direction of motion and causing the length of the objects to change [2]. This would mean that in the Michelson-Morley experiment, the arm of the interferometer in the direction of motion would have shrunk just enough to compensate for the expected time difference! Lorentz then calculated that this meant that all physical objects had to be contracted in their direction of motion by a factor related to the square of the ratio of the speed of the object to the speed of light (the "length contraction'):

$$L_v = L_o \sqrt{1 - v^2/c^2}$$

It is thereby important to stress the fact that Lorentz was strongly convinced that this "length

(ii) The concept of vacuum space consisting of rotating vortices was first suggested by René Descartes in his "Principles of Philosophy" (1644) and reappears in the present loop quantum gravity in which vacuum space consists of 'spin' networks.

contraction" in the direction of motion was a real physical compression of the moving body in that direction. In the same year, completely independently from Lorentz, George Fitzgerald came to exactly that same conclusion and therefore Lorentz' equation is also known as the 'Lorentz-Fitzgerald contraction'.
In 1904, Lorentz published a new version of his theory which dealt with measurements in different inertial reference frames in which he introduced his so-called 'Lorentz transformations'. These transformation equations led him to conclude that not only the length of moving electrons, diminishes with increasing speed, but that also their clocks run slower or in other words, that the unit time interval between two consecutive ticks dilates with increasing speed (the 'Lorentz time dilation'):

$$T_v = \frac{T0}{\sqrt{1 - v^2/c^2}}$$

From his assumption of a deformable electron and his transformation equations, Lorentz then derived the expression for the 'mass increase' of moving electrons in their direction of motion:

$$m_v = \frac{m0}{\sqrt{1 - v^2/c^2}}$$

Finally his transformations led to his 'velocity addition law' for two bodies moving at high speeds u and v: $W = (u + v)/(1 + uv/c^2)$. This equation corresponds to the 'Galilean addition law' for low speeds, and it leads to the invariance of the speed of light if one of the speeds is equal to 'c'.

- In 1905 Albert Einstein published his paper "On the Electrodynamics of Moving Bodies" which later became known as the "Special Theory of Relativity". Einstein based his whole theory on his two fundamental postulates [3] [4]:

1. **The relativistic principle**: The laws of physics are the same in all inertial reference frames, which implies that absolute motion cannot be detected.
2. **The invariance of the speed of light**: The speed of light in vacuum space is equal to the value 'c' independent of the motion of the source.

On the basis of these two simple postulates, Albert Einstein came directly to a set of transformation equations, that were identical to those elaborated by Lorentz, from which he derived the equations for "time dilation" and "length contraction".
According to Stanley Goldberg [5] "*For Einstein, mass had no such cosmic significance. After all, it was clear to him that he had produced a theory of measurement, not a theory of matter*" and "*For the mass to vary, not only with frame of reference, but with direction within a frame, would vastly complicate the derived laws of physics, for example, the conservation of energy and the conservation of momentum*". So Einstein replaced Lorentz' mass increase equation by his own relativistic kinetic energy equation:

$$E = \frac{mc^2}{\sqrt{1 - v^2/c^2}}$$

which for $v = 0$ leads to his famous mass-energy equation of the rest mass: $E = mc^2$.

In his special theory of relativity, Einstein has demonstrated that motion (and therefore velocity) is a relative characteristic of which the numerical value is determined by the (arbitrarily) chosen reference frame (which is consequently also the case for its derived characteristics, such as 'linear momentum' and 'kinetic energy'). It was thereby considered as a reassuring factor, that despite the fact that observers in different inertial reference frames would disagree about the values of these fundamental characteristics, they all would agree that their numerical values are conserved in physical interactions, so that the conservation laws would remain valid all reference frames.
In his book "Über die spezielle und die allgemeine Relativitätstheorie" [6] Einstein writes that he extracted the special theory of relativity from the Maxwell-Lorentz theory on electromagnetic phenomena. He thereby underlines that Lorentz' theory is based on the hypothesis that electrons undergo a physical contraction in their direction of motion, but that there is no proof at all for this hypothesis!
He also underlines that his 'Special Theory of Relativity' comes to exactly the same equations as Lorentz, without the need for any hypothesis about the composition of matter (electrons or other) or the existence of an 'ether', because in his theory, the contraction of moving bodies follows directly from his basic postulates in which there is no preferential reference system and consequently no ether drift. Einstein thereby expresses his view that crucial for his theory is not the motion of the body itself, but the motion with respect to the chosen reference frame.

2. The physical ambiguity of the relativistic concept of velocity

In his book "Understanding Relativity" Stanley Goldberg underlines the deep, fundamental difference between the Einstein and the Lorentz-Fitzgerald views about the length contraction [7]: *"Whereas Lorentz considered the length contraction as a real physical phenomenon and tried to understand it in physical terms, the question of the reality of the contraction did not arise in Einstein's analysis. He rather considered the length contraction as an artifact of the way we measure and of the discrepancy between different inertial frames of reference about the time interval between any two events."... "In Einstein's view the discrepancies are not a result of squeezing of rods; rather, a result of the way we measure."*
According to Stanley Goldberg this complete difference of opinion between Lorentz and Einstein's point of view about the true nature of the length contraction didn't much trouble the physicists of that time [8]: *"In the minds of many, since the predictions of Einstein's and the predictions of Lorentz were the same, they were seen as aspects of the same theory. Even supporters of Einstein shared this confusion: for example, Max Planck referred to the Lorentz-Einstein theory and Hermann Minkowski, the man who is credited with generalizing Einstein's theory to four dimensions, remarked that Einstein's work was a generalization of Lorentz's".*
Lorentz however never changed his mind about his physical interpretation of the length contraction. Shortly before his death he wrote [9]: *"I should like to emphasize the fact that the variations of length caused by a translation, are real phenomena, no less than for instance, the variations that are produced by changes of temperature"*. This complete disagreement between Lorentz's absolute and Einstein's relative viewpoints in regard of the real nature of velocity and the associated length contraction, has however never been properly cleared out. According to Goldberg: *"The persistence with which Lorentz maintained his interpretation illustrates a point made by Max Planck in his Scientific Autobiography. According to Planck, new ideas do not gain favor by changing the minds of established individuals in the field. Rather, as the older members of a profession die, they are replaced by younger men who*

become familiar with the newer idea's, and eventually recognize the advantages of replacing the old with the new" and concludes that *"Individuals, Planck included, elaborated on the consequences of the theory. It was that elaboration that more and more revealed the heuristic power of Einstein's formulation and the lack of it in the Lorentz formulation, that led to the gradual appearance of the Einstein theory in textbook formulations"*.
It is in that way that over the years, Einstein's Special Theory of Relativity has become the cornerstone of the present theory of motion and Lorentz' contribution is restricted to the mathematical equations that fit in with Einstein's theory, such as e.g. "the Lorentz transformation", the "Lorentz(-Fitzgerald) contraction" and "the "time-dilation".

So, as far as the nature of velocity concerns, the problem seems to be solved. But is this really the case? The Lorentz transformations, on which Lorentz' as well as Einstein's theories are based, make a mathematical overlap between relative velocities at low speeds and an absolute velocity at the speed of light, but in Einstein's view it is not clear whether these equations describe observational or real physical phenomena.
Lorentz' electromechanical theory tried to explain the dynamic behavior of matter (in his case, the 'electrons') in relation with an increasing velocity, whereas Einstein's theory of relativity is a purely kinematic theory, that describes the relation between observations of different events in reference frames that have increasing speeds relative to each other.
This ambiguity between both points of view has never been cleared out and still blurs modern textbooks, as is demonstrated by the following examples.

1. The textbook " Physics – Second Edition, Expanded" [10].
   - **Time-dilation**: *"As measured by the clocks on the Earth, the clock on the spaceship runs slow. The time-dilation effect is symmetric: as measured by the clocks on the spaceship, a clock on the Earth runs slow by the same factor. The slowing down of the rate of lapse of time applies to all physical processes. In accurate experiments performed at CERN, muons with a speed of 99,94% of the speed of light were found to have an average lifetime 29 times as large as that of muons at rest."*
   - **Length contraction**: *"Suppose that a rigid body is at rest in a spaceship relative to the Earth. The length of the body measured in the reference frame of the Earth is shorter than the length measured in the reference frame of the spaceship. This effect is symmetric: a body at rest on the Earth will suffer from contraction when measured by instruments on board of the spaceship. The length contraction has not been tested directly by experiment."*

2. The textbook "Physics for Scientists and Engineers with Modern Physics – Third Edition" [11]:
   - **Time-dilation**: *"Moving clocks are observed to run more slowly than clocks at rest do. It is not that the clocks are physically altered, rather time intervals that are observed in different inertial frames differ." "The time dilation is a symmetric effect. The time-dilation effect is real: We can produce experimental evidence with measurements of the half-lives of radioactive nuclei or unstable particles in motion."*
   - **Length contraction**: *"The slowing down of moving clocks is accompanied by the contraction of the length of moving objects along their direction of motion." "To the moving observer, the atmospheric height, or any length in the direction of his motion, has undergone a length contraction."*

3. The textbook "Modern Physics" [12]:

- **Time-dilation, or time stretching**: *"Observers in S conclude that the clock in S' runs slow since that clock measures a smaller time interval between the two events." "In 2010 J. C.-W. Chou at NIST used precision optical clocks to detect the minuscule time dilation at a speed of only 10 m/s. These experimental result leave little basis for further debate as to whether traveling clocks lose time. They do."*
- **Length contraction**: *"The length of an object measured in the reference frame in which the object is at rest, is called its proper length. In a reference frame in which the object is moving, the measured length parallel to the direction of motion is shorter than its proper length."*

4. The book "An illustrated Guide to Relativity" [13]:
   - **Time-dilation**: *"Moving clocks are always observed to be running slower. This effect is known as time dilation. "Time dilation is often misunderstood to mean that time itself is flowing at a slower rate in a moving frame compared to a frame at rest. This is not true at all: The relationship between the stationary and moving frames is completely symmetrical and time dilation is a phenomenon that is caused by the relativity of simultaneity and has nothing to do with how fast time is flowing."*
   - **Length contraction**: *"Length is the distance separating the two ends of an object at the same time. The natural length of an object is its length measured by an observer moving along with the object. Objects that are moving relative to an observer always look shorter than their natural lengths." "Just like time dilation, Lorentz contraction is often misunderstood to mean that space itself shrinks in the direction of motion in the moving frame. This is not true. Lorentz contraction is a phenomenon caused by the relativity of simultaneity, just like time dilation, and does not imply the stretching or shrinking of space itself."*

5. The book "Relativity, Gravitation and Cosmology" [14]:
   - **Time-dilation**: *"Any inertial observer will find that time passes more slowly for any other inertial observer who is in relative motion. Both will be right because time is a relative quantity, not an absolute one."*
   - **Length contraction**: *"The rod is observed to be shorter in the laboratory frame than in its own rest frame. In short moving rods contract. Any moving rod will be observed to contract in its direction of motion."* And further: "*Length contraction is called Lorentz-Fitzgerald contraction, though their interpretation was rather different from that of Einstein*".

From this short, though representative, survey we can conclude that these different and even contradictory "explications" of Einstein's theory on 'time-dilation' and 'length contraction' stand in strong contrast with the accuracy of the definitions that one is used to find in the other areas of physics. One reason for this lack of clarity is that the theory of relativity is not exactly commonplace for physicists and engineers, who are trained to describe how things work and who are less concerned with how they appear to different observers.
All these descriptions are in some way ambiguous, not only because they contradict each other in subtle ways, but especially because they contradict themselves by underlining that these effects are fully symmetric and suggesting at the same time that they are real. It is indeed a paradox that a relative speed, that completely depends on an arbitrarily chosen reference frame, can have physical consequences, such as e.g. the time-dilation of the muon decay. Even Einstein himself sustained this ambiguity, because in his theory he considers time dilation a genuine phenomenon [15].

It is consequently not surprising that this intrinsic ambiguity has led to the well-known contradictions, such as e.g. the "twin paradox" and the "pole an barn paradox.

All these considerations oblige us to conclude that when we leaf through the present textbooks of physics, we realize that roughly a hundred years after the publication of the "Special Theory of Relativity", the differences in opinion between Einstein's and Lorentz view about the real nature of the length contraction, the time-dilation and the mass increase, have never been scientifically cleared out and therefore the question remains whether it are genuine physical processes or mere measurement problems? To reveal this once and for all we have to unveil the real nature of velocity (or speed) in a clear, unambiguous way.

3. The physical nature of the 'size' or 'extent' of a particle system

In nature, all material objects are in fact composite, multi-particle systems, composed of molecules, that on their turn are composed of atoms, that are further composed of a nucleus surrounded by electrons. This nucleus is on its turn composed of protons and neutrons, which are on their turn composed of quarks, .. .
This means that all material objects are in reality multi-level "particle-systems" that consist of some very small 'basic' constituents that are moving about each other. In that way the 'shape', 'size' or 'extent' of an observable (macroscopic) 'particle' is nothing else than the area that is repetitively covered by the motions of these rapidly moving 'pointlike' constituents. (This phenomenon is comparable to the glowing 'donut' that is perceived when one rapidly sweeps the glowing point at the end of a wooden stick around in the dark.)
This means that a particle system, consisting of rapidly moving, undetectably small components that repeatedly cover a three dimensional area with a radius 'R', will be perceived as a massive 'particle' with a diameter '2R' and some sort of internal rotational motion.
When a number of these 'particles' are relatively small and have on their turn rapid repetitive rotational/vibrational motions around each other, then even this multi-level particle-system will be perceived as a massive 'particle' with some sort of internal motion.
These dynamic, multi-level particles systems, that are built up from undetectably small basic unit particles and that are subjectively perceived as massive 'particles', corresponds quite well to our historical view of the structure of matter (from Rutherford's massive proton nucleus, that later appeared to consist of vibrating protons and neutrons, which on their turn appear to consist of quarks, etc.). This leads us to a dynamical 'particle' model in which all observable 'particles' are in reality dynamic wavelike particle clouds of the underlying basic particles.

- Such a dynamic, multilevel translational/rotational/vibrational particle system will have more chance to be perceived as a massive 'particle', when the distribution of its components is denser and/or their angular velocity is greater.
- It will, on the contrary have more chance to be perceived as a 'particle cloud', when the distribution of its components is less dense and their angular velocity is lower. A typical example of this is the so-called "angular probability density of electron clouds".

Since these so-called particle clouds represent the repetitive motions of the considered particles, the places where it passes more frequently are as a matter of fact the places where the probability to find it is higher. In that way, it becomes self-evident that the intensity of a wave at some point is proportional to the probability of finding the particle there.

- The reason why an electron cloud is not seen as a "particle" is that the existence of electrons was assumed by Joseph Thomson in 1895 approximately thirty years before

the establishment of electron clouds on the basis Schrödinger's equation in 1926 (Fig. 7.1).

- Protons on the other hand are not designated as 'quark clouds', because the existence of protons has been assumed in 1886, some 80 years before the discovery of quarks in 1968 [16].

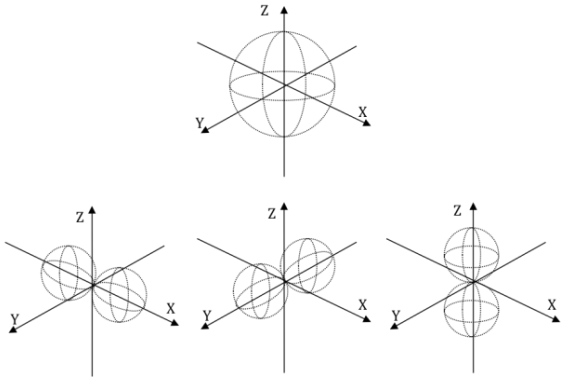

Fig. 7.1

For smaller components with much higher velocities, the repetitive trajectories will have a greater chance to be perceived as a single 'particle' or 'wave-packet' (Fig 7.2).

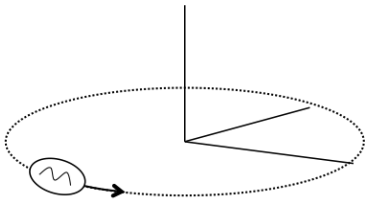

Fig. 7.2

From this perspective, all detectable 'particles' are to be seen as dynamic vibrating/rotating structures of basic elements that obtain new, emerging macroscopic properties in the same way that a 'swarm' of bees, a 'colony' of ants, or a 'flock' of birds can be seen as new entities with their own specific (group) characteristics.
This view corresponds quit well to the view of Don Lincoln [17] who demonstrates that, although the present Standard Model treats the basic particles (the quarks, leptons and bosons) as pointlike, zero size particles without internal structure, the patterns within the Standard Model raise the possibility that the differences of their characteristics (mass, charge, spin, ..) are caused by the nature of smaller underlying particles, that he calls 'preons'. He points thereby out that these 'preons' could even consist of still smaller vibrating systems, such as 'superstrings'.

4. The physical nature of the 'velocity' of particle systems

4.1 The variable speed of particle systems

In section 3 of my paper Part 1 on the physical nature of 'linear momentum', I have demonstrated that the velocities of the elements of a monatomic particle system can be split up into their natural components:

- Their common, congruent translational velocity '$\mathbf{v_c} = \Sigma m_j \mathbf{v_j}/m$' with which all unit particles move in a coherent way, that is with the same speed in the same direction '$\mathbf{v} = \mathbf{v_c}$'. This means that the congruent velocity '$\mathbf{v}$' of a particle system can be represented on a real x-axis as a real vector with a given length and a given direction.

- Their internal translational/rotational velocities with witch the individual particles move in regard of the center of mass of the particle system and which are isotropicly distributed over all possible directions. Since these isotropic velocities do not produce a resultant velocity and don't in that way affect the congruent velocity of the particle system, they can be represented by their average RMS-speeds $q = \sqrt{\frac{3kT}{m1}}$ on an 'isotropic' axis that stands perpendicular on the real x-axis. Mathematically this means that we can represent the RMS-speed of the internal motion of a particle system on an imaginary axis 'i', with a given magnitude 'q' but with no specific direction.

Both considerations allow us to represent the total velocity of an individual element of a moving particle system, composed of identical basic unit particles, as a complex number:
$z = v + iq$

In section 2.3.1 "The degree of coherence of a particle system" of my paper Part 6 on the physical nature of entropy, I have demonstrated that the adiabatic expansion in the x-direction of a moving piston, causes a (partial) rectification of the isotropic motion of the particles and produces an amount of congruent motion in that direction, at the cost of their isotropic, thermal speed [(iii)].
During that adiabatic expansion, a part of the thermal isotropic motion is transformed into congruent translational motion, which means that their thermal speed has decreased from q_h to q_c so that the frequency of the collisions between the molecules, and consequently their thermal radiation, will also have decreased.

This allows me to represent this partial rectification of the velocities of the particle system, by the rotation over an angle 'α' of the thermal speed 'q_h' which results in a lower thermal speed 'q_c' and a congruent velocity '$\mathbf{v}$' (fig. 7.3).
This degree of 'rectification' of the particles' motion, can be represented by the sinus of the angular rectification 'α' so that:
$\sin\alpha = v/q_h$ and: $v = q_h \sin\alpha$

(iii) For the classic Earth bound applications, where one disposes of a fixed, immovable point. In the case where there is no stationary point (e.g. in space) the adiabatic expansion will cause a bilateral rectification in both opposite directions of the x-axis, but the principle of the rectification of thermal motion remains the same.

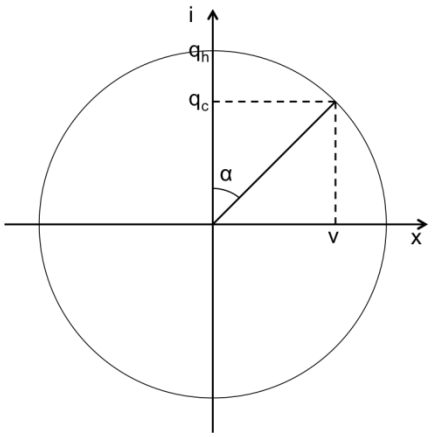

FIG 7.3

In that way the total (RMS) speed of a particle system as a whole varies in function of its degree of congruency:

- When the velocities of the basic elements of a such a composite particle system are completely isotropic, they will not produce a resultant velocity (v = 0) so that the total amount of motion will be present in the particle system under the form of internal, isotropic, thermal velocity, with an RMS-speed 'q_h'. The velocity distribution of the basic particles can in that case be represented in 3 dimensions as a sphere with a radius 'q_h'.

- When all the basic elements move in a congruent way, that is at the same time with the same speed 'v' in the same direction, the particle system as a whole will move in this direction with a congruent velocity '**v**'. In that case the velocity distribution of the basic elements can be represented by a single vector in the x-direction with a length '$v = q_h$'.

- In the intermediate cases, the velocities of the basic particles will produce a resultant or congruent velocity component ($0 < v < q_h$) with which the particle system will move as a whole. The remaining internal velocity component (q_c) is by definition the internal speed of the basic components of the particle system.

4.2. The speed limit of particle systems

In section 3, I have demonstrated that all the 'particles' that we are able to detect, are in fact 'particle systems' that consist of undetectably small 'unit' particles that are moving at very high speed about each other.

One way to increase the speed of such a particle system, is to increase its amount of congruent translational motion by means of a collision with another particle system that has a higher congruent velocity in the given direction. It is clear that if this procedure could be repeated over and over again, that this would mean that there is no upper speed limit at all for particle systems.
This is however not the case, because there is a universal speed limit, which is known to be 'the speed of light', which is the speed of 'massless' photons, that cannot by any means change their speed.

This stands in contrast with the 'mass' particles, such as e.g. electrons, that can vary their speed over a very wide range, but that have a maximum speed limit, that happens to be exactly the invariable speed of the massless particles, which strongly suggest that elementary mass particles are particle systems that consist of massless particles that move at the invariable speed of light.

This hypothesis complies with the process of 'gamma decay' whereby (high energy) photons are emitted from the mass particles of the nucleus, and with the electron-positron annihilation and creation where an electron-positron pair is transformed into photons and vice-versa, and also with the fact that electrons interact which each other through the exchange of photons.
Although the actual processes at the first moments of the Big Bang are not really known, it complies with the descriptions of the first moments after the Big Bang [18] "*In the beginning the universe was dominated by energy at negative pressure, which led to an early exponentially accelerated expansion, referred to as inflation. ... Following that brief but extremely rapid inflation, the universe was first dominated by radiation and then subsequently by matter*", and also [19] "*The original universe was a very small roll pure concentrated energy*".
These examples of the massless origin of mass particles and the permanent interchange between mass and massless particles, strongly suggest that mass particles might be built up from massless particles.

This is perhaps a bolt hypothesis, but it reminds me of the story of the electron's spin, discovered in 1925 by George Uhlenbeck and Sam Goudsmit of Leiden University while studying the Zeeman effect, which were the spectral lines of atoms in an electric field that couldn't be explained at the time [20]. Uhlenbeck and Goudsmit suggested to professor Ehrenfest that besides angular momentum due to its orbital motion round the nucleus, the electrons had also had a spin angular momentum. Ehrenfest advised them to ask the opinion of Lorentz. (At the same time however, a young physicist named Ralph Kronig had already come to the same conclusion and had asked Walter Pauli's opinion, and Pauli had convinced him that his idea couldn't possibly be right!) After examination of their paper, Lorentz pointed out many serious difficulties with the classical picture of a rotating electron. According to him the electron would even have to spin faster than the speed of light [21]. So Uhlenbeck and Goudsmit asked Ehrenfest to withdraw their paper. But Ehrenfest had already sent it in for publication and in that way the concept of 'spin' was introduced!

As the present name suggests, spin was conceived as the rotation of an electron around its own axis. This is however not exactly what I propose. In my view, elementary mass particles consists of massless particles that move about each other at the speed of light. Given the wave characteristic of light, this orbiting is probably materialized under the form of some kind of circular standing wave. Kronig, Uhlenbeck and Goudsmit's story tells us that sometimes even the so-called 'impossible' is true. So I will work further on my hypothesis that mass particles are composed of massless particles, and we'll see if it leads to valid conclusions.

4.3. The variable velocity of mass particles

From the former sections we can conclude that elementary mass particles are not monolithic objects, but that are in fact 3-dimensional particle systems that consist of massless particles rotating about each other at the speed of light, so that the variable velocity of a mass particle system can be represented as a complex number (Fig. 7.4):

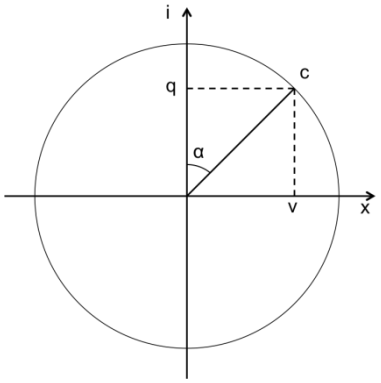

Fig. 7.4

$c^2 = v^2 + q^2$
or $v^2/c^2 + q^2/c^2 = 1$
and $\sin^2\alpha + \cos^2\alpha = 1$

In this representation, of the (congruent) velocity '**v**' as a real velocity vector and the internal RMS-speed 'q' as the imaginary component of a complex number, we can define a degree of 'rectification', 'coherence', or 'congruence' of the particles' motion, as the sinus of the mean angular rectification 'α': $\sin\alpha = v/c$
which is classically designed as $\beta = v/c = \sin\alpha$
In that way the speed of a particle system can be expressed as the degree of rectification of the individual particles' motion, as:

$$v = c.\sin\alpha$$

This physically means that the variable speed of a mass particle system is an absolute physical state of that particle system, that expresses its degree of congruence or rectification, of the (invariable) velocities of its components.

5. The physical nature of the Length contraction

In section 3, I came to the conclusion that the 'size', 'shape' or 'extent' of a 'particle cloud' is the area that is repeatedly covered by the repetitive motions of its basic constituents.

In section 4.3 I have demonstrated, that if this particle cloud is at rest as a whole ($v_c = 0$), the angular distribution of the invariable speeds of the elementary particles will be isotropic ($\alpha = 0$), which means that the velocity distribution of the particle cloud will have the form of a sphere with a radius 'c', which is also the form of the repetitive motions of its basic constituents (Fig. 7.5).

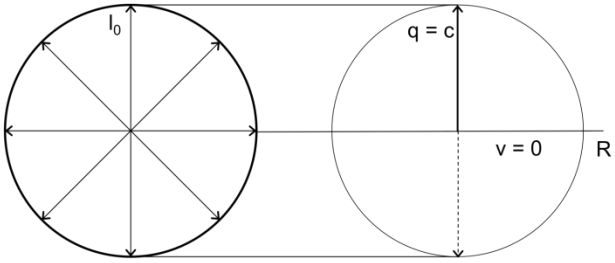

FIG. 7.5

If this particle system moves however as a whole with a velocity 'v = c.sinα' in a given direction (e.g. the x-axis), then according to our physical velocity concept, the speed distribution in the direction of the congruent velocity will be rectified by an angle 'α'.
This rectification results in the fact that in the x-direction, the repetitive internal motions of the basic particles will have diminished at the benefit of their congruent translational motion, while the repetitive internal motion in the plane 'yz' perpendicular to this direction has remained unchanged. This means that the particle system has received an anisotropic contraction in the x-direction, while it remains unchanged in the yz-directions and that the originally spherical form of the particle cloud has transformed into a ellipsoid.

Although the mechanism of this phenomenon lies far deeper, it is, as Lorentz has expressed it: "*of the same nature as the well-known phenomenon of thermal dilation that is perceived when the temperature of material objects is increased*". In that case, the molecules in solids are held together by inter molecular forces that act like springs and the molecules vibrate about their equilibrium position with an average amplitude that depends on their 'thermal' speed and it is the amplitude of these oscillations that determine the size of these solids.
This amplitude 'L' can be calculated from the energy conservation in a mass-spring system:
$mv^2/2 = kL^2/2$ and $L = v\sqrt{m/k}$
so that the relative displacement of the thermal dilation is proportional to the average thermal speed of the individual particles.

Since we have demonstrated that the size and the shape of a composite "particle" is determined by the internal motion of its basic components (which we represented by their internal repetitive RMS-speed 'q') this means that the size of the composite 'particle' in the direction of its congruent velocity 'v' will be proportional to the value of 'q' in that direction (Fig. 7.6).

It follows from this, that the proportion of the size in the direction of motion (l_v) of this ellipsoid to its size at rest (l_0) will be equal to the proportion of the internal speed (q) in its direction of motion to the internal speed at rest (c), so that:

$$l_v/l_o = q/c = \cos\alpha$$

Which can be written as: $l_v/l_o = (1-\sin^2\alpha)^{1/2}$
Which, since I have demonstrated that: $\sin\alpha = v/c$, becomes:

$$\boxed{l_v/l_o = (1-v^2/c^2)^{1/2}}$$

This is the equation of the "Length contraction", which gives the proportion between the size of a moving particle system in its direction of (congruent) motion to its size when at rest.

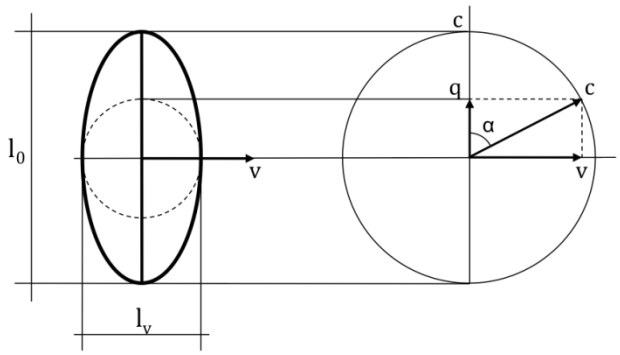

Fig. 7.6

In that way, the velocity is given by the degree of rectification of the motion of the elementary particles, which is expressed as the sine of the angle of rectification 'α'.
And the length contraction is expressed as the cosine of 'α'.

Angle of Rectification α	**sinα (v/c)**	**cosα (l_v/l_o)**
0°	0.000	1.000
1°	0.017	0.999
12°	0.208	0.978
30°	0.500	0.866
45°	0.707	0.707
60°	0.866	0.500
78°	0.978	0.208
90°	1.000	0.000

Since I derived the equation of the length contraction from the calculation of the physical area that is repeatedly covered by the motion of the elementary components, this variation of the size in the direction of motion is not an observation or a measurement problem [22], but it is, as Lorentz has formulated it (see section 2): a real physical distortion, no less than for instance, the variations of length that are produced by thermal expansion (iv).
The physical meaning of the length contraction can be described in yet another way. The size or extend of a particle system is determined by the area that is covered by the repetitive internal isotropic motion of its components. A part of this repetitive internal motion of the individual components of a particle system that accelerates in a given direction is transformed in congruent motion, so that its 'size' shrinks in that particular direction.

7. The absolute nature of the speed of light

In the former section, I came to the conclusion that a moving mass particle undergoes a physical length contraction in its direction of motion, which is mathematically expressed as the proportion of the size of the mass particle in its x-direction of (congruent) motion to its size in the two other yz-directions: $l_v/l_o = (1-v^2/c^2)^{1/2}$
It follows automatically from this equation, that when the speed of such a mass particle reaches the speed of light 'c', the size 'l_v' of the mass particle system in its direction of

(iv) The dynamical analysis of the forces and the energy involved in this length contraction will be analyzed in my paper on the physical nature of 'mass'.

motion will virtually have become zero. This means that we now have a particle that proceeds with the speed of light and that has only internal translational-vibrational-rotational motion in a plane that stands orthogonal on the direction of its invariable speed.

This phenomenon corresponds quite well to the view elaborated in quantum field theory with regard to the increasing speed of spin ½ fermions, such as electrons, neutrino's and quarks [23]. One knows from testing that the spin of high speed quantum particles like e.g. electrons, does not change in magnitude, no matter what speed they have, they always have spin ½ (in natural units). Quantum mechanically, with an increasing speed, a particle's angular momentum (spin) magnitude remains indeed unchanged, but its direction appears to realign itself closer to that of the translational velocity vector, so that the translation affects the direction of the spin vector axis. As the velocity approaches the speed of light, the angular momentum (spin) approaches the velocity direction.
This means that mass particles that travel at the speed of light, disintegrate into photons (v) , of which the spin is always aligned with the velocity vector, either in the direction of its velocity (Fig. 7.6) or in the opposite direction.

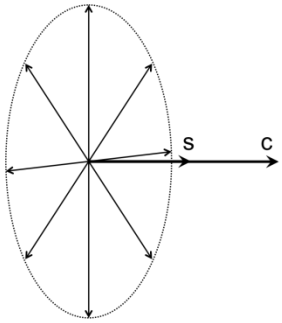

Fig. 7.6

This is the physical explanation of Einstein's mass-energy relation: $E = mc^2$.
It demonstrates that my supposition at the end of section 4.2, that mass particles are built up from massless particles, is right because it demonstrates that when mass particles reach the speed of light, they simply become light.
This learns us that mass particles are in fact 3-dimensional particle systems that can vary their speed in all 3 directions and that the so-called 'energy' particles (photons) are in fact 2-dimensional particle systems, that can only vary their speed, and have mass characteristics, such as variable momentum and gravitational attraction, in the 2 directions that stand perpendicular to the direction of their invariable speed.
This conclusion is in fact very similar to the modern concept of "symmetry breaking" [24] in which the massive weak bosons are associated with waves that can oscillate in three directions, whereas massless gauge bosons that proceed at the speed of light, have only two polarizations. The third polarization, which is called the longitudinal polarization because it oscillates along the direction of motion, doesn't exist in the case of massless particles such as photons. In that way, the apparent 'mystery', that the speed of a light beam that is sent from a light emitting source that moves with any given speed, cannot be affected by the motion of the source, becomes self-evident. It also explains the so-called curved trajectory of light rays passing near the sun, by means of the transverse mass characteristics of photons (vi).

(v) The concept of photons was introduced by Einstein in his paper on the photoelectric effect, for which he received the Nobel Prize in 1921.
(vi) The transverse gravitational attraction of photons by means of their transversal mass characteristics, will be analyzed in my papers on the physical nature of 'gravitation'.

8. Conclusion: The physical nature of the variable velocity of particle systems

In section my paper Part 5 on the true nature of temperature and thermal energy, I demonstrated that the internal velocities of particle systems are absolute, hard physical characteristics that form the physical basis for the absolute nature of temperature and thermal motion and which are responsible for extreme physical phenomena, such as the melting of hard solid rocks.

In this paper I demonstrated the variable velocity of a composite mass particle is a function of state of this particle, that can be expressed as the degree of rectification of the repetitive motions of its basic component. This allowed me to conclude that the variable velocity of a mass particle is an absolute, physical characteristic. Although this absolute, physical nature of variable velocity is a completely new viewpoint and totally different from the present relativistic speed concept, it is basically nothing more than an application of the obvious fact that the resultant velocity of a particle-system is the vector sum of the velocities of its components!

In Einstein's special theory of relativity that was developed at the beginning of the twentieth century, a 'body' was considered as an monolithic object without internal structure and its speed was considered in relation to any arbitrarily chosen "frame of reference". In that purely mathematical context of a rigid 'body' in any possible reference frame, 'velocity' was obviously a relative data. In that purely kinematic context, that focused on how one measures moving bodies in different inertial frames of reference, the question of the physical reality of the length contraction (and of the internal tensions that it caused) did not arise so that Einstein evidently came to the conclusion that when one considers two inertial observers that are in relative motion with one another, both will equally observe:
- that the clocks used by the other observer appear to run slow, and
- that their objects appear to be shorter
And that both observers are be right, because time and length are relative quantities, not absolute ones [25].

It must however be clear that for e.g. a Lorentz-contracted ion moving at 99.99 percent of the speed of light to the Earth, one can hardly say that its situation is identical to the case in which the Earth is moving in the opposite direction at 99,99 percent of the speed of light, and we don't thereby even mention the energies involved in both situations. When we consider the case of two Lorentz-contracted ions, each moving at 99,99 percent of the speed of light toward each other [26] (as this is the case in e.g. the Relativistic Heavy Ion Collider) the relativistic view of the rotational speed of the Earth becomes even more untenable.

My concept of a physical velocity automatically leads in this paper to the physical reality of the Lorentz contraction and will in my next papers lead to a deeper understanding of the internal structure of mass and massless particles and of the mass increase (vii) and the time dilation (viii) of moving bodies, and will in that way solve the paradoxes, such as the twin paradox and the pole and barn paradox, that were created by the relativistic speed concept.

(vii) The dynamic s will be analyzed in my paper on the physical nature of 'mass'.
(viii) This will be analyzed in my paper on the physical nature of 'time'.

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