Dear reader,
I am sorry, this article is still a draft also written in German English. This will be changed in due course. Please have a look at the logic of the arguments and not so much at the English grammar. Thanks a lot…☺…

# Einstein's Special Theory of Relativity can be derived from Quantum Entanglement, especially regarding the basic Lorentz factor

Paul Drechsel 2010

Most physicists would reject the idea that Einstein's Theory of Special Relativity (SR) will have anything to do with Quantum Entanglement (QE). Also Einstein himself rejected vehemently this idea and called entanglement derogatively a '*spooky action at a distance'*; he fought against it during his whole lifetime.[1] Therefore to state that despite this rejection by Einstein SR would be derivable from this 'spooky entanglement' will be seen as a sacrilege. But why do I state it anyway? Not because I would like to make quarrels, or to make myself a fool, but because of some cryptical principles of mathematics fundamental for QE and SR. It can be demonstrated that the core principles of both SR and QE are based on the Law of Pythagoras, and the derivation of SR from QE – and vice versa - has to do with the so-called 'squaring of the amplitude'.

First one should be aware about a fundamental fact in Quantum Mechanics (QM). It is based on the Schrödinger equation

$$i\hbar\psi = H\psi$$

As can be seen, this equation is fundamentally based on imaginarity *i*. This is usually dismissed as beside a relevant point, but it is not to neglect. I assume, what makes most physicists fearful is this possibility of an imaginary reality! It seems this is seen like the appearance of the devil and has consequently to be combated. Therefore to get rid of it one has to destroy it in order to move into the accepted ontology of a 'classical real number reality'. In QM this is simply done by squaring of the absolute value of the amplitude $\left|i\psi(x)\right|^2$, and because $\left|i\right|^2 = 1$ the problem seems to be solved. But it has a price, because one has to normalize the projections as the amplitudes and one gets only probabilities.

$$\frac{\left|z_i\right|}{\left|i\psi\right|^2} = p_i$$

This is based on complex number arithmetic. One must take the squared modulus of the quantum complex amplitude to get the classical probability! Because it is of relevance for my argumentation I would like to present it shortly.

**Excursus: Complex modulus or absolute value**

[1] With Nathan Rosen and Roman Podolsky he invented the so-called EPR-Paradox.

A complex number $z = x + iy$ can be defined with the help of the following Pythagorean triangle, also called the Gaussian or Argand plane:

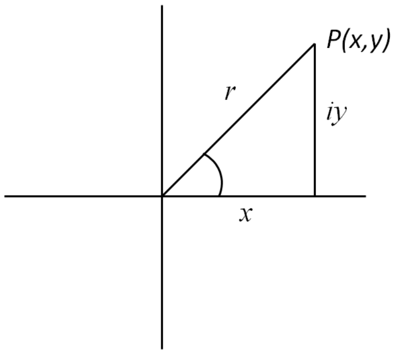


Figure: 1

The point $P(x,y)$ is $z = x + iy$. As it is known from trigonometry both sides of the triangle can be represented by $x = r\cos\theta$, and $y = r\sin\theta$, where by the Law of Pythagoras

$$r = \sqrt{x^2 + y^2} = |x + iy|$$

is called the *modulus* or *absolute value* of $z = x + iy$; denoted by $|z|$ or *mod z*; and $\theta$ is called the amplitude or argument of $z = x + iy$. $z = x + iy = r(\cos\theta + i\sin\theta)$ is called the *polar form* of a complex number. Finally

$$e^{i\theta} = \cos\theta + i\sin\theta$$

is called the famous *Euler formula*. The *squaring of the amplitude*, or the modulus, is therefore

$$|z|^2 = x^2 + y^2$$

To be an actual 'normalized' probability, the value of $|z|^2$ lies somewhere between 0 and 1.

Next I would like to explain the so-called *Lorentz factor* in Einstein's Theory of Special Relativity and its possible relationship with entanglement.

**The Lorentz factor in Einstein's Special Theory of Relativity (SR)**

It is known that Einstein's theory of space and time refers to a so-called pseudo-Euclidian four-dimensional Minkowski space. Referring to space coordinate differences *dx, dy, dz* and the time-difference *dt* of the four-dimensional space of STR, Einstein offers the standard squares of distances of Minkowski spacetime as:

$$ds^2 = dx^2 + dy^2 + dz^2 - cdt^2$$

*c* is the constant speed of light.[2] In order to conform to the usual positive definite Euclidian metric he wanted to get rid of the Minus sign '$-cdt^2$'. For that he inserted the imaginary $i = \sqrt{-1}$ with the square of –1. In his book about the Special and the General Relativity (1961) he writes: "*If we replace x, y, z,* $\sqrt{-1}ct$ *, by* $x_1, x_2, x_3, x_4$*, we also obtain the result that*

$$ds^2 = dx_1^2 + dy_2^2 + dz_3^2 + dx_4^2$$

*is independent of the choice of the body of reference."* (1961:102)

[2] This is the formula expressed by the signature $+,+,+,-$; there is the opposite possibility like $-,-,-,+$.

Very important for SR are the so-called *Lorentz transformations*. Einstein states: "*We can characterize the Lorentz transformation still more simply if we introduce the imaginary* $i = \sqrt{-1}ct$ *in place of t, as time-variable. If, in accordance with this, we insert*

$$x_1 = x;\ x_2 = y;\ x_3 = z;\ x_4 = \sqrt{-1}.ct$$

*...*" (1961:139)
Einstein also says that "*we must replace the usual time-co-ordinate t by an imaginary magnitude* $\sqrt{-1}.ct$ *proportional to it.*" (1961:63)[3]

Taking Einstein's imaginarity for granted I would like to move with it to the fundamental Lorentz transformations of STR. The Lorentz transformations are based on the Lorentz factor $\gamma$: (*v* = velocity of an object)

$$\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$

The Lorentz transformations of the four spacetime coordinates *x, y, z, t* can then be formulated like this: (1961:37)

$$x' = \frac{x - vt}{\sqrt{1-\frac{v^2}{c^2}}};\ y' = y;\ z' = z;\ t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1-\frac{v^2}{c^2}}}$$

This is common knowledge but with regard to the Lorentz factor $\gamma$ of special interest. As long as $v < c$ there is no problem, but the problems arise when *v* = *c*. Einstein writes:

> "***For the velocity*** $v = c$ ***we should have*** $\sqrt{1 - v^2/c^2} = 0$***,***
> ***and for still greater velocities the square-root becomes imaginary.***
> ***From this we conclude that in the theory of relativity the velocity c plays the part of a limiting velocity, which can neither be reached nor exceeded by any real body."***
> (1961:41)

Most physicists would see these properties as a triviality, but for me it is something of a 'missing link' for the relationship between Classical Mechanics (CM) and QM, especially QE.

The constant speed of light *c* is usually seen as a property of photons. Only massless particles can have this velocity. Theoretically seen there are two extreme possibilities for photons with regard to the Lorentz factor:

a) $v = c \to 0$;
b) $v > c \to i$ ;

Case a) is logical, but case b) is forbidden. Case b) would be valid if *v* of a photon could be greater than *c*. As we could see referring to the last quotation of Einstein, this is vehemently

[3] These are the words of Albert Einstein. I take note of the fact that today probably no physicist refers to this imaginarity and mathematically on speaks simply of a pseudo-Euclidian Minkowski space $E_{3,1}$ or $E_{1,3}$ and allows squares of $+1$ and $-1$.

rejected, also from the community of physicists. But let me mention the following experiments:

In 2008 it was experimentally proven by Nicolas Gisin et al. that entanglement is independent from the principle of relativity and from the constant speed of light *c*. In this experiment Gisin et al. also found out that the speed of entanglement could be many thousand times faster than the constant speed of light *c*; probably faster than$10^5 \cdot c$. In an interview the co-researcher Cyril Branciard assumed that the speed of entanglement is probably infinite.[4] All in all these experiments, which all have to do with entanglement, violate basic principles of the theories of relativity. Nicolas Gisin (2005) stated:

> *"In relativity there is space-time out there. In quantum mechanics there is entanglement.*

Assumed that would be true, what would be the consequences seen with regard to SR? The answer is straight. Because of case b) of Einstein's special theory of relativity it follows:

> ***Everything which has to do with entanglement must be imaginary!***

Now we already know, everything which has to do with QM has to do with imaginary. This is simply a fact because of the imaginary Schrödinger equation $i\hbar\psi = H\psi$. But could we now conclude that everything in QM be faster than *c*? This is definitely not the case; otherwise the most successful Quantum Electrodynamics (QED) and Quantum Field Theory (QFT) as combinations of SR with QM would not be possible. Therefore, when I speak about something faster than *c* then I only refer to the domain of quantum entanglement. Let me offer a model or order of dimensions of our Reality of Nature – or our universe:

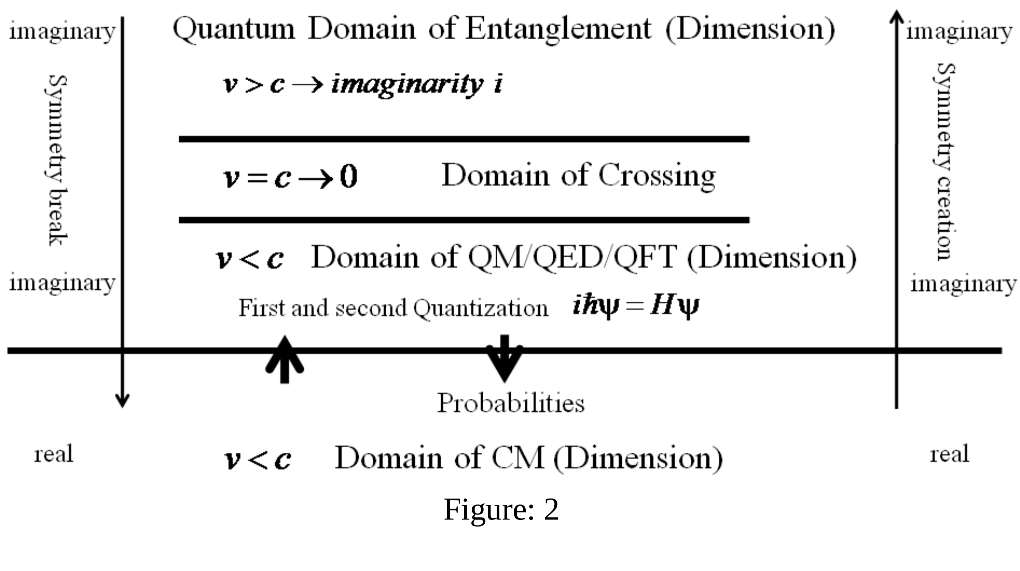


Figure: 2

[4] I am aware of the reservations against something faster than the constant speed of light *c*. Usually it is argued that this does not imply any classical communication or signal transfer fast than *c*. But I would like to ask what has classical physics to do with quantum physics and why should there no communication be possible which is based on quantum entanglement? One should not always argue with arguments which belong to a paradigm which is already in question! New realities need new arguments! What is known is the fact that entanglement violates Bell's inequality – period! For an overview about '*c*' see Ellis (2003).

That is it how I understand it. But before I discuss it in depth, let me come back to the mathematical fundamentals. First question: Which mathematical law is the base of SR? For an answer let me again come back to the Lorentz factor, now in another display.

**The Lorentz factor based on the Law of Pythagoras**

For a geometrical explanation of the Lorentz factor I would like to offer the following figure:

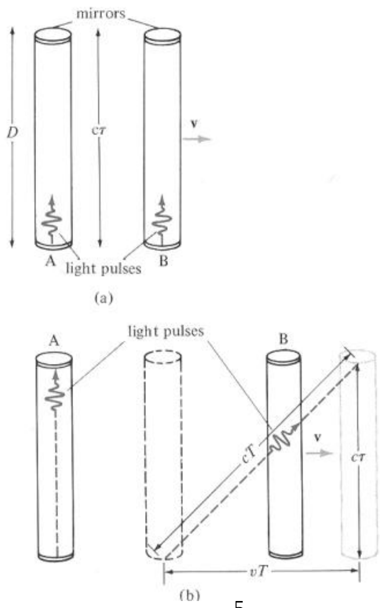


Figure: 3[5]

Figure (a) represents two light-clocks which have two ideal reflecting mirrors. $\tau$ is the time a light-beam takes from the lower to the upper mirror. Every time when a light beam reaches the upper mirror this clock "ticks". The time between two "ticks" is $\tau = D/c$. In figure (b) the experiment starts with the two nearby light-clocks A and B. Next the light-clock B should move with the velocity $v$ to the right. We get the triangle $cT$, $c\tau$ and $vT$. $cT$ appears as something faster than *c* when *v* would be equal to *c*; assumed the constant speed of light *c*, which means $cT$, cannot be faster than *c*. Therefore we will get this length dilation when *v* is nearby the speed of light *c*. To correct this "faster than light velocity *c*" beyond the presumed constant speed of light *c* one can refer to the Theorem of Pythagoras and solve it for *T*.

$$(cT)^2 = (vT)^2 + (c\tau)^2$$

Solving this equation for *T* one gets:

$$T = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\tau$$

Without the $\tau$ this formula is known as the *Lorentz-factor* $\gamma$ in STR. The factor $\frac{v}{c} = \beta$ is called the "speed parameter". Within Einstein's STR it is always less than unity, and, provided *v* is not zero, $\gamma$ is always greater than unity. As shown in the following figure, $\gamma$ increases rapidly in magnitude as $\beta$ approaches 1; which means when *v* approaches *c*.

[5] This figure is taken from the book written by Jay Orear (1991:151).

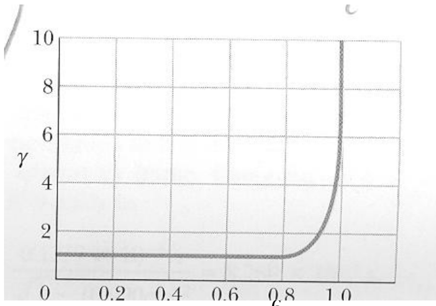

Figure: 4[6]

It is assumed as evident - provided the maximum constant speed of light *c* as an absolute limit for velocity – that the greater the relative speed between A and B, the greater will be the time interval measured by B, until at a great enough speed, the interval takes “forever”.

Evidently, the elementary Lorentz factor is based on the following triangle

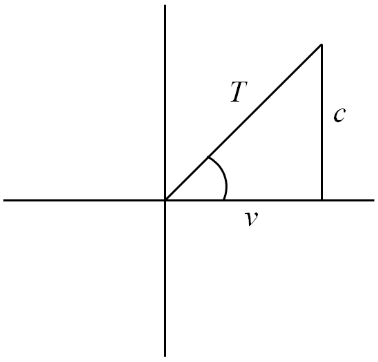

Figure: 5

This we know already from the definition of the complex number *z* and the modulus. The modulus would be:

$$|T| = \sqrt{v^2 + c^2}$$

Funny, isn’t it? But we have to do with real numbers and no imaginarity. Because I need if for the discussion further below let me discuss the following cases:

a’) If $v = c = 1$, the Pythagorean triangle of the elementary Lorentz factor would appear in the following display:

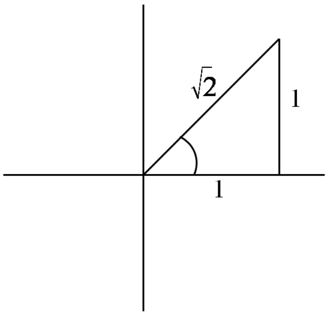

Figure: 6

For the sake of arguments now not referring to $v = c = 0$ we would get something similar to the modulus $r = \sqrt{x^2 + y^2}$ with $r = \sqrt{2}$. Now my important argument:

[6] This figure is taken from the book written by David Halliday et al. , 2005, p.1029.

b') If $v > c = i$ the side *c* of the triangle should be imaginary and appear as *ic*:

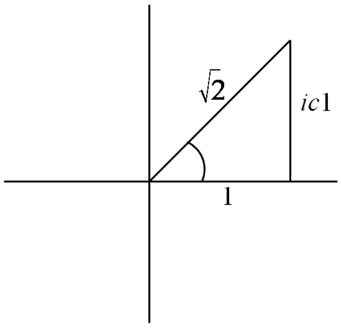


Figure: 7

Whatever this may be the absolute value would again be the modulus $r = \sqrt{x^2 + y^2} = |x + iy|$ also with $r = \sqrt{2}$. But in this case one can see that something has to be wrong, because it would have the consequence that $v = c = 1$ despite the assumption of $v > c$.

c) Again for arguments sake let me ignore the modulus and let me assume $v = x$ and $ic = y$. Only technically using the Law of Pythagoras and squaring the sides would result in $r^2 = x^2 - y^2$. I admit, everyone would say nonsense, but taken the cosine and sine one would get:

$$cos\, 2\theta = cos^2\, \theta - sin^2\, \theta$$

Strange, isn't it? This formula can be derived by trigonometric tricks, but it is also a result of 'squaring the amplitudes' of elementary entanglement. I will come back to this point. The next case will only be an example what projection could be:

d) A projection of the hypotenuse of $\sqrt{2}$ on each side would result in:

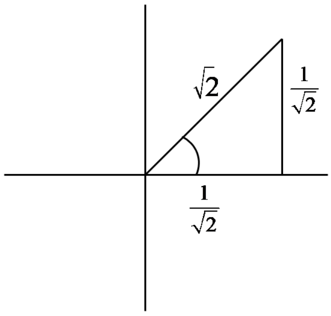


Figure: 8

**Remark:**

If there would be something as fast as a photon with the constant speed of light *c* it does not matter classically seen, because it would appear as 'nothing' or 'zero = 0' in the classical Einstein world. But it could be a modulus of $\sqrt{2}$ in another world beyond the Einstein universe.

The same would be true for the case $v > c$. This imaginary world would, if squared, also appear as the modulus of $\sqrt{2}$.

Now an important aspect: Whatever this world beyond the Einstein universe might be, it can only appear IN the Einstein world either as 0, or as the modulus $\sqrt{2}$; or as its projection $\frac{1}{\sqrt{2}}$.

For a better explanation let me move to entanglement.

**Entanglement**

Entanglement was invented by Erwin Schrödinger (1935, 1936) with regard to the property of quantum superposition of the equation bearing his name. It is a property of a quantum mechanical state of a system of two or more objects in which the quantum states of the constituting objects are linked together by one Schrödinger equation – and not two or more separate equations - so that one object can no longer be adequately described without full mention of its counterparts – even if the individual objects are spatially separated in a spacelike manner. This interconnection beyond space – and probably also time – leads to non-classical correlations between observable physical properties of remote systems, often referred to as *nonlocal correlations*. For Einstein such *instantaneousity*, regardless of any distance and localities, was impossible because it violated his paradigm of *local realism'* [7] and the limitation of the *constant speed of light c*, fundamental for the property of *causality* and also his Theories of Relativity (1961). Einstein assumed that a quantum theory which allowed for such 'spooky things' had to be incomplete. In an article published in 1935 with Roman Podolsky and Nathan Rosen, he postulated 'hidden variables' which have been known ever since as the *EPR-Paradox*.

It took three decades before John Bell in 1964 offered his now famous inequality[8] that made an experiment of entanglement possible. It took another two decades before in 1982 Alain Aspect et al. could carry out such an experiment in order to convincingly prove that entanglement was a quantum physical fact and that it possessed the property of instantaneousity and non-locality. Again two decades later the relevance of time and space was experimentally questioned by the so-called *before-before experiment* undertaken by Antoine Suarez et al. (2002/3; also 1997, 2000, 2001). Recently *Einstein's realism* was experimentally violated by Anton Zeilinger et al. in 2007 and by Nicolas Gisin et al. in 2008 by violating *Leggett's inequality* (2002, 2003). Entanglement also independent from the principle of relativity and from the constant speed of light *c* was experimentally proven by Nicolas Gisin et al. in 2008 at Geneva. In this experiment Gisin et al. found out that the speed of entanglement could be many thousand times faster than the constant speed of light *c*; probably faster than$10^5 \cdot c$. In an interview the co-researcher Cyril Branciard assumed that the speed of entanglement is probably infinite.[9] All in all these experiments, which all have to do with entanglement, violate basic principles of the theories of relativity. Nicolas Gisin (2005) stated:

> *"In relativity there is space-time out there. In quantum mechanics there is entanglement.*

Antoine Suarez supports this point of view…

> *"…the result of the before-before experiment does not mean that "our universe is without time and space", but rather that in our universe phenomena occur, which come from outside space-time, or, in other words, do not have any material observable origin."*[10]

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[7] See for example http://en.wikipedia.org/wiki/Principle_of_locality.
[8] See for example http://en.wikipedia.org/wiki/Bell%27s_theorem.
[9] I am aware of the reservations against something faster than the constant speed of light *c*. Usually it is argued that this does not imply any classical communication or signal transfer fast than *c*. But I would like to ask what has classical physics to do with quantum physics and why should there no communication be possible which is based on quantum entanglement? One should not always argue with arguments which belong to a paradigm which is already in question! New realities need new arguments! What is known is the fact that entanglement violates Bell's inequality – period! For an overview about '*c*' see Ellis (2003).
[10] Private Mail from 30. July 2008. Also in "History. The Story behind the Experiments" In: http://www.quantumphil.org/history.htm, he writes at the end: "The final results of the experiments with moving measuring devices rule out the possibility to describe the quantum correlations by means of real clocks, in terms

Alain Aspect, Anton Zeilinger, Nicolas Gisin and Antoine Suarez are known as sober experimental physicists. For example Alain Aspect, Anton Zeilinger and John Clauser have got the renowned Wolf Price 2010 for their work on entanglement.[11] Next I would like to present a design and a mathematical description/explanation of an experiment of entanglement.

**Experiment of entanglement**

The following figure serves as a short presentation of an experiment with entangled polarized photons: (See Audretsch 1994) [12]

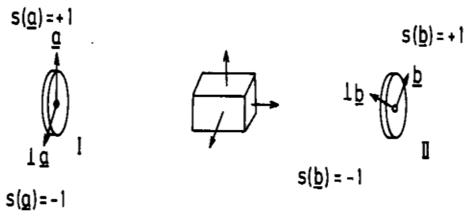


Figure: 9

There is a source for parametric *down-converted entangled photons. These e*ntangled photons are sent in different directions to two detectors/analyzers. The detectors measure the polarization of the photons. The angles of polarization can be expressed by an alternative +1 and −1. The usual classical probability for the alternative +1 or −1 of *a* will be $P_+(a) = \frac{1}{2}$ and $P_-(a) = \frac{1}{2}$. The same is true for *b*. Now for calculating entanglement formally we have to combine the analyzers and to take the angles of the analyzers for polarization in this way:

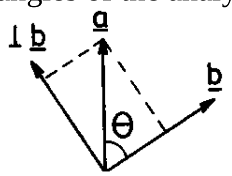


Figure: 10

With regard to the combined probabilities this leads to:

of "before" and "after"; nonlocal quantum phenomena cannot be described with the notions of space and time. This means there is no time ordering behind nonlocal correlations, so the causal order cannot be reduced to the temporal one. Quantum correlations somehow reveal dependence between the events, or logical order. Experiments show that this dependence, or logical order, is beyond any real time ordering. In the realm of the nonlocal quantum phenomena, things come to pass but the time doesn't seem to pass here."

[11] This Wolf price is seen as a step before the Nobel price! It is a pity – or is unfair – that N. Gisin was not included.

[12] As I already suggested an extensive study of entanglement is offered by Audretsch (2007). Another in-depth discussion can be found in A. Aspect (2000): 'Bell's Theorem: The naive view of an experimentalist.' In: arXiv:quant-ph/0402001v1.

$$P_{++} = P_+(\underline{a})\cos^2\theta = \frac{1}{2}\cos^2\theta \leftrightarrow s(\underline{a})s(\underline{b}) = +1$$

$$P_{+-} = P_+(\underline{a})\sin^2\theta = \frac{1}{2}\sin^2\theta \leftrightarrow s(\underline{a})s(\underline{b}) = -1$$

$$P_{--} = P_-(\underline{a})\cos^2\theta = \frac{1}{2}\cos^2\theta \leftrightarrow s(\underline{a})s(\underline{b}) = +1$$

$$P_{-+} = P_-(\underline{a})\sin^2\theta = \frac{1}{2}\sin^2\theta \leftrightarrow s(\underline{a})s(\underline{b}) = -1$$

These probabilities have to be summarized to the combined quantum expectation value $E^{QM}$ or to a quantum correlation coefficient

$$E^{QM}(\underline{a},\underline{b}) = P_{++}(+1) + P_{+-}(-1) + P_{--}(+1) + P_{-+}(-1)$$

The combined quantum probabilities as expectation value $E^{QM}$ seen as a quantum correlation coefficient results in

$$E^{QM}(a,b) = \cos^2\theta - \sin^2\theta = \cos 2\theta$$

This formula can also be derived by real number trigonometry from the formula $\cos\alpha\cos\beta - \sin\alpha\sin\beta = \cos(\alpha+\beta)$ if $\alpha = \beta$. But it can also be derived from the *De Moivre Theorem* for $\cos 2\alpha$ based on complex number trigonometry: $\cos(2\alpha) = Re\left\{\left(\cos(\alpha) + i\sin(\alpha)\right)^2\right\}$. We have to find out what is more important; which means real or complex number reality.

Now taking into account four directions of the analyzers of the polarization experiment for entangled photons including their angles:

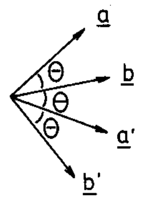


Figure:11

one can derive a combined expectation value:

$$S(\theta) = E(a',b) + E(a',b') + E(a,b) - E(a,b')$$

Summarizing the quantum expectation values for the four analyzers $E^{QM}$ one gets:

$$S^{QM}(\theta) = 3\cos 2\theta - \cos 6\theta$$

which results in the maximum value at 22.5 degree:

$$S^{QM}(\theta = 22.5^0) = 2\sqrt{2} = 2.8284...$$

Alain Aspect et al. (1982) present the following curve fitting the data (marks) of their experiment for entanglement:

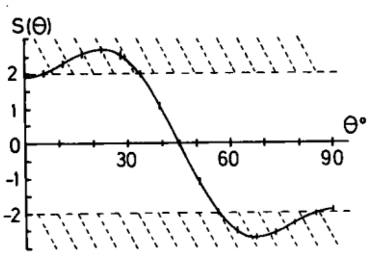


Figure: 12

The trigonometric formula for this curve is the same as mentioned before:

$$3\,cos\,2\alpha - cos\,6\alpha = 2\sqrt{2}$$

It is evident, two times $\sqrt{2}$ is $2\sqrt{2}$. Further above we already met this $\sqrt{2}$ as the modulus or the hypotenuse of a unit triangle. But what is this $2\sqrt{2}$? For an answer to this question let me offer the following diagram:

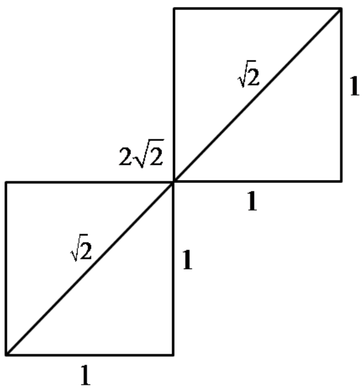


Figure: 13

$2\sqrt{2}$ is simply the double of a unit square with a unit triangle. It is the diagonal of two combined unit-squares with sides 1. But, seen from the side of the complex numbers, it is also the combined modulus of two complex numbers with *x, iy* = 1. This means: Entanglement appearing in the classical world as $3\,cos\,2\alpha - cos\,6\alpha$ or $2\sqrt{2}$ can be seen as the modulus or as the squaring of the amplitude of an imaginary quantum entity. For this classical world it is, as we have seen, zero. This means it does not exist in the classical real number Einstein universe! But it can appear as $2\sqrt{2}$. This is also the double of the Lorentz factor based on a unit Pythagorean triangle. Itself the usual projections of the diagonals of these triangles on its sides leads to the same result, because:

$$\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2}$$

With it we have an explanation for these $\sqrt{2}$, $2\sqrt{2}$ and $\frac{1}{\sqrt{2}}$ .which I could derive further above in relation to the Lorentz factor based on the Law of Pythagoras! Now a ‘Gedankenmodel’.

**A ‘Gedankenmodel’ about imaginary photons**

The squaring of entanglement as the squaring of the amplitude of a unit Pythagorean triangle leads to the Lorentz factor of 0, because the sides of the Pythagorean triangle are 1, and these introduced as *v* and *c* into the Lorentz factor results in $\sqrt{1-v^2/c^2}=0$, or, what is forbidden,

$$\gamma=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}=\frac{1}{0}\ \rightarrow\ undefined$$

This means, entanglement does not exist in the classical SR; what evidently should be the case! Therefore what is left over is the case of v < c and the usual Lorentz factor

$$\gamma=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$$

But what about be the case *v* > *c*? As Einstein conceded, this should be imaginary. What could this mean? It should result in something of the opposite of what I have just now derived! Instead of destroying or better extinguish entanglement it should create it! But a condition should be imaginary photons like *ic*. Let me offer a *Gedankenmodel*. For that a figure of the Lorentz factor as a Pythagorean triangle:

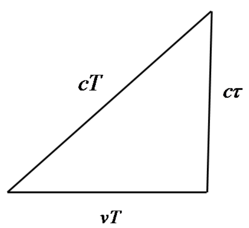


Figure: 14

Analogue to a complex number let me disregard the *c* of the hypotenuse or $cT$ at all - or let the question of the hypotenuse open – and let me assume *v = c = 1*, the side of $vT=c=1$ and the side of $c\tau=i1$. For that the following figure:

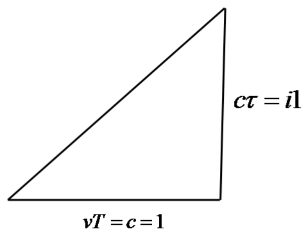


Figure: 15

Now taking into account the logic of imaginarity $i^2=-1$ and putting it into the Lorentz factor, we would get:

$$\gamma=\frac{1}{\sqrt{1-\frac{1}{i^2}}}=\frac{1}{\sqrt{1-\frac{1}{-1}}}=\frac{1}{\sqrt{2}}$$

Before asking any further question about the relevance of this fraction I would like to mention that this is the positive Plus-version. One could also try a negative Minus-version when $c\tau=-i$ and $vT=c=-1$. Also inserted in the formula for the Lorentz factor one gets the following:

$$\gamma = \frac{1}{\sqrt{1-\frac{-1}{-i^2}}} = \frac{1}{\sqrt{1-\frac{-1}{+1}}} = \frac{1}{\sqrt{2}}$$

This is a surprise, because this fraction in the same as we could get with photons in a positive direction. Again before I answer any question about the sense or nonsense of my doings we could ask from where this $\sqrt{2}$ could come from? Referring to the Pythagorean triangle above with both sides of 1, because of the Law of Pythagoras, the hypotenuse can only be $\sqrt{2}$. What we have got with the value of $1/\sqrt{2}$ is the projection of this hypotenuse of this triangle to its sides. We get the conditions for entanglement, because squaring of the amplitude will lead again to

$$3cos\,2\alpha - cos\,6\alpha = 2\sqrt{2}$$

This means:

**Inserting imaginarity in the Lorentz factor will result in entanglement!**

For that the following figure:

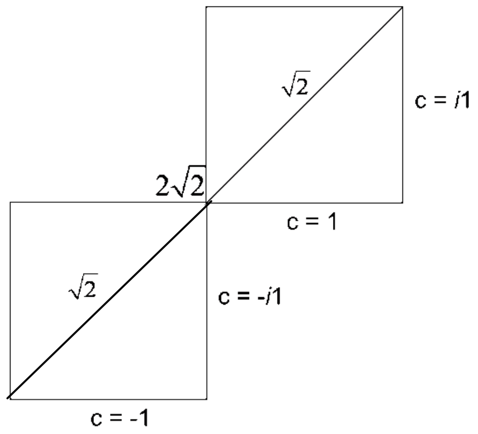


Figure: 16

**Resume**

Let me again offer a diagram compatible with the diagram of figure 2 above, showing the result of the ‘squaring of the amplitude’:

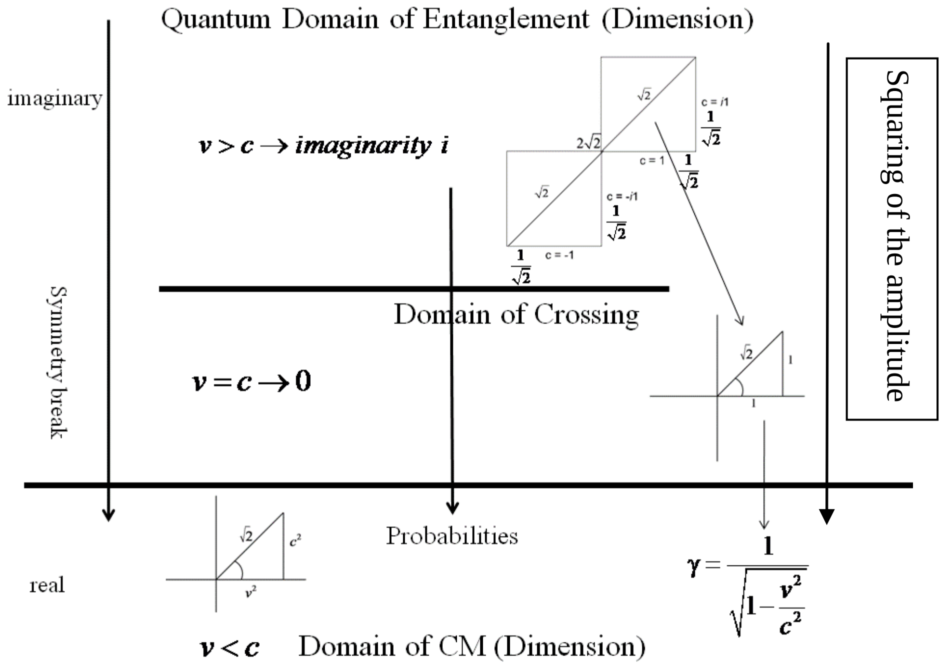


Figure: 17

In this way from the imaginary entanglement to the real classical Einstein world one can see that entanglement has to be reduced via a domain of crossing, which does not exist for the Einstein universe, formally appearing as the usual Lorentz factor, or as the usual real quantum probabilities. What happens is a kind of symmetry breaking. Pure quantum imaginarity is broken into real number reality. Usually this is known as the squaring of the amplitude in quantum physics. But it has, as I could demonstrate, a far greater relevance. It is a fact that the classical Einstein universe of relativity is a much reduced real version of an unlimited imaginary universe of entanglement.

In a similar way I could demonstrate the reduction of this imaginary universe is possible to demonstrate the construction from the real to the imaginary universe. This is already known as the first and second quantization of classical particle physics and classical field physics, but nowhere is it mentioned that there is a third kind of quantization, namely into entanglement; because the first and second quantization is still based on the limit of the constant speed of light *c*. This, I have to apology at Einstein's grave, has to be overcome to enter the pure imaginary world of nonlocal entanglement. For that another diagram:

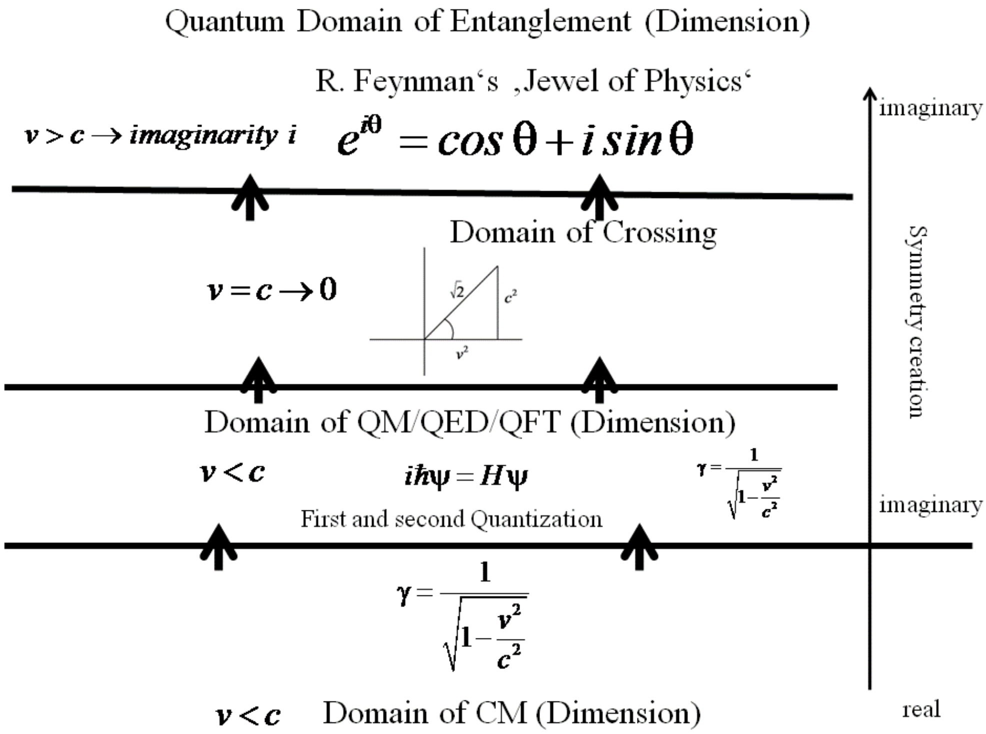


Figure: 18

It should be evident that to arrive at the domain of imaginary entanglement one has to overcome not only the real number classical reality, but also the constant speed of light *c* of the theories of relativity. This is already a consequence of the non-locality of entanglement. This way is, as we know, not easy to go. It is easier for us to destroy the imaginary world of entanglement by observation and squaring the amplitude.

One could ask what this could be, this domain of imaginary entanglement? In my mind a convincing answer was given by the physicochemist Lothar Schäfer (1997). He has written a book about the relevance of 'virtual realities' behind the scene of the quantum reality, which until now can only be seen by its immediate decoherence of quantum states, which means 'virtual realities'. But because of these acts of 'state reduction' the universe of 'virtual realities' will not be destroyed. On the contrary, it is the fundamental transcendental non-local imaginary world or universe, based on entanglement.

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