Gedankenexperiment of the Unification of General Relativity and Quantum Mechanics

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***Abstract* — The unification of general relativity and quantum mechanics is a century long quest. This paper presents a gedankenexperiment how the unification of general relativity and quantum mechanics could look like. The basic assumption of the gedankenexperiment is that any velocity is a probability mixture between being static and moving with lightspeed. Furthermore, it is assumed that matter is allowed only to exist at discrete locations in space. Within the gedankenexperiment, two gluons share the burden of a hypothetical graviton; three fermions form a gravitino. Existing measurements from general relativity can be explained within the stated gedanken-experiment.**

***Index Terms* — Quantum gravity, graviton, general relativity**

I. Introduction

In nature, an underlying simple structure is at work. The intention of science is to probe this structure through experimentation and observation, through argument and debate to 'see what holds the world together in its innermost'[2].

Newton's law of gravitation reigned for centuries our universe until Einstein's unfinished revolution, general relativity, explained large distance physics. On the other side of the scale, quantum mechanics in the form of the standard model describes the interaction of particles with one another. Attempts to unite both theories were not successful until now. 'Getting both gravity and the standard model out of a simple easily visualizable idea is what is beauty.'[3] This paper presents such an idea: Any matter can only exist as particle while resting or travel as wave with lightspeed; any other velocity than lightspeed is an illusion. What we know as velocity is the probability to travel with lightspeed.

The paper is organized as follow:

II. Setting the Stage

The basis for any theory of quantum gravity is the discretization of the 4D space-time.

A. Quantization of Space-Time

'Most things are made of smaller things.'[4] The simplest possible geometric figure to quantize space is a tetrahedron with time as the fourth dimension of space [Fig. 1]. A 4D space-time quantization element has an appearance of a cut crystal, but in four dimensions. It reminds on Ptolemy's crystal spheres with tetrahedrons instead of spheres. The thickness of such a crystal complies with the quantization of time and is given by Planck's time. What we call time is like the fourth dimension of space. Expressed the other way around: what we call space are three other dimensions of time. A 4D space-time quantization element seems to be the basic architecture of a quantum computer; at least the one our universe is running on. Wheeler called it 'it from bit'[5]. It is like a state machine but with the logic given by the standard model.

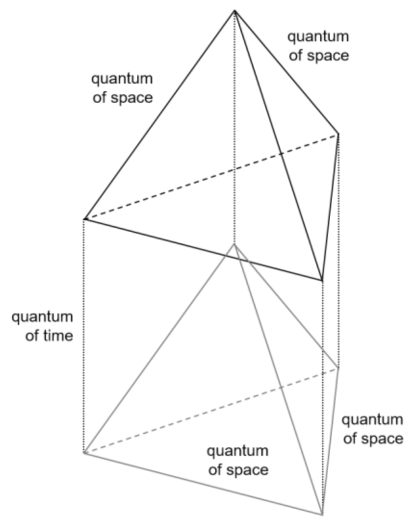

Fig 1: 4D space-time quantization element drawn in the 2D plain.

[1] klaus.pourvoyeur at gmail.com

[2] Goethe: *Faust*, the brilliance of Goethe's writing suffers due to translation.

[3] Woit: *Not Even Wrong*, p. 196

[4] Butterworth: *A Map of the Invisible: Journeys into Particle Physics*, p. 5

[5] Wheeler.: "Information, physics, quantum: the search for links", *Proceedings III International Symposium on Foundations of Quantum Mechanics*, Tokyo, 1989, p. 354-368.

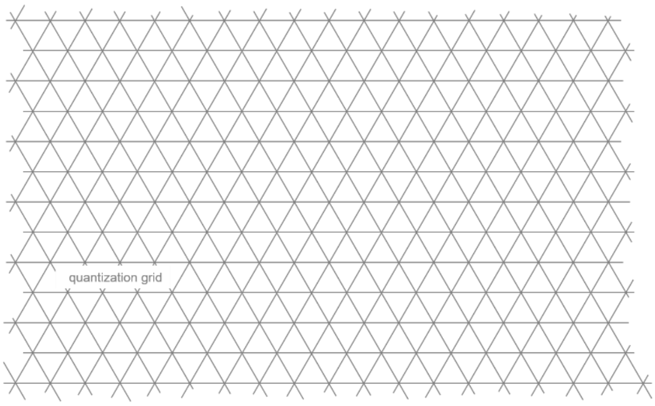

Fig 2: Space-time quantization grid formed by 4D quantization elements. For drawing reasons, the quantization grid is shown only in 2D.

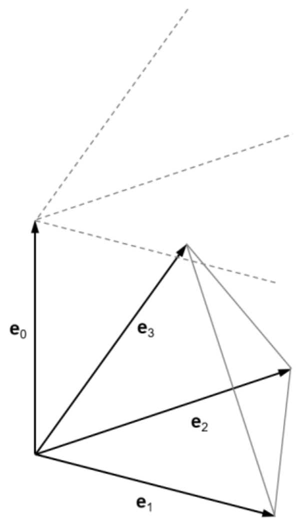

Fig 3: Base vectors of 3D space forming the quantization grid.

These 4D space-time quantization elements form a space-time quantization grid [Fig. 2]. The 4 non-orthogonal base vectors of this quantization grid [Fig. 3] are given by

$$\begin{aligned}\mathbf{e_0} &= [\boldsymbol{t_P} \quad \mathbf{0} \quad \mathbf{0} \quad \mathbf{0}]^\mathbf{T} \\ \mathbf{e_1} &= [\mathbf{0} \quad \boldsymbol{l_P} \quad \mathbf{0} \quad \mathbf{0}]^\mathbf{T} \\ \mathbf{e_2} &= [\mathbf{0} \quad \mathbf{0} \quad \boldsymbol{l_P} \quad \mathbf{0}]^\mathbf{T} \\ \mathbf{e_3} &= [\mathbf{0} \quad \mathbf{0} \quad \mathbf{0} \quad \boldsymbol{l_P}]^\mathbf{T}\end{aligned} \tag{1}$$

For $\mathbf{e}_0$ the length of the base vector is given by Planck's time t_P, for $\mathbf{e}_1$, $\mathbf{e}_2$, and $\mathbf{e}_3$ the length of the base vectors are given by Planck's length l_P with the relation between Planck's time and Planck's length according to

$$l_\mathrm{P} = t_\mathrm{P} c \tag{2}$$

The difference between both entities is a scaling with lightspeed c. Planck's length is the distance travelled with lightspeed for the duration of Planck's time. With the scaling matrix **K,**

$$\mathbf{K} = \mathrm{trace}([t_\mathrm{P} \quad l_\mathrm{P} \quad l_\mathrm{P} \quad l_\mathrm{P}]^\mathrm{T}) \tag{3}$$

an arbitrary point in the regular 4D quantization grid $\mathbf{q}_4$ is addressed by

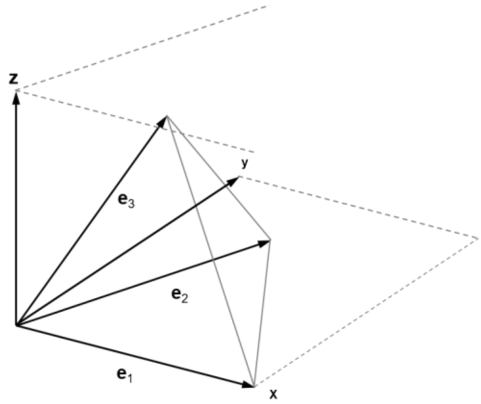

Fig 4: 3D space-time (without time) in Cartesian coordinates.

$$\mathbf{q}_4 = \mathbf{Kn} = \begin{bmatrix} n_0 t_\mathrm{P} \\ n_1 l_\mathrm{P} \\ n_2 l_\mathrm{P} \\ n_3 l_\mathrm{P} \end{bmatrix} = t_\mathrm{P} \begin{bmatrix} n_0 \\ n_1 c \\ n_2 c \\ n_3 c \end{bmatrix} \tag{4}$$

The vector $\mathbf{n}$ gives the amount of quantization steps in each direction,

$$\mathbf{n} = [n_0 \quad n_1 \quad n_2 \quad n_3]^\mathrm{T} \tag{5}$$

with n_0, n_1, n_2, and n_3 as signed integer numbers; the point of origin can be chosen arbitrarily. In a quantized world, the location on the quantization grid itself is allowed only to change in a quantized way.

Leaving the base vector for time $\mathbf{e}_0$ as it is and expressing the spatial base vectors $\mathbf{e}_1$, $\mathbf{e}_2$, and $\mathbf{e}_3$ in Cartesian coordinates [Fig. 4] results in

$$\begin{aligned}\mathbf{e}_0 &= t_\mathrm{P}[1 \quad 0 \quad 0 \quad 0]^\mathrm{T} \\ \mathbf{e}_1 &= c t_\mathrm{P}[0 \quad 1 \quad 0 \quad 0]^\mathrm{T} \\ \mathbf{e}_2 &= c t_\mathrm{P}\left[0 \quad \sin\frac{\pi}{3} \quad \cos\frac{\pi}{3} \quad 0\right]^\mathrm{T} \\ \mathbf{e}_3 &= c t_\mathrm{P}\left[0 \quad \sin\frac{\pi}{6} \quad \cos\frac{\pi}{6} \quad \cos\frac{\pi}{3}\right]^\mathrm{T}\end{aligned} \tag{6}$$

With the matrix $\mathbf{E}$ given by

$$\mathbf{E} = [\mathbf{e}_0 \quad \mathbf{e}_1 \quad \mathbf{e}_2 \quad \mathbf{e}_3] \tag{7}$$

and using

$$\begin{aligned}\sin\frac{\pi}{3} = \cos\frac{\pi}{6} &= \sqrt{3}/2 \\ \sin\frac{\pi}{6} = \cos\frac{\pi}{3} &= 1/2\end{aligned} \tag{8}$$

a point in the quantized 4D space-time $\mathbf{s}_\mathrm{q}$ expressed in Cartesian coordinates x, y, and z results in

$$\begin{aligned}\mathbf{s}_\mathrm{q} &= \mathbf{E}^\mathrm{T}\mathbf{n} \\ &= n_0\mathbf{e}_0 + n_1\mathbf{e}_1 + n_2\mathbf{e}_2 + n_3\mathbf{e}_3 \\ &= t_\mathrm{P}\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & \sqrt{3}/2 & 1/2 \\ 0 & 0 & 1/2 & \sqrt{3}/2 \\ 0 & 0 & 0 & 1/2 \end{bmatrix}\begin{bmatrix} n_0 \\ n_1 c \\ n_2 c \\ n_3 c \end{bmatrix} \\ &= [t \quad x \quad y \quad z]^\mathrm{T}\end{aligned} \tag{9}$$

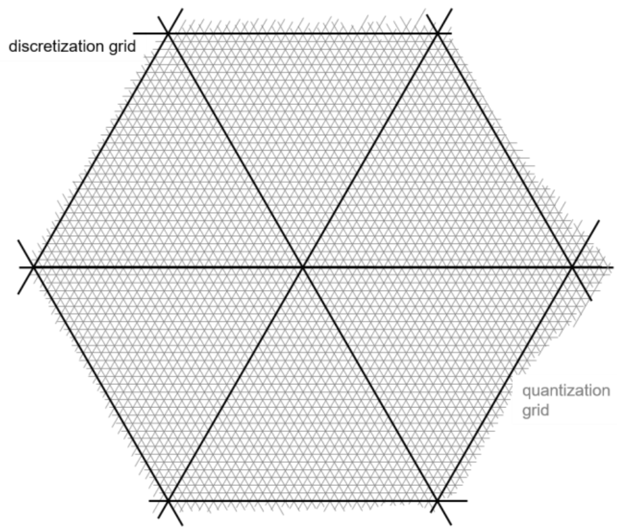

Fig 5: Space-time discretization grid as imposed on the quantization grid illustrated in 2D.

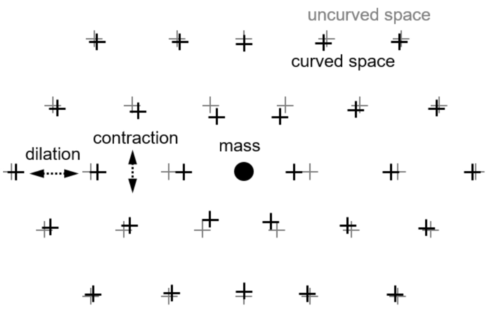

Fig 6: Curving of the space-time discretization grid caused by a point mass in the horizontal plane for selected discrete points drawn in the 2D (grey cross: uncurved space; black cross: curved space; filled circle: point mass).

B. *Discretization of Space-Time*

'In the case of the continuous space, suppose that the precise proportion is that space really consist of a series of dots, and that the space between them does not mean anything, and that the dots are in a cubic array , then we can prove immediately that this is wrong. It does not work.'[6] Feynman did not believe in continuous space, although he did not know how to substitute it. In this gedankenexperiment, particles are allowed only to exist at discrete locations in the space-time discretium given by the cornerstones of a discretization grid [Fig. 5] superimposed on the quantization grid. Throughout the whole paper, this is a central assumption. The first consequence is that volume is an illusion; only the structure is in three spacial dimensions.

This discretization grid superimposed on the quantization grid is necessary to be able to model the curvature for a quantized space-time. Without the presence of mass, the discretization grid is regular. An allowed change of the cornerstones of the discretization grid is given by the quantization of space-time. Discretization and quantization are two different concepts and it is essential to separate them mentally. Think of two aircraft separated by at least 2000 ft; the measurement quantization of the barometric altitude for a Mode-S transponder is 25 ft. In comparison to the Pauli exclusion principle, the 2000 ft separation is a human made law enforced by humans.

In the absence of mass, each point in the regular 4D space-time discretization grid $\mathbf{d}_4$ is addressed by

$$\mathbf{d}_4 = d\mathbf{q}_4 = dt_\mathrm{P}\begin{bmatrix} n_0 \\ n_1 c \\ n_2 c \\ n_3 c \end{bmatrix} \tag{10}$$

with d as the amount of quantization steps to form the discretization grid and with n_0, n_1, n_2, and n_3 as signed integer numbers. Hence each point in the 4D space-time discretization grid is represented by 4 integer values. The introduction of the parameter d is a necessity regarding the discretization of space-time. Obviously, for the region in the 4D space-time discretium we require this parameter to be far greater than one,

$$d \gg 1 \tag{11}$$

A point in the discretization grid $\mathbf{s}_\mathrm{d}$ expressed in Cartesian coordinates is calculated to

$$\begin{aligned} \mathbf{s}_\mathrm{d} &= d\mathbf{E}\mathbf{n} \\ &= t_\mathrm{P} d \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & \sqrt{3}/2 & 1/2 \\ 0 & 0 & 1/2 & \sqrt{3}/2 \\ 0 & 0 & 0 & 1/2 \end{bmatrix} \begin{bmatrix} n_0 \\ n_1 c \\ n_2 c \\ n_3 c \end{bmatrix} \end{aligned} \tag{12}$$

Only $\mathbf{n}$ are valid combinations describing a point on the discretization grid.

The concept of a quantum field complies with the discretization grid; although it is no field in a strict sense because it has no defined value on each point in space-time – the very definition of a field; it exists only on the discrete points for static particles and on the connections of these discrete points for moving waves.

C. *Curving of Space-Time*

One of the deep insights of Einstein was that mass curves space-time and equals energy. In the absence of mass, the discretization space-time grid is formed by regular tetrahedrons with an additional dimension for time. From general relativity we learned that mass is curving space. In the direction towards mass, space is dilated, in across direction, space is contracted [Fig. 6].

Imagine that each side length of the space-time discretization grid is a spring capable to store energy. What we call mass is the stored energy in the spring network forming the fabric of space-time itself [Fig. 7]. The spring network is an interpretation of the curving of space by mass and provides the mechanism for vacuum energy of quantum mechanics. Therefore, the quantization of energy results directly in the quantization of the change of the springs length. In Newtons law of gravitation, the squared range term can be interpreted as spreading the force of the springs along the surface of a sphere. The spreading of force occurs with respect to discretization steps and not continuously.

[6] Feynman: *The Character of Physical Law*, p. 155

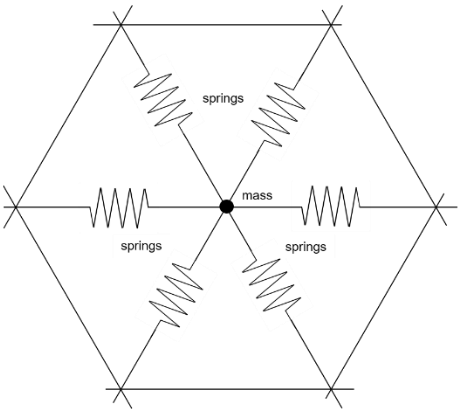

Fig 7: Interpretation of mass as energy stored in the discretization grid as springs formed by the side lines of the tetrahedron of space causing the curving of space.

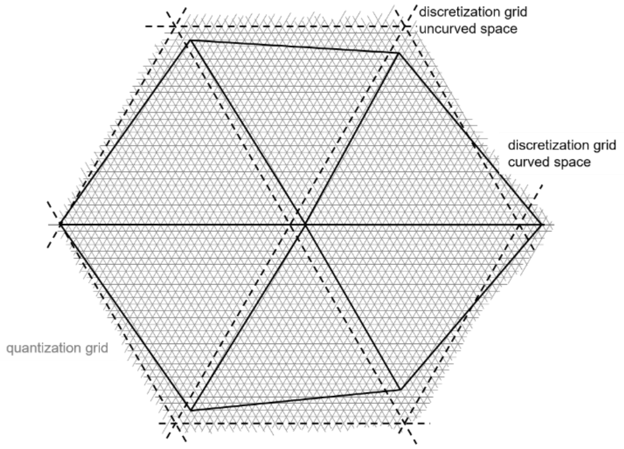

Fig 8: Discrete representation of the curvature of space in the horizontal plane. Particles are allowed only on the intersection points of the discretization grid; the discretization grid can be changed only with respect to the quantization grid.

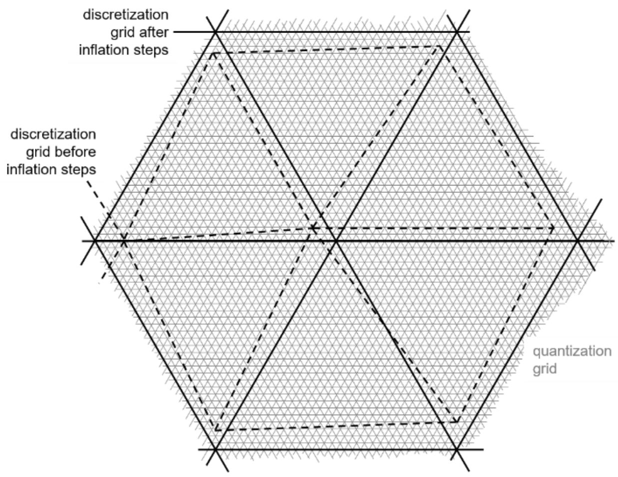

Fig 9: Inflation steps acting on the discretization grid (solid gray: quantization grid, dashed black: discretization grid before inflation, solid black: discretization grid after inflation steps)

A discrete representation of the curvature of space in the horizontal plane is given in Fig. 8. Particles are allowed only on the intersection points of the discretization grid; the discretization grid can be changed only with respect to the quantization grid. The quantization grid is not subjected to curving of space. The space-time discretium is curved in a discrete manner. The curving of space in Einstein's formula of general relativity is a continuous representation of such curved discretization elements.

Discrete curving of space-time in all 4 dimensions, $\Delta\boldsymbol{S}$, is given by

$$\begin{aligned}\Delta\mathbf{S} &= [\Delta\boldsymbol{s}_0 \quad \Delta\boldsymbol{s}_1 \quad \Delta\boldsymbol{s}_2 \quad \Delta\boldsymbol{s}_3] \\ &= \boldsymbol{\kappa}\,\mathbf{E}\end{aligned} \tag{13}$$

with $\boldsymbol{\kappa}$ as a discrete version of the curvature tensor

$$\boldsymbol{\kappa} = \begin{bmatrix} \kappa_{00} & \kappa_{01} & \kappa_{02} & \kappa_{03} \\ \kappa_{10} & \kappa_{11} & \kappa_{12} & \kappa_{13} \\ \kappa_{20} & \kappa_{21} & \kappa_{22} & \kappa_{23} \\ \kappa_{30} & \kappa_{31} & \kappa_{32} & \kappa_{33} \end{bmatrix} \tag{14}$$

Hence the discrete curving in each dimension, $\Delta\mathbf{s}_0$, $\Delta\mathbf{s}_1$, $\Delta\mathbf{s}_3$, and $\Delta\mathbf{s}_4$, is given by

$$\begin{aligned}\Delta\mathbf{s}_0 &= \kappa_{00}\mathbf{e}_0 + \kappa_{01}\mathbf{e}_1 + \kappa_{02}\mathbf{e}_2 + \kappa_{03}\mathbf{e}_3 \\ \Delta\mathbf{s}_1 &= \kappa_{10}\mathbf{e}_0 + \kappa_{11}\mathbf{e}_1 + \kappa_{12}\mathbf{e}_2 + \kappa_{13}\mathbf{e}_3 \\ \Delta\mathbf{s}_2 &= \kappa_{20}\mathbf{e}_0 + \kappa_{21}\mathbf{e}_1 + \kappa_{22}\mathbf{e}_2 + \kappa_{23}\mathbf{e}_3 \\ \Delta\mathbf{s}_3 &= \kappa_{30}\mathbf{e}_0 + \kappa_{31}\mathbf{e}_1 + \kappa_{32}\mathbf{e}_2 + \kappa_{33}\mathbf{e}_3\end{aligned} \tag{15}$$

What Newton was not aware of – how could he – is that the presence of mass also alters the way how objects move in space. The deflection angle φ of a massless proton moving close-by a mass is given by

$$\varphi = \frac{4Gm}{rc^2} \tag{16}$$

with *G* as the gravitational constant, *m* as the mass of the object, *r* the distance of closest approach and *c* as lightspeed. No force is caused by the mass *m* acting on the massless photon; the photon follows its way along the discrete curved space-time discretium with lightspeed.

In its current form general relativity is only suitable for distances larger than the discretization grid but has no extrapolative character for distances below. Note that the discretization grid is a function of mass and not constant.

Regarding quantum mechanics, the curvature of space-time is the creditor to borrow large amounts of energy for a short time.

D. *Inflation of Space-Time*

Quantized inflation steps are visualized in Fig. 9. A similarity in appearance to Fig. 8 showing the discrete curving of space-time caused by mass is no coincidence. Inflation is the de-curving of space-time. No dark energy pushes from the inside, but a pulling from the outside by the discretization grid explains the inflation of the universe within the gedankenexperiment. Since mass is curving space and mass equals energy, a de-curving of space is a release of energy.

III. A Probabilistic World

While quantum mechanics describes a world subjected to probabilities; Einstein's mechanic describes a deterministic behaviour. Within the gedankenexperiment Einstein's deterministic world is re-formulated to include a probabilistic element.

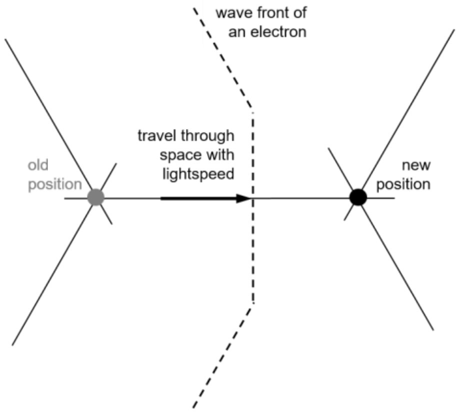

Fig 10: Matter travelling as wave with lightspeed between two discrete positions. The localization of the wave can be interpreted as a wave front (filled grey circle: old position; filled black circle: new position black cross: curved space; filled circle: point mass, dashed line: wave front).

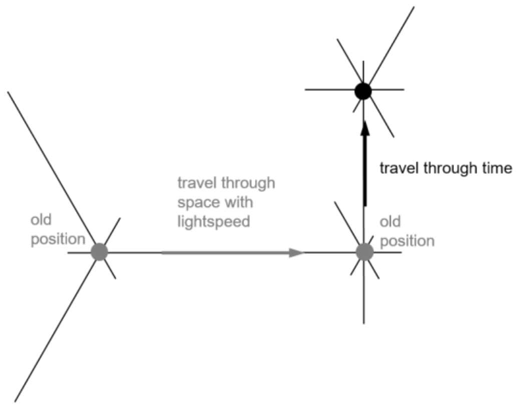

Fig 11. Adding a rest time component to a Feynman diagram. Matter as wave can traverses space and matter as particle traverses rest time.

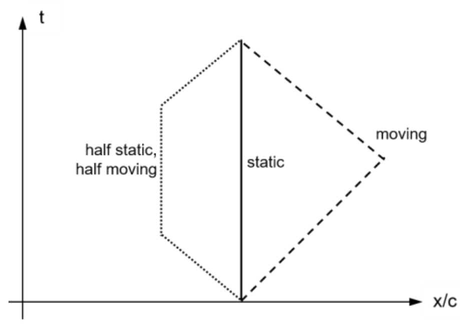

Fig 12: Three different ways of moving ending up at the same point in the space-time discretium. For each of the movements a different rest time has passed (moving: dashed line; static: solid line; half static, half moving: dotted line).

A. Wave-Particle Duality

Meeting means, being at the same place at the same time and still comply with Pauli's exclusion principle. In a discrete space, the particle nature is limited to discrete points, where the traversing between these two points is conducted as wave with lightspeed [Fig. 10].

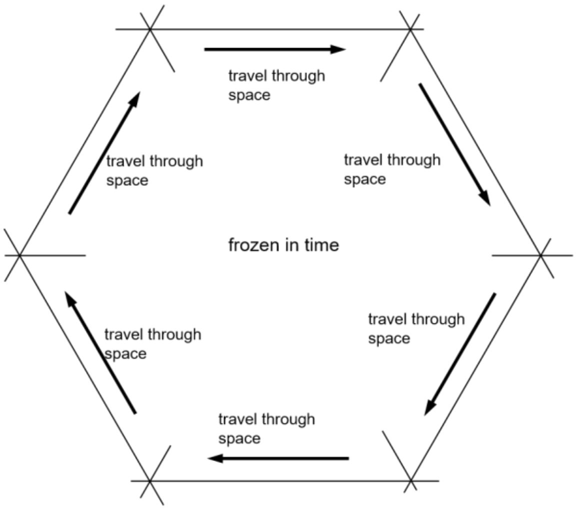

Fig 13: Wave travelling in a circle without rest time passing.

The localization of the wave can be interpreted as a wave front. Any object (micro- or macroscopic) moves as wave until it rests at a discretization point on the space-time discretization grid.

The similarity in appearance between the discrete space-time grid to a Feynman diagram is no coincidence. In a Feynman diagram both axes have different units. Feynman's description of the behaviour of the anti-particle as moving 'backward in time and reversed in space'[7] shrouds the circumstance that backward in time is reversed in space – for the time travelled in space. The anti-particle is moving backward in space.

Adding a rest time component to a Feynman diagram is shown in [Fig. 11]. Rest time exists only on discrete points in 3D space and time passes only if matter is localized as a particle. Like a radar blip refreshing the target position each 5 s. After some time, the radar operator starts to feel, that this is the normal behaviour. And indeed, it is; although on a vastly different scale.

Consider three different objects, one being static, one travelling half the time forward and backward with lightspeed and one travelling the whole time forward and backward with lightspeed [Fig. 12]. Reversed in space is backward in time for the time travelled through this very same space. For the figure, each travel ends at the same point in space-time, but for each traveller a different rest time has passed.

A wave travelling in a honeycomb like structure is frozen in time [Fig. 13]; only space passes, which is reversed after a cycle is completed. What separates macroscopic objects from atoms is the probability they usually travel with lightspeed. The double slit experiment can be conducted with molecule sized objects and it became some sort of a race 'to see who can bell the biggest Schrödinger's cat'[8].

B. Probabilistic Velocity

Special relativity is based on two postulates, the constant of lightspeed and the equality of inertial systems towards each other. The first assumption is necessary to explain the Michelson-Morley measurements, the second to avoid contradiction with Maxwell's description of electro-

[7] Feynman, Weinberg: Elementary Particles and the Laws of Physics, p. 40

[8] Ananthaswamy: *Through Two Doors at Once*, p. 197

magnetism. One of the finer details is that Michelson-Morley measured a two path round trip, and not a one path propagation. It is not a huge cosmic conspiracy to ensure the constancy of the speed of light[9] if the velocity of any movement of each particle is divided between phases of lightspeed and rest. Any inertial system is obviously equal to one another for the phases not moving with lightspeed. A velocity v is the probability of travelling with lightspeed p_v,

$$v = p_v c \tag{17}$$

neglecting a transition phase between moving with lightspeed and resting; between being wave and being particle. Planck's time t_P is defined as the time, which passes for Planck's length l_P travelled by lightspeed. The very definition of Planck's time t_P indicates that travelling occurs with lightspeed – always.

$$t_\mathrm{P} = \frac{l_\mathrm{P}}{c} = 5.391\,247 \cdot 10^{-44}\mathrm{s} \tag{18}$$

Lesch[10] called the theory of relativity jokingly as the theory of the absolute lightspeed; as usual a good joke contains a deeper truth. Matter is not wave and particle, at least not at the same time. Moving matter is wave, static matter is particle. Bohr had the hypothesis that 'light is wave or particle' [11] but he limited this thinking to photons, which have no rest mass. Matter is moving either with lightspeed or being static; there is nothing in-between. Movement is always conducted with lightspeed [Fig. 14]. Likewise, it is not relevant how specific the movement is split up between moving with lightspeed and resting.

Heisenberg's uncertainty principle was trying to tell us this circumstance all the time. Heisenberg's uncertainty principle can't be fooled, because there is nothing to fool. Michelson–Morley[12] measurement of the speed of light was of course equal in all direct. Any other velocity than lightspeed is an illusion. As Einstein stated, reality is merely an illusion, albeit a very persistent one.

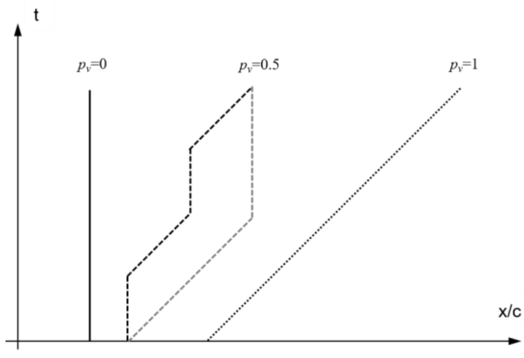

Fig 14: Probabilities for various mean velocities (solid black: static; dashed black: half lightspeed, half static; dashed grey: alternative combination between half lightspeed and half static; dotted black: lightspeed).

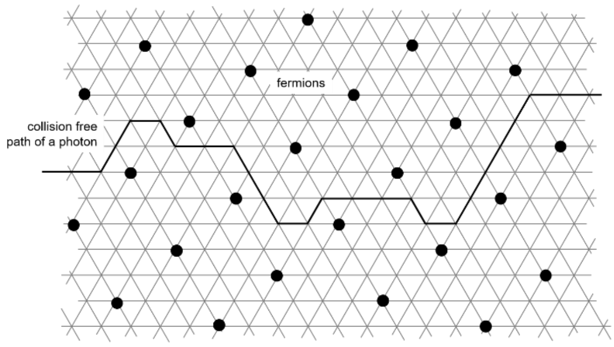

Fig 15: Prolonged path of a particle moving through a dense medium. (black line: collision free path of a photon, filled circle: fermions).

Newton's/Leibnitz's calculus derives the mean velocity instead of the momentary velocity. Fermions of any macroscopic object are travelling through space with lightspeed or travelling through time. While the Tardis[13] is standing still, she is travelling through time. Some science fiction series and movies came involuntarily close in portraying reality.

For a photon moving through transparent matter, quantum mechanics tells us that the photon takes all possible paths at once. Feynman described it as 'sum them up and re-normalize'. He summoned up paths not existing due to discretization. The constant d of the discretization grid can be determined by finding a discretization scheme, which requires no re-normalization having inherently no infinities. For a photon moving through translucent matter, travelling time is increased by prolonging the path, but not by slowing down the velocity of propagation [Fig. 15]. Photons 'bounce around' and are being 'absorbed and re-emitted'[14] prolonging their travel time. For a proton or neutron, the position is absolute. It is background dependent; it depends on the exact geometry of space.

Schrödinger's cat is either dead or alive, but these states are not intermingled with one another except the cat is continuously moving with lightspeed, which the poor creature will never do. In the double slit experiment, the photons/electrons are travelling through space as wave until they rest and become particles. Photons have no rest mass, don't interact with the Brout-Englert-Higgs field and therefore can't travel through rest time. For a photon only space passes, but no rest time, while for an absolute static observer only rest time passes but no space.

C. *Velocity-Addition Formula*

The goal is to calculate the velocity u of an object, if the object is moving with velocity u' and the velocity of the reference frame is v.

Newton calculated u according to

$$u = u' + v \tag{19}$$

Einstein calculated u according to

[9] in analogy to Chown: *The Ascent of Gravity*, p. 102.
[10] Video clip from Lesch: *Vom Rand der Erkenntnis*
[11] Susskind: *Black Hole War*, p. 243
[12] Michelson and Gale, "The Effect of the Earth's Rotation on the Velocity of Light", *The Astrophysical Journal*, vol. 16, No. 3, pp. 137-145, April 1925
[13] Time travelling spaceship from the sci-fi series *Doctor Who* camouflaged as a blue police box.
[14] Butterworth: *A Map of the Invisible: Journeys into Particle Physics*, p. 184

$$u = \frac{u' + v}{1 + \frac{u'v}{c^2}} \quad (20)$$

For the assumption that any velocity is a mixture between moving with lightspeed and being static, the velocity of an object u' is given by the probability $p_{u'}$ the object is moving with lightspeed multiplied by the lightspeed; p_v is the probability the reference frame is moving with lightspeed.

$$\begin{aligned} u' &= p_{u'}c \\ v &= p_v c \end{aligned} \quad (21)$$

The summation of the velocities u' and v is done according to the following logic, complying to a logic-or combination [Table 1].

Table 1:
Combination logic for adding velocities.

u'/c	1	1	0	0
v/c	1	0	1	0
u/c	1	1	1	0

The resulting velocity is then given according to

$$u = (p_{u'}(1 - p_v) + p_v(1 - p_{u'}) + p_{u'}p_v)c \quad (22)$$

Considering the sign of lightspeed results in [Table 2].

Table 2:
Combination logic for adding
velocities considering the sign of lightspeed.

v/c u'/c	-1	0	1
-1	-1	-1	-1
0	-1	0	1
1	1	1	1

This table does not comply to a three-valued-logic; there is only an impact on the sign of the terms but not on the basic structure of the formula. [Table 3] presents case examples comparing Newton, Einstein and the gedankenexperiment:

Table 3:
Case examples c for adding velocities comparing
Newton, Einstein and the gedankenexperiment.

$\frac{u'}{c}$	$\frac{v}{c}$	Newton	Einstein	gedanken-experiment
0	0	0	0	0
0.01	0.0001	0.0101	0.01009998…	0.010099
0.01	0.01	0.02	0.0198039…	0.0198
0.05	0.05	0.1	0.0997…	0.0975
0.5	0.5	1	0.8	0.75
0.95	0.95	1.9	0.9986…	0.9975
0	1	1	1	1
1	0	1	1	1
1	1	2	1	1

[15] Feynman, Weinberg: *Elementary Particles and the Laws of Physics*.

The resulting values obey the following order:

$$\text{Newton} \geq \text{Einstein} \geq \text{gedankenexperiment} \quad (23)$$

For velocities up to 1% of lightspeed (approx. 3000 km/s), the difference between the values according to Einstein and the gedankenexperiment are identical up to the 6th decimal place. 'The symmetry known as Lorentz invariance is almost incompatible with quantum mechanics.'[15] To make special relativity compatible with quantum mechanics, the Lorentz transformation is replaced by a probabilistic calculation achieving almost identical results.

And it is not a bug but a feature that they are not identical. 'The difficulty with Minkowski space is, that there is a kind of no-man's land […]; the Lorentz transformation can't really move through them.'[16] In the gedankenexperiment this no-man's land is gone.

D. Probabilistic Acceleration

Acceleration a is the rate of change of velocity. In the gedankenexperiment, velocity v is defined as the probability of travelling with lightspeed and therefore acceleration becomes the rate of change of the probability p travelling with lightspeed.

$$a = \frac{\partial v}{\partial t} = c\frac{\partial p_v}{\partial t} \quad (24)$$

A visualization of the rate of change of the probability travelling with lightspeed is given in [Fig. 16].

E. Probabilistic Mass

In the world of Newton, the energy of a moving mass E consists of

$$\begin{aligned} E &= \frac{1}{2}mv^2 + mc^2 \\ &= \left(1 + \frac{1}{2}\left(\frac{v}{c}\right)^2\right)mc^2 \end{aligned} \quad (25)$$

The ratio between moving mass m_v and rest mass m is calculated to

$$\frac{m_v}{m} = 1 + \frac{1}{2}\left(\frac{v}{c}\right)^2 \quad (26)$$

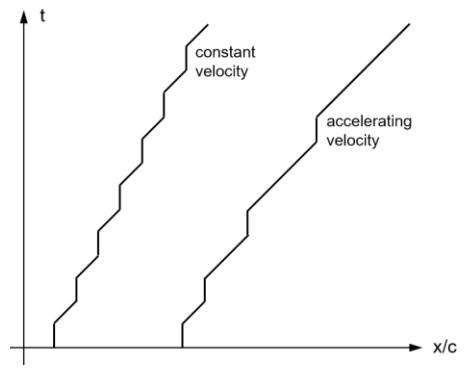

Fig 16: Acceleration as the rate of change of the probability moving with lightspeed (left: constant velocity, right: accelerating velocity).

[16] Feynman, Weinberg: *Elementary Particles and the Laws of Physics*, p. 27

'Newton believed that this was not the case, and that the masses stayed constant.'[17]

For Einstein, the energy of a moving mass is given by

$$E = \left(\frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} - 1 \right) mc^2 \tag{27}$$

With the moving mass m_v calculated to

$$m_v = \frac{m}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \tag{28}$$

the ratio between moving mass and rest mass becomes

$$\frac{m_v}{m} = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \tag{29}$$

In the gedankenexperiment, the concept of mass is only applied to static particles

$$m_v = \begin{cases} m & \text{for } v = 0 \\ 0 & \text{for } v = c \end{cases} \tag{30}$$

A force can only act on matter while being a static particle; general relativity interpreted this as an increase of mass. Hence the total energy for a moving mass is calculated to

$$\begin{aligned} E &= \frac{1}{2} p_v m v^2 + (1 - p_v) mc^2 \\ &= \left(\frac{1}{2} p_v^3 + (1 - p_v) \right) mc^2 \end{aligned} \tag{31}$$

In the gedankenexperiment, the ratio between a virtual moving mass m_v and a rest mass m is given by

$$\begin{aligned} \frac{m_v}{m} &= \sqrt{\frac{\frac{1}{2} p_v^3 + (1 - p_v)}{1 - p_v}} \\ &= \sqrt{1 + \frac{p_v^3}{2(1 - p_v)}} \end{aligned} \tag{32}$$

[Table 4] compares the results of the ratio of moving mass m_v and rest mass m for different velocities between Newton, Einstein and the gedankenexperiment.

Table 4:
Case examples c the ratio of moving mass and rest mass comparing Newton, Einstein and the gedankenexperiment.

$\frac{v}{c}$	Newton	Einstein	gedanken-experiment
0	1	1	1
0.1	1.05	1.0050…	1.0002…
0.5	1.25	1.1547…	1.0606…
0.9	1.45	2.2941…	2.1552…
0.95	1.475	3.2025…	3.0941…
0.99	1.495	7.0888…	7.0366…

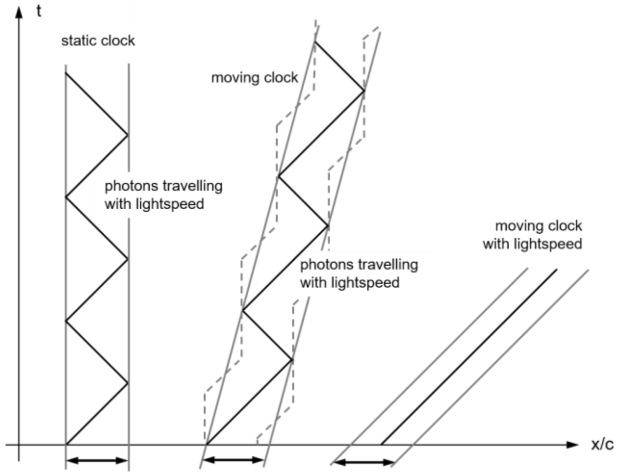

Fig 17: Comparison of a static clock (left), a moving clock (middle) and a clock moving with lightspeed (right). Time measurement is achieved by photons bouncing back on the clock walls. For the clock moving with lightspeed, no time passes. No length contraction occurs due to the movement.

Hence, the gedankenexperiment is able to explain the virtual increase of mass measured by the Kaufmann experiment.[18] Kaufmann measured a dependence of mass with the velocity of moving particles.

F. Time Dilation

The comparison of a static clock and a moving clock (sub lightspeed and lightspeed) is given in [Fig. 17]; for the moving clock, movement is divided between phases of lightspeed and rest. In the gedankenexperiment no length contraction occurs due to the movement.

Einstein calculated the time dilation T_v/T of a moving system to

$$\frac{T_v}{T} = \frac{1}{\sqrt{1-\left(\frac{v}{c}\right)^2}} \tag{33}$$

It should be noted that no precise derivation of the validity of the Lorentz transformation exists – so far.[19] For Einstein the factor is identical to the increase of mass due to movement.

In the gedankenexperiment the impact of movement on the ticking of the clock [Fig. 18] is calculated for the tick to

$$\frac{T_v^{\text{tick}}}{T} = \frac{1}{1 - p_v} \tag{34}$$

and for the tock to

$$\frac{T_v^{\text{tock}}}{T} = \frac{1}{1 + p_v} \tag{35}$$

The time for the tick is increased, while the time for the tock is decreased. The geometric mean between tick and tock is calculated to

[17] Feynman: *The Character of Physical Law*, p. 70
[18] Kaufmann: Über die Konstitution des Elektrons. *Annalen der Physik*, 4. Folge, Bd.19,487 (1906).
[19] Brandes: *Spezielle und Allgemeine Relativitätstheorie für Physiker und Philosophen: Einstein- und Lorentz-Interpretation, Paradoxien, Raum und Zeit, Experimente*, p. 256

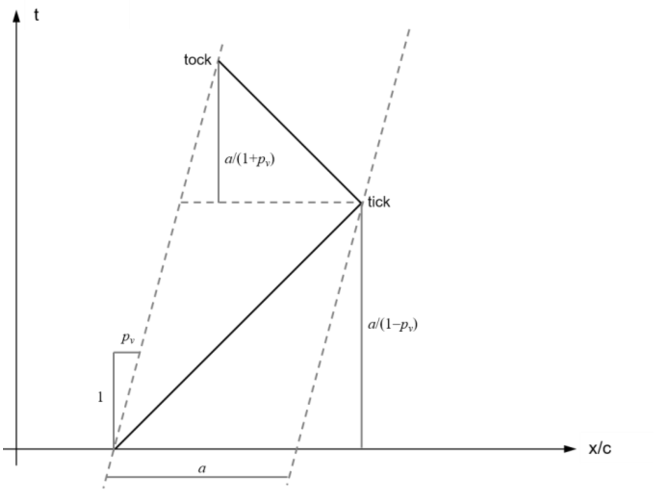

Fig 18: Impact of movement on the ticking of a clock. The time for the tick is increased while the time for the tock is decreased.

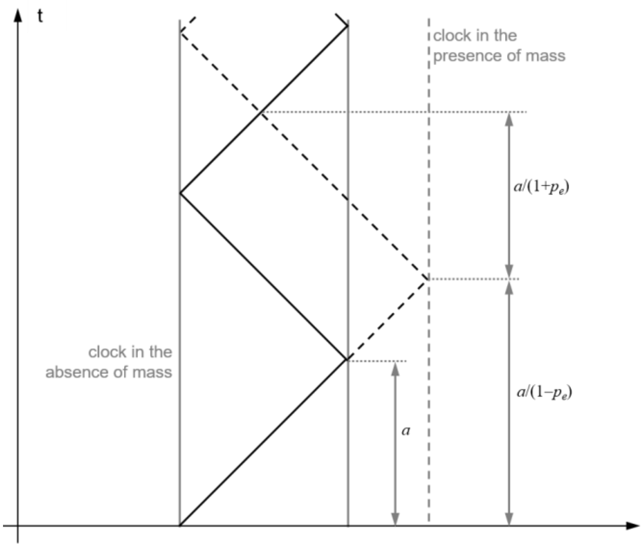

Fig 19: Impact of mass on the ticking of a clock.

$$\frac{T_v}{T} = \sqrt{\frac{T_v^{\text{tick}}}{T} \cdot \frac{T_v^{\text{tock}}}{T}} = \sqrt{\frac{1}{1-p_v} \cdot \frac{1}{1+p_v}} = \sqrt{\frac{1}{1-p_v^2}} \tag{36}$$

which is identical to the formula used by Einstein for time dilation. The time dilation is a measurement artefact caused by the movement of the clock. Rest time passes when not moving with lightspeed according to

$$\frac{T_v}{T} = 1 - p_v \tag{37}$$

Since particle decay according to the previous formula[20], these tiny little things seem to obey the beat of a moving clock.

The comparison of a clock in the absence of mass and a clock in the presence of mass is given in [Fig. 18]. Einstein calculated the time dilation T_m/T of a clock to

$$\frac{T_m}{T} = \frac{1}{\sqrt{1-\left(\frac{v_e}{c}\right)^2}} \tag{38}$$

with the escape velocity v_e given by

$$v_e = \sqrt{\frac{2Gm}{r}} \tag{39}$$

were r is the distance to a mass m. In the gedanken-experiment the impact of mass on the time dilation of a clock [Fig. 19] is calculated to

$$\frac{T_m}{T} = \sqrt{\frac{1}{1-p_e} \cdot \frac{1}{1+p_e}} = \sqrt{\frac{1}{1-p_e^2}} \tag{40}$$

with p_e as the probability to move with lightspeed to achieve the escape velocity v_e,

$$p_e = \frac{v_e}{c} \tag{41}$$

which is identical to the formula used by Einstein for time dilation by mass.

IV. Force of Gravitation

Refinement of Rutherford's probing of the atom showed for the proton three entities with basically nothing in between. These three entities became known as quarks. A proton, forming the nucleus of a hydrogen H atom, consists of two up quarks with a charge of +2/3 and one down quark with a charge of -1/3 resulting in a total charge of +1. For a static proton, these quarks are located on the discretization grid of space [Fig. 20]. A neutron consists of one up quark and two down quarks with a total charge of zero.

The separation of the quarks is far off Planck's length. With $1.7 \cdot 10^{-15}$ m as the diameter of a proton/neutron, the amount of quantization steps d to form the discretization grid must therefore comply with

$$d \ll \frac{1.7 \cdot 10^{-15}\ \text{m}}{1.616 \cdot 10^{-35}\ \text{m}} \approx 10^{20} \tag{42}$$

Hence there is plenty of range to form the discretization grid as multiples of the quantization grid and to form the radius of a proton as multiple of the discretization grid.

A. Harvesting Gravity

The bending of space alone is not what causes what we call the force of gravitation; it must be harvested somehow. A graviton, the hypothetical force carrying particle for the force of gravitation, must have a spin of 2; its fermionic partner a spin of 1½. Although no elementary particle, particles with the required spin are protons and neutrons. Consider a proton/neutron swimming on the curved space like a leaf swimming on water [Fig. 21] reminding on the Kohnke-triangle-cap parachute RZ-36 patented 1943 by Schauenburg.

[20] Rossi, Hall: Variation of the Rate of Decay of Mesotrons with Momentum. *Phys. Rev.* 59, 223 (1941).

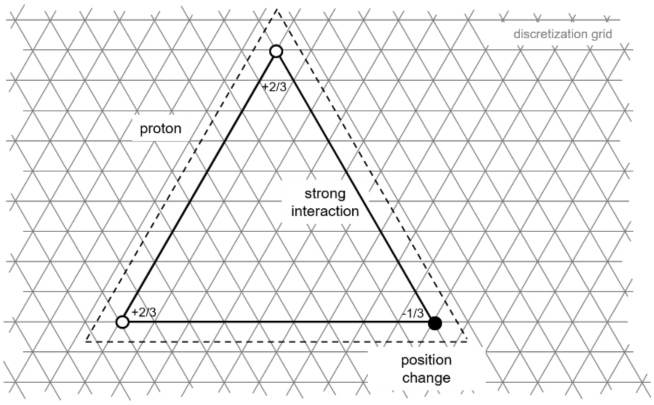

Fig 20: Proton consisting of two up quarks and one down quark; for a static proton each of the quarks is located on the discretization grid.

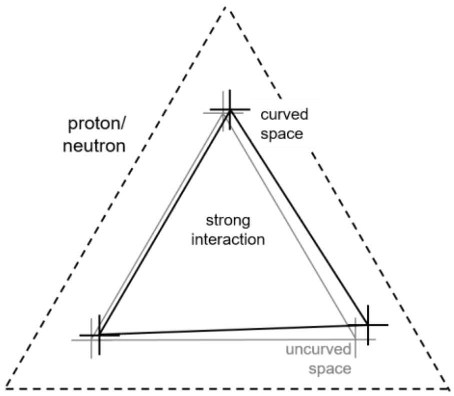

Fig 21: Proton/neutron swimming on the curved space like a leaf swimming on water. Mass curving space is above or below the proton/neutron (grey cross: uncurved space; black cross: curved space).

Generation of a force is caused due to a gradient in the quantized space caused by the presence of mass, where this gradient is caused by the square term in Newton's law of gravitation. A proton or neutron is capable to harvest this force. It is caused by the different binding forces between both pairs of the up and down quarks located in the discretization grid of absolute space [Fig. 21]. 'Difference in potential gives rise to force.'[21] The strong force gets weak for short distances; putting the quarks loose, these quarks show a tendency to follow the curving of space. For an increased distance the strong force kicks in again and the two remaining quarks are pulled one by one along the gradient – at least on average. This first quark acts as some sort of a towing anchor. With large ranges, the strong force is independent of the distance.

Gravity is a side product of the strong interaction together with mass caused by the Higgs boson and not a separate force. A proton or neutron orients itself with respect to the gradient of curved spaced like a leaf swimming on water. No separate particle is causing the force of gravitation; two gluons share the burden of a hypothetical graviton having a cumulated spin of 2; the theoretically required spin. The gravitino, the fermionic partner of a graviton, has a predicted spin of 1½, which complies to the spin of a proton or neutron. Considering the size of the fermionic partner, the name gravitone appears much more appropriate than gravitino.

Each and every rest mass curves space, but only proton and neutrons are able to harvest gravity. Our everyday experience deludes us because we usually only deal with protons or neutrons. 380.000 years after the Big Bang, gravity has been switched on;[22] it seems to be more than a coincidence this happened together with the forming of protons and neutrons.

Like gas pressure, gravity is a statistical property and not a separate force. A proton/neutron is not only the smallest but the only entity being able to harvest the force of gravitation. Using the Avogadro number of $6.02214129 \cdot 10^{23}$ mol^{-1}, 1 mol ^{12}C atoms complies with 12 g (old definition till 2019) or 1 mol of protons/neutrons for ^{12}C complies with 1 gram. Different elements have different binding forces; hence the protons/neutrons of different elements cause a different amount in bending space and also harvest a different amount of gravity. This circumstance is basically addressed by the molar mass in the periodic table and this concept seems to be the origin of quantum gravity.

Susskind wrote: "But something like the proton radius is not very fundamental. […] It makes better sense to pick constants that control the deepest and most universal laws of physics."[23]. The author wholeheartedly disagrees and remains in the hope that the presented ideas are judged not only as fundamental, but also as beautiful.

B. *Minimal Gravity*

The current definition of Planck's mass m_{P},

$$m_{\mathrm{P}} = \sqrt{\frac{\hbar c}{G}} = 2.176\,434 \cdot 10^{-8}\mathrm{kg} \tag{43}$$

does obviously not represent the smallest entity of mass; quite the opposite, it represents the maximal energy storable in a discrete space-time element scaled by c^2.

The minimal mass is a change by one quantization step of a single Planck's length in the discretization grid. With $|\cdot|$ as the determinate,

$$\left|\frac{d}{ct_{\mathrm{P}}}[\mathbf{e}_1 \quad \mathbf{e}_2 \quad \mathbf{e}_3]\right| = \left|d\begin{bmatrix}1 & \sqrt{3}/2 & 1/2\\ 0 & 1/2 & 1/2\\ 0 & 0 & 1/2\end{bmatrix}\right| = \frac{d^3}{4} \tag{44}$$

the modified Planck's mass $\overline{m}_{\mathrm{P}}$ is given by

$$\overline{m}_{\mathrm{P}} = \frac{4}{d^3}\sqrt{\frac{\hbar c}{G}} \tag{45}$$

With the unknown amount of quantization steps to form the discretization grid d. Using the mass of a neutrino m_η,

$$m_\eta < 2 \cdot 10^{-36}\mathrm{kg} \tag{46}$$

to get a boundary for the amount of quantization steps to form the discretization grid d, results in

[21] Basil: *The Man Who Changed Everything: The Life of James Clerk Maxwell*, p. 74

[22] Chown: *The Ascent of Gravity: The Quest to Understand the Force that Explains Everything*, p. 167

[23] Susskind, *The Black Hole War*, p. 113

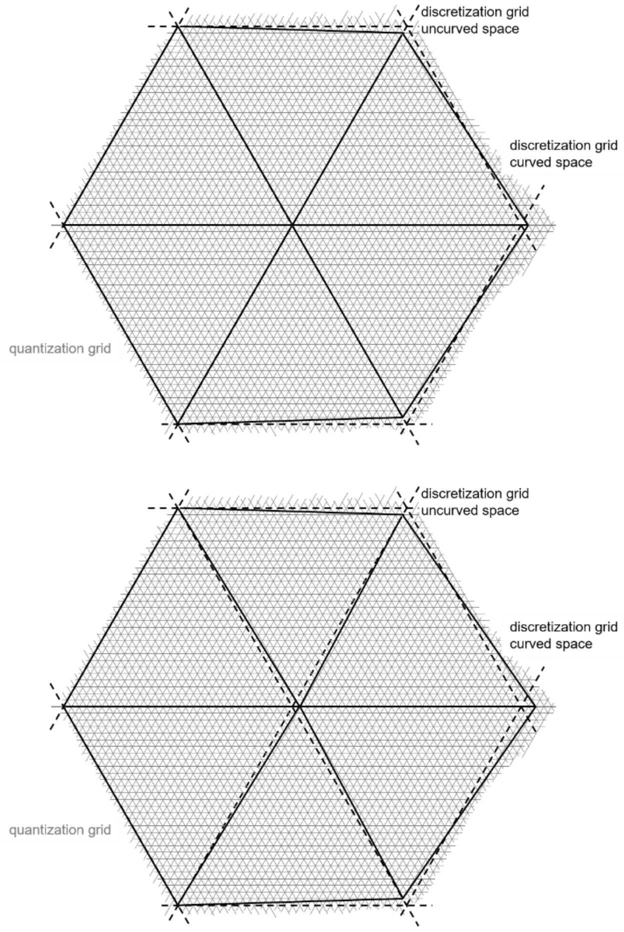

Fig 22: Almost the same curving of space due to quantization effects for different amount of quantization steps; above: zero quantization steps in the left grid element and one quantization step in the right grid element; below: one quantization steps in the left grid element and two quantization step in the right grid element. The mass bending space is located somewhere on the right. (dashed black: discretization grid of uncurved space, solid black: discretization grid of curved space, solid grey: quantization grid)

$$d \geq \sqrt[3]{\frac{4m_{\mathrm{P}}}{m_\eta}} = \sqrt[3]{\frac{4 \cdot 2.176\,434 \cdot 10^{-8}\mathrm{kg}}{2 \cdot 10^{-36}\mathrm{kg}}} = 3.517 \cdot 10^{9} \quad (47)$$

Due to the quantization of space-time, gravity has not an unlimited outreach. Almost the same curvature in space is achieved by curving zero steps in one grid element and one step in the adjacent grid element or one step in one grid element and two steps in the adjacent grid element. This circumstance is shown in Fig. 22. In the outer reach of spiral galaxies, discretization effects start to dominate. Dark matter is not necessary to explain the properties of such cosmic objects. Hence spiral galaxies are a perfect test laboratory to probe the last gasp of gravity for the last quantization steps. General relativity does not take into account quantization effects and can therefore not address such effects.

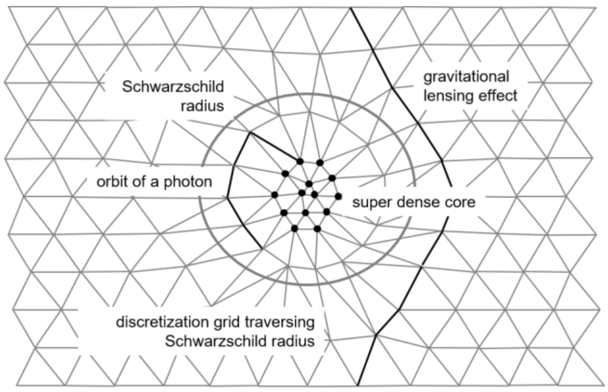

Fig 23: Schwarzschild radius of a black hole traversed by the Brout-Englert-Higgs field. Photons are subjected to the bending of space, but not to a force of gravitation.

With the tip of Einstein's fountain pen, planet Vulcan was gone[24]. A hundred years later, within this gedanken-experiment, with a keystroke a little bit more doubt on the necessity of dark matter has been raised.

C. *Maximal Gravity*

A black hole is a collection of mass so large, that space is bend so much, that no particles can escape any more. No particle of the standard model can travel faster than lightspeed, but the escape velocity necessary to escape is hypothetical larger. Keep in mind that travelling occurs always with lightspeed; faster than lightspeed would comply to a probability of travelling with lightspeed greater than one. Hence the effect of a black hole must be related to the geometry of space-time.

A black hole is no uniform entity without entropy. The discretization grid traversing the Schwarzschild radius has an impact on the rest of the universe. This circumstance is described by the holographic principle of a black hole [Fig. 23]. Limit of knowledge is not at the Schwarzschild radius. Black holes hold information and quite a lot of it. The term gravitational lensing is misleading; space is bent by mass, but a photon is not influenced by a force of gravitation; nevertheless, inside the Schwarzschild radius the bending of space directs a proton into an orbit around the core of a black hole. The formula to calculate the deflection angle of a photon close to a mass object refers only to the mass of this object.[25]

Inside a black hole the space-time discretium is described by the Schwarzschild metric; outside a black hole it is described by the Minkowski metric. The rough discretization scheme of [Fig. 23] already grasps the basic properties of the underlying metrices. Numerical simulations conducted on a significant coarser grid than of Planck length are therefore able to reflect the basic circumstances.

A single photon entering a black hole changes at least the length of a single discretization grid point by a single quantization step. A black hole 'has no hairs', as Wheeler stated, but it has spikes formed by the discretization grid. This is also proportional to the numbers of connections in the field.

[24] Levenson: *The Hunt For Vulcan*

[25] $\varphi = \frac{4Gm}{rc^2}$ with φ as the deflection angle, G as the gravitational constant, m as the mass of the object, r the distance of closest approach and c as lightspeed.

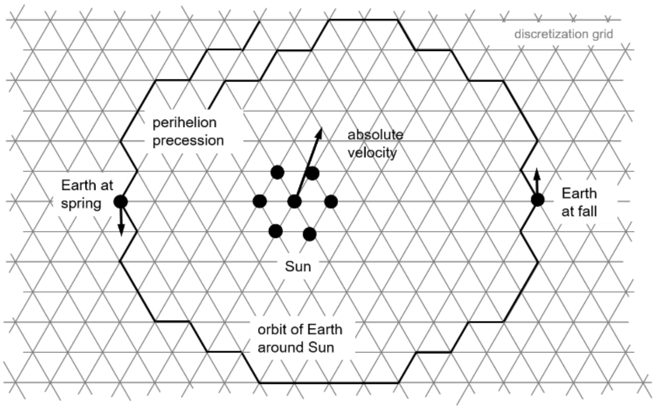

Fig 24: Absolute space grid with Earth moving around the Sun. The curving of the space-time discretization grid by the presence of mass is not illustrated.

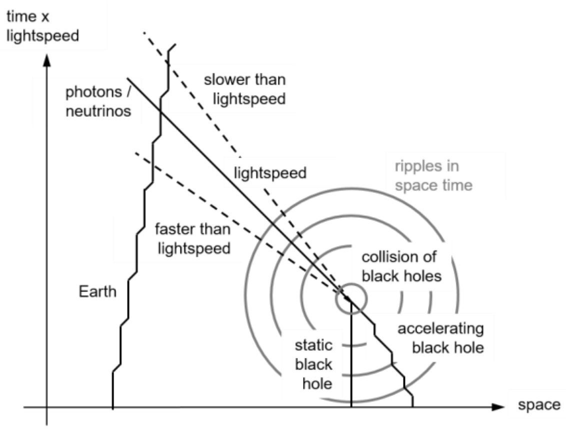

Fig 25: Ripples in space-time in a Minkowski diagram due to the collision of two black holes. Matter is either static or moving with lightspeed while ripples in space-time move differently.

A black hole might be interpreted as the nucleus of a super atom, where the binding forces are supported by the curvature of space. No singularity occurs due to the quantization of the position; the whole universe is pulling against the bending forces. Probing the inner of a black hole by a model on the quantized nature of space will reveal some very interesting properties. The few discretization points drawn in [Fig. 24] were enough to grasp basic properties of a black hole; much more details can be achieved by relying on the computational plenty of our age.

The Big Bang nearly 14 billion years ago can be explained as a black hole torn apart by pulling 'from so far away'[26] by the discretization grid. A black hole being torn apart might easily be misinterpreted as an exploding black hole; and explode they do.[27] The author likes to imagine that a single simple photon caused this super black hole to burst. In this model, the cosmological constant (which is no constant at all) describes the snapping back after the black hole has been torn apart and by doing so explaining dark energy. The de-curving of the discretization grid provides the mechanism for inflation with the consequence that the discrete space grid existed long before the Big Bang. The black hole which exploded at the Big Bang consisted of matter not antimatter; an explanation – and not even a new one – why we see so few anti particles coming from afar.

D. Planetary Movement

Measuring the absolute velocity of Earth travelling through the space-time continuum was a very old endeavour. One claim of success by Smooth[28] was based on Doppler shift measurements of cosmic microwave radiation who calculated an absolute velocity of Earth of 300 km/s towards the constellation Leo.

DAMA/LIBRA[29] detected a change in particle detection, while the Earth is moving around the sun in a cyclic way in years rhythm. Absolute space explains these measurements and it would show that probing of the absolute space is possible [Fig. 24]; DAMA/LIBRA tried to explain this behaviour via dark matter but found little to no acceptance for this hypothesis in the scientific community.

E. Ripples in Space-Time

As the name states, ripples in space-time detected by LIGO travelled through space and through time, making a visual confirmation of the event causing the disruption in the space-time discretium a challenge; photons travel only through space until they are measured [Fig. 25]. With a sensitivity of 10^{-19} m, LIGO measures in principle time differences of arrival assuming a velocity of lightspeed for gravitational waves to pinpoint the source location. But ripples in space-time are so different, that this assumption holds no longer true; these ripples can have any velocity. The conventional concept of speed suits not well to describe their behaviour. The concept of 'nonlocality' from quantum mechanics seems to grasp the basic issue much better. LIGO might wonder, why they have so many detections and often without optical confirmation. When more gravitational observatories[30] become available, an estimation of the velocities of the ripples in space-time for different events can verify this hypothesis.

V. Conclusion

A gedankenexperiment of the unification between general relativity and quantum mechanics has been presented resulting in a hypothesis for quantum gravity. The basic assumption of the presented gedankenexperiment is, that velocity is a probability travelling with lightspeed. Any other velocity than lightspeed is an illusion; although a very persistent one[31]. 'Simple in hypotheses and rich in phenomena[32]'. Applications of the gedankenexperiment were given from the nucleus of an atom to a black hole; from the Big Bang to the present age.

The consequences stated through discretization (resolution) and quantization of space and time are hopefully more than enough to call this gedankenexperiment falsifiable. Einstein was right about the incompleteness of quantum

[26] A theme from the sci-fi series *Doctor Who*.

[27] Giacintucci et all: Discovery of a Giant Radio Fossil in the Ophiuchus Galaxy Cluster, *The Astrophysical Journal*, Volume 891, Number 1 (2020)

[28] G.F. Smoot, M. V. Gorenstein and R. A. Muller, „Detection of anisotropy in the cosmic blackbody radiation", *Phys. Rev. Letters*, vol. 39, No 14, pp.898-901, 1977

[29] Gagnon: *Who cares about particle physics?*, p. 118

[30] LIGO Hanford / Livingston / India, Virgo, GEO 600, KAGRA etc.

[31] in analogy to Einstein

[32] Leibnitz

mechanics. What was missing, was the curving of space-time provided by general relativity. As Hawking predicted, all the information was available.

No higher dimensions and no new particle were introduced for the unification of general relativity and quantum mechanics. General relativity has been re-interpreted to become background dependent without changing the key predictions – except for length contraction with respect to velocity.

Within the gedankenexperiment, general relativity and quantum mechanics are deeply intermingled with one another and into each other forming a complex system; both were right in their own interpretation of reality and on their own scale. An appropriate name for the combination of both theories seems to be 'General Quantum Mechanics'. All these years, the information necessary for a unification between general relativity and quantum mechanics was hiding in plain sight but covered by misassumptions which became so dear to us.

Inspired by the list stated by Gagnon[33] the presented gedankenexperiment explains gravity and its weakness, why there is so little anti matter observed. Furthermore, the shroud surrounding dark energy has been lifted. In addition, the presented gedankenexperiment explains the wave particle dualism of matter and determines the fate of Schrödinger's cat. Newton's/Leibnitz's calculus within this gedanken-experiment has been addressed; the measurements from DAMA/LIBRA and the amount of measurements of LIGO/Virgo can be explained.

The author made his case, it is up to his peers to judge on him. He does not fear to be proven wrong; in this case he would join an illustrious round of 'crackpots and philosophers'[34] who worked on quantum gravity. He fears to be right.

ACKNOWLEDGEMENT

Conducting this gedankenexperiment felt more like designing the background for a science fiction story rather than describing the nature of nature. Fantastic stories are indeed written in the book of nature; to learn to read in the book of nature, the author was inspired by Kepler.

Writing an appropriate acknowledgement to satisfy everyone seems to be harder than unifying general relativity and quantum mechanics. Someone is always forgotten in the acknowledgement. Another is not accordingly honored; it is enough if that person feels so to achieve exactly the opposite what is intended by writing the acknowledgement. Each person you ever interacted, each book you ever read, each movie you ever watched formed you to the person you are and so in what you create. Although without personal interaction, the author listened closely when the mighty of their craft spoke to him by their texts written with masterly skills. The author would like to express his deepest gratitude to all who contributed to this work – known and unknowingly. The author's interest in quantum mechanics was awaken by a biography on Max Born[35] bought in a second-hand welfare bookstore. The author is deeply thankful to the person who donated this book.

Klaus Pourvoyeur received his PhD degree in Mechatronics from the Johannes Kepler University of Linz, Austria. Dr. Pourvoyeur works in the field of multi-sensor data-fusion. His interest in general relativity and quantum mechanics is not related in any kind to his profession and the stated opinion is purely personal and not related in any kind to his employer.

[33] Gagnon: *Who cares about particle physics?* p. 139
[34] Susskind, *The Black Hole War*
[35] Greenspan: *Max Born*