Significance of the Number Space and Coordinate System in Physics for Elementary Particles and the Planetary System

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Abstract

The universe can be understood as a set of rational numbers $\mathbb{Q}$. This is to be distinguished from how we see the world, a 3-dimensional space with time. Observations from the past is the subset $\mathbb{Q}^+$ for physics. A system of 3 objects, each with 3 spatial coordinates on the surface and time, is sufficient for physics. For the microcosm, the energy results from the 10 independent parameters as a polynomial $P(2)$. For an observer, the local coordinates are the normalization for the metric. Our idea of a space with revolutions of 2π gives the coordinates in the macrocosm in epicycles. For the observer this means a transformation of the energies into polynomials $P(2\pi)$. c can be calculated from the units meter and day.

$$2\pi\ c\ m\ day = (Earth's\ diameter)^2$$

This formula provides the equatorial radius of the earth with an accuracy of 489 m. Orbits can be calculated using polynomials $P(2\pi)$ and orbital times in the planetary system with $P(8)$. A common constant can be derived from h, G and c with the consequence for H0:

$$hGc^5s^8/m^{10}\sqrt{\pi^4-\pi^2-\pi^{-1}-\pi^{-3}} = 1.00000 \quad H0_{theory} = \sqrt{\pi}hGc^3s^5/m^8$$

$$m_{neutron}/m_e = (2\pi)^4+(2\pi)^3+(2\pi)^2-(2\pi)^1-(2\pi)^0-(2\pi)^{-1}+2(2\pi)^{-2}+ 2(2\pi)^{-4}-2(2\pi)^{-6}+6(2\pi)^{-8} = 1838.6836611$$

$$Theory: 1838.6836611 m_e \qquad measured: 1838.68366173(89) m_e$$

For each charge there is an energy C in $P(\pi)$:

$$C = -\pi + 2\pi^{-1} - \pi^{-3} + 2\pi^{-5} - \pi^{-7} + \pi^{-9} - \pi^{-12}$$

Together with the neutron mass, the result for the proton is:

$$m_{proton} = m_{neutron} + Cm_e = 1836.15267363\ m_e$$

A photon corresponds to two entangled electrons e and e^+, or two coupled neutrinos.

Fine-structure constant:

$$1/\alpha = \pi^4+\pi^3+\pi^2-1-\pi^{-1}+\pi^{-2}-\pi^{-3}+\pi^{-7}-\pi^{-9}-2\pi^{-10}-2\pi^{-11}-2\pi^{-12} = 137.035999107$$

The muon and tauon masses as well as calculations for the inner planetary system are given.

1 Introduction

For a unification of the general theory of relativity (GR) and the quantum theory, it is crucial to work out the essential features of the theories. The fundamental equations of GR are differential equations for the 10 independent

components of the metric [1]. The number of equations is an important criterion for the minimum required parameters for a system of 3 objects, each with 3 spatial coordinates and a common time.
Quantum field theories (QFT) are based on a more fundamental quantum theory and quantum mechanics (QM) and thus on a non-local reality. Bohr postulated the quantization of the angular momentum of the electron with $L = nh/(2\pi)$ [2]. The key idea was to convert the information from the micro world into rotations of 2π for observers in the macro world. Numerous experiments on Bell nonlocality [3] have shown that the inequality for entangled particle pairs is violated, thereby confirming the predictions of quantum mechanics [4, 5, 6, 7, 8].
The quantum information (QI) goes back to C.F. back from Weizsacker. In 1958 he presented his quantum theory of original alternatives [9]. It was an attempt to derive quantum theory as a fundamental theory of nature from epistemological postulates. The information can be output in binary and corresponds to the energy in the micro-world.

The standard model contains at least 18 free parameters. The open questions include: Why are there only three generations of fundamental fermions and why do the fundamental interactions have different coupling strengths? Physics approaches beyond the Standard Model include loop quantum gravity [10,11] and causal fermion systems [12, 13, 14, 15, 16] and attempted to overcome the limitations of physical objects of space and time in favor of the energy and momentum of elementary particles. However, a unification of the 4 natural forces did not succeed.

The GR is perfect for calculating an orbit in the planetary system. The distances between the planets are not yet fixed. For the mean distances there is the empirical formula of the Titius-Bode law [17]. The orbital periods of neighboring planets or moons result - partly approximately, partly quite exactly - from ratios of small whole numbers [18] and also apply to exoplanets [19]. But the problem itself is not solved. In addition, ancient galaxies were found with the James Webb Space Telescope (JWST), which appear to contradict these estimates of the universe of 13.7 billion [20]. The ideas about the formation of planets are to be revised by the discovery of exoplanets the size of Jupiter and the orbital period of only 2 days [21].

2 Physics before General Relativity and the Standard Model

2.1 Nature

Quantum information can be formulated in binary or as a polynomial P(2). The prerequisite can be summarized as follows: nature consists exclusively of ratios, and thus, of rational numbers $\mathbb{Q}$. The first consequence is that there is a primary particle $n = 1$ from which all objects can be built.

2.2 The world as we see it

Every observation in the macro world results from rotations along the geodesic lines with conversion from $P(2)$ to 2π for neutral and with π for charged objects.

$$\text{neutral: } E = P(2\pi), \text{ charges: } E_c = P(\pi)$$

We experience nature through time t and can only compare energies from the past.

$$-t(n+1) < -t(n) < -t(0) = 0 \qquad t \in \mathbb{Q}^+ \qquad n \in \mathbb{N}^+ \tag{2.1}$$

For calculations, the time t(0) = 0 is fictitious and cannot be assigned a value. Physics is always a comparison between two objects and the result is again an object. A system consists of at least 3 objects. For the normalization of meters and seconds, the surface of the earth is set as object O_0.

$$O_i \ i \in \{..., 0, 1, 2, ...\} \tag{2.2}$$

The 4 dimensions $t,\ \varphi,\ r$ and θ are orthograde. Each dimension t, r, φ, θ corresponds to an exponent d

$$d_t = t = 2 \ \ d_\varphi = \varphi = 1 \ \ d_r = r = 0 \ \ d_\theta = \theta = -1$$

For multiple objects i the dimensions follow successively.

$$d_i = d + 4i \text{ e.g. } r_i = r + 4i$$

The prefactors for each exponent or dimension $q_{d,i} \in \mathbb{Z}$ refer to spatial coordinates or time:

$$q_{t,i} \ \ q_{\varphi,i} \ \ q_{r,i} \ \ q_{\theta,i}$$

The number s of the particle starts in the center of the system.

$$s_i = q_{t,i} + q_{\varphi,i} + q_{r,i} + q_{\theta,i} \quad s = \textstyle\sum_i s_i \tag{2.3}$$

At the end of $q_{\varphi,i}$ the object is complete. It corresponds to the surface. A minimum energy means a ground state.

$$\begin{aligned} 1/f_i &= q_{t,i} = q_{\varphi,i} = q_{r,i} = q_{\theta,i} \\ 1/f_{1,2} &= 1/f_1 - 1/f_2 \end{aligned} \tag{2.4}$$

Only the frequency $1/f_{1,2}$ is observable (Fig. 1).

In the universe, the local coordinates move in epicyles (2π). The metric results from the epicycles.

All particles spiral along these geodesic lines and correspond to the energy.

$$Orbit_i(s) = E_i = q_{t,i}(2\pi)^{t+4i} + q_{\varphi,i}(2\pi)^{\varphi+4i} + q_{r,i}(2\pi)^{r+4i} + q_{\theta,i}(2\pi)^{\theta+4i} \tag{2.5}$$

Velocities of the system in epicycles:

$$dOrbit_i(s)/ds = 0 = \dot{q}_{t,i}(2\pi)^{t+4i} + \dot{q}_{\varphi,i}(2\pi)^{\varphi+4i} + \dot{q}_{r,i}(2\pi)^{r+4i} + \dot{q}_{\theta,i}(2\pi)^{\theta+4i} \tag{2.6}$$

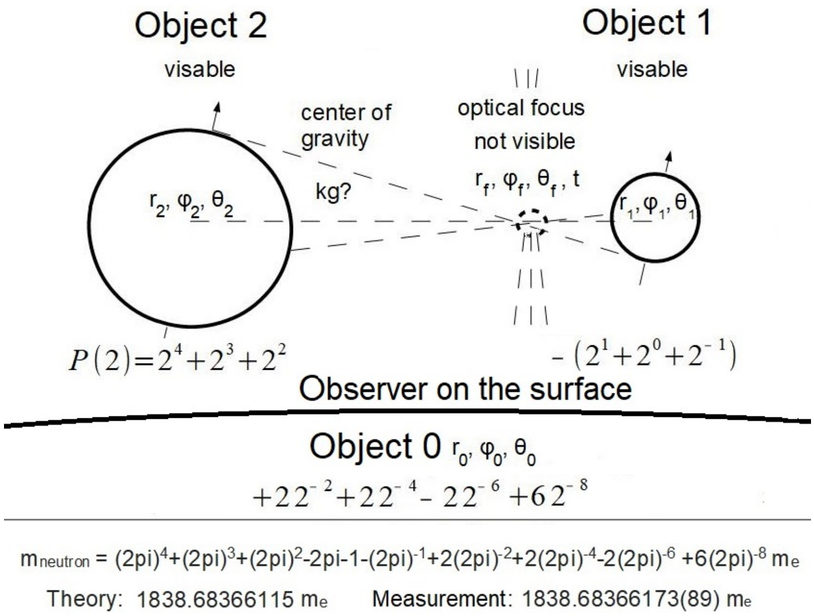

Fig. 1: Transformation of the quantum information $P(2)$ into the energies $P(2\pi)$ using the example of the neutron.

As a number space, the universe as a whole is an incompressible object. The local coordinates are normalized to the surface of an object. For brevity, the formulas can be set up with only the prefactors. The end result is always the energy after transformation into $E = P(2\pi)$.

$$0 = \dot{q}_{t,i} + \dot{q}_{\varphi,i} + \dot{q}_{r,i} + \dot{q}_{\theta,i} \tag{2.7}$$

Within an object, for each dimension d, with $t_{surface} = t_i$:

$$\dot{q}_{d,i}(t) = q_{d,i}(t_{surface,i}) - q_{d,i}(t) \tag{2.8}$$

According to the approach $\mathbb{Q}^+$ half of the particles are invisible. As an example, we just see an extension of the earth into the future and feel that gravity. Particles that move in the direction of the center cannot be recognized and can be called antimatter. Only the superimposition of both matters and becomes kinetic energy $E = T + U$. It is a consequence of the spherical shape of the earth.

$$E_{d,i} = \sum_{t_{i-1}}^{t_i} \dot{q}_{d,i}(t) q_{d,i}(t) \quad E_{d,i}(t_i) = 1/2\ \dot{q}_{d,i}^2 + 1/2\ q_{d,i}^2 \tag{2.9}$$

An observer on the surface of O_0 is assumed for the normalization. Below the surface of O_0 are 3 spatial foci of O_1 and O_2:

$$r_{f,1,2},\ \varphi_{f,1,2},\ \theta_{f,1,2} \text{ with the energies } E_{f,\varphi}\ E_{f,r}\ E_{f,\theta} \tag{2.10}$$

They can be interpreted as diffraction by the surface of O_0. Symmetry points within the system are the surfaces of objects. For a system, the space coordinates s_i can be summarized in a schematic formula.

$$\text{attraction:}\quad E_{d,2}E_{d,1}E_{d,f} = -1/\pi \tag{2.11}$$
$$\text{repulsion:}\quad E_{d,2}E_{d,1}E_{d,f} = 1/\pi \tag{2.12}$$

The temporal focus is $t_{f,1,2}$:

$$E_{t,2}E_{t,1}E_{t,f} = -\pi^{-3} \tag{2.13}$$

The time sequence with 2 loops for O_1 and O_2 for 3 spatial each is to be simulated in a program. Step-by-step calculations of E_f from high to low energies:

$$\begin{aligned}
&for\ i = \varphi_2\ to\ \theta_2\ step - 1 \\
&\quad for\ j = \varphi_1\ to\ \theta_1\ step\ -1 \\
&\qquad E_{f,-i-j-1} = -g_{2,i}g_{1,j}(2\pi)^{-j-i}/\pi \\
&\qquad E_{f,t} = |g_{2,i}g_{1,j}|(2\pi)^{-2\varphi_2} \\
&\quad \text{next} \\
&\text{next}
\end{aligned} \tag{2.14}$$

2 terms with a $E < 0$ and adjacent to a term $0(2\pi)^d$ lead to decay with the creation of a neutrino $1/\pi$.

$$\begin{aligned}
&for\ i = \varphi_2\ to\ \theta_2\ step - 1 \\
&\quad for\ j = \varphi_1\ to\ \theta_1\ step - 1 \\
&\qquad E_{f,-i-j} = -g_{2,i}g_{1,j}(2\pi)^{-j-i} + \pi^{-i-j-1} \\
&\quad \text{next} \\
&\text{next}
\end{aligned} \tag{2.15}$$

Equivalent to the Coriolis force $F = 2m\vec{a} \times \vec{v}$, the relation $\dot{q}_\theta = -\dot{q}_\varphi$ applies on the surface $\dot{q}_r = 0$. The total energy E_f by diffraction of O_1 and O_2 is:

$$E_f = E_{f,\varphi} + E_{f,r} - E_{f,\theta} + E_{f,t} \tag{2.16}$$

All energies must be converted to ecliptic coordinates.

In the QT, the number of parameters for the energy is also 10:

$$\text{OT:}\quad E(t, c, h, G, x, y, z, p_x, p_y, p_z)$$

GR and QM with QFT describe the same facts. Only the interpretation is different.

A summary of the most important formula is in Table 1 in the appendix.

2.3. Neutron

The first example is the calculation of the rest mass of the neutron since it is uncharged. For an object at rest, the derivatives are $\dot{q}_{d,i} = 0$. As a visible object, the energy is $E > 0$ and consists of 2 directly neighboring objects with $E_2 > E_1$. The objects are immediately adjacent. For stationary experiments directly on the surface of O_0, $q_{t,1} = 0$ and $q_{t,2} = 0$. Toward the center, however, the time $E_{f,t}$ is relevant and correct.

$$E_2 = (2\pi)^4 + (2\pi)^3 + (2\pi)^2 \tag{2.17}$$

The smaller object corresponds to an electron and normalizes the energy

$$E_1 = -((2\pi)^1 + (2\pi)^0 + (2\pi)^{-1}) \tag{2.18}$$

The axis of symmetry between the objects with the energies $E_{1,2}$ and E_0 is the surface of Object 0. The appropriate image is the diffraction on the curved surface. The energy E_f in O_0 decreases with the 2nd power, analogous to the law of gravitation. $F = (m_1 m_2)/r^2$. In coordinates of epicycles:

$$E_f = 2(2\pi)^{-2} + 2(2\pi)^{-4} - 2(2\pi)^{-6} + 6(2\pi)^{-8}$$

$$m_{neutron}/m_e = (2\pi)^4 + (2\pi)^3 + (2\pi)^2 - (2\pi)^1 - (2\pi)^0 - (2\pi)^{-1} + 2(2\pi)^{-2} + 2(2\pi)^{-4} - 2(2\pi)^{-6} + 6(2\pi)^{-8} = 1838.6836611 \tag{2.19}$$

$theory: 1838.6836611 m_e$ $\qquad$ $measured: 1838.68366173(89) m_e$ [22]

The descendant digit $m_{neutron}/m_e$ is $(2\pi)^{-8} = 4\ 10^{-7}$ and in the range of the measurement error of 1838.68366173(89).

The calculation required only 10 terms, making it the most efficient method for $m_{neutron}/m_e$. The result is unique like the binary number P(2). It is also unique because of the transcendental number π.

In the macro world, the comparison between the large and small object is visible. In the micro world, matter is separated from antimatter by a parity operator (Fig. 2). The structure of the polynomial can be illustrated using a hall of mirrors. The objects consist of the same particles in three different views.

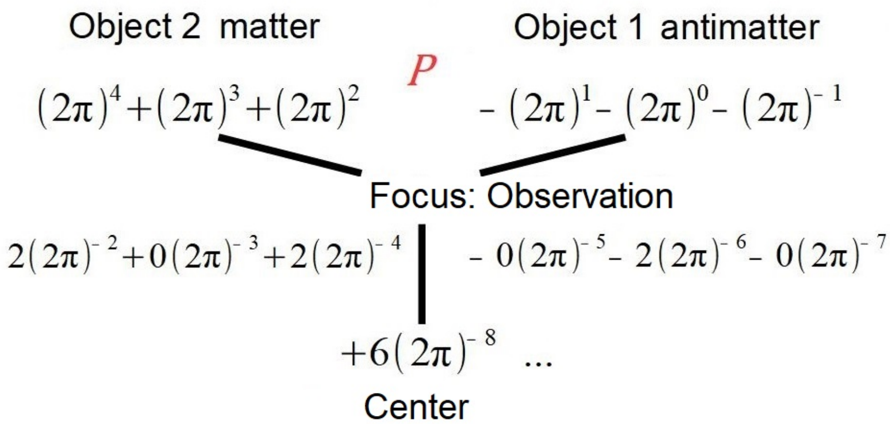

Fig. 2: $m_{neutron}/m_e$ as polynomial $P(2\pi)$

2.4. Neutrinos - Electromagnetic force

The primary particles are polynomials $P(\pi)$ and correspond to the three families of neutrinos.

$$\begin{aligned} Orbit_\varphi &= q_t\pi^t + g_\varphi\pi^\varphi \quad \nu_\tau \\ Orbit_r &= q_t\pi^t + g_r\pi^r \quad \nu_\mu \\ Orbit_\theta &= q_t\pi^t + g_\theta\pi^\theta \quad \nu_e \end{aligned} \tag{2.20}$$

The assignment of the neutrinos results from the energies of the muon (see 2.9.) and tauon decays(see 2.10.). Compared to another object, neutrino oscillations result. The entire wave train $(2\pi)^1 + (2\pi)^0 + (2\pi)^{-1}$ of an electron is in the spatial coordinates $\Delta s_e = 3$. It means an additional dimension compared to a neutrino $P(\pi)$ with $\Delta s_\nu = 4$.

$$E_{d,i} = q_{t,i}\pi^{t+4i} + q_\varphi\pi^{\varphi+4i} + q_{r,i}\pi^{r+4i} + q_{\theta,i}\pi^{\theta+4i} \tag{2.21}$$

Three entangled neurinos result in a charge with the minimum energy:

$$E_{c,1} = -\pi^\varphi + 2\pi^\theta + E_{c,f} = -\pi^1 + 2\pi^{-1} + E_{c,f} \quad \Delta s_\nu = 4 \text{ vs. } \Delta s_e = 3 \tag{2.22}$$

2.5 Proton

The mass difference between neutron and proton already largely corresponds to $E_{c,1} = -\pi^1 + 2\pi^{-1}$ (2.22). There are no neutrinos in O_2. Therefore, in the first step of E_f there is no diffraction, but a transition with spacetime $s_\nu = 4$.

$$E_{c,f} = \pi^{-3} - 2\pi^{-5} + E_{c,f,1} \tag{2.23}$$

The diffraction takes place in the second step to the ground state of two particles in different dimensions and minimal energy. It is the neutrino oscillation:

$$E_{c,f,2} = pi^{-7} - \pi^{-9} + \pi^{-12} \tag{2.24}$$

Together with the neutron mass, the result for the proton is:

$$\begin{aligned} C = E_c &= -\pi^1 + 2\pi^{-1} + \pi^{-3} - 2\pi^{-5} + \pi^{-7} - \pi^{-9} + \pi^{-12} \\ m_{proton} &= m_{neutron} + Cm_e = 1836.15267363\ m_e \end{aligned} \tag{2.25}$$

In Fig. 3, the negative terms on C stand for matter on the left and the positive terms on the right for antimatter.

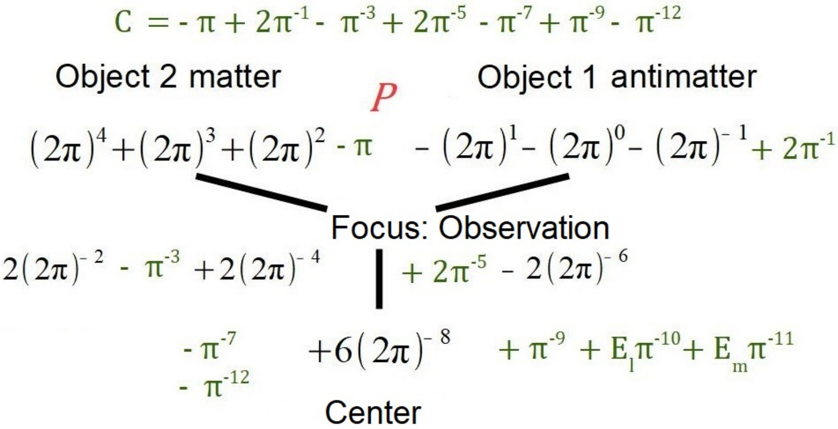

Fig. 3: m_{proton}/m_e as polynomial $P(2\pi)$

$$m_{proton}/m_e = (2\pi)^4+(2\pi)^3+(2\pi)^2-(2\pi)^1-(2\pi)^0-(2\pi)^{-1}+2(2\pi)^{-2}+2(2\pi)^{-4}-2(2\pi)^{-6}+6(2\pi)^{-8}+(-\pi+2\pi^{-1}-\pi^{-3}+2\pi^{-5}-\pi^{-7}+\pi^{-9}-\pi^{-12}) = 1836.15267363 \quad (2.26)$$

$theory : 1836.15267363 m_e$ $\qquad$ $measured : 1836.15267343(11) m_e$ [22]

In the case of the neutron, E_f has several prefactors of 0. C precisely fills these positions with powers of π. The two terms π^{-10} and π^{-11} are the placeholders for the valence electrons. The calculated proton mass corresponds to the measured value.
The $\pm 1/3e$ or $\pm 2/3e$ charges of quarks are explained simply by the fact that there are three objects in a system. Because quarks only exist in the hall of mirrors, they do not exist as free particles either.

2.6 Photon - speed of light

A photon corresponds to two entangled electrons e and e^+, or two coupled neutrinos. The electrons are the objects O_1 and O_2. For each electron i is:

$$Orbit_i(t) = q_{t,i}\pi^{t,i} + q_{\varphi,i}\pi^{\varphi,i} + q_{r,i}\pi^{r,i} + q_{\theta,i}\pi^{\theta,i} \quad (2.27)$$

The cohesion of e and e^+ in the photon results from the minimal energy.

$$Orbit_{1,2} = E_\gamma = t(2\pi)^t + (g_{\varphi,1} - g_{\varphi,2})(2\pi)^\varphi + (g_{r,1} - g_{r,2})(2\pi)^r - 2\pi^\theta \quad (2.28)$$

$$1/f_{1,2} = g_{\varphi,1} - g_{\varphi,2}$$
$$n_{1,2}\lambda_{1,2} = g_{r,1} - g_{r,2}$$
$$2/pi = spin\ 1$$
$$Orbit_\lambda(t) = \Delta t(2\pi)^2 + 1/f(2\pi)^1 + n\lambda - 2/pi \quad (2.29)$$

The speed of light must always be specified relative to another object. The normalization is done on object O_0 with the local coordinates.

$$\dot{g}_{r,0} = 0 \quad t(2\pi)^2 = n\lambda \quad c[m/s] = (2\pi)^2 \quad (2.30)$$

In local coordinates, the energy of the photon is independent of the length of the wave train. $\dot{q}_{d,f}$ is derived from $q_{d,0}$:

$$E_\gamma(t_0) = \Delta t(2\pi)^2 + 1/f(2\pi)^1 + n\lambda - 2/pi \tag{2.31}$$
$$E_{d,0}(t_0) = 1/2\dot{q}^2_{d,f} + 1/2\ q^2_{d,0} \tag{2.32}$$

The geodesic line of the photon is itself a line of symmetry between past and future and the entire object O_0. Diffraction under object 0 corresponds to conservation of torque. c is determined by normalizing with m and s on the surface of O_0.

$$M_\gamma = 2\pi \qquad \dot{q}^2_{d,f} = q^2_{d,0} \tag{2.33}$$

$$2\pi\ c\ m\ day = (earth's\ equatorial\ diameter)^2 \tag{2.34}$$

Orbits can be calculated using polynomials $P(2\pi)$.

Sidereal orbital times in the planetary system can be calculated with $P(8)$. The synodic orbital times are based on the center of a system and thus on the ecliptic coordinates.

The vacuum $Object_V$ is not visible. It is the connection between two visible objects O_2 and O_0 with maximum wavelength λ_V, minimum frequency f_V and spin 1.

$$\lambda_V = g_{r,2} - g_{r,0} \quad 1/f_V = g_{\varphi,2} - g_{\varphi,0} \quad spin\ 1 = 2/\pi \tag{2.35}$$

The vacuum consists of three spatial dimensions $\Delta d_V = 3$ and the time t: $s_V = 4$. The energy E_V is the vacuum energy (T + U) after

$$Orbit_V = E_V = t(2\pi)^t + 1/f(2\pi)^\varphi + \lambda_V(2\pi)^\lambda - 2/pi = -c^2 \tag{2.36}$$

Thus the universe is in equilibrium between vacuum and visible mass.

$$0 = E_V + E_M = E_V + mc^2 \tag{2.37}$$

The interaction between two entangled and thus immediately adjacent photons results solely from angular momentum. This applies to all the entangled objects.

2.7. Fine-structure constant

The following considerations regarding the fine-structure constant are speculative for the time being. α is the ratio of energies between the electron orbits. The general rule for an electron is:

$$E_{e,1} = t(\pi)^t + 1/f_1(\pi)^\varphi + \lambda_1(\pi)^\lambda - 1/pi. \tag{2.38}$$

For the minimum energy in the electron itself, $1/f_1 = 0$ applies.

$$E_{e,1} = 0\pi^2 + 0 + 1 - 1/pi \tag{2.39}$$

For a free electron, $E_{e,2}$ is adjacent with the lowest possible energy. This is not visible.

$$E_{e,2} = \pi^4 + \pi^3 + \pi^2 \tag{2.40}$$

For E_f in O_0 the first step is a transition with spacetime $\Delta s\nu = 4$.

$$E_{e,f,1} = \pi^{-2} - \pi^{-3} \tag{2.41}$$

Symmetric to $E_{e,2}$ there are no neutrinos in the range π^{-4} to π^{-6} The second step is the defraction.

$$E_{e,f,2} = \pi^{-7} - \pi^{-9} \tag{2.42}$$

The third step is a neutrino oscillation.

$$E_{e,f,3} = -2/pi^{-10} - 2/pi^{-11} - 2/pi^{-12} \tag{2.43}$$

Combined, $1/\alpha$ results in energy from the ratios with the polynomial $P(\pi)$ (Fig. 4).

$$E_\alpha = 1/\alpha = \pi^4+\pi^3+\pi^2-1-\pi^{-1}+\pi^{-2}-\pi^{-3}+\pi^{-7}-\pi^{-9}-2\pi^{-10}-2\pi^{-11}-2\pi^{-12} \tag{2.44}$$

$theory$: 137.035999107m_e $measured$: 137.035999206(11)m_e [18]

The discrepancy to the measured value is π^{-14}. For this further considerations for the continuation of the series $E_{e,f}$ are necessary.

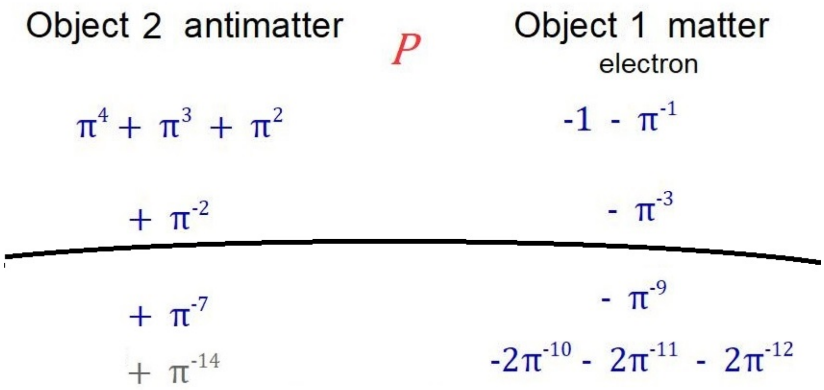

Fig. 4: Fine-structure constant as polynomial $P(\pi)$

2.8 Hydrogen atom

The three-fold polynomial $\pi^4 + \pi^3 + \pi^2$ disappears upon binding of the electron to the proton (Fig. 5). In particular, the ratios of $1/\pi$ are interesting. They describe the spin. Without interaction, the sum was $2/\pi$. After flipping the spin, the energy decreases to $-3/(2\pi)$. Using the rules described above, the mass of the hydrogen atom can be determined. The mass of the hydrogen atom is only known in five digits.

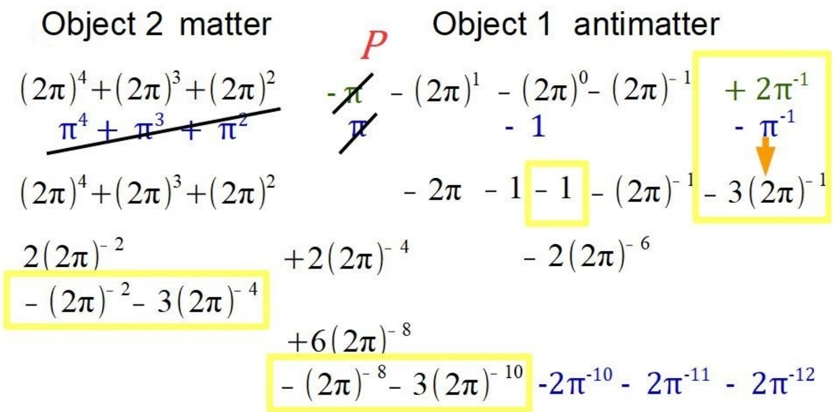

Fig. 5: $m_{hydrogenatom}/m_e$ as polynomial $P(2\pi)$

$$m_H/m_e = (2\pi)^4 + (2\pi)^3 + (2\pi)^2 - (2\pi)^1 - 2 - (2\pi)^{-1} - 3(2\pi)^{-1} + 2(2\pi)^{-2}+ 2(2\pi)^{-4} - 2(2\pi)^{-6} + 6(2\pi)^{-8} - (2\pi)^{-2} - 3(2\pi)^{-3} - (2\pi)^{-8} - 3(2\pi)^{-9} \quad (2.45)$$

$theory: 1837.179 m_e$ $\quad$ $measured: 1837.180 m_e$ $\quad$ $(1.00784–1.00811)u$ [18]

2.9 Muon

The muon consists of 2 particles, each with a triple polynomial. As a charged particle, it contains the Energy E_C.

$$E_{\mu,2} = (2\pi)^3 - (2\pi)^2 + (2\pi)^1 \qquad E_{\mu,1} = -(2\pi)^1 + (2\pi)^0 - (2\pi)^{-1} \quad (2.46)$$
$$E_C = -\pi + 2\pi^{-1} - \pi^{-3} + 2\pi^{-5} - \pi^{-7} + \pi^{-9} - \pi^{-12}$$

The space coordinates of E_2 and E_1 are transformed into $E_{f,space}$ by diffraction at the symmetry point $1/\pi$. 2 entangled terms of E_2 and E_1 lead to a term $2(2\pi)^d$ with the minimum energy. For the time these are summarized to $E_{f,t}$.

Step-by-step calculations of E_f from high to low energies (2.14):

$for\ i = \varphi_2\ to\ 2\ step\ -1$ (2.47)
  $for\ j = \varphi_1\ to\ -1\ step\ -1$
    $E_{f,-i-j-1} = -g_{2,i}g_{1,j}(2\pi)^{-j-i}/\pi$
    $E_{f,t} = |g_{2,i}g_{1,j}|(2\pi)^{-2\varphi_2}$
  next
next

2 terms with a $E < 0$ and adjacent to a term $0(2\pi)^d$ lead to decay with the creation of a neutrino $1/\pi$.

$$
\begin{aligned}
&for\ i = \varphi_2\ to\ 2\ step - 1 \\
&\quad for\ j = \varphi_1\ to\ -1\ step\ \text{-1} \\
&\qquad E_{f,-i-j} = -g_{2,i} g_{1,j} (2\pi)^{-j-i} + \pi^{-i-j-1} \\
&\quad \text{next} \\
&\text{next}
\end{aligned} \tag{2.48}
$$

One of the possible decays of the muon:

$$
\begin{aligned}
E_{nu,1,2} &= 0(2\pi)^4 + (2\pi)^3 - (2\pi)^2 + (2\pi)^1 - ((2\pi)^1 - (2\pi)^0 + (2\pi)^{-1}) \\
&(2\pi)^3(-2\pi)^1 >> E_{nu,f,1} = (2\pi)^{-4}/\pi = 2(2\pi)^{-5}
\end{aligned} \tag{2.49}
$$

$$
\begin{aligned}
E_{nu,1,2,-1} &= 0(2\pi)^4 - (2\pi)^2 + (2\pi)^1 - ((-2\pi)^0 + (2\pi)^{-1}) \\
&(2\pi)^1(2\pi)^0 >> E_{nu,f,2} = (2\pi)^{-1}/\pi = -2(2\pi)^{-2}
\end{aligned} \tag{2.50}
$$

Production of the neutrinos:

$$
\begin{aligned}
E_{nu,1,2,-2} &= 0(2\pi)^4 - (2\pi)^2 - ((2\pi)^{-1}) \\
&-(2\pi)^2(-2\pi)^{-1} >> E_{nu,f,3} = -(2\pi)^{-3} - 1/\pi = -(2\pi)^{-3} - \overline{\nu}_e
\end{aligned} \tag{2.51}
$$

$$
\begin{aligned}
&E_{nu,1,2,-3} = 0(2\pi)^4 \\
&\text{Transformation into } (2\pi)^{-4} \text{ and neutrinos and then to an electron.} \\
&E_{nu,1,2,-3} = 0(2\pi)^4 >> E_{nu,f,4} = -(2\pi)^{-4} + \pi^{-1} + \pi^{-2} + \pi^{-3} = \\
&\qquad -(2\pi)^{-4} + \pi^{-1}(\pi^0 + \pi^{-1}) + \pi^{-3} = \\
&\qquad -(2\pi)^{-4} - E_e e + \nu_\mu \qquad (2.52) \\
&\qquad \pi^{-1} \text{ corresponds to the energy } E_e \text{ the electron}
\end{aligned}
$$

In summary, the decay process and the rest mass of the neutron are:

$$\mu^- = e^- + \overline{\nu}_e + \nu_\mu$$

$$
\begin{aligned}
m_\mu/m_e = {} & (2\pi)^3 - (2\pi)^2 + (2\pi)^1 - (2\pi)^1 + 1 - (2\pi)^{-1} \\
& -E_e e - \overline{\nu}_e + \nu_\mu + 2(2\pi)^{-2} - (2\pi)^{-3} - (2\pi)^{-4} - 2(2\pi)^{-5} + 4(2\pi)^{-8} \\
& -\pi + 2\pi^{-1} - \pi^{-3} + 2\pi^{-5} - \pi^{-7} + \pi^{-9} - \pi^{-12} = 206.7682833
\end{aligned} \tag{2.53}
$$

$theory : 206.7682833 m_e$ $\qquad$ $measured : 206.7682830(46) m_e$

2.10. Tauon

A tauon consists of many particles, as seen from the numerous decay channels. Any polynomial with base 2π could correspond to a primary particle. The more complex the polynomial is, the faster the particle decays. The first particle with the factor $(2\pi)^4$ is the proton. The tauon should therefore have the factor $2(2\pi)^4$ and thus indicates a particle that is composed of at least 3 objects.

$$E_{\tau,3} = 2(2\pi)^4 + 2(2\pi)^3 - 2(2\pi)^2 \qquad E_{\tau,2} = -(2\pi)^2 - (2\pi)^1 - 1$$
$$E_{\tau,1} = -2\pi - 1 - (2\pi)^{-1}$$

Along with $E_C = -\pi + 2\pi^{-1} - \pi^{-3} + ...$, the first estimate is:

$$m_\tau = 2(2\pi)^4 + 2(2\pi)^3 - 3(2\pi)^2 - 2(2\pi)^1 - 2 - (2\pi)^{-1} + (-\pi + 2\pi^{-1} - \pi^{-3})m_e = 3477.34m_e \quad (2.54)$$

$$theory : 3477.34m_e \qquad measured : 3477.23m_e \text{ [22]}$$

2.11 Gravitational constant - Planck constant

The unit kg is not required in this theory. The simplest system for calculating the common constant G h consists of 2 neutrinos π^φ and π^θ with energy E_2, compared to 2 neutrinos in $E_{1,0}$

$$E_2 = \pi^4 - \dot{g}_{r,2}\pi^3 - pi^2 \qquad E_{1,0} = \pi^{-1} - \dot{g}_{r,0}\pi^{-2} - pi^{-3} \quad (2.55)$$

According to the ratio $\Delta s_\nu = 4$ to $\Delta s_e = 3$ (2.22), the entire wave train is complete with the symmetry point of $1/\pi$.

$$E_{2,1,0} = \pi^4 - \pi^2 - \pi^{-1} - \pi^{-3} \quad (2.56)$$

$d_{r,2} - d_{r,0} = 5$ correspond to 5 spacetime dimensions. A common constant can be derived from h, G and c zusammen mit (2.30), (2.34) (2.36):

$$hGc^5s^8/m^{10}\sqrt{\pi^4 - \pi^2 - \pi^{-1} - \pi^{-3}} = 0.999991 \quad (2.57)$$

The units of meters and seconds must appear in this formula. The value of G is only known up to the fifth digit. In this respect, the result can be assumed to be 1. h and c are already exactly defined. The only parameter left to be determined by measurement is G. The only force holding the world together are natural numbers.

2.12. H0 and the gravitational constant

With the assumption of $\mathbb{Q}^+$ the expansion of the universe is already given. Diffraction of the epicycles for the objects O_0 to O_2 were performed with π^{-1}. $\sqrt{\pi}$ is to be assumed for the expansion of the universe as a whole. With the conversion into the units m and s, the minimum energy is $E_{min} = \sqrt{\pi}/c^2$. According to (2.55) it follows for the expansion of the universe:

$$H0_{theory} = hGc^5s^8/m^{10}\sqrt{\pi}/c^2 = \sqrt{\pi}hGc^3s^5/m^8 = 2.13\ 10^{-18}/s \quad (2.57)$$
$$\text{Measurement: } H0 = 2.1910^{-18}/s$$

All interactions are thus the result of the expansion of the universe. In this theory, the universe is infinite. We see half of the universe with snapshots of all possible states filtered to our idea of a curved, 3-dimensional world.

3 Planetensystem

3.1. Sun - Earth - Moon

The Sun, Earth and the bound Moon have a stable ratio of radii and orbits and largely correspond to a ground state. Earth and moon are quantized. With the reduced mass we get:

$$R_{Moon}/(R_{Earth} + R_{Moon}) = 2^3/(2\pi) = 4/\pi \tag{3.1}$$

Calculated: $R_{Moon} = 6356.75\ km\ (4/\pi - 1) = 1736.9$ km related to the pole diameter. The rel. deviation is 1.00011.

3.2. Calculations of the orbits in the planetary system

The solar system can be viewed as an atom. The advantage of the solar system is that the apoapsis and periapsis are directly observable, while in the atom, some energy levels are degenerate. The apoapsis and periapsis can be determined using the same polynomials as those used in atomic physics.

The center is t_{Focus}. Due to its higher energy, the Sun orbits Mercury. The large solar radius leads to a clear difference between the apoapsis and periapsis of Mercury's orbits. This smallest possible focus is orbited by Venus, leading to a nearly circular orbit. A static image was sufficient to calculate the periapsis and apoapsis (Tab. 1). As with ladder operators, orbits can be iteratively constructed. The energies in a planetary system result as a polynomial $P(2\pi)$. According to (2.30),(2.34) and (2.37) the radii are proportional to the square root of the total energy.

$$E_n = (2\pi)^5 g_{r,n} + (2\pi)^4 g_{\varphi,n} + (2\pi)^3 g_{\theta,n} - ((2\pi)^2 g_{r,n-1} + 2\pi g_{\varphi,n-1} + g_{\theta,n-1}) \tag{3.2}$$

With the normalization to $r_{sun} = 696342km$ the orbits follow:

$$r_{apo/periasis} = r_{sun}\sqrt{E_n} \tag{3.3}$$

The first three terms already result in apoasis and periasis with an accuracy of approximately 1‰ :

Mercury

$$r_{apoapsis} = 696342km\sqrt{32/2\ \pi^5 - 16/2\ \pi^4 + 8\pi^3} = 46006512km$$
$$measure:\ 46.002\ 10^6 km\ \ rel.deviation = 0.0001$$

$$r_{periapsis} = 696342km\sqrt{32\pi^5 - 0 * 16\pi^4 + 8\pi^3} = 69775692km$$
$$measure:\ 69.81\ 10^6 km\ \ rel.deviation = 0.0005$$

Venus

$$r_{apoapsis} = 696342km\sqrt{2 * 32\ \pi^5 + 3 * 16\ \pi^4 - 8\pi^3} = 107905705km$$
$$measure:\ 107.4128\ 10^6 km\ \ rel.deviation = 0.004$$
$$r_{periapsis} = 696342km\sqrt{2 * 32\pi^5 + 3 * 16\pi^4 + 8\pi^3} = 109014662km$$
$$measure:\ 108.9088\ 10^6 km\ \ rel.deviation = 0.001$$

Tab. 1: Apoapsis and periapsis of Mercury and Venus (3.4)

$$r_{Venus}/r_{Mercury} = 6123.80/2448.57 = 2.50094$$
$$(6123.80 - 2448.57)/2448.57) = 3/2 \qquad (3.5)$$

The ratios of the radii of Mercury and Venus are quantum numbers.

3.2. Orbital periods in the planetary system

For the three spatial dimensions, $2^3 = 8$ is the natural ratio between the rotations/orbital periods of the celestial bodies. The orbital times of the planets iteratively result from the sun, mercury, and their focus. These calculations are always without π, but are polynomials in the same manner. The factor $\frac{1}{2}$ leads to the relative speed in each case (Tab. 1). These orbital periods complement those of observations on the Titius-Bode law [17].

Orbital period of Mercury relative to the Sun's rotation of 25.38 d
$25.38\ d\ \ 1/2(8 - 1 - 1/2/8)\ d\ = 88.04\ d$ measured: 87.969 d

Orbital period of the venus:
$1/2(8^3 - 8^2 + 0 * 8 + 1)\ d\ = 224.5d$ measured: 224.70 d

Orbital period of the earth:
$1/2(8^3 + 3(8^2 + 8 + 1))\ d\ = 365.5\ d$ measured: 365.25 d

Orbital period of the moon:
$1/2(8^2 - 8^1 - 1)\ d\ = 27.5\ d$ measured: 27.322 d

Orbital period of the mars with two moons:
$1/2 * (3\ 8^3 - 3(8^2 - 8 - 2))\ d\ = 687\ d$ measured: 686.98 d

Tab. 1: Orbital period in the planetary system in P(8) (3.6)

Summary and conclusions

Exact predictions for the masses of elementary particles result solely from the assumption of rational numbers in the universe with the physics of $\mathbb{Q}^+$. Spatial dimensions and time are a consequence of our idea of rotations in space. The simplest possible world sets the parity operator between two objects on three spatial dimensions. The primary particles are the neutrinos with the 3 families. The epicyclic coordinates are derived from the local dimensions with the units m and s and result in the energies as polynomials $P(\pi)$ and $P(2\pi)$. The rest mass of the neutron $m_{neutron}$ relative to the electron is a $P(2\pi)$ with the ten minimum required terms and an accuracy of 10 digits. In a rational space, a photon has a beginning and an end through immediately adjacent e^+ and e^-, or neutrinos. This theory enables the calculation the fine structure constant and the ratio of the gravitational constant to Planck constant with a common constant $hGc^5s^8/m^{10}\sqrt{\pi^4 - \pi^2 - \pi^{-1} - \pi^{-3}} = 1.00000$. c follows from the normalization the local units with m and s to $2\pi\ c\ m\ day = (Earth's\ diameter)^2$. To this theory, the universe is infinite. We see half the universe with snapshots of all possible states, filtered by our idea of a curved, three-dimensional world $H0_{theory} = \sqrt{\pi}hGc^3s^5/m^8$.

GR and QM with QFT describe the same facts. Only the interpretation is different.

$P(2\pi)$ show a way beyond QM and GR and enable further insights into the planetary system. If all properties of matter can be calculated with a single polynomial, this could lead to new approaches in physics.

Appendix:

Table 1: Compilation of the essential formula

Physics before the Standard Model

Nature consists of indivisible primal particles	$\mathbb{N}$
Numberspace in Nature	$\mathbb{Q}$
Physics only affects the past	$\mathbb{Q}^+$
The information from Nature is the Energy, binary	polynomial P(2)
Man-made: how we see the world	
Each observation is treated as a rotation in the macro world. Transformation of $P(2)$ into π $E =$	$P(\pi)$, neutral $P(2\pi)$
A system consists of at least 3 objects:	O_i $i \in \{..., 0, 1, 2, ...\}$
The 4 dimensions t, φ, r and θ are orthograde	
Each dimension t, r, φ, θ corresponds to an exponent d	$d_t = t = 2$ $d_\varphi = \varphi = 1$
	$d_r = r = 0$ $d_\theta = \theta = -1$
For multiple objects i:	$d_i = d + 4i$ e.g. $r_i = r + 4i$
$q_{d,i} \in \mathbb{Z}$ for Dimensions d	$q_{t,i}$ $q_{\varphi,i}$ $q_{r,i}$ $q_{\theta,i}$
$s \in \mathbb{N}$ starts in the center of the system $s = \sum_i s_i$	$s_i = q_{t,i} + q_{\varphi,i} + q_{r,i} + q_{\theta,i}$
Completed object, neutral, ground state, frequency f :	$1/f_i = q_{t,i} = q_{\varphi,i} = q_{r,i} = q_{\theta,i}$
Orbit in epicyles (2π) $Orbit_i(s) = q_{t,i}(2\pi)^{t+4i} +$	$q_{\varphi,i}(2\pi)^{\varphi+4i} + q_{r,i}(2\pi)^{r+4i} + q_{\theta,i}(2\pi)^{\theta+4i}$
velocity: $dOrbit_i(s)/ds = 0 = \dot{q}_{t,i}(2\pi)^{t+4i} +$	$\dot{q}_{\varphi,i}(2\pi)^{\varphi+4i} + \dot{q}_{r,i}(2\pi)^{r+4i} + \dot{q}_{\theta,i}(2\pi)^{\theta+4i}$
incompressible object, normalization:	$\dot{q}_{t,i} = \dot{q}_{\varphi,i} + \dot{q}_{r,i} + \dot{q}_{\theta,i}$
Within an object, for every dimension d, $t_{surface} = t_i$:	$\dot{q}_{d,i}(t) = q_{d,i}(t_{surface,i}) - q_{d,i}(t)$
$E = T + U$ of object $E_{d,i} = \sum_{t_{i-1}}^{t_i} \dot{q}_{d,i}(t) q_{d,i}(t)$	$E_{d,i}(t_i) = 1/2\ \dot{q}_{d,i}^2 + 1/2\ q_{d,i}^2$
Observer is on the surface of O_0	
under the surface of O_0, 3 spatial foci $r_{f,1,2}$, $\varphi_{f,1,2}$, $\theta_{f,1,2}$	$E_{f,\varphi}$ $E_{f,r}$ $E_{f,\theta}$
Symmetry points in a system are the surfaces of objects	attraction: $E_{s,2}E_{s,1}E_{s,f} = -1/\pi$
	repulsion: $E_{s,2}E_{s,1}E_{s,f} = 1/\pi$
In the center is the temporal focus $t_{f,1,2}$	$E_{t,2}E_{t,1}E_{t,f} = -\pi^{-3}$
Corioslis force $F = 2m\vec{w} \times \vec{v}$, equivalent on the surface	$\dot{q}_r = 0$ $\dot{q}_\theta = -\dot{q}_\varphi$
Energy of O_1 and O_2 by diffraction in O_0 $E_f =$	$E_{f,\varphi} + E_{f,r} - E_{f,\theta} + E_{f,t}$
Gravity in the system neutron - Earth:	$\dot{q}_{t,1} = \dot{q}_{t,2} = 0$ visable $E > 0$
Elektron, normalization $E_{t,1} = 3(2\pi)^2$ $E_1 =$	$-((2\pi)^1 + (2\pi)^0 + (2\pi)^{-1})$
compared to adjacent object 2 $E_{t,1} = 3(2\pi)^5$ $E_2 =$	$(2\pi)^4 + (2\pi)^3 + (2\pi)^2$
Diffraction at the surface of Object 0 $E_f =$	$E_{f,\varphi} + E_{f,r} - E_{f,\theta} + E_{f,t}$
Neutron: $E_n = E_2 + E_1 + E_f$ $m_{neutron}/c^2 =$	$(2\pi)^4 + (2\pi)^3 + (2\pi)^2 -$
	$((2\pi)^1 + (2\pi)^0 + (2\pi)^{-1}) +$
	$2(2\pi)^{-2} + 2(2\pi)^{-4} - 2(2\pi)^{-6} + 6(2\pi)^{-8}$

Physics before the Standard Model Neutrino - Photon - Gravity

The primary particles correspond to $P(\pi)$ $E_{d,i} =$	$q_{t,i}\pi^{t+4i} + q_\varphi \pi^{\varphi+4i} + q_{r,i}\pi^{r,i} + q_{\theta,i}\pi^{\theta+4i}$
Three families of neutrinos:	$Orbit_\varphi = q_t\pi^t + g_\varphi \pi^\varphi$
	$Orbit_r = q_t\pi^t + g_r\pi^r$
	$Orbit_\theta = q_t\pi^t + g_\theta\pi^\theta$
electromagnetic force, energy of the charge: $E_c =$	$-E_{c,1} + E_{c,f}$
3 Neutrions are required with minimal energy $E_{c,1} =$	$-\pi^\varphi + 2\pi^\theta$
no particle in O_2 >> no diffraction the first step	
transition with timespace $\Delta s = 4$ $E_{c,f,1} =$	$\pi^{-3} - 2\pi^{-5} + E_{c,f,2}$
Diffraction with neutrion oscillation $E_{c,f,2} =$	$+\pi^{-7} - \pi^{-9} + \pi^{-12}$
Proton: $E_p = E_n + E_{c,1} + E_{c,f,1} + E_{c,f,2}$ $E_p =$	$E_n - \pi^\varphi + 2\pi^\theta +$
	$\pi^{-3} - 2\pi^{-5} +$
	$\pi^{-7} - \pi^{-9} + \pi^{-12}$
Photon corresponds 2 entangled electrons e and e^+	
For each electron i $Orbit_i(t) = q_{t,i}(\pi)^t +$	$q_{\varphi,i}(\pi)^{\varphi,i} + q_{r,i}(\pi)^{r,i} + q_{\theta,i}(\pi)^{\theta,i}$
entangled Electrons $Orbit_i(t) = \Delta t(2\pi)^t +$	$\Delta g_{\varphi,1,2}(2\pi)^\varphi + \Delta g_{r,1,2}(2\pi)^r + 2/\pi$
438	$1/f_{1,2} = g_{\varphi,1} - g_{\varphi,2}$
	$n_{1,2}\lambda_{1,2} = g_{r,1} - g_{r,2}$
	$spin\ 1 = 2(\pi)^\theta = 2/pi$
Photon $Orbit_\lambda(t) = \Delta t(2\pi)^2 +$	$1/f(2\pi)^1 + n\lambda + 2/\pi$
speed of light relativ to Object 0 and $\dot{g}_{r,0} = 0$	$t(2\pi)^2 = n\lambda$
in local coordinates with m and s is c:	$c = (2\pi)^2 m/s$
at time $t_0 = 0$ and $\dot{g}_{r,0} = 0$: $E_\gamma(t_0) =$	$t(2\pi)^2 + 1/f(2\pi)^1 + n\lambda - 1/pi$
	$E_{d,0}(t_0) = 1/2\ \dot{q}_{d,0}^2 + 1/2\ q_{d,0}^2$
Geodesic line of the photon is the symmetry line	$M_\gamma = 2\pi\ \ \dot{q}_{\theta,0}^2 = q_{\theta,0}^2$
$D_\theta = D_{Earth} = equatorial\ diameter$	$2\pi\ c\ m\ day = D_{Earth}^2$
G h of two neutrion in a neutron on the object 0	$E_\nu = \pi^4 - \pi^2$
with $\dot{g}_{r,0} = 0$ and diffraction with minimal energy	$E_0 = -\pi^{-1} - \pi^{-3}$
A common constant can be derived from h, G and c:	$hGc^5 s^8/m^{10}\sqrt{\pi^4 - \pi^2 - \pi^{-1} - \pi^{-3}} =$
	$= 0.999991$
Diffraction of the universe with $E_{min} = \sqrt{\pi}/c^2$	$H0_{theory} = \sqrt{\pi} hGc^3 s^5/m^8$

REFERENCES

[1] Einstein, A ”The Foundation of the General Theory of Relativity”. Annalen Phys. 49 (1916) 7, 769-822.

[2] Haken, H and Wolf H.C. ”Atomic and Quantum Physics” 1987, ISBN : 978-3-540-17702-9, pp. 105-108

[3] Bell, JS: ”On the Einstein Podolsky Rosen Paradox.” In: Physics. Volume 1, No. 3, (1964), pp. 195–200 (cern.ch [PDF]).

[4] Hensen B, Bernien H., Hanson R. et al.: Experimental loophole-free violation of a Bell inequality using entangled electron spins separated by 1.3km. In: Nature. Volume 526, (2015), pp. 682–686, arxiv:1508.05949.

[5] Giustina M, Versteegh, MA, Zeilinger A. et al.: Significant-Loophole-Free Test of Bell’s Theorem with Entangled Photons. In: Phys. Rev. Lett. Volume 115, (2015), p. 250401, arxiv:1511.03190.

[6] Shalm LK, Meyer-Scott, E, Sae Woo Nam et al.: Strong Loophole-Free Test of Local Realism. In: Phys. Rev. Lett. Volume 115, (2015), p. 250402, arxiv:1511.03189.

[7] Li J. et al. ”All-optical synchronization of remote optomechanical systems,” Phys. Rev. Lett. 129, 063605 (2022).

[8] Tomm, N., Mahmoodian, S., Antoniadis, N.O. et al. Photon bound state dynamics from a single artificial atom. Nat. Phys. (2023). https://doi.org/10.1038/s41567-023-01997-6

[9] von Weizsäcker C. F.: ”Complementarity and Logic. II. The Quantum Theory of the Simple Alternative.” Journal of Natural Research 13a (1958) 245-253

[10] C. Rovelli, Quantum Gravity (Cambridge University Press Cambridge, MA, 2005).

[11] C. Rovelli, Living Rev. Relativ. 11, 5 (2008).

[12] Finster, F. ”The Principle of the Fermionic Projector”. Providence, R.I: American Mathematical Society. ISBN 978-0-8218-3974-4. OCLC 61211466.(2006) Chapters 1-4Chapters 5-8Appendices

[13] Finster, F. ”Entanglement and second quantization in the framework of the fermionic projector”. Journal of Physics A: Mathematical and Theoretical. 43 (39): 395302 (2010). arXiv:0911.0076. Bibcode:2010JPhA...43M5302F. doi:10.1088/1751-8113/43/39/395302. ISSN 1751-8113. S2CID 33980400.

[14] Finster, F. ”Perturbative quantum field theory in the framework of the fermionic projector”. Journal of Mathematical Physics. (2014) 55(4):042301.arXiv:1310.4121.

Bibcode:2014JMP....55d2301F. doi:10.1063/1.4871549. ISSN 0022-2488. S2CID 10515274.

[15] Finster, F., Grotz, A. and Schiefeneder, D. "Causal Fermion Systems: A Quantum Space-Time Emerging From an Action Principle". Quantum Field Theory and Gravity. Basel: Springer Basel. (2012) pp. 157–182. arXiv:1102.2585. doi:10.1007/978-3-0348-0043-3-9. ISBN 978-3-0348-0042-6. S2CID 39687703.

[16] Finster, F. and Kleiner J. "Noether-like theorems for causal variational principles". Calculus of Variations and Partial Differential Equations. (2016) 55(2):35.arXiv:1506.09076. doi:10.1007/s00526-016-0966-y. ISSN 0944-2669. S2CID 116964958.

[17] Nieto, M(1972). The Titius–Bode Law of Planetary Distances. Pergamon Press.

[18] Dermott S. F. "On the origin of commensurabilities in the solar system", Monthly Notices Roy. Astron. Soc., Band 141, (1968), S. 349, 363

[19] Bovaird T, Lineweaver C, "Exoplanet predictions based on the generalized Titius–Bode relation", Monthly Notices Royal Astron. Soc., Band 435, (2013), S. 1126–1139

[20] Labbé, I., van Dokkum, P., Nelson, E. et al. A population of red candidate massive galaxies 600 Myr after the Big Bang. Nature 616, 266–269 (2023). https://doi.org/10.1038/s41586-023-05786-2

[21] Gáspár, A., Wolff, S.G., Rieke, G.H. et al. Spatially resolved imaging of the inner Fomalhaut disk using JWST/MIRI. Nat Astron 7, 790–798 (2023). https://doi.org/10.1038/s41550-023-01962-6

[22] CODATA Task Group on Fundamental Constants: CODATA Recommended Values. National Institute of Standards and Technology, accessed November 22, 2022 (English)

Opinions and Statements

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