Calculation of the rest masses of neutron and proton by polynomials with base π in relation to the electron

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Abstract

Nature 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 and Physics is the subset $\mathbb{Q}^+$. As described in the general relativity, 10 independent equations are required. The micro world also requires these ten parameters in quanta. This allows the description and simulation of nature as a polynomial of ten parameters $P(2)$. Imagining a space with revolutions of 2π provides the basis for polynomials at $P(2\pi)$. E.g.

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

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

For charged objects, the charge operator C results 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:

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

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 ratios of energies are raw natural data. The length and time are derived values. The calculations go beyond quantum theory and general relativity. E.g.

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

This formula provides the equatorial radius of the earth with an accuracy of 489 m. From the details of the radius and rotation of the sun, the radii and, orbits can be calculated using polynomials $P(2\pi)$ and orbital times in the planetary system with $P(8)$.

1 Introduction

To calculate the rest mass of elementary particles, unification of the general theory of relativity (GR) and quantum theory is required. It is crucial to extract 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 two objects and one observer.
Quantum field theories are based on 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.
The quantum information (QI) goes back to C.F. from Weizsäcker. In 1958 he presented his quantum theory of original alternatives [3]. This was an attempt to derive quantum theory as a fundamental theory of nature from epistemological postulates. The information can be output in binary form.
The common basis of GR, QM and QI leads back to Hilbert's 6th problem in 1900, whether and how physics can be axiomatized [4]. However, this problem is only been partially solved. Kolmogorov's (1933) axiomatics are considered the standard of statistical physics [5]. The beginning of physics must be the definition of the number space in nature.

The hypothesis is: Nature consists of relations and the number space is $\mathbb{Q}$. Physics is always a comparison between 2 objects and an observer and only affects the past with $\mathbb{Q}^+$. Energies are ratios and require a total of nine parameters for the three spatial dimensions, together with time this results in 10. The information from the micro-world is binary and can be formulated as a polynomial P(2) The information from the micro world is binary and can be formulated as a polynomial $P(2)$. Every observation in the macro world leads to a transformation from the polynomial $P(2)$ to $P(2\pi)$.

2 Background

2.1 Nature

There are numerous examples of rational numbers in nature, such as the Fibonacci series in biology [6]. Numerous experiments on Bell nonlocality [7] have shown that the inequality for entangled particle pairs is violated, thereby confirming the predictions of quantum mechanics [8, 9, 10, 11, 12]. For an observer, the results can be reduced to rational numbers. Quantum information is the result of these numbers and 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 particle $n = 1$ from which all objects can be built. Raw data from nature are the ratios of the energies. Appropriately, all the energies can be normalized to the electron $n = 1$. Finster [13, 14, 15, 16, 17] introduced causal fermion systems in 2006. Similarly, he sought to overcome the limitations of the physical objects of space and time in favor of the underlying elementary particles through energy and momentum.

2.2 The world as we see it

There was no such thing as a trip to the past. We experience nature through time t and can only compare energies from the past.

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

Everything else is speculative. For calculations, the time t(0) = 0 is fictitious and cannot be assigned a value. There is probably no single straight line in the universe. This puts the linear space in the universe into question. Noether's theorem is mathematical for post-processing in physics. However, every physical state constantly changes with time. No single complete circle exists in the universe. In nature itself, the Noether theorem is meaningless.

Physics is always a comparison between two objects and the result is again an object. Sure are only results from the past.

$$\begin{aligned} System: \quad & object_1(t1), \quad object_2(t2), \quad object_3(t3) \\ \text{with parameter time t}: \; & -t1 < -t2 < -t3 < 0 \qquad t1, t2, t3 \in \mathbb{Q}^+ \end{aligned} \tag{2.2}$$

$object_1$ and $object_2$ are connected with a chain of n $object_n$, up to the observer $object_{obs}$

$$object_1(t_1) < object_2(t_2) < ... < object_{n-1}(t_{n-1}) < object_{obs}(t_{obs}) \tag{2.3}$$

The objects can be visible or invisible. The center of gravity between objects 1 and 2 is invisible. The assumption that the center of gravity can be reduced to a point contradicts the assumption with $\mathbb{Q}^+$. This also means that each spatial dimension must have its own smallest possible focal point, referred to as r_{focus}, φ_{focus}, θ_{focus} and t_{focus}.

$$object_1(t_1) < object_{focus}(t_f) < object_2(t_2) \tag{2.4}$$

2.3. Energy, Space and Time

Owing to evolution, 3 is the smallest number of dimensions for a higher being with the concept of space. Two eyes are advantageous because to the parallax between the large outside world and the small inside world. Polynomials can be transformed into different bases from n. For the three spatial dimensions, the base was $2^3 = 8$. This corresponds to three orthogonal parameters: r, φ, θ
For attraction between two objects this means a parity operator of -1, for repulsion +1 (Fig. 1) .

$$E_{attraction} = E_{object1} - E_{object2} \tag{2.5}$$
$$E_{repulsion} = E_{object1} + E_{object2} \tag{2.6}$$

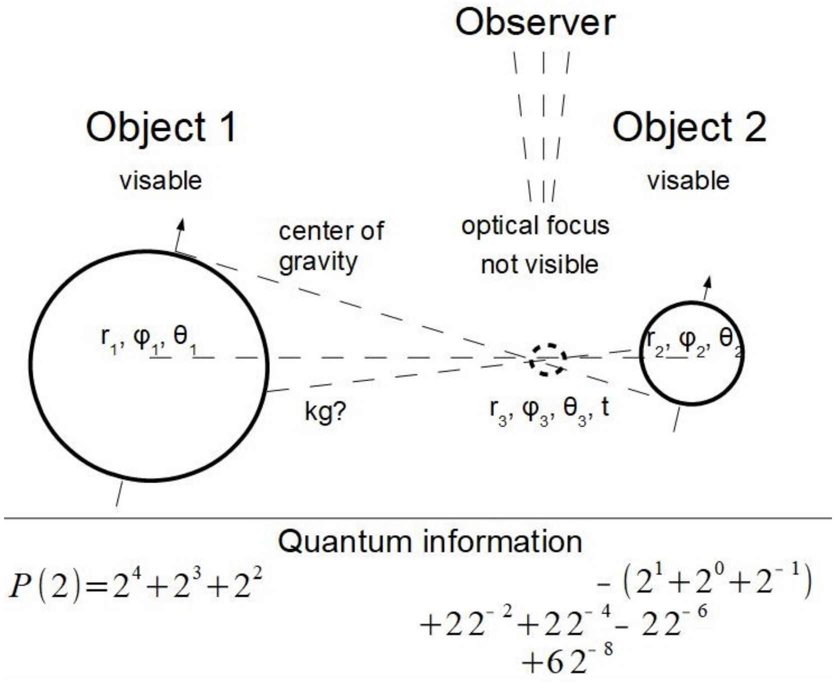

Fig. 1: System of 2 objects and an observer as polynomial $P(2)$ using the example of the neutron

The question is which coordinate system is the simplest and the most effective. Ultimately, because not a single straight line is known in the universe, **r is assumed to be another arc of a circle for all further considerations**. This is an assumption and can ultimately only be verified through experiments and the effort involved in the calculation. E can also be reformulated as polynomial P(2). Each of the parameters is simultaneously an energy of.:

$$P(2) = E = r\ 2^{d_3} + \varphi\ 2^{d_2} + \theta\ 2^{d_1} = E_r\ 2^{d_3} + E_\varphi\ 2^{d_2} + E_\theta\ 2^{d_1} \tag{2.7}$$

The simplest system consists of three objects. For the micro world it is appropriate to relate the energy to the electron mass m_e: $1\ 2^0$. For the rest mass of the electron it can be assumed that E_e results from the geometric mean:

$$E_e = E_{e,r}2^1 + E_{e,\varphi}2^0 + E_{e,\theta}2^{-1} = 2^1 + 2^0 + 2^{-1} \tag{2.8}$$

This sets the dimensions for comparison to a larger object:

$$E_b = E_{b,r}2^4 + E_{b,\varphi}2^3 + E_{b,\theta}2^2 \tag{2.9}$$

For E_b the components $E_{b,r}$, $E_{b,\varphi}$ and $E_{b,\theta}$ add up because all three parameters are observable. This applies to the micro and the macro world.
The 3rd object is the focus of this study.

$$E_f = E_{f,r}2^{d_r} + E_{f,\varphi}2^{d_\varphi} + E_{f,\theta}2^{d_\theta} + E_{f,t}2^{d_t} \tag{2.10}$$

This measurement result is determined by the common point in time, $-t_f < 0$, of the interaction between two adjacent rational numbers:

$$-t_f = 1/2(l_t/n_t + (l_t+1)/n_t) = l_t/n_t + 1/2 < 1 \quad -t_f \in \mathbb{Q}^+ \quad l_t, n_t \ \in \mathbb{N} \tag{2.11}$$

$-t_f$ is a ratio of the quantized round trip time n_t. For an isolated system without further interaction, this results in a ground state or a rest mass.

For foci r_f, φ_f and θ_f the corresponding equations with relative rotary movements of $\omega_r, \omega_\varphi, \omega_\theta \in \mathbb{Z}$ apply.

$$r_f = (l_r + \omega_r)/n_r + 1/2 \tag{2.12}$$
$$\varphi_f = (l_\varphi + \omega_\varphi)/n_\varphi + 1/2 \tag{2.13}$$
$$\theta_f = (l_\theta + \omega_\theta)/n_\theta + 1/2 \tag{2.14}$$

The calculations must be run step by step to simulate nature.

$$t(0) \ ... \ \theta(1) \ ... \ \varphi(2) \ ... r(3) \ ... \ t(4) ... \ \theta(5) \ ... \ \varphi(6) \ ... \tag{2.15}$$

According to the principle that there is no complete circle in the universe, creation or annihilation operators result in equations (2.11,2.12,2.13,2.14) after each complete rotation. Only creation operator make sense for the t_f. **The precursor t_f is not known for the step** $t(0)$ ... $\theta(1)$. For an elementary particle to be assigned a constant value, after $E_{f,t} > 0 \ \ E_{f,\theta} < 0$ is required. It is the first step to the balance between the big and the small objects. This defines the signs:

$$E_{f,t} > 0 \ ... \ E_{f,\theta} < 0 \ ... \ E_{f,\varphi} > 0 \ ... E_{f,r} > 0 \tag{2.16}$$

In this step the symmetry of time is broken. It is the transition from the rational relationships in nature to the linear space in physics.

The sum of the prefactors as absolute values is a consequence of the particle numbers and is constant for each cycle $t_f(n)$ to $r_f(n)$. For each of the three terms $E_{f,i} \ \ i \in \{r, \ \varphi, \ \theta\}$ at least two memory locations for the new two variables are necessary. To calculate from the exponents d two single steps are necessary with $d+1$ and $d+2$. In general, $E_{f,i}$ describes the angular momentum of two moving particles using six parameters.

$$\begin{gathered} E_{f,i} = n_{f,i} 2^{-d_i} + n_{f,j} 2^{-d_i+1} + n_{f,k} 2^{-d_i+2} \\ |n_{f,i}| = |n_{f,j}| + |n_{f,k}| \quad n_{f,j} \neq n_{f,k} \ n \in \mathbb{N} \end{gathered} \tag{2.17}$$

Thus, the foci were fixed for the calculation of the rest mass of the neutrons.

$$\begin{gathered} E_{neutron} = E_b - E_e + E_{f,r} + E_{f,\varphi} + E_{f,\theta} + E_{f,t} \\ E_{b,r} = 1, E_{b,\varphi} = 1, E_{b,\theta} = 1 \\ E_{e,r} = 1, E_{e,\varphi} = 1, E_{e,\theta} = 1 \\ E_{f,r} = 2, E_{f,\varphi} = 2, E_{f,\theta} = -2 \\ E_{f,t} = 6 \\ E_{neutron} = 2^4 + 2^3 + 2^2 - 2^1 - 2^0 - 2^{-1} + 2\ 2^{-2} + 2\ 2^{-4} - 2\ 2^{-6} + 6\ 2^{-8} = 25.1171875 \end{gathered} \tag{2.18}$$

3 Physics in the macro world as $P(2\pi)$

3.1 Neutron

Result (2.18) from the micro world can be transformed into $P(2\pi)$ in our imagination of a space with rotation of 2π.

$$m_{neutron}/m_e = (2\pi)^4 + (2\pi)^3 + (2\pi)^2 - (2\pi)^1 - (2\pi)^0 - (2\pi)^{-1} + 2(2\pi)^{-2} + 2(2\pi)^{-4} - 2(2\pi)^{-6} + 6(2\pi)^{-8} = 1838.6836611 \tag{3.1}$$

$theory: 1838.6836611 m_e$ $\qquad$ $measured: 1838.68366173(89) m_e$ [18]

In the micro world, the closest value was $\Delta = 2^{-8} = 0.0039$. In the macro world, the closest value is $\Delta = (2\pi)^{-8} = 4\ 10^{-7}$. The relative error is thus $2\ 10^{-10}$ and in the range of the measurement error of 1838.68366173(89). The calculation required only 10 terms and was therefore 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 transcendent number π.
It can be assumed that the theory with polynomial $P(2\pi)$ is generally valid. In the following $P(2\pi)$ and $P(\pi)$ are used for m_{proton}/m_e, the fine-structure constant and the photon. Length and time are parameters derived from the particle number and energy.

3.2 Solution of the Schrödinger equation as a polynomial

The Schrödinger wave equation for free particles has the approach

$$\Psi = Ae^{-i/\hbar(Et - m\vec{r}\vec{v})} \tag{3.2}$$

Ψ contains 10 parameters $E, h, m, t, r_x, v_x, r_y, v_y, r_z, v_z$. From the number of parameters alone, the ratios of energies should be calculated from a single 10-term formula:

$$\Psi = Ae^{-i2pi(E_t + \sum_{j=1,2,3}(E_{r,j} + E_{\varphi,j} + E_{\theta,j}))} = Ae^{-i\pi k} \qquad k \in \mathbb{Q} \tag{3.3}$$

Each of the 10 terms d consists of multiple rotations, that is $d\ 2\pi$ and rational divisors of a circle. For the quantum numbers $n = l + 1/2$ this means that the last segment leads to a new circle or to the term $d \pm 1$. This results in the creation and annihilation operators between full rotations of 2π. Each summand k in Ψ can be split into integers d and $k_d < 2\pi$:

$$\Psi = Ae^{-i2\pi E_k} = Ae^{-i(2\pi d + \pi k_d)} = Ae^{-i2\pi d}e^{-i\pi k_d} = Ai^d e^{-i\pi k_d} \tag{3.4}$$

In the exponential function d becomes 1 or -1. In QM, the respective rotations d only result after normalization. To measurement $\Psi\Psi^*$ the summands are separated according to a Fourier analysis with prefactors n, l and s. As an alternative to QM, the energies are simpler to represent as a polynomial $P(2\pi)$ with the prefactors E_d for each turn.

$$E = \sum_d (2\pi)^d E_d \tag{3.5}$$

E describes an Archimedean spiral in time and in three spatial dimensions. The spiral begins at the center of gravity.

3.3. Pictorial representation of the neutron

Matter and antimatter can only be distinguished by comparing a large object with a small one (Fig. 2). In the macro-world, this comparison has no meaning. Matter and antimatter are separated by parity operator. The structure of the polynomial can be illustrated using a Hall of mirrors. How the series is structured can be illustrated using a hall of mirrors. All objects are made up of the same particles. As observers, we see an object in three dimensions in three views. The focus differed depending on the viewing angle. The further away the viewer is from the object, the lower the resolution. The mapping from the focus can be understood as the time operator T. The intensities in the image planes T0, T1 and T2 result from the absolute values of the prefactors, and each adds up to 6.

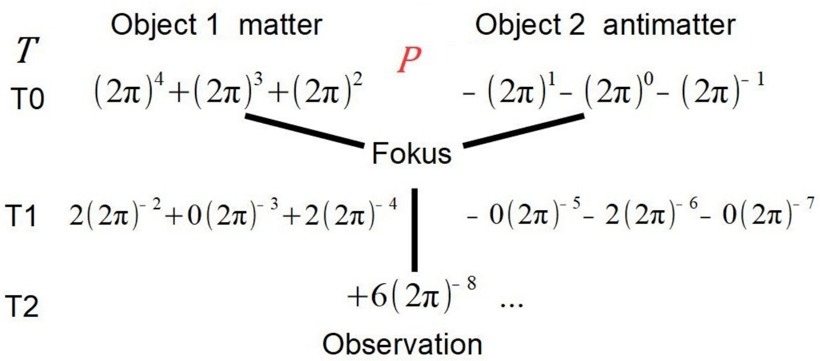

Fig. 1: $m_{neutron}/m_e$ as polynomial $P(2\pi)$

3.4. Proton

The neutral object was $P(2\pi)$. Thus, only polynomials with base π remain for the mass difference between the protons and neutrons. $C = P(\pi) = \sum E_d \pi^d$ with $E_d, d \in \mathbb{Z}$. For each prefactor, $|E_d| <= 3 < \pi$. If we assume that the positron = -1 is the center of the charge, one can assume $C = -pi + 2\pi^{-1}$ as the minimum energy for T0. The neutral state can only be restored with a fourth, negatively charged object with $P(\pi) = pi - 1\pi^{-1}$. The flipping of the spins results in a minimum possible energy of $E_{\theta,e} = -3/(2\pi)$ (see the hydrogen atom 3.6.). With neutral objects $P(2\pi)$, the six prefactors of T0 add up to 3x2 T1, and up to 6 at T2. On the other hand, for C, it is expected that the prefactors of 2 gradually decrease, and the terms with an alternating series converge to the smallest possible focus $\pi^{-f} \quad f > 8$.

With this information and the measured mass difference between protons and neutrons, C is obtained.

$$C = -\pi + 2\pi^{-1} - \pi^{-3} + 2\pi^{-5} - \pi^{-7} + \pi^{-9} - \pi^{-12} \tag{3.6}$$

	T0	T1	T2	T3 $= pi^f$
r:	$-\pi$	$-\pi^{-3}$	$-\pi^{-7}$	$-pi^{-12}$
θ:	$2pi^{-1}$	$2pi^{-5}$	pi^{-9}	

In bothe series r and θ the foci are at distances d = 4, that is, spacetime. Only with $-\pi^{-7}$ and pi^{-9} does the series converge to the common focus $-pi^{-12}$. In Fig. 3, the negative terms on C stand for matter on the left and the positive terms on the right for antimatter.

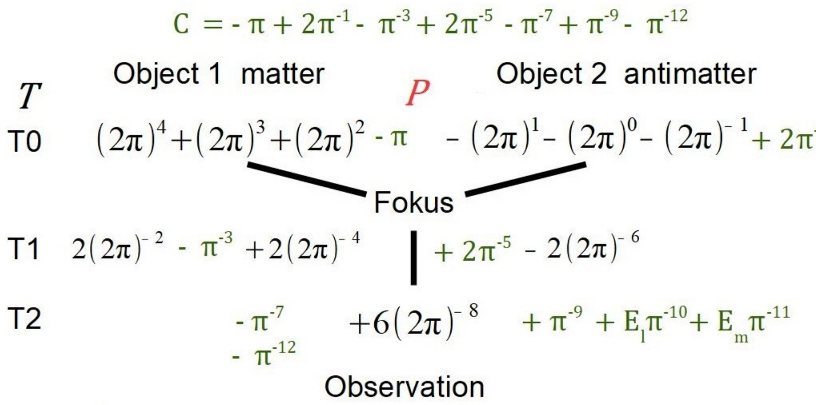

Fig. 2: m_{proton}/m_e as polynomial $P(2\pi)$

$$m_{proton}/m_e = (2\pi)^4 + (2\pi)^3 + (2\pi)^2 - (2\pi)^1 - (2\pi)^0 - (2\pi)^{-1} + 2(2\pi)^{-2} + 2(2\pi)^{-4} - 2(2\pi)^{-6} + 6(2\pi)^{-8} + (-\pi + 2\pi^{-1} - \pi^{-3} + 2\pi^{-5} - \pi^{-7} + \pi^{-9} - \pi^{-12}) = 1836.15267363 \tag{3.7}$$

$theory : 1836.15267363 m_e$ $\qquad$ $measured : 1836.15267343(11) m_e$ [18]

For neutrons, there are several factors with 0 at T1 and T2. 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.

3.5. Electron - Fine-structure constant

α is the ratio of energies between the electron orbits and must also result from a polynomial $P(\pi)$ (Fig. 4). The electron is on the right as matter. 1 is the unit of an electron and $-1/\pi$ its spin. The axis of symmetry between matter and antimatter, and between the three polynomials at the top left and bottom right, is striking. $\pi^4 + \pi^3 + \pi^2$ is antimatter and is not visible to us. They are placeholders for binding to a proton and are at the bottom right for the next electron. This series is probably infinite. The last term π^{-14} is speculative for now. Thus α is in the measuring range.

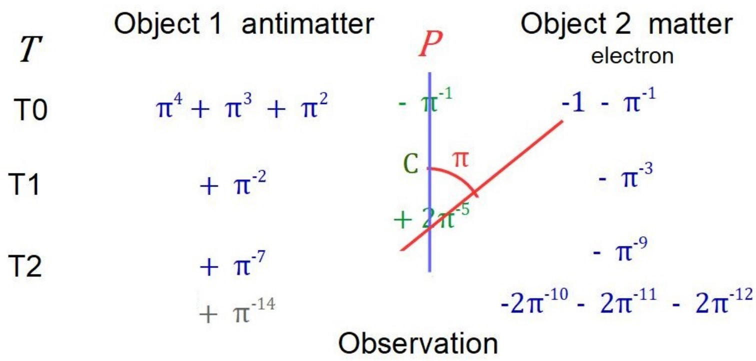

Fig. 3: Fine-structure constant as polynomial $P(\pi)$

$$1/\alpha = \pi^4+\pi^3+\pi^2-1-\pi^{-1}+\pi^{-2}-\pi^{-3}+\pi^{-7}-\pi^{-9}-2\pi^{-10}-2\pi^{-11}-2\pi^{-12}-\pi^{-14} \tag{3.8}$$

$theory: 137.035999216 m_e$ $\qquad$ $measured: 137.035999206(11) m_e$ [18]

3.6. 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.

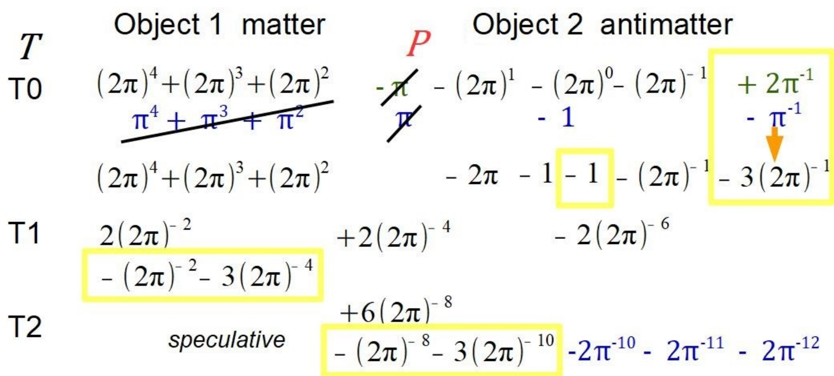

Fig. 4: $m_{hydrogenatom}/m_e$ as polynomial $P(2\pi)$

$$m_H/m_e = (2\pi)^4 + (2\pi)^3 + (2\pi)^2 - (2\pi)^1 - 2 - (2\pi)^{-1} - 3(2\pi)^{-1} + 2(2\pi)^{-2} + 2(2\pi)^{-4} - 2(2\pi)^{-6} + 6(2\pi)^{-8} - (2\pi)^{-2} - 3(2\pi)^{-3} - (2\pi)^{-8} - 3(2\pi)^{-9} \quad (3.9)$$

$$theory: 1837.179 m_e \qquad measured: 1837.180 m_e \qquad (1.00784\text{–}1.00811)u\ [18]$$

3.7. Photon

The emission and absorption of a photon in an atom follows rational coordinates and corresponds to two directly neighboring e^- and e^+ with $-t_f = (l_t + 1)/n_t - l_t/n_t$.
$1/\alpha = \pi^4+\pi^3+\pi^2-1-\pi^{-1}+\pi^{-2}-\pi^{-3}+\pi^{-7}-\pi^{-9}-2\pi^{-10}-2\pi^{-11}-2\pi^{-12}-\pi^{-14}$ is essential for the properties of photons and several terms from $1/\alpha$ should cancel each other out. From the emission in the micro world, the photon expands into space-time. For an observer, the photon can be compared to 2 coupled e^- and e^+, each spiraling around a geodesic line. The energy and number of particles n = 2 are conserved. The ratios φ and θ between emitting objects 1 and 2 are subtracted or added.

$$spin1 = spin\tfrac{1}{2} + spin\tfrac{1}{2} \qquad E_{ges} = E_{electron} + E_{positron}$$
$$N_e = 1\ \ E_e > 0\ \ E_{e,r} = 1 \qquad N_{e^+} = 1\ \ E_{e^+} < 0\ \ E_{e^+,r} = -1$$
$$E_e = 1 + \pi^{-1}E_{e,\theta} + \pi^{-d}E_{e,\varphi} \qquad E_p = -1 + \pi^{-1}E_{e^+,\theta} - \pi^{-d}E_{e^+,\varphi}$$
$$N_{photon} = N_\gamma = 2$$
$$E_\gamma = \pi^{-d}E_\varphi + 2\ \pi^{-1} = \pi^{-d}E_\varphi + spin1 \qquad (3.10)$$

For emission from a hydrogen atom, d depends on the electron orbit (n,l,s), with $d > 9$.

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

4. Macro world

4.1. n - length - time - c

For an observer on Earth, the relative speed of a photon is calculable. According to classical mechanics, the angular momentum L depends on the mass m. $\vec{L} = m\ \vec{r} \times \vec{v}$. In the direction of the axis of circular motion, the amount is $L = mrv = mr^2\omega$. Analogously, L without kg can be formulated in n quanta. The radius of the earth corresponds to the fictitious number of particles $n_{Earth,r}$, the area is $A_{Earth} \propto n^2$. The rotation of the surface is one day. The movements between the atoms are not relevant for this. The angular momentum is in quanta:

$$L_{Earth} \propto n^2 * 1.$$

The corresponding area for the photon is $A_{Photon} = 1 * 1$. With one rotation, corresponding to spin = 1, the angular momentum of the photon is:

$$L_{Photon} = 1 * 1 * 1$$

The relative speed c results from the ratio L_{Earth}/L_{Photon} and a proportional constant.

$$n^2_{Earth,r} \propto c \tag{4.1}$$

With the units m and day we get:

$$\begin{gathered} r^2_{Earth}\ /m\ /day = pi/2\ c \\ 2\pi c\ m\ day = (Earth's\ diameter)^2 \end{gathered} \tag{4.2}$$

2π is a consequence of our view of rotations. This formula provides the equatorial radius of the earth with an accuracy of 489 m. After adopting the numbers $\mathbb{Q}^+$ for physics, it is the first formula that unifies 3 dimensions. The formula is understandable and ultimately not further provable. It is also a possible law from nature, like Newton's law of gravitation or the quantum of action. The evidence comes from nature as long as it is correct.

The diameter of the earth is defined by an unknown but constant number of particles. As long as there is a Michelson interferometer on the earth's surface, this device always supplies the same value for c. Length, time and c are orthogonal to each other. A mass in kilograms does not define the radius of the celestial body. Instead, everything results from the geometric optics of the radii and paths. In any system, the energies are the raw data and they are ordered one-dimensionally in time from a center. The time axis is independent of space. Whether time is assumed to be linear from the center or a constant speed of light is arbitrary.

4.2. Sun - Earth - Moon

The Sun, Earth, and bound Moon have a stable ratio of radii and orbits, and largely correspond to the ground state. The diameters of Earth and Moon should also be quantized.

$$R_{Moon}/(R_{Earth} + R_{Moon}) = 2^3/(2\pi) = 4/\pi \tag{4.4}$$

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

The same applies to the coincidence of the apparent diameters of the Moon and Sun. The distances between all bodies can also be the result of the expansion of the entire universe $H0 = 2.1910^{-18}/s$.

$$\begin{gathered} d/dt\ distance(moon) = 38.2\ mm/384400\ km/year = 3.15\ 10^{-18}/s \\ (1 - 1/\pi)3.15\ 10^{-18}/s \approx H0 \end{gathered} \tag{4.5}$$

The factor $(1 - 1/\pi)$ must be a consequence of the basic assumptions (1.3. Energy, space and time) when a constant value is assigned to elementary particles (16).

4.3. 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 (Tab. 1). 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. These calculations were accurate to approximately 1 per thousand.

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

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

These orbital periods complement those of observations on the Titius-Bode law [19]. The neighboring planets or moons result - partly approximately, partly quite exactly - by ratios of small whole numbers e.g. from Dermott S.F. [20] and also applies to exoplanets [21].

4.4. Calculations of the orbits in the planetary system

The solar system can be thought of as an enlarged 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}. Mercury is closer to this center. The Sun orbits Mercury due to its higher energy. 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. 2). As with ladder operators, orbits can be iteratively constructed. Generally, the energies in a planetary system can be formulated as a polynomial $P(2\pi)$.

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

According to (4.2) normalization to the radius of the sun results in:

$$r_{sun} = 696342km \quad r_{apo/periasis} = r_{sun}\sqrt{E_n}$$

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

Mercury

$r_{apoapsis} = 696342km\sqrt{32/2\ \pi^5 - 16/2\ \pi^4 + 8\pi^3} = 46006512km$
$measure:\ 46.002\ 10^6km\ \ rel.error = 1.0001$

$r_{periapsis} = 696342km\sqrt{32\pi^5 - 0 * 16\pi^4 + 8\pi^3} = 69775692km$
$measure:\ 69.81\ 10^6km\ \ rel.error = 1.0005$

Venus

$r_{apoapsis} = 696342km\sqrt{2 * 32\ \pi^5 + 3 * 16\ \pi^4 - 8\pi^3} = 107905705km$
$measure:\ 107.4128\ 10^6km\ \ rel.error = 1.004$
$r_{periapsis} = 696342km\sqrt{2 * 32\pi^5 + 3 * 16\pi^4 + 8\pi^3} = 109014662km$
$measure:\ 108.9088\ 10^6km\ \ rel.error = 1.001$

Tab. 2: Apoapsis and periapsis of Mercury and Venus

$$r_{Venus}/r_{Mercury} = 6123.80/2448.57 = 2.50096 \tag{4.6}$$

This indicates that Mercury and Venus are themselves quantum numbers.

5 Summary and conclusions

Exact predictions for the masses of elementary parts result solely from the assumption of rational numbers in the universe. These three spatial dimensions and time are a consequence of our idea of rotations in space. The polynomials $P(\pi)$ and $P(2\pi)$ result in rest masses relative to the electron. $m_{neutron}/m_e$ is a $P(2\pi)$ with the ten minimum required terms. In a rational space, a photon has a beginning and an end through the immediately adjacent e^+ and e^-. Our concept of space and time fills this gap with real and transcendent numbers. m_{proton}/m_e was calculated using $P(2\pi)$ and $P(\pi)$. Polynomials show a way beyond quantum theory and GR, with insights for the planetary system. Calculating the proton radius of the muonic hydrogen atom would test the correctness of this theory. Should all properties of matter be calculable with a single polynomial, this could lead to new approaches in physics.

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