

At the International Congress of Mathematicians at Paris in 1900 [David Hilbert](#) delivered a lecture about 23 fundamental problems in both physics and mathematics that weren't solved at that time.

Up to this day David Hilbert's 6<sup>th</sup> problem isn't solved.

(The original text can be found at:

<http://quantumuniverse.eu/Tom/Hilberts%2023%20Mathematische%20Probleme.pdf> )

Translated in English ( <http://aleph0.clarku.edu/~djoyce/hilbert/problems.html> ) it reads:

## 6. Mathematical treatment of the axioms of physics

The investigations on the foundations of geometry suggest the problem:

*To treat in the same manner, by means of axioms, those physical sciences in which mathematics plays an important part, in the first rank are the theory of probabilities and mechanics.*

As to the axioms of the theory of probabilities, it seems to me desirable that their logical investigation should be accompanied by a rigorous and satisfactory development of the method of mean values in mathematical physics, and in particular in the kinetic theory of gases.

Important investigations by physicists on the foundations of mechanics are at hand; I refer to the writings of [Mach](#), [Hertz](#), [Boltzmann](#) and P. Volkmann (Einführung in das Studium der theoretischen Physik, Leipzig 1900). It is therefore very desirable that the discussion of the foundations of mechanics be taken up by mathematicians also. Thus [Boltzmann](#)'s work on the principles of mechanics suggests the problem of developing mathematically the limiting processes, there merely indicated, which lead from the atomistic view to the laws of motion of continua. Conversely one might try to derive the laws of the motion of rigid bodies by a limiting process from a system of axioms depending upon the idea of continuously varying conditions of a material filling all space continuously, these conditions being defined by parameters.

For the question as to the equivalence of different systems of axioms is always of great theoretical interest.

If geometry is to serve as a model for the treatment of physical axioms, we shall try first by a small number of axioms to include as large a class as possible of physical phenomena, and then by adjoining new axioms to arrive gradually at the more special theories. At the same time [Lie](#)'s principle of subdivision can perhaps be derived from a profound theory of infinite transformation groups. The mathematician will have also to take account not only of those theories coming near to reality, but also, as in geometry, of all logically possible theories. He must be always alert to obtain a complete survey of all conclusions derivable from [the system of axioms assumed](#).

Further, the mathematician has the duty to test exactly in each instance whether the new axioms are compatible with the previous ones. The physicist, as his theories develop, often finds himself forced by the results of his experiments to make new hypotheses, while he depends, with respect to the compatibility of the new hypotheses with the old axioms, solely upon these experiments or upon a certain physical intuition, a practice which in the rigorously logical building up of a theory is not admissible. The desired proof of the compatibility of all

assumptions seems to me also of importance, because the effort to obtain such proof always forces us most effectual to an exact formulation of the axioms.

### **End of David Hilbert's translated sixth problem.**

All explanations of used concepts in physics will be based on Wikipedia's information on these concepts.

First some insight in the concept "geometry": <http://en.wikipedia.org/wiki/Geometry> . Geometry is a part of [mathematics](#) concerned with questions of size, shape, and relative position of figures and with properties of space. [Geometry](#) is one of the oldest sciences. Initially a body of practical knowledge concerning lengths, areas, and volumes, in the third century BC geometry was put into an axiomatic form by [Euclid](#), - [whose treatment](#) - set a standard for many centuries to follow. The field of [astronomy](#), especially mapping the positions of the stars and planets on the celestial sphere, served as an important source of geometric problems during the next one and a half millennium. A mathematician who works in the field of [geometry](#) is called a [geometer](#).

Introduction of [coordinates](#) by [Descartes](#) and the concurrent development of [Algebra](#) marked a new stage for [geometry](#), since geometric figures, such as [plane curves](#), could now be represented [analytically](#), i.e., with functions and equations. This played a key role in the emergence of [Calculus](#) in the 17<sup>th</sup> century. Furthermore, the theory of [perspective](#) showed that there is more to [geometry](#) than just the metric properties of figures. The subject of [geometry](#) was further enriched by the study of intrinsic structure of geometric objects that originated with [Leonard Euler](#) and [Carl Friedrich Gauss](#) and led to the creation of [Topology](#) and [Differential geometry](#).

Since the 19<sup>th</sup> century discovery of [Non-Euclidean geometry](#), the concept of [space](#) has undergone a radical transformation. Contemporary [geometry](#) considers [manifolds](#), spaces that are considerably more abstract than the familiar [Euclidean space](#), , which they only approximately resemble at small scales. These spaces may be endowed with additional structure, allowing one to speak about length.

Modern geometry has multiple strong bonds with [physics](#), exemplified by the ties between [Riemannian geometry](#) and [General Relativity](#). One of the youngest physical theories, [String theory](#), is also very geometric in flavor.

The visual nature of [geometry](#) makes it initially more accessible than other parts of [mathematics](#), such as [algebra](#) or [number-theory](#). However, the geometric language is also used in contexts that are far removed from its traditional, Euclidean provenance, for example, in [fractal geometry](#), and especially in [Algebraic geometry](#).

All so-called elementary particles, together with all their characteristics can be derived from a complete non-reducible geometric symmetry analysis of 4D-space-time. I.e. the only space-time that can be used to describe [mathematical knots](#). This fact proofs David Hilbert's wish as described as his [6<sup>th</sup> problem](#).

**The proof of David Hilbert's problem 6 will be given below:**

In the summer of 2003 [Grigori Perelman](#) proved that the only mathematical space in which knots are possible is Einstein's S(pecial)R(elativistic) 4D-space-time.

In his papers [0211159v1.pdf](#), [0303109v1.pdf](#) and [0307245v1.pdf](#) G. Perelman shows that knots are only possible in 3D-space, i.e. the easy imaginable [SR](#) 4D-spacetime. In smaller dimensional spaces knots are not possible as anyone can imagine straight away. In higher dimensional spaces knots are again not possible due to symmetry demands of such spaces. This is the main reason why all [SuperString](#) theories will proof incorrect within the coming years as the [LHC](#) not only tries to verify experimentally the existence of the elementary spinless [Higgs-boson](#), but also tries to detect the lightest so-called [SuperPartner](#). A simple mathematical explanation of [problem 6 of David Hilbert](#) will also show that both the [Higgs-mechanism](#) and [SuperString](#) theories do not describe our reality on a deeper level.

G(eneral)R(elativistic) space-time is curved. This curved space-time can be analyzed mathematically, i.e. linear, when the amount of degrees of freedom is doubled as explained in [Curvature and QM](#). Einstein solved curvature mathematically in a (linear) so-called [Riemann-space](#). Mathematical analysis is only possible in a linear space specified with rectilinear axes. Curvature is due to in-homogeneous distribution of mass and mass-speed in any possible universe. The only way to solve this characteristic mathematically is describing all elementary particles extended in the 2D-plane orthogonal to the (described) direction of motion ([SR-worldline](#)). The movement of the mathematical point in this plane must oscillate harmonically because all so-called particles (building blocks of nature) possess energy proportional to a detected frequency. Einstein proved this for the spin1 [photon](#) and [Louis-Victor de Broglie](#) proved this fact for all [fermions](#). The time-like conserved energy has to be described as the constant [Hamiltonian](#):

$$H = hf = E(\mathbf{p}) + U(\rho) \quad (1)$$

All bold symbols specify space-like 3D-vectors.

This Hamiltonian is described with respect to the inertial frame moving with the harmonic oscillating particle and with origin at the average position of the oscillating point, i.e. at the position on the [SR-worldline](#) at which the particle is described in the standard [Q\(uantum\) F\(ield\) T\(theories\)](#).

With  $h$  Planck's constant,  $f$  the frequency of oscillation in this 2D-plane orthogonal to the direction of motion,  $E(\mathbf{p})$  the kinetic energy which depends on the momentum  $\mathbf{p}$ , rest-mass  $m_0$  and  $U(\rho)$  the potential energy, which must enforce harmonic oscillation:

$$E(\mathbf{p}) = \sqrt{(m_0^2 c^4 + \mathbf{p}^2 c^2)} \wedge U(\rho \equiv |\rho|) = \frac{1}{2} k \rho^2 \quad (2)$$

With  $m_0$  the rest-mass of the elementary particle,  $\rho$  the polar distance of the harmonic oscillating point with respect to the worldline in the 2D-plane orthogonal to this [worldline](#) and  $k$  a force-constant of an harmonic oscillation inducing force:  $\mathbf{F} = -k\mathbf{\rho}$  (3)

Here  $\mathbf{\rho}$  is the polar vector in the 2D-plane from the origin of the inertial frame moving with the oscillating point-particle at the position of the elementary particle as described in all [QFT](#). The space-like constant of motion just is the so-called intrinsic angular momentum, usually called the spin, or more correctly the [helicity](#), i.e. [spin](#) in the direction of motion of the particle. In all [SR QFT](#) not spin as such is a conserved quantity, only the [spin](#) of the particle in the direction of motion is a conserved quantity usually called the "[intrinsic angular momentum](#)".

All so-called [elementary particles](#) with all their characteristics are in fact the non-reducible representations of all geometric possible symmetry groups of the described 4D-spacetime

universe. Where it should be realized that these discrete and continuous symmetries also imply inversion and [gauge-symmetries](#).

The harmonic oscillating motion in the 2D-plane orthogonal to the (observed) direction of motion implies an average extendedness of the described elementary particle. The average extendedness is equal to:  $2\langle\rho\rangle = \rho_{\max} + \rho_{\min} = 1\frac{1}{2} \rho_{\min}$  (4)

This extendedness is proportional to the spin  $s$  of the described elementary particle in compliance with the [C\(omprehensive\) A\(ction\) P\(rinciple\)](#).

Paul Dirac already concluded in 1929 that spin is a necessary characteristic of electrons when combining [QM](#) and [SR](#). In 1921 Albert Einstein showed that any physical description must include the gravitational action, i.e. include curvature of space-time, in short comply with the [CAP](#).

A [CAP](#) complying description of any possible elementary particle shows that [CAP](#) complying elementary particles always possess [spin](#)  $> 0$ . I.e. a spinless elementary particle does not comply with the [CAP](#), so can **NOT** exist in real life! Up to this day no elementary spinless particle has ever been observed experimentally.

This fact can be imagined quite easily. A mathematical point moving along a 1D-worldline is not able to oscillate harmonically, so can't carry energy proportion to a frequency.

In all [QFT](#) elementary particles are described as point-particles, which move along their worldlines. All characteristics of elementary particles are described with so-called state-functions. The statefunction is solved using an [Euler-Lagrange](#) equation and solving the stationary action of Hamilton's principle. In [QFT](#) all that's possible to deduce from an analyzed system can be deduced from the resulting state-function following from the Lagrangian density. In [QFT](#) this function is expressed in second quantization, i.e. using creation and annihilation operators. In all used [QFT](#) the state-functions are exact mathematical point-equations. As a result the used state-functions of [QFT](#) do not comply with the [CAP](#). All so-called characteristics of all described elementary particles are derived from the state-function. I.e. the spin is assumed to follow from the angular-momentum of the state-function integrated over all space where the state-function cannot be assumed zero. However, angular-momentum is a conserved quantity and this fact is also included in the complex state-function in Hilbert space. It's quite easy to derive that a state-function of a spinless elementary particle can only be non-zero on the 1D-worldline, i.e. using a non-[CAP](#) compliant description.

However, it is easy to rewrite [QFT](#) such that they comply with the [CAP](#): Describe elementary particles as harmonic oscillating mathematical points in the 2D-plane orthogonal to the observed direction of motion ([SR-worldline](#)).

**But first all possible elementary particles of any possible, i.e. 4D-space-time universe, will be derived from a complete, but non-reducible, geodesic symmetry analysis:**

First of all it will as a simple start be assumed that space-time is 4Dimensional. Later it will be proven that other dimensional space-times cannot describe any valid reality.

In this case all possible infinitesimal (i.e. linear [SR](#)) transformations of a 4-vector can be given by a  $4 \times 4 = 16$  independent degrees of freedom transformation matrix. The transformation matrix must be a tensor to yield (relativistic) transformation invariant expressions. This tensor can be uniquely given as the sum of a symmetrical tensor  $S_{\mu\nu}$  and an anti-symmetrical tensor  $A_{\mu\nu}$ :

$$T_{\mu\nu} = S_{\mu\nu} + A_{\mu\nu}, \text{ with: Symmetrical: } S_{\mu\nu} = S_{\nu\mu} \wedge \text{ Anti-Symmetrical: } A_{\mu\nu} = -A_{\nu\mu} \quad (5)$$

All possible infinitesimal transformations of a 4-vector are included in (5).

The symmetrical transformation tensor  $S_{\mu\nu}$  can 1-to-1 be represented by  $\text{spin}^{1/2} \otimes \text{spin}2$ . The  $\text{spin}^{1/2}$  represents the massive stable elementary and compound particles, which are the sources of the  $\text{spin}2$  gravitational field.

The anti-symmetrical transformation tensor  $A_{\mu\nu}$  can 1-to-1 be represented by  $\text{spin}^{1/2} \otimes \text{spin}1$ . The  $\text{spin}^{1/2}$  now represents the electrically charged stable elementary and compound particles, which are the sources of the  $\text{spin}1$  [EM-field](#).

So, all possible transformations of a 4-vector can also be represented mathematically by the following stable particles of any possible, i.e. 4D-spacetime universe:

$$\text{spin}^{1/2} \otimes \text{spin}2 \oplus \text{spin}^{1/2} \otimes \text{spin}1 \quad (6)$$

As is well known, the [EM-field](#) is only specified completely after implying the Lorentz  $U(1)$ -gauge symmetry. In a 4D-space-time universe, the complete non-reducible gauge symmetry is just the used gauge-symmetry of the [S\(andard\)M\(odell\)](#):

$$U(1) \times SU(2) \times SU(3), \text{ the Complete-Non-Reducible } \text{gauge-symmetry}. \quad (7)$$

The  $U(1) \times SU(2)$  gauge symmetry describes mixed by the Weinberg angle  $\theta_w$  the [EM-field](#) (the photon) and the weak nuclear forces (the three massive  $\{W^\pm, Z\}$  [IVB](#)), which must all be massive  $\text{spin}1$  bosons.

All charged particles are massive, so all bosons of the weak nuclear forces are massive.

The  $SU(3)$  gauge symmetry describes all quarks as  $\text{spin}1/2$  fermions without so-called iso- $\text{spin}^{1/2}$ . A simple complete non-reducible gauge-symmetry analysis implies that quarks are  $\text{spin}1/2$  fermions to represent the  $SU(3)$  gauge-symmetry 1-to-1. As a result [all possible spins](#), possible in a 4D-spacetime universe, i.e.  $s \in \{1/2, 1, 1/2, 2\}$ , are the building-blocks of the only possible constituents in real life.

The [quarks](#) are the unstable  $\text{spin}1/2$  constituents of the compound [fermions](#) called [baryons](#), and the compound bosons, called [mesons](#) and [gluons](#) which keep the three [quarks](#) of a [baryon](#) together in a stable compound  $\text{spin}1/2$  fermion. The only possible (i.e. intrinsic-) stable [spins](#) are given by representation (6):  $s \in \{1/2, 1, 2\}$  (8)

The only still possible particles in any valid 4D-universe, deduced from (6), are the stable elementary  $\text{spin}1/2$  [fermions](#), called the [leptons](#).

The basic electric charge of an elementary particle is equal to the electron charge, usually defined as electron charge  $-e$ . Any acceptable model of any possible universe, i.e. our reality, must be non-reducible. As a result of this fact and the mathematical fact that the symmetrical and anti-symmetrical actions are orthogonal implies that there is only one possible stable elementary charge, which in our universe is the so-called electron charge. Even though the [CAP](#) still has to be taken into account! All particles have so-called anti-particles, with the same characteristics except for an opposite charge. All stable baryons also have charges in stable integer values of electron charge  $\{-e, 0, e\}$ . The quarks themselves have charges of  $\pm 1/3e$  and  $\pm 2/3e$ , but aren't stable particles on their own and always surrounded by a so-called gluon sea (2 quarks connected into a boson) that describes the strong nuclear force.

In the [SM](#), quarks are assumed to be  $\text{spin}1/2$  fermions with additional so-called isospin. However, this description does not explain why quarks cannot be observed on their own, while  $\text{spin}1/2$  combined with also dual isospin  $1/2$  does not follow from a complete non-reducible symmetries analysis.

The 2D-extendedness in the 2D-plane orthogonal to the observed direction of motion (worldline) must be described mathematical, i.e. infinitesimal linear, with the following D(ifferential)E(quation)'s:

$$\dot{\mathbf{p}} = \frac{\dot{\mathbf{p}}}{E} \quad (9)$$

Here  $\mathbf{p}$  is the polar vector in the 2D-plane and the 'dot' stands for differentiation with respect to the proper time in the inertial frame with origin moving with the average position of the particle, chosen as the z-axis.

$$\dot{\mathbf{p}} = \mathbf{F}(\rho \equiv |\boldsymbol{\rho}|) \quad (10)$$

$$\dot{\mathbf{p}} \cdot \mathbf{p} = \mathbf{p} \cdot \dot{\mathbf{p}} = 0, \text{ the required harmonic demand.} \quad (11)$$

$$\text{Force (3) is conservative and can be related to a potential energy: } \mathbf{F} = -\nabla U(\rho) \quad (12)$$

From (9), (10), (2) and (12) one also deduces:

$$E = -\dot{\mathbf{p}} \cdot \nabla U(\rho), \quad (13)$$

, which implies conservation of total energy (1).

Differentiating (9), using (10), (13) and (1) yields a 2<sup>nd</sup> order [DE](#):

$$(\ddot{H}-U)\mathbf{p} + \nabla U(\rho) - \dot{\mathbf{p}} \cdot (\dot{\mathbf{p}} \cdot \nabla U(\rho)) = 0 \quad (14)$$

A central conservative force (3) implies a conserved angular momentum ([helicity](#)) of the [CAP](#) described extended elementary particle:

$$\mathbf{S} = \boldsymbol{\rho} \times \dot{\mathbf{p}} = (H-U(\rho))\boldsymbol{\rho} \times \dot{\boldsymbol{\rho}} \quad (15)$$

In which the usually used symbol  $\mathbf{L}$  of the orbital angular momentum is denoted as the so-called intrinsic angular momentum  $\mathbf{S}$  (conserved [helicity](#)) to yield a [QM](#) description in compliance with the [CAP](#). I.e. [QM](#) in compliance with the [CAP](#) explains spin completely on a classical level.

In polar coordinates  $(\rho, \varphi, z)$  the [DE](#)'s to be solved are completely integrable as long as one solves for the square  $x \equiv \rho^2$ .

Using  $S = |\mathbf{S}| \wedge U' = \frac{\partial U}{\partial \rho}$ , the [DE](#)'s read:

$$\ddot{\rho} + \frac{U'}{(H-U)} (\dot{c}^2 - \dot{\rho}^2) - \frac{(c^2 S)^2}{(H-U)^2 \rho^3} = 0 \quad (16)$$

┆Set I

$$\dot{\varphi} = \frac{c^2 S}{(H-U)\rho^2} \wedge z = z' = 0 \quad (17)$$

Call equations (16) and (17) set I, i.e. the set of equations of motion described from the inertial frame with origin at the average position (the position of the elementary particle assumed in all [QFT](#)) of the particle and with the z-axis chosen in the direction of motion. Set I is the starting point of the equations of motion of all possible geometric symmetry relations induced elementary particles.

In the case [QFT](#) theories are rewritten in compliance with the [CAP](#), the spin is explained completely at classical level.

[DE](#)'s (14) and (16) are second order proper time derivatives and require 2 B(oundary) C(onditions) to be solved. The used BC are either open or closed. Closed BC only allow interaction of the 2D-extended elementary particles in the direction of motion, i.e. the [SR-worldline](#). This type of solution explains all characteristics of so-called [bosons](#). Such particles are allowed to be at the same space-time location with all quantum numbers in the same [eigen-state](#). Also, of [bosons](#) only one type or so-called “[family](#)” exists of all possible infinitesimal relativistic symmetry groups. Likewise, all [fermions](#) must be described at infinitesimal level with open BC. Open BC have one positive integer degree of freedom extra. This degree of freedom represents the particle family. The higher this number the more interaction with the gravitational spin2 field, so the higher the mass. Open BC allow interactions of such particles in all space-like directions. As a direct result [fermions](#) comply to [Pauli's exclusion principle](#).

Using  $x = \rho^2$ , [DE](#) (16) can be written as:

$$\ddot{x} = \frac{1}{2} \left( \frac{k}{H - \frac{1}{2}kx} + \frac{1}{x} \right) \dot{x}^2 - \frac{2kc^2}{(H - \frac{1}{2}kx)} x + 2 \frac{(c^2S)^2}{x(H - \frac{1}{2}kx)^2} \quad (18)$$

And the [DE](#) of polar angle (17) is already written with  $x = \rho^2$  as it is given in (17). [DE](#) (18) written out explicitly using (2):

$$(H-U)^2 \ddot{x} = \frac{1}{2}(H-U)(H+U)\dot{x}^2 - 4c^2(H-U)U \cdot x + 2(c^2S)^2 \quad (19)$$

Where it should be realized that (H-U) just is the extended particle's kinetic energy centered at the particle's exact (oscillating) point-like position in the 2D-plane orthogonal to the [SR-worldline](#). And this 2<sup>nd</sup> order [DE](#) can be solved exactly, because all powers in  $x^n$  are:  $n \leq 4$ . This is not true for the polar distance  $\rho$ , but  $\rho > 0$ , so can be solved completely with the solution of [DE](#) (18) after suitable BC are chosen for the specific elementary particle ([boson](#) closed BC, [fermion](#) open BC).

In the case of a massless particle one has the constant velocity:  $|\dot{\boldsymbol{\rho}}|^2 = \dot{\rho}^2 + \rho^2 \dot{\varphi}^2 = c^2 \quad (20)$   
This makes the equations of motion of the two massless elementary Bose-particles (spin2 [graviton](#) and spin1 [photon](#)) relatively easy.

But solutions of these force-particles only make sense after solutions of interacting [fermions](#) are known.

This complete 4D-space-time symmetry analysis implies the following elementary particles in any possible universe:

**Table 1.** All possible elementary particles and their observable forms.

<b>Fermions: 3 different families</b>	<b>Bosons:</b> <i>The elementary spin1 and spin2 bosons, see (26), and the <math>U(1) \times SU(2) \times SU(3)</math> gauge-bosons:</i>
leptons: electron, muon and tauon + anti-particles	graviton, a spin2 elementary massless boson
leptons: massive but chargeless neutrino's	photon, a spin1 elementary massless boson
quarks 1st family: up-quark and down-quark	weak-nuclear forces: spin1 elementary massive gauge-bosons $W^\pm, Z$
quarks 2nd family: charm-quark and strange-quark	strong-nuclear forces: spin1 colored quark+anti-quark gluons
quarks 3rd family: top-quark and bottom-quark	mesons: all non-gluon bose-quark combinations

All fermions have so-called anti-particles with changed charge sin of charged particles and opposite [helicity](#) in case of uncharged particles. All [leptons](#) are spin $\frac{1}{2}$  particles and all confined [quarks](#) are spin $\frac{1}{2}$  particles.

Any [fermion](#) must be described with open [BC](#). This implies interactions in all spacelike directions, i.e. at least necessary interaction with the spin2 gravitational field and as a result of that (rest-)mass  $> 0$ .

As a result any massive particle always has velocities:

$$\dot{v} < (\text{lightspeed}) c \quad (21)$$

As a result of this fact, a simple [SR](#) symmetry analysis allows knots in the path of every free fermion. I.e. mathematical spaces that do not allow knots cannot describe fermions mathematically. Without fermions all sources of bosons, i.e. force-particles, are removed. As a result of this fact, only universes are possible in space-time geometry's which allow knots. Therefore, only 4D-space-time universes are possible! And such universes only allow fermions with spins  $s \in \{\frac{1}{2}, 1\frac{1}{2}\}$ , of which only  $s = \frac{1}{2}$  elementary and compound fermions are possible as stable fermions. The only allowed elementary bosons have spins  $s \in \{1, 2\}$ , which just have one type or "family" of boson for each possible different symmetry group. [DE](#) (18) and (19) are 2<sup>nd</sup> order time derivative [DE](#). A set of two consecutive 1<sup>st</sup> order time derivative DE is much easier to solve. This is why set I will be rewritten into a set of two consecutive 1<sup>st</sup> order time derivative [DE](#):

The massless case yields an easy to solve 1<sup>st</sup> order time derivative [DE](#) due to the fact that the speed

$$v = \sqrt{(\dot{\rho}^2 + \dot{\rho}^2 \dot{\varphi}^2)} = (\text{lightspeed}) c \text{ is a constant. In this case one has using (17):}$$

$$\left(\frac{1}{2}\dot{x}\right)^2 = xc^2 - \frac{(c^2S)^2}{(H - \frac{1}{2}kx)^2} \quad (22)$$

The solution of  $x(\tau) = \rho^2(\tau)$  has exact solutions with incomplete elliptic integrals of both the 1<sup>st</sup> and 2<sup>nd</sup> kind. The solution of  $\varphi(\tau)$  has exact solutions with incomplete elliptic integrals of the 3<sup>rd</sup> kind.

So all kinds of (incomplete) elliptic integrals appear in the solutions which also require the [Golden Ratio](#)  $\phi = \frac{1}{2}(\sqrt{5}+1)$  as a proportionality constant in the exact solutions.

The actual solution for any possible elementary particle still depends on whether the described particle is a boson or fermion, on the conserved spin in the direction of motion (i.e. helicity), the rest-mass, the frequency (i.e. total [SR](#) energy) and the force-constant "k". The force-constant "k" depends on the intrinsic angular momentum S (15) and the Hamiltonian H (1) and has the same expression for all possible elementary particles.

After all solutions are given, the Feynman-rules of the [SM](#) must be rewritten with [CAP](#) complying extended elementary particles in the 2D-plane orthogonal to the described direction of motion ([SR-worldline](#)). And instead of the [Higgs-mechanism](#) to include mass contributions on a re-normalizable manner, the [gravitational \(spin2\) field](#) must be included, described as the [CAP](#) complying (only allowed) spin2 elementary boson to describe the always attractive force between elementary and of course also compound masses. The [CAP](#) complying description explains why elementary fermions cannot reach one another at zero distance, but always stay apart at distances larger or equal to the Planck length ( $l_h = \sqrt{(hG/2\pi c^3)} \approx 1.61625281 \cdot 10^{-35}$  m, with  $h$  [Planck's constant](#),  $G$  Newton's gravitational constant and  $c$  the speed of light in vacuum. Also see: [http://en.wikipedia.org/wiki/Planck\\_length](http://en.wikipedia.org/wiki/Planck_length) ).

When rewriting QFT with [CAP](#) complying extended particles one is able to include the gravitational force and write all four different fundamental forces in one Unified Theory. When realizing that any model without the gravitational field, i.e. curvature of space-time, is not correct, as it doesn't comply with the [CAP](#), one should also realize that the most perfect description of physics, i.e. the [Standard Model](#) of Quantum Field Theories, does not comply with the [CAP](#). The only way to yield this very successful [SM](#) correct implies rewriting it in compliance with the [CAP](#). And this implies 2D-extended harmonic oscillating elementary particles in the plane orthogonal to the direction of motion.

The symmetrical gravitational field (the [Ricci-tensor](#) is symmetric) has one additional problem. All gravitational effects can't be measured directly by the (i.e. mathematical orthogonal) anti-symmetrical [EM-field](#).

For example, up to today the [graviton](#) has never been detected as a force particle directly in any experiment. This is the reason that about 73% of the total [mass-energy](#) of our universe is invisible and as a result of that fact called [Dark energy](#). Just like it is extremely difficult to detect uncharged [neutrinos](#)! Mostly in measurements [neutrinos](#) are assumed as missing energy in collision processes, because they can't be observed by [EM](#)-equipment. If my description of [QFT](#) is correct, all of the not observed mass in our universe consists out of almost massless [neutrinos](#). At first sight [neutrons](#) may also seem chargeless, because the net charge is zero. However when realizing the fact that the [neutron](#) is a colorless compound particle build from three different charged quarks, the extendedness of all elementary particles implies a small area around the [COM](#) position of the neutron that's not chargeless. Due to the low weight of [neutrinos](#), they almost move with the speed of light, so a very homogeneous distribution of dark mass is to be expected in our universe. Where it should be realized that the spin2 [gravitational field](#) carries invisible energy, just like the [EM-field](#) carries visible energy. As given in table 1 other elementary particles to explain dark matter aren't available, because no more as the particles given in table 1 can be deduced from a non-reducible complete 4D-spacetime geometric symmetries analysis.

This recapitulated description of [QFT](#) will be tested to the full at the new [LHC](#) at [CERN](#) near Geneva within the next years 2012 and 2013. I sincerely hope to have finished the complete [CAP](#) compliant Feynman rules of [QFT](#) before the [LHC](#) reaches the 1 TeV boundary for Higgs boson production!?!

The elementary spinless [Higgs-boson](#) was assumed to have a [mass](#) in the range:

$$114.4 \text{ GeV} < m_H < 156 \text{ GeV} \quad (23)$$

The detected Higgs-resonance detected at the LHC, already in 2014, has a mass of about:

$$m_H \approx 125.6 \text{ GeV} \quad (24)$$

I.e. the force-particle assumed to be responsible for non-zero masses of [elementary particles](#) appears to have a (rest-)mass almost as heavy as the heaviest discovered elementary particle, the [top-quark](#)  $172.9 \pm 1.5$  GeV! The heavier the mass, the shorter the mean-lifetime. The [Standard Model](#) predicts the [top-quark mean lifetime](#) to be roughly  $5 \times 10^{-25}$  s. This is about 20 times shorter than the timescale for strong interactions and therefore it does not [hadronize](#)! As is well known from [astro-physics](#) the gravitational force, which attracts masses of planets, travels with the speed-of-light, i.e. is massless. This astro-physical fact contradicts the assumed mass-range (23) completely. This simple fact alone shows that the [Higgs-mechanism](#), even though brightly discovered, cannot be correct! And when realizing that the [Higgs-mechanism](#) was developed without understanding the beautiful world of [QM](#), one also at-once understands why this mechanism is still assumed to be correct after more than 50 years.

In my thoughts, this is the century in which all possible [Theories Of Everything](#) finally come to life, just by *understanding*, instead of just “*knowing*”, our universe both on microscopic [QM](#)-scale and on macroscopic [astro-physical](#)-scale!

And to keep everybody positive, remember that our reality can *only* be analyzed in simple linear 4D-spacetime! And this is why also the demanded [CAP](#) compliance must be described in this simple linear, i.e. [mathematical](#), 4D-spacetime!

Albert Einstein himself assumed that [QM](#) could possibly be analyzed logical deterministic with the use of extra “hidden”-degrees of freedom as described in the [Einstein-Podolsky-Rosen](#) experiment. However, John Bell [showed](#) that all hidden-variable proposals must be incorrect because they shall never be able to explain the non-local behavior of [QM](#).

Besides that, all possible variables to describe our reality in 4D-Spacetime completely, but also, non-reducible at-once explains all possible variables for all possible different [elementary-particles](#) completely. As a direct result, we can NOT use “hidden”-variables to explain QM in a more logical manner.

However, when one describes [QM](#) in compliance to the [CAP](#), i.e. when describing all [elementary-particles](#) as extended harmonic-oscillating entities in the 2D-plane orthogonal to the analyzed direction of motion, the spin2 “*dual*” character comes to life naturally. The mathematical point of the harmonic oscillation cannot be on its average position “[worldline](#)”, so interaction must be described as interactions between 3D-harmonic-oscillating waves with either Closed-BC (bosons) or Open-BC (fermions). These mathematical analyses can only be solved in the [complex Hilbert-Space](#) of [QM](#)!

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P.S. To be able to explain [QM](#) in person with others *not* all results are given here (the massive solutions, force-constant k, etc. ..).