Einstein's Weltformel

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Abstract: As long as humans have been trying to understand the laws of objective reality, they have been proposing theories. In contrast to the well-known quantum theory, the most fundamental theory of matter currently available, Laplace's demon and Einstein's Weltformel are related more widely at least by standing out against the indeterminacy as stipulated by today's quantum theory. Randomness as such does not exclude a deterministic relationship between cause and effect, since every random event has its own cause. The purpose of this publication is to provide a satisfactory description of the microstructure of space-time by mathematising the deterministic relationship between cause and effect at quantum level in the form of a mathematical formula of the causal relationship k.

Key words: Quantum theory, relativity theory, unified field theory, causality.

1. Introduction

Despite our best and different approaches of theorists worldwide spanning more than thousands of years taken to describe the workings of the universe in general, to understand the nature at the most fundamental quantum level and to develop a theory of everything progress has been very slow. There are a lot of proposals and interpretations, some of them grounded on a picturesque interplay of observation and experiment with ideas. In short, the battle for the correct theory is not completely free of metaphysics. Yet, besides of the many efforts and attempts to reconcile quantum mechanics with general relativity an ultimate triumph of human reason on this matter is not in sight. There is still no single theory which provides a genuine insight and understanding of gravity and quantum mechanics, one of the most cherished dreams of physics and of science as such. Some of the front runners are the string theory, the loop quantum gravity et cetera and the quantum field theory. Among the numerous alternative proposals for reconciling quantum physics and general relativity theory, the mathematical and conceptual framework of quantum field theory (QFT) covers the electromagnetic, the weak and the strong interaction. In quantum field theory, there is a field associated to each type of a fundamental particle that appears in nature. However, quantization of a classical field proposed by quantum field theory is (philosophically) unsatisfactory since the very important and fundamental force in nature, gravitation, has defied quantization so far. The problems are related to the quantum mechanical framework as such. The usual axioms of quantum mechanics say that observables are represented by Hermitian operators which is not entirely true. At least one observable in quantum mechanics is not represented by a Hermitian operator: the time it self. Today, the time itself enters into the mathematical formalism of quantum mechanics but not as an eigenvalue of any operator. Our subsequent discussion will be restricted almost completely to both, the principles of general relativity and quantum theory.

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2. Definitions

2.1. **Definition. The Expectation Value Of A Random Variable X**

Let $_{R}X$ denote a random variable which can take the value $_{0}X$ with the probability $p(_{0}X)$, the value $_{1}X$ with the probability $p(_{1}X)$ and so on up to value $_{N}X$ with the probability $p(_{N}X)$. Then the expectation of a single random variable $_{i}X$ is defined as

$$E(_{i}X) \equiv p(_{i}X) \times _{i}X \tag{1}$$

while the expectation value of the population $E(_{R}X)$ is defined as

$$E(_{R}X) \equiv E(_{0}X) + E(_{1}X) + \ldots + E(_{N}X) \tag{2}$$

More important, all probabilities p_i add up to one ($p_0 + p_1 + \ldots + p_N = 1$). Quite naturally, the expected value can be viewed something like the weighted average, with p_i's being the weights.

$$E(_{R}X) \equiv \frac{p(_{0}X) \times_{0} X + p(_{1}X) \times_{1} X + \ldots + p(_{N}X) \times_{N} X}{p(_{0}X) + p(_{1}X) + \ldots + p(_{N}X)} \tag{3}$$

Under conditions where all outcomes $_{i}x$ are equally likely (that is, $p_0 = p_1 = \ldots = p_N$), the weighted average turns finally into a simple average.

2.2. **Definition. The Complex Conjugate Of A Random Variable X**

Let $_{i}X$ denote a random variable. Let $_{i}X^{*}$ denote the complex conjugate of the random variable $_{i}X$. The complex conjugate of a random variable $_{i}X^{*}$ (the asterisk indicates the complex conjugate) is defined as

$$_{i}X^{*} \equiv \frac{p(_{i}X)}{_{i}X} \equiv \frac{E(_{i}X)}{_{i}X^{2}}. \tag{4}$$

Consequently, it is $p(_{i}X) \equiv _{i}X \times _{i}X^{*} \equiv _{i}X \times \frac{E(_{i}X)}{_{i}X^{2}}$.

2.3. **Definition. Born's rule**

The meaning of the wave function and the status of the Born Rule depends to some extent upon the preferred formulation of quantum mechanics. The wave function (the set of all the amplitudes) as such assigns a (complex) number, called the "amplitude", i. e. to each possible measurement outcome. The measurement of a quantum system returns a number, denoted as the eigenvalue of the quantity being measured. Due to Born's rule, the probability of getting any particular eigenvalue is equal to the square of the corresponding amplitude for that eigenvalue

$$p(_{R}\Psi(t)) \equiv _{R}\Psi(t) \times _{R}\Psi^{*}(t) \tag{5}$$

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2.4. **Definition. The Variance Of A Random Variable X**

Let $_iX$ denote a random variable. Let $\sigma({}_iX)^2$ denote the variance of the random variable $_iX$. The variance of the random variable $_iX$ at a single Bernoulli trial t is defined as

$$\sigma({}_iX)^2 \equiv E({}_iX^2) - E({}_iX)^2 \equiv ({}_iX^2) \times p({}_iX) \times (1 - p({}_iX)) \tag{6}$$

or as

$$\sigma({}_iX)^2 \equiv {}_iX \times E({}_iX) - E({}_iX)^2 \equiv E({}_iX) \times ({}_iX - E({}_iX)) = E({}_iX) \times E({}_i\underline{X}) \tag{7}$$

where $E({}_i\underline{X}) = ({}_iX - E({}_iX)) = ({}_iX) \times (1 - p({}_iX))$ denotes something like an expectation value of anti $_iX$. Sometimes, this is called the "hidden" variable. Let $\sigma({}_iX)$ denote the standard deviation of the random variable $_iX$. The standard deviation of the random variable $_iX$ is defined as

$$\sigma({}_iX) \equiv \sqrt[2]{E({}_iX^2) - E({}_iX)^2} \equiv \sqrt[2]{({}_iX^2) \times p({}_iX) \times (1 - p({}_iX))} \tag{8}$$

2.5. **Definition. The Logical Contradiction And The Inner Contradiction Of A Random Variable X**

Let $\Delta({}_iX)^2$ denote the logical contradiction. We define

$$\Delta({}_iX)^2 \equiv \frac{\sigma({}_iX)^2}{({}_iX^2)} \equiv \frac{E({}_iX^2) - E({}_iX)^2}{({}_iX^2)} \equiv p({}_iX) \times (1 - p({}_iX)) \tag{9}$$

Let $\Delta({}_iX)$ denote the inner contradiction. We define

$$\Delta({}_iX) \equiv \frac{\sigma({}_iX)}{({}_iX)} \equiv \sqrt[2]{\frac{E({}_iX^2) - E({}_iX)^2}{({}_iX^2)}} \equiv \sqrt[2]{p({}_iX) \times (1 - p({}_iX))} \tag{10}$$

Scholium

Under conditions of special theory of relativity, $_RE$ can denote the expectation value as determined by the stationary observer R while $_0X$ can denote the value (i. e. after the collapse of the wave function) as determined by the moving observer O.

2.6. **Definition. The Schrödinger equation**

The famous Schrödinger equation [1], a partial differential equation which describes how a quantum state of a system changes with time. The Schrödinger equation **for any system**, **no matter whether relativistic or not**, no matter how complicated, has the form

$${}_R\hat{H} \times {}_R\Psi(t) = i\hbar \frac{\partial}{\partial t} {}_R\Psi(t), \tag{11}$$

where *i* is the imaginary unit, $\hbar = \frac{h}{2 \times \pi}$ is Planck's constant h divided by 2xπ, the symbol $\frac{\partial}{\partial t}$ indicates a partial derivative with respect to time t, $_R\Psi$ is the wave function of the quantum system, and $_R\hat{H}$ is the Hamiltonian operator.

2.7. Definition. The Quantum Mechanical Operator Of Energy $_{R}\hat{H}$

Let

$$_{R}\hat{H} \quad (12)$$

where $_{R}\hat{H}$ denotes the Hamiltonian, the quantum mechanical operator of energy.

Scholium.
The theory of quantum mechanics is built upon the fundamental concepts of operators and wave-functions. The Hamiltonian operator (=total energy operator), a Hermitian operator, is equal to the total energy of the system. The set of all allowed values of $_{R}\hat{H}$ is called the spectrum of the Hamiltonian $_{R}\hat{H}$. A solution of $_{R}\Psi(t)$ associated with an energy $_{0}\hat{H}$ is called an energy eigenstate of energy $_{R}\hat{H}$. The eigenstates $_{0}\hat{H}$ of the Hamiltonian $_{R}\hat{H}$ provide a useful set of functions. Consequently, an eigenstate $_{0}\hat{H}$ of the Hamiltonian operator $_{R}\hat{H}$ is one in which the energy is perfectly defined. When a system has a definite energy, all probabilities are constant, so that the state is stationary.

2.8. Definition. The Quantum Mechanical Eigenvalue Of Energy $_{0}\hat{H}$

The quantum mechanical operator associated with the total energy of a system is the Hamiltonian. The specific values of energy of the Hamiltonian are called energy eigenvalues. Let

$$_{0}\hat{H} \quad (13)$$

denote a specific energy eigenvalue associated with the quantum mechanical operator of energy.

2.9. Definition. The Quantum Mechanical Anti Eigenvalue Of Energy $_{\Delta}\hat{H}$

Let

$$_{\Delta}\hat{H} \equiv {}_{R}\hat{H} - {}_{0}\hat{H} \quad (14)$$

denote a specific anti eigenvalue of energy associated with the quantum mechanical operator of energy.

2.10. Definition. The Relationship Between An Eigenvalue And An Anti Eigenvalue Of The Quantum Mechanical Operator Of Energy $_{R}\hat{H}$

Let

$$_{R}\hat{H} \equiv {}_{0}\hat{H} + {}_{\Delta}\hat{H}\,. \quad (15)$$

Scholium.
In quantum field theory (QFT), the interaction picture, one splits up the Hamiltonian operator H into two parts H = H_0 + H_{int} , where H_0 describes the free system, i.e., the system without interaction, and H_{int} is the interaction part of the Hamiltonian. The above definition of the Hamiltonian operator H follows to some extent this logic but goes equally beyond the same. Under conditions of quantum field theory (QFT) there are situations where ${}_0\hat{H} \equiv H_o$ and ${}_\Delta\hat{H} \equiv H_{Int}$ or the other way.

2.11. Definition. The Quantum Mechanical Operator Of Matter ${}_R\hat{M}$

Let

$$ {}_R\hat{M} \equiv \frac{{}_R\hat{H}}{c^2}, \tag{16} $$

where ${}_R\hat{M}$ is quantum mechanical operator of matter (and not only of mass [2]), c is the speed of the light in vacuum and ${}_R\hat{H}$ is the Hamiltonian operator.

2.12. Definition. The Quantum Mechanical Operator ${}_0\hat{M}$

Let

$$ {}_0\hat{M} \equiv \frac{{}_0\hat{H}}{c^2} . \tag{17} $$

2.13. Definition. The Quantum Mechanical Operator ${}_\Delta\hat{M}$

Let

$$ {}_\Delta\hat{M} \equiv \frac{{}_\Delta\hat{H}}{c^2} . \tag{18} $$

2.14. Definition. The Wavefunction ${}_R\Psi$

Let

$$ {}_R\Psi(t) \tag{19} $$

denote the wavefunction.

2.15. Definition. The Eigenstate ${}_0\Psi(t)$

A wave function ${}_R\Psi(t)$ is in a superposition of several eigenstates. The wave function can reduce into a single eigenstate ${}_0\Psi(t)$ (i. e. out of itself or by a measurement et cetera). Thus far, let

$$ {}_0\Psi(t) \tag{20} $$

denote an eigenstate (i. e. after the collapse of the wavefunction) of the wavefunction $_{R}\Psi$.

2.16. **Definition. The Anti Eigenstate** $_{\Delta}\Psi(t)$

Let

$$_{\Delta}\Psi(t) \tag{21}$$

denote an anti eigenstate (i. e. after the collapse of the wavefunction) of the wavefunction $_{R}\Psi(t)$.

2.17. **Definition. The Quantum Mechanical Mathematical Identity $_{0}$S**

Let

$$_{0}S \equiv {}_{0}\hat{H} + {}_{0}\Psi(t), \tag{22}$$

where $_{0}\Psi(t)$ is an eigenstate of the wave function of the quantum system, and $_{0}\hat{H}$ is an eigenfunction of the Hamiltonian operator.

2.18. **Definition. The Quantum Mechanical Mathematical Identity $_{\Delta}$S**

Let

$$_{\Delta}S \equiv {}_{\Delta}\hat{H} + {}_{\Delta}\Psi(t). \tag{23}$$

where $_{\Delta}\Psi(t)$ is an anti eigenstate of the wave function of the quantum system, and $_{\Delta}\hat{H}$ is an anti eigenfunction of the Hamiltonian operator.

2.19. **Definition. The Quantum Mechanical Mathematical Identity $_{R}$S**

Let

$$_{R}S \equiv {}_{R}\hat{H} + {}_{R}\Psi(t) = {}_{0}S + {}_{\Delta}S \tag{24}$$

or

$$_{R}S \equiv {}_{R}\hat{H} + {}_{R}\Psi(t) = {}_{0}S + {}_{\Delta}S \equiv {}_{0}\hat{H} + {}_{\Delta}\hat{H} + {}_{0}\Psi(t) + {}_{\Delta}\Psi(t). \tag{25}$$

or as

$$\frac{_{R}S}{_{R}S} \equiv \frac{_{R}\hat{H}}{_{R}S} + \frac{_{R}\Psi(t)}{_{R}S} = \frac{_{0}S}{_{R}S} + \frac{_{\Delta}S}{_{R}S} \equiv + \frac{_{0}\hat{H}}{_{R}S} + \frac{_{\Delta}\hat{H}}{_{R}S} + \frac{_{0}\Psi(t)}{_{R}S} + + \frac{_{\Delta}\Psi(t)}{_{R}S} = 1. \tag{26}$$

Scholium.
The following figure may illustrate the above definitions from the standpoint of physics.

Fig.		“Curvature”		
		yes	no	
“Momentum”	yes	$_{0}\hat{H}$	$_{\Delta}\hat{H}$	$_{R}\hat{H}$
	no	$_{0}\Psi(t)$	$_{\Delta}\Psi(t)$	$_{R}\Psi(t)$
		$_{0}S$	$_{\Delta}S$	$_{R}S$

2.20. **Definition. The Quantum Mechanical Mathematical Identity $_{R}$N**

Let

$$_{R}N \equiv \frac{_{R}S}{c^2}. \tag{27}$$

2.21. **Definition. Einstein’s Cosmological “Constant” Λ**

In our understanding, we are assuming (an [experimental] proof is necessary) that

$$_{0}S + \Lambda \equiv {_{R}\hat{H}}. \tag{28}$$

where Λ denotes Einstein’s cosmological “ constant” Λ.

Scholium.
Due to the definition above, a firm grasp of what Einstein’s Cosmological “Constant” Λ is, and how the same is essential for a successful investigation of the world around us follows from the relationship $_{0}S + \Lambda \equiv {_{R}\hat{H}}$. The same relationship can be decomposed into the relationship between $_{0}\hat{H} + {_{0}\Psi(t)} + \Lambda \equiv {_{0}\hat{H}} + {_{\Delta}\hat{H}}$. Under these appropriate circumstances, the cosmological constant Λ follows as $+\Lambda \equiv {_{\Delta}\hat{H}} - {_{0}\Psi(t)}$. Due to this definition, the value of the anti cosmological constant Anti Λ follows as $\text{Anti } \Lambda \equiv R - \Lambda \equiv R - \left({_{\Delta}\hat{H}} - {_{0}\Psi(t)} \right)$, which is equivalent with $\text{Anti } \Lambda \equiv R - \Lambda \equiv R - {_{\Delta}H} + {_{0}\Psi(t)}$. Besides of all, experimental proofs on this matter are welcomed more than definitions.

2.22. **Definition. The Variance Of The Hamiltonian $_{R}\hat{H}$**

Let $\sigma\left({_{R}\hat{H}} \right)^2$ denote the variance of the Hamiltonian $_{R}\hat{H}$. The variance of the Hamiltonian $_{R}\hat{H}$ is defined as

$$\sigma\left({}_{R}\hat{H}\right)^{2} \equiv E\left({}_{R}\hat{H}^{2}\right)-E\left({}_{R}\hat{H}\right)^{2} \equiv \left({}_{R}\hat{H}^{2}\right)\times p\left({}_{R}\hat{H}\right)\times\left(1-p\left({}_{R}\hat{H}\right)\right) \qquad (29)$$

where $p\left({}_{R}\hat{H}\right)$ denotes the probability as associated with the Hamiltonian ${}_{R}\hat{H}$. The standard deviation of the Hamiltonian ${}_{R}\hat{H}$ follows as

$$\sigma\left({}_{R}\hat{H}\right) \equiv \sqrt[2]{E\left({}_{R}\hat{H}^{2}\right)-E\left({}_{R}\hat{H}\right)^{2}} \equiv \left|{}_{R}\hat{H}\right|\times\sqrt[2]{p\left({}_{R}\hat{H}\right)\times\left(1-p\left({}_{R}\hat{H}\right)\right)} \qquad (30)$$

where $E\left({}_{R}\hat{H}^{2}\right)$ denotes the expectation value of the Hamiltonian ${}_{R}\hat{H}$ squared and $E\left({}_{R}\hat{H}\right)$ denotes the expectation value of the Hamiltonian ${}_{R}\hat{H}$.

2.23. Definition. The Quantum Mechanical Identity $\Delta\left({}_{R}\hat{H}\right)^{2}$

In general, we define

$$\Delta\left({}_{R}\hat{H}\right)^{2} \equiv \frac{\sigma\left({}_{R}\hat{H}\right)^{2}}{\left({}_{R}\hat{H}\right)^{2}} \qquad (31)$$

Due to this definition, it is

$$\left|{}_{R}\hat{H}\right| \equiv \frac{\sigma\left({}_{R}\hat{H}\right)}{\Delta\left({}_{R}\hat{H}\right)} = \sqrt[2]{\frac{\sigma\left({}_{R}\hat{H}\right)^{2}}{\left({}_{R}\hat{H}\right)^{2}}} \qquad (32)$$

2.24. Definition. The Variance Of Mathematical Identity ${}_{0}S$

Let $\sigma\left({}_{0}S\right)^{2}$ denote the variance of the mathematical identity ${}_{0}S$. Let $\sigma\left({}_{0}S\right)^{2}$ denote the variance of the mathematical identity ${}_{0}S$. The variance of the mathematical identity ${}_{0}S$ is defined as

$$\sigma\left({}_{0}S\right)^{2} \equiv E\left({}_{0}S^{2}\right)-E\left({}_{0}S\right)^{2} \equiv \left({}_{0}S^{2}\right)\times p\left({}_{0}S\right)\times\left(1-p\left({}_{0}S\right)\right) \qquad (33)$$

where $p\left({}_{0}S\right)$ denotes the probability as associated with the mathematical identity ${}_{0}S$. The standard deviation of the mathematical identity ${}_{0}S$ follows as

$$\sigma\left({}_0S\right) \equiv \sqrt[2]{E\left({}_0S^2\right) - E\left({}_0S\right)^2} \equiv \left|{}_0S\right| \times \sqrt[2]{p\left({}_0S\right) \times \left(1 - p\left({}_0S\right)\right)} \tag{34}$$

where $E\left({}_0S^2\right)$ denotes the expectation value of the mathematical identity ${}_0S$ squared and $E\left({}_0S\right)$ denotes the expectation value of the mathematical identity ${}_0S$.

2.25. **Definition. The Quantum Mechanical Identity** $\Delta\left({}_0S\right)^2$

In general, we define

$$\Delta\left({}_0S\right)^2 \equiv \frac{\sigma\left({}_0S\right)^2}{{}_0S^2} \tag{35}$$

Due to this definition, it is

$$\frac{\sigma\left({}_0S\right)}{\Delta\left({}_0S\right)} \equiv \left|{}_0S\right|. \tag{36}$$

2.26. **Definition. The Co-Variance Of The Hamiltonian** ${}_R\hat{H}$ **And The Mathematical Identity** ${}_0S$**.**

Let $\sigma\left({}_R\hat{H}, {}_0S\right)$ denote the co-variance of the Hamiltonian ${}_R\hat{H}$ and the mathematical identity ${}_0S$. Let $p\left({}_0S\right)$ denote the probability as associated with the mathematical identity ${}_0S$. Let $p\left({}_R\hat{H}\right)$ denote the probability as associated with the Hamiltonian ${}_R\hat{H}$. Let $p\left({}_R\hat{H},{}_0S\right)$ denote the joint probability distribution/density function as associated with the Hamiltonian ${}_R\hat{H}$ and the mathematical identity ${}_0S$. The co-variance $\sigma\left({}_R\hat{H}, {}_0S\right)$ of the Hamiltonian ${}_R\hat{H}$ and the mathematical identity ${}_0S$ is defined as

$$\sigma\left({}_{R}\hat{H}\,,\,{}_{0}S\right) \equiv E\left({}_{R}\hat{H},{}_{0}S\right) - E\left({}_{R}\hat{H}\right) \times E\left({}_{0}S\right) \tag{37}$$

or as

$$\sigma\left({}_{R}\hat{H}\,,\,{}_{0}S\right) \equiv \left|{}_{R}\hat{H}\right| \times \left|{}_{0}S\right| \times \left(p\left({}_{R}\hat{H},{}_{0}S\right) - p\left({}_{R}\hat{H}\right) \times p\left({}_{0}S\right)\right). \tag{38}$$

2.27. **Definition. The Quantum Mechanical Identity** $\Delta\left({}_{R}\hat{H},{}_{0}S\right)$

In general, we define

$$\sigma\left({}_{R}\hat{H},\,{}_{0}S\right) \equiv \left|{}_{R}\hat{H}\right| \times \left|{}_{0}S\right| \times \Delta\left({}_{R}\hat{H},\,{}_{0}S\right). \tag{39}$$

Due to this definition, it is

$$\frac{\sigma\left({}_{R}\hat{H},\,{}_{0}S\right)}{\Delta\left({}_{R}\hat{H},\,{}_{0}S\right)} \equiv \left|{}_{R}\hat{H}\right| \times \left|{}_{0}S\right|. \tag{40}$$

2.28. **Definition. Einstein's Weltformel. The Mathematical Formula Of The Causal Relationship k**

In general, we define the mathematical formula of the causal relationship k (Einstein's Weltformel) as

$$k\left({}_{R}\hat{H}\,,\,{}_{0}S\right) \equiv \frac{\sigma\left({}_{R}\hat{H},\,{}_{0}S\right)}{\sigma\left({}_{R}\hat{H}\right) \times \sigma\left({}_{0}S\right)} \equiv \frac{\Delta\left({}_{R}\hat{H},\,{}_{0}S\right)}{\Delta\left({}_{R}\hat{H}\right) \times \Delta\left({}_{0}S\right)} \equiv \frac{\left({}_{R}S \times {}_{0}\hat{H}\right) - \left({}_{R}\hat{H} \times {}_{0}S\right)}{\sqrt[2]{{}_{0}S \times {}_{\Delta}S \times {}_{R}\hat{H} \times {}_{R}\Psi(t)}} \tag{41}$$

Scholium.
The mathematical formula of the causal relationship k (Einstein's Weltformel) can take several values: $-1 \leq k\left({}_{R}\hat{H}\,,\,{}_{0}S\right) \leq +1$. An overview may illustrate the relationships again.

Fig.		**Effectum**		
		yes	no	
Causa	yes	${}_{0}\hat{H}$	${}_{\Delta}\hat{H}$	${}_{R}\hat{H}$
	no	${}_{0}\Psi(t)$	${}_{\Delta}\Psi(t)$	${}_{R}\Psi(t)$
		${}_{0}S$	${}_{\Delta}S$	${}_{R}S$

2.29. **Axioms.**

The following theory is based on the following axioms.

Axiom I. (Lex identitatis)

$$+1 = +1. \qquad \text{(Axiom I)}$$

Axiom II.

$$\frac{+0}{+0} \equiv +1 \qquad \text{(Axiom II)}$$

Scholium.
We are of the opinion that (0 +X)/(0 + X) =1. From this follows that (0 +X)=1*(0 + X) or that +X=+ X, which is true, even if +X =+0. In contrast to this, 0 / (0 +X) = 1 only if X = 0, otherwise not.

Axiom III.

$$\frac{+1}{+0} \equiv +\infty \qquad \text{(Axiom III)}$$

Scholium.
Consequently, we must accept that $+1 \equiv +\infty \times +0$.

3. Theorems

3.1. **Theorem. Newton's Third Law.**

Due to Newton's third law, forces between two (quantum mechanical) objects exist in equal magnitude and opposite direction.

Claim.
Newton's third law can be derived from axiom I as

$$ {}_{A}\overrightarrow{F} - {}_{B}\overleftarrow{F} = 0. \tag{42}$$

Proof.
Starting with Axiom I it is

$$ +1 = +1. \tag{43}$$

Multiplying this equation by the force ${}_{A}\overrightarrow{F}$ we obtain

$$ {}_{A}\overrightarrow{F} = {}_{A}\overrightarrow{F}. \tag{44}$$

Subtracting ${}_{A}\overrightarrow{F}$ it follows that

$$ {}_{A}\overrightarrow{F} - {}_{A}\overrightarrow{F} = 0 \tag{45}$$

Due to Newton's third law it is ${}_{A}\overrightarrow{F} - {}_{B}\overleftarrow{F} = 0$. We rearrange the equation above and obtain

$$ {}_{A}\overrightarrow{F} - {}_{A}\overrightarrow{F} = {}_{A}\overrightarrow{F} - {}_{B}\overleftarrow{F} \quad . \tag{46}$$

Subtracting ${}_{A}\overrightarrow{F}$ yields

$$ - {}_{A}\overrightarrow{F} = - {}_{B}\overleftarrow{F} \quad . \tag{47}$$

And at the end Newton's third law as

$$ {}_{A}\overrightarrow{F} - {}_{B}\overleftarrow{F} = 0. \tag{48}$$

Quod erat demonstrandum.

Scholium.
Newton's axioms can be derived from the axioms as presented in this theory without any contradiction.

3.2. **Theorem. The Measure Of Probability p Is Reference Frame Independent.**

Coordinate systems are used in describing nature and physical laws. But does a coordinate system exist *a priori* in nature? What is the relationship between a coordinate system and physical law? Are the physical laws independent of the choice of a coordinate system related to each other by *any kind* of relative motion? Can a physical law take the same mathematical form in all coordinate systems (*Einstein's principle of general covariance*)?

Claim.

Under conditions of the special theory of relativity, the probability measure p is reference frame or coordinate system independent. We obtain

$$ {}_{O}p = {}_{R}p \tag{49} $$

Proof.

It is

$$ E({}_{O}m) = E({}_{O}m) \tag{50} $$

or due to special relativity

$$ E({}_{O}m) = E\left(\sqrt[2]{1-\frac{v^2}{c^2}} \times {}_{R}m\right) \tag{51} $$

Under conditions of special theory of relativity, the term $\sqrt[2]{1-\frac{v^2}{c^2}}$ = constant. In general, due to mathematical statistics, it is **E(constant * X) = constant * E(X)** , where E(X) denotes the expectation value. We obtain

$$ E({}_{O}m) = \sqrt[2]{1-\frac{v^2}{c^2}} \times E({}_{R}m) \ . \tag{52} $$

Rearranging equation yields

$$ \frac{E({}_{O}m)}{E({}_{R}m)} = \sqrt[2]{1-\frac{v^2}{c^2}} \tag{53} $$

and equally

$$ \frac{E({}_{O}m)}{E({}_{R}m)} = \frac{{}_{O}p \times {}_{O}m}{{}_{R}p \times {}_{R}m} = \sqrt[2]{1-\frac{v^2}{c^2}} \tag{54} $$

where ${}_{0}p$ denotes the probability of ${}_{0}m$ as determined by the co-*moving* observer (observer at rest relative to ${}_{0}m$) and ${}_{R}p$ denotes the probability of ${}_{R}m$ as determined by the *stationary* observer. We obtain

$$\frac{{}_{O}p \times {}_{O}m}{{}_{R}p \times {}_{R}m} = \sqrt[2]{1-\frac{v^2}{c^2}} . \tag{55}$$

Due to special relativity it is

$$\frac{{}_{O}p \times {}_{O}m}{{}_{R}p} \times \frac{\sqrt[2]{1-\frac{v^2}{c^2}}}{{}_{O}m} = \sqrt[2]{1-\frac{v^2}{c^2}} \tag{56}$$

The most terms cancel out. We obtain

$$\frac{{}_{O}p}{{}_{R}p} = 1 \tag{57}$$

which completes our proof. Under conditions of the special theory of relativity it is

$${}_{O}p = {}_{R}\ p \tag{58}$$

Quod erat demonstrandum.

Scholium.
In principle, probability is reference frame independent. The probability is left unchanged if it is measured within a co-ordinate system moving with some other, constant velocity. This proof is of far reaching and general importance especially for quantum field theory. Under conditions of the theory of special relativity the *stationary* and the *moving* observer will agree on the probability *p* of a random variable while both observers will disagree at the same time on the expectation value (in principle). We see from the proof above that in relativistic quantum theory, the probability is left unchanged if it is measured in a co-ordinate system moving with some other constant relative velocity. In attempts to extend the quantum theory to the relativistic domain, serious difficulties have arisen. Thus far, is this theorem valid under conditions of the general theory of relativity too? Under conditions of the general theory of relativity at every space-time point there exist a locally inertial reference frames in which the physics of general theory of relativity is locally indistinguishable from that of special relativity (*Einstein's famous strong equivalence principle*). Due to our proof above, it is reasonable to expect that probability theory is of use even under conditions of the general theory of relativity. A reference frame independent account of probability is appropriate for causal inference. Any subjective interpretation of probability advocated by some prominent philosopher and psychologist has no place in science.

3.3. **Theorem.**

Claim.
Schrödinger's wave equation can be expressed as

$$ {}_{R}S \times {}_{R}\Psi(t) - {}_{R}\Psi(t) \times {}_{R}\Psi(t) \equiv {}_{R}\hat{H} \times {}_{R}\Psi(t) \tag{59} $$

Proof.
Starting with Axiom I it is

$$ +1 = +1 . \tag{60} $$

Multiplying this equation by ${}_{R}S$ we obtain

$$ {}_{R}S = {}_{R}S . \tag{61} $$

which is equal to

$$ {}_{R}S \equiv {}_{R}\hat{H} + {}_{R}\Psi(t) \tag{62} $$

Multiplying this equation by the wave function ${}_{R}\Psi(t)$ we obtain

$$ {}_{R}S \times {}_{R}\Psi(t) \equiv {}_{R}\hat{H} \times {}_{R}\Psi(t) + {}_{R}\Psi(t) \times {}_{R}\Psi(t) \tag{63} $$

After subtraction ${}_{R}\Psi(t) \times {}_{R}\Psi(t)$, we obtain

$$ {}_{R}S \times {}_{R}\Psi(t) - {}_{R}\Psi(t) \times {}_{R}\Psi(t) \equiv {}_{R}\hat{H} \times {}_{R}\Psi(t) \tag{64} $$

Quod erat demonstrandum.

3.4. **Theorem.**

Claim.
Schrödinger's wave equation can be expressed as

$$ {}_{R}S \times {}_{R}\hat{H} - {}_{R}\hat{H} \times {}_{R}\hat{H} \equiv {}_{R}\hat{H} \times {}_{R}\Psi(t) \tag{65} $$

Proof.
Starting with Axiom I it is

$$ +1 = +1 . \tag{66} $$

Multiplying this equation by ${}_{R}S$ we obtain

$$ {}_{R}S = {}_{R}S . \tag{67} $$

which is equal to

$$ {}_{R}S \equiv {}_{R}\hat{H} + {}_{R}\Psi(t) \tag{68} $$

Multiplying this equation by the wave function ${}_{R}\hat{H}$ we obtain

$$ {}_{R}S \times {}_{R}\hat{H} \equiv {}_{R}\hat{H} \times {}_{R}\hat{H} + {}_{R}\hat{H} \times {}_{R}\Psi(t) \tag{69} $$

After subtraction ${}_{R}\hat{H} \times {}_{R}\hat{H}$, we obtain

$$ {}_{R}S \times {}_{R}\hat{H} - {}_{R}\hat{H} \times {}_{R}\hat{H} \equiv {}_{R}\hat{H} \times {}_{R}\Psi(t) \tag{70} $$

Quod erat demonstrandum.

3.5. **Theorem.**

Claim.
Schrödinger's wave equation can be expressed as

$$ {}_R S \times {}_R \hat{H} - {}_R \hat{H} \times {}_R \hat{H} \equiv {}_R \hat{H} \times {}_R \Psi(t) \quad (71) $$

Proof.
Starting with Axiom I it is

$$ +1 = +1 . \quad (72) $$

Multiplying this equation by ${}_R \hat{H} \times {}_R \Psi(t)$ we obtain

$$ {}_R \hat{H} \times {}_R \Psi(t) = {}_R \hat{H} \times {}_R \Psi(t) . \quad (73) $$

Due to our theorems above, this is equal to

$$ {}_R S \times {}_R \hat{H} - {}_R \hat{H} \times {}_R \hat{H} \equiv {}_R S \times {}_R \Psi(t) - {}_R \Psi(t) \times {}_R \Psi(t) \quad (74) $$

Rearranging this equation we obtain

$$ {}_R S \times {}_R \hat{H} - {}_R S \times {}_R \Psi(t) \equiv {}_R \hat{H} \times {}_R \hat{H} - {}_R \Psi(t) \times {}_R \Psi(t) \quad (75) $$

or

$$ {}_R S \times \left({}_R \hat{H} - {}_R \Psi(t) \right) \equiv {}_R \hat{H} \times {}_R \hat{H} - {}_R \Psi(t) \times {}_R \Psi(t) \quad (76) $$

Quod erat demonstrandum.

3.6. **Theorem. I. The Unknown Parameter Y.**

Claim.
The unknown parameter Y follows as

$$ Y \equiv \frac{1}{{}_R S} \quad (77) $$

Proof.
Starting with Axiom I it is

$$ +1 = +1 . \quad (78) $$

Multiplying this equation by ${}_R S \times Y$ we obtain

$$ {}_R S \times Y \equiv {}_R S \times Y \quad (79) $$

In this way, the multiplication ${}_R S$ of by the unknown parameter Y must ensure under any circumstances that ${}_R S \times Y \equiv 1$. Thus far, the multiplication by Y changes the equation above to

$${}_{R}S \times Y \equiv 1 \tag{80}$$

Consequently, on property of the unknown parameter Y is determined as

$$Y \equiv \frac{1}{{}_{R}S} \tag{81}$$

Quod erat demonstrandum.

3.7. **Theorem. II. The Unknown Parameter Y: The Equivalence Of The Unknown Parameter Y And The Complex Conjugate Of The Wavefunction $_{R}\Psi^{*}$(t).**

On property of the unknown parameter Y is determined as $Y \equiv \frac{1}{{}_{R}S}$. At the same time, the unknown parameter Y must ensure another important condition. If we multiply the wave function $_{R}\Psi$(t) by the same unknown parameter Y, we must obtain the probability due to Born's rule.

Claim.
The second property of the unknown parameter Y follows as

$$Y = \frac{p\left({}_{R}\Psi(t)\right)}{{}_{R}\Psi(t)} = {}_{R}\Psi^{*}(t). \tag{82}$$

Proof.
Starting with Axiom I it is

$$+1 = +1. \tag{83}$$

Multiplying this equation by the wavefunction $_{R}\Psi$(t)*Y we obtain

$${}_{R}\Psi(t) \times Y = {}_{R}\Psi(t) \times Y. \tag{84}$$

Following Born's rule, the equation $_{R}\Psi$(t)*Y should yield $|{}_{R}\Psi(t)|^{2}=p({}_{R}\Psi(t))={}_{R}\Psi(t)*Y$. We obtain

$${}_{R}\Psi(t) \times Y = p\left({}_{R}\Psi(t)\right) = \left|{}_{R}\Psi(t)\right|^{2}. \tag{85}$$

Thus far, it follows that the unknown parameter Y is determined as

$$Y = \frac{p\left({}_{R}\Psi(t)\right)}{{}_{R}\Psi(t)} == {}_{R}\Psi^{*}(t). \tag{86}$$

Quod erat demonstrandum.

3.8. **Theorem. The Unified Field.**

Claim.
Under the above conditions, the unknown parameter Y follows as

$$ {}_R\Psi^*(t) \times {}_R S = {}_R\Psi^*(t) \times \left({}_R\hat{H} + {}_R\Psi(t) \right) = 1 \tag{87}$$

Proof.
Starting with Axiom I it is

$$ +1 = +1 . \tag{88}$$

Multiplying this equation by Y we obtain

$$ Y \equiv Y \tag{89}$$

Due to our theorem above it is $Y = \frac{p({}_R\Psi(t))}{{}_R\Psi(t)}$. Thus far, it follows that

$$ \frac{p({}_R\Psi(t))}{{}_R\Psi(t)} = Y \tag{90}$$

Further, due to previous theorem above, it is $Y \equiv \frac{1}{{}_R S}$. We obtain

$$ \frac{p({}_R\Psi(t))}{{}_R\Psi(t)} = \frac{1}{{}_R S} = Y \tag{91}$$

Due to quantum theory, the complex conjugate of the wavefunction ${}_R\Psi^*(t)$ is defined as

${}_R\Psi^*(t) \equiv \frac{p({}_R\Psi(t))}{{}_R\Psi(t)} = |{}_R\Psi(t)|^2$. It follows that

$$ {}_R\Psi^*(t) = \frac{1}{{}_R S} = Y \tag{92}$$

This equation can be multiplied by ${}_R S$. Thus far, in general we must accept that

$$ {}_R\Psi^*(t) \times {}_R S = {}_R\Psi^*(t) \times \left({}_R\hat{H} + {}_R\Psi(t) \right) = 1 \tag{93}$$

Quod erat demonstrandum.

3.9. **Theorem. The probability associated with the Hamiltonian**

Claim.
The probability associated with the Hamiltonian is equal to

$$\left({}_{R}\hat{H} \times {}_{R}\Psi^{*}(t)\right) \equiv 1 - p\left({}_{R}\Psi(t)\right). \tag{94}$$

Proof.
Starting with Axiom I it is

$$+1 = +1. \tag{95}$$

Multiplying this equation by $\left({}_{R}\hat{H} + {}_{R}\Psi(t)\right)$ we obtain

$$\left({}_{R}\hat{H} + {}_{R}\Psi(t)\right) \equiv \left({}_{R}\hat{H} + {}_{R}\Psi(t)\right) \tag{96}$$

which is equivalent too

$$\left({}_{R}\hat{H} + {}_{R}\Psi(t)\right) \equiv {}_{R}S\ . \tag{97}$$

Multiplying by the complex conjugate ${}_{R}\Psi^{*}(t)$ of the wave function, we obtain

$$\left({}_{R}\hat{H} \times {}_{R}\Psi^{*}(t) + {}_{R}\Psi(t) \times {}_{R}\Psi^{*}(t)\right) \equiv {}_{R}S \times {}_{R}\Psi^{*}(t)\ . \tag{98}$$

Due to our theorem above it is ${}_{R}\Psi^{*}(t) \times {}_{R}S = 1$. This equation changes to

$$\left({}_{R}\hat{H} \times {}_{R}\Psi^{*}(t) + {}_{R}\Psi(t) \times {}_{R}\Psi^{*}(t)\right) \equiv 1\ . \tag{99}$$

Due to Born's rule, it is ${}_{R}\Psi(t) \times {}_{R}\Psi^{*}(t) = p\left({}_{R}\Psi(t)\right)$. The equation changes to

$$\left({}_{R}\hat{H} \times {}_{R}\Psi^{*}(t)\right) + p\left({}_{R}\Psi(t)\right) \equiv 1\ . \tag{100}$$

Consequently, in general, it is

$$\left({}_{R}\hat{H} \times {}_{R}\Psi^{*}(t)\right) \equiv 1 - p\left({}_{R}\Psi(t)\right). \tag{101}$$

Quod erat demonstrandum.

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The following figure may provide a preliminary review of the defined relationships.

Fig.		Effectum		
		yes	no	
Causa	yes	$_{0}\hat{H}$	$_{\Delta}\hat{H}$	$_{R}\hat{H}$
	no	$_{0}\Psi(t)$	$_{\Delta}\Psi(t)$	$_{R}\Psi(t)$
		$_{0}S$	$_{\Delta}S$	$_{R}S$

3.10. **Theorem.**

Let p($_{\Delta}$S) denote the probability as associated with $_{\Delta}$S. Let Y denote an unknown parameter which assures the relationship $_{\Delta}S \times Y = p(_{\Delta}S)$. Due to the theorem above it is equally $Y = \frac{1}{_{R}S}$.

Claim.
Under these conditions it is

$$_{\Delta}S \times \frac{1}{_{R}S} \equiv p(_{\Delta}S). \tag{102}$$

Proof.
Starting with Axiom I it is

$$+1 = +1. \tag{103}$$

Multiplying this equation by $_{\Delta}S \times Y$ we obtain

$$_{\Delta}S \times Y = _{\Delta}S \times Y. \tag{104}$$

The parameter Y assures that

$$_{\Delta}S \times Y \equiv p(_{\Delta}S). \tag{105}$$

Due to our theorem above it is $Y = \frac{1}{_{R}S} = _{R}\Psi^{*}(t)$. Thus far, the equality changes to

$$_{\Delta}S \times \frac{1}{_{R}S} \equiv _{\Delta}S \times _{R}\Psi^{*}(t) \equiv p(_{\Delta}S). \tag{106}$$

Quod erat demonstrandum.

3.11. **Theorem.**

Let $p\left({}_R\hat{H}\right)$ denote the probability as associated with the Hamiltonian ${}_R\hat{H}$. Let Y denote an unknown parameter which assures the relationship ${}_R\hat{H} \times Y = p\left({}_R\hat{H}\right)$. Due to the theorem above it is equally $Y = \frac{1}{{}_R S}$.

Claim.
Under these conditions it is

$${}_R\hat{H} \times \frac{1}{{}_R S} \equiv p\left({}_R\hat{H}\right). \tag{107}$$

Proof.
Starting with Axiom I it is

$$+1 = +1. \tag{108}$$

Multiplying this equation by ${}_R\hat{H} \times Y$ we obtain

$${}_R\hat{H} \times Y = {}_R\hat{H} \times Y. \tag{109}$$

The parameter Y assures that

$${}_R\hat{H} \times Y \equiv p\left({}_R\hat{H}\right). \tag{110}$$

Due to our theorem above it is $Y = \frac{1}{{}_R S} = {}_R\Psi^*(t)$. Thus far, the equality changes to

$${}_R\hat{H} \times \frac{1}{{}_R S} \equiv {}_R\hat{H} \times {}_R\Psi^*(t) \equiv p\left({}_R\hat{H}\right). \tag{111}$$

Quod erat demonstrandum.

3.12. **Theorem.**

Let $p\left({}_{0}\hat{H}\right) \equiv p\left({}_{R}\hat{H} \cap {}_{0}S\right)$ denote the probability as associated with ${}_{0}\hat{H}$. Let Y denote an unknown parameter which assures the relationship ${}_{0}\hat{H} \times Y = p\left({}_{0}\hat{H}\right)$. Due to the theorem above it is equally true that $Y = \frac{1}{{}_{R}S}$.

Claim.
Under these conditions it is

$${}_{0}\hat{H} \times \frac{1}{{}_{R}S} \equiv p\left({}_{0}\hat{H}\right). \tag{112}$$

Proof.
Starting with Axiom I it is

$$+1 = +1. \tag{113}$$

Multiplying this equation by ${}_{0}\hat{H} \times Y$ we obtain

$${}_{0}\hat{H} \times Y = {}_{0}\hat{H} \times Y. \tag{114}$$

The parameter Y assures that

$${}_{0}\hat{H} \times Y \equiv p\left({}_{0}\hat{H}\right). \tag{115}$$

Due to our theorem above it is $Y = \frac{1}{{}_{R}S} = {}_{R}\Psi^{*}(t)$. Thus far, the equality changes to

$${}_{0}\hat{H} \times \frac{1}{{}_{R}S} \equiv {}_{0}\hat{H} \times {}_{R}\Psi^{*}(t) \equiv p\left({}_{0}\hat{H}\right). \tag{116}$$

Quod erat demonstrandum.

3.13. **Theorem.**

Let $p\left({}_{\Delta}\hat{H}\right) \equiv p\left({}_{R}\hat{H} \cap {}_{\Delta}S\right)$ denote the probability as associated with ${}_{\Delta}\hat{H}$. Let Y denote an unknown parameter which assures the relationship ${}_{\Delta}\hat{H} \times Y = p\left({}_{\Delta}\hat{H}\right)$. Due to the theorem above it is equally true that $Y = \frac{1}{{}_{R}S}$.

Claim.
Under these conditions, we must accept that

$$ {}_{\Delta}\hat{H} \times \frac{1}{{}_{R}S} \equiv p\left({}_{\Delta}\hat{H}\right). \tag{117} $$

Proof.
Starting with Axiom I it is

$$ +1 = +1. \tag{118} $$

Multiplying this equation by ${}_{\Delta}\hat{H} \times Y$ we obtain

$$ {}_{\Delta}\hat{H} \times Y = {}_{\Delta}\hat{H} \times Y. \tag{119} $$

The parameter Y assures that

$$ {}_{\Delta}\hat{H} \times Y \equiv p\left({}_{\Delta}\hat{H}\right). \tag{120} $$

Due to our theorem above it is $Y = \frac{1}{{}_{R}S} = {}_{R}\Psi^{*}(t)$. Thus far, the equality changes to

$$ {}_{\Delta}\hat{H} \times \frac{1}{{}_{R}S} \equiv {}_{\Delta}\hat{H} \times {}_{R}\Psi^{*}(t) \equiv p\left({}_{\Delta}\hat{H}\right). \tag{121} $$

Quod erat demonstrandum.

3.14. **Theorem.**

Let $p({}_0\Psi(t)) \equiv p\left({}_R\Psi(t) \cap {}_0S\right)$ denote the probability as associated with ${}_0\Psi(t)$. Let Y denote an unknown parameter which assures the relationship ${}_0\Psi(t) \times Y = p({}_0\Psi(t))$. Due to the theorem above it is equally true that $Y = \frac{1}{{}_RS}$.

Claim.
Under these conditions it is

$$ {}_0\Psi(t) \times \frac{1}{{}_RS} \equiv p({}_0\Psi(t)). \tag{122}$$

Proof.
Starting with Axiom I it is

$$ +1 = +1. \tag{123}$$

Multiplying this equation by ${}_0\Psi(t) \times Y$ we obtain

$$ {}_0\Psi(t) \times Y = {}_0\Psi(t) \times Y. \tag{124}$$

The parameter Y assures that

$$ {}_0\Psi(t) \times Y \equiv p({}_0\Psi(t)). \tag{125}$$

Due to our theorem above it is $Y = \frac{1}{{}_RS} = {}_R\Psi^*(t)$. Thus far, the equality changes to

$$ {}_0\Psi(t) \times \frac{1}{{}_RS} \equiv {}_0\Psi(t) \times {}_R\Psi^*(t) \equiv p({}_0\Psi(t)). \tag{126}$$

Quod erat demonstrandum.

3.15. **Theorem.**

Let $p\left({}_{\Delta}\Psi(t)\right) \equiv p\left({}_{R}\Psi(t) \cap {}_{\Delta}S\right)$ denote the probability as associated with ${}_{\Delta}\Psi(t)$. Let Y denote an unknown parameter which assures the relationship ${}_{\Delta}\Psi(t) \times Y = p\left({}_{\Delta}\Psi(t)\right)$. Due to the theorem above it is equally true that $Y = \frac{1}{{}_{R}S}$.

Claim.
Under these conditions it is

$$ {}_{\Delta}\Psi(t) \times \frac{1}{{}_{R}S} \equiv p\left({}_{\Delta}\Psi(t)\right). \quad (127) $$

Proof.
Starting with Axiom I it is

$$ +1 = +1. \quad (128) $$

Multiplying this equation by ${}_{\Delta}\Psi(t) \times Y$ we obtain

$$ {}_{\Delta}\Psi(t) \times Y = {}_{\Delta}\Psi(t) \times Y. \quad (129) $$

The parameter Y assures that

$$ {}_{\Delta}\Psi(t) \times Y \equiv p\left({}_{\Delta}\Psi(t)\right). \quad (130) $$

Due to our theorem above it is $Y = \frac{1}{{}_{R}S} = {}_{R}\Psi^{*}(t)$. Thus far, the equality changes to

$$ {}_{\Delta}\Psi(t) \times \frac{1}{{}_{R}S} \equiv {}_{\Delta}\Psi(t) \times {}_{R}\Psi^{*}(t) \equiv p\left({}_{\Delta}\Psi(t)\right). \quad (131) $$

Quod erat demonstrandum.

Scholium.
The above theorems are assuring the following picture. We know about the relationship

$$ {}_{R}S \equiv {}_{R}\hat{H} + {}_{R}\Psi(t) = {}_{0}S + {}_{\Delta}S \equiv {}_{0}\hat{H} + {}_{\Delta}\hat{H} + {}_{0}\Psi(t) + {}_{\Delta}\Psi(t). \quad (132) $$

Multiplying this equation by ${}_{R}\Psi^{*}(t)$ we obtain

$$
\begin{aligned}
{}_R S \times {}_R\Psi^*(t) &\equiv {}_R\hat{H} \times {}_R\Psi^*(t) + {}_R\Psi(t) \times {}_R\Psi^*(t) \\
&\equiv {}_0 S \times {}_R\Psi^*(t) + {}_\Delta S \times {}_R\Psi^*(t) \qquad (133)\\
&\equiv {}_0\hat{H} \times {}_R\Psi^*(t) + {}_\Delta\hat{H} \times {}_R\Psi^*(t) + {}_0\Psi(t) \times {}_R\Psi^*(t) + {}_\Delta\Psi(t) \times {}_R\Psi^*(t)
\end{aligned}
$$

which may be illustrated as follows:

Fig.		"Curvature"		
		yes	no	
"Momentum"	yes	${}_0\hat{H} \times {}_R\Psi^*(t)$	$\times {}_R\Psi^*(t)_\Delta \hat{H}$	${}_R\hat{H} \times {}_R\Psi^*(t)$
	no	${}_0\Psi(t) \times {}_R\Psi^*(t)$	${}_\Delta\Psi(t) \times {}_R\Psi^*(t)$	${}_R\Psi(t) \times {}_R\Psi^*(t)$
		${}_0 S \times {}_R\Psi^*(t)$	${}_\Delta S \times {}_R\Psi^*(t)$	${}_R S \times {}_R\Psi^*(t) = 1$

which is equivalent with

$$
\begin{aligned}
1 &\equiv p\left({}_R\hat{H}\right) + p\left({}_R\Psi(t)\right) \\
&\equiv p\left({}_0 S\right) + p\left({}_\Delta S\right) \qquad (134)\\
&\equiv p\left({}_0\hat{H}\right) + p\left({}_\Delta\hat{H}\right) + p\left({}_0\Psi(t)\right) + p\left({}_\Delta\Psi(t)\right)
\end{aligned}
$$

The following figure may illustrate these relationships.

Fig.		"Curvature"		
		yes	no	
"Momentum"	yes	$p\left({}_0\hat{H}\right)$	$p\left({}_\Delta\hat{H}\right)$	$p\left({}_R\hat{H}\right)$
	no	$p\left({}_0\Psi(t)\right)$	$p\left({}_\Delta\Psi(t)\right)$	$p\left({}_R\Psi(t)\right)$
		$p\left({}_0 S\right)$	$p\left({}_\Delta S\right)$	${}_R S \times {}_R\Psi^*(t) \equiv 1$

Clearly, it is $p\left({}_0\hat{H}\right) + p\left({}_\Delta\hat{H}\right) = p\left({}_R\hat{H}\right)$. Equally it is $p\left({}_0\hat{H}\right) + p\left({}_0\Psi(t)\right) = p\left({}_0 S\right)$ and of course $p\left({}_\Delta\hat{H}\right) + p\left({}_\Delta\Psi(t)\right) = p\left({}_\Delta S\right)$. Finally, it is $p\left({}_0\Psi(t)\right) + p\left({}_\Delta\Psi(t)\right) = p\left({}_R\Psi(t)\right)$. Einstein's cosmological constant was defined as $+\Lambda \equiv {}_R\hat{H} - {}_0 S$. Dividing by $_R$S we obtain $\frac{+\Lambda}{{}_R S} \equiv \frac{{}_R\hat{H} - {}_0 S}{{}_R S}$. Assumed that this definition is correct we obtain $p(+\Lambda) \equiv \frac{+\Lambda}{{}_R S} \equiv p\left({}_R\hat{H}\right) - p\left({}_0 S\right)$.

3.16. **Theorem. The Hamiltonian** $_{R}\hat{H}$

Claim.

In general, under some circumstances, the Hamiltonian $_{R}\hat{H}$ is determined as

$$\left|_{R}\hat{H}\right| = \frac{\sigma\left(_{R}\hat{H}\right)}{\sqrt[2]{p\left(_{R}\hat{H}\right)\times\left(1-p\left(_{R}\hat{H}\right)\right)}}. \tag{135}$$

Proof.
Starting with Axiom I it is

$$+1 = +1. \tag{136}$$

Multiplying this equation by standard deviation of $_{R}\hat{H}$ it is

$$\sigma\left(_{R}\hat{H}\right) = \sigma\left(_{R}\hat{H}\right). \tag{137}$$

In general, the standard deviation $\sigma\left(_{R}\hat{H}\right)$ of the Hamiltonian was defined as by the relationship $\sigma\left(_{R}\hat{H}\right) \equiv \sqrt[2]{\sigma\left(_{R}\hat{H}\right)^2} \equiv \sqrt[2]{E\left(_{R}\hat{H}^2\right) - E\left(_{R}\hat{H}\right)^2} = \left|_{R}\hat{H}\right| \times \sqrt[2]{p\left(_{R}\hat{H}\right)\times\left(1-p\left(_{R}\hat{H}\right)\right)}$
and we obtain

$$\sigma\left(_{R}\hat{H}\right) = \left|_{R}\hat{H}\right| \times \sqrt[2]{p\left(_{R}\hat{H}\right)\times\left(1-p\left(_{R}\hat{H}\right)\right)}. \tag{138}$$

After division it follows that

$$\left|_{R}\hat{H}\right| = \frac{\sigma\left(_{R}\hat{H}\right)}{\sqrt[2]{p\left(_{R}\hat{H}\right)\times\left(1-p\left(_{R}\hat{H}\right)\right)}}. \tag{139}$$

Quod erat demonstrandum.

3.17. Theorem. The Mathematical Identity ${}_0S$

Claim.

In general, under some circumstances, the mathematical identity ${}_0S$ is determined as

$$\left|{}_0S\right| = \frac{\sigma\left({}_0S\right)}{\sqrt[2]{p\left({}_0S\right)\times\left(1-p\left({}_0S\right)\right)}}. \tag{140}$$

Proof.
Starting with Axiom I it is

$$+1=+1. \tag{141}$$

Multiplying this equation by standard deviation of ${}_0S$ it is

$$\sigma\left({}_0S\right)=\sigma\left({}_0S\right). \tag{142}$$

In general, the standard deviation $\sigma\left({}_0S\right)$ of the Hamiltonian was defined as by the relationship $\sigma\left({}_0S\right) \equiv \sqrt[2]{\sigma\left({}_0S\right)^2} \equiv \sqrt[2]{E\left({}_0S^2\right)-E\left({}_0S\right)^2} = \left|{}_0S\right| \times \sqrt[2]{p\left({}_0S\right)\times\left(1-p\left({}_0S\right)\right)}$
and we obtain

$$\sigma\left({}_0S\right)=\left|{}_0S\right|\times\sqrt[2]{p\left({}_0S\right)\times\left(1-p\left({}_0S\right)\right)}. \tag{143}$$

After division it follows that

$$\left|{}_0S\right| = \frac{\sigma\left({}_0S\right)}{\sqrt[2]{p\left({}_0S\right)\times\left(1-p\left({}_0S\right)\right)}}. \tag{144}$$

Quod erat demonstrandum.

3.18. Theorem. The Hamiltonian ${}_{R}\hat{H}$ And The Mathematical Identity ${}_{0}S$

Claim.

In general, under some circumstances, the Hamiltonian ${}_{R}\hat{H}$ and the mathematical identity ${}_{0}S$ are determined as

$$\left| {}_{R}\hat{H} \right| \times \left| {}_{0}S \right| = \frac{\sigma\left({}_{R}\hat{H} , {}_{0}S \right)}{p\left({}_{R}\hat{H} \cap {}_{0}S \right) - p\left({}_{R}\hat{H} \right) \times p\left({}_{0}S \right)}. \tag{145}$$

Proof.

Starting with Axiom I it is

$$+1 = +1. \tag{146}$$

Multiplying this equation by the co-variance $\sigma\left({}_{R}\hat{H} , {}_{0}S \right)$ of the Hamiltonian ${}_{R}\hat{H}$ and the mathematical identity ${}_{0}S$ it is

$$\sigma\left({}_{R}\hat{H} , {}_{0}S \right) = \sigma\left({}_{R}\hat{H} , {}_{0}S \right). \tag{147}$$

The co-variance $\sigma\left({}_{R}\hat{H} , {}_{0}S \right)$ of the Hamiltonian ${}_{R}\hat{H}$ and the mathematical identity ${}_{0}S$ was defined as $\sigma\left({}_{R}\hat{H} , {}_{0}S \right) \equiv E\left({}_{R}\hat{H} , {}_{0}S \right) - \left(E\left({}_{R}\hat{H} \right) \times E\left({}_{0}S \right) \right) = \left| {}_{R}\hat{H} \right| \times \left| {}_{0}S \right| \times \left(p\left({}_{R}\hat{H} \cap {}_{0}S \right) - p\left({}_{R}\hat{H} \right) \times p\left({}_{0}S \right) \right)$ and we obtain

$$\sigma\left({}_{R}\hat{H} , {}_{0}S \right) \equiv \left| {}_{R}\hat{H} \right| \times \left| {}_{0}S \right| \times \left(p\left({}_{R}\hat{H} \cap {}_{0}S \right) - p\left({}_{R}\hat{H} \right) \times p\left({}_{0}S \right) \right). \tag{148}$$

After Division, it follows that

$$\left| {}_{R}\hat{H} \right| \times \left| {}_{0}S \right| \equiv \frac{\sigma\left({}_{R}\hat{H} , {}_{0}S \right)}{\left(p\left({}_{R}\hat{H} \cap {}_{0}S \right) - p\left({}_{R}\hat{H} \right) \times p\left({}_{0}S \right) \right)}. \tag{149}$$

Quod erat demonstrandum.

3.19. Theorem. The Mathematical Formula Of The Causal Relationship k

Claim.

In general, the mathematical formula of the causal relationship $k\left({}_{R}\hat{H}\,,\,{}_{0}S\right)$ at quantum level (Einstein's Weltformel) is determined as

$$k\left({}_{R}\hat{H}\,,\,{}_{0}S\right)\equiv\frac{\sigma\left({}_{R}\hat{H}\,,\,{}_{0}S\right)}{\sigma\left({}_{R}\hat{H}\right)\times\sigma\left({}_{0}S\right)}=\frac{\left(p\left({}_{R}\hat{H}\cap{}_{0}S\right)-p\left({}_{R}\hat{H}\right)\times p\left({}_{0}S\right)\right)}{\sqrt[2]{p\left({}_{R}\hat{H}\right)\times\left(1-p\left({}_{R}\hat{H}\right)\right)\times p\left({}_{0}S\right)\times\left(1-p\left({}_{0}S\right)\right)}}\tag{150}$$

Proof.

Starting with Axiom I it is

$$+1=+1.\tag{151}$$

Multiplying this equation by the Hamiltonian ${}_{R}\hat{H}$ it is

$$\left|{}_{R}\hat{H}\right|=\left|{}_{R}\hat{H}\right|.\tag{152}$$

Multiplying this equation by the mathematical identity ${}_{0}S$ yields

$$\left|{}_{R}\hat{H}\right|\times\left|{}_{0}S\right|=\left|{}_{R}\hat{H}\right|\times\left|{}_{0}S\right|.\tag{153}$$

Due to our theorem above, it is $\left|{}_{R}\hat{H}\right|=\frac{\sigma\left({}_{R}\hat{H}\right)}{\sqrt[2]{p\left({}_{R}\hat{H}\right)\times\left(1-p\left({}_{R}\hat{H}\right)\right)}}$.

Thus far, rearranging equation, it follows that

$$\left|{}_{R}\hat{H}\right|\times\left|{}_{0}S\right|=\frac{\sigma\left({}_{R}\hat{H}\right)}{\sqrt[2]{p\left({}_{R}\hat{H}\right)\times\left(1-p\left({}_{R}\hat{H}\right)\right)}}\times\left|{}_{0}S\right|.\tag{154}$$

Due to our theorem above, it is $\left|{}_{0}S\right|=\frac{\sigma\left({}_{0}S\right)}{\sqrt[2]{p\left({}_{0}S\right)\times\left(1-p\left({}_{0}S\right)\right)}}$.

Consequently, we can rearrange the equation before once again and do obtains

$$\left|{}_{R}\hat{H}\right| \times \left|{}_{0}S\right| = \frac{\sigma\left({}_{R}\hat{H}\right)}{\sqrt[2]{p\left({}_{R}\hat{H}\right)\times\left(1-p\left({}_{R}\hat{H}\right)\right)}} \times \frac{\sigma\left({}_{0}S\right)}{\sqrt[2]{p\left({}_{0}S\right)\times\left(1-p\left({}_{0}S\right)\right)}}. \tag{155}$$

Due to our theorem concerning the co-variance $\sigma\left({}_{R}\hat{H}\,,\,{}_{0}S\right)$ of the Hamiltonian ${}_{R}\hat{H}$ and the mathematical identity ${}_{0}S$ it is $\left|{}_{R}\hat{H}\right| \times \left|{}_{0}S\right| \equiv \frac{\sigma\left({}_{R}\hat{H}\,,\,{}_{0}S\right)}{\left(p\left({}_{R}\hat{H}\cap{}_{0}S\right)-p\left({}_{R}\hat{H}\right)\times p\left({}_{0}S\right)\right)}$. Thus far, we rearrange the equation before and obtain in the following the next relationship as

$$\frac{\sigma\left({}_{R}\hat{H}\,,\,{}_{0}S\right)}{\left(p\left({}_{R}\hat{H}\cap{}_{0}S\right)-p\left({}_{R}\hat{H}\right)\times p\left({}_{0}S\right)\right)} = \frac{\sigma\left({}_{R}\hat{H}\right)}{\sqrt[2]{p\left({}_{R}\hat{H}\right)\times\left(1-p\left({}_{R}\hat{H}\right)\right)}} \times \frac{\sigma\left({}_{0}S\right)}{\sqrt[2]{p\left({}_{0}S\right)\times\left(1-p\left({}_{0}S\right)\right)}} \tag{156}$$

which can be simplified as

$$\frac{\sigma\left({}_{R}\hat{H}\,,\,{}_{0}S\right)}{\sigma\left({}_{R}\hat{H}\right)\times\sigma\left({}_{0}S\right)} = \frac{\left(p\left({}_{R}\hat{H}\cap{}_{0}S\right)-p\left({}_{R}\hat{H}\right)\times p\left({}_{0}S\right)\right)}{\sqrt[2]{p\left({}_{R}\hat{H}\right)\times\left(1-p\left({}_{R}\hat{H}\right)\right)\times p\left({}_{0}S\right)\times\left(1-p\left({}_{0}S\right)\right)}} \quad . \tag{157}$$

The mathematical formula of the causal relationship $k\left({}_{R}\hat{H}\,,\,{}_{0}S\right)$ (Einstein's Weltformel) follows in general as

$$k\left({}_{R}\hat{H}\,,\,{}_{0}S\right) \equiv \frac{\sigma\left({}_{R}\hat{H}\,,\,{}_{0}S\right)}{\sigma\left({}_{R}\hat{H}\right)\times\sigma\left({}_{0}S\right)} = \frac{\left(p\left({}_{R}\hat{H}\cap{}_{0}S\right)-p\left({}_{R}\hat{H}\right)\times p\left({}_{0}S\right)\right)}{\sqrt[2]{p\left({}_{R}\hat{H}\right)\times\left(1-p\left({}_{R}\hat{H}\right)\right)\times p\left({}_{0}S\right)\times\left(1-p\left({}_{0}S\right)\right)}}. \tag{158}$$

Quod erat demonstrandum.

Scholium.

In general, the mathematical formula of the causal relationship $k\left({}_{R}\hat{H}\,,\,{}_{0}S\right)$ can take the following values: $-1 \leq k\left({}_{R}\hat{H}\,,\,{}_{0}S\right) \leq +1$.

3.20. **Theorem. The Relationship Between The Chi-Square Distribution And The Mathematical Formula Of The Causal Relationship k.**

Claim.
Under some assumptions, the mathematical formula of the causal relationship k is determined by the chi-square distribution as

$$k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) = \sqrt[2]{\frac{\mathrm{X}^{2}{}_{N}}{N}} \tag{159}$$

Proof.
Starting with Axiom I it is

$$+1 = +1. \tag{160}$$

Multiplying this equation by the causal relationship $k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right)$ it is

$$k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) = k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \tag{161}$$

which is equivalent to

$$\frac{k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) - E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)}{\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)} = \frac{k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) - E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)}{\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)} \tag{162}$$

where $E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)$ denotes the expectation value of the causal relationship k and $\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)$ denotes the deviation of the causal relationship k. The normal random variable of a standard normal distribution (called a standard score or a z-score) is determined as $Z\left(k\left({}_{R}U_{t}\ ,\ {}_{0}W_{t} \right) \right) \equiv \frac{k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) - E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)}{\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)}$. Thus far we obtain

$$Z\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right) = \frac{k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) - E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)}{\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)} \tag{163}$$

Under conditions, where $E\left(k\left({}_{R}\hat{H}, {}_{0}S\right)\right)=0$ and $\sigma\left(k\left({}_{R}\hat{H}, {}_{0}S\right)\right)=1$ we obtain

$$Z\left(k\left({}_{R}\hat{H}, {}_{0}S\right)\right)=\frac{k\left({}_{R}\hat{H}, {}_{0}S\right)-0}{1} \tag{164}$$

or

$$Z\left(k\left({}_{R}\hat{H}, {}_{0}S\right)\right)=k\left({}_{R}\hat{H}, {}_{0}S\right) \tag{165}$$

After the square root operation it is

$$Z\left(k\left({}_{R}\hat{H}, {}_{0}S\right)\right)^{2}=k\left({}_{R}\hat{H}, {}_{0}S\right)^{2} \tag{166}$$

Summarizing (i. e. after N experiments) yields

$$\sum_{t=1}^{N} Z\left(k\left({}_{R}\hat{H}, {}_{0}S\right)\right)^{2}=\sum_{t=1}^{N} k\left({}_{R}\hat{H}, {}_{0}S\right)^{2} \tag{167}$$

which is equivalent with

$$Z^{2}=\sum_{t=1}^{N} k\left({}_{R}\hat{H}, {}_{0}S\right)^{2} \tag{168}$$

Under conditions, where the causal relationship **k is constant from trial to trial**, from experiment to experiment, i. e. it is

$$Z^{2}=\sum_{t=1}^{N} k\left({}_{R}\hat{H}, {}_{0}S\right)^{2}=k\left({}_{R}\hat{H}, {}_{0}S\right)^{2}+k\left({}_{R}\hat{H}, {}_{0}S\right)^{2}+\ldots k\left({}_{R}\hat{H}, {}_{0}S\right)^{2}=N\times k\left({}_{R}\hat{H}, {}_{0}S\right)^{2} \tag{169}$$

In statistics, it is known that $Z^{2}=\sum_{t=1}^{N} k\left({}_{R}\hat{H}, {}_{0}S\right)^{2}=X^{2}{}_{N}$ with N degrees of freedom. Under the above assumption's, we obtain

$$Z^{2}=\sum_{t=1}^{N} k\left({}_{R}\hat{H}, {}_{0}S\right)^{2}=N\times k\left({}_{R}\hat{H}, {}_{0}S\right)^{2}=\mathrm{X}^{2}{}_{N} \tag{170}$$

We re-write this equation as

$$\mathrm{X}^{2}{}_{N}=N\times=\mathrm{X}^{2}{}_{N}{}^{2} \tag{171}$$

where $\mathrm{X}^{2}{}_{\mathrm{N}}$ denotes the chi-squared distribution (also chi-square distribution) with N degrees of freedom. At the end, it follows that

$$k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) = \sqrt[2]{\frac{X^{2}{}_{N}}{N}} \tag{172}$$

Quod erat demonstrandum.

Scholium.
In mathematical statistics, the t-distribution, the chi squared distribution and the Z-value are related [4], [5] by the formula $t_N = \frac{Z}{\sqrt[2]{\frac{X^{2}{}_{N}}{N}}}$.

3.21. **Theorem. The Relationship Between The Standard Normal Distribution And The Mathematical Formula Of The Causal Relationship k.**

Claim.
Under some assumptions, the mathematical formula of the causal relationship k is determined by the chi-square distribution as

$$\overline{k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right)} = \sqrt[2]{\frac{X^{2}{}_{N}}{N}} \tag{173}$$

Proof.
Starting with Axiom I it is

$$+1 = +1. \tag{174}$$

Multiplying this equation by the causal relationship $k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right)$ it is

$$k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) = k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \tag{175}$$

which is equivalent to

$$\frac{k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) - E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)}{\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)} = \frac{k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) - E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)}{\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)} \tag{176}$$

where $E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)$ denotes the expectation value of the causal relationship k and $\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S \right) \right)$ denotes the deviation of the causal relationship k. The normal random variable of a standard normal distribution (called a standard score or a z-score) is determined as $Z\left(k\left({}_{R}U_{t}\ ,\ {}_{0}W_{t}\right)\right) \equiv \dfrac{k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right) - E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right)}{\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right)}$. Thus far we obtain

$$Z\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right) = \frac{k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right) - E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right)}{\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right)} \tag{177}$$

Under conditions, where $E\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right) = 0$ and $\sigma\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right) = 1$ we obtain

$$Z\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right) = \frac{k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right) - 0}{1} \tag{178}$$

or

$$Z\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right) = k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right) \tag{179}$$

After the square root operation it is

$$Z\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right)^{2} = k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)^{2} \tag{180}$$

Summarizing (i. e. after N experiments) yields

$$\sum_{t=1}^{N} Z\left(k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)\right)^{2} = \sum_{t=1}^{N} k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)^{2} \tag{181}$$

which is equivalent with

$$Z^{2} = \sum_{t=1}^{N} k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)^{2} \tag{182}$$

Under conditions, where the causal relationship **k can, but must not be constant from trial to trial**, from experiment to experiment, i. e. it is

$$Z^{2} = \sum_{t=1}^{N} k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)^{2} = {}_{1}k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)^{2} + {}_{2}k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)^{2} + \ldots + {}_{N}k\left({}_{R}\hat{H}\ ,\ {}_{0}S\right)^{2} \tag{183}$$

In general, it is $Z^2 = \sum_{t=1}^{N} k\left({}_R\hat{H} , {}_0S \right)^2 = X^2{}_N$ with N degrees of freedom. Under these conditions we define $\overline{k\left({}_R\hat{H} , {}_0S \right)^2} \equiv \frac{Z^2}{N} = \frac{\sum_{t=1}^{N} k\left({}_R\hat{H} , {}_0S \right)^2}{N} = \frac{X^2{}_N}{N}$. We re-write the equation before as

$$\overline{k\left({}_R\hat{H} , {}_0S \right)^2} = \frac{X^2{}_N}{N} \tag{184}$$

where $X^2{}_N$ denotes the chi-squared distribution (also chi-square distribution) with N *degrees of freedom*. At the end, it follows that

$$\overline{k\left({}_R\hat{H} , {}_0S \right)} = \sqrt[2]{\frac{X^2{}_N}{N}} \equiv \sqrt[2]{\frac{Z^2}{N}} \tag{185}$$

Quod erat demonstrandum.

Scholium.
Especially, the quantum field theory describes systems with an infinite number of degrees of freedoms i.e. fields, which is obeyed by the formula above.

4. Discussion

The theory presented here is built upon already well-established, empirically verified structures and assures mathematical consistency and compatibility with established laws. The theory developed here is making falsifiable predictions and a lot of phenomena that have not yet been found which rapidly can be tested or confirmed by experiments since the relationship between cause and effect is explained at quantum level too. The mathematical formula of the causal relationship k provides a completely description of the basic forces of nature. In a rather informal sense quantum field theory (QFT) is something like an extension of quantum mechanics (QM) while dealing with particles over to fields. Quantum field theory (QFT) allows describing a system with an infinite number of degrees of freedoms i.e. fields. In the following we will not try to reformulate the mathematical and conceptual framework of quantum field theory. Since one important group of target readers are philosophers too who would like to get a first impression of some issues that may help them for their own work let us define the following basic fields of nature **A, B, C, D**. It is not necessary, but just **for the sake of the argument**, let every field be determined by only one particle. The field A is determined by the particle a, the field B is determined by the particle b, the field C is determined by the particle c, the field D is determined by the particle d. To assure compatibility with quantum mechanics, we define only for the sake of the argument something like the following (another definition is of course possible too):

$$ {}_{0}\hat{H} \equiv a \times \frac{{}_{0}\hat{H}}{a} \equiv a \times A \text{ and } {}_{\Delta}\hat{H} \equiv b \times \frac{{}_{\Delta}\hat{H}}{b} = b \times B \text{ and } {}_{0}\Psi(t) \equiv c \times C \text{ and } {}_{\Delta}\Psi(t) \equiv d \times D. \quad (186) $$

For a proper understanding, let us illustrate the above relationships once again.

Fig.		"Curvature"		
		yes	no	
"Momentum"	yes	${}_{0}\hat{H} \equiv a \times A$	${}_{\Delta}\hat{H} \equiv b \times B$	${}_{R}\hat{H}$
	no	${}_{0}\Psi(t) \equiv c \times C$	${}_{\Delta}\Psi(t) \equiv d \times D$	${}_{R}\Psi(t)$
		${}_{0}S$	${}_{\Delta}S$	${}_{R}S$

Consequently, the four fundamental interactions, also known as fundamental forces or interactive forces, of nature within one framework, unifying all four fundamental interactions along with gravitation can be illustrated as

Fig.		"Curvature"		
		yes	no	
"Momentum"	yes	Strong force	Electroweak	${}_{R}\hat{H}$
	no	Gravitation	Vacuum	${}_{R}\Psi(t)$
		${}_{0}S$	${}_{\Delta}S$	${}_{R}S$

Theoretically, it is possible to unify the strong force and the weak force into an ordinary force. In other words **ordinary force = strong force + weak force**. Thus far we would obtain another picture of the basic fields of nature.

Fig.		"Curvature"		
		yes	no	
"Momentum"	yes	**Ordinary force**	Electro-magnetic force	${}_{R}\hat{H}$
	no	Gravitation	Vacuum	${}_{R}\Psi(t)$
		${}_{0}S$	${}_{\Delta}S$	${}_{R}S$

Such an approach would follow Einstein's demand of the unification of gravitation and electro-magnetism. Under conditions, where ${}_{\Delta}\hat{H}$ is identical with the electromagnetic field, the quantum mechanical operator of gravitation and electro-magnetism GEM follows in a very general sense something like $GEM = {}_{\Delta}\hat{H} + {}_{0}\Psi(t)$.

In our understanding, Einstein's field equation at quantum level appears to be related to something like ${}_0S+\Lambda \equiv {}_R\hat{H}$ while ${}_0S$ denotes the quantum mechanical understanding of curvature as such (in general relativity: Einstein's tensor G_{ae}). The unified field follows as $\frac{{}_R\hat{H}}{{}_RS}+\frac{{}_R\Psi(t)}{{}_RS}=1$, The unified field can be multiplied by the Ricci-tensor R_{ae} to obtain $\frac{{}_R\hat{H}}{{}_RS}\times R_{ae}+\frac{{}_R\Psi(t)}{{}_RS}\times R_{ae}=R_{ae}$ which is equivalent with Einstein's field equation as $\frac{{}_R\hat{H}}{{}_RS}\times R_{ae}+\frac{{}_R\Psi(t)}{{}_RS}\times R_{ae}=R_{ae}=\frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times\times c}T_{ae}+\frac{R}{2}g_{ae}-\Lambda g_{ae}$. In general it is $S_{ae} = E_{ae} + t_{ae}$, where S_{ae} denotes the tensor of space, E_{ae} denotes the stress energy tensor, t_{ae} denotes the tensor of time. Einstein's field equation known as $R_{ae}=\frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times\times c}T_{ae}+\frac{R}{2}g_{ae}-\Lambda g_{ae}$ can be changed to $R_{ae}-\left(\frac{R}{2}g_{ae}-\Lambda g_{ae}\right)=\frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times\times c}T_{ae}$. In our understanding it is $E_{ae}=\frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times\times c}T_{ae}$ and $E_{ae}=S_{ae}-t_{ae}$. In general, it should be taken into considerations that $R_{ae}-\left(\frac{R}{2}g_{ae}-\Lambda g_{ae}\right)=\frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times\times c}T_{ae}=S_{ae}-t_{ae}$ and the tensor of space S_{ae} follows as $S_{ae}=R_{ae}+t_{ae}-\left(\frac{R}{2}g_{ae}-\Lambda g_{ae}\right)$. We define that $X_{ae}=+t_{ae}-\left(\frac{R}{2}g_{ae}-\Lambda g_{ae}\right)$. Consequently, the relationship between the tensor of space S_{ae} and the Ricci tensor R_{ae} is given by $S_{ae}=R_{ae}+X_{ae}$ which must be considered when trying to quantize the gravitational field. Only under conditions where $X_{ae} = 0$, the tensor of space S_{ae} and the Ricci tensor R_{ae} are equivalent but not in general. But under conditions where $\mathbf{X_{ae} = 0}$, the tensor of time follows as $t_{ae}=\left(\frac{R}{2}g_{ae}-\Lambda g_{ae}\right)=\left(\frac{R}{2}-\Lambda\right)g_{ae}$. The following 2x2 table may illustrate the relationships from the standpoint of the general theory of relativity.

Fig.		**"Curvature"**		
		yes	no	
"Momentum"	yes	**Ordinary force**	Electro-magnetic force	$\frac{4\times 2\times \pi\times \gamma}{c\times c\times c\times\times c}T_{ae}$
	no	Gravitation	Vacuum	$\frac{R}{2}g_{ae}-\Lambda g_{ae}$
		G_{ae}	$\frac{R}{2}g_{ae}$	R_{ae}

In general, the energy [-momentum(-stress)] tensor of matter is decomposed to the sum of two tensors one of which is due to the electromagnetic field.

"On peut aussi supposer que le tenseur d'énergie T_{kl} soit la somme de deux tenseurs dont un dû au champ électromagnétique …" [7]

Translated into English:
>>One can also assume that the energy tensor T_{kl} be the sum of two tensors one of which is due to the electromagnetic field<<

The stress-energy tensor of the electro-magnetic field is the part of the stress–energy tensor which due to the electromagnetic field. It is of course possible to express the mathematical formula of the causal relationship $k\left({}_{R}\hat{H}, {}_{0}S \right)$ using the tensor calculus of general theory of relativity. This is already published [8]. To achieve general acceptance on this issue, we will have to wait until the tenor calculus is improved as necessary. The mathematical formula of the causal relationship $k\left({}_{R}\hat{H}, {}_{0}S \right)$ assumes *a deterministic relationship between cause and effect at every point in space-time* but the same does not exclude randomness since every random event as such has its own cause.

The mechanical determinism generally referred to as *Laplace demon* is of course incompatible with the mainstream interpretations of today quantum mechanics which stipulates indeterminacy, and was formulated by Laplace as follows:

"Une intelligence qui, pour un instant donné, connaîtrait toutes les forces dont la nature est animée, et la situation respective des êtres qui la composent, si d'ailleurs elle était assez vaste pour soumettre ces données à l'analyse, embrasserait dans la même formule les mouvements des plus grand corps de l'univers et ceux du plus léger atome: rien ne serait incertain pour elle, l'avenir comme le passé seraient présents à ses yeux." [9]
Laplace demon translated into English:
>>We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.<<

5. Conclusion

The mathematical formula of the causal relationship $k\left({}_{R}\hat{H}, {}_{0}S \right)$ can be expressed within the framework of quantum theory without any contradiction.

Acknowledgment

None.

Appendix

None.

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