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Cyclic Mechanics: the Principle of Cyclicity

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CYCLIC MECHANICS: THE PRINCIPLE OF CYCLICITY

Cyclic mechanic is intended as a suitable generalization both of quantum mechanics and general relativity apt to unify them. It is founded on a few principles, which can be enumerated approximately as follows:

1. Actual infinity or the universe can be considered as a physical and experimentally verifiable entity. It allows of mechanical motion to exist.

2. A new law of conservation has to be involved to generalize and comprise the separate laws of conservation of classical and relativistic mechanics, and especially that of conservation of energy: This is the conservation of action or information.

3. Time is not a uniformly flowing time in general. It can have some speed, acceleration, more than one dimension, to be discrete.

4. The following principle of cyclicity: The universe returns in any point of it. The return can be only kinematic, i.e. per a unit of energy (or mass), and thermodynamic, i.e. considering the universe as a thermodynamic whole.

5. The kinematic return, which is per a unit of energy (or mass), is the counterpart of conservation of energy, which can be interpreted as the particular case of conservation of action "per a unit of time". The kinematic return per a unit of energy (or mass) can be interpreted in turn as another particular law of conservation in the framework of conservation of action (or information), namely conservation of wave period (or time). These two counterpart laws of conservation correspond exactly to the particle "half" and to the wave "half" of wave-particle duality.

6. The principle of quantum invariance is introduced. It means that all physical laws have to be invariant to discrete and continuous (smooth) morphisms (motions) or mathematically, to the axiom of choice.

The list is not intended to be exhausted or disjunctive, but only to give an introductory idea about the text, which follows:

The mutual transformation between mass, energy, time, and quantum information (figure 1):

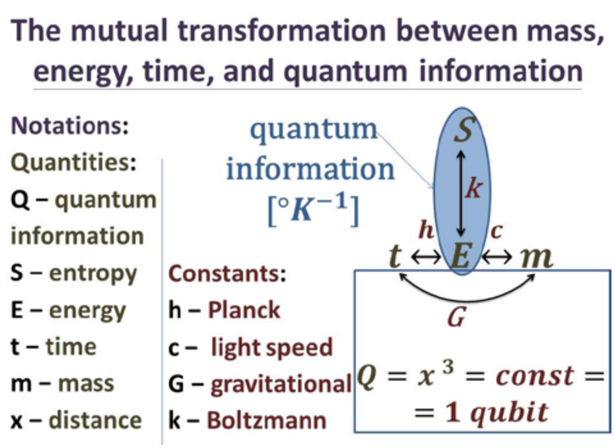

Figure 1

That transformation motivates and allows of involving the physical quantity of quantum information. Its meaning is similar to that of information at all. The differences are the following:

– Quantum information refers to the information per a unit of energy (or mass, or time for the transformation in question) for its carrier. Consequently, its physical dimension has to be the reciprocal of temperature: $[°K^{-1}]$. In philosophical terms, it means the relation (as a quality) or the ratio (as a quantity) between the mathematical (entropy, information) and the physical (energy, mass, time), or in other words how much matter, or physical being measured in units of energy (or mass, or time) “goes” to code an unit of information, i.e. a digit, which is accepted to be binary and the corresponding information unit to be a bit (**b**inary dig**it**).

– The three basic kinds of code according to the kind of information carrier (energy, mass, and time) are ***absolutely independent*** (!) in general. This imposes two requirements for the physical quantity of quantum information: (1) to be coded on two of them (conventionally and usually, those carriers are energy, or energy-momentum, and time, or space-time) the corresponding quantity of quantum temperature is a complex number; (2) to be coded on the third of them (conventionally and usually, that carrier is mass), quantum mechanics (2.1) and general relativity (2.2) found to be used two alternative (but equivalent) methods: (2.1) quantum measure is utilized as qubits, after which the three dimensions of the three encoding are represented as the three dimensions of a unit 3D ball, which is mathematically isomorphic to a qubit; (2.2) mass is definitely juxtaposed to a varying ratio of the units of the former two quantities of energy (energy-momentum) and time (space-time), or as a curvature (of space-time in general).

– The three-dimensional quantum information allows of a more general viewpoint, from which quantum mechanics and general relativity can be seen as one and the same in two equivalent hypostases (forms), on the one hand, but also allows of unifying gravity, entanglement, and even electromagnetism, on the other hand. So the electromagnetism can link this approach to the standard model involving it in another way.

Quantum information in terms of quantum temperature and the Bekenstein bound (figure 2)

Quantum information in terms of quantum temperature and the Bekenstein bound

$$Q_2 = \frac{S_2}{E_2} = \frac{1}{T_2} \leq \frac{2\pi k}{\hbar c} x_2$$

$$Q_1 = \frac{S_1 t_1}{\hbar} = \frac{S_1}{E_1} \leq \frac{2\pi k}{\hbar c} x_1 = \frac{2\pi k}{\hbar} t_1$$

Here x_1, x_2 are the corresponding radiuses of spheres, which can place (2) the energy-momentum and (1) the space-time of the system in question

$$Q = Q_1 + iQ_2;\ |Q| = \sqrt{(Q_1)^2 + (Q_2)^2}$$

Figure 2

The quantity of quantum temperature admits only two of the three degrees of freedom of a qubit (quantum measure), and its values are complex numbers. In tradition, they are usually energy (momentum) and time (position). Then its physical meaning is energy/ time per a unit of entropy and implicitly their current ratio as well. The reciprocal ratios (entropy per a unit of energy/ time) are low boundaries in two examples of the Bekenstein bound (figure 2).

They define two balls with radiuses correspondingly x_1 and x_2, which can be interpreted as two qubits. However doing so, one equates their informational content, which is different just for the Bekenstein inequality.

This imposes a third quantity (in tradition, mass), which can be considered as an additional degree of freedom, to be involved. This third whatever is it, but already specified as a definite quantity (to say, mass), leads to general relativity. By the way, this allows of Jacobson (1995) to deduce general relativity from the Bekenstein bound and the laws of thermodynamics.

The same third, but remained as an empty degree of freedom, leads to quantum mechanics. Consequently, the latter is a more general consideration that the former.

The relation between an empty degree of freedom (or a free variable) and the same degree of freedom as a physical quantity accepting different, but defined values (i.e. a bound variable) is interpreted necessarily as an invariance in quantum mechanics for its invariance to the axiom of choice. The distinction between quantum mechanics and general relativity can be reduced to that not rather essential one between involving a free variable or a bound variable, which makes one to declare general relativity for a quantum theory.

The base of their unification is the notion of quantum measure. If it is normed as a qubit, this leads to quantum mechanics, and normed as a 3D ball, to general relativity. The former remains the comparison between two qubits as an additional degree of freedom, i.e. a free variable, and the latter specifies it as a quantity (the curvature of space-time linked to mass), i.e. a bound variable.

The transformation (from figure 1) **in terms of quantum measure** (figure 3):

Any equation in physics, even the most elementary one, equates two different quantities, consequently two different qualities: that in the left side to that in the right side in the equation. The necessary condition, under which the equating is possible, is both quantities (qualities) to share a common measure. That can happen as the physical dimensions are suitably equated and both quantities are represented by suitable mathematical functions, which values are equated by the equation.

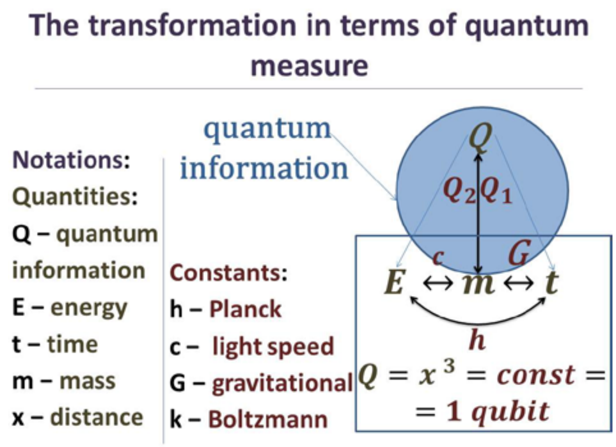

Figure 3

The unifying of quantum mechanics and general relativity has to resolve a similar, but al-ready generalized problem: how to be equated two equations (Einstein's for general relativity and Schrödinger's for quantum mechanics) rather than two kinds of quantity in a single equation. That task is successfully solved creating a new theory, and maybe the first example is special relativity, which unifies electromagnetism (Maxwell's equations) and the Newton mechanics on the fundament of a new and generalizing mathematical formalism: that of Minkowski space. It had given a successful and as if universal model: any new unifying theory in physics to rest on a new mathematical formalism, and the corresponding equations of the old theories, which are unified, to be its particular cases.

However that model could not be followed as to general relativity and quantum mechanics: It seems that no mathematical formalism, which both share.

In fact, that imposes to "dig deeper": to generalize the mathematical conception of measure. Then the failure to unify quantum mechanics and general relativity by means of any mathematical formalism can be easily explain as the incorrect identification of 'mathematical formalism' with the subset of such ones, which share the classical notion of measure. Indeed the conception of quantum measure complemented with relevant set-theory approaches (first of all, the notion of infinity, potential and actual infinity, the axiom of choice and Skolem's paradox) as well as working philosophical ideas (such as those of wholeness and cyclicity, and the unification of the mathematical and physical, of model and reality) can resolve the problem, which is the subject of this paper.

Involving quantum measure reflects on involving a new physical quantity – quantum information, which is measured directly by the quantum measure (figure 3), i.e. by qubits, though its physical dimension is classical $[°K^{-1}]$. Its meaning is to equate the mathematical (entropy, information) and the physical (energy) on the base of the three-dimensional quantum measure after the transformation of the fundamental physical quantities (energy, mass, time) is meant (figure 1). Consequently, it means the quantity of the mathematical, i.e. the quantity of number, per a unit of the physical, too, and can be interpreted as the quantity of number per a unit of its physical carrier. However its natural unit (i.e. the unit in nature) is three-dimensional: And the corresponding measure is quantum, the quantum measure.

The universe as a single qubit ... and even as a single bit (figure 4)**:**

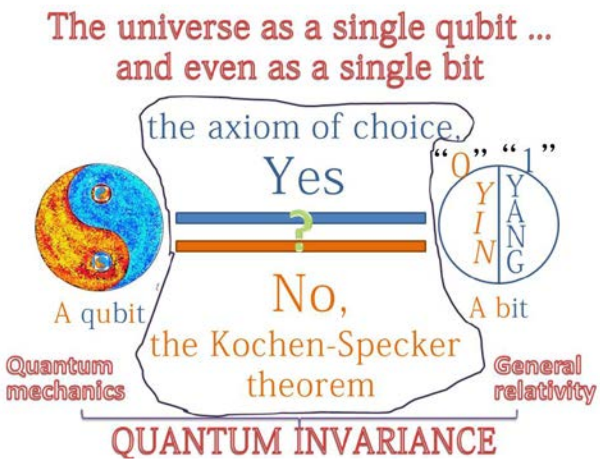

Figure 4

After one has introduced the quantum measure, the question how it should refer to the classical (e.g. the Lebesgue or Borel measure) arises. The "atom" of the same question in an informational frame is how a qubit refers to a bit (or to any finite or even infinite set of bits). Two mathematical statements give two opposite answers to that question (figure 4):

"Yes, unconditionally": answers the axiom of choice.

"No, to any finite set of bits" is the answer of the Kochen – Specker theorem, though.

Well, but quantum mechanics needs both. Then the only option to be reconciled is to be posited: either an infinite process for a qubit to be decomposed into a set of bits, or an infinite set of bits as the only possible result of the decomposition: The axiom of choice allows it, and the Kochen – Specker theorem does not forbid it. Consequently, given a qubit and the necessity it to be decomposed into bits, some infinity either as a process or as a result is implied necessarily.

The universe as an infinite cocoon of light = one qubit (figure 5)**:**

One can imagine a single photon for that single qubit and all the space-time for the infinite sets of bits. Then the latter will arise from the latter only from those grounds, which are purely mathematical.

How should the single qubit and all the space-time be juxtaposed? Where is the qubit? And where is the space-time? The answer based on Minkowski space is as obvious as paradoxical: The qubit of light as a "many" is within space-time, and the space-time is within the single qubit being a "much". We have talked of "cyclicity" above, but only abstractly: mathematically and philosophically. However if the cyclicity is physical, it should have some corresponding physical carrier, which should realize it as a physically observable phenomenon.

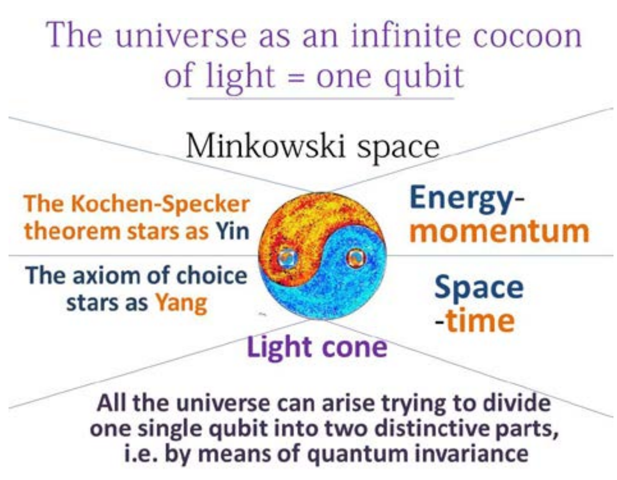

Figure 5

The discussion above (figure 5) shows that the light, i.e. electromagnetic wave or electromagnetism should be that physical carrier of cyclicity after one has unified Minkovski space, the Kochen – Specker theorem, and the axiom of choice. Indeed, that qubit of light as if envelopes all the space-time in the form of the light cone visible only after its projection on some Euclidean space since it is an isotropic surface with zero length in the true Minkowski space. The same qubit can be found in any space-time point, in fact created by its presence in it, as a photon and in any set of space-time points as a distinctive "many" of photons. Consequently, one can think of electromagnetic wave as the way for the universe as a whole to be in any space-time point of its, creating it or as the physical carrier of cyclicity.

If one considers the physical interactions adding entanglement to them, the electromagnetic one takes an intermediate and unified position among them. It can be thought as a Janus with two faces, the one of which is linked to gravity and entanglement, but the other to weak and strong interaction. The standard model is a confirmed theory about the latter face, and such a one as to the former is forthcoming to be created: Only then the unity of the two "faces" within a single Janus will be able to be evolved as a "theory of everything" at the present stage.

Correspondingly, Minkowski and Hilbert space can be imagine as also this Janus with a face to pseudo-Riemannian and Banach space and another to the representations of groups within Hilbert space by means of its automorhisms. The symmetries (groups) of the sphere featuring the electromagnetic interaction and wave intermediate between the kinds of mathematical formalisms.

Mass at rest as another "Janus" between the forces in nature (figure 6):

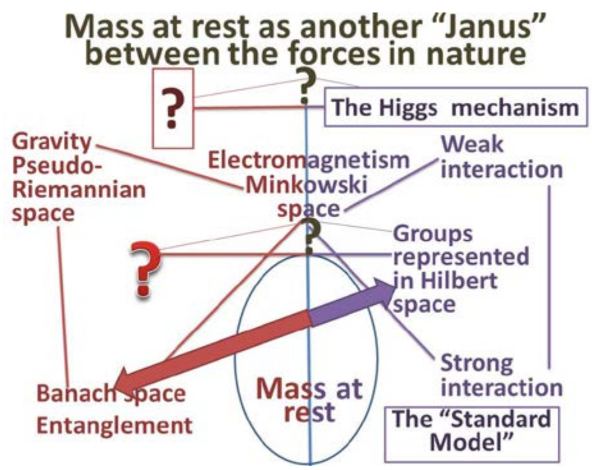

Figure 6

There are two equivalent ways for a mechanical motion to be represented: either as a smooth curve or as a discrete leap. There are two components in both cases: In the former case, these are a segment in the straight trajectory and a curve with a longer length and correspondingly, a difference between the lengths of the segment and the curve, which is nonzero in general. In the latter case, those are a discrete leap with a given length of the leap and a segment in a straight and continuous (therefore smooth) trajectory with another length in general as well as a corresponding difference between these two lengths. The two cases share a common segment in a straight and continuous (therefore smooth) trajectory as well as a difference. Only the interpretation of that difference and the subtrahends are dissimilar: The former subtrahend is the length of a smooth curve while the latter one is a length of a discrete jump. However if that jump is interpreted as a quantum one, the Heisenberg uncertainty should add (more exactly, distract) between the two components in the latter, i.e. discrete case. All this state of affairs reflects on the "forces" (or interactions) in nature according to modern ideas as this is shown on the scheme above. Only entanglement is added to them on the side of the "curved". The "Standard Model" comprises in turn the "discrete" interpreted as the "quantum" (i.e. including the uncertainty). Electromagnetism and mass at rest are located on the boundary between the two opposite domains as the two invariants between the discrete and quantum: accordingly the segment with the same (i.e. Lorentz invariant) length and the difference between the two lengths. Therefore that difference as the rest mass is interpreted as some curvature of space-time in the former case (the left side of the scheme) and as the Higgs mechanism in the latter case (the right side of the scheme). Furthermore the Higgs mechanism should be understood as the way an asymmetry to appear between the discrete leap and the smooth straight motion thus redefining exactly the quantum uncertainty. How is then the Higgs mechanism compatible with uncertainty underlying quantum mechanics, though?

How the mass at rest can arise by a mathematical mechanism (figure 7, 8, 9)**:**

One can involve the Kochen - Specker theorem to explain how mass at rest can appear even under the quantum uncertainty as well as what 'at rest' should mean in quantum mechanics at all: First the latter: only a whole can be "at rest" in quantum mechanics rather than any proper subset of it. Even then it should be postulated as such a one, and as the probability is smaller (i.e. a smaller measure of that part), the quantum movement (of that part) is faster. However according to the Kochen – Specker theorem the rest mass should link to the irremovable quantum correlations between the part in question and all environment, which complements it to the whole. Then, to be obtained its mass at rest, its environment should converge to the limit of zero. This means correspondingly for the part to converge to or to be considered as a whole and all quantum correlations to be able to be concentrated entirely within that part considered as a whole. The same this is equivalent to being chosen that part only by means of the axiom of choice. Furthermore, the so-called above quantum invariance between the Kochen – Specker theorem and the axiom of choice can be interpreted and thus serve as an explanation of that invariance as follows: Any part of a quantum whole can be equivalently accepted as a new quantum whole in turn without any change of its physical properties or quantities. This would also mean that any choice for the axiom of choice does not have any physical cost. The opposite viewpoint is also possible, namely that all the rest mass of a quantum entity consists of the physical cost of many, many choices measured by the amount of the physical equivalent of *a bit* of choice or information (the most elementary unit of choice is the choice between two equally probable alternatives). One can obtain the physical cost of a bit of information in the physical dimension of mass after accepting time for a unit, which is equivalent to conservation of energy:

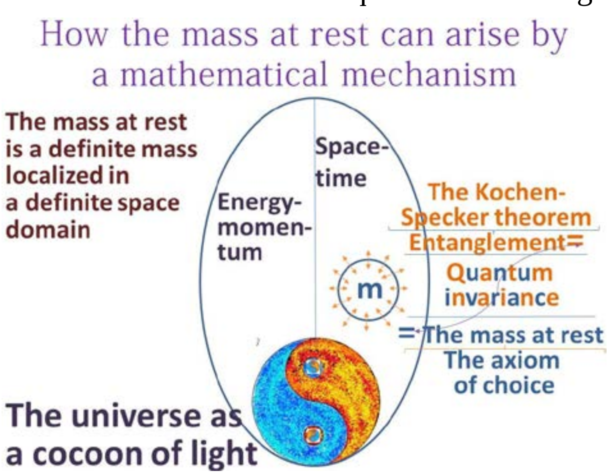

Figure 7

$$Mass_{bit} = \left(\frac{K_B}{N_A}\frac{h}{c^2}\right)_{t=1}$$

K_B is the Boltzmann constant, N_A is Avogadro's number, h is the Planck constant, and c is the speed of light in vacuum.

Furthermore one can deduce the necessity of energy conservation for the notion of 'mass at rest' from conservation of action as follows. If as above the mass at rest of a quantum entity is defined by converging to a limit when the entity converges to a whole, the principle of cyclicity requires for the corresponding speed of time to converge to 1, which is equivalent to reducing conservation of action to that of energy.

Consequently, the notion of 'mass at rest' can exist only under the necessary and sufficient condition of conservation of energy or in other words, on the anthropomorphic screen of the human perception of time as a series of present moments, each of which is given only now and all of which seem equal. If that "screen" is removed, one will see only flows of physical information, which interact with each other. Gravity is the image of this interaction on that screen.

Mass at rest in relativity and wave-particle duality (figure 8):

If one has already identified mass at rest, conservation of energy, and the constant speed of time, this implies an exact ratio between the energy-momentum and the space-time position of any physical entity, or in other words, they imply a one-to-one mapping between energy-momentum and space-time. The opposite is also true: Any one-to-one mapping between the energy-momentum and the space-time position of an entity defines a time: It is the time of that entity. Both, that time and that one-to-one mapping require and are equivalent to the axiom of choice in physics. Furthermore, it is obvious that general relativity as a space-time theory does two things: First, it introduces that time, that one-to-one mapping and thus the axiom of choice in physics. Second, it "distorts" the introduced thus time, by which the speed of time is no longer constant but variable. Then what are consequences of that introducing for the ratio of energy-momentum and space-time (i.e. mass at rest), conservation of energy, and the axiom of choice in physics. Roughly speaking, all three become variable in turn, too. This means in relation to each of them the following:

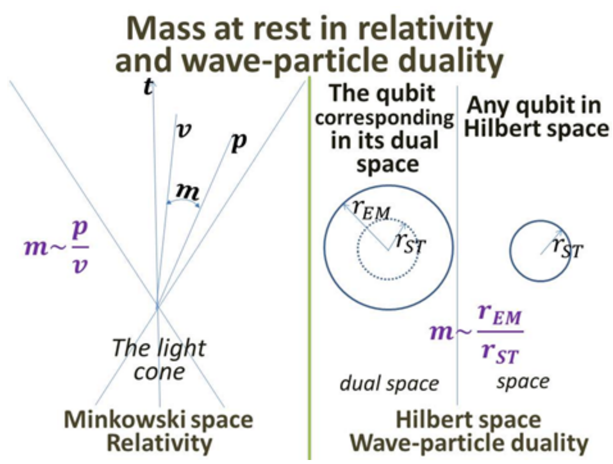

Figure 8

1. The mass at rest of an entity is variable, i.e. this means that is a function of space-time position, which can be equivalently re-presented by the pair of constant mass at rest in any space-time point and a gravitational field generally different in any space-time point. The former defines a physical item, and the latter gravity. This shows that the physical being of anything and gravity are closely interrelated, and the hypothesis that they can pass into one another can be admitted.

2. Conservation of energy is no longer valid in general relativity, but it remains locally valid. It can be generalized as conservation of action, which means that the product of the changes of energy-momentum and of the space-time position is conserved.

3. The physical cost of a bit of choice (information) is variable and depends on space-time position. If the function thus obtained be normed by its integral over all space-time, then one gains a probability distribution over all space-time function, too. Two things are immediately obvious. First, that probability distribution can be identified as the square modulus of a wave function and second, it can be mapped one-to-one into a gravitational field. If quantum mechanics and general relativity are one and the same in a sense, that mapping should be quite simple as a function, maybe even a mere proportionality through the fundamental constants:

Wave function as gravitational field and gravitational field as wave function (9):

However, the one-to-one mapping between a state of gravitational field and a wave function generates an essential problem: The gravitational field defines a 4-vector for any space-time point while the wave function not more than a probability (i.e. a normable scalar) for a

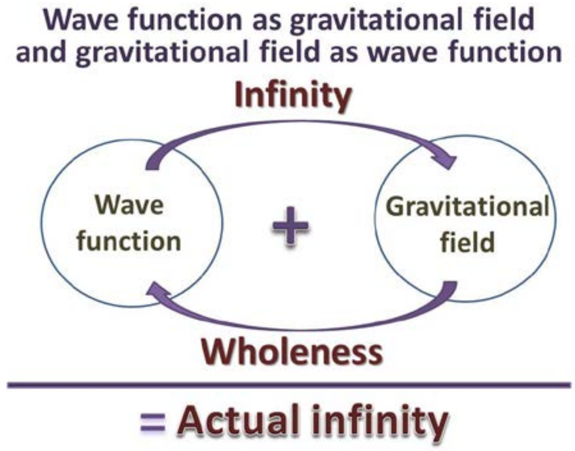

Figure 9

quantum entity to turn out in that point after measuring. Consequently, a gravitational field can be mapped into a wave function if and only if the field is normable e.g. by an integral over the ***whole***, however a wave function needs redefining to a 4-vector, i.e. 3 additional degrees of freedom should be redefined somehow. It can happen only over an ***infinite*** set. Therefore, the one-to-one mapping between a gravitational field and a wave function requires necessarily to be defined over not less than actual infinity since only it can be both ***infinite and whole***. Thus if quantum gravity is defined as any one-to-one mapping between the set of all wave functions and that of all states of gravitational field, it requires necessarily not less than actual infinity. This is a rather remarkable philosophical and mathematical fact: There is a scientific even physical and consequently experimentally verifiable theory, that of quantum gravity, which includes necessarily actual infinity in it!

How to compare qubits, or a quantum definition of mass at rest (figure 10):

The key implication above is: $r_{Q\equiv any\ qubit} \neq 1 \quad \Rightarrow Q \nvdash Q_0\ (r_{Q_0} = 1)$. It means a curving or in other words, a projection of the space-time qubit onto the energy-momentum qubit or vice versa. If one considers all the infinite set of space-time and energy-momentum qubits, which correspond to each other by the one-to-one mapping generated by conservation of energy, mass at rest denominates the minimal angle of curving since negative mass cannot exist and consequently all qubits are entangled. The curvature of entanglement can be equivalently represented by the ratio of the corresponding radiuses after projection and this ratio is equal to the mass at rest. One can notices that a Hilbert space and its dual one are entangled thus defining a Banach space. When two Hilbert spaces are entangled, they defines analogically a Banach space of the whole entangled system and consequently the phenomena of entanglement imply some mass at rest and proper energy, which equates the entire energy of the system and those of its parts for the conservation of energy.

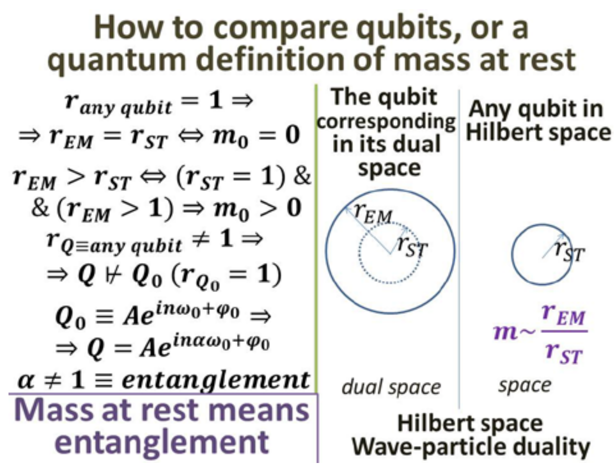

Figure 10

How mass at rest can arise by a mathematical mechanism (figure 11):

The projection of a set of "bigger" energy-momentum qubits onto a one-to-one corresponding set of "smaller" space-time qubits can be visualized as insertion. Thus quantum invariance can be visualized, too: The projection for the Kochen-Specker theorem is equated to

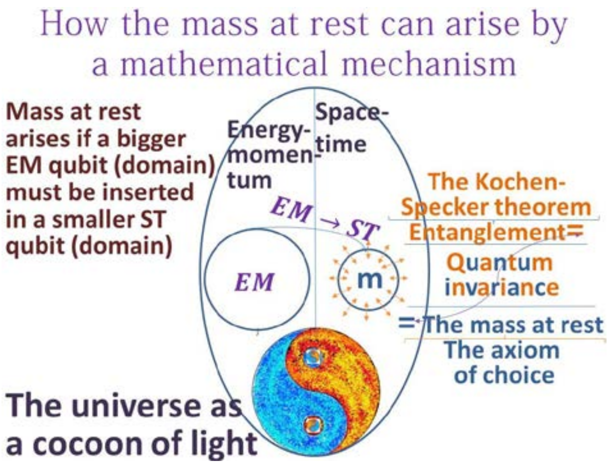

Figure 11

the "insertion" for the axiom of choice. That representation of quantum invariance is on the "screen" of energy conservation where it should be affixed as an additional principle (and a rather strange and counterintuitive one). In essence, quantum invariance is implied by conservation of action: The different "times" for the Kochen – Specker theorem can be equivalently represented by equal "times" for the axiom of choice complemented by correspondingly different energies. Consequently, conservation of action is involved for the Kochen – Specker theorem, and conservation of energy for the axiom of choice. Mass at rest appears "between" them to be equated.

Mass at rest and quantum uncertainty: a resistless conflict (figure 12**):**

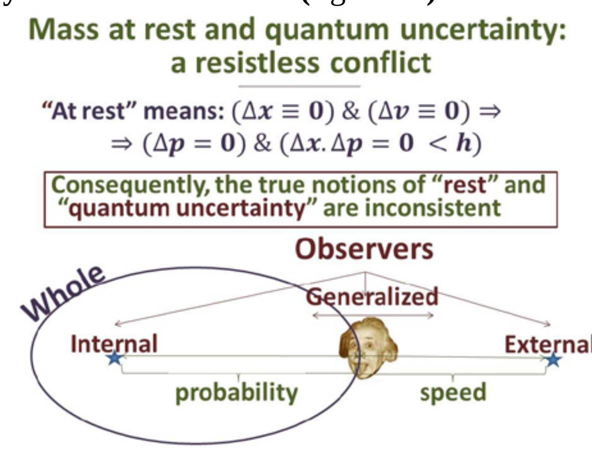

Figure 12

Moreover, the ground notion for relativity, that of reference frame, does not make sense since any reference frame is "at rest" to itself. However, if 'reference frame' keeps only the meaning of a relation between two reference frames, the quantum uncertainty forbids only the notion of "relative rest", i.e. the Galilean relativity does not make sense. In fact, 'reference frame' is used only relatively in the Einstein relativity, i.e. to another reference frame rather than to itself. One should introduce the notion of "internal observer" unlike the classical and standard observer who can be designated as "external" already as well as that of "internal motion" in relation to the "internal observer". Any internal observer should be featured by a probability (i.e. a ratio of that "internal reference frame" to the whole, within which that observer is, or to another "internal reference frame"). An internal observer would be immovable if the corresponding probability is identically equal to 1, which means that the internal observer coincides identically as with the whole as with the immovable external observer. The quantum uncertainty forbids just that observer. In fact that prohibition can be explained quite naturally in terms of 'internal observer' supposedly immovable with nothing to watch. However as an immovable as an external observer can be thought in relation to an internal one by means of a negative or complex relative probability , and vice versa: An immovable or internal observer can be thought in relation to an external observer by dint of a speed correspondingly equal or bigger than the light speed in vacuum. Finally, a generalized observer who can be as an internal as an external one as well as any superposition (combination) of the two can be introduced. A corresponding generalized invariance of all physical laws to the generalized observer should be admitted, and hypothesis that the generalized invariance can coincide with the "quantum invariance" already involved in relation to the discrete (quantum) and continuous (smooth).

Mass at rest and quantum uncertainty: a surmountable conflict (figure 13):

Quantum uncertainty for the quantity of $\frac{m}{t}$ has to remain always only an indeterminate degree of freedom. However, the force of gravity, the gravitational constant and general relativity require for it to be rigorously determined per any fixed finite volume$[x^3]$. This allows of quantum uncertainty and general relativity to be divided in "different and disjunctive aspects", by which their conflict can be overcome: Quantum uncertainty remains if any volume is indeterminate or infinite, i.e. before or beyond space-time. General relativity remains if any volume is determinate and finite, i.e. within space-time. The bound and mediator between them is the true space-time and the "light" (i.e. electromagnetism), which constitutes it transforming any inseparable quantum "much" into a divided "many" of space-time points by dint of the light-speed constant. Consequently, the only way to define mass at rest is by a passage to the limit:

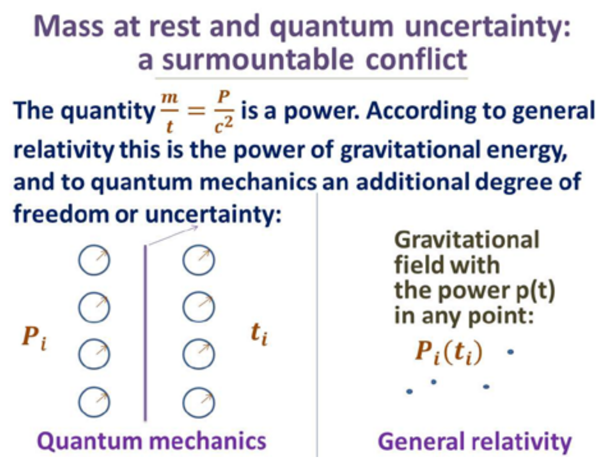

Figure 13

$$m_0 = \lim_{t \to 0} \frac{m}{t} = \lim_{V_{ST} \to V_S} \frac{m}{t} \text{ (where } V_{ST} = ctx^3 \to V_S = x^3)$$

The Bekenstein bound as a thermodynamic law for the upper limit of entropy (figure 14):

If mass at rest can be equated to energy by means of the speed of light in vacuum ($E = mc^2$), and energy to frequency by the Planck constant ($E = h\frac{N}{t}$), mass at rest can be equated thus to the number of oscillations per a unit of time ($m = \frac{h}{c^2}\frac{N}{t}$). Then the number of oscillations is proportional to entropy by dint of Avogadro's number and the Boltzmann constant ($S = K_B \frac{N}{N_A}$), and the true notion of "mass at rest" is equivalent to that of "unit if time" by means of conservation of energy ($E = const \Rightarrow speed_{time} = 1 \Rightarrow$ t=1). Consequently all this implies that mass at rest is proportional to entropy and can be interpreted as saved entropy, i.e. as negentropy and thus as information.

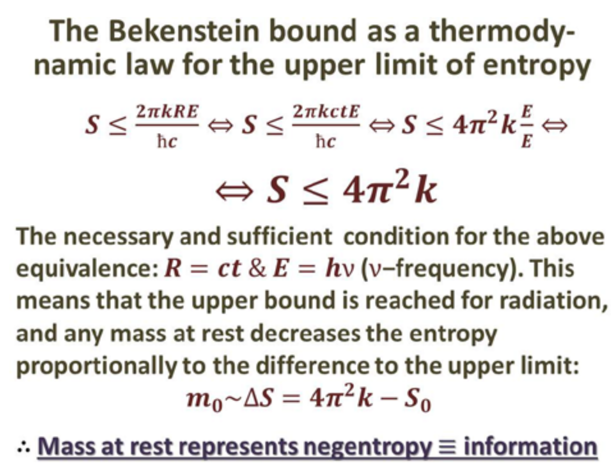

Figure 14

So another way leads to the same conclusion as the understanding of the Bekenstein bound as a thermodynamic law for the upper limit of entropy as on the figure.

All this supports once again the hypothesis that the boundary between model and reality, between mathematics and physics is “open”, and quantum mechanics is its crossing. As the scientific area of “biophysics” exists, an analogic new domain of “mathphysics” appears. An amazing fundamental corollary is option for mankind to cross the “border” in the direction from a model to reality after understanding the essence of quantum mechanics:

Quantum mechanics is God’s science of creation! Learn carefully and understand in depth quantum mechanics if you want to become creators of reality in a literal sense!

The Bekenstein bound as a function of two conjugate quantities, e.g. time and energy (figure 15):

The Bekenstein bound allows of one to think of quantum uncertainty as an undetermined rest mass of the system of the measuring apparatus and quantum entity. This can be described and interpreted as follows: Quantum mechanics studies that system, after which the rest mass of the apparatus is as much, much bigger than that of the measured quantum entity as absolutely undetermined. As one is going to see, that mass can be interpreted as the missing hidden variable in quantum mechanics. Then the meaning of the “no hidden variables” theorems in quantum mechanics would be that quantum mechanics is valid for any apparatus whatever its mass is. This imposes a philosophical reflection and comparison between the kind scientific objectivity in classical science as a whole, on the one hand, and the same in quantum mechanics. In both, it is understood as the uniformity of an investigated or measured entity in relation to the investigator or apparatus. However this leads to quite different results in each one of the cases because classical science puts the observer and devices ***outside and beyond*** the studied while quantum mechanics is forced they to be ***insides and within*** it. The same makes the holism of quantum mechanics, which is unique among all sciences and rather shocking as to the exact ones as physics. The whole, infinity, the probability as a quantitative ratio of any part to the whole and many other amazing peculiarities of quantum mechanics can be deduced from the inner place of the observer and measuring devise in relation of the investigated system. For example, if the observer is always inside and within the observed, it ought to be the true universe, and thus quantum mechanics should be accepted as the science studying the universe as a whole unlike any other one studying some part inside and within it.

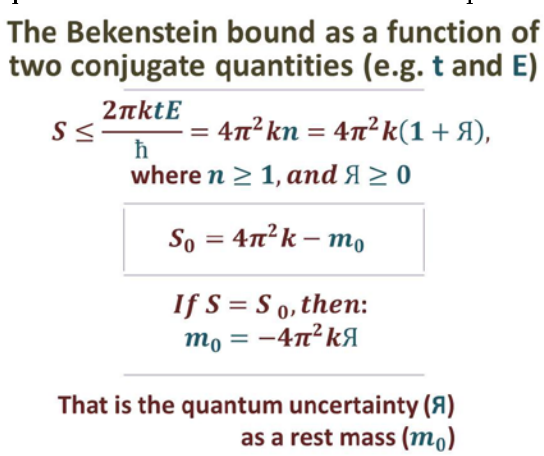

Figure 15

In particular one can compare the concept of “observer” in quantum mechanics and relativity extracting wonderful and rather useful ideas: In special or general relativity, the “observer” is always external. This allows to be introduced the relevant notion of ‘reference frame’, ‘relative velocity between two frames”, and any movement to be always smooth, i.e. with a speed quite exactly defined in any point of the trajectory. On the contrary, the “observer” is always internal in quantum mechanics. The notion of “relative speed” loses any meaning, but it can be replaced by the ‘change of probability’. Indeed, quantum mechanics (e.g. von Neumann 1932: 167) establishes that any change of probability is a physical quantity, and any physical quantity is a change of probability in its domain. This suggests a few relative ideas: 'Speed' in classical mechanics and relativity, on the one hand, and 'probability' in quantum mechanics, on the other, are not only corresponding or complementary notions, but besides they can pass each other and a new "information conservation" should define the quantitative ratio in that passage as well as a combined physical quantity of 'speed-probability', which should feature the passage or correspondence, or complementarity, or the invariance of physical laws to an internal and an external observer in final analysis. Quantum mechanics and quantum information describe the world in relation to an internal observer, and special and general relativity accordingly describe it for an external observer. At last one can put an equal sign between an external and an internal observer introducing a generalized observer, to whom quantum mechanics and information, on the one hand, and special and general relativity, on the other hand, can be unified, or in other words, the cherished quantum gravity is possible only in relation to the generalized observer in question.

About the "new" invariance to the generalized observer (figure 16):

One can formulate a supposedly new invariance of all physical laws to the generalized observer, or in other words, to whether the observer is internal or external, or partly external and partly internal. The external observer of classical physics is equivalent to energy conservation. That energy conservation borrowed from classical physics has been transferred to quantum mechanics creating its current appearance, in which time is ought to be a singular physical quantity, and energy a universal one, whose operator commutates with that of any other physical quantity. In fact that state of affairs is semi-classical, generating fictive phenomena like the Big Bang. However the transition to the generalized observer is what forces the corresponding generalization of energy conservation to information (or action) conservation. The change between an external and an internal observer or between various combinations of observers partly internal and partly external requires two different times for the external observer and for the internal one and thus introducing the new physical quantity of 'time speed' as well generalizing the energy conservation as action conservation, which directly converts to information conservation by means of the Planck constant. Once done, the alleged as a new invariance, namely that to a generalized observer, turns out to be the discussed above quantum invariance between the discrete and continuous (smooth), or in other words, the generalized Einstein principle of relativity (1916-1918) comprising not only any smooth movement (therefore possessing an exactly defined finite velocity in any point of its trajectory), but also any discrete movement such as quantum motions (leaps). The generalized observer who can be even partly external and partly internal, i.e. in a process of passage from the externality to the internality of the investigated system or vice versa, rigorously corresponds to a mixed motion, which is partly discrete (quantum) and to the internal observer, and partly continuous (smooth) as to the external observer.

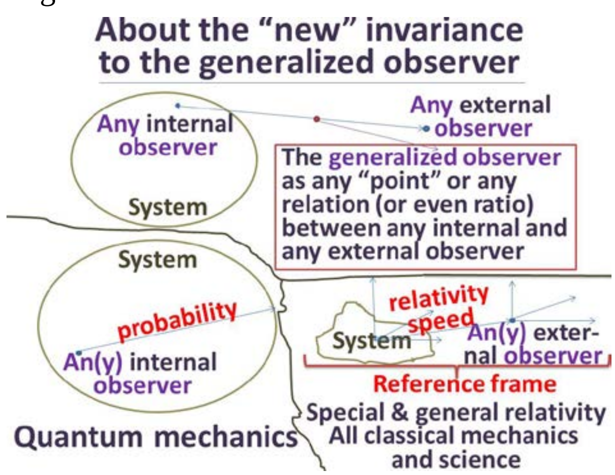

Figure 16

Then, the next question should be how the discrete (quantum) part of the motion would seem to the external observer. One could no longer be sure that it should seem as a force, moreover as a one exactly coinciding with that of gravity. The twin of the same question is how continuous (smooth) part of the motion would seem to the internal observer. One could no longer ascertain that it would seem as or like entanglement. Consequently the generalized observer as above is to whom entanglement and gravity are the same already obeying a law of conservation of information (action).

Cyclicity from the viewpoint of the generalized observer (figure 17):

Energy conservation and even energy-momentum conservation is not invariant to that cyclicity or to the "generalized observer". The latter two require conservation of information (or of action as a physical quantity with a physical dimension and unlike the information, which is dimensionless). The unification of quantum mechanics and general relativity can be completed only to the "generalized observer", which is that notion can generalize and thus include the too different conceptual foundation of both the most fundamental theories of the contemporary physics. The "generalized observer" allows of that cyclicity to be discussed as a real physical process of transformation of an internal into an external observer, or in other words, the transformation of the description of a system seen inside into that outside.

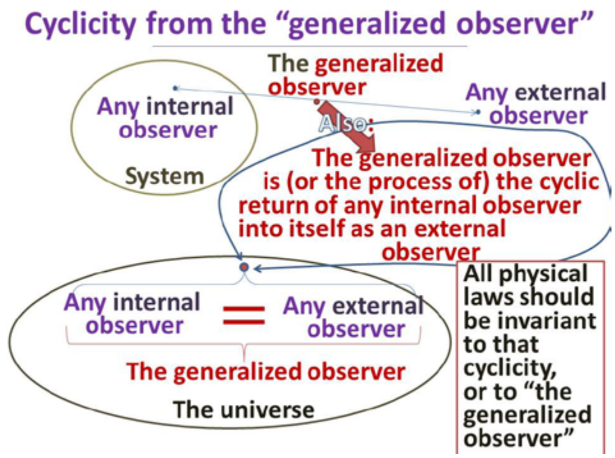

Figure 17

General relativity as a superluminal generalization of special relativity (fig. 18):

In particular, the concept of the "generalized observer" allows of general relativity to be understood as the superluminal generalization of special relativity, and gravity with its energy as the representation of the quantitative difference between the energy to the internal and external observer in terms of energy conservation. Consequently, the gravitational energy should interpret as way for the violation of energy conservation to be uniformly thought in the obligatory "attire" of energy conservation. This peel is as necessary for "good manners" in science yet as it is unnecessary, arbitrary, obstruction, conventional like a "tailcoat". It is about time to get rid of it!

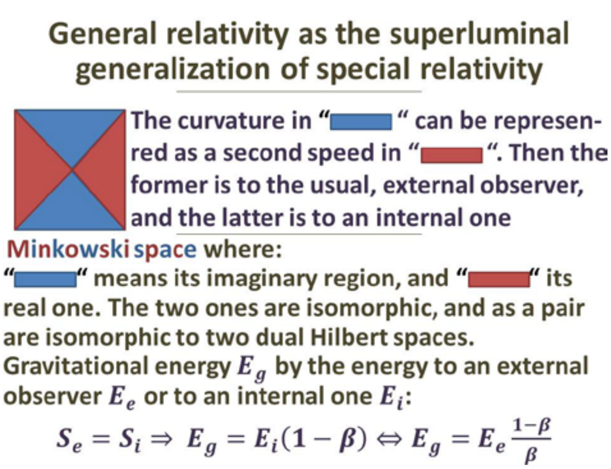

Figure 18

But one by one: the first one is general relativity as the superluminal generalization of special relativity. This can happen by means of the interpretation of the superluminal domain (the real area of Minkowski space) as the quantum dual counterpart of the subluminal one (the imaginary region of Minkowski space). Then, with the example of one dimension, the conjugate of the subluminal velocity $v_e = \frac{x_e}{t_e} = \frac{dx_e}{dt_e}$ is the curvature of that one-dimensional space $\sigma = m.x = dm.dx$. Thus one can equivalently represent σ as another speed $v_i = \frac{x_i}{t_i} = \frac{dx_i}{dt_i}$, namely as if the superluminal one, which is just another subluminal velocity, to say to the "internal observer" if the first speed, that in the subluminal region, be called being in relation to the external "observer". The choice which region is to the external observer and which to the internal is thoroughly conventional, though. We keep the above convention, which is established in the literature on special relativity and according to which the usual external observer "dwells" the subluminal domain (the imaginary region of Minkowski space). Then special relativity refers only to the subluminal area with the light cone while general relativity refers to both the subluminal and superluminal region sharing the light cone between them. So the second speed, that to the "internal observer" is equivalently and in tradition represented as some curvature of space-time and thus as gravity by dint of general relativity. This rather artificial construction is imposed only to be able to dress the "tuxedo" of energy conservation yet mandatory for "good manners" in science. But now it's time to throw it:

The second one in the above "one by one" is to be shown that action (information) conservation generalizing the old conservation of energy explains gravity much simpler as well as naturally linked to quantum mechanics:

$$S_e = S_i \Leftrightarrow E_e t_e = E_i t_i \Rightarrow E_g = E_i - E_e \Leftrightarrow E_g = E_i\left(1 - \frac{t_i}{t_e}\right) \Leftrightarrow$$
$$\Leftrightarrow E_g = E_i(1-\beta) \Leftrightarrow E_g = E_e \frac{1-\beta}{\beta}.$$

The quotient β is the same or equal to the quotient $\beta = \frac{v_i}{c} = \frac{v}{c}$ of special relativity. If the point of the generalized observer is moving from the one extreme, that of the external observer to the other, that of the internal observer, the quotient β is decreasing smoothly and accordingly from 1 to 0.

Cyclicity as a condition of gravity (figure 19):

At least the sense of gravitational energy and thus that of gravity can be deduced from the condition of cyclicity: In special relativity, the energy of a system is constant in time to any observer but different to different observers. In general relativity, it is not constant in time even to one and the same observer, though. This is due to the curvature of time in pseudo-Riemannian space unlike the "straight" time in Minkowski space. However if one is projecting the "crooked" time onto a straight line, equal lengths of time will be represented by different lengths on the line. Since conservation of energy is valid in the line, it will be transformed

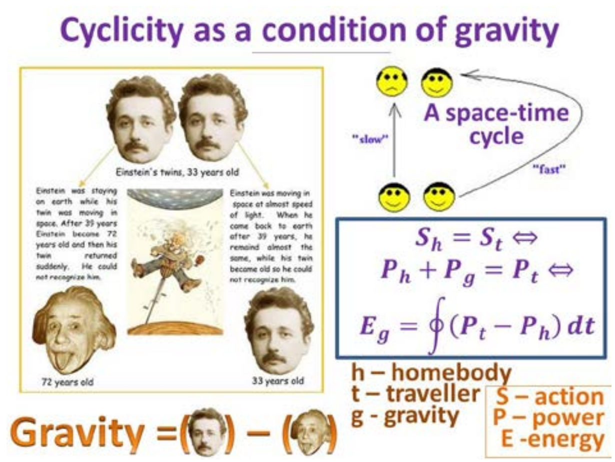

Figure 19

into conservation of action for the different lengths of the “crooked” time corresponding to the equal segments of the straight line. If the process of curving of time is closed into a cycle, then both viewpoints on energy conservation should be unified:

In special relativity, there will be two different observers in the same point: The one has traveled around the cycle while the other has been the whole time in the starting point. Of course, this is the “twin paradox” in special relativity from a different viewpoint. Since the travelled twin is younger, his energy should be bigger according conservation of action. However after his return in the starting point, one and the same point, i.e. the starting point has two different energies: that according to the twin homebody will be smaller than that according the twin traveller. To align them, the twin homebody should complement his, i.e. the energy according to him as the one observer in one and the same point. This energy is which is the gravitational energy (e.g. due to the gravitational field of Earth).

In general relativity, the time of the twin homebody will be a straight line, while the time of the twin traveller will be a curve. According to conservation of action, the energy according to each of the two should be different, and gravitational energy is added to align the two energies. The result is the same as above, in terms of special relativity.

As one can see, the difference of the energies to each of the twins depends on the magnitude of the cycle. There are two options accordingly: Conservation of action can be considered as per a unit of length of the cycle as per a unit of area of the cycle. The former does not require the curve to be closed, i.e. to be properly a cycle while the latter does for a number to be able to be juxtaposed to any cycle as its area. The former leads to conservation of momentum, which is not valid globally as to general relativity but only locally for the approximation by Minkowski space in any point of pseudo-Riemannian space as well as conservation of energy is not globally valid, too. Though conservation of energy-momentum (4-momentum) is not valid to the cycle in general, it will be identically true for the starting point of the cycle, which coincides necessarily with its end point since it is locally valid. That consideration is false, though, since no trajectory in space-time can be closed as a cycle as the time coordinates of the starting and of the end point are necessarily different.

The latter case, that per a unit of area of the cycle remains the single option since the area of a space-time cycle can be yet defined as the area between the straight time line of the twin homebody (h) and the time curved of the twin traveller (t). Thus the latter means the equality of the powers (P, energy per a unit of time) to each twin by means of gravitational power as follows:

$$S_h = S_t \Leftrightarrow (px)_h = (px)_t \Leftrightarrow \left(\frac{E}{tc^2}\right)_h = \left(\frac{E}{tc^2}\right)_t \Leftrightarrow P_h + P_g = P_t \Leftrightarrow E_g = \oint (P_t - P_h)\, dt$$

Cyclicity as the foundation of conservation of action (figure 20):

The cyclicity of the universe as a global whole to any point in it requires the alignment of the kinematic and dynamic consideration, i.e. the consideration to be per a unit of energy (mass). Well, if one unifies this condition of cyclicity and conservation of action, the following is implied:

$$S_i = S_e \xLeftrightarrow{per\ a\ unit\ of\ energy} t_i = t_e$$

Consequently, the condition of cyclicity including $t_i = t_e$ and the alignment of the kinematic and dynamic approach per a unit of energy ***is equivalent*** to conservation of action (information): Each side of equivalence founds the other. This direct link between them makes

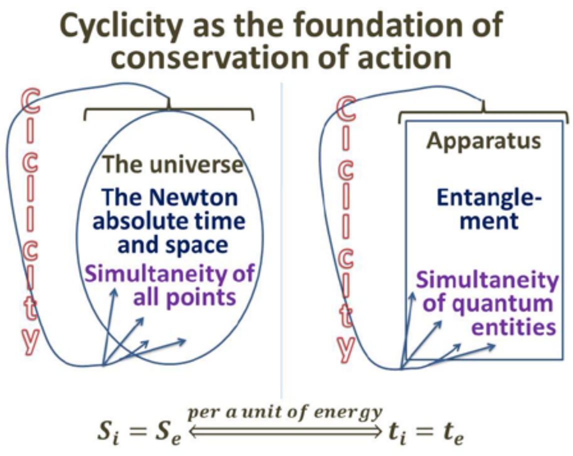

Figure 20

both more credible as the two "elephants" supporting the discussion turn out to be one and the same.

The same condition in relation to all points of the universe can explain that: The time of any point coincides with the time of any other: Thus the Newton absolute time makes a clear physical sense and the principle of action at distance as well. The carrier of both of them is the universe as a whole and cyclicity as a real physical mechanism. Furthermore this is consistent with special relativity and Lorentz invariance in a sense, though. All points of 3D space (i.e. the Newton absolute space) can be considered as lying on the light cone with zero space-time distance between them or in other words, as simultaneous.

The cause to appear non-simultaneity is the separation between kinematics and dynamics, i.e. the energetic (mass) inhomogeneity of space-time for the bodies, radiation and gravitational field in it.

– The phenomena of entanglement where two or arbitrarily many points at any distance seem simultaneous. That simultaneity is "caused" by the wholeness of the apparatus as which all the universe can be considered, too.

– Gravity and entanglement share that common physical mechanism based on cyclicity being only different perspectives to one and the same: correspondingly the temporal and holistic aspect of that cyclicity.

Mathematical and physical uncertainty (figure 21)**:**

One can see quantum as logical uncertainty using the concept of 'free variable'. The free variable can accept an exact value among many ones transforming itself into a bound variable. So, one can think of a free variable as an undetermined "much" while of a bound variable as a "many" or as a usual set of all possible values, which the bound variable can accept. Consequently the relation of a free and a bound variable being the same in both cases is analogical and even isomorphic to the relation of a quantum quantity before and after a measurement. Further, quantum uncertainty can be represented logically as a relation between two free variables being conjugate. If one of two classical conjugates is bound, the other is necessarily bound, too. However two quantum free conjugates are as if semi-independent (or said otherwise, semi-dependent): They are neither one-to-one dependent as classical ones, nor absolutely independent as two different free variables

Mathematical and physical uncertainty

	Certainty	Uncertainty	Independence
Set theory	Any element of any set (the axiom of choice)	Any set	Disjunctive sets
Logic	Bound variable	Free variable	Independent variables
Physics (relativity)	Force	Degree of freedom	Independent quantities
Quantum mechanics	The measured value of a conjugate	Any two conjugates	Independent quantities (not conjugates)

Figure 21

since they obey the Heisenberg (or quantum) uncertainty. Then one can think of their product as a pure free variable, which cannot be transformed into a bound variable in principle though one but only one of its factors can (after a measurement).

However if the product is a free variable in principle, then the ratio of its two factors is necessarily a free variable in principle, too. Quantum mechanics is consistent with this, but general relativity requires it to be a bound variable. Consequently, the kind of invariance required by the pair of quantum mechanics and general relativity, which has been called quantum invariance above, translated in terms of free and bound variables, means the invariance between a variable being free and the same one being bound. In set theory, that invariance requires at least the "many" of infinity. However the infinity of physical entities seems not to make sense and another way to generate infinity should be sought as to physical entities. Any coherent "much" and the axiom of choice offers the infinity to be "created". This method is especially impressive if one takes the coherent empty "nothing" as the initial "much": Then the axiom of choice generates infinity choosing element by element from the empty set, i.e. from nothing. Of course, the axiom of choice is used to be formulated only for non-empty sets, but why? Either way it is a conventional axiom with a more than doubtful intuitive sense. *Choice can generate the world from nothing, and quantum mechanics can describe the way of that generation and the thus created world*.

If one utilizes the notions of "free and bound variable", the same state of affairs ceases to be so shocking: A free variable can take new and new values as a bound variable even an infinite set of values without causing resentment though the free variable is the same empty name like any empty set. Then the empty set could be reformulated from "a set without elements" to "a set without any determined elements", i.e. as the simple coherent "much" necessary to quantum mechanics. Not only the notion of "free variable", but also that of "degree of freedom" would correspond to it. The thus outlined isomorphism between free variable and degree of freedom connects logic and physics and can be continued unlimitedly: e.g. "force" will correspond to "bound variable". An additional degree of freedom exists between any conjugates in quantum mechanics and absent in classical mechanics as well as in special and general relativity. This additional degree of freedom can be thought furthermore as an additional free variable, which classical mechanics or relativity "binds" and to be interpreted as the physical quantity of time as follows: The former refers to time at all, i.e. to eternity as all time or as a free variable while the latter refers to each moment of time or to time as a bound variable. The so-called holographic principle requires a similar alignment of n and n+1 dimensions. Cyclicity is the way to achieve the same in this paper. Infinity, quantum coherence, etc. are not anything but a different name of the same alignment necessary for "quantum gravity", i.e. for the quantum representation of gravity.

General relativity is entirely a thermodynamic theory (figure 22):

However, one should ask if indeed general relativity would be a thermodynamic theory, then what this should mean and how this should be interpreted. What should be the definition that a theory is thermodynamic? The implicit meaning, in which the term is utilized above, is the following: All the principles of it are thermodynamic and as the theory is a necessary deduction from them, it has to be thermodynamic. This is an indirect conclusion and a direct and explicit deduction, which to complement it, would be rather useful and convincing. Then meaning classical thermodynamics as an example, one could derive the following features for a theory to be called thermodynamic:

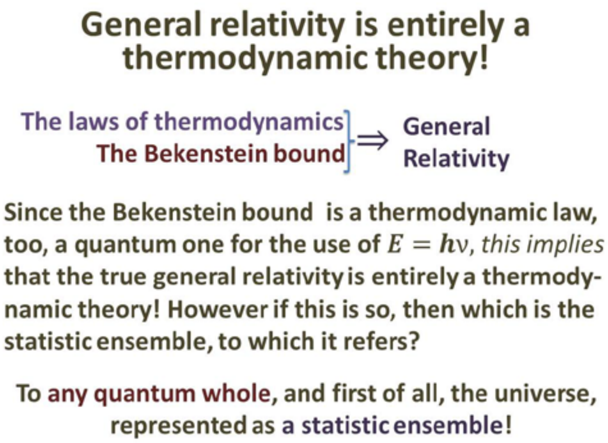

Figure 22

1. It has to refer to some whole described by thermodynamic quantities like pressure, volume, temperature, etc. Each combination of them defines a thermodynamic state of the whole.

2. The whole can be equivalently represented as a statistical ensemble of entities, e.g. atoms, molecules, etc. and its thermodynamic quantities can be reduced to their mechanical quantities.

Consequently, one should answer the following questions as to general relativity to be able to declare it as a thermodynamic theory:

1. Which is the whole described by it?

2. Which are its thermodynamic states?

3. Which is the statistical ensemble, to which that whole can be reduced.

An additional question can be inserted as well:

4. Which is the way to be constructed a mapping between the sets of the states of the whole and of the corresponding statistical ensemble, which seems to have to be one-to-one?

The answers are accordingly as follows:

1^{a}. The whole described by the thermodynamic general relativity is the universe.

2^{a}. As the universe is that whole, which is maximal and absolute, its thermodynamic states can be pointed only indirectly, namely by means of the mapping defined in 4.

3^{a}. Its statistical ensemble is the collection of all space-time points, and its states are identical with those of gravitational field.

4^{a}. The way to be constructed that mapping is cycling. The cycling is what forces general relativity understood thermodynamically to be necessarily a quantum theory in addition.

The cycling is an equivalent to a new law of conservation: conservation of time, or more precisely said, conservation of wave period rather than of time. Conservation of wave period is the exact counterpart of conservation of energy in the more general frame of conservation of action or information. As one can see above, the cycling is possible only under the "kinematic" consideration, which equates the universe and any point in it per a unit of mass (or energy). This can be interpreted for example as an "equienergetic" dividing the space into disjunctive domains with one and the same energy (or otherwise, mass) and this is an exact analog of the "equitemporal" dividing the time into disjunctive moments with one and the same time length required by or equivalent to conservation of energy (mass). Consequently, the space divided equienergetically implies conservation of wave period (time) analogically on the same ground of the conservation of action.

Well, but how should that conservation of wave period be interpreted? What does it mean? What is its physical meaning?

This is the missing quantum counterpart of conservation of energy linked to the "particle half" of wave-particle duality: That is the conservation of wave period has to be attached to the "wave half" of wave-particle duality and both "halves" of partial conservation constitutes the common and most general conservation of action (information). This can be visualized especially well by the wave and particle "phase" of the process of motion in an as quantum as cyclic way as follows.

Cycling and motion (figure 23):

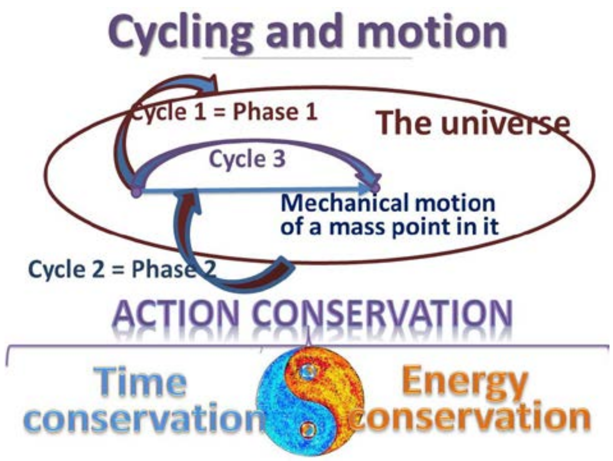

Figure 23

Mechanical motion can be represented by two phases which can be thought as sequential as parallel. These two phases correspond exactly to space-time position and energy-momentum of a point and consequently to the value of gravitational field in that point. The usual picture of the physical world is projected on the "screen" of conservation of energy. It represents a body with nonzero mass at rest or some radiation with nonzero energy, but with zero mass at rest, which are at this point.

The hypothesis of cyclicity offers another picture including the above one as a particular case. One of those two phases is the image of the universe after its return into itself obeying the conservation of action (information) as the general case or obeying the "conservation of wave period" in particular. So there are three kinds of the picture of the physical world according to wave-particle duality: The first one is the "particle" picture of classical physics on the screen of conservation of energy. The second one is the generalized picture of quantum mechanics, which in fact requires conservation of action (information) rather than of energy (mass). It implies an unknown, "wave" counterpart of the picture obtained by means of conservation of energy, namely that for conservation of wave period (time).

Then the cyclicity of mechanical movement can be explained easily by a few consecutive cycles, after which the change of a point in the universe causes a change of the entire universe, and the change of the universe causes in turn the change of this point in it. These cycles can be described more precisely this way:

1. The change of the point in the previous cycle causes the change of the state of the universe as a whole.

2. The universe returns to this point for the principle of cyclicity as the other phase of mechanical movement obeying conservation of action (information).

3. This second phase causes the change of the point of the universe, which is the first phase of the next state of mechanical motion (or the next point of the trajectory of mechanical motion according to classical physics).

4. The cycle (1-3) is repeated again and again ... and again ... monotonically and unlimitedly.

Consequently mechanical motion cannot be effected otherwise than by means of the universe as a whole or in other words, of actual infinity. All this alludes to Hegel's dialectic.

Furthermore, that cyclicity explains easily the equation of inertial and gravitational mass: The former is defined to equate the cycles 1 and 2 while the latter equates 2 and 3. Since mechanical motion is postulated not only continuous but even smooth in that model, inertial and gravitational mass coincides necessarily. The opposite (i.e. an eventual inequality of inertial and gravitational mass) would mean that the left (forward in time) and wright (backward in time) derivative are different and the quantity of speed cannot be defined unambiguously. However Einstein's "general covariance" deduced just from the equation of inertial and gravitational mass postulates that smoothness.

Nevertheless there are a series of equivalences or invariances which are one and the same in essence, namely quantum invariance described in detail above. For examples it includes:

- Lagrangian and Hamiltonian
- The Lagrangian and Hamiltonian formulation of mechanics
- Quantum mechanics and general relativity
- The Kochen – Specker theorem and the axiom of choice
- Skolem's "paradox"
- Etcetera as above.

General relativity is really a thermodynamic theory (figure 24):

There is another way for general relativity to be thought as a thermodynamic theory, namely indirectly by the mediation of quantum mechanics. Then, first of all, quantum mechanics should be understood as a thermodynamic theory. However quantum mechanics being understood as a thermodynamic theory is rather extraordinary. The term of "cyclic mechanics" has already coined above to designate the opposite way, in which quantum mechanics reduces its subject in comparison to statistical thermodynamics. Indeed statistical thermodynamics reduces theoretically the whole with its macroscopic thermodynamic quantities to set of states of a statistical ensemble consisting of entities like atoms, molecules, etc. with their microscopic mechanical quantities. Quantum mechanics does the opposite: It reduces theoretically the state of a statistical ensemble to an inseparable and unorderable quantum whole called coherent superposition of this state and all rest possible states of that statistical ensemble. However unlike the kind of reduction of statistical mechanics, which represents the macroscopic and properly thermodynamic state as a function of the states of the microscopic ensemble, the kind of reduction of quantum mechanics is inverse and requires correspondingly the inverse function, which is not defined as a function in general but as a generalized function (or "Schwartz distribution"). The coherent superposition just mentioned is generally such one. In terms of classical epistemology it describes the state of the investigated quantum whole "by itself". If the theoretical reduction has necessarily reached to a coherent superposition (or generalized function), it requires a corresponding practical reverse reduction carried out by quantum measurement and device. The mathematical nature of that reduction is choice and accordingly it supposes the validity of the axiom of choice. The fundamental necessity of that choice generates the specific delusion that an observer who to carry out that choice is necessary for quantum mechanics or that it is "subjective" or "arbitrary", even not a science in a rigorous sense. The mistake, which creates that delusion, consists in the identification of choice with an observer or "decision maker" ostensibly necessary for it. In fact, choice is "objective", it does not need somebody who to choose. That choice is a part of nature, of physics. It leads to information as the fundamental base of the world and of the universe. As choice does not need a "chooser", as information does not need an energetic carrier as the etymology of "in-form-ation" misleads thus.

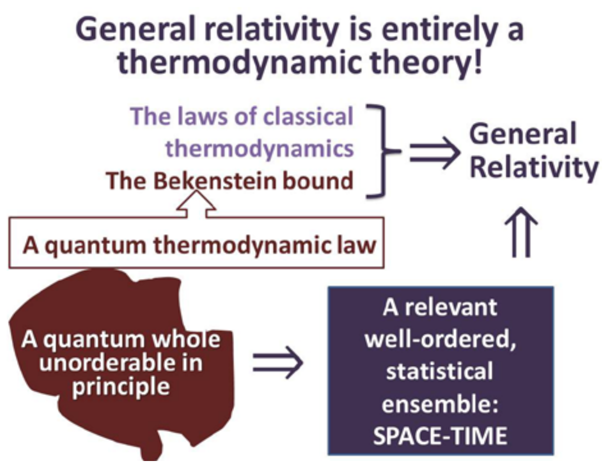

Figure 24

Since quantum mechanics has to refer both to a quantum whole and to the classical statistical ensemble of all measurable values for it, quantum invariance is unavoidable and the derivative invariance in relation to the axiom of choice as well.

Now general relativity can be seen as the standard kind of thermodynamic theory, to which quantum mechanics is the reverse kind as described above, and both together constitute a cyclic whole – cyclic mechanics!

The statistic ensemble of general relativity (figure 25):

The idea that the universe as a whole is a prerequisite and thus participates directly in any mechanical motion is quite amazing and maybe even shocking. However just this is the true sense and meaning of quantum mechanics. Just this is the prerequisite for quantum mechanics and general relativity to be unified and it leads to the understanding that information is the real fundament of the world. Mankind has known so far only one projection of that fundament: the world only as an energetic (or material) image of the omnipresence and ubiquitous information. That image is obtained as cyclicty remains hidden and the well-ordered space-time as well as anything in it is taken for granted, which is not negotiable.

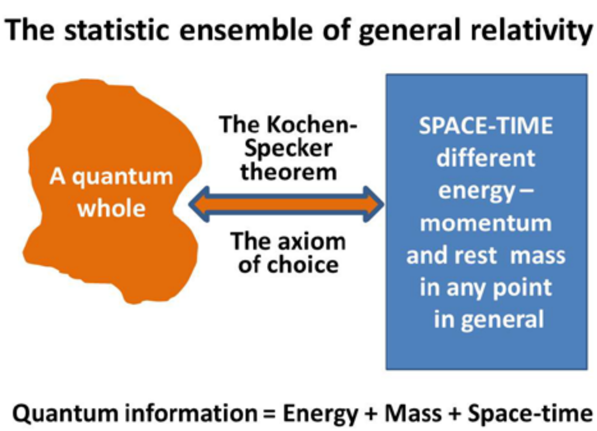

Figure 25

But now even the idea of what is great and what is little needs to be revolutionized. Information worldview presupposes another dimension or fundamental quantity, which is equipollent and tantamount to the energetic or material one, that of a variable time or wave period. The magnitudes of those two dimensions are reverse. The big as energy is small as time and vice versa. So the immensely biggest according to the energetic or material "dogma" as the ostensibly scientific viewpoint on the universe is, in fact, is the least tiniest according to the complementary viewpoint.

Just this interchange of the big and the small makes and requires cyclicity. The cyclicity is that special site, everywhere and nowhere, where the big becomes small and the small becomes big. Quantum information is that frame, which regulates that becoming, and conservation of action is the quantitative law and way for the big and small to pass into each other.

The necessity of that ciclicity originates from the nature of quantum wholeness or coherence after one creates the well-order of space-time in it.

Einstein's emblem (figure 26):

The only necessary is to extend the interpretation of Einstein's formula, $E = h\nu$, involving the true space-time as an infinite set of photons with zero energy. Though any photon of those has almost zero energy, some infinite sets of them can have nonzero energy. Mathematically, those photons have some infinitely small, but not zero energy. They correspond to infinite subspaces of space-time.

The mathematical notion of measure for an infinite set can express this: For example, given any finite measure, x^3, of some infinite set of infinite subspaces of space-time, then some nonzero energy reciprocally proportional to this measure will correspond, namely $E \sim \frac{1}{x}$, or $E = \frac{hc}{x}$. An obstacle would bar to introduce those photons with infinitely small energy, though: They are inconsistent with the Lorentz invariance and accordingly, with the postulate for the limiting light speed in vacuum. Since general relativity is locally Lorentz invariant, some nonzero action at distance (as in Newton's theory of gravity) is necessary to be accepted. Well, after the phenomena of entanglement have already confirmed experimentally, that action at distance is admitted in contemporary physics. It has only to be adapted to general relativity and to its link to quantum mechanics (so-called quantum gravity). However the following was shown above: The way to involve the action at distance by entanglement requires necessarily introducing actual infinity or wholeness as physical entities experimentally observable. In final analysis, this leads to be cancelled any distinction between reality and its model, between the physical and the mathematical. That's what we do ... It supposes the relevant evolvement of philosophy, mathematics and physics partly made in different contexts above: In philosophy, this means to remove the postulate that there exists some principle difference between reality and cognition, or knowledge, or model as well as introducing cyclicity in the manner of Nicolas of Cues or of the Chinese thought. In mathematics, this means to be introduced the notion for the invariance to the axiom of choice (i.e. a Skolemian "relativity"), and in quantum mechanics the corresponding conception of quantum invariance. As to general relativity the same leads to be understood as a thoroughly thermodynamic theory.

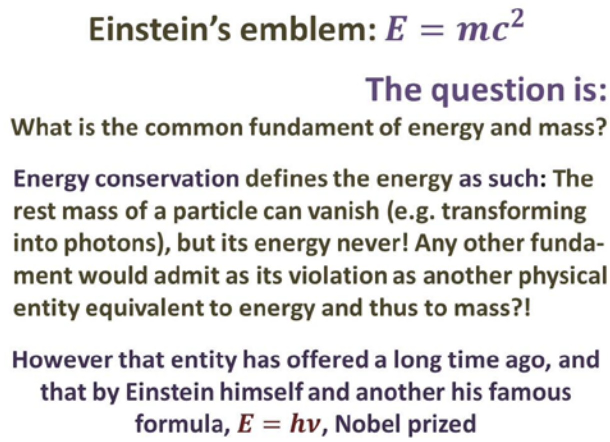

Figure 26

Again about the statistic ensemble of general relativity (figure 27)**:**

That statistic ensemble is the true space-time as an original gas consisting of all the space-time points, indeed an ideal one. Its entropy corresponds exactly to the Bekenstein bound. "Coagulates" with different masses at rest and smaller entropies can arise in it. The mass of rest takes the corresponding difference in entropy to the Bekenstein bound. So all the bodies or quantum "particles" with any nonzero mass at rest are in fact negentropic, i.e. informational coagulates within the ideal gas of space-time. They all can transform into photons with zero rest mass and different energies, which take the rest mass. This means that negentropy or information as a physical quantity, i.e. quantum information can exist in two forms, mass and energy, which can transform into each other obeying energy conservation, in particular, or information conservation, in general. The latter means that a fundamentally new member so far implicitly assumed to be zero should add in conservation of energy (mass). It can exist in two

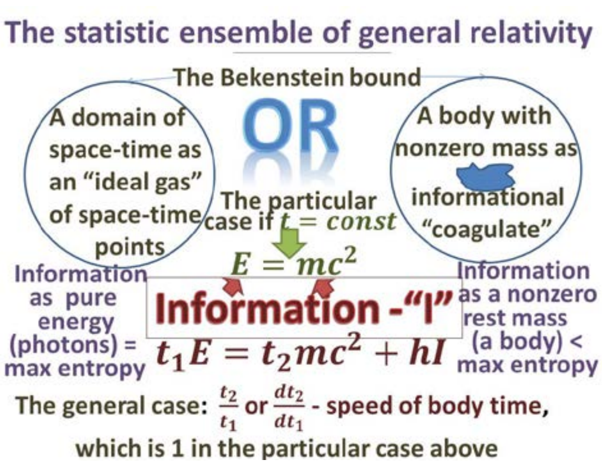

Figure 27

equivalent forms: as qubits or as space-time, i.e. both as an unorderable in principle quantum whole and as a well-ordered space-time domain free of any mass or energy, which is the vacuum.

Reflections on the information equation (figure 28):

The information equation combines the two most famous Einstein equations: $E = h\nu = \hbar\omega$ and $E = mc^2$. They are particular cases of the information equation for alternative boundary conditions, accordingly: $m_0 = 0$, and $t_1 = t_2 \Leftrightarrow I = 0$. The former can be interpreted as referring to a "pure" radiation, and the latter as referring to a "pure" particle. Both conditions can be interpreted in terms of wave-particle duality. However after one has combined them in the information equation, entities possessing both radiation or wave properties and particle ones are its content. Consequently wave-particle duality is revised as just one "ratio" fixed by the information equation between "wave" and "particle" properties is discussed. If one returns in terms of quantum mechanics, this can mean that a measurement is made or that suitable "hidden variables" are involved though forbidden by the John von Neumann or Kochen-Specker theorem. Obviously, information (entropy) as a physical quantity is that hidden parameter, which could absolutely determine quantum uncertainty eventually. Information (entropy) should refer to a special statistical ensemble of all space-time point featured by its gravitational field. That statistical ensemble as ones saw above can be interpreted as an ideal gas or the rehabilitated aether of general relativity. Then the entropy of that ensemble is what is limited by the Bekenstein bound.

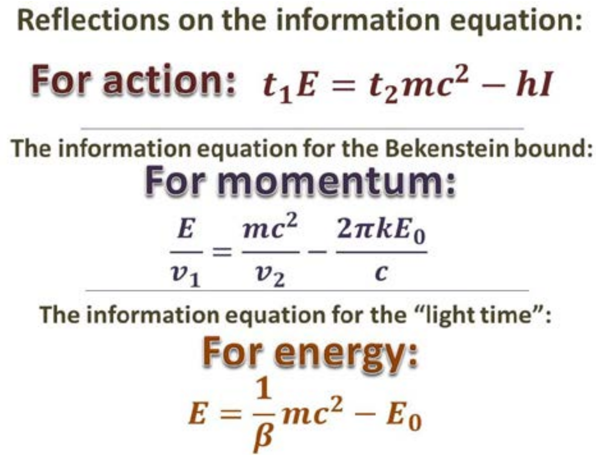

Figure 28

The distinction between energy and rest mass (figure 29)**:**

Consequently, energy defines a property of a granted entity while mass at rest defines that entity as a maximal informational potential to be described properties. The information, which can be obtained for the entity and its properties, cannot exceed the savings entropy (= negentropy = information), which is saved in the form of mass at rest. The Bekenstein bound implies this. Besides, one can suppose that the common quantity of the mass and energy of an entity, and the information, which can be yielded from it, obeys the Bekenstein bound. If the rest mass is a savings entropy, then "Einstein's emblem", $\boldsymbol{E = mc^2}$, implies that energy is a form of informational expenditure. Besides, the mass limits the quantity of information for the properties of the entity or in its cognition. The Heisenberg uncertainty will seem strange, though it is a law in quantum mechanics, while one does manage to explain why it exists. The Bekenstein bound, which can be interpreted as its equivalent, shows the meaning

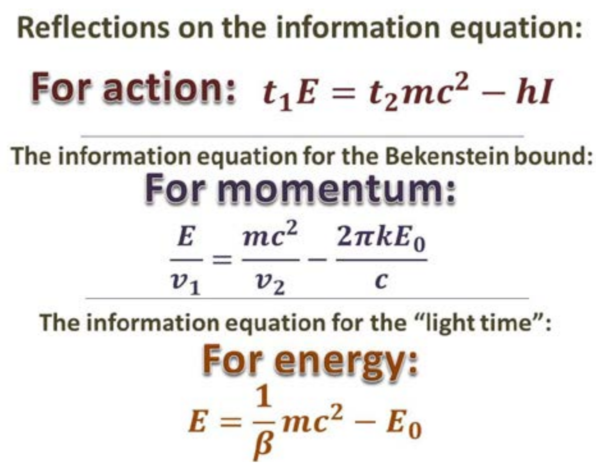

Figure 29

of it as the upper limit of the information, which can be extracted from a physical entity, according to its mass. The mass of a quantum entity, unlike a body in classical physics, is too small to allow of more cognition than the quantity restricted by the Heisenberg uncertainty. Moreover, and rather unexpectedly, the Einstein − Podolsky − Rosen “paradox” as well as all the phenomena of entanglement (and quantum information in general) can be easily elucidated, too, by the adding of space-time among energy and mass as another form of quantum information. If a quantum system includes adequate space as in EPR, then this allows of a more extended knowledge of it as if violating the Heisenberg uncertainty and displaying the claimed “incompleteness of quantum mechanics”. The maximal possible cognition of a system depends on the amount of space (space-time), within which it is located. The term of “adequate space”, within which a quantum system should be located to allow of the complete cognition of its properties, admits a quite exact definition: It has to be bigger than the light cone, whose center is the system in question so that this allows of „action at distance“. Consequently, all the phenomena of entanglement should cease in an adequate period of time, which is necessary for a light signal to reach all spatially located parts of the system. This is what is observed for “decoherence”, which is disentanglement in essence. However it is partly misinterpreted as another entanglement – that of the system with its environment, and which destroys ostensibly the investigated entanglement of the system. For example, a difference between the two different explanations would be that decoherence should observed also in a completely isolated system over time, i.e. in the course of time. However after action at distance has been accepted for entanglement, the concept of “completely isolated system” loses its meaning even as a theoretical one. This allows the two above explanations of decoherence to be identified, which is consistent with the understanding of general relativity as the superluminal generalization of special relativity.

Gravitational field as a limit, to which the statistical ensemble of an ideal gas converges (figure 30):

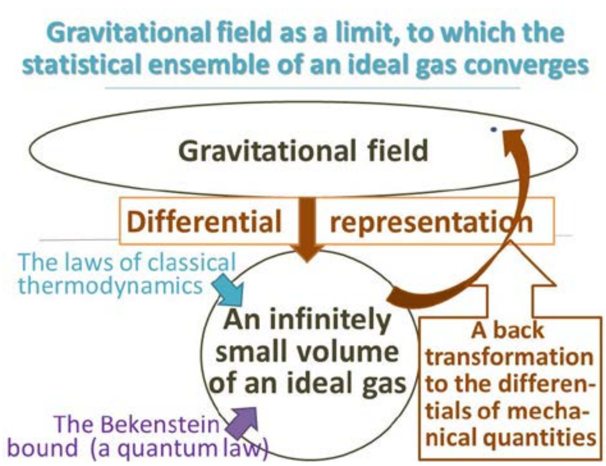

Figure 30

The statistical ensemble of any ideal gas is finite and discrete. However it can be transformed into an infinite and continuous (even smooth) ensemble under the following conditions. One considers a sequence of ideal gases such that the number of its “atoms” or “molecules” tends to infinity while the distance between them tends to zero. Besides, they are situated in the space-time of relativity rather than the independent space and time of classical physics. Given this, the sequences of ideal gases converge to gravitational field. A few comments: Unlike ‘ideal gas’ in classical physics, energy conservation is not more valid for the transition to the relativistic space-time as it is not valid in general relativity. However, it remains locally valid in both cases, since any small neighborhood of a point is “flat” and Lorentz invariant.

For the limiting process described above any infinite small neighborhood of a point can be reckoned as a volume of an ideal gas including energy conservation, too, and consequently it can be well represented by the laws of classical thermodynamics complemented by the Bekenstein bound. In fact, the latter serves to express the reciprocal dependence between two conjugates and thus the existence of an upper limit of entropy reached for radiation. Then, that infinitely small volume of an ideal gas is transformed back into a point, after which its thermodynamic quantities are transformed into the differentials of mechanical ones of a point of some physical medium, namely gravitational field. The Bekenstein bound as an upper limit of entropy adds quantum reciprocity within any pair of conjugates as to any differential of mechanical quantities. That allows of introducing the notion of 'quantum-mechanical differential' as the pair of the differentials of two conjugates satisfying the condition of an upper limit of entropy as to the product of the distributions of those conjugates within the "quantum differential".

The rehabilitated aether, or: Gravitational field as aether (figure **31):**

If any infinitely small volume of gravitational field can be considered as a finite volume of ideal gas for infinitely large magnification, then the aether, which had become redundant for special relativity, was rehabilitated by general relativity as Einstein declared in 1920 in his speech in the Leiden university (Einstein 1920): „der Ätherbegriff wieder zu einem deutlichen Inhalt gekommen": „Der Äther der allgemeinen Relativitätstheorie ist ein Medium, welches selbst aller mechanischen und kinematischen Eigenschaften bar ist, aber das mechanische (und elektromagnetische) Geschehen mitbestimmt." [„the conception of the ether has again acquired an intelligible content": "The ether of the general theory of relativity is a medium which is itself devoid of all mechanical and kinematical qualities, but helps to determine mechanical (and electromagnetic) events."] The „aether" of general relativity is a mathematical rather than physical medium. It consists of points than of atoms or molecules. However, those points should be "material ones", and their set finite. Then any space-time point could be considered as an infinitely small volume filled with an ideal gas of those points. This allows of the properties of the gravitational field in the point to be represented thoroughly by the thermodynamic properties of the corresponding infinitely small volume consisting in turn of material points, after which the differential distortion of space-time in the point can be represented by the temperature and pressure of the volume of an ideal gas. As Einstein said in that speech: "Die Existenz des Gravitationsfeldes ist an die Existenz des Raumes unmittelbar gebunden." [„The existence of the gravitational field is inseparably bound up with the existence of space.] However, the geometric properties of any space-time point should be variable and correlated with the properties of the gravitational field in the same point. This is what imposes for it to be discussed in terms of a variable, though infinitely small volume. The space-time of general relativity is an infinite set of infinitely small volumes of ideal gas, which do not constitute a common unified volume of an ideal gas. One can figure some imaginary partitions between points, i.e. between the separate,

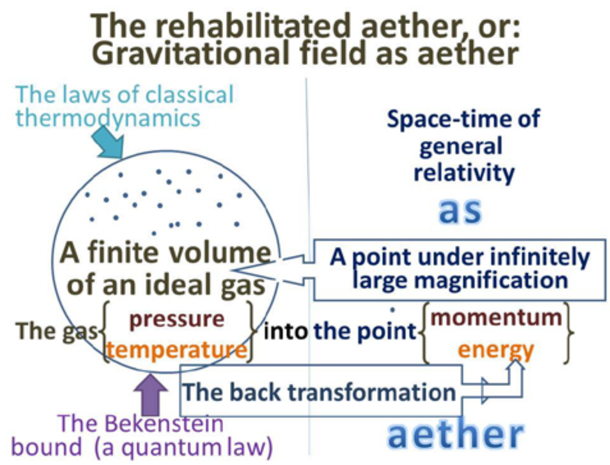

Figure 31

infinitely small volumes. Resuming, the aether of general relativity is that set of imaginarily separated and infinitely small volumes. However those partitions should be deformable or semitransparent, or semipermeable, so that the function of gravitational field is continuous and even smooth, i.e. the thermodynamic difference between any two infinitely close and infinitely small volumes is necessarily infinitely small, but not zero in general. Being zero, the space-time of general relativity is reduced to that of special one, or as Einstein said: "Das prinzipiell Neuartige des Äthers der allgemeinen Relativitätstheorie gegenüber dem Lorentzschen Äther besteht darin, daß der Zustand des ersteren an jeder Stelle bestimmt ist durch gesetzliche Zusammenhänge mit der Materie und mit dem Ätherzustände in benachbarten Stellen in Gestalt von Differentialgleichungen, während der Zustand des Lorentzschen Äthers bei Abwesenheit von elektromagnetischen Feldern durch nichts außer ihm bedingt und überall der gleiche ist. Der Äther der allgemeinen Relativitätstheorie geht gedanklich dadurch in den Lorentzschen über, daß man die ihn beschreibenden Raumfunktionen durch Konstante ersetzt, indem man absieht von den seinen Zustand bedingenden Ursachen." [What is fundamentally new in the ether of the general theory of relativity as opposed to the ether of Lorentz consists in this, that the state of the former is at every place determined by connections with the matter and the state of the ether in neighbouring places, which are amenable to law in the form of differential equations, whereas the state of the Lorentzian ether in the absence of electromagnetic fields is conditioned by nothing outside itself, and is everywhere the same. The ether of the general theory of relativity is transmuted conceptually into the ether of Lorentz if we substitute constants for the functions of space which describe the former, disregarding the causes which condition its state.]

Given the laws of classical thermodynamics, this is yet not enough to be deduced general relativity from them. Of course, they describe well any volume of an ideal gas, but ours should be an "infinitely small one", which opposes classical and quantum mechanics. The former one states that the infinitely small is a linear version of the finite while the latter, a reciprocal one. The really interesting is which side general relativity takes. Judging by Einstein criticism to quantum mechanics, as if it seems for him to take the classical-mechanics side. "Yes", but not in fact. The necessity to be added the Bekenstein bound to the laws of classical thermodynamics one to deduce general relativity evidences clearly that it is a quantum theory, in the same side as quantum mechanics being partly alternative, partly equivalent to it. Indeed, the Bekenstein bound requires for the double differential of two conjugates such as energy and time (distance) to be a "quantum" one, i.e. the two quantities to be reciprocal, while classical mechanics supposes for them to be independent, and their double differential to be linear for each of them, i.e. a "classical" one.

There is another way to juxtapose the classical and quantum viewpoint on two infinitely small conjugates. The quantum ones constitute a multiplicative group while the classical one only a semigroup. Consequently, all laws of conservation obtain a simple and clear explanation based on Emmy Noether's proof (1918). Since any group is symmetric, it implies a dual counterpart to any law of conservation. For example, the conservation of energy implies a conservation of time (wave period) per a unit of energy. In other words, the group of translation of the one conjugate and the conservation of the other mean one and the same. A reverse interpretation would be rather interesting: *Do the laws of conservation imply the structure of a group for any pair of conjugates and thus its neutral element, i.e. a fundamental constant like the Planck one, and further, the quantum wave-particle duality*? The dual counterpart of the very conservation of action is the conservation of a dimensionless physical quantity such as entropy or information. This means also that wave-particle duality implies the duality of the physical and the mathematical as well as the option to go out beyond them: i.e. to *their mutual transformations*.

An additional step consistent with the "thermodynamic" general relativity (fig. 32):

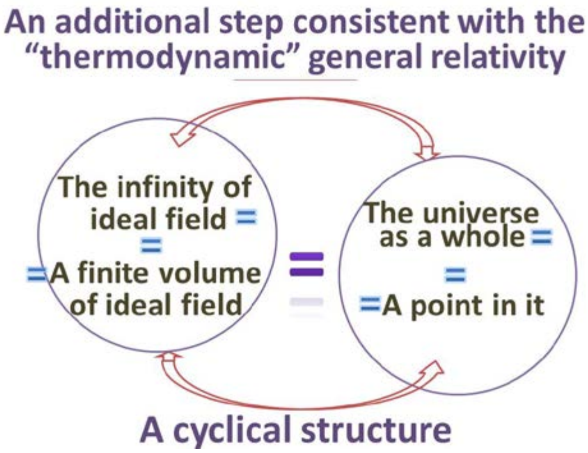

Figure 32

The conception of 'ideal gas' supposes some finite set of point material particles, which move in different finite distances with different velocities colliding with others giving them energy and momentum according to the corresponding conservation laws. We could see above how any point of the space-time of general relativity can be "watched" as a volume of that "ideal gas" for infinitely large magnification forbidding any discrete leap in thermodynamic quantities between any two infinitely close volumes of an ideal gas. This prohibition seems strange, though. It needs some explanation, which is going to be offered now:

One can generalize the volume of an ideal gas to the same volume of an "ideal field" under the following conditions: the energy (mass) of any point tends to zero and, their set is a space-time continuum rather than a finite set of points limited in a space-time volume. This already explains the prohibition of any discrete leap between two infinitely small volumes since each of them is a volume of ideal field instead of a volume of an ideal gas and it should pass smoothly from one to another, i.e. without discrete jumps. Thinking thus, one can easily identified all the space-time of the universe and the gravitational field defined well in any point of the former with the "internal universe" in the same space-time point by dint of the above "ideal field".

This step is consistent with the "thermodynamic" general relativity, i.e. with general relativity considered as a thermodynamic theory. However that step is not required by the thermodynamic approach to general relativity as above. It is necessary for the cyclical approach in this paper, which identifies the universe with any point of it.

The cyclicity both of the universe and gravitational field (figure 33):

If the universe as a whole returns back to any point of it, then which is the mechanism as well as the physical carrier of that cyclic return? The latter part of question has been already answered above: The physical carrier of that unity is "light", i.e. electromagnetic wave and interaction. It has two equivalent mathematical and physical representations: as a single qubit or as the light cone in Minkowski space, on the one hand, and as any point in space-time and all the space-time within the qubit or the cocoon of the light cone, on the other. The light in the points of space-time can be thought as special particles with zero

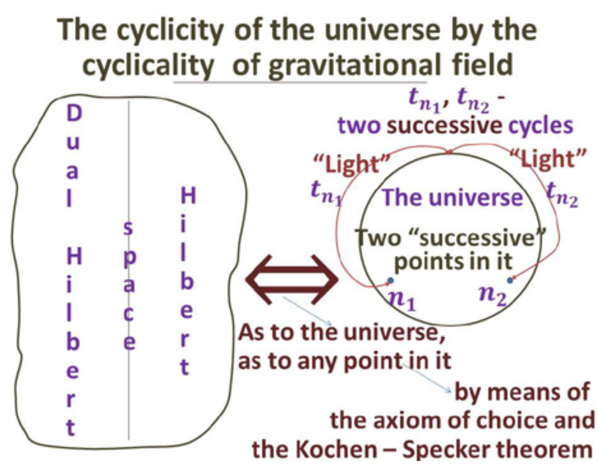

Figure 33

rest mass, i.e. photons. As the light is one and the same in both cases, both the hypostases of it are one and same being the physical carrier of cyclicity.

The former part of the question can be answered by means of the explained above "quantum invariance" with two "Janus-faces": the Kochen-Specker theorem and the axiom of choice. The physical meaning is a kind of equivalence between the discrete and continuous as to infinity and cyclicity. That equivalence (or Skolem's "relativity", or invariance) is necessary for any synthesis of the discrete quantum mechanics with the smooth general relativity, i.e. for any "quantum gravity" in final analysis. A possible form to express that synthesis is a generalization of Einstein's general principle of relativity (e.g. 1918) to comprise also quantum movement (discrete morphisms) beside and among the classical, smooth one. It seems that synthesis is impossible "before" the infinity or accordingly, wholeness. However the true principle of classical science to be empiric collides with introducing the infinity or wholeness in physics. Quantum mechanics dared to that seems "mystic" and doubtful (ostensibly). All those are only prejudices. Mathematics clearly shows that infinity can be put in the true fundament of an exact science like it being even a model of scientific rigor.

Then how can the mechanism for the whole to return in it as an element or point of itself can be described?

It can be seen as successive cycles:

1. The change of the point state $\boldsymbol{n_1}$, which implies the change of the universe: let one call this cycle t_{n_1}.

2. The changed state of the universe returns as the state of the *next* point $\boldsymbol{n_2}$, which in turn implies the next change of the universe: let one call this cycle t_{n_2}.

3. And so on ...

Consequently, the return of the universe as a point into it itself requires the well-ordering theorem and thus the axiom of choice. This implies the state of any point to be able to be represented by Hilbert space and its dual one, which in turn implies the option or even necessity to be interpreted as wave-particle dualism. The way back is also accessible: The above cyclicity or wholeness can be easily deduced from the wave-particle dualism by means of the quantum invariance of the discrete and continuous (smooth), then the two dual Hilbert spaces, the axiom of choice (the well-ordering theorem), the invariance between the axiom of choice and the Kochen − Specker theorem, and finally: the wholeness of the universe and the back return into a point of it in the true universe.

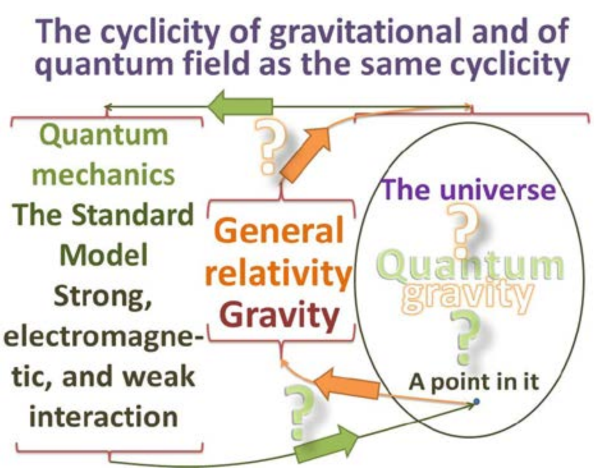

Figure 34

The cyclicity of gravitational and quantum field as the same (figure 34):

The previous figure (33) has shown two "cyclicities", which are as parallel as directed back to each other: "clockwise" and "anticlockwise". The same idea of two opposite directions was promoted already. The invariance of cyclicity to the exchange of "clockwise" and "anticlockwise" is natural to be postulated. However cyclicity is directly linked to wholeness and infinity and thus that invariance becomes problematic. As all questions connected to infinity, it had seemed as a metaphysical one until quantum mechanics being an empirical and exact science has included the wholeness as measurable physical quantities after quantum leaps. Infinity is the "lowest common denominator" of quantum mechanics and general relativity and thus it is a necessary condition of the synthesis known as "quantum gravity".

Gravitational and quantum field as an ideal gas and an ideal "anti-gas" accordingly (figure 35):

A possible next question could be: What is quantum field (or the second quantization) in terms of cyclicity and as well as the way the quantum and gravitational field to be discussed together, i.e. in unified or common terms? Since general relativity as a thermodynamic theory calls for any point of gravitational field to be considered as a volume of an ideal gas seen under the infinitely large magnification of that point, then the same kind of thermodynamic approach can be applied to quantum mechanics and quantum field in attempting to be unified quantum mechanics and general relativity.

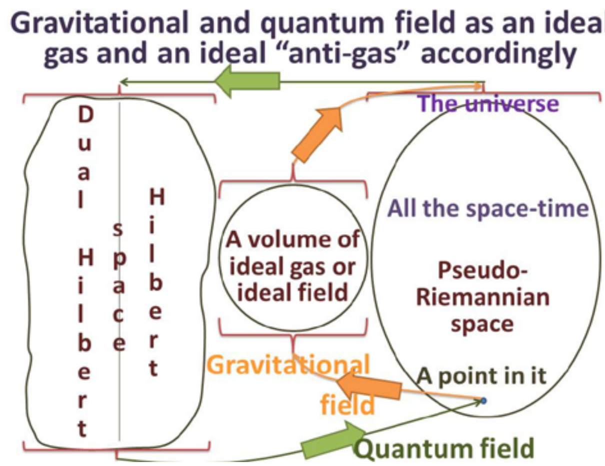

Figure 35

However that thermodynamic approach to quantum mechanics requires cyclicity, which is consistent with general relativity, too. Its essence is to be ascribed a state of the universe to each one space-time point, consequently generating a mapping of the space-time into Hilbert space (interpreted as the set of all possible quantum states of the universe), or in other words, generating quantum field. The cyclicity is what "inserts" the state of the universe into and within any given space-time point according to "gauge ideology" interpreting the mapping in question and thus the notion of "quantum field".

For this reason a new term, that of an "ideal anti-gas", is coined: If a point of gravitational field can be considered thermodynamically as a finite volume of an ideal gas, and the latter be generalized as a finite volume of ideal field, then as the infinity of ideal field is identified as the universe as whole, the "anti" in "anti-gas" means the opposite direction, i.e. "anticlockwise" in the figure. The distinctive feature of this direction called figuratively "anticlockwise" is: Hilbert space for or instead of pseudo-Riemannian space "clockwise".

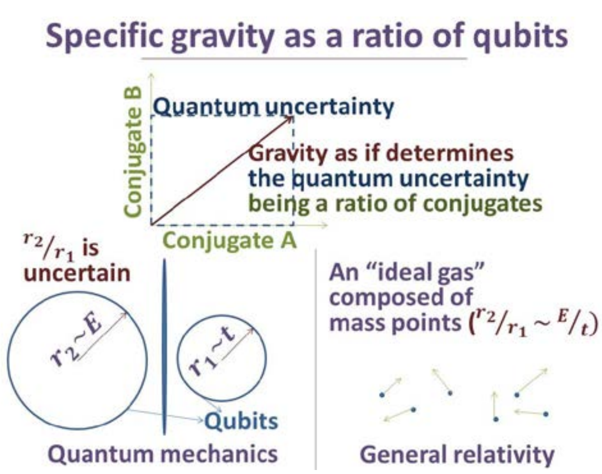

Figure 36

Specific gravity as a ratio of qubits (figure 36):

There is a series of physical quantities, which quantum mechanics remains uncertain since they are ratios of conjugates. They should be exactly determined according to general relativity. A such one has been considered above: It is the power of gravitational field: $=\frac{mc^2}{t}$. Specific gravity (other terms: specific weight, unit weight, mass density) is another quantity of that kind. Gravity as well as any theory of it including general relativity describes various ratios of conjugates ostensibly forbidden by quantum mechanics to be considered. This kind of ratios of conjugates can be also represented as a ratio of the radiuses of qubits. Consequently the so-called quantum gravity (understood as the domain of simultaneous validity of both quantum mechanics and any theory of gravity, e.g. general relativity) involves and necessarily evolves a special kind of equality between n and n+1 dimensions. The one additional dimension is for quantum uncertainty. In fact the true alignment of n and n+1 defines a series of closely connected and even sometimes equivalent to each other concepts already enumerated above: infinity, wholeness, cyclicity, etc. The common between them is that they are rather mathematical and even speculative and philosophical, though they are required for a physical theory, which should be experimentally verifiable and thus those so far purely mathematical, philosophical and speculative ideas alleged as vague and unclear, inexact turn out to be a possible subject of quantitative description and even of experiments. This is an amazing contribution of quantum mechanics to philosophy and to mathematics. It makes sense one to speak of the "real mathematics" as well as of the "real philosophy" of our world as the concept of the "real geometry" of our world has coined for general relativity.

One can transfer that duality of quantum mechanics and a theory of gravity using general relativity as an example of the latter in the thermodynamic terms of an "ideal gas": Quantum mechanics supposes space-time as "aether" or as a medium, in which there are somehow various probability distributions of energy, momentum and any other physical quantity while general relativity considers space-time as an ideal gas one-to-one mapping energy-momentum into space-time as gravitational field. Then the ratio of the radiuses of the corresponding space-time and energy-momentum qubits is the mass of the space-time point as a "molecule" of the gravitational "ideal gas", consequently the specific gravity in it. Therefore quantum mechanics and general relativity will refer to each other accordingly as a phenomenological macro-thermodynamic theory and a statistical micro-thermodynamic theory. However that pair requires again ciclicity for the universe as a whole to be able to be considered paradoxically outside itself within itself in any point of it. This sounds rather philosophical and speculative recalling the language of Hegel and Kant, doesn't it?

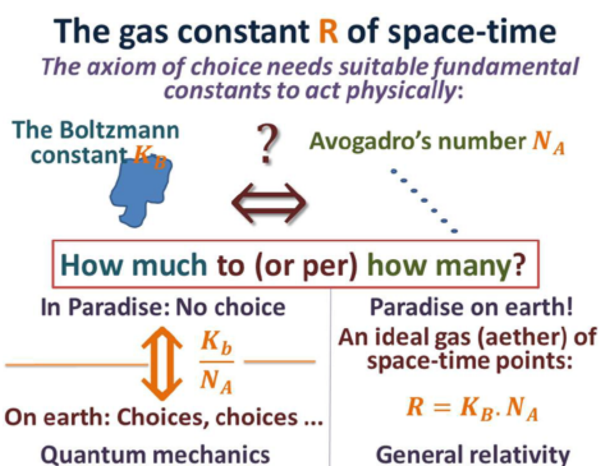

Figure 37

The gas constant of space-time (figure 37)**:**

The next question would be: How much does a mole of space-time weigh? Or otherwise, if there is a volume of space-time, then what is the quantity of moles of space-time, which it contents? One needs to juxtapose some mass or energy to an unit of entropy, e.g. to what is determined by the Boltzmann constant: K_B, and to utilize the limit of entropy of the Bekenstein bound since it gives how much of energy (mass) might correspond maximally to a quantity of entropy per a unit of volume. That energy for the maximal entropy per a unit of volume should correspond to the pure energy of the true space-time because any entity in that volume of space-time would decrease its maximal entropy. One cannot yet know how much of moles of space-time that volume does include since the mass of a mole of space-time is still unknown, though. This mass can be obtained if one considers the limit of the Bekenstein bound for the value of the Boltzmann constant: $m_{R=1} = \frac{h}{4\pi^2 c}$. However space-time is a paradoxical "matter": Two moles of space-time ($m_{R=2}$) will weigh ... the half of one mole : $m_{R=1} = 2\, m_{R=2}$! This is caused by using the Bekenstein bound (a quantum law transferred in general relativity) to determine the "mass" of space-time. Turns out that both mass and space-time are additive separately, but they are inversely proportional to each other. We can say that they are the same quantity divided into two parts to keep additivity for each one of them. In fact general relativity states the same: Mass and space-time are the same quantity, but divided into two parts, which are inversely proportional to each other. This allows of introducing a variable "ratio" or functional relation between them representing the curvature of space-time. Indeed if special relativity reveals that space and time are one and the same, then general relativity continues further and really generalizes it discovering that not only space and time but also mass is the same with them. However, general relativity does not offer any explanation of that rather strange state of affairs though unifying mass and space-time inversely proportional. On the contrary, cyclicity is a natural and simple elucidation why: The return of space-time into itself cyclically as all and any space-time point(s) involves all the universe as an infinite quantity of space-time as any space-time point in it with zero mass. Cyclicity is accomplished mathematically quite simple: as an inverse proprtionality of the biggest (the universe) and the tinniest (all quantum entities). Now one can really understand the sense and meaning of quantum complementarity, uncertainty, paradoxicality, etc. as a quantitative doctrine on that cyclicity. In particular, the Heisenberg uncertainty is what allows of the universe to piece cyclically and return into itself being or becoming really a whole. Any pair of conjugates represents the same quantity though of the two extremes, the biggest and the tinniest where and when they join and "glue" together up to down and down to up. Energy conservation is valid everywhere except the splice site, which is everywhere, too, though. That "splice site" requires conservation of action (information) since the "times" (or more exactly, space-times) of the two extremes being joined are quite different in general.

Time as entropy: CMB as a fundamental constant or as a variable (figure 38):

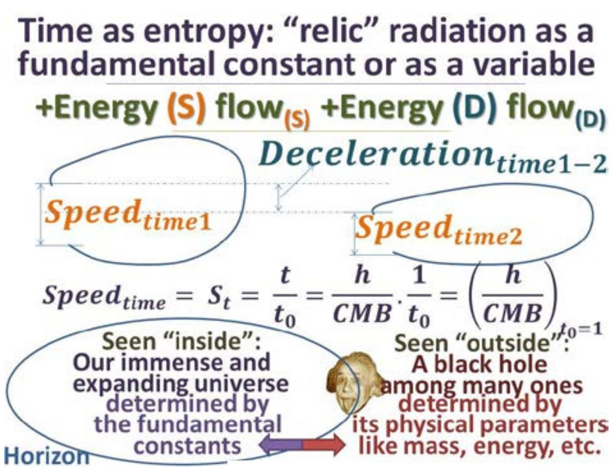

Figure 38

Entropy increases in time: This is well known even as one of the laws of thermodynamics. Is not there a minimal increase of entropy per a unit of time, e.g. per a second, though? Its meaning would be that of a quantity for the speed of time and it would allow of the true time to be thought as a marker for the current quantity of entropy. If that speed of time is constant, it could be an unknown fundamental constant. If there is nonzero acceleration of time, which is small enough, it can be accepted approximately to be constant for a long enough period of time. Is there a suitable candidate for this position?

Yes, there is: It is cosmic background microwave radiation: $CMB = 2.72548 \pm 0.00057\ K$. If one utilizes the conservation of action (information), then the speed of time for and by entropy can be defined as:

$$Speed_{time} = S_t = \frac{t}{t_0} = \frac{h}{CMB}.\frac{1}{t_0} = \left(\frac{h}{CMB}\right)_{t_0=1}$$

Consequently, the speed of time should be incredibly small ($\approx 2{,}432.10^{-34}$), namely as small as the Plank constant ($\approx 6{,}626.10^{-34}$J.s). This means that conservation of energy is an exceptionally exact approximation to the true conservation of action since the speed of time needs $\approx 10^{28}$ years to give difference in time of a second while the "Big Bang" is only about $\approx 1{,}5.10^{10}$ years ago. Though incredibly small, that speed of time is not zero and should be experimentally confirmable at least in principle.

However much more interesting is its meaning and interpretation:

The speed of time should be due to the formation of a cycle of the universe to any and all points in it. The speed of time and accordingly CBR represents the alignment of space-time after its return in the beginning of the cycle, i.e. the ratio of a unit of space-time measured in units of time in the end and in the beginning of the cycle (the universe). That alignment generates a constant flow of energy, namely CMB.

How much should the deceleration of time be? (Figure 39**)**

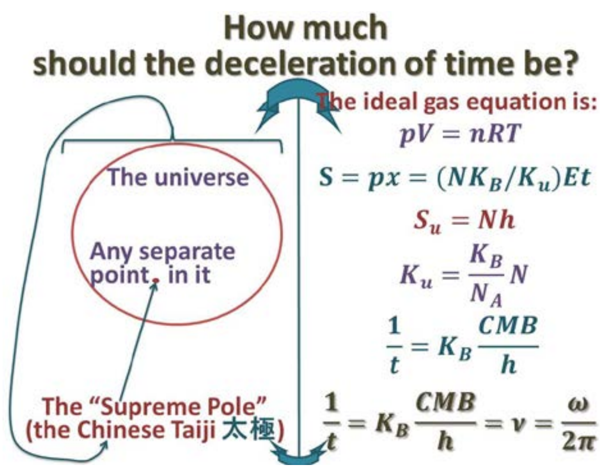

Figure 39

To determine the deceleration of time, one can use the ideal gas equation as to the universe as a whole after its return into an arbitrary point of it. If statistic thermodynamic reduces all thermodynamic quantities like pressure, volume, temperature, etc. to the distribution of an statistic ensemble consisting of molecules, atoms, etc. as material points with their positions, velocities, momenta, energies, etc., our objectivity is to be determined energy, momentum, position, velocity of a single point of the universe, which embeds currently the universe after its return into itself. The ideal gas equation is: $\boldsymbol{pV = nRT}$, where p is the pressure, V is the volume, T is the temperature, R is the gas constant, i.e. the Boltzmann constant K_B per a mole, and finally n is the number of the moles. Consequently, that equation can be transformed into $S = px = (NK_B/K_u)Et$, after the return of the universe in any single point of it, where S, p, x, E, t, are correspondingly the action, momentum, position, energy, time of the point, which is currently embedding the universe. If the aggregate action of the universe is: $S_u = Nh$, where, h is the Planck constant, and N is the number of all points in the universe, then the action S of a separate point must be equal exactly to the Planck constant, h. The number, N should be finite since the entropy of the universe should be finite, and a quantum of entropy, i.e. the Boltzmann constant corresponds to Avogadro's number of points per that quantum of entropy. Then the entire entropy of the universe K_u must be proportional to the number of points, i.e. $K_u = \frac{K_B}{N_A}N$. The last equation, the reverse quantum transformation, $N_A \to K_B$ and CBR as the temperature of any single point in the universe imply that the deceleration of time is as follows: $\frac{1}{t} = K_B \frac{CMB}{h}$, or the same obtained in the previous figure another way, namely using conservation of action (information). Consequently, the Boltzmann constant can be interpreted as a constant ratio: that of the length of a time interval per a unit of time. That interpretation reveals the exact meaning, in which time is entropy. Furthermore, $\frac{1}{t} = K_B \frac{CMB}{h} = \nu = \frac{\omega}{2\pi}$ defines a frequency, which is with the same exponent as the maximum in the frequency spectrum of CMB. That frequency and the temperature (energy) of CMB should be considered as conjugates. Then the exact value of CMB is what forces the entire spectrum of CMB. However if one considers the universe rather than a point of it, that frequency, or the deceleration of time in other words, is exactly equal to $K_B \frac{CMB}{h}$. As a principle the inverse proportionality of all conjugates in quantum mechanics allows of the universe to close regardless of the enormous difference in scale conserving as an invariant only the quantity of action (information) passing through the "Supreme Pole" (the Chinese Taiji 太極). Nay, the quantity of information is a scale invariant, which is what supports the wholeness of a fractal structure in all scales.

The Einstein and Schrödinger equation: the new cyclic mechanics (figure 40):

The sense of Schrödinger's equation is: The change of entropy (information) in time (the left side) is exactly equal to the change of energy in time (the right side of the equation): $i\hbar \frac{\partial \boldsymbol{\Psi}}{\partial t} = \widehat{H}\boldsymbol{\Psi}$. Consequently, space or space-time does not contain any entropy (information). At first glance, it is not more than an empty framework, in which all physics can happen. In fact, it is an absolute (or granted as zero) reference frame, a benchmark of minimal information or of maximal entropy, to which information (entropy) of what is happening can be read.

The approach of general relativity is different, but equivalent: A part of information is contained in space-time as its current curvature and distortion and thus its benchmark can be arbitrary or nonzero in general unlike the quantum mechanics of Schrödinger equation. However this is not an obstacle for the entire information in the investigated system to be the same. Then the gravitational energy to an arbitrary benchmark of pseudo-Riemannian space-time should be necessarily different in general from the "quantum energy" to the zero benchmark of an empty (and absolute) space and time (or of the empty space-time of special relativity). However conservation of action (information) requires for quantum and gravitational energy to be equal always: Consequently, there is no gravity in any quantum system since gravity is expressed exhaustedly, entirely and equivalently by or as quantum energy of the rest three interactions. There is no quantum mechanics, more exactly no weak or strong interaction since they are expressed not less exhaustedly, entirely, and equivalently by or as gravitational energy.

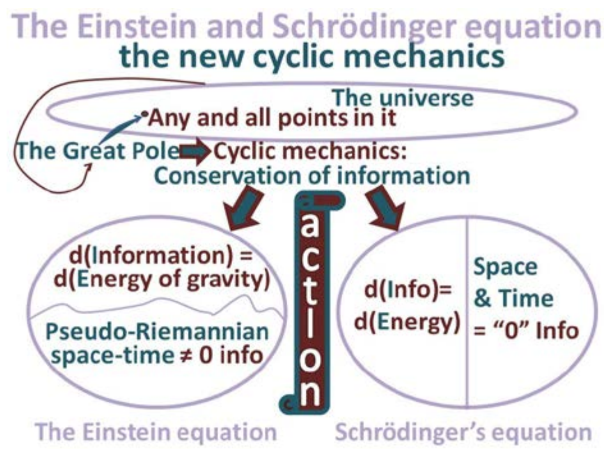

Figure 40

However the phenomena of entanglement involve an arbitrary benchmark for reading the entire information of the system. Consequently, entanglement and gravity can be considered as equivalent, or as the same seen from two different viewpoints: The one (gravity) is that of a process in time while the other (entanglement) is that of completeness as if out of time (or in "eternity").

Finally and most important, the principle of cyclicity is equivalent to conservation of action and implies the identification of general relativity and quantum mechanics as two quite different but equivalent ways to express one and the same. Furthermore that principle can be considered as the opposed approach to the statistic thermodynamics: If that reduces all thermodynamic quantities to the statistical distribution of a mechanical ensemble, the new, to call it, cyclic mechanics reduces a mechanical ensemble to all states of its whole, e.g. of the universe.

Conclusions:

The introductory list of the principles of cyclic mechanics can be specified on the ground of all what has discussed above as follows: It seems that only three principles are enough for all cyclic mechanics to be deduced from them:

1. Quantum invariance
2. Cyclicity
3. Conservation of action or information

All of them have described in detail over the entire text.

A single comment should complement these principles to elucidate the mutual interrelation between them and the true meaning of cyclic mechanics:

The Einstein equation in general relativity and Schrödinger's equation in quantum mechanics can be deduced from each other if these three principles are granted. In other words they are sufficient and maybe even necessary condition for the equivalence of the equations.

This paper has been devoted first of all to the meaningful, both physical and philosophical interpretation of the principles and all cyclic mechanics by means of them. A next and forthcoming study will try to show mathematically their equivalence under the condition of these three principles granted as very well interpretable and meaningful physically and philosophically on the base of this text.

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