The Case of Quantum Mechanics Mathematizing Reality: the "Superposition" of Mathematically Modelled and Mathematical Reality: Is There Any Room for Gravity?

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Abstract. A case study of quantum mechanics is investigated in the framework of the philosophical opposition "mathematical model – reality". All classical science obeys the postulate about the fundamental difference of model and reality, and thus distinguishing epistemology from ontology fundamentally. The theorems about the absence of hidden variables in quantum mechanics imply for it to be "complete" (versus Einstein's opinion). That consistent completeness (unlike arithmetic to set theory in the foundations of mathematics in Gödel's opinion) can be interpreted furthermore as the coincidence of model and reality. The paper discusses the option and fact of that coincidence it its base: the fundamental postulate formulated by Niels Bohr about what quantum mechanics studies (unlike all classical science). Quantum mechanics involves and develops further both identification and disjunctive distinction of the global space of the apparatus and the local space of the investigated quantum entity as complementary to each other. This results into the analogical complementarity of model and reality in quantum mechanics. The apparatus turns out to be both absolutely "transparent" and identically coinciding simultaneously with the reflected quantum reality. Thus, the coincidence of model and reality is postulated as necessary condition for cognition in quantum mechanics by Bohr's postulate and further, embodied in its formalism of the separable complex Hilbert space, in turn, implying the theorems of the absence of hidden variables (or the equivalent to them "conservation of energy conservation" in quantum mechanics). What the apparatus and measured entity exchange cannot be energy (for the different exponents of energy), but quantum information (as a certain, unambiguously determined wave function) therefore a generalized law of conservation, from which the conservation of energy conservation is a corollary. Particularly, the local and global space (rigorously justified in the Standard model) share the complementarity isomorphic to that of model and reality in the foundation of quantum mechanics. On that background, one can think of the troubles of "quantum gravity" as fundamental, direct corollaries from the postulates of quantum mechanics. Gravity can be defined only as a relation or by a pair of non-orthogonal separable complex Hilbert space attachable whether to two "parts" or to a whole and its parts. On the contrary, all the three fundamental interactions in the Standard model are "flat" and only "properties": they need only a single separable complex Hilbert space to be defined.

Key words: confinement, entanglement, general relativity, model, reality, quantum gravity, quantum information,

An intentionally unprecious beginning …

The thesis is:

Quantum mechanics can be described both as mathematizing an external reality, which is not mathematical by itself, and as studding mathematical reality. Thus, quantum mechanics occupies a unique place among all sciences including the physical and mathematical ones in relation to the mathematizing of sciences.

Being a physical science, quantum mechanics starts from the common attitude of physics to mathematizing and reality (or "versus reality"). The reality is external, presumably deterministic and causal, independent of any observer, and allowing for very precise and experimentally well-corroborated mathematical models. The history of physics has established that approach since the age of Galileo Galilei and Sir Isaac Newton. Quantum mechanics has followed it initially, in its beginning. However:

The main problem of quantum mechanics is how to generalize the models of classical mechanics in a way, which can uniformly include both the new quantum leaps and the motions in smooth trajectories featuring classical physics. It should find that description of reality, which is invariant in relation to discreteness and continuity. No finite mathematical structure can satisfy that condition. Thus, quantum mechanics was forced to involve a properly mathematical entity such as infinity in an experimental science what it is. The way for infinity to be introduced in its framework is fundamentally different from that of classical physics to utilize infinitesimal models of smooth motion:

The concept of measurement in classical physics may serve anyway as an initial "reference frame", to which that generalization to be introduced. In fact, the analogical problem of how the state before measurement to be mapped into the statistical ensemble of the measured results exists in classical physics and can be solved only for the above discrepancy is able to converge to zero:

Indeed, any statistical ensemble of results is finite and thus well-orderable while the corresponding physical quantity "before measurement" has to be smooth (and consequently continuous) so that its change to be described by differential equations. Only the axiom of choice is able to order it well[1] transforming it into the statistical ensemble of measured results. However the necessary collaboration of the axiom of choice is hidden since the difference between the real value before measurement and the corresponding element in the statistical ensemble of results converges to zero in principle for the Plank constant has no analog in classical physics.

That way out is closed as to quantum mechanics. Any smooth quantity differs fundamentally from its measured value just for the Planck constant. Any quantum coherent state before measurement cannot be a statistical ensemble excluding any "hidden variables" for the fundamental theorems of John von Neumann (1932) and of Simon Kochen and Ernst Specker (1968). Nevertheless, the results after measurement constitute a statistical ensemble ordered in some finite values of a finite set of variables, e.g. the space-time coordinates of the measured results.

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[1] That is in the rigorous mathematical meaning of "well-ordering".

However, once that is the case, the following new epistemological or ontological problems arise:

How should map a coherent state (not being any statistical ensemble fundamentally) before measurement with a statistical ensemble after measurement? Can just that mapping represent the original philosophical essence of quantum measurement? What are the definitive mathematical features of that mapping?

Quantum mechanics is the first physical theory, which involves infinity as essential element in its basic mathematical model. It utilizes the separable complex Hilbert space, an infinitely dimensional vector space, thus requiring convergence for the length of any vector in it to be finite. The true notion of limit of an infinite convergent series supposes for it to be considered as a whole by or in its limit: however no way that sequence to be differentiated experimentally from a finite one just for its convergence.

The gauge idea conjectures that the separable complex Hilbert space of quantum mechanics is "inserted" in any (or rather, in each) space-time point and that a series of elements in Hilbert space, designated by successive space-time points of a trajectory, (as if) can be "gauged" by the limit, to which they converge. Thus, the weak, strong and electromagnetic interaction(s) as the Standard model manifests turn(s) out unified as those limits and in fact actual infinity is used as a necessary conception under which these three interactions can be unified.

All experiments in favor of the Standard model including those, which confirmed the existence of Higgs boson with sufficient accuracy, can be interpreted as the indirect experimental proof of actual infinity.

Another ways for that experimentally confirmable actual infinity are all phenomena of entanglement studied by quantum information. Being defined by the cases of a wave function of a quantum system which cannot be factorized to any tensor product of those of its subsystems, entanglement can be interpreted as a direct interaction of coherent states of these quantum subsystems. The coherent states involve actual infinity immediately: the Kochen – Specker theorem (1968) excludes any "hidden variable" and thus any well-ordering in coherent state before measurement. However, it turns out to be well-ordered as the results of measurement. So, the measurement in quantum mechanics requires the well-ordering theorem equivalent to the axiom of choice, and one cannot help but introduce actual infinity.

Then, the phenomena of entanglement can be directly deduced from the necessity of actual infinity in quantum mechanics and information. So, entanglement can be considered as an experimentally observable effect, in the final analysis, being due to the physical actual infinity involved in quantum mechanics by means of "coherent state".

Quantum mechanics as well as the gauge theories underlying the dominating Standard model cannot exclude to be interpreted implicitly or explicitly in terms of actual infinity thus introducing it as a possible element in a physical theory and as a subject of experiments. That experimentally accessible actual infinity, its philosophical context and admissibility will be meant in the paper.

Quantum mechanics is the first and single theory, experimentally very well confirmed, which can be interpreted as based on actual infinity and thus accepting it as a physical entity:

a domain of unification, transition or even identification between physics and mathematics appears.

Motivation

There is a fundamental prejudice in the European modern worldview, both in philosophy and science presumably rooted in Descartes's dualism already: the dualism of mathematics and physics, model and reality. In the same framework, experimental science adds the postulate for model to be secondary, and needing to be repaired permanently in the process of cognition.

However, quantum mechanics substitutes the same dualism with "complementarity" (and thus, "duality" rather than dualism) therefore allowing for model and reality to coincide eventually, and even, proving the same coincidence as necessary after the model of separable complex Hilbert space has been once adopted, proved namely by the theorems of the absence of "hidden variables" (Neumann 1932; Kochen and Specker 1968).

Another strange peculiarity of quantum mechanics is that "no room for gravity" in it. Even more, one can track the "troubles of quantum gravity" still to the "absence of hidden variables", i.e. to the fundamental epistemological framework of quantum mechanics, which is quite different from that of all classical physics. Speaking loosely or even rigorously, "no hidden variables" implies "no quantum gravity" in the following mathematical and philosophical meaning: any possible state of quantum gravity can be represented equivalently by means of the state of zero quantum gravity (i.e. its absence) in the epistemological framework of quantum mechanics, and therefore, Occam's razor cuts instantly any theory of quantum gravity being redundant (e.g. metaphysical) at least as to quantum mechanics.

As any statistic thermodynamic theory in classical physics, quantum mechanics means only classes of equivalence, but any state of quantum gravity is a certain element in some of those classes, and thus, inaccessible as the to the cognition of quantum mechanics:

Consequently, quantum mechanics is constituted still even as a science in a way so that "no room for gravity in it"!

The "absence of hidden variables" generates an extraordinary and even unique epistemological situation in quantum mechanics: unlike any theory in classical physics, quantum mechanics is constituted (as well as it can be constituted only) as a science after the postulate for the mathematical model and physical reality to coincide in its framework resulting a new quantum Pythagoreanism of reality being mathematical in the final analysis.

Anyway, it admits any deviation from that mathematical reality, but (notice!) only *within* the class represented by the mathematical reality meant by quantum mechanics. Thus, the mathematical reality is the class of equivalence of all the relevant physical realities, and therefore, the physical reality obeys the mathematical model (as an element in a class) rather than vice versa as in classical physics and science.

Then, gravity being absent *within* quantum mechanics is able to appear but only as a relation *to* quantum mechanics in order to describe a certain physical reality as an element of the class meant by quantum mechanics. That relation can also be described exhaustively and thoroughly in the framework of quantum mechanics (properly, "quantum information" as the theory of entanglement) as a certain state of entanglement. Thus, the physical reality turns out to be describable as the also mathematical relation of two mathematical realities, different enough in a rigorous mathematical meaning.

In fact, entanglement can be understood as a "nonstandard interpretation of quantum gravity": "nonstandard", furthermore, for identifying it with gravity in general relativity, i.e. with the smooth "classical" gravity.

As to the motivation of the present paper, gravity can be seen also as the force (respectively, field or interaction) generating the properly physical, but starting from the mathematical in a way both physical and mathematical indistinguishably; and accordingly, quantum mechanics: as describing both mathematical reality and physical reality only modeled mathematically. Those two possible epistemological hypostases of quantum mechanics implies "quantum gravity" (a.k.a. gravity of general relativity) within the epistemological space between them as two opposite poles of it:

The one epistemological pole of quantum mechanics: "mathematical reality"

Quantum mechanics possesses a unique structure according to Niels Bohr's postulate (about what quantum mechanics studies) since the "size" and energy of the apparatus versus those of the investigated entity differ dorm each other in decades of exponents. The mediation of the macroscopic apparatus is unavoidable as far as quantum mechanics cannot help but be an experimental science. However, the apparatus and entity (unlike those in classical physics and experimental science) cannot share directly physical quantities being different in decades of exponents (for example the measured physical quantity would be thoroughly and always within the limit of the instrument error of any macroscopic apparatus to any quantum entity).

Thus, they should exchange and share only quantities dimensionless physically for the difference in size is an insurmountable barrier to any quantity of physical dimension. Indeed, quantum mechanics demonstrated that they share probabilities, probability distributions, wave functions, and thus, only quantum information in the final analysis: all of them being physically dimensionless.

Anyway, all of those quantities are definable mathematically very well. Thus, they can be exchanged and shared independently of size and energy: That independence is a fundamental condition necessary for quantum mechanics to be an objective experimental science.

Thus, quantum information conservation[2] irrespective of size and energy, and thus, a new generalization relevant to the epistemological situation in quantum mechanics should be

[2] In the next paper (what means the paper I am starting since tomorrow), I will deduce quantum information conservation from time arrow, and in the final analysis, from "transcendental invariance" (a concept coined in: Penchev 2020, August 20) in the following sense. Time arrow can be interpreted as the linear increase proportional to the standard quantity of time and definable by a dimensionless temporal quantity meaning the change of the units of time in the course of time, i.e. speaking only physical dimensionally, "time per time". Its first "derivative" (in a partly generalized sense of derivative) is just quantum information being conserved right for the linear increase of that "dimensionless time" usually meant in time arrow. Further, time arrow meant already as well-ordering or eventually as the class of all permutable well-orderings, i.e. an ordinal number, can be deduced in turn from the "transcendental invariance" as it introduced in the paper cited above in the footnote.

formulated. The same generalized conservation implies the special way for energy conservation to be kept in quantum mechanics as well as the absence of "hidden variables" in it. "No hidden variables" means system "apparatus – quantum entity" (as it is explained above) and "no quantum gravity" elucidate before that.

In other words, reality being mathematical and even only mathematical does not need and even does not admit gravity. Thus the adjective of quantum in "quantum gravity" generates a "mistake in definition" as far as what is quantum can be interpreted mathematically and even only mathematically therefore excluding the option of gravity within its scope.

However, the same disadvantage can be seen furthermore as a huge and unique advantage. Gravity can show how all the physical appear from the mathematical (i.e. "quantum" once interpreted physically) in an only mathematical, and thus necessary way.

The present paper intends to reveal at least philosophically that gravity is available at the genesis of all the physical world from the mathematical only and even only in a mathematical way.

The other epistemological pole of quantum mechanics: a mathematical model of reality

Anyway, the standard viewpoint (i.e. according to the epistemology of classical science) is also possible and relevant as to quantum mechanics, but with a rather essential difference. Then, the quantum reality and mathematical model both independent of each other are involved, however the difference can be described exhaustively and thoroughly mathematically, and thus the quantum reality itself can, also mathematically again, which is absolutely impossible in classical epistemology. In fact, this is a generalization of the EPR argument excluding the conclusion of incompleteness[3].

Philosophically, the one approach means a whole and its properties, the other approach, parts of (or to) the same whole and corresponding relations. Then, the unique feature of quantum mechanics consists in the *only mathematical* description of the difference between

[3] According to the three authors, the availability of still one and absolutely independent description of the quantum reality at issue demonstrates that the corresponding description is "incomplete". It is complete according to the contemporary common viewpoint since the additional or complementary description involves still one variable *externally* (i.e. it is not a "hidden variable" in the former description) linked to a certain subsystem of the of the investigated quantum system. A confusion or mess can arise as far as the addition external variable(s) is simultaneously one or more parts of the whole a thus, as if they should be considered as internal or "hidden" variable(s). That "dialectics" of the internal and external as to the totality is considered in detail as the "principle of physical and mathematical transcendentalism" in a previous paper (Penchev 2020, August 20). In other words, the former description means only properties of the system as a whole, and the latter description, relations to certain subsystems therefore being able to be considered as additional variables to the former description, but not "hidden" because they are available only as relations rather than as properties of the system (to its subsystems). The extraordinary and unique feature of quantum mechanics (properly generating the mess) is the absolute relativity of those properties and relations: both kinds of description are always possible, and a mathematical transformation corresponds unambiguously to the transition between the viewpoints: from that of a whole (in relation only to itself, i.e. a property) to that of a certain part to the same whole (i.e. a relation properly). The physical force of gravity appears to equate the two viewpoints; or speaking loosely, to compensate physically otherwise only the logical deference of "property" from "relation".

the two approaches, which allows for the equivalent change or exchange of their viewpoints: that of the single whole by itself and that of a certain part of (or to) the same whole.

The latter description involves entanglement, and thus, the concept of quantum information. Furthermore, entanglement can be interpreted as being due to overlapping of probability distributions of two or more parts of the whole, after which the whole ceases to be "orthogonal" to (i.e. independent of[4]) its parts once being entangled.

Thus, the extraordinary epistemological situation in quantum mechanics turns to be even still more extraordinary and unexpected. The description of a quantum system by itself and to any subsystem of it is essentially different: the relations can be interpreted naturally as emergent properties of the initial system. Entanglement can be granted as such an emergent property of the metasystem consisting of the system and its subsystems (in terms of set theory, being emergent as referring only to the set of subsets, but absent in the initial set).

The space of all the quantum superpositions of those two poles

One might utilize the famous metaphor of Schrödinger's cat therefore suggesting a kind of quantum epistemology similar to "Schrödinger's cat" in the following sense: it is a superposition of the two epistemological poles sketched above. That is:

One may mean as the epistemology, i.e. the class consisting of all those theories or any single theory of that kind. All of them share to be in a state of "quantum superposition" of classical-and-quantum theory similar to an "alive-and-dead cat". Then, both following statements are included in a "quantum superposition" simultaneously: model and reality coincide identically as in the standard quantum mechanics (the former epistemological pole above); model and reality differ from each other essentially, but in way that can be described mathematically thoroughly as in the theory of entanglement (the latter epistemological pole).

One can define furthermore a meta-epistemology (the epistemology of epistemology) referring to meta-reality consisting of all possible theories, each of which representing a certain state of superposition of those two epistemological poles. That meta-model and that meat-reality coincide again necessarily. This seems to be too paradoxical at first glance since the latter pole implicitly meant in each state of epistemological superposition represents in turn and definitively a certain essential difference of model and reality though representable mathematically absolutely.

The repeated identity of meta-level is due to the unity of model and reality in a single whole or system (which can be named "quantum ontology"). Once one means a single quantum system (though a quantum meta-system properly), the standard quantum mechanics, the absence of hidden variables, and the coincidence of model and reality are valid.

Thus, the state of entanglement cannot be a hidden variable in the sense and meaning of classical physics: it can be defined only as a relation of any certain subsystem to the system, but not as a property of the same subsystem, i.e. not as an independent variable remained

[4] The conjecture of hidden variables interprets the same dependence as an implicit availability of hidden variables.

"hidden" temporarily (as in statistic thermodynamics) or in definition (as in phenomenological thermodynamics).

One can demonstrate that "quantum gravity" should be investigated and thus implicitly defined in the same "meta-reality" between the two epistemological realities and constructed by means of entanglement. Thus, one can suggest the close link of entanglement and quantum gravity if one proves that quantum gravity refers to that "meta-reality"

The strange epistemological status of "quantum gravity"

One can prove that quantum gravity cannot be defined in the framework of the Standard model, and it does not exist even only as far as any quantum phenomenon can be equivalently represented in its framework, or speaking figuratively, "no room for quantum gravity" once the Standard model is valid as a huge number of experiments (practically all) confirms.

The mechanism for quantum gravity to "vanish into thin year after the Standard model" is guaranteed still in the fundamental level of set theory by the following consideration:

Gravity in general or quantum gravity particularly is to be defined as a relation. However, quantum gravity unlike classical one should involve some relation of infinite sets for the separable complex Hilbert space of quantum mechanics (and thus, of quantum gravity eventually) is infinitely dimensional. Then, any relation of infinite sets can be represented (tautologically logically) as a property of an infinite set, even of any of both referring to each other in the relation in question. That representability of a relation into an equivalent property is valid only as to infinite sets and relays of the Dedekind property, by which they can be defined, that there exist(s) bijection(s) to their true subsets (*eventually* also infinite). In the final analysis, this is what underlies the ability of any set of quantum system to be considerable as a single one, and thus, thoroughly in the framework of the Standard model, after which any quantum gravity to "vanish into thin air".

This implies one too curious or even shocking corollary. Quantum gravity should possess a counterpart within the Standard model equivalent effectively (i.e. causing the same physical result) as it or gravity in general. For considerations, which will be omitted in this paper, but will be discussed in detail in a future one, that counterpart should be concentrated only in the strong interaction, as referring to SU(2), and even most presumably, to the phenomena of confinement.

The same way out for quantum gravity to vanish, however, is fundamentally impossible as to classical gravity as far as it does not involve an infinitely dimensional space as quantum mechanics does by means of the separable complex Hilbert space. The analogical mechanism for any property of finite sets to be reduced to a property of any finite[5] set does not exist.

Thus gravity turns out to be epistemologically rather extraordinary, or even unique "force" or interaction valid only after classical consideration (if and as far as it is possible) unconditionally, but not, as to any quantum consideration (or in other words, being possible in quantum consideration *only conditionally*, a case discussed in the next section).

[5] However, that relation can be reduced to a property of some infinite set the mediation of Dedekind, set-theoretical finiteness.

One can demonstrates the same impossibility comparing the introduction of gravity as a relation of local and global space in the classical case and in the Standard model:

1. Gravity as the relation of local and global space in general relativity:

Without violating generality, one can exclude any singularities. Then, the global space is pseudo-Riemannian and smooth. The local space attachable to any point of the global smooth pseudo-Riemannian space would be the tangential space in this point, and thus, a "flat" Minkowski space. The local Minkowski space and the global pseudo-Riemannian space are different, but comparable mathematically by the quantity of tensor curvature: zero in the case of Minkowski space and nonzero as to pseudo-Riemannian space in general. Gravity therefore refers just to that curvature.

2. However, the analogical relation of local and global space in the Standard model is identity, and thus, "no room for gravity" in it.

Indeed, the local space is the separable complex Hilbert space, and the global one is the separable complex Hilbert space as well. That identity turns out to be possible just for the infinite dimensionality of both local and global space, on the one hand, or for the identity of both dual Hilbert spaces, on the other hand. Thus, which space to be local and which global is absolutely conventional.

Anyway, the usual approach for the global and local space to be introduced as to the Standard model considers (unavoidably conventionally) the former as the space of the "global" composite symmetry:

$[U(0)\otimes[SU(1)]\otimes[SU(2)]$.

Then, the local space turns out to be its Noether counterpart, i.e. the space of all elements of the group meant as a whole in the global space of symmetry.

As an illustration, one can consider the system of the universe as a single whole. Then, the "flat" separable complex Hilbert space is to be involved without the option of any relation to anything, from which the universe be a part (if the universe is defined as the totality: what "all" is in definition). This consideration implies for the global curvature of the universe to be zero. Though seeming to be paradoxical as to the scientific common sense, the experiments confirm that zero global curvature of the universe (e.g.: Masi, S. et al. 2002).

Entanglement as "quantum gravity"

One can consider a construction analogical to that generating the gravity of general relativity (i.e. in terms of pseudo-Riemannian space), now, in terms of the separable complex Hilbert space of quantum mechanics. Gravity appears as the nonzero difference of local and global space in the same point therefore allowing for them to be identified by the mediation of equating gravitational field (definable in each point of the global space).

That analogical construction involves two different separable complex Hilbert spaces, being non-orthogonal to each other in general, in each point of the global space (which is the one of those Hilbert spaces), As this is explained in detail in the previous section, one can ignore the non-orthogonality of the two spaces for their infinite dimensionality in general. However, the present section means just the case of their nonzero non-orthogonality (i.e. the resultative curvature, or phase shift for certain "axes" of the same name for both spaces) as well as its physical and philosophical interpretation.

The same construction involves implicitly entanglement between each point of the global space and an arbitrary number of other points of it. The local space (the one of the two separable complex Hilbert spaces meant in each point of the global space) refers to the point by itself. Its deformation as to the global space in the same point is due to its entanglement to other points of the global space.

In other words the same construction only "paraphrased" form terms of the pseudo-Riemannian space of general relativity into terms of the separable complex Hilbert space of quantum mechanics, and thus, it is naturally interpretable as "quantum gravity" turning out to be definable equivalently as entanglement at the same time. Then, one can herald concisely that entanglement is quantum gravity in the described rigorous meaning.

Entanglement and confinement (eventually)

One can ask which or what the equivalent of entanglement (and thus, of quantum gravity) would be in the framework of the Standard model itself for the same construction is "zero" there and entanglement (or quantum gravity) should be available in it somehow otherwise, but equivalently physically (i.e. resulting in the equal quantity of physical action).

If one grants confinement after strong interaction in the Standard model for considerations, which will be postponed for a future paper, the following sketch would appear:

Confinement means a special, extraordinary, and even unique (at least on the contemporary physics) kind of physical field. It cannot be identified as any other field corresponding to any of the three "legal" interactions in the Standard model even only as the force corresponding to confinement should increase in distance, and that according to any of the three rest interactions decreases.

It is a rather hypothetical phenomenon introduced only to explain why "free quarks" are not observed experimentally at all though they are proclaimed as really existing according to the Standard model. However, one can thought of existence or nonexistence of free quarks as a kind of relation between the local and global space as to strong interaction since one can interpret the "free quarks" as quarks available (also) in the global space unlike the rest quarks available only in the local space. The rest two fundamental interactions in the Standard model are not able to distinguish between local and global space therefore identifying them.

However, their distinction is necessary for any relation of them to appear, and such a relation is necessary in turn to be defined entanglement. At the same time, the same relation (defining entanglement) is rather "spooky" being able to "vanish into thin air" equivalently. Analogically, the force of confinement (once one has granted for it to exist) vanish in the framework only of local space, but it appears and even increases exponentially, approaching the boundary of the local space and preventing for "free quarks" to appear in the global space.

Thus, the smooth physical field of confinement acting upon quarks only in the local space (and even furthermore acting in the global space if they have managed somehow to find themselves in the global space) should be equivalent to any quantum leap between the local and global space (respectively vice versa, fetching quarks instantly if they find themselves in the global space in the virtue of quantum uncertainty, i.e. rather virtually).

Then, the physical field of confinement would be to be defined logically at that of equating field (interaction) allowing for transforming of a relation into a property (or in other words, depicting all virtual parts of a whole only onto the screen of that whole by means of the single infinitely dimensional complex Hilbert space of quantum mechanics, an so much the more, of the Standard model).

Then, if one would define entanglement as a physical field, it should be anti-isometric, i.e. complimentary as to a complex Hilbert space, as far as it the reverse logical case where one adds to a whole any virtual part of it, or in other words, a property of a whole turns out to be transformed equivalently into a relation if the some whole to some part of it by an equating physical force (interaction) between them.

If one grants that anti-isometry as proved (though only sketched here) for the transformation of the same property into a relation and its converse accordingly, this would justify at the same time the unity of confinement and entanglement. Meaning only to outline the "forest" in the present paper rather than the "trees", the link of entanglement and confinement is visualized enough.

Quantum gravity as the smooth "classical gravity"

If one sees as (above) entanglement (being a relation of local and global space therefore being able to vanish "spookily", but equivalently) as confinement in terms only of the local space as the single space of the Standard model, the reverse problem might be suggested:

How one should see entanglement in terms only of the single global space of general relativity meaning furthermore that it is finite even in two ways: finitely-dimensional and restricted in time till the present moment of time: as gravitational field (as that) is explained in detail in a previous pater (Penchev 2020, August 20). Here is a concise summary of those arguments:

1. One represents the separable complex Hilbert space of quantum mechanics by means of qubits as follows. A qubit is defined as usual: as the normed superposition of two orthogonal subspaces of that Hilbert space, and thus particularly, as two successive axes in an arbitrarily chosen well-ordering of all the axes. Thus, the qubit representation would be linked rather to the vector representation of Hilbert space than to the function one. One can represent equivalently a vector in that Hilbert space by a vector, the components of which are qubits[6]. Then, the function representation where any qubit is an elementary function (rather than an "axis" as in the standard representation of that Hilbert space) can be restored thoroughly in the final analysis[7].

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[6] If one considers the wave function equivalent of the corresponding qubit vector, it would include the class of all permutations of qubits. Any single qubit means two alternatives about the pair of axes are ordered or not. One can agree the picture by qubits with the standard one absolutely by elementary technical exercises.

[7] A "qubit" can be thought equivalently as the identical unit of both quantum information (entanglement particularly) and the usual Hilbert space meant by quantum mechanics as the construction

2. By the equivalence of the axiom of choice and the well-ordering "theorem", one can equate the qubit Hilbert space of quantum mechanics and the Minkowski space of special relativity. Then, the two identical (identifying isometry and anti-isometry) dual Hilbert spaces would correspond to the real and imaginary domain of Minkowski space.

3. One means the two domains of Minkowski space as a contravariant and a covariant space coinciding in the case of "flat" space. Then, if any pseudo-Riemannian space is granted, it can be decomposed to a contravariant and a covariant space differing from each other and therefore resulting in a "curved" space pseudo-Riemannian,

4. Using again the equivalence meant in (2), one can transfer the covariant and contravariant space able to determine any pseudo-Riemannian space into two "qubit Hilbert spaces" differing from each other unlike the case of a single qubit Hilbert space, and therefore, involving unambiguously a state of entanglement as a single counterpart of the corresponding pseudo-Riemannian space at issue,

The considered construction is the searched link of gravity in general relativity and entanglement (which can be neglected in the framework of the Standard model as well as "quantum gravity" for the compensating mechanism of confinement as it is elucidated above).

The unusual epistemological and ontological room of gravity

Gravity, as it is well-known, possesses a few notable peculiarities: it is universal, only positive (attraction), acting at an arbitrary distance like electromagnetic interaction, exceptionally weak unlike the other three interactions in the Standard model (including to the so-called weak interaction) While weak or strong interactions are only quantum (which is due to the fact that the particles corresponding to their fields accordingly have a certain non-zero mass at rest), gravity, on the contrary is only classical (at least until now).

Now, gravitational interaction will be investigated from an extraordinary viewpoint properly philosophical to be elucidated its unique ontological and epistemological properties following the context of the present paper. It will be considered as what differs from each other model and reality, but a way relating them and thus reducing them to a common and most fundamental substance: information whether classical or quantum.

The conjecture in a few sentences will be the following:

Model and reality share information classical as to the former and quantum as to the latter. Quantum information is a generalization if classical one referring to finite sets and series, therefore meaning the information of infinite ones. So, the difference between model and reality (regardless of which, exactly, philosophical terms or concepts are involved explicitly or implicitly as to that or similar opposition) can be represented absolutely in the framework of mathematics as thoroughly corresponding to the opposition of infinity and finiteness, and the shared ground of information whether classical or quantum is the Number (whether

demonstrates. Thus, it is able to embody the fundamental idea of "flattening" (respectively, "curving" in the reverse direction). That "curving" will be necessary a little further to transfer from the "flat" single space of the Standard model (or quantum mechanics) to the curved pseudo-Riemannian space of general relativity via quantum information and entanglement.

Pythagorean or quantum and neo-Pythagorean) mathematically and ontologically seen as the fundamental element of the universe whether "subjective" (model) or "objective" (reality).

From the same mathematical and Pythagorean viewpoint, the relation between them is that between finiteness and infinity, natural numbers and set, arithmetic and set theory. The corresponding physical difference consists in the fact that quantum information (the substance of reality) possesses nonzero energy or mass (not necessary mass at rest) once "Mach's principle" of Einstein (1918) is granted, but classical information (considered as the "substance of model") does not possesses any nonzero energy and mass (or in other words/ it possesses always and only "zero energy and mass").

There exists still one and absolutely independent viewpoint to the same relation of model and reality (seeming to be a thermodynamic relation in terms of physics). Any single system consider as quantum can be considered always as a model ant thus finite. It turns out to be real (i.e. not to be a model at best) only considered in relation to any other system therefore implicitly implying the existence of a metasystem on the next hierarchical level consisting of those subsystems in the relation at issue.

Then, any nonzero mass and energy (such as that of quantum information) implies a nonzero quantity of gravitational quantity (and vice versa as well). Consequently, gravity differs simultaneously and independently in two dimensions: reality from model; part from whole. There exists the option (which is only an option and thus, not necessary) both dimensions to be unified and then gravity as distinguishing as above at the same time would unify "reality" and "part", on the one hand, or "model" and "whole", on the other hand (therefore contradicting common sense including scientific).

A philosophical reflection of the same conclusion being too paradoxical, but only at a first glance, is the following:

Gravity is an extraordinary and unique interaction (or "force") both physical and mathematical as unifying the mathematical and physically in the single homogeneity of information as distinguishing them by means of the concept of infinity (versus finiteness) mathematically or by the quantity of mass physically

Speaking not only figuratively, one may say that reality are those models that have mass (meaning any nonzero energy or mass more precisely): or in other words, gravitation is the unique physical interaction ("force") able to generate reality (starting from a certain model as granted).

Furthermore, gravity can be defined only mathematically as a relation of infinity and finiteness following the context of a previous paper (Penchev 2020, July 20), but which will be postponed to a future paper to be exhibited explicitly.

Instead of conclusion: from "no room for gravity" to the creation of physical reality by gravity

There exists a trend for new, more and more complicated mathematical models to be offered for quantum gravity. The usual suggestion of the scientific common sense is that the gap between model and reality though fundamentally unavoidable can be shortened enough so an appropriate theory of quantum gravity to be provable experimentally at last and thus, more relevant than general relativity.

However, the history of scientific progress instructs that a new relevant theory needs very often a new worldview rather than more and more clever mathematical formalism in hope for the cherished relevance. The essence of many creative new theories is rather an adequate, but revolutionary change of the followed pathway rather than a single direction to be followed stubbornly and steadily.

The corresponding process of epistemological reorientation needs, first of all, a new philosophy able to see the "forest for the tree" for any new direction would be conditioned necessarily by a relevant change of Gestalt what the whole of the observed picture means in fact.

That new Gestalt meant in this paper rejects the old one (as usual) consisting in the research of a suitable nook where the kittle gravity might be situated anyway in the framework of quantum mechanics and conservatively to the Standard model, which to be generalizable relevantly in turn.

The refusal, from which the present research starts, can be summarized by the slogan: "No room for gravity in quantum mechanics!" therefore renouncing thoroughly all attempts for any clever mathematical formalism of quantum gravity sharing the prejudice sketched above. Speaking loosely or metaphorically, that kind of quantum gravity being heralded as impossible fundamentally can be liken to "perpetuum mobile", the projects of which the French Academy had ceased to consider a long time ago for all of them contradict necessarily the laws of nature.

Analogically, the present paper insists that quantum gravity of the kind above cannot exist for quantum mechanics and general relativity mean the same from the viewpoint properly inherent to quantum mechanics and consisting in the unification of the discrete and continuous, therefore being absolutely necessary for quantum mechanics to be both objective and experimental science. That unity can be made obvious explicitly involving the concept and quantity of quantum information and respectively, entanglement.

Quantum information is able to exist in two equivalent hypostases: "flat" and "bandy" studied correspondingly and disjunctively by quantum mechanics culminating in the Standard model and by general relativity. The opposition "microscopic – macroscopic", in which the scientific common sense think of them is incorrect and implies wrong conclusions being absolutely misleading.

On the contrary, the viewpoint of entanglement involves "quantum information", to which that opposition is meaningless, and the transformation of each of them into the other one can be investigated relevantly by "curving", therefore mediating the poles of "flat" (zero curvature) and "bandy" (any nonzero curvature). The theory of entanglement (quantum information) is properly the unification of both so that they be two hypostases of the same, namely quantum information.

Once the new physical worldview has been conquested, it implies a counterpart of entanglement in the framework of the Standard model, and confinement is suggested as that. Indeed confinement is a mysterious interaction involved *ad hoc* in the Standard model for the absence of "free quarks", which are neither observed experimentally nor explicable otherwise.

However, there is no room for confinement just as for gravity in the Standard model, in which all existing interactions are enumerated by name: weak, strong, and electromagnetic (i.e. no confinement)

Furthermore, entanglement turns out to be a bridge able to connect confinement and gravity both mathematically and physically. They seem to be two entities, each of which is absolutely standalone only on the "screen" of common sense, for which the hierarchical opposition "big - small", respectively, "macroscopic – microscopic" is crucial and predetermining any possible worldview.

Once quantum gravity has been seen in the only correct way as the identical twin (eventually, complementary as to the terms of quantum mechanics) of the "classical", i.e. smooth gravity of general relativity, the pathway to its philosophical meaning both epistemological and ontological is open:

Gravity simultaneously quantum and classical is what generates the physical world, which is rather less (some true part, necessarily) than more, than the physical nothingness of any (finite) mathematical model. On the contrary, quantum mechanics is what calls for the holistic viewpoint meaning immanently the whole, system, thus a single one regardless of any parts of it. However, that whole turns out (too paradoxically as to common sense) to be physically "nothing", and the creation of the physical world by gravity takes away rather than adds …

Then the being at all (i.e. philosophically and ontologically) should be thought rather negative than positive. Accordingly, one can interpret the *being as a deficiency of nothing*, and the process of perfection as a pathway to the Nothing, just as Buddhism or a few other branches of East Philosophy do …

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