THE GENERALIZATION OF THE PERIODIC TABLE: THE "PERIODIC TABLE" OF "DARK MATTER"

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Abstract. The thesis is: the "periodic table" of "dark matter" is equivalent to the standard Periodic table of the visible matter once being entangled. Thus, it is to consist of all possible entangled states of the atoms of chemical elements as quantum systems. In other words, an atom of any chemical element and as a quantum system, i.e. as a wave function, should be represented as a non-orthogonal in general (i.e. entangled) subspace of the separable complex Hilbert space relevant to the system to which the atom at issue is related as a true part of it. The paper follows previous publications of mine stating that "dark matter" and "dark energy" are projections of arbitrarily entangled states on the "cognitive screen" of Einstein's "Mach's principle" in general relativity postulating that gravitational fields can be generated only by mass or energy. The "cosmological constant" introduced by Einstein additionally in 1918 is generalized to a "cosmological function" depending on space-time coordinates, and then to a "cosmological function of entanglement" being a quantum field and decomposable to two entangled subfields, correspondingly depending on space-time coordinates and energy-momentum ones. Entanglement is an additional source of gravitation and can be represented by equivalent mass and energy observable as dark ones. In fact, it violates or complements "Mach's principle", but is forced to be mapped only as mass and energy in virtue of the principle, being furthermore available implicitly in the structure of the Einstein field equation of general relativity.

One can use the metaphor of Plato's "cave" about dark matter, dark energy or entanglement: the people are chained and thus can observe only the wall and shadows on it, but not what causes the shadows. So, the shadows can be described only in terms of the wall though those terms are irrelevant to the shadows by themselves: i.e. as dark matter and energy or entanglement. All possible experience of humankind is temporal: thus, the "screen of time" is what that metaphor means as depicted by the "wall of the cave". On the contrary, what causes the shadows is not temporal, nonetheless being visible only as shadows of the temporal screen. So, the "shadows of dark matter" can be observed only on the "screen" of the usual Periodic table of visible matter.

Anyway, one can question what the dark "Periodic table" by itself is (i.e. not as a projection onto the visible Periodic table). What becomes visible on the "screen of time" (i.e. the non-Hermitian operators projected as Hermitian ones) can be likened as incomplete quantum calculations. The "complete calculations of the universe" as a quantum computer are all Hermitian operators and thus physical quantities, only to which the concept of the Periodic table makes sense; or in other words, the dark Periodic table by itself is relevant to non-Hermitian operators distinguishable into classes, each of which corresponds to a single subclass of Hermitian operator as any chemical element of the Periodic table can be represented.

Keywords: dark matter, dark energy, entanglement, Periodic table, separable complex Hilbert space

I CONTEXT AND FRAMEWORK: SYNOPSIS

The paper follows a presentation in Torino (2019 July 15) also a paper (Penchev 2019). It discusses a thought experiment in Einstein's manner to suggest a possible generalization of the invariance of physical laws to arbitrarily accelerated reference frames in general relativity further: in astrochemistry.

The conclusion claims the indistinguishability of two kinds of spectral lines of the same chemical substance: (1) due to redshift and originating from an arbitrarily distant astronomical object (such as a star, a galaxy, etc.), anywhere in the universe; and (2), after entanglement in experiments conducted on our planet; furthermore (3), a bijection exists between all possible redshifts and the spectral shifts due to entanglement:

As accelerated motion and gravity are indistinguishable after Einstein's "*Gedankenexperiment"* about elevators (Einstein 1956), as any accelerated motion, gravity, *and entanglement* are suggested to be indistinguishable under the conditions of the thought experiment in the previous paper and presentation.

The conclusion relies on an eventual conservation of quantum information (considered as the Noether correlate of the physical quantity of action) generalizing energy and matter conservation in physics and chemistry. A generalized Periodic table of entangled chemical elements can be put forward as identical to standard one but dispersed in any possible motion anywhere in the universe and accessible by spectral observations on our planet.

The article accepts the existence of "dark matter" (Peebles[1] 1984; Trimble 1987; Sciama 1993; Sanders 2010; He & Wang 2011; Majumdar 2014; Gramling 2018) and "dark energy" (Riess[2] et al. 1998, Perlmutter[2] 2000; 2003; 2012; Schmidt[2] 2003) as very well established experimentally and will state that the Periodic table of entangled chemical elements can be interpreted as the "Periodic table" of "dark matter": dark matter is due to entanglement since the pair of dark matter and dark energy is equivalent to entanglement in virtue of quantum information conservation[3]. Dark matter is "visible" only as entangled states of the standard matter (meant e.g. by the Standard model or the Periodic table); entanglement propagating "instantly" by quantum correlations is what adds dark matter and dark energy to the visible ones just "visible" after propagating any electromagnetic radiation therefore limited of the constant of light speed in a vacuum. Mass and energy can be divided unambiguously into visible or dark by the velocity of interaction either subluminal or superluminal respectively. Dark matter and dark energy available in advance due to the "instantaneous" entanglement are to be added to the visible ones.

Entanglement in turn is to be identified with gravity just as gravity is identified with relative acceleration in virtue of general relativity. Quantum information conservation admits

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[1] The Nobel Prize in Physics 2019 was awarded "for contributions to our understanding of the evolution of the universe and Earth's place in the cosmos" with one half to James Peebles "for theoretical discoveries in physical cosmology" (including for his research of dark matter) https://www.nobelprize.org/prizes/physics/2019/summary/ .

[2] The Nobel Prize in Physics 2011 was divided, one half awarded to Saul Perlmutter, the other half jointly to Brian P. Schmidt and Adam G. Riess "for the discovery of the accelerating expansion of the Universe through observations of distant supernovae." https://www.nobelprize.org/prizes/physics/2011/summary/

[3] The generalizing law of quantum information conservation and its proof are published in: *Penchev 2020 August 17*; the link to dark matter and energy, in: *Penchev 2020 August 31*.

the violation of energy conservation since the latter should be restricted only to the subluminal area unlike quantum correlations. Then, quantum correlations meant by quantum information conservation are "depicted on the screen" of visible matter and energy (e.g. in virtue of Einstein's (1918) "Mach's principle") as invisible, or they are "dark" as far as are out of that "screen" by themselves and only projected on it (metaphorically, "shadows on the wall" of Plato's "cave").

"Mach's principle" was introduced by Einstein to justify the "cosmological constant"[4] in the field equation. It states that only mass and energy (both visible on the temporal "screen") can be the source of gravity in the framework of general relativity. If any other source of gravity exists (as this follows from the option of energy non-conservation within quantum-information conservation), it would project as dark matter and dark energy. Dark matter and dark energy would be observable only after gravitational phenomena and described by general relativity. No experiment in the framework of the Standard model referring only to visible matter and energy can establish any effect of dark matter or dark energy.

The generalization of energy conservation (e.g. as quantum information conservation here) would be necessary. Anyway, dark matter and dark energy might be interpreted "conservatively", i.e. in the framework of energy conservation therefore excluding any violations of it. As *neutrino* was discovered initially theoretically in virtue of energy conservation, any observed violation would mean the existence of yet unknown entity, but visible and confirmable by relevant experiments: some researches grant that the ostensible "darkness" is not more than an unrevealed yet "visibility" obeying the absolutely universal energy conservation.

The dilemma is: a new law in cognition versus new entities in nature. The former seems to be more revolutionary implying the reformation of many scientific areas; e.g. chemistry (Penchev 2020 June 15): though equivalent as to spectral lines, a chemical substance on a distant star only observable terrestrially and the same substance in an entangled state equivalent as to spectral lines keep to be fundamentally different as to their empirical or experimental properties. The substance being on the distant star cannot behave as the substance which it only depicts on Earth by identical spectral lines.

The entangled substance should behave just as the corresponding substance: if any substance is entangled so that its spectral lines turn out to be those of gold, for example, it would be indistinguishable from gold by itself. Entanglement changes the substance itself; gravity, only the signal of it: the generalized "periodic table" of "dark matter" should be related to the former, but not to the latter.

II THE STATE OF ART AND RESULTS: ENTANGLEMENT ON THE SCREEN OF "MACH'S PRINCIPLE": DARK MATTER & DARK ENERGY

Einstein's "Gedankenexperiment" (Einstein 1956; Norton 1984) about an accelerating elevator demonstrates his generalized principle of relativity by the indistinguishability of experience after observations in: (1) an arbitrary accelerated elevator; (2) the same elevator

[4] Einstein's main consideration referred to the universe to be static, which is not valid as to the initial equation (Einstein 1916). However, Einstein observed in Hubble's observatory (Topper 2013) that the universe expands and declared the cosmological constant to be his "biggest blunt" (Gamow 1970: 44). Anyway, "Mach's principle" in Einstein's interpretation is consistent with the expanding universe (Ghosh 2018; Ne'eman 2006).

situated in a gravitational field. Gravitational field is equivalent to *relations* of accelerated reference frames in the general principle of *relativity*.

The following two groups of experiments can be suggested analogically to be indistinguishable as to entanglement and gravitational field:

(1) The redshift of spectral lines of a certain chemical substance in any point of the universe and observed from Earth.

(2) The redshift of spectral lines of the same substance being on Earth, but entangled relevantly for the redshift at issue.

The wave function of that chemical substance observed on Earth is modified by: (1.1) the geodesic line from any point in the universe to Earth in pseudo-Riemannian space due to the gravitational field of the universe, in the former case, (1.2) a second wave function entangled with that of the substance, in the latter case.

Einstein's "*Gedankenexperiment*" demonstrates the experimental indistinguishability of gravitational and force field causing the same acceleration. The intended thought experiment is to show an analogical, but generalized experimental indistinguishability of gravitational field and entanglement causing the same observed redshift. One extends the general principle of relativity (GPR): gravitational field is representable by two equivalent ways: (1) as a relation of two arbitrarily accelerated reference frames; (2) as a relation of two arbitrarily entangled wave functions.

That generalization of GPR postulates the equivalence of GPR and the quantum phenomena of entanglement. This implies a theory of quantum gravity (though nonstandard due to the *complementarity of the quantization* of the gravitational field unlike that of each of the three interactions of the Standard model). General relativity understood as a nonstandard theory of quantum gravity would state that it is a complementary, smooth description of entanglement, but equivalent to it after a relevant transformation, for which a new concept: "discrete (or external, or quantum) reference frame" seems to be relevant and generalizing GPR from smoothly accelerated reference frames, to discrete ones (i.e. non-continuous and thus, non-smooth).

"*Discrete* reference frame" needs a generalization of time as well: from the irreversible (though arbitrarily "curved") time of general relativity to the reversible time of coherent quantum state. This implies further a generalization of energy and matter, which is a particular case of energy due to Einstein's "$E = mc^2$": "dark matter" & "dark energy" describable whether as "atemporal" or as relevant to the reversible time of coherent state.

If that generalization is linked to "dark matter" and "dark energy" directly and explicitly, they can be explained as a projection on the "cognitive screen" of general relativity after "Mach's principle".

Einstein introduced "Mach's principle" only in 1918 to infer from it for the universe to be static adding the "cosmological constant" to the initial equation(s) of general relativity. However, "Mach's principle" is much more general, stating that the "only source of gravitational field can be matter and energy". In fact, "Mach's principle" is implicit even in the initial "Einstein field equation" for its structure: a space-time tensor (Ricci tensor) corresponding to mass is to be equated to an energy-momentum tensor for energy: if anything

else generates a gravitational field, it would imply relevant mass and energy corrections in the Einstein field equation.

Both dark matter and dark energy can be established only after astronomical observations therefore based only on general relativity and thus, "switching on the cognitive screen of Mach's principle". Dark matter is necessary for the Milky Way and many other galaxies to rotate too fast and should disintegrate and scatter due to centrifugal force since their visible mass and energy including the dark holes within them are extremely insufficient to balance it. Dark energy explains the observed acceleration of the expansion of the universe: the universe is a closed system, but obtains some energy permanently, namely "dark energy" which accelerates its expansion.

Though the dark matter & energy in total are about 20 times more than the visible ones, they can be considered mathematically as corresponding corrections in the Einstein field equation. Also, they can be contained implicitly in a modified "cosmological constant" generalized as a "cosmological *function*". Meaning some hypothetical source only projectable on "Mach's screen" as dark matter and dark energy, it is identifiable as entanglement for the "still more general principle of relativity" demonstrated by the thought experiment in the beginning.

Dark matter is to be a "correction" in the space-time tensor, and dark energy, in that of energy-momenta accordingly. Both corrections can be separated in a "cosmological function" so that its variables would be two entangled wave functions, corresponding to the effective gravitational field caused by dark mass or dark energy.

The usual Einstein field equation would be a particular case of the generalized one if (1) both "fields" are zero; or (2): they are orthogonal (or complimentary as in the "classical" quantum mechanics) to each other, and thus their entanglement is zero.

The Einstein field equation can be represented conceptually so:

$$\{R_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}\} + \{\frac{R}{2} g_{\mu\nu}\}$$

Here $R_{\mu\nu}$ is the Ricci curvature tensor; G is the gravitational constant; c is the constant of light speed in a vacuum; R is the scalar curvature; $g_{\mu\nu}$ is the metric tensor; and $T_{\mu\nu}$ is the energy – momentum tensor. The sense is:

{The gravitational field due to mass = that due to energy} +
+ {a function due to the metric of pseudo-Riemannian space}

The former brackets surround the "screen of Mach's principle", and the latter brackets, what is to be "projected" on that screen as both dark matter and dark energy.

Einstein introduced the "cosmological constant" in the equation in 1918:

$$\{R_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}\} + \{\left(\frac{R}{2} - \Lambda\right) g_{\mu\nu}\}$$

The sense of adding the **"cosmological constant"** Λ is: there exists some unknown influence on the relation of the gravitational field due to mass and the gravitational field due

to energy. Furthermore, that (today, "dark") influence changes the metric of pseudo-Riemannian space.

One can generalize the cosmological constant to a "cosmological *function*" $\Lambda(x,\ y,\ z,\ t)$:

$$\{R_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}\} + \left\{\left(\frac{R}{2} - \ \Lambda(x,y,z,t)\right) g_{\mu\nu}\right\}$$

The sense of the generalization is: that "dark influence" is not homogeneous, constant, but different in any space-time point (in general): the transformation of pseudo-Riemannian space is accomplished by an arbitrary operator, the action of which is experimentally observable as the additional "dark matter" and "dark energy".

The cosmological function can be interpreted as two entangled quantum fields, i.e. as the "cosmological *function of entanglement*":

$$\{R_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}\} + \left\{\left(\frac{R}{2} - \ \Lambda[\Psi(x,y,z,t), \Theta\left(p_x, p_y, p_z, E\right)]\right) g_{\mu\nu}\right\} \text{ (\textit{Equation A})}$$

That is: $\Lambda[\Psi(x,y,z,t), \Theta\left(p_x, p_y, p_z, E\right)]$ is the "function of entanglement" of two quantum fields: $\Psi(x,y,z,t)$ and $\Theta\left(p_x, p_y, p_z, E\right)$: the observable dark influence is due to entanglement being the *macroscopic* total effect of the microscopic quantum entanglement. The "cosmological function of entanglement" is projected on the "screen of mass and energy":

The structure of the Einstein field equation is:

"{GF due to mass = GF due to energy} + "**dark** GF" implies:

*{GF due to mass visible + **dark**= GF due to energy visible + **dark**}*

Dark gravitational field GF = that of dark matter (mass) + that of dark energy

The dark GF is due to entanglement or even, only to entanglement. Entanglement by itself is only information, therefore invisible or "dark": it seems as both dark matter & dark energy only on the "screen" of the Einstein field equation by Mach's principle.

After Einstein's "$E = mc^2$", energy & matter are the same, but what is "the same" at issue? It should be *temporality*; "Mach's principle" can be paraphrased as "any physical process is temporal".

This is not valid as to entanglement: it is a physical process, but not in time since its time to occur is zero definitively, being furthermore another source of GF: the "screen of Mach's principle" and the "screen of temporality" are the same after energy is the universal physical quantity and implies time according to the first Noether (1918) theorem.

All physical quantities in quantum mechanics are Hermitian operators, which is consistent to the unitarity of the separable complex Hilbert space and to their general commutativity with the Hamiltonian of the system as the operator of energy. If time is the only physical

quantity which is not an operator[5], but the conjugate of energy, it is universal not less than energy and valid to any quantity, which is a Hermitian operator. However, entanglement is equivalent to non-Hermitian operators and out of the temporal screen.

Quantum information is measured in units of qubits (where "qubit" is an orthonormal superposition of any two orthogonal subspaces of the Hilbert space of quantum mechanics). Quantum information: (1) unifies and describes uniformly Hermitian operators (i.e. all temporal physical quantities) and non-Hermitian operators (i.e. entanglement); (2) acts physically and is equivalent to a certain quantity of action.

Since quantum information can be represented as equivalent to the information of infinite series or sets (Penchev 2020 July 10), a qubit is an infinite set of bits, and the physical action of any finite sets of classical bits is zero (as it is commonly accepted).

Entanglement being by itself quantum information equivalent to physical action is, nonetheless, out of time. That physical action is out of time and conditions 95-96% of the total mass and energy of the universe in units of mass or energy.

The conclusion is: our scientific worldview is extremely incomplete for ignoring all physical out of time. Two metaphors of the "temporal screen" are possible: (1) as the "wall of Plato's cave"; (2) as the "screen of the quantum computer of the universe".

III REFLECTIONS, SUGGESTIONS AND CONCLUSIONS: MATER AND DARK MATTER IN CHEMISTRY AND QUANTUM CHEMISTRY, THE PERIODIC TABLE

The proven existence of dark matter restricts all chemical knowledge only within the scope of visible matter. The advocated hypothesis considers dark matter by itself as the *substance of quantum information* due to entanglement. Visible matter refers only to the particular case of quantum information on the "screen of time", on which it is distinguishable from visible energy.

Can the existent chemistry of visible matter be generalized as to an eventual chemistry of quantum information?

Though visible, plasma does not possess chemical properties in the usual meaning: so, chemical properties are defined standardly as to the non-plasma, low-energetic states. They refer to the electron shell of the atom divided into discrete energy levels (or layers and sublayers) and especially, to the top energy level of valence electrons. All atoms can be separated in classes according to their chemical properties into about 118 chemical elements (discovered or synthesized until now). Their chemical properties are altered discretely and correspond to the number of electrons in the shell constituting periodic groups of similar chemical properties because all electron shells obey rigorous quantitative laws of quantum physics.

All chemical elements can be visualized by the periodic groups of their chemical properties in a compact two-dimensional ordering known as the "Periodic table". Meaning the advocated hypothesis of dark matter as entangled states, that Periodic table of dark matter is

[5] That idea was suggested by Wolfgang Pauli in his debate with Niels Bohr about the "conservation of energy conservation" in quantum mechanics: if time were an operator as all the rest physical quantities in quantum mechanics, this would imply its variability after measurement and thus, a different value of energy in any single measurement, i.e. the violation of energy conservation in the final analysis.

interpreted as the meaning or relation of the Periodic table to entangled states. Obstacles for this are:

The Periodic table of visible matter is discrete, but entanglement is not. All chemical properties are defined only on the "screen of time". Thus, the concept of chemical property suggests the distinction of matter and energy, but entanglement implies their indistinguishability.

After dark matter, the Periodic table can be understood as a two-dimensional series of atomic states whether stable or radioactive, but only on the "temporal screen" (or that of energy, resp. matter conservation). One can figure quantum information as a mathematical function definable as by the variable of time (the case of the "classical" quantum mechanics) as independently of it (studying the phenomena of entanglement). Then, the chemical elements as all visible matter would be the "roots ("zeros") of the equation of quantum information" to the variable of time (i.e. the points in which the "function graphic of quantum information crosses the axis of time", and time makes sense).

The Periodic table was invented by the Russian scientist Mendeleev by generalizing the empirical experience of chemistry, but without any reason why the Periodic law exists. Only quantum chemistry after the Bohr model of the atom managed to reduce the Periodic law to quantum properties of the corresponding electron shells, their discrete energy levels and their filling by electrons following the principle of Pauli.

The quantum foundation of chemistry prefers the language of particles rather than the equivalent language of waves, but the theory of quantum information and entanglement uses the "wave language". The appearing quantum-information chemistry of entangled chemical substances needs wave-particle duality to synthesize quantum chemistry with quantum information. For example, the electron shell of the atom of a certain chemical element is to be represented by a single wave function for investigating its entanglement with any other wave function. The reverse approach, the translation of entanglement into the language of particles, is not less admissible, but seems to be more difficult technically.

The few principles of the translation of "particle language" into "wave language" are based on "quantum number" granting it to any quantum physical quantity whether continuous or discrete. Any physical quantity is described by a relevant Hilbert subspace: finitely dimensional for discrete quantities, but infinitely dimensional for continuous ones. Any quantum entity is described by a finite set of quantities therefore by that separable complex Hilbert space consisting of the same set of subspaces though some of them being infinitely dimensional. The shell properties (quantum numbers) relevant to chemistry refer only to finite Hilbert subspaces.

The "conservation of energy conservation" in quantum mechanics (Penchev 2020 August 17) is a postulate imposed initially by Pauli debating against Bohr[6], and now, as commonly accepted as underlying the Standard model and the language of quantum particles. If the separable complex Hilbert space unifying Heisenberg's matrix mechanics and Schrödinger's wave ("ondulatory") mechanics is given, its property of unitarity implies energy conservation as a necessary physical interpretation. The justification is: if the wave function of an entity is

[6] The "BKS theory" (Bohr, Kramers, Slater 1924) is meant. Hendry (1984) elucidates the dialogue of Bohr and Pauli to energy conservation in quantum mechanics and the BKS theory.

the same to all possible apparatuses, and the dual Hilbert spaces are idempotent, the former can be interpreted equivalently: any possible wave function of the same entity is the same (e.g. to a certain apparatus).

Entanglement needs a relevant generalized conservation therefore violating energy conservation: "quantum information conservation" meaning that the set of quantum numbers is predetermined and unchangeable and only namesake quantum numbers of two or more wave functions can be entangled. The violation of energy conservation consists in the direct transformation of quantum information into energy, but only under the condition of quantum information conservation.

Though energy and matter are equivalent after "$E = mc^2$", matter in chemistry is meant *only as "matter at rest" (having mass at rest) and being non-plasma (for electron shells to exist)*. One needs the *Ricci tensor* of the Einstein field equation and relevant to the *gravitational field of matter at rest* to be represented by the entanglement of two (or more) wave functions. This is very complicated technically, but not conceptually:

The Ricci tensor at issue is the Ricci tensor of the one of the two entangled quantum fields; namely: $\Psi(x, y, z, t)$ in relation to $\Lambda[\Psi(x, y, z, t), \Theta\left(p_x, p_y, p_z, E\right)]$. This means:

$$R_{\mu\nu} = \left\{R\left(\Psi(x, y, z, t), \Lambda[\Psi(x, y, z, t), \Theta\left(p_x, p_y, p_z, E\right)]\right)g_{\mu\nu}\right\}$$

The result is inferred from *Equation A* above and where $R_{\mu\nu}$ is the Ricci tensor of $\Lambda[\Psi(x, y, z, t)$ to $\Lambda[\Psi(x, y, z, t), \Theta(p_x, p_y, p_z,\ E)]$.

Quantum information chemistry is to be defined as that quantum chemistry studying the influence of entanglement. As chemical properties are determined by electron shells, quantum information chemistry investigates entangled electron shells (since only namesake quantum numbers can be entangled according to quantum information conservation). Entanglement adds "dark matter" to the visible matter of chemical substances obeying the Periodic law and would modify the Periodic table of visible matter.

The Periodic law follows the successive filling of the admissible discrete energy levels of electron shells one by one in accordance with the serial numbers of the chemical elements. The second dimension of the Periodic table corresponds to the number of filled energy layers (or sublayers) of the electron shell.

Chemical elements in entangled states can remain the same, but energetically excited therefore radiating photons after decoherence. Furthermore, the entangled chemical element may be changed into another substance (not necessary element) due to the chemical properties of the entangled system. A few questions follow:

Can the Pauling (1960) chemical bond be interpreted as an entangled state of electrons belonging to different atoms?

Can "chemical compound" be generalized as to the entanglement (chemical bond) of non-valence electrons of the shell?

Can entanglement generate new chemical compounds, which cannot be a result of any classical chemical reaction?

Can entanglement explain the phenomena of *catalysis*?

One can generalize entangled electron shells by adding the entanglement of the corresponding nuclei. This means to investigate the influence of entanglement of the corresponding discrete quantum numbers of atomic nuclei. Analogically, the entangled atomic nucleus can remain the same, but energetically excited, or can change in another isotope or chemical element. Is nuclear fusion needing additional energy can be explained or generalized by entanglement?

Can any radioactive isotope be interpreted as an entangled state of the products of its decay? If yes, which is the reason for the process of decoherence after many radioactive isotopes to be so slow? That reason would be a key to creating huge, super-powerful and mass-available quantum computers. Can one influence the speed of radioactive decay by entanglement? For example, can the chemical element "118", Oganesson with the semi-decay of 700 microseconds for the isotope ^{294}Og to be stabilized by entanglement?

The only quantity which can be assigned to dark matter (as well as to dark energy) directly is quantum information, furthermore shared with visible matter and energy. All other quantities are the influence and change of the namesake quantities (quantum numbers) of visible matter and energy. One can speak of dark matter and dark energy only continuing the list of dark quantities as corresponding counterparts of the visible ones.

If one accepts the Periodic table only as a list of quantum numbers relevant to the electron shell, it will be valid to matter as visible as dark.

The influence of quantum information can be visualized by decomposing the relevant non-Hermitian operators into pairs of Hermitian one changing a certain quantum quantity and Hamiltonian changing energy accordingly. Entanglement can be interpreted also as an omnipresent physical interaction implying for any physical system not to be closed. Thus, entanglement is able to change the value of any quantum number (including those relevant to the Periodic table), but not to create new quantum numbers (forbidden by quantum information conservation).

Any scientific hypothesis is to offer new predictions. The advocated one implies:

Energy can be transformed directly into quantum numbers relevant to a certain chemical substance by entanglement with another substance sharing the same quantum numbers as those undergone to change.

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