An Info-Digital Universe (Toy) Model (IDUM) (in brief) using the hypothetical gravitonic qubit as the basic unit of the physical information

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Essay written for the Gravity Research Foundation 2016 Awards for Essays on Gravitation
(Submission date: 31 March 2016; Last revised: 19 May 2016)

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Motto: "[**God:**] Universe is nothing but a big copying machine, reproducing your thoughts [pure information] in physical form [energy/matter], that will be your experience [in classical linear time]"[3]

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Abstract

A growing trend in physics is to define the physical world as being made up of *information* **[1]**. An important direct relationship between information and *entropy* is demonstrated by the Maxwell's demon thought experiment **[2]**: an important consequence is that *information may be interchangeable with energy* **[3]**. Wheeler's *"it from bit" principle (hypothesis)* is also famous **[4,5]**. In this essay (which is a short essentialised summary of the author's Bio-IDUM (BIDUM) version 1.1 **[6]),** I argue that *energy and time are indissolubly connected* and can be integrated in a concept of *physical information (**PI**)* measurable in *qbits (qubits)* as an alternative interpretation to the (quantum) angular momentum: energy, matter and their behaviors may be considered proprieties of different PI-quanta.

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[3] Walsch N.D. (2000). „Conversations with God: An Uncommon Dialogue (Book 3)" (book). Chapter 1. (URL: nytimes.com/books/first/w/walsch-god3.html) (the passages marked between „[ ]" are my own explanatory and anticipative insertions)

Part 1. A physical information quantity scalar proposal

From the standpoints of digital physics the most important classification of the elementary quantum particles (**EQPs**) should be considered the gauge/non-gauge (relative) "functional" dichotomy (which is fundamentally based on the fermionic/bosonic dichotomy of EQPs and on the Pauli Exclusion Principle of the fermions). The gauge EQPs (**GPs**) are mainly energetic "messages" (carriers of energetic-quanta) and the non-gauge QPs (**NGPs**) can be regarded mainly as processors of energetic-quanta that can receive GPs (energetic-quanta "messages") and then emit other GPs as (processed) "replies". It's obviously a relative classification as all the EQPs can function as both messages (when the macro-objects interchange NGPs as also energetic carriers) and message-processors (when two or more GPs may interact with each other): however, the fact that GPs are all bosons (that can all occupy the same quantum state in the same time and space) is surely not a coincidence, because GPs mainly tend to carry "messages" and not to process other GPs as "messages". As all GPs are bosons, I shall rename them more specifically as gauge-bosons (**GBs**) in the rest of this essay. It's clear that GBs are much more "adapted" than NGPs to carry multiple parallel simultaneous messages (one message per each GB) on the same channel, as they can all literally "fill" that channel by their potential to occupy the same quantum state simultaneously.

Although it's not possible for PI-quantity (**PIq** or **I**) to be exactly defined/measured, in the observable physical world (in which the arrow of the physical classical linear time is oriented from a lower entropy to a higher entropy), when a NGP is not isolated from any other QP, it is clear that: **(1)** the (input[**in**]/output[**out**]) PIq transferred/extracted to/from that NGP is directly proportional (**dp**) to the (classical linear) time interval of measurement ($\Delta t=t_2-t_1$) (as a larger time interval means a higher probability of [more] virtual and real GBs reception/emission, as each GB participates with its own intrinsic PIq to the PIq input/output to/from a NGP); **(2)** PIq is also dp to the energy of each emitted/received GB ($\mathbf{E_{GB}}$) (the more energy per each GB, the more chances to change the subquantum and/or quantum state of an emitter/receiver NGP). Based on these 2 simple observational assumptions we can establish a plausible hypothetical scalar for the intrinsic PIq of a QP, based on a (hypothetical) simplified constant of direct proportionality $K_{PI}=1$**.** For further details and arguments, see the full BIDUM version 1.1 **[6]**

$$\boxed{K_{PI}=1(by\ hypothesis\ H-I)} \Rightarrow \boxed{I_{GB(in/out)}=K_{PI}\cdot(E_{GB(in/out)}\cdot\Delta t)=E_{GB(in/out)}\cdot\Delta t} \qquad \textbf{(E-I-1.1,1.2)}$$

GBs may be considered not only an energetic quanta (e-quanta [**Equa**]) and a (kinetic and/or rest) mass quanta (m-quanta[**Mqua**]), but also a PI-quanta (**PIqua**) (as GBs are quantum-PI carriers) that, when emitted/received by a NGP, have the potential to change the (detectable and/or undetectable) subquantum and/or quantum (informational[momentum]/energetic) state of that emitter/receiver NGP. As the individual (hypothetical) gravitons have probably very subtle subquantum manifestation (that are almost/practically impossible to be measured and distinguished individually even in the distant future of technology), the theoretical number of (**nof.**) all the (quantum and subquantum) distinguishable states ($\mathbf{N_S}$) of an NGP[4] is a the product between $\mathbf{N_Q}$ (all the possibly distinguishable quantum energetic/momentum [macro]states of that NGP) and $\mathbf{N_{SQ}}$ (all the possibly distinguishable sub-quantum energetic/momentum [micro]states of that QP). The total intrinsic PI quantity of a NGP [$\mathbf{PI(N_S)}$] can be generally defined as the binary-logarithmic measure of $\mathbf{N_s}$ of that NGP (as the binary logarithm is generally used in the definition of any type of information quantity).

$$\boxed{N_S=N_Q\times N_{SQ}} \Rightarrow \boxed{I(N_S)=\log_2(N_S)=\log_2(N_Q\times N_{SQ})=\log_2(N_Q)+\log_2(N_{SQ})} \qquad \textbf{(E-I-2.1, 2.2)}$$

As frequency (υ) is the inverse of the time interval (Δt) taken by a full cycle of a periodical physical process (including the full oscillation of a wave-like EQP like the photon is), $\upsilon=c/\lambda=1/\Delta t$, the energy of a single photon scalar $E_{ph}(\lambda)$ can be expressed as a function of this time interval (Δt):

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[4] As all the NGP interact by gravity, no matter if gravity is a quantized fundamental force (mediated by the hypothetical spin-2 graviton, as predicted by the quantum field theory [**QFT**]) or the curvature of the spacetime (as predicted by the General Relativity [**GR**]) or both (as explained by BIDUMv1.1)

$$\left[\nu = c/\lambda = 1/\Delta t\right] \Rightarrow \left[\begin{array}{l} E_{ph}(\nu) = h\nu \;\Leftrightarrow\; E_{ph}(\Delta t) = h/\Delta t \Leftrightarrow \\ \Leftrightarrow\; \boxed{h = E_{ph}(\Delta t)\cdot\Delta t \equiv PIq} \end{array}\right] \quad \textbf{(E-I-3.1, 3.2, 3.3)} \quad \textbf{(E-I-3.4)}$$

As a generalization, all the GBs[5] can be considered PIqua (location-and-momentum [PI] packs: LMIPs or shortly **IPs** [informational packs]). All the NGPs can be considered (generally parallel)PI-processors (each with a specific intrinsic PIq) that permanently interchange IPs with each other (they emit/receive IPs not continuously, but in a pulsated mode describable as 0/1 time series possibly similar to the Cantor set [7]).

The PIq (as previously defined in equations **E-I-2.2**, but also in **E-I-1.2**) can be theoretically measured in qbits (as any kind of sub/quantum information quantity, as only one bit can be extracted from the state of one qbit of PI) and supports addition and subtraction as standard algebraic operations. The total (rest and/or kinetic) PIq **(I_T)** of an NGP is obviously related to a (classical linear) time interval (Δt) of measurement (in a specific reference frame) and can be defined as a function of an intrinsic (internal) PIq (I_{int}) (as measured in the Δt interval or previously), an input (received) PIq (I_{in}) and an output (emitted) PIq (I_{out}) of that NGP such as:

$$\boxed{I_T(\Delta t) = I_{int}(\Delta t) + I_{in}(\Delta t) - I_{out}(\Delta t)} \quad \textbf{(E-I-4)}$$

As it cannot be exactly known how many qbits of intrinsic PIq are contained in any QP, a special (physical) qbit (p-bit or shortly pit) can be defined to measure PIq, as an integer multiple of the qbit (but with a [still] unknown/uncertain factor of multiplication):

$$\boxed{I_{[pit]} = E_{[J]}\cdot t_{[s]}} \Leftrightarrow \boxed{E_{[J]} = I_{[pit]}/t_{[s]}} \quad \textbf{(E-I-5.1, 5.2)}$$

$$\boxed{pit = J\cdot s = k_{pit}\left(states\ per\ pit\right) = \log_2\left(k_{pit}\right) qbits} \quad \textbf{(E-I-5.3)}$$

with **k_{pit}=?states per pit (an adimensional integer constant with an uncertain value)**

As it can be observed from equations **E-I-5.1, E-5.2** and **E-5.3**, the pit is equivalent (only by scalar value, and not necessarily by meaning) to the measure-unit of the (quantum) action and the (quantum) angular momentum (Js=J·s), and that's why the Planck constant (**h**) (which is standardly measured in Js) may be considered the electromagnetic (**EM**) PIqua of the EM force/ field (**EMF**) which is an essential PIqua of our universe (measurable in pits=Js). However, the (quantum) angular momentum conservation law becomes a **PIq conservation law (PICL)**, with the energy-mass equivalence and conservation principles becoming just special cases of this (general) PICL. In E_{ph} scalar, the relation between the PIq and energy is also obvious:

$$h \sim 6.626\times10^{-34}\ pits\ (= 6.626\times10^{-34}\ Js);\ \boxed{E_{ph}(\Delta t)_{[J]} = h_{[pit]}/\Delta t_{[s]}} \quad \textbf{(E-I-6.1, 6.2)}$$

As it can be observed in equations **E-I-5.2** and **E-I-6.2**, one can extract a hypothetical definition for energy as the PIq transfer speed (pits transferred per [unit of] a time interval [s]):

$$\boxed{E_{[J]} = \frac{I_{[pit]}}{t_{[s]}} \;\Leftrightarrow\; J = \frac{pit}{s} = \frac{k_{pit}\left(states\right)}{s} = \frac{\log_2\left(k_{pit}\right)\cdot qbit}{s}} \quad \textbf{(E-I-7)}$$

In this view, energy and matter are NOT fundamental as PI is, but they are just the result of measuring (in various ways) the PIq interchanged between the observer (including his measuring tools) and the physical system observed, but also the PIq transferred between the subcomponents of that system, both types of measurement being undertaken in a specific chosen time interval ($\Delta t = t_2 - t_1$). What is perceived physically as the "energy/matter of an observed system" (and/or through measuring tools which are the observer's body extensions) is the result of the capacity of the observed system (including the spacetime [vacuum] it occupies) to

[5] the (spin-1) gluon, the (spin-1) W^+/ W^-/Z bosons, the (spin-1) photon and the hypothetical (spin-2) graviton

transfer a specific PIq to the observer or the capacity of the observed subcomponents (of that system) to interchange a specific nof. IPs per unit of (subjective and/or objective) (classical linear) time interval. In conclusion, energy and matter may be generated by PIqua flows of different types (as explained later on).

Hypothesis H-I is a general principle that can also be applied to Einstein's (mass-energy) equivalence principle (**EEP**), as any energy and/or mass measurement must be related to a finite time interval ($\Delta t=t_2-t_1$, a time frame than can tend to 0 or to infinity, but cannot effectively reach these limits). In this informational view, Einstein's equivalence principle becomes just a particular case (the case in which $\Delta t \rightarrow \infty$, when matter turns to stable radiation composed of different GBs with potential infinite mean half-lives) of the more general/unified and profound PICL. The other extreme particular case ($\Delta t \rightarrow 0$) of hypothesis H-I is when Δt=Planck time interval $(tP)=[\hbar G/c^5]^{1/2}$ as the (hypothesized) minimum possible duration of a quantum process. Δt will be noted as "t" for the simplicity of the next sets of equations.

$$\boxed{I = E \cdot t} \qquad \textbf{(E-I-8)}$$

$$E = mc^2 \Leftrightarrow E \cdot t = (mc^2) \cdot t \Leftrightarrow \boxed{I = (mc^2) \cdot t} \text{ or } \boxed{I_E = I_{mc^2}} \qquad \textbf{(E-I-9.1, 9.2, 9.3, 9.4)}$$

The most general form of the PICL (as expressed in equation E-I-4) may be also applied to the info-energy-matter conservation principle (as expressed in equation E-I-9.4) as any QP probably emits and/or receives undetectable (hypothetical) gravitons independently to any possible additional EM radiation (and gravitons are hypothesized to generally have the same speed **c**[6] than the additional optional real/virtual photons), when it transforms into energy (which is generally and mostly EM energy/radiation plus [hard to detect] gravitational radiation). As gravitation cannot be shielded, it is inevitable that any form of matter emits and receives gravitons in the time interval in which it converts to energy, so that EEP scalar is not an exact mathematical equality but just a very accurate approximate equality (as the hypothetical gravitons may be closed strings that may escape the 5th dimension as the Super String Theories [**SSTs**] and M-theory [**MT**] predict). In the next equations, $N_{gr(in)(out/esc)}$ is the nof. hypothetical input/output (including escaped) hypothetical gravitons in the Δt interval and E_{gr} is the average energy of these gravitons.

$$\boxed{I_T(t) = I_{int}(t) + I_{in}(t) - I_{out}(t)} \Rightarrow \boxed{I_E(t) = E \cdot t + I_{E(in)}(t) - I_{E(out)}(t)} \; and \qquad \textbf{(E-I-9.5)}$$

$$\boxed{I_{mc^2}(t) = (mc^2 \cdot t) + I_{mc^2(in)}(t) - I_{mc^2(out)}(t)} \; and \qquad \textbf{(E-I-9.6)}$$

$$\boxed{E \cdot t + I_{E(in)}(t) - I_{E(out)}(t) = (mc^2 \cdot t) + I_{mc^2(in)}(t) - I_{mc^2(out)}(t)} \qquad \textbf{(E-I-9.7)}$$

$$\left.\begin{aligned} &E(\Delta t) = E + \left(N_{gr(in)(\Delta t)} - N_{gr(out/esc)(\Delta t)}\right) \cdot E_{gr} \\ &mc^2(\Delta t) = mc^2 + \left(N_{gr(in)(\Delta t)} - N_{gr(out/esc)(\Delta t)}\right) \cdot E_{gr} \\ &\left(N_{gr(in)(\Delta t)} - N_{gr(out)(\Delta t)}\right) \cdot E_{gr} << E \end{aligned}\right\} \Rightarrow \boxed{E(\Delta t) = mc^2(\Delta t)} \; AND \; \boxed{E \sim mc^2} \qquad \textbf{(E-I-9.8)}$$

[6] c is the speed of light in vacuum

Part 2. The informational quanta for the four known fundamental forces

Hypothesis II (**H-II**). We can also generalize that all the classical mass/charge-related non-I physical (scalar) invariants (such as the Newtonian universal gravitational constant[**G**], the Coulomb constant [$\mathbf{K_e}$], masses/charges of all QPs and the forces they exert etc.) that appear in the quantitative formulations of the (classical) physical laws are essentially scalar functions of different PIqua that generate them (for example, Planck constant [**h**] is the measure of the EM PIqua) and this fact may explain the products and ratios of these classical scalar invariants (energies/masses/charges) as "masking" additions and/or subtractions of PIqs measured as defined in equation E-I-1.1, such as:

$$\boxed{I(N_S)=\log_2(N_S)} \Leftrightarrow \boxed{I(N_{S1})+I(N_{S2})=\log_2(N_{S1})+\log_2(N_{S2})=\log_2(N_{S1}\cdot N_{S2})} \quad \textbf{(E-II-1.1,1.2)}$$

$$\boxed{2^{I(N_{S1})+I(N_{S2})}=2^{\log_2(N_{S1}\cdot N_{S2})}=N_{S1}\cdot N_{S2}} \equiv \boxed{E_1\cdot E_2} \equiv \boxed{m_1\cdot m_2} \equiv \boxed{q_1\cdot q_2} \text{ (logical equivalences)} \quad \textbf{(E-II-2)}$$

In the view of hypothesis H-II, (electrostatic/electromagnetic) Coulomb constant ($\mathbf{K_e}$) may be considered an indirect measure scalar function of the photon/EM PIqua ($\mathbf{h_{ph}[=h]}$). This scalar function can be expressed using the inverse of the (EM) Fine Structure Constant (**FSC**), α= 1/FSC (considering α=1/FSC a pre-designed adimensional constant, with another definition which is theoretically independent of h, as explained in the full BIDUMv1.1):

$$\boxed{K_e=f(h)=k_C\cdot h},\ with\ \boxed{k_C=\frac{c}{q_e^{\,2}(2\pi\alpha)}}\ and\ \boxed{\alpha=\frac{1}{FSC}=\frac{\hbar c}{K_e q_e^{\,2}}\left(\sim 137.036\right)}\ [7] \quad \textbf{(E-II-3.1, 3.2, 3.3)}$$

Analogously, the Newtonian universal gravitational constant (**G**) may be also considered an indirect measure scalar function of a hypothetical (electro)gravitational (**EGF**) Planck-like PIqua ($\mathbf{h_{eg}}$) of a hypothetical electrograviton (**eg**) having a scalar exactly analogous to K_e (this scalar analogy being the reason for calling this hypothetical graviton an "electrograviton"), considering $\not{\alpha}_G = 1/\alpha_G$ a pre-designed adimensional constant, with another definition which is theoretically independent of h (as explained in the full BIDUMv1.1):

$$\boxed{G=f\left(h_{eg}\right)=k_G\cdot h_{eg}},\ with\ \boxed{k_G=\frac{c}{m_e^{\,2}(2\pi\alpha)}}, \quad \textbf{(E-II-4.1, 4.2)}$$

$$\boxed{h_{eg}=\frac{h}{K_{eg}}=\left(\sim 1.58\times10^{-76}\ pit\right)},\ with\ \boxed{K_{eg}=\not{\alpha}_G/\alpha\left(\sim 4.182\times10^{42}\right)}\ and\ [8] \quad \textbf{(E-II-4.3, 4.4)}$$

$$\boxed{\not{\alpha}_G=\frac{1}{\alpha_G}=\frac{\hbar c}{G m_e^{\,2}}\left(\sim 2.85\times10^{44}\right)} \quad \textbf{(E-II-4.5)}$$

The equation E-II-4.1 is also a potential candidate for the hypothetical quantum ("big") G scalar which is probably a function of a gravitational Planck-like PIqua constant (h_{eg}). The energy scalar of a single eg with a frequency υ [$\mathbf{E_{eg}(\upsilon)}$] can be expressed in analogy with a single photon energy scalar [$\mathbf{E_{ph}(\upsilon)=h\upsilon=[E_{ph}(\Delta t)=h/\Delta t]}$] such as: $\mathbf{E_{eg}(\upsilon)=h_{eg}\upsilon=E_{eg}(\Delta t)=h_{eg}/\Delta t}$. K_{eg} (as defined in equation **E-II-4.4**) is an electrogravitational constant, named as such because it interconnects the EM and EG PIqua (h and h_{eg}). k_C (as defined in equation **E-II-3.2**) and k_G (as defined in equation **E-II-4.2**) are two analogous (secondary) constants defined to simplify the scalars $K_e=k_C\cdot h$ and $G=k_G\cdot h$ as functions of h and h_{eg} respectively. $\not{\alpha}_G$ is the inverse of the reduced gravitational coupling constant ($\mathbf{GCC}=\alpha_G$), which is considered a pre-designed adimensional constant, with another definition which is theoretically independent of h (as explained in the full BIDUMv1.1)

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[7] $\hbar = h/(2\pi)$ is the reduced Planck constant; K_e is the classical Coulomb (electrostatic) constant; q_e is the elementary (electric) charge; c is speed of light in vacuum

[8] m_e is the rest mass of the electron; c is speed of light in vacuum

The logical equivalence between the Planck-like EGF PIqua (h_{eg}) and the qbit (hypothesis H-III). Even if k_{pit} (as defined in equation **E-I-5.3**) has an uncertain numerical value, there is a method that can roughly estimate its value based on a plausible assumption/hypothesis that *the eg may carry at least one qbit of subquantum EGF-PIq, as the eg is a "wavicle" with (at least) 2 extreme space-dependent quantum states (x-polarized and y polarized eg): that's why h_{eg} (also measured in pits=Js) can be (logically) associated with one qbit (logical equivalence of minimal PIqs).* As the h_{eg} scalar can be (theoretically) measured in both pits and qbits, an approximation of k_{pit} and an estimation of h (measured in qbits, not just in pits) can be obtained (it's obvious from the next equations that pit is a huge multiple of the qbit and that a single h-based photon may theoretically carry a huge amount of EG-PIq):

$$\boxed{h_{eg} \equiv 2(ExtremeSubQuantumStates) \Leftrightarrow \log_2[h_{eg}] = 1qbit} \text{ (logical equivalence)} \qquad \textbf{(E-III-1)}$$

$$\boxed{h_{eg} \sim 1.6\times10^{-76}\, pits = 2(states) = 1qbit} \Rightarrow \qquad \textbf{(E-III -2.1, 2.2)}$$

$$\boxed{k_{pit} = \frac{2(states)}{1.6\times10^{-76}\, pits} \sim 1.25\times10^{76}\,(states\ per\ pit) \sim 253(qbits\ per\ pit)}$$

$$\boxed{h_{ph} = h = K_{eg}\cdot h_{eg} = K_{eg}\cdot 2(states)\left[\sim 8.4\times10^{42}\, states \sim 143qbits\right]} \qquad \textbf{(E-III-3)}$$

The rest energy/mass definition is indissolubly related to movement definition and that's why it is also (indissolubly) related to classical linear time definition (including the mean lifetime or the half-life of a QP). The generic PIq scalar (as expressed in equation **E-I-8**) can also be applied in the practical (mean) estimation of the intrinsic PIqua (at rest) [$\mathbf{I_{int(rest)}}$] of the other GBs, but also the $\mathbf{I_{int(rest)}}$ of the NGPs based on their resting energy/mass and their specific mean lifetimes (also measured as half-lives) (**hypothesis H-IV**). See **Table T-IV-1** and **Table T-IV-2.**

$$\boxed{I_{\mathrm{int}(rest)(mean)} = E_{rest}\cdot\Delta t_{mean\_lifetime} = \left(m_{rest}\cdot c^2\right)\cdot\Delta t_{mean\_lifetime}} \qquad \textbf{(E-IV-1)}$$

Table T-IV-1. The intrinsic (rest) PIqua of all the four GBs (generating all the four FFs) of our universe	
The (hypothetical) electrogravitational field/force (EGF) PIqua (h_{eg})	$h_{eg} \sim 1.6\times10^{-76}\, pits \sim \left[k_{pit}\cdot\left(1.6\times10^{-76}\right) states\right] = 1qbit, with \boxed{k_{pit} \sim 253qbits/pit}$
The electromagnetic field/force (EMF) PIqua (h_{ph}=h)	$h_{ph} = h \sim 6.626\times10^{-34}\, pits \sim 8.4\times10^{42}\, states \sim 143qbits$
The weak nuclear field/force (WNF) specific PIqua at rest (h_W and h_Z)	
The intrinsic PIq at rest of a single W^+/W^- boson (**h_W**) is a function of its rest mass (**m_W ~ 80.385±0.015GeV/c² [8,9]**) and its half-life (**t_W ~ 3·10⁻²⁵s**)	$h_W = (m_W c^2)\cdot t_W\left[\sim 3.86\times10^{-33}\, pits \sim 145qbits\right] \Rightarrow \boxed{h_W / h_{ph} \sim 5.8^*}$ *****as W-boson is considered a "heavy" photon, it carries almost 6 times more intrinsic PIq (at rest) than a photon
The intrinsic PIq at rest of a single Z boson (**h_Z**) is also a function of its rest mass (**m_Z ~ 91.1876±0.0021GeV/c[8,9]**) and its half-life (**t_Z ~ 3·10⁻²⁵s**)	$h_Z = (m_Z c^2)\cdot t_Z\left[\sim 4.38\times10^{-33}\, pits \sim 145qbits\right] \Rightarrow \boxed{h_Z / h_{ph} \sim 6.6^*}$ *as Z-boson is also considered a "heavy" photon, it carries almost 7 times more intrinsic PIq (at rest) than a photon
The strong nuclear field/force (SNF) specific PIqua at rest (h_{gl})	
For the **SNF**, the intrinsic PIq of a single gluon (**h_{gl}**) cannot be measured directly using the PIq scalar definition (such as the W and Z bosons which have non-0 rest masses), but can be measured indirectly (inversely) based on the known *SNF coupling constant* (**α_S**) which has a value close to 1 (practically ~137 times larger than FSC at rest)	$h_{gl} = (\alpha_S\cdot FSC)\cdot h_{ph} \sim FSC\cdot h_{ph}\left[\sim 4.8\times10^{-36}\, pits \sim 135qbits\right]$ $with\ \boxed{h_{gl}/h_{ph} \sim FSC \sim 1/137^*}\ and\ \boxed{h_{gl}/h_{eg} \sim 3\times10^{40}}$ *when compared to the photons and the W/Z-bosons, the gluons may be considered "(very) light" (special) photons, as a gluon carries ~137 times less intrinsic PIq (at rest) than a photon

Table T-IV-2. The intrinsic PIqua of the main (known) NGP of our universe	
The intrinsic PIq at rest of a single proton ($\mathbf{h_p}$) is as a function of its rest mass ($\mathbf{m_p \sim 0.938GeV/c^2}$ **[10]**) and its mean lifetime (with an experimental lower bound $\mathbf{t_p > 10^{31}}$ **years [11,12]**)	$h_p > \left[(m_p c^2) \cdot t_p \sim 4.7 \times 10^{28}\, pits \sim 6 \times 10^{104}\, states \sim 348 qbits \right]$, $with \boxed{h_p / h_{ph} > 7.2 \times 10^{61}}\ and \boxed{h_p / h_{eg} > 3 \times 10^{104}}$
The intrinsic PIq at rest of a single electron ($\mathbf{h_e}$) is a function of its rest mass ($\mathbf{m_e \sim 0.511MeV/c^2}$ **[13]**) and its mean lifetime (with an experimental lower bound $\mathbf{t_e > 6.6 \cdot 10^{28}}$ **years [14]**). Electrons can be considered "hyper" photons, with $h_e > 10^{54} h$ (this h_e gives them a non-0 rest mass and some common photon-electron proprieties)	$h_e > \left[(m_e c^2) \cdot t_e \sim 1.2 \times 10^{21}\, pits \sim 1.5 \times 10^{97}\, states \sim 323 qbits \right]$, $with \boxed{h_e / h_{ph} > 1.8 \times 10^{54}}\ and \boxed{h_e / h_{eg} > 7.5 \times 10^{96}}$

Checkpoint conclusion. This IDUM is different from other informational universe models/descriptions **[15,16,17,18]** as it offers an indirect theoretical way to measure the followings: **(1)** the intrinsic (essentially) subquantum PIq of any known QP; **(2)** all the PIqua of the four known **FFs** (including h_{eg} – the PIqua for a hypothetical electrograviton [eg] that is proposed as a scalar model for the hypothetical graviton [a spin 2 boson]); **(3)** a new definition of energy (as PIq transfer speed). All sources of energy can be (essentially) considered sources of PI (as energy is essentially PI): however PIq is not perfectly interchangeable with physical energy and (physical) matter (but a time-dependent quasi-interchangeable concept). Although apparently descriptive, this IDUM can also offer some important (predictive) reformulations and generalizations of classical and modern notions/concepts of physics. This IDUM tries to impose the PI concept (together with its powerful tool: the PIq scalar defined by hypothesis **H-I**) as a sine-qua-non (central/fundamental) component of any "mature" TOE to be discovered/proposed in the future. See **Table T-IV-3.**

Table T-IV-3. Important consequences of the PIq scalar and the four PIqua of the four FFs		
As this IDUM treats the four FF PIqua [$h_{(ph)}$, h_{eg} , $h_{W/Z}$ and h_{gl}] as central and more important that the energy/mass quanta, I argue that energy, force, mass and all their derivatives (together with their SI units of measurement which are essentially based on the kilogram) should be "inversely" redefined from this PIq scalar (as defined by **E-I-1.1** and denoted as "I") using also time intervals (denoted as "t") and linear/circular lengths/distances (denoted as "d"**)**	I(=E·t)	(pit=J·s)≡qbit
	E=I/t	(J=pit/s)≡qbit/s
	$P=I/t^2$	($W=pit/s^2$)≡$qbit/s^2$
	F=I/(d·t)	[N=pit/(m·s)]≡qbit/(m·s)
	$M=(I \cdot t)/d^2$	(kg=pit·s /m^2)≡qbit·s /m^2
The Planck constant (h_{ph}=h) is also the (central) PIq unit in the Planck (natural) Units System (**PUS**), a system which can be generalized for any other Planck-like (PIqua) constant (h_{gl}, $h_{W/Z}$ and h_{eg}) and called Planck-Like Units System (**PLUS**[h_x], such as PSU is the private case PLUS[h_{ph}]).	$PLUS(h_x), with \boxed{h_x \in \{h_{eg}, h_{ph}(=h), h_{W/Z}, h_{gl}\}}$, $with\ PUS = PLUS(h_{ph})$	
The coupling (α) constants (at rest) for the three non-EGF FFs can be generalized as a PIq-function (in analogy to FSC definition, but expressed as ratio of two different PIqs), as GCC is not a function of the $K_e q_e^2$, but is conventionally expressed as a function of Gm_e^2/c and h only.	$\alpha_f(\hbar_x) = \left[K_e q_e^2 / c \right] / \hbar_x, with \boxed{\hbar_x \in \{\hbar_{gl}, \hbar_{ph}(=\hbar), \hbar_{W/Z}\}}$, $\alpha_G = \left[G m_e^2 / c \right] / \hbar$	
The *Bekenstein bound (**BB**)* **[19,20,21]** (defined as the maximum PIq [I] [measurable in qbits or in the equivalent bits extracted from those qbits] contained in all the quantum states (N_Q) of a sphere that has a finite ray R and contains a finite energy E, when/if assumed that the perfect vacuum carries NO [additional] PIq) can be reformulated as a two PIqs ratio using an additional adimensional constant $\mathbf{k_{BB}=(2\pi)^2/ln(2)}$	$\underline{I \le \frac{2\pi E R}{\hbar c \ln(2)}} \Leftrightarrow \underline{\boxed{I \le \frac{\frac{(2\pi)^2}{\ln(2)} E \frac{R}{c}}{h_{ph}}}} \Leftrightarrow \underline{\boxed{I \le \frac{k_{BB} \cdot (E \cdot \Delta t_{R,c})}{h_{ph}}}} \Leftrightarrow$ $\Leftrightarrow \boxed{I \le \left[\frac{k_{BB} \cdot I_{(E,\Delta t_{R,c})}}{h_{ph}} = \frac{(2\pi)^2 \cdot \log_2(N_Q)}{h_{ph}} \right]}, I_{(E,\Delta t_{R,c})} = \ln(N_Q)$	
Analogously to PLUS(h_x) generalization, BB can be also generalized for any PIqua of the four FFs, including h_{eg} which counts the total nof. quantum and subquantum [micro]states Ns=N_Q x N_{SQ} (as the emission/reception of egs may generate all the possible subquantum energetic [micro]states [N_{SQ}] that can be "hidden" in a single quantum state of a QP).	$\boxed{I(E, \Delta t_{c,R}, h_x) \le \frac{k_{BB} \cdot I_{(E,\Delta t_{c,R})}}{h_x}}$, $with \boxed{h_x \in \{h_{eg}, h_{ph}(=h), h_{W/Z}, h_{gl}\}}$	
h can be considered a fundamental cutoff for which any QP with intrinsic PIqua > h will have a non-0 rest mass (as in the case of W/Z bosons, the leptons, the quarks, the nucleons etc.) and all the QPs with intrinsic PIqua ≤ h will have 0-rest mass (the photons, the gluons, and the hypothetical egs). By this h-cutoff, EMF (with its specific h PIqua) is profoundly related in fact to the triad of indissolubly related concepts: rest mass, classical linear time and gravity. If the intrinsic PIqua of all QP are pre-considered finite, an important consequence is that all QPs will finally decay (by finite lifetimes).	$\boxed{m_x \cdot t_x \le \frac{h}{c^2}}$ *for photons, gluons and egs*	
	$\boxed{m_x \cdot t_x > \frac{h}{c^2}}$ *for W / Z bosons, Higgs boson, neutrinos, leptons and quarks*	

Part 3. The global PI quanta of the white universe and its relation with the four known fundamental forces

The PIq scalar is a powerful theoretical tool that can also be applied at global scales (H-V). The PIq scalar can be used to calculate the main global PIqs of the (directly observable) "white" (finite) part of the universe (**WU**[9]). See **Table T-V-1.**

Table T-V-1. The main global PIqs of the WU (part A)	
The (apparently[10]) rest energy of the WU ($\mathbf{E_{arWU}}$) can be estimated using the recent measurements of the total (apparent rest) mass of WU ($\mathbf{M_{arWU}}$) **[22]**	$M_{arWU} \sim 1.45\times10^{53} kg \Rightarrow E_{arWU} = M_{arWU}c^2 \sim 1.3\times10^{70} J$
Based on $\mathbf{M_{arWU}}$ one may calculate an (Eddington's-number-like) hypothetical (maximum) number of proton-electron pairs (**pep**) (noted as $\mathbf{N_P}$) that may (theoretically) compose/generate integrally $\mathbf{M_{arWU}}$ (including neutrons, as they can be considered compact forms of peps[11]).Each pep may be considered a spacetime atom (**STA**) as it includes not only matter and energy (the energetically charged pep) but also the spacetime which the (resting or dynamic) pep may occupy (the definition of pep/STA in BIDUM).	$m_{pep} = m_p + m_e \Rightarrow$ $\Rightarrow N_P \sim M_{arWU} / m_{pep} \sim 8.7\times10^{79} (peps)$
By considering a (hypothetical) mean lifetime of the (apparently rest) WU ($\mathbf{t_{arWU}}$) larger than the lower bound of the mean lifetime of the proton (t_p) **[11,12]** ($\mathbf{t_{arWU}} > t_p$ no matter if WU is cyclic or not), one can estimate the (apparently at rest) intrinsic PIq of the WU (as a hypothetical inequality) based on $\mathbf{E_{arWU}}$	$t_{arWU} > [t_p > 10^{31} years] \Rightarrow$ $[I_{arWU} = E_{arWU} \cdot t_{arWU}] > [\sim 614 qbits]$
The (global expansion/inflation) apparent kinetic energy of WU ($\mathbf{E_{akWU}}$) (which is mainly due to gravity as EM radiation only had a significant contribution to the global inflation only when the WU was [very] young) is estimated at ~3/10(0.3) of the (apparent) rest energy of the WU ($\mathbf{E_{arWU}}$) **[23].** The apparent kinetic (global) PIq of WU (I_{akWU}) can be estimated based on $\mathbf{E_{arWU}}$ and $t_{WU.} > t_P$.	$E_{akWU} = 0.3E_{arWU} \sim 3.9\times10^{69} J$ $I_{akWU} = [E_{akWU} \cdot t_{WU}] > [\sim 612 qbits]$
The total (global) energy of WU ($\mathbf{E_{tWU}}$) can be estimated as the sum of the (apparent) resting energy of the WU ($\mathbf{E_{arWU}}$) and the (apparent) kinetic energy of the WU ($\mathbf{E_{akWU}}$). The total (global) PIq of the WU ($\mathbf{I_{tWU}}$) can be estimated as the sum of the (apparent) resting and kinetic PIqs of the WU (I_{arWU} and I_{akWU}).	$E_{tWU} = E_{arWU} + E_{akWU} \Rightarrow [I_{tWU} = E_{tWU} \cdot t_{WU}]$ $\Rightarrow [I_{tWU} = I_{arWU} + I_{akWU}] > [\sim 614 qbits]$
The global EGF-PIq (I_{egWU}) is in fact the apparent kinetic (global) PIq of WU (I_{akWU}), as $\mathbf{E_{akWU}}$ is mainly due to gravity (mediated by the hypothetical egs)	$I_{egWU} \sim I_{akWU} \sim (23.3\%) I_{tWU} > (\sim 612 qbits)$
I have called the rest and kinetic mass/energy/PIq of the WU (just) "apparent" ($[M/E/I]_{arWU}$ and $[E/I]_{akWU}$) because it is proven that the sum of the rest masses of the three protonic (up/down) quarks $\mathbf{m_{pq}}$(=$2\mathbf{m_{qu}}+\mathbf{m_{qd}}$) is only ~1.002% of the total proton (nucleon) rest mass ($\mathbf{m_p}$) and $\phi=\mathbf{m_{pq}}/m_{pep}$~1.001%. In conclusion, the real (global) rest PIq of the WU ($\mathbf{I_{rWU}}$) is in fact only the real (global) rest PIqs of all the up/down quarks and electrons from the WU ($\mathbf{I_{qeWU}}$) (which is only ϕ~1.001% of $\mathbf{I_{arWU}}$) AND (1-ϕ)~98.999% of $I_{ar}\mathbf{_{WU}}$ is in fact (also) kinetic/dynamic PIq generated by the kinetic energy of the all the gluons of the WU ($\mathbf{I_{glWU}}$) (as gluons may also be considered white/WU radiation). In this context, the real kinetic (global) PIq of the WU ($\mathbf{I_{kWU}}$) is in fact I_{kWU}(= I_{tWU} - I_{rWU}) ~ 99.23% of I_{tWU}, which is significantly larger than I_{akWU} (~23.1% of I_{tWU}). In conclusion, $\mathbf{I_{kWU}}$ **is** ~99% of $\mathbf{I_{tWU}}$ and is composed mainly from $\mathbf{I_{glWU}}$ and $\mathbf{I_{egWU}}$ in a proportion of about 3 to 1.	$m_{pq} / m_p \sim 1.002\% \Rightarrow \Phi = m_{pq} / m_{pep} \sim 1.001\%$ $I_{qeWU} = N_P [(m_{pq}c^2 \cdot t_{WU}) + h_e]$ $(I_{rWU} = I_{qeWU}) \sim (0.77\%) I_{tWU} > [\sim 607 qbits]$ $I_{glWU} = I_{arWU} - I_{rWU} = (1-\Phi) \cdot I_{arWU} \Leftrightarrow$ $\Leftrightarrow I_{glWU} \sim (76.153\%) I_{tWU} > [\sim 614 qbits]$ $I_{kWU} = I_{tWU} - I_{rWU} \sim (99.23\%) I_{tWU} \sim 3.3\times10^{184} qbits$ $I_{egWU} \sim I_{akWU} \sim (23.1\%) I_{kWU}$ $I_{glWU} \sim (76.8\%) I_{kWU} \sim 3 I_{egWU}$
The WU may be represented as a pep-based essentialised 3D graph with (N_{qe}=4NP) nodes* and four layers of internodes, one per each type of FF/GB flow (EGF, EMF, WNF and SNF). (*as each pep is in fact a tetrad of EQPs containing 3 up/down quarks and one electron)	$N_{qe} = 4N_P \sim 3.5\times10^{80} (NGP - nodes)$

[9] the White (part of the) Universe (**WU)** is conventionally defined as all the (finite) matter and (finite) energy/radiation that can be measured directly with the recent specific tools (WU is defined as "white" because also considering the dark/matter-energy hypothesis, as WU is complementary to this "dark" (part of the) universe [**DU**]

[10] the standard estimation of the WU rest mass ($\mathbf{M_{arWU}}$) is just "apparently" a rest mass, as it is generated by the sum of the rest masses of all the nucleons of all the atoms, which are quark-based and have ~99% of their masses determined by the kinetic energy of the gluons: in conclusion, $\mathbf{M_{arWU}}$ **is in fact a kinetic mass generated by the sum of the kinetic energies of all the gluons of the WU**

[11] each pep is in fact a tetrad of four EQPs: 3 up/down quarks and an electron [the lightest lepton] interconnected by all the four FFs; additionally, it is obvious that the protons outnumber the neutrons by far, as the stars [which have the hydrogen atoms as the major constituents] are the main contributors to $\mathbf{M_{arWU}}$

Part 4. The meta-PI-"gene" hypothesis and the materialization hypothesis

The meta-PI-"gene" hypothesis. On the qualitative (not just quantitative) aspect of PI, it's very plausible that I_{tWU} to be organized in multiple meta-layers as not all the qbits store the same type of PI (as the global PIqua is an informational map of energy-matter structures and functions/dynamics that can also be considered an universal operating system [**UOS**] analogous to those used in IT/computers): there are blocks of meta-PI (**mPI**) (also measured in qbits) that describe algorithms applied on other blocks of PI (of inferior grade) ("information about information" is meta-information [**meta-PI**]). **mPI** may describe groups of possible states and their successions/parallel associations. mPI may also contain algorithms/code lines that process basic input/output PI. mPI may be indexed as n-grade mPI [mPI(n)]: mPI(0) is basic input/output PI (basic input/output qbits of data usually carried by GBs), mPI(1) describes and even may process blocks of mPI(0) (as it may contain algorithms similar to a software subroutine), mPI(2) may integrate and coordinate all mPI(1) in super-subroutines and so on. However, this IDUM predicts that the maximum n (n_{max}) may be a finite natural number (as based on a global possible finite I_{tWU}), and mPI(n_{max}) is the analogous to a **UOS**, a macro-PI-"skeleton"/master-mPI in which all the other mPI($n<n_{max}$) are embedded and coordinated. As it can be seen, all types of mPI(n) are mathematical bodies/entities containing number or a combination of numbers and algorithms (composed of logical and other mathematical operations[**ops**]), which makes this BIDUM very similar to Tegmark's Mathematical Universe Hypothesis (**MUH**) **[24]** and may explain why all the EQPs of the same type have the same (probably perfectly identical) properties when tested in the same conditions: this apparent tautology (as one may argue that some QPs are defined as the same type of particle just because they show identical properties in identical experimental conditions) may be explained by the fact that, in this IDUM, all the particles of the same type correspond and are generated to/by the same type of mPI-"gene" with the same index (n), which functions like a "gene" that is used to produce multiple copies of the same fundamental particle. Using the **mPI-gene hypothesis**, this IDUM explains an re-brings in attention *Wheeler's one-electron-universe intuition*[**[,25]**]: in terms of PI, it is very plausible that the WU has only one mPI-gene for the electron (mPI[n_e]) from which a nof. energetic-materialized "copies" ($N_e=N_P$) were produced after the Big Bang. The same for the other EQPs.

The four-steps materialization of a PIqua (replication-dichotomization-materialization-particulation) hypothesis. The process of materialization of a PIqua can be analyzed as a four steps process: (**1**) the replication of the mPI-gene into a PIqua, in which the intrinsic PIq contained in that mPI-gene is copied into a replica (possibly stored in the observer/human consciousness [**OC/HC**]); (**2**) the software-hardware PIqua dichotomization in which the primary ("mother") PIqua splits in two secondary ("daughter") PIquas (software **sPIq** and hardware **hPIq**); (**3**) the energy-time splitting of the hPIq (by establishing a classical linear time construct, mind produces perceptible Equa from any hPIq); (**4**) the "particulation" process in which that specific **Equa** (produced from that PIqua) also decomposes into a specific particle with a specific rest mass (Mqua) that moves with a specific speed (v). In this view, I_{tWU} (stored in the vacuum) may be considered a "hard-disk" (a read-only-memory [ROM]: a phase space **[26]** which stores all the possibilities of any potential [dynamical] particle and process). The observer plays the role of a random-access-memory (RAM) unit that applies an algorithm that extracts PI from the ROM (by a copy-paste process [not a cut-paste process] similar to the living cell DNA/RNA transcription/translation which generates proteins from coding genes) and generate different dynamical particles (Equa) and processes with specific energies/frequencies/t-quanta (limited superiorly by the Planck frequency υ_P). The speed of light in vacuum (c) defines the Planck (maximum possible) frequency ($\upsilon_P=c/l_P$) of local retrieval/copying/replication of a specific PIqua from the global PIqua (I_{tWU}). The same i-quanta can theoretically decompose in a spectrum of all the possible variants of Equa ($\mathbf{E_q}$) and half-times($t_{1/2}$) with a probably Gaussian (natural) distribution (with a peak around the mean lifetime and the specific Equa of that measured/observed QP) and any external source of PI (including the mind and measurement tools of the observer) can influence the probability of each (E_q,$t_{1/2}$) possible combination: this may to explain the wave function collapse and that's why the question "Does the Universe Exist if We're Not Looking?"[**[4]**] (the participatory universe hypothesis) may be legitimate**[27,28]** as the most recent experiments**[29]** confirm (legitimate in the energetic sense, not in the PI sense, as the PIqua may pre-exist in the vacuum long before the moment of a specific observation).

The EQP-microchip/microprocessor hypothesis. Each EQP may be a quantum microchip (with both a software/code and a hardware, a form of micro/sub-universe of the WU analogously to a software application

being a subroutine of the UOS, a microchip that can receive, process and emit/output PIquas (mPI[0]) as responses to any external PI "stimuli".

Essentially, BIDUM sustains the Simulation Hypothesis (SH) [30] by which WU and HC are parts of a simulated reality based on PIq gradients (measurable in qbits or any other potential PIq units). In the absence of a mature theory to explain the existence and functioning of the human consciousness (HC), all the types of TOE produced by HC may be flaws generated by incomplete self-knowledge.

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