One number that encodes fundamental constants of nature

Author's name: Alexander N. Balatsky

E-mail: a.n.balatsky@gmail.com

The paper explores an algebraic pattern that describes physical reality exclusively in terms of dimensionless quantities. This pattern reveals a spatial limit that gives rise to all fundamental constants of nature, underpins its physical structure and determines the principles of its conservation.

Keywords: causality; cosmology; gravity; space; time

1. The fundamental limit

In addressing certain challenges faced by fundamental physics, the paper relies on the idea of an originary numeric nature to the world order. It was Migdal who gave us a perfect clue as to how we might develop this idea. It was suggested [1, p. 139] that gravity and electrodynamics might be interconnected as follows: $\alpha \cdot \ln\xi \sim 1$, where $\alpha = \frac{e^2}{\hbar \cdot c}$ is the fine structure constant and $\xi = \frac{\hbar \cdot c}{G \cdot m^2}$ is a typical 'large number.' The departure point for this assumption is that the five fundamental physical constants (Newton's constant G, light speed c, Planck's constant $\hbar$, the electron mass m, and the electron charge e) can yield only two independent quantities: α and ξ. Mathematically, $\alpha \cdot \ln\xi = 1$, if $\xi = e^{\alpha^{-1}}$; to unfold this identity into a full-fledged analytical framework, the paper relies on the following recursion:

$$(\alpha) \cdot \left(e^{\alpha^{-1}}\right) \cdot \left(\alpha \cdot e^{\alpha^{-1}}\right) \approx \omega \cdot 10^{115} \tag{1}$$

where $\omega = \mathrm{W}(1) \approx 0.567 \ldots$ W is the Lambert function defined as the function that solves the equation $z = \mathrm{W}(z) \cdot e^{\mathrm{W}(z)}$). Of specific interest is that between $-e^{-1}$ and 0 the function has two values $y, \bar{y}$ (Fig. 1) that exhibit consistent mirror anti-equality, implying both chirality and complementarity (two quantities complement each other if they constitute a complete system and each quantity has a unique property that another ultimately misses, e.g., right and left). Given that argument precedes function value, $x \in [-e^{-1}, 0)$ can be thought of as a causal variable that underpins two mutually complementing physical objects, e.g., clockwise and counter-clockwise rotating spins y and $\bar{y}$; therefore, the triad $x, y, \bar{y}$ describes a perfect equilibrium at which a physical process ($x \longmapsto y$) and its exact reverse ($x \longmapsto \bar{y}$) completely cancel each other out.

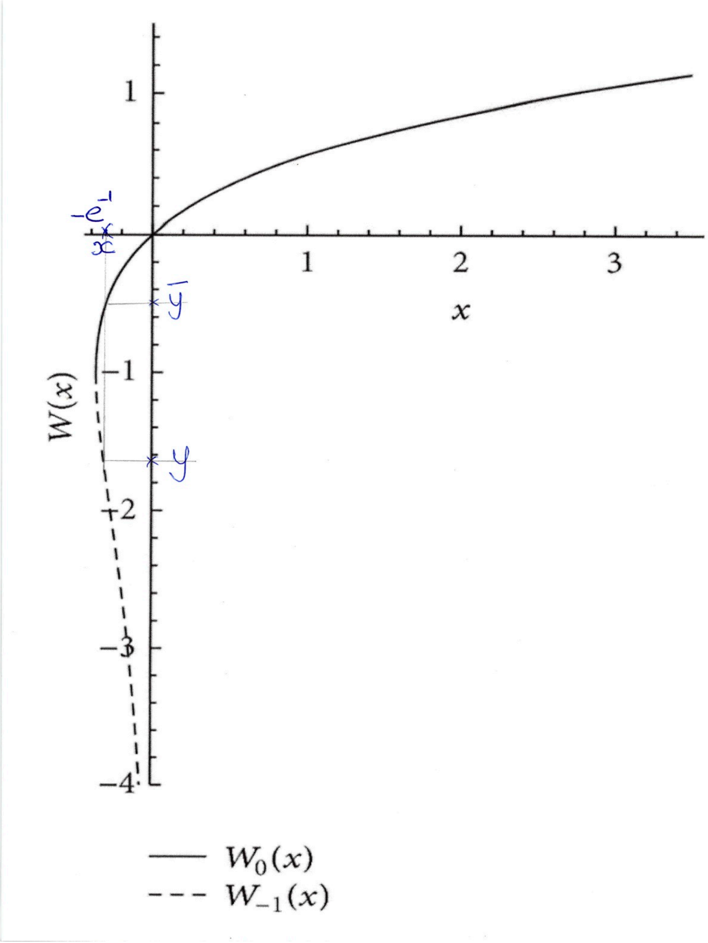

Fig. 1. The Lambert function and its two branches

Mathematically, if x is known, then y and $\bar{y}$ are also known at once; in physics, the things are different: two mutually complementing physical entities cannot be measured and therefore known simultaneously: it is impossible to foreknow which spin will be left-handed and which right-handed until it becomes observable. For that very reason, quantum mechanics relies fundamentally on probability. Of specific relevance to quantum physics is the branch point of the Lambert function $(-e^{-1}, -1)$. The number $1 - e^{-1} \approx 63.2\%$ determines the probability that a permutation of many elements will have at least one fixed point (an element equal to its image), which means that a quantity remains invariant under transformations, implying self-similarity (self-identity). In physics, the number $|-e^{-1}|$ determines the time constant ($\approx 36.8\%$) that is used to measure the thermal responsiveness of a physical system while the number $1 - e^{-1}$ determines change in the energy state of physical system: it determines the time it takes the output of an electric process to change by $\approx 63.2\%$ of the peak-to-peak amplitude on every phase transition. Thus, the number $-e^{-1}$ somehow connects electrodynamics, invariance, probability, self-similarity, thermodynamics and time; which forces us to take a closer look at the branch point in question.

If the causal variables $x \in [-e^{-1}, 0)$ describe a statistical behaviour of physical objects, then the branch point $(-e^{-1}, -1)$ describes a chiral twist in this behaviour, which is mathematically relevant to a bifurcation into two fundamental singularities, negative and positive ones. That is, the bottom branch of the Lambert function W_{-1} tends to $-\infty$ as x tends to 0^- (negative singularity) while, at the same time and for the same x, the principal branch of the function W_0 tends to $+\infty$ (positive singularity). Mediating between $\pm\infty$, this twist necessarily implies the sign interchange $\pm$ that exists by virtue of 0. Here we should pause to note that, mathematically, 0 arises from $-e^{-1}$: 0 lies exactly between the numbers $+1$ and -1; these numbers are full (additive and multiplicative) inverses of each other, which is what the Lambert function makes explicit: $-1 = \mathrm{W}(-e^{-1})$, $+1 = \mathrm{W}(e\ )$. Thus, the Lambert function describes a physically interpretable statistical distribution of the causal variables $x \in [-e^{-1}, 0)$; its branch point determines the left boundary of the distribution and by the same token yields 0; therefore, one of these variables, an exceptional one, necessarily describes a physical limit. To reveal that limit, we need to find an exact solution of Eq. 1:

$$(x) \cdot \left(e^{x^{-1}}\right) \cdot \left(x \cdot e^{x^{-1}}\right) = 10 \cdot \omega \cdot 10^{114} \tag{2}$$

Solving this equation reveals that it has three real roots; all of them derive from the omega constant ω only:

$$\mp x_{1,2} = \mp R_w = - \mathrm{W}_0{}^{-1}\ (\pm R_w^{-1}) \text{ and } x_3 = \alpha_w = - \mathrm{W}_{-1}^{-1}(- R_w^{-1}) \tag{3}$$

where $R_w = \alpha_w \cdot e^{\alpha_w^{-1}} = |\sqrt{10 \cdot \omega}| \cdot 10^{57}$ (in what follows, upper-case letters denote the macro-scale of the universe while lower-case ones its micro-scale). Note that the third root $x_3 = \alpha_w \approx 7.29739 \ldots \cdot 10^{-3}$ is remarkably close to the currently accepted value of the fine structure constant $\alpha_c \approx 7.29735 \ldots \cdot 10^{-3}$ ('c' (reads 'current') is interpreted as the running value of a physical quantity; $\alpha_w = \alpha_c$ implies a state of equilibrium). Equilibrium is complete coincidence of an object with itself; such state can be attained via a series of identity transformations, implying approaching self-similarity (which is precisely what the modus operandi of the Lambert function implies and this becomes perfectly obvious if we represent the function as a series of continued logarithms). Self-similarity of a unique specimen (say, R_w) can be written formally as follows: $R_w^{-1} \cdot R_w = 1$. The physical meaning of this identity reveals itself via the fine structure constant. Given the frequency-like nature of this quantity, the left-hand terms of Eq. 2 can be thought of as describing three pillars of mechanics: contraction-extension (x), rotation ($e^{x^{-1}}$) and translation ($x \cdot e^{x^{-1}}$), where $x = \alpha_w$. Thus, $R_w = \alpha_w \cdot e^{\alpha_w^{-1}}$ can be thought of as defining an upper limit of translational force and R_w^{-1} its lower limit: the minimal wavelength, contributing to the zero-point energy and describing the lowest energy state of physical void.

2. Quantum interactions

Of relevance to quantum mechanics is that the limit in question explains how fermions and bosons can be bridged. It is considered that fermions make up matter and take up space; they have half-integral spins and obey the exclusion principle, implying that fermions can have either left- or right-handed spin, but not both at once. Bosons carry energy; they neither make up matter nor take up space; they have integral spin and do not obey the exclusion principle. The causal variable $x \in [-e^{-1}, 0)$ yields two non-integer values y, $\bar{y}$, associated with non-integer single-valued spins and describing the asymmetric behaviour of fermions. The Lambert function also tells us that for the same real argument there exists an infinite number of complex multiple-valued solutions $\mathrm{W_n}(z)$, where $\mathrm{n} \in \mathbb{Z}$. These solutions can be associated with the integer values of spins and multiple degrees of freedom, which is fit to describe bosons' symmetric behaviour. Mapping the asymmetry of fermions into the symmetry of bosons, this construct depicts quantum dynamics as arising from a particle-like asymmetric distribution of the causal variables (associated with fermions and the past), amplified by oppositely directed higher order field-like symmetric correlations (associated with bosons and the future). The lower limit of this process is $\pm R_w^{-1}$ and its upper limit is $\mp R_w$; here, the sign interchange does not mean that physical energy can be negative or positive; what it (the sign) means is that physical energy arises from clockwise and counter-clockwise spin rotation, resulting in two counter-rotating quantum domains of the universe. Mathematically, these two domains are interconnected via the branch point $(-e^{-1}, \mathrm{W}(-e^{-1}))$, implying a physical equilibrium via which quantum separation occurs. Thus, the causal variables $x \in [-e^{-1}, 0)$ describe quantum information, associated with fermions; the branch point corresponds to a chiral twist via which this information increments and bifurcates, so that the resulting energy fluxes are mutually compensated and the total entropic balance within the system remains constant; a series of the resulting successive equilibriums ensures a smooth variation in the order of magnitude, standing behind the energy transfer within the space-and-time continuum.

The construct just sketched distinguishes between two types of infinity: spurious (secondary) mathematical infinity and genuine (primary) physical infinity. The former derives from the imaginary mathematical nothing 0 (null), implying symmetry and reversibility; the latter derives from the real physical nothingness R_w^{-1} (zero), implying asymmetry and irreversibility. Fundamentally, such distinction is bound up with the question of whether time is reversible or irreversible, which gives us a clue as to how we can re-address the concept of time.

3. Clocks and time

Time is associated with change and duration. According to Eq. 2, change takes its rise in the contraction-extension of the electron α_w (the time-rate of the electron), which results in rotational and translational motions of quantum particles. Physically, this equation describes a transition of quanta from the initial state of the universe $\pm R_w^{-1}$ to its boundary state $\mp R_w$, implying cause and effect, respectively. Given that it takes duration to bridge these states, time can be defined as an imaginary mathematical quantity that determines duration, rate of change and direction of rotation of real physical objects as they pass from cause to effect. The roots of Eq. 2 (α_w, $\mp R_w$) tell us that the clockwise and counter-clockwise quantum domains $\mp R_w$ are synchronized via the same mathematical variable α_w. Since these domains are interconnected in a chiral manner, an observer in either domain recognizes physical processes in the counter-rotating domain as rotating in opposite direction. Thus, from the perspective of that observer, time flows as if in two directions at once; and therein arises a contradiction: mathematical physics depicts time as reversible and symmetric, but time as we perceive it is asymmetric and irreversible; it always passes from cause to effect and never in the reverse, as our life experience and the second law of thermodynamics tell us.

Thus, differently rotating quantum particles evolve into two mutually compensating counter-rotating quantum domains; the causal order of that evolution is determined by the causal variables $x \in [-e^{-1}, 0)$. If all these variables take the value of null ($x = 0$) and do not change, then we adopt the concept of spurious time (clock-time), as is currently the case in physics. Such time describes a world in which entropy increases when clock hands are moving; accordingly, when clock hands stay put, it is considered that entropy remains constant, which is at odds with what is observed in reality: actually, we observe that entropy monotonically increases with time and it cannot be otherwise, because time, genuine time, irreversibly passes. It is therefore reasonable to differentiate between spurious clock-time and genuine time. Clock-time is strictly limited to equilibrium situations: it depicts a real dynamical process as an idealized approximation of successive equilibriums. Real physical dynamics derives from and occurs in non-equilibrium environments only, implying that the causal variables $x \in [-e^{-1}, 0)$ cannot but change (otherwise, physical motion could not be possible). Thus, genuine time is relevant to real irreversible information increment while clock-time to an imaginary state at which this information bifurcates, creating a logical hiatus that allows us to distinguish between the past and the future states of the universe.

4. The roots of conservation

What makes the roots of Eq. 2 particularly relevant to physics is that they can be interpreted in terms of certain conservation laws. The invariance of α_w implies the law of conservation of energy and homogeneity in time (translation symmetry); the invariance of $\mp R_w$ implies the law of conservation of linear momentum and homogeneity of space (the symmetry of translational forces). As it follows from the equation, the former (time) and the latter (translational forces) are bridged via rotation ($e^{\alpha_w{}^{-1}}$), which perfectly conveys the meaning of the law of conservation of angular momentum and isotropy of space. It is not immediately evident, but to interpret these laws in terms of quantum mechanics, we need to consider all four remarkable algebras: the one-dimensional real numbers, the two-dimensional complex numbers, the four-dimensional quaternions and the eight-dimensional octonions.

The real numbers describe a one-dimensional distribution of the causal variables over the real axis, implying real physical objects; the imaginary numbers describe change of these variables in time, implying the imaginary nature of time. Given that the information that describes space-like and time-like constituents of physical energy originates from the same point zero that mathematically concurs with 0, it is natural to describe the dynamics of the space-and-time continuum in terms of the complex numbers, which means that physical conservation is effectively two-dimensional, implying squaring (note that the complex number multiplied by its conjugate always yields a non-negative real number; that is, energy remains real under any transformations, which conveys the meaning of the first law of thermodynamics: energy can be neither created nor destroyed, but only changed from one form to another). The next milestone in that construct is the algebra of quaternions; it adds three-dimensionality, rotation and irreversibility, but the quaternions are irrelevant to causality. It is the algebra of octonions that extends the quaternions to causality; and that is where the non-associativity of the octonions becomes indispensable (the octonions are neither real nor commutative nor associative, implying imaginariness, irreversibility and causality, respectively). In what follows, the paper shows how exactly that eight-dimensional algebraic structure connects time, gravity and translational forces at both macroscopic and microscopic scales of the universe.

The mathematical formalism provided by the eight-dimensional algebra allows us to define a quantum state of a physical object as follows:

$$\pm\Delta + \alpha_w i + G_w j + R_w k + \Omega l + m_w il + l_w jl + t_w kl = \psi_w \tag{4}$$

According to our convention, $\pm\Delta$ implies that the universe comprises two counter-rotating quantum domains $\pm R_w$; this delta stands for the value of displacement (relative to 0, the only exact middle between R_w and $-R_w$) while its sign indicates direction of rotation of the physical object; the terms *i, j, k, l* are imaginary units such as $i^2 = j^2 = k^2 = l^2 = -1$; and ψ_w denotes the quantum state of the object.

To remind, the time-like microscopic α_w and the space-like macroscopic $\mp R_w$ constitute an algebraic triad ensures synchronization of all translational (inertial) forces via rotation. Given that macroscopic and microscopic units are interconnected in a manner of mathematical reciprocity, we are able to determine the microscopic unit of rotation via its macroscopic equivalent $e^{\alpha_w{}^{-1}}$ as follows $\alpha_w = \ln^{-1}(e^{\alpha_w{}^{-1}})$. Physical theory claims that gravity is essentially a curve in the geometry of the space-and-time continuum caused by mass; such claim makes it possible to associate $e^{\alpha_w{}^{-1}}$ (rotation) with gravity; accordingly, its micro-equivalent α_w can be associated with the gravitational mass of the electron. That is, the time-rate of the electron α_w uniquely specifies its gravitational mass: $\alpha_w = m_w$, establishing a mathematical identity between time and matter (which is parallel to the equivalence principle, claiming that inertial mass is proportional to gravitational mass). Given that gravity is associated with rotation, we are able to claim that Eq. 2 describes the following causal connection: time (contraction-extension) precedes gravity (rotation) and both precede translational (inertial) forces. Thus, whenever one claims that masses of physical particles create gravitational fields, this should not be understood in the sense that mass *causes* gravity; quite the opposite: it is gravity that causes mass. Clearly enough, until that causal connection and the causal nature of time remain unrevealed, it is impossible to differentiate the effects of inertia-translation from those imposed by gravity-rotation. To appreciate this claim, take a look at the fourth term of Eq. 2 ($\Omega = R_w^2 = \omega \cdot 10^{115}$). Given the physical meanings of the left-hand terms, its right-hand term Ω can be interpreted as the duration it takes gravity to shape the physical structure of the universe; that is, to bind the quantum information that ensures a translation of quantum particles from $\pm R_w^{-1}$ to $\mp R_w$. Conceptually, the fourth term complements time with duration, making it possible to turn the notion of time-rate into a full-fledged concept of time that combines change with duration: time as we know it. Completely balanced by its constituents and fully accounting for their contributions to the total energy content of the universe, the fourth term Ω can be thought of as a cosmological constant: it bridges the zero-point energy of void (the 'micro') and the total energy content of the universe (the 'macro') as follows: ${R_w}/{R_w^{-1}} = R_w^2 = \omega \cdot 10^{115}$, which clarifies the essence of the cosmological constant problem.

Thus, Eq. 4 translates the classical laws of physical conservation into the terms of quantum mechanics, namely, α_w is associated with conservation of energy and homogeneity in time; m_w with conservation of angular momentum and isotropy of space; l_w with conservation of linear momentum and homogeneity of space; t_w stands behind their synchronization (the microscopic units of mass, length and time are defined as follows: $m_w = \ln^{-1} G_w$ (mass), $l_w = \ln^{-1} R_w$ (length), $t_w = \ln^{-1} \Omega$ (time), where $\Omega = R_w^2$, $G_w = e^{\alpha_w^{-1}}$, $R_w = \alpha_w \cdot e^{\alpha_w^{-1}}$). In terms of geodesics, Eq. 4 describes how exactly time causes matter to gravitate towards the point of their common origin in the shortest way possible, which bridges the principles of causality, least time and least action. In terms of topology, Eq. 4 describes a rotation of quantum objects on a double twisted surface on which it takes two circuits to compensate the contribution of their zero-point energies, as Eq. 3 tells us: $\mp R_w = -\mathrm{W_0}^{-1}\ (\pm R_w^{-1})$, explaining why electrons, and other fermions, return to their original orientation after 4π −rotation in space: such type of rotation strikes exact balance between the identities shared by coupled objects, such as fermions and their chiral twins.

Time runs at different rates; every quantum system operates at its own time scale; gravity and translational forces are synchronized via time at all scales of the universe. Time and gravity are in inverse exponential dependence: $G_w = e^{\alpha_w^{-1}}$. Gravity causes mass; the time-rate of the electron α_w plays an exceptional role in setting the identity between time and matter $\alpha_w = m_w$. Time and gravity precede translational forces. The operational range of gravity exceeds that of translational forces by $\alpha_w^{-1} = {G_w}/{R_w}$. The quantity α_w^{-1} is amenable to interpretation in terms of Boltzmann's entropy formula: $S = k \cdot \ln W$. Given that $W = G_w$ is the number of all possible quantum states and that void itself produces neither translational motion nor action ($k = 1$), $S = \alpha_w^{-1}$ can be interpreted as the free (initial, negative) entropy of the electron, its gravitational potential, implying a measure of information that is to be bounded to produce the entire energy content of the universe. Mediating between time and matter, gravity compartmentalizes unbounded quantum information, associated with entropy (which is what the second law of thermodynamics essentially implies). That is, gravity serves the entropic debt via creating order in advance of thermodynamic processes; to exclude any possibility for these processes to collapse, this service is designed to run in an uninterrupted manner, which is why it is mathematically impossible for gravity to take the value 0: there is no x to satisfy $e^x = 0$.

5. Quantum entanglement

The phenomenon of quantum entanglement has long been a stone of stumbling in physics (a quantum pair is said to be entangled if each object of the pair cannot be described independently of the other and these objects are perfectly correlated to each other, no matter how distant they are from each other, e.g., if one spin is right-handed, then its paired spin is invariably left-handed). Such 'spooky' correlation has long been haunting theoretical physicists, because no information can travel faster than the speed of light. The explanation is simple: no information transfer is required to *know* the states of the entangled pair, because this information underpins the gravitational contour of the universe at the level of the causal variables $x \in [-e^{-1}, 0)$. That is, if neither y nor $\bar{y}$ causes each other and the two are mutually correlated, then there must exist their common cause, which is what their common argument x implies: mathematically, x determines y and $\bar{y}$ simultaneously and independently from each other. The states y and $\bar{y}$ cannot be measured simultaneously, but this impossibility in no way entails that they cannot be known simultaneously. Understandably, similar difficulties arise when it comes to the principle of quantum superposition, claiming that until a quantum object remains unobserved, it exists in all states at once. It is true that until certain quantum information remains hidden, it is impossible to observe which spin is left-handed and which is right-handed, but this does not entail that spin rotates in all directions at once. The exact direction of that rotation becomes observable when quantum separation occurs, implying that certain statistical condition has been fulfilled and certain information has been released. Then, it becomes possible for observers to observe what is observable in the domain of their original handedness. Such event concurs with the branch point $(-e^{-1}, \mathrm{W}(-e^{-1}))$, implying a separation of formless void into two counter-rotating quantum domains, which is manifest in a π −turn between 1 and −1 ($e^{2\pi i} = 1 = \mathrm{W}(e\ )$ and $e^{\pi i} = -1 = \mathrm{W}(-e^{-1})$) or, we may say, between two mathematically indoctrinated infinities $\pm\infty$. Physics addresses this event in terms of continuous mathematics, which makes the wave function reduction (ψ −collapse) mathematically unavoidable: responding to discontinuity, any continuous function necessarily fails to evince its continuity (though, the root cause of that reduction lies deeper: the effect (null) consistently declines to be identified as the cause (zero), implying that calculus excludes any possibility of addressing causation). To the above, it may be added that it is a common practice for physicists to address the probability of a quantum event as the modulus squared of its amplitude ($|\psi|^2$). This trick allows negative probability to be excluded from the equations of quantum mechanics, but the reverse side of that convenience is that it forecloses a possibility of inquiring into the physical meaning of that very probability; and the same holds for infinity: many efforts have been made to expunge the symbol '∞' from the equations of physics, but this tactically correct move remains futile as long as the physical meaning of mathematical infinity remains unexplored. Obviously, when we start to distinguish between imaginary null and real zero, everything falls into place and division one by zero becomes physically meaningful. This operation yields neither infinity nor indefiniteness, it yields everything: $R_w = (R_w^{-1})^{-1}$, implying the maximum of physically realizable force R_w

that is actualized in the process of becoming Ω, which can be written formally as follows: $R_w = R_w^{-1} \cdot \Omega$.

Given that zero is real, physical container of information can never be annihilated. This means that there always exists a possibility for information exchange, which is what the third law of thermodynamics implies: the absolute zero (null, complete stasis) is physically unattainable. Mathematically, physical dynamics derives from a causal connection between the alpha constant α_w and the omega constant ω. Because of irrationality of these numbers, one can combine them infinitely often, which is a problem for hard sciences: infinity is not amenable to measuring. In addressing this difficulty, it is semantically correct to rely on the concept of self-similarity (double negation), which makes it possible to address physical theory in terms of finiteness.

6. The fundamental interactions

All syntactic information that describes physical reality is encoded in numbers, the rest is meaning. In particular, it is the meaning of self-similarity that is crucial to explain the fundamental physical interactions. The point is that the self-similarity of space-and-time ($R_w^{-1} \cdot R_w = 1 = \alpha_w^{-1} \cdot \alpha_w$) derive from the same invariant ω, which allows us to address space-like and time-like constituents of reality in terms of a common framework; at the heart of that framework lies the identity of time and mass $\alpha_w = (\alpha_w^{-1})^{-1} = m_w$. Formally, a parity between two variables, say, α_w and ω can be written as follows: $\frac{\alpha_w \cdot \omega}{\alpha_w} = \omega = \frac{\alpha_w \cdot \omega}{\alpha_w}$. Mathematically, the number ω and the number e are interconnected as follows: $\omega \cdot e^{\omega} = 1 = \omega^n \cdot e^{n\omega}$ $(n \in \mathbb{Z})$, which makes it possible to deduce an analytical relation between the time-rate and the mass of the electron:

$$\frac{\alpha_w \cdot \omega}{\alpha_w} \cdot e^{\alpha_w \cdot \omega / m_w} = 1 = \frac{\alpha_w \cdot \omega}{m_w} \cdot e^{\alpha_w \cdot \omega / \alpha_w} \tag{5}$$

It is not immediately obvious, but the middle term of Eq. 5 exactly equals the macroscopic radius of the electron $R_e = 1$. Here we should clarify the line of reasoning underpinning this deduction, and those that are to follow. The macroscopic units are associated with their microscopic equivalents; in particular, it is reasonable to associate the maximum of physically realizable action R_w (the macro-equivalent of the quantum of action) with the speed of light. In physics, the radius of the electron is as follows: $r = \alpha \cdot \lambda$, where $\lambda = {}^{\hbar}/_{mv}$. Given that the macroscopic equivalent of the speed of light is $v = c = R_w$; $\alpha = \alpha_w, m = \alpha_w$, $\hbar = R_w$, we can determine the macroscopic radius of the electron as follows:
$R_e = \alpha_w \cdot \alpha_w^{-1} = 1$. Next, the parity of reasoning allows us to extend Eq. 5 into the field of other elementary physical particles as follows:

$$\frac{\alpha_w \cdot \omega}{\alpha_p} \cdot e^{\alpha_w \cdot \omega / m_p} = R_p = \frac{\alpha_w \cdot \omega}{m_p} \cdot e^{\alpha_w \cdot \omega / \alpha_p} \quad (6)$$

where α_p, m_p, and R_p are the time-rate, the mass and the radius of an elementary physical particle (p). Mathematically, one can calculate the time-rates and radii corresponding to the unique masses of distinct elementary physical particles by substitution into Eq. 6 of appropriate values given in the units of the electron-masses. As it follows from these substitutions, each unique mass has two real roots; that is, any elementary physical particle constitutes an algebraic pair, consisting of two conjugated quantities interconnected via the electron joint $R_e = 1$ (Table 1).

Table 1. The time-rates (α_p, A_p^D) and radii (R_p, R_p^D) of certain remarkable elementary particles (R_e and r_e are the electron radii at the macro- and micro-scales, respectively)

The elementary particle	α_p	R_p	A_p^D	R_p^D
…			…	…
'Dark' proton			≈ 0.00039…	≈ 10.43…
'Dark' pion			≈ 0.00049…	≈ 8.59…
'Dark' gamma-quantum			≈ 0.00055…	≈ 7.67…
Electron (*e*) and its 'dark' twin	$= \alpha_w$	= 1 (R_e)	≈ 0.00256…	≈ 2.84…
Gamma-quantum (γ)	≈ 1…	≈ 0.00414… ($2r_e$)		
Pion (π^+)	≈ 2…	≈ 0.00207… (r_e)		
Proton (p^+)	≈ 13.4…	≈ 0.000309…		
…	…	…		

Table 1 describes an algebraic pattern designed in such a way that for every elementary physical particle its time-rate increases as its radius decreases in one realm while in the other realm the time-rate decreases as the radius increases, so an action in one realm reciprocally induces a counter-action in the other, in such a way that these realms unceasingly induce each other; this means that right-handed and left-handed low-energy microscopic domains exist simultaneously, remaining interconnected via the electron joint R_e; in bridging these domains, R_e serves as an attractor towards which differently rotating quantum particles tend to evolve. Step by step, physicists explore the microscopic world that surrounds them (left lower part of Table 1) while its inverse remains a dark side of the universe amenable only to crude approximation (right upper part of Table 1). Next, the logic suggested allows us to deduce major dimensionless quantities of the electron (Table 2).

Table 2. Major dimensionless quantities of the electron

Quantity	Macro-scale	Micro-scale	Source formula
Quantum of action ($R_w, \hbar_w$)	$\alpha_w G_w$	$\alpha_w \omega$	See below
Classical radius (R_e, r_e)	1	$\approx \frac{\hbar_w}{2}$	$r = \lambda\alpha$
Gravitational radius (R_g, r_g)	2	$\approx \frac{\hbar_w}{2}$	$R_g = \frac{2Gm}{v^2}$
Compton wavelength (Λ_w, λ_w)	α_w^{-1}	$\approx \frac{\omega}{2}$	$\lambda = \frac{\hbar}{mv}$
Charge ($-, e_w$)	$-$	$\approx \pm\sqrt{2\alpha_w^2\omega}$	$\hbar = \frac{e^2}{\alpha v}$
Bohr radius (A_0, a_0)	α_w^{-2}	$\approx \alpha_w^{-1} \cdot ½\omega$	$a_0 = \frac{\hbar}{mv\alpha}$
Angular momentum (for a circular Bohr's orbit, L_e, l_e)	G_w	ω	$L_e = mva_0$
Ratio 1: quantum of action to angular momentum	α_w	α_w	
Ratio 2: classical radius to Compton wavelength	α_w	α_w	

Here we should explain how we define the microscopic velocity v and the microscopic quantum of action $\hbar_w$. The microscopic velocity is defined as follows: $v = \frac{l_w}{t_w} \approx 2.000264$ ... further referred to as ≈ 2, which is the classical representation of velocity of a material body moving in Euclidean space: distance divided by time. The micro-quantum of action is defined as follows: $\hbar_w = \alpha_w \cdot \omega$, which can be interpreted in the following way: α_w is the reciprocal of the Compton wavelength of the electron $\Lambda_w = \alpha_w^{-1}$, given the frequency-like nature of α_w, this quantity can be thought of as describing the changeability of the quantum vortex in time while the angular momentum of the electron ω (Table 2) stands for its rotational invariance, implying the angular momentum conservation. From the above, it follows that the micro-quantum of action sets a one-to-one correspondence between individuated ($\propto \alpha_p$) values of the time-rates of the physical (quantum) particles and the angular momentum of the electron. Thus, the quantum of action of a microscopic quantum participle (p) is defined as follows: $\hbar_p = \alpha_p \cdot \omega$. To define the gravitational radius of the electron (R_g, r_g), we rely on Schwarzschild's equation (Table 2); appropriate substitutions are as follows: $G = G_w, m = \alpha_w, c^2 = R_w$ (the macro-scale) and $G = \omega, m = \alpha_w, v^2 = 4$ (the micro-scale), respectively. Note that Schwarzschild's solution is relevant to stasis, which is what the concept of equilibrium $\alpha_w = \alpha_c$ implies. Also, note that two ratios (the lower part of Table 2) are put in the table to highlight the exceptional role of the alpha constant in bridging physical fundamentals: $\frac{R_w}{G_w} = \alpha_w = \frac{\hbar_w}{\omega}$; in terms of the omega constant: $\frac{\hbar_w}{\alpha_w} = \omega = \frac{\hbar_w}{m_w}$.

In principle, if the Compton wavelength (λ_p) of an elementary physical particle is known, one can calculate its microscopic radius as follows: $r_p = \lambda_p \cdot T_p \cdot R_p$, where the right-hand terms are the Compton wavelength (microscopic dimensional), the time-rate and the radius of the elementary physical particle (macroscopic dimensionless), respectively. Given Table 1 and the data obtained through empirical research [2], one can calculate the radii of any elementary physical particle, for example, for proton ≈ $\frac{0.842...}{1000}$ fm, pion ≈ $\frac{0.585...}{100}$ fm, electron ≈ $\frac{2.818...}{1}$ fm, which makes it possible to bridge dimensional physical quantities with their dimensionless equivalents (the factor of ten should be taken into account).

Physical interactions arise from differences in energy levels between quantum particles with a universal tendency to the lowest energy level, implying equilibrium. Given that $R_e = \alpha_w \cdot \alpha_w^{-1} = 1$ is a mathematical manifestation of physical equilibrium, and drawing on Table 1, it is logical to assume that the fundamental physical interactions should be based on the following reciprocation: if the value of the Compton wavelength α_c^{-1} increases then the value of the time-rate α_c decreases (in this case, the strong nuclear forces prevail: they conserve atom's integrity and provoke gain in gravity); the weak nuclear forces act in a reciprocal manner: they stimulate nuclear decay and compensate gain in gravity. To give the above a concrete physical footing, take a closer look at the four remarkable elementary physical particles (Table 1). These particles specify the ranges of action of the fundamental forces that are manifest in their time-rates and radii for: (i) the electro-magnetic forces that act within the electron e and the gamma-quantum γ layers (α_w, 1 and 1, 2r_e); (ii) the strong forces that act within the γ and the pion π^+ layers (1, 2 and 2r_e, r_e); and (iii) the weak forces that act beyond the Yukawa potential, restricted by the π^+ and the proton p^+ layers, where the latter (the proton-layer) closes the gravity loop via the radius of the proton and the zero-point energy R_w^{-1}:

$$R_{proton} \approx G_w^{-1} \cdot 10^{56} \tag{7}$$

From the above, it follows that the electro-magnetic and nuclear forces constitute a single translational force: they act within different energy layers that are manifest in different time-rates and therefore in different quanta of action. The above explicates that the weak interactions constitute the weakest link in the gravity contour of the universe as against the strict determinism inherent in the electro-magnetic and strong forces, which is manifest in the attractor $R_e = 1$. Thus, the attractor epitomizes a perfect order that exists as if outside physical environment. Which needs to be explained: the very notion of dynamics makes sense only if it is measured up against a fixed frame of reference being at absolute rest; such frame cannot be physical part of its physical environment—absolute rest can exist only in imagination, implying $\alpha_c = \alpha_w$. Therefore, physical dynamics is possible only if

$\alpha_c \neq \alpha_w$, which means that α_c describes realities of the world while α_w its perfect imaginary order.

Cosmologically, the difference between α_c and α_w ($\approx 4 \cdot 10^{-8}$) determines the curvature of the universe: ${R_c}/{R_w} \approx 1.000746 \ldots$ given that $\alpha_c \approx 7.29735 \ldots \cdot 10^{-3}$. That is, the universe is very close to being flat but is not completely flat. The energy that ensures perfect order is associated with its surface area, but surface area increases at lower rate as compared to its volume. Since the universe is restricted in space, such irreconcilability can be resolved either through a collapse or through a deliberate canalization of energy into nuclear fission. Which is what the fermion-boson coupling implies: formation of matter runs via a series of twisted reversals of quanta in the course of which appropriately scaled local equilibriums are sequentially settled and mechanical peaks of translational forces are sequentially localized, which is manifest in the peaks (twists) of the nuclear reaction: $\mathrm{H} \ldots \rightarrow \mathrm{C} \leftarrow \mathrm{N} \rightarrow \mathrm{O} \ldots \leftarrow \mathrm{Fe} \rightarrow \ldots \leftarrow \mathrm{Ag} \rightarrow \cdots \leftarrow \mathrm{Au} \rightarrow \cdots \leftarrow \mathrm{Tl}\ (\mathrm{P}(\mathrm{Tl}_{208}) = \mathrm{W}(e) - e^{-1} \approx 63.2\%) \leftarrow \mathrm{Bi} \rightarrow \mathrm{Po}\ (\mathrm{P}(\mathrm{Po}_{212}) = |-\ e^{-1}| \approx 36.8\%) \ldots$ where P (element) is the probability of the element decay bracketed. The bismuth (Bi) twist holds a special position in that chain: it serves as a critical threshold through which the time-rate of the electron yields a qualitative shift in the process of nuclear formation, which is what a connection between r-process (rapid neutron capture) and s-process (slow neutron capture) highlights: Bi –twist terminates the slow neutron capture so that all heavy nuclei after bismuth are built via the rapid neutron capture only.

To gain a further insight into the mechanism of nuclear formation, it would be helpful to address the following recursive construct:

$$\begin{array}{ll} -x^{-1} & \mapsto \mathrm{W}(-x^{-1}) = -1 \mapsto \mathrm{W}(-1) \mapsto \alpha\text{–}point\ (\rho \approx 137 \cdot 10^{-2}\ and\ \varphi \approx 103°) \\ \updownarrow & \\ x & \mapsto \mathrm{W}(x) = 1 \mapsto \mathrm{W}(1) = \omega \mapsto \omega\text{–}point\ (1 +\ \omega i) \end{array} \qquad (8)$$

where $x = e$ is the base of natural logarithms; $\mathrm{A} \mapsto \mathrm{B}$ reads as A gives rise to B; the two different forms (polar and rectangular) that describe the $\alpha-$ and $\omega-$based branches are used for a clearer representation of the following double helix pattern:

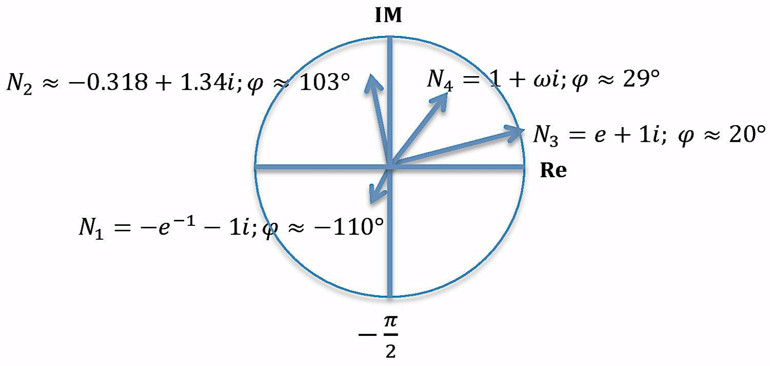

Fig. 2. The initial twist of the double helix pattern

The upper $\alpha -$ branch yields the time-rate of the proton ($\Im(N_2) = T_{proton} \cdot 10^{-1}$) and the gravitational potential of the electron ($\mathrm{mod}(N_2) = \alpha_w^{-1} \cdot 10^{-2}$); multiplying the boundary numbers of this pattern immediately yields the radius of the proton: $N_1 \cdot N_3 = (-e^{-1} - 1i) \cdot (e + 1i) = -(e^{-1} + e)i,$ or in terms of polar coordinates, $\rho \approx 3.09 \ldots \approx R_{proton} \cdot 10^4;\ \varphi = -\boldsymbol{\pi}/\mathbf{2}$ (emphasis added; R_{proton} defines the point of reverse of the quantum vortex (Eq. 7)). Thus, the pattern immediately yields the time-rate and the radius of the proton, scaled in accordance with the factor of ten (the logic of this research assumes that this factor is an arithmetic simplification of π^2, interpreted as an arc length corresponding to the central angle of 180° given that $r = \pi$, which is the shortest way to connect opposites, implying perfect spatial equilibrium). Also, note that that pattern describes the structure of both the ordinary and 'dark' hydrogen (the radius of the 'dark' electron: $R_e^D = T_0 \cdot e^{T_0^{-1}} \approx 2.84 \ldots$, where $T_0 = \alpha_w^{-1} \cdot 10^{-2} \approx 1.37 = \mathrm{mod}(N_2)$), assuming that the hydrogen atom is the first shape drawn from the primordial void.

Concurring with the proton-neutron contact area, R_{proton} is characterized by an anomalously huge gravitational steepness (Table 1), which emerges in a response to the influx of free neutrons, corresponding to the maximum of the magnetic-mechanical momentum of translational forces. This mechanical pressure is sequentially compensated via a series of successive equilibriums as the whole process is orchestrated by the proton-electron relationship. Which explains why electric and magnetic fields move at right angles: this orthogonal property is predetermined by the mutual arrangement of the time-rate of the electron and the radius of the proton (Fig. 2). This orthogonal property is parallel to Brewster's law, claiming that perfect polarization occurs only if reflected and refracted influxes are set orthogonally to each other. The perfect polarization of the neutron influx occurs at the angle corresponding to $\cos \varphi_d = 10 \cdot T_{proton} \cdot \alpha_w = \Im(N_2)/\mathrm{mod}(N_2)$, which is the primordial angular displacement φ_d against the symmetry of the attractor (Fig.2). To this, it may be added that individually canalized quantum information is strictly related to the bismuth twist and therefore to other elemental abundances of the periodic table, such as the iron peak, which means that all physical processes are invariant under any transformations.

Gravity causes masses of all physical particles and twists all translational (inertial) forces together, which makes it reasonable to take a closer look at the gravitational radius of the electron (Table 2). This quantity is $R_g = 2R_e = 2$ (macro-scale) while its micro-equivalent exactly equals the classical radius of the electron: $r_g \approx \frac{\hbar_w}{2} = r_e$; that is, the gravitational and classical microscopic radii of the electron concur with each other. The physical meaning of the former relationship ($R_g = 2$) is that the macroscopic gravitational radius of the electron contains twice the physical degree of freedom of the electron, implying that the universe comprises two quantum domains, right-handed and left-handed ones. The latter relationship ($r_g = r_e$) implies that the mass of every particle, in each domain, is determined in terms of gravity via the classical radius of the electron $\frac{\hbar_w}{2}$, equivalently, via the quantum of action of the electron $\hbar_w = \alpha_w \cdot \omega$ or, in terms of electrodynamics, via the electric charge of the electron $\pm\sqrt{2\alpha_w^2\omega}$.

Thus, two counter-rotating quantum domains unceasingly induce each other in a deterministic manner: the $-e^{-1}-$ based probability holds in both quantum domains; either domain works as well as the other, but due to the initial conditions one species sooner or later become more numerous than the other, and then the more numerous species, marked with the same handedness, ineluctably become dominant in the domain of their original handedness. Therefore, conventional electrons, in each domain, outnumber conventional positrons, which is why positrons can be conceived as the electrons that rotate in reverse; so, it is natural to associate positrons with the electrons that move as if backwards in time. Accordingly, any physical process exists only in parallel with its chiral counterpart that evolves as if backwards in time. Given that time is associated with direction of rotation of quantum particles, it becomes obvious why physical theory associates time reversal with changing the positive mass of a physical particle into the negative one. Of worth noting is that the very term 'negative mass' is an oxymoron, let alone the term 'massless particle.' Such oxymoronic logic arises because of ignorance of the modus operandi of time and gravity: time synchronizes counter-rotations of the left- and right-handed quantum domains via gravity; gravity gives rise to mass in both domains; each domain operates on the basis of its initial handedness; as for everything else, each domain works as well as the other. It is true that the electro-magnetic force has never been observed to flow backwards, but it is also true that physics distinguishes between the negative and positive electric charges, which is manifest in the bi-polarity of the electric charge of the electron $\pm\sqrt{2\alpha_w^2\omega}$, implying that the entire electrodynamics derives from an alternation of left- and right-handed spins. To this, it may be added that some atoms are marked with positive (such as bromine) and some (such as lithium) with negative charge domination; different charges attract each other, which results in the formation of almost neutral molecular structures. The universe however has not so far collapsed into stasis; quite the opposite: the energy of void does not dilute over time, but consistently sustains enduring existence of the universe. And perhaps it is already obvious why all three fundamental symmetries (C, particle-antiparticle interchange; P, parity reversal and T, time reversal) hold only at once: these symmetries arise from the same logical pattern, remaining anchored to the gravitational radius of the electron, equivalently, to the fundamental limit of the universe.

7. Gravitating around oneness

All physical interactions are synchronized to each other via the macroscopic angular momentum of the electron G_w, implying multiple degrees of freedom, and its microscopic complementarity ω, implying single degree of freedom. All quantum particles are characterized by individuated quanta of action ($\propto \hbar_p = \alpha_p \cdot \omega$) that are strictly anchored to the physical limit of the universe R_w^{-1}. It is precisely the individuated values of the quantum of action that ensure invariance of all fundamental physical forces in both space and time, and by the same token allow all particles to be kept apart as they pass via the attractor $\mathrm{R_e} = 1$ that bridges differently rotating microscopic domains through the dark interstellar void. In the neighbourhood of the attractor the strength of gravity steeply increases as the time-rate of the electron decreases in the same abrupt manner (Table 1), implying that time dramatically slows down; that is, the self-organization within a quantum system intensifies as the system tends to restore its disturbed equilibrium.

Of specific interest to physics is that the above gives us sufficient grounds to formulate the law of conservation of the universe. Compactly, such law can be written as follows: $(\pm R_w^{-1})^0 = 1$, implying that the zero-point energy of void is conserved via the attraction and repulsion of differently rotating quantum particles around the attractor; and exactly the same can be formulated in terms of 0: $\ln\Omega^{-1} + \ln\Omega = 0$, where $\Omega = R_w^2$, implying that the initial and boundary states of the universe are reciprocally squared with each other or, we may say, fundamental physical constants are perfectly tailored to square the initial and boundary states of the universe. In classical physics, this conservation law reveals itself via a relationship between centrifugal and Coulomb forces: $\frac{mV^2}{r} = \frac{e^2}{r^2}$. Addressed in terms of appropriate dimensionless quantities (Table 2), this identity yields $\frac{8}{\omega} = \frac{8}{\omega}$, re-written as $\frac{8}{\omega} \cdot \frac{\omega}{8} = 1 = \frac{8}{\omega} \cdot \frac{\omega}{8}$, it aptly highlights the meaning of the attractor.

8. Returning to origin

The above makes it possible to address the deepest riddle of cosmology: what is the ultimate fate of the universe? Physics gives us three mutually exclusive scenarios: the universe is either open and expands forever or close and eventually collapses; otherwise, it is flat and neither expands nor shrinks. The construct suggested pieces these scenarios together: it is a combination of the future (openness, symmetric bosons), the past (closeness, asymmetric fermions) and the present (flatness, their connecting equilibrium) that makes it possible for the self-referential universe to alternate clockwise and counter-clockwise rotations, remaining invariably anchored to its fundamental limit $|R_w^{-1}| = \left(\left|\sqrt{10\omega}\right|\right)^{-1} \cdot\ 10^{-57} \approx 42 \cdot 10^{-59}$.

Ultimately, a permanent rotational motion of a material object, say a distinct planet, results in irreversible matter splitting, which is manifest in crystal dislocations, occurring until a single crystal loses its individuated identity, becoming a structure-less specimen. The more complex a system, the more information connections it contains, which ensures higher resistance to destruction, but, ultimately, decomposition of matter is irreversible. As time does its work, the surface of the planet becomes more uniform; as it becomes more uniform, it needs less energy and information to stay in equilibrium. This process occurs until all matter of the planet turns into a uniform radiation, implying stasis $\alpha_c = \alpha_w$. When α_c and α_w become equal, change and stasis become one. At that moment, the last quantum of once living matter dissipates into nothingness where a new star and a new life are to be born, but in a new time—if time comes to end in one spatial enclave of the universe, it will certainly arise in another one, which means that cosmos as the entire physical universe can never reach a state of ultimate stasis.

Of relevance to the second law of thermodynamics is that entropy (unbounded information) and gravity (bounded information) are bridged via time; as long as the time-rate of the electron and its gravitational potential are reciprocally interconnected, their product remains constant: $\alpha_w \cdot \alpha_w^{-1} = 1$, where α_w is the time-rate of the electron and α_w^{-1} its gravitational potential, its free entropy. Gravity controls entropy throughout both the aeon of ascent ($\alpha_w \longmapsto \alpha_c$) and the aeon of descent ($\alpha_w \longleftarrow\!\shortmid \alpha_c$). The difference between the ascending and descending phases of a cosmic cycle is that in the former case entropy sustains genesis of matter while in the latter case it sustains decomposition of matter; in both cases, the rate of incoming entropy is synchronized to gravity via time.

Thus, time and matter systematically nullify each other, but what reconciles this annihilation with life is that life perpetuates itself via information, implying that there is no material force that is able to destroy all life in the universe: if information becomes disconnected from its material carrier, it remains connected to its underlying pre-material void, which ensures an enduring possibility for information to be preserved. To complete, it would perhaps be appropriate to note that the construct just sketched assumes that every quantum originates from and comes back the omega point, implying that it is the omega constant that underpins all fundamental constants of nature.

References

1. Migdal, A. B. Auf der Suche nach Wahrheit: e. Physiker erzählt (Verlag Mir; Leipzig; Jena; Berlin: Urania-Verlag, 1990).
2. Mohr, P. J., Taylor, B. N., Newell, D. B. (2012). CODATA recommended values of the fundamental physical constants, Rev. Mod. Phys.84, 1527–1605; Henley, E. M., Garcia, A. Subatomic Physics (World Scientific Publishing: Singapore, 2007).