Geometrical appearance of circumference as statistical consequence

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Abstract— ***Because identical fermions (elementary particles with rest mass) have (except spacetime coordinates) exactly the same features everywhere, these are (per proper time) a multiple mapping of the same. This mapping also leads to the geometrical appearance (of spacetime) and it provides a set of possibilities from which can be selected (like "phase space") within proper time. Selection of possibilities means information. Selection in simultaneous (elementary seen therefore 2), equiprobable possibilities means elementary information. New selection of possibilities means decision resp. creation of information. This paper should motivate to a more consequent information theoretical approach (not only in quantum mechanics but) also towards spacetime geometry. It is a supplement to previously published material [O2], where it was shown that proper time is proportional to the sum of return probabilities of a Bernoulli Random Walk. The probabilities at every point in such a walk result from "OR" operation of incoming paths. The probability of a "AND" operation at a certain point can be interpreted as meeting probability of two simultaneous and independent Bernoulli Random Walks. If no direction is preferred (p=1/2), after n steps this meeting probability (of two simultaneous independent Bernoulli Random Walks resp. BRWs) in the common starting point goes for large n to 1/(2πn), which is the inverse of the circumference of a circle with radius n. So if a BRW pair denotes two commonly starting simultaneous independent BRWs (each with p=1/2), after n steps (in case of large n) in the average 1 of 2πn BRW pairs meet again in its original starting point. Likewise due to the limited speed of light our knowledge of surrounding is the more delayed, the greater the distance n is. Therefore there are the more (geometric) possibilities of return (2πn possibilities for multiples of the same fermion on a circle with radius n), the greater the distance (the radius) n is. This shows a basic example for a connection between statistical results and geometrical appearance.***

Keywords — Bernoulli Random Walk, BRW, quantum physics, statistics, circumference, circumferential length, circle, geometrical appearance, spacetime geometry

1. Introduction

The preparation of a physical experiment predefines the set of its possible results (domain), and the result of every experiment provides information. So fundamental physics should be the initial science about information. Macroscopic information is usually not identical, but at best "similar". So physics should also introduce the term "similar information", e.g. similar "distance", as statistical, macroscopic consequence which secondary leads to geometrical appearance.

Nevertheless geometrically starting approaches to physics are up to now (2022) still in common due to their practicability for description of macroscopic appearance. Differential calculus[1] over geometrical (spacetime) coordinates is often a matter of course, but we know that this is imprecise and that it allows completely wrong extrapolations[2]. Even for microscopic experiments the geometric term "particle" is still common. So there is clearly the danger to overinterpret geometric terms and pictures[3].

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[1] The term "wave function" is a typical example. For well-founded physics, however, there is missing information (which can be "copied" from past), and this leads to properties of a random walk (BRW, see below). Secondary this also has statistical properties which are very interesting, because derivations and overlapping of BRWs can lead to wave like appearances. It is very recommendable to derive the current models from this, it can explain much more.

[2] Geometric approaches are not only invalid in the small scale. The measurements show clear deviations (from general relativity) also in the very large scale, so that further terms like "dark matter" were postulated. Instead of introducing such terms to justify geometric approaches, it is more reasonable to analyze the limit of validity statistically, like (or in connection with) the limit of the range of the strong interaction, (see section 6).

[3] It should be mentioned that extrapolation and overinterpretation of geometry forms the basis of "materialistic" view of life. This viewpoint is not only restricted, it is wrong - without foundation. It ignores the primary precondition for information exchange (and measurement): The necessity of an ordered common set of possibilities which is primary (primary domain PD) and has (by definition) minimal count of (common) elements, but is accessed with maximal frequency, see below.

There is no need for discussion (e.g. about "wave–particle" duality) - because results of measurements provide *information,* it is long overdue to *derive geometry* from a more fundamental information theoretical basis. Geometry is only a quickly derived first approximation of a subgroup of measurement results. Due to quantum physical results we know that measurements play a determining role (at once demonstrable in the microscopic world). This means that we need an approach where the (later complex) selection of a possibility from a set of possibilities (measurement = acquisition of information) plays a determining role. Of course we need also such an approach to space-time geometry (even if it is more complicated because the set of possibilities changes with the speed of light[4]). This paper should recall this and provide first hints.

---> Discrete simulations of interesting basic algorithms (as shown in section 8 and [O3]) could provide further hints and are recommended for research.

There are important basal questions: How are possibilities generated and selected under strict consideration of long term symmetry (and resulting conservation laws) *from the beginning*, so that the macroscopic (within proper time multiple mapping of "particles" resp. possibilities with) appearance of spacetime results? What are the consequences?

Due to quantum physical results it is reasonable to assume that geometry of spacetime has a discrete (and statistical) origin. A basal geometric feature is the nontrivial proportionality factor 2π between radius and circumference of a circle. Here we show a short statistical approach to this proportionality factor.

2. Approach

A Bernoulli Random Walk[5] is generated by a sequence of independent trials or "steps" [Fe] [Sp], each one of which can have two results, e.g. "positive" (with probability p) or "negative" (with probability 1 - p). We can interpret it as model for the movement of a particle in a one-dimensional lattice of equidistant points or "states" which are indexed by an integer coordinate k. With every trial the particle makes a step from point k to point k + 1 with given probability p ("positive direction") or a step from point k to point k - 1 with probability 1 - p ("negative direction"). As in [O2] for $n \in \{1,2,3,...\}$ we denote by Q0P(n, k, p) the probability, that the particle is at point k after the n-th step and by Q0P(0, k, p) this probability before the first step. We assume start of movement at k = 0, so Q0P(0, 0, p) = 1 and Q0P(0, k, p) = 0 for k ≠ 0 and furthermore

$$Q0P(n+1, k, p) = p\, Q0P(n, k-1, p) + (1-p)\, Q0P(n, k+1, p) \qquad (1)$$

When making n trials, point k is only within reach, if n - k and n + k are non-negative even numbers. We will presuppose this subsequently. There are exactly n!/(((n+k)/2)! ((n-k)/2)!) paths with (n+k)/2 steps in positive and (n-k)/2 steps in negative direction, which lead into point k after the n-the step. They respectively have the probability $(1-p)^{(n-k)/2}\, p^{(n+k)/2}$. So the chaining of these Bernoulli trials results into the binomial distribution

$$Q0P(n,k,p) := \frac{(1-p)^{(n-k)/2}\, p^{(n+k)/2}\; n!}{\left(\frac{n-k}{2}\right)!\left(\frac{n+k}{2}\right)!} \qquad (2)$$

Subsequently assume assume p=1/2 and define $Q0(n,k) := Q0P(n,k,\frac{1}{2}) = \frac{n!}{\left(\frac{n-k}{2}\right)!\left(\frac{n+k}{2}\right)!\; 2^n}$ (3)

By BRW we denote a Bernoulli Random Walk with p=1/2. Due to p=1-p and so equal probability of both alternatives its probability distribution is symmetric.

Q0(n,k) represents probabilities in case of p=1/2. In the symmetry center we get $Q0(n,0) = \frac{n!}{\left(\frac{n}{2}\right)!\left(\frac{n}{2}\right)!\; 2^n}$ (4)

[4] The *minimal* common set of possibilities resp. primary domain "PD" must be accessed in extemely high frequency, see first estimations in sections 6, 7 and 10.

[5] The one dimensional Random Walk approach is a simplification, but it already shows important details, which are transferable to reality. The approach in **section 8 and [O3]** is multidimensional and directly related to Maxwell's Equations.

Fig. 1 shows the Q0(n,k) which represent the probabilities of a BRW (Bernoulli random walk with p=1/2).

n ↓ \ k->	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	
0										1										*1/1
1									1		1									*1/2
2								1		2		1								*1/4
3							1		3		3		1							*1/8
4						1		4		6		4		1						*1/16
5					1		5		10		10		5		1					*1/32
6				1		6		15		20		15		6		1				*1/64
7			1		7		21		35		35		21		7		1			*1/128
8		1		8		28		56		70		56		28		8		1		*1/256
9	1		9		36		84		126		126		84		36		9		1	*1/512

...

Fig. 1 Probabilities of a BRW (symmetric Bernoulli random walk with probabilities p=1-p=1/2 for both sides). The probabilities in the central column k=0 are underlined. Conservation laws suggest a natural privilege of these central states. The probabilities of the inflowing paths are in the columns with k=-1 and k=1.

The probabilities of the 2 (left and right) paths into the center are

$$Q0(n-1,1) = Q0(n-1,-1) = \frac{(n-1)!}{\left(\frac{n-2}{2}\right)!\left(\frac{n}{2}\right)!\ 2^{(n-1)}} = Q0(n,0)\frac{\left(\frac{n}{2}\right)!\left(\frac{n}{2}\right)!\ 2}{\left(\frac{n-2}{2}\right)!\left(\frac{n}{2}\right)!\ n} = Q0(n,0) \tag{5}$$

It is $Q0(n,0) = \frac{1}{2}Q0(n-1,1) + \frac{1}{2}Q0(n+1,1)$ because Q0(n,k) is an OR-operation of both incoming paths (from Q0(n-1,k+1) plus from Q0(n-1,k-1)). This defines a BRW.

Suppose that two BRWs (BRW1 and BRW2) start simultaneously and are stepping simultaneously.

First we assume that the sum of all k is constant (symmetry around k=0, conservation law). In this case we know: If k increases in BRW1, then k decreases in BRW2, and reverse. If at start k=0, there is complete symmetry. We can assume that one of both BRWs moves freely and the other totally depends on it. If one BRW arrives at k=0, then also the other. So the meeting probability is the return probability of a BRW:

$$Q0(n,0) = Q0(n-1,-1)/2 + Q0(n-1,1)/2 \tag{6}$$

Now suppose that two BRWs again start in k=0 and step simultaneously, but step directions (k+1 or k-1) are done independently. Let Q0AND(n,k) denote the meeting probability of two such BRWs with independent step directions. In this case the probability that one arrives after n steps at k=0 is Q0(n-1,-1)/2, and that the other arrives at k=0 is Q0(n-1,1)/2. Because steps are done independently, the probability Q0AND(n,0) that both meet in k is due to (5):

$$Q0AND(n,0) = \frac{Q0(n-1,-1)}{2}\,\frac{Q0(n-1,1)}{2} = \left(\frac{Q0(n,0)}{2}\right)^2 \tag{7}$$

Equivalently we can suppose to do the split into two halves directly in the start, so that every half is an independent BRW with half probability. In point (n,k) it is Q0(n,k)/2 which again leads to the combined probability (7).

Using the Stirling formula $\lim_{n\to\infty} n! = \sqrt{2\pi n}\left(\frac{n}{e}\right)^n$ we get for large n

$$Q0(n,0) \approx \frac{\sqrt{2\pi n}\left(\frac{n}{e}\right)^n}{\left(\sqrt{\pi n}\left(\frac{n}{2e}\right)^{n/2}\right)^2 2^n} = \frac{\sqrt{2\pi n}\left(\frac{n}{e}\right)^n}{\pi n\left(\frac{n}{2e}\right)^n 2^n} = \sqrt{\frac{2}{\pi n}} \tag{8}$$

and for large n so from (7)

$$Q0AND(n,0) \approx \left(\sqrt{\frac{1}{2\pi n}}\right)^2 = \frac{1}{2\pi n} \tag{9}$$

From this follows (for BRWs with no preferred direction and large n)

Formulation 1:

The meeting probability of two commonly starting simultaneous independent BRWs after n steps in their common starting point goes for large n to 1/(2πn), which is the inverse of the circumference of a circle with radius n (or the probability to meet a segment of length 1 on a circle with radius n).

More demonstrative may be the viewpoint after "renormalization". Implicitly we make within every perception a renormalization. The "probability" of an altogether very improbable perception is renormalized to 1. According to the following formulation 2 the factor for such renormalization after n steps can be just 2πn:

Formulation 2:

If a *BRW pair* denotes two commonly starting simultaneous independent BRWs, after n steps (in case of large n) in the average 1 of 2πn BRW pairs meet again in its original starting point (normalized to 1 per proper time).

This is interesting because it shows a relatively simple connection between statistics and geometry. If both BRWs start simultaneously and the sum of k is conserved (symmetry), the return probability (6) is also a meeting probability ("OR" operation). If, however, the BRWs start (later) simultaneously and decide independently ("AND" operation, (7)), the probability that they meet after n steps in the starting point k=0 is the geometrical probability Q0AND(n,0) which is the inverse of the circumference of a circle with radius n.

The following sections are in parts not strict but added for explanation and to show ideas and connections to current models.

3. INTERPRETATION, FURTHER THOUGHTS

At first the above approach seems to be only 2D (two-dimensional) because circumference (9) is contained in a 2D plane. But this fits to propagation of electromagnetic fields, which transport *information*. With (3) p=1/2 and according to [O2] this is connected with the propagation speed v=c (speed of light). So we can assume electromagnetic interaction. At this inducing resp. induced electric current and change in electric (resp. magnetic) field is proportional to the circulating magnetic (resp. electric) field. There are the more locations for creation or measuring the circulating field (or circumference), the longer the delay t - due to the speed of light c the count of locations resp. possibilities is proportional to 2π c t. The 2D plane of a circulating (magnetic or electric) field is shown (resp. determined) by the direction of the inducing resp. induced (electric or magnetic) field.

The 3D propagation of information results after more steps.

Due to the limited speed of light our knowledge of surrounding is the more delayed, the greater the distance n is. Therefore there are the more (geometric) possibilities of return (2πn possibilities for multiples of the same fermion on a circle with radius n), the greater the distance (the radius) n is.

So the above approach also shows first steps to answers of the following questions:

(Of course to such questions I can only try rough answers with simplifications - for readability, this fact is not repeated again and again.)

- **Why are there conservation laws?**
  - Because completed perception at last is only possible inside the symmetry center (k=0, see Fig. 1).[6]
- **Why is v=c?** (Why is the maximal information speed constant and finite)?
  - Because a well defined delay (at least n>=2 in Fig. 1) is necessary for statistical development of geometry, i.e. for freedom of geometrical coordinates in surrounding. The delay is probably necessary for creation of new information, see 101.1.1.
- **Why do the same fermions have exactly the same features everywhere?**
  - Because during statistical development of geometry multiple possibilities (geometrical coordinates) of the same kind (more exactly: over the same kind of step sequence which represents this kind of fermion in the graph since early past) lead back to the common central (and symmetric) constellation.
- **What is the information theoretical origin of the proportionality factor π in geometric formulas?**
  - see (9). Due to limits (8) and (9) the occurrence of π in geometric formulas (e.g. the proportionality factor 2π between radial distance and circumference) indicates a combination (concatenation or "AND" operation) of two statistics (BRWs).

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[6] The (strict) conservation law even requires that every BRW is coupled with a mirrored (negative) BRW "on the other side". The meeting probability of mirrored BRWs is identical to (6) which is the return probability Q0(n,0) for one BRW. The proportionality of the sum of these return probabilities to proper time is shown in [O2]. If the BRWs are independent, their meeting probability is shown in (9) .

(The strict conservation law is probably relevant for the ultimate effect of our decisions to the - at last - resulting "own" perceptions: Altogether every conscious "decision" can only effect a symmetric separation, see 101.1.1, it cannot cause a permanent asymmetry. (It seems that our body "follows" our decisions to keep symmetry.))

Two past[7] BRWs compared to what? One step forward is more probable than a series of 2 steps back - this could define an order. Interpretation of experimental results concerning definition of time direction? (At this recall: Information can be copied and transported. This is coupled with physical energy consumption and *progress* of time.)

- **Why must we (all who can exchange information) have a common past?**
  Because we can exchange information, we must have (quick, often unconscious) knowledge about the domain of information. This domain is the common ordered set of possibilities, from which information can select (due to the same common order). This identical knowledge comes from the past, i.e. the part of past from which this knowledge descends, is identical.
  "past" is defined by (due to former decisions) determined ways of energy back to the symmetry center.
- **Why are we currently individuals with individual reality?**
  As individuals we have rest mass and individual geometric coordinates which are connected with certain proper time which occurs "seldom times" within the maximal frequency ("MF" of BRW_{max}, see section 7). It is plausible that the small probability of "proper time" results from the small probability of the "own" past (decision sequence) within total past (all decision sequences). The resulting own (individual) proper time leads to "own" perception of information and so to individual reality. We can (as sender and receiver of information), however, exchange information via "outside" or "geometry", i.e. by (both, i.e. 2 times) going enough back into past, because in this case the used initial (most past) part of BRW_{max} is common. Every objectifiable measurement leads to common measurement results because it uses only the common part of BRW_{max}.
- **Where is the connection to quantum mechanics?**
  Quantum mechanical "states" are related to (parts of) BRWs within BRW_{max} .
  For example, in connection with the basal (discrete) Schroedinger Equation it is striking that
  $$(Q0(n,k-2)-Q0(n,k)) - (Q0(n,k)-Q0(n,k+2)) \;=\; 4(Q0(n+2,k) - Q0(n,k))$$
  where the left side can be interpreted as discrete 2. derivation along location
  and the right side can be interpreted as discrete derivation along time.
  ---> Thus, the quantum mechanical "state" or "wave function" may fulfill the Schroedinger Equation, because in the end it results from a BRW (as part of extremely fast BRW_{max}). Because there must be a common (unique) set of possibilities (domain) for information exchange, it is plausible that in the end there is only one[8] BRW. Only a small part of this infinite BRW is perceptible for us. The part of it within the observable universe is called BRW_{max} in section 6. Precondition for creation of a BRW are decisions without information on its top. To create all resulting information which we later can measure, the decision frequency must be extremely high there (see below section 7).
  Such a high frequency can also cause statistical behavior and probabilities in quantum mechanics. It seems that there is a relationship between the BRW pair mentioned above (in section 2 in **Formulation 2**) and the in pairing of bra and ket vectors (introduced by Dirac in quantum mechanics). This seems interesting for further elaboration.
- **Why are experimental results "near" predictions of quantum mechanical approaches which use continous sets (domains).**
  Due to large n_{max} of BRW_{max} (section 6) and therefore small standard deviation r_{min} , its probability distribution is pointed within about 10^{-15} m (due to small r_{min}). This seems small, but due to large n_{max} (see section 7) there are on average about $n_{nucl} = MF * t_{nucl} = 4{,}219 * 10^{41}$ steps "located" within such distance. This seems to be continuous because we cannot distinguish between neighbored steps, nevertheless it is discrete: The count of steps dn is proportional to a time dt. For example, if we sum up in the largest part (not too near to the borders) of BRW_{max} over "only" 10^{30} steps (more than 10^{11} times smaller than n_{nucl}), the average value of every summand is nearly constant, i.e. the count dn of summands is proportional to the difference in time dt. Thus, an integral over t can approximate a sum over n. Thus, the result of the integral agrees (except for a not measurable deviation) with the experimental results. Analogous arguments can be made for other seemingly continuous physical quantities (energy, distance, momentum). However, the combinatorial meaningful basis is a discrete sum over a finite (not continuous) set of numbers. Therefore, for reasons of combinatorial understanding, the study of discrete approaches (see [O3] and section 8) is recommended.

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[7] Perceptable (measurable) geometry shows past (due to the limited information speed), so statistics which (very quickly) lead to geometry are past.

[8] This means, that in the end there is only one source for decisions on the top of the BRW.

4. SUPPLEMENTARY QUESTIONS FOR CONTINUATION

As already mentioned above, for description of 3D propagation of information more steps are necessary. How can we extend the (information theoretical) approach to 3 dimensions which represent statistically nearly uncorrelated quantities?

Ideas and questions for continuation:

- Can the simplified low energy model of atomic shell help as connection?
- Comparison is basal element during measurement and information acquirement. To avoid confusion of languages we need to go back from "elegant" (analytical) concepts to basal comparable combinatorics using (nested) matrices with comparable quantities, e.g. 2x2 matrices instead of complex numbers in quantum mechanics, discrete matrix representation of Maxwell Equations, see [O3] and further aspects in section 10.

5. CONSTRUCTIVE COMMENT TO CURRENT COSMOLOGICAL MODELS

We should recall that a direct experimental evaluation of cosmological models is not possible. We cannot make experiments under conditions at very past time (e.g. with past physical constants). Therefore cosmological models are extrapolations. Current cosmological models ("Big Bang") extrapolate and start geometrically - despite the experimentally proven limits of geometrical models[9]. Compared to this an approach with geometry as statistical consequence leads to completely different start conditions[10] and conclusions. We recommend to investigate these in more detail. Plausible would be to use from the beginning an information theoretical approach which develops into increasing complexity resp. branching depth. We can ask for the initial (most simple) situation of "information".
We know that information means selection from a set (of possibilities). A selection from a set with 0 elements is not possible. A selection from a set with 1 element (without alternative) provides no (new) information. So the most fundamental initial new information must describe selection of one element from a set with 2 elements. If both elements have equal probability (which defines a completely new situation), this is just one step in a symmetric BRW (Fig 1). At this starting from an initial original state (state 1) one element from a set with 2 elements (state 2 or state 3) is selected. Return to its original center is related to progress of time [O2]. It seems that from this results order of time and secondarily order of other dimensions. A graph theoretical approach can provide deeper insight into multiple steps. These allow multiple possibilities for return. If this allows different distinction between "past" and "presence", there must be a temporary separation ("localization"). Information exchange between separated systems must not contradict (long term) progress of common time.
So it is recommendable to look in more detail and consequently for discrete definition of (local and global) time and to develop from this a contradiction free (information theoretical) interpretation of macroscopic geometrical appearance as statistical result.

6. Can we estimate the maximal stepcount n_{max}?

Even if we use astronomical and elementary measurement results, it is restricted within the limits of our measurements. By principle we cannot "conceive the totality". The best what we can do is to try to search for a (along "time") controlled increment towards infinity, and avoid time-independent statements like "for $r \to 0$" or for "$n \to \infty$".

Information means selection from a domain (a common set of possibilities). So there must be a common origin of the domains which first lead to an InitialDomain (ID)[11] and which meanwhile developed into an extremely large "common distribution" (and is still increasing fast).

A simple BRW is not enough for reality. Reality has more dimensions[12] and it has generated much measurable information (selections of possibilities - asymmetries - information). Thus, we also have to think in detail about

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[9] Geometry provides no explanation. Thus, it is as a matter of principle unsuitable for cosmological models *if* they want to provide explanations. If not, another name like "geometrical approximation" could help to avoid misunderstandings and wrong expectations.
[10] An information theoretic approach would not allow within finite time the selection from an a priori infinite set (e.g. continuous sets are a priori infinite). The sets must be created stepwise from the beginning. Concerning conditions at much earlier times: It is plausible that there was significant less branching depth which was connected with other physical constants. It would be interesting to look for possibilities to test the **hypothesis** that the quotient of comparable physical sizes (e.g. of electromagnetic and gravitational interaction of proton and electron) at much earlier times has been nearer to 1 or -1 (concerning gravitation and electromagnetism "much more gravitational effect"). Initially discrete sign conversion is possible.

[11] Only secondary to common domains domains like multiples of elementary charge, multiples of elementary particles. The InitinalDomain (ID) is a very interesting topic, also for research!

"asymmetric" results of measurements and the consequence. Nevertheless, we can only measure a small part, most information is missing in the large scale[13]. Therefore, as approximation of one dimension ("radius") in the large scale and as first step, subsequently we assume that it grows in the principle of a BRW.

At this it is interesting that a BRW and also the maxima and minima of its derivations[14] become pointed after large stepcount n. Compared to the total extension, the width of the extrema becomes relatively small (like the small range of the strong interaction and the small "diameter" of a nontrivial elementary particle) (Update 2020_01). An estimate for this is the standard deviation. We try (from viewpoint of nucleon) a rough estimation of the maximal count n_{max} of (*time generating, ordered*) steps of the original maximal BRW_{max} (with initial center) since t=0 at the separation of matter and antimatter. This **antisymmetric fermionic "BRWmax"** is paired into matter and antimatter and restricted within the observable universe. Of course in this state it has to be **only initial guesswork** [15]. According to https://en.wikipedia.org/wiki/Atomic_nucleus (2020) we assume 1,7566 $*10^{-15}$ m as rough diameter and so $r_{min} := 8,783 *10^{-16}$ m as radius of a nucleon as caused by the standard deviation[16] of the maximal BRW_{max} with n_{max} steps. How large may be n_{max} since start of our observable universe? According to https://en.wikipedia.org/wiki/Observable_universe (2020) the diameter of the observable universe is $8,8*10^{26}$m , so we assume $r_{max}:= 4,4*10^{26}$m as rough "radius" of the observable universe and get rounded $r_{max}/r_{min} = 5,01*10^{41}$. We regard r_{max} as maximal extent n_{max} of BRW_{max}
and r_{min} as standard deviation $\sqrt{(n_{max}\, pq)}$ of BRW_{max} and so get
$5,01*10^{41} = n_{max} / \sqrt{(n_{max}\, pq)} = 2 \sqrt{n_{max}}$, where we assumed p=q=1/2, and so

$$\mathbf{n_{max} = 6,27 * 10^{82}} \qquad (10)$$

This suggests after renormalization all together a very large (and increasing) statistics per proper time. n_{max} seems near to the currently estimated count of nucleons[17] resp. positive or negative charges in the observable universe. It is roughly p(all nucleons) / p(this nucleon) = n_{max}

This leads to the idea to regard every BRW pair as +-charge pair. Charges are conserved per perception because complete perception implies a complete BRW pair (with way there and back, i.e. + and - direction, sum=0). There is a strict primary conservation law (total sum of k is 0) around the global symmetry center. All conserved quantities are 0 there, also charge = 0. It is plausible that other conservation laws result from measurements with more branching depth relative to the global center.

For propagation of information electromagnetic interaction is relevant, i.e. Maxwell Equations provide important hints (and of course also probability functions of quantum mechanics). For information theory we need to search comparable quantities.

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[12] Section 8 shows how a BRW like behavior can appear as part of an higher dimensional algorithm.

[13] For example, the perceptible excess of matter (in comparison of antimatter) may result from the fact that in this system (temporarily) our perception starts within one of two paired (entangled) BRWs with opposite sign. It is plausible that also the fermionic BRWmax is paired (as matter and antimatter), because from the beginning the conservation law (symmetry) is essential, which results in superposition of (temporarily separated, paired) BRWs with opposite sign.
If we can measure (perceive) only one of the two paired fermionic BRWs (due to the antisymmetric starting position of matter as fermions), asymmetric perceptions (measurement results) may occur (in a time-limited frame), e.g. rest mass with (directed) gravity.

[14] For example first derivation: Minimum at 0 - also strong interaction has exclusion principle at r=0, maximum is near to r=standard_deviation. Thus, strong interaction intensity is like the first derivation of a BRW.

[15] Start of the observable universe: t=0 is defined inside the considered reference system as the earliest time since which information (from an initial symmetry breaking between matter and antimatter) is transportable. **It is plausible that in total there is further growing nesting** (nesting along time leads to the only possible "time conform infinity"). In the current system this out of range and therefore not observable.

[16] It seems interesting to derive the short range of the strong interaction from the large size of the total distribution. Here this distribution is approximated by the (fermionic) BRW_{max} which at every step has probability 0.5 for both (new) possibilities, because initially there is no information but only a set of (two new) possibilities. Information results only *after* selection of a (new) possibility.

[17] The n_{max} steps of BRW_{max} are separated, also nucleons are separated due to the Pauli Exclusion Principle.

Nucleons have correlated features which could result from correlated sequences the graph in the beginning of BRW_{max} which are relevant only in case of extremely high frequency in the very beginning of BRW_{max} which causes short range of strong interaction of nucleons. The short range of the strong interaction could be consequence of the large size of BRW_{max} and of its derivatives. For example the first derivative of a BRW is zero around the center like the zero probability caused by the Pauli Exclusion Principle.

7. Maximal frequency (intital estimation in this limited frame)

According to section 6 from (fermionic) viewpoint of a nucleon (neutron, proton) the maximal count of ordered ("*time generating*") steps (of BRW_{max}) is about

$$\mathbf{n_{max} = 6{,}27 * 10^{82}}$$

https://en.wikipedia.org/wiki/Observable_universe in 2020 estimated the age of the universe
$t_{max} = 4{,}35 * 10^{17}$ sec
$n_{max} / t_{max} = 1{,}44 * 10^{65}$ per second = MF could approximate "maximal frequency" - it is out of range, but it can cause development of statistics within minimal proper time.

If $t_{nucl} = r_{min} / c = 2{,}93 * 10^{-24}$ sec elementary time for nucleon, then
$n_{nucl} = MF * t_{nucl} = 4{,}219 * 10^{41}$ = maximal count within t_{nucl}
This is near to the following proper time t_p:
In case of v=c resp. p=q=1/2 proper time t_p can be regarded *[O2]* as proportional to the sum of return probabilities of a BRW. In case of BRW_{max} we get according page 9 of *[O2]* $t_p = \sqrt{(n_{max}/\pi)} = 1{,}41 * 10^{41}$

7.1. Exemplary discrete approach to the Dirac Delta Function

Because (at a certain time) infinite relations are never reality conform, we know that also the Dirac delta function δ(x) can be only an approximation of exact discrete physical reality.

We know, however, that δ(x) can be represented by $\lim_{n\to\infty}\left(\sqrt{\frac{n}{\pi}}\, e^{-nx^2}\right)$.

This is a limit of a normalized Gaussian function. It (and with this the Dirac Delta Function) can (among others) result as an analytical limit from a BRW after an extreme high number of steps, like from BRW_{max} , or from a secondary effect of it.

8. A concrete discrete basic algorithm

First let denote the fine structure constant by $\alpha := e^2 / (4\pi\, \varepsilon_0\, \hbar\, c) = e^2 / (2\, \varepsilon_0\, h\, c)$
(with $h = 2\pi\, \hbar$)

Preface: In [O3] the results of a discrete numeric simulation of the vacuum Maxell Equations was described. For connection of the discrete (pure algebraic) steps a numeric coupling factor p was (automatically!) necessary. It was (is) striking that just in case of $p = \sqrt{\alpha}$ (i.e. pp = α) the resulting waves have shown "reasonable" propagation along time (with initially nearly the same height). At this the discrete simulation ware pure algebraic and without usage of further physical constants.

2021-09-27: Recalling the relevance of the Maxwell Equations for information transport, their discrete simulation in [O3] and the noticeable similarity of the found (necessary) coupling factor p to the root of the fine structure constant (for height "1" of the first wave) indicates, that this discrete algorithm may be related to reality. (Imaginary unit i of quantum mechanics can be represented as 2x2 = (1+1)x(1+1) SubMatrix within (3+3)x(3+3) Matrices)

It is possible to extract from the algorithm of [O3] a BRW. For this subsequently 2 consecutive steps as shown in (16) of [O3] are written explicitly now. At this pp is written instead of p^2 :

```
For the second derivative we explicitly make 2 steps according to (16) of [O3]; for 2. step we represent Bx by E:

pBx(t+1, x, y, z) = pBx(t, x, y, z) − ppEz(t, x, y + 1, z) + ppEz(t, x, y − 1, z) + ppEy(t, x, y, z + 1) − ppEy(t, x, y, z − 1),
pBy(t+1, x, y, z) = pBy(t, x, y, z) − ppEx(t, x, y, z + 1) + ppEx(t, x, y, z − 1) + ppEz(t, x + 1, y, z) − ppEz(t, x − 1, y, z),
pBz(t+1, x, y, z) = pBz(t, x, y, z) − ppEy(t, x + 1, y, z) + ppEy(t, x − 1, y, z) + ppEx(t, x, y + 1, z) − ppEx(t, x, y − 1, z).

now insert into

Ex(t+2, x, y, z) = Ex(t+1, x, y, z)
+ pBz(t+1, x, y+1, z)
− pBz(t+1, x, y−1, z)
− pBy(t+1, x, y, z+1)
+ pBy(t+1, x, y, z−1)

yields:

Ex(t+2, x, y, z) = Ex(t+1, x, y, z)
+ pBz(t, x, y+1, z) − ppEy(t, x + 1, y+1, z) + ppEy(t, x − 1, y+1, z)+ ppEx(t, x, y+1 + 1, z) − ppEx(t, x, y+1 − 1, z)
- pBz(t, x, y-1, z) + ppEy(t, x + 1, y-1, z) - ppEy(t, x − 1, y-1, z)- ppEx(t, x, y-1 + 1, z) + ppEx(t, x, y-1 − 1, z)
− pBy(t, x, y, z+1) + ppEx(t, x, y, z+1 + 1) - ppEx(t, x, y, z+1 − 1)- ppEz(t, x + 1, y, z+1) + ppEz(t, x − 1, y, z+1)
+ pBy(t, x, y, z-1) − ppEx(t, x, y, z-1 + 1) + ppEx(t, x, y, z-1 − 1)+ ppEz(t, x + 1, y, z-1) − ppEz(t, x − 1, y, z-1)

Setting Bz and By initially to 0 for t=0 yields:

Ex(t+2, x, y, z) = Ex(t+1, x, y, z)
```

```
− ppEy(t, x + 1, y+1, z) + ppEy(t, x − 1, y+1, z)+ ppEx(t, x, y+1 + 1, z) − ppEx(t, x, y+1 − 1, z)
+ ppEy(t, x + 1, y-1, z) - ppEy(t, x − 1, y-1, z)- ppEx(t, x, y-1 + 1, z) + ppEx(t, x, y-1 − 1, z)
+ ppEx(t, x, y, z+1 + 1) - ppEx(t, x, y, z+1 − 1)- ppEz(t, x + 1, y, z+1) + ppEz(t, x − 1, y, z+1)
− ppEx(t, x, y, z-1 + 1) + ppEx(t, x, y, z-1 − 1)+ ppEz(t, x + 1, y, z-1) − ppEz(t, x − 1, y, z-1)

yields:

Ex(t+2, x, y, z) = Ex(t+1, x, y, z)
− ppEy(t, x + 1, y+1, z) + ppEy(t, x − 1, y+1, z)+ ppEx(t, x, y+2    , z) − ppEx(t, x, y      , z)
+ ppEy(t, x + 1, y-1, z) - ppEy(t, x − 1, y-1, z)- ppEx(t, x, y      , z) + ppEx(t, x, y-2    , z)
+ ppEx(t, x, y, z+2    ) - ppEx(t, x, y, z      )- ppEz(t, x + 1, y, z+1) + ppEz(t, x − 1, y, z+1)
− ppEx(t, x, y, z      ) + ppEx(t, x, y, z-2    )+ ppEz(t, x + 1, y, z-1) − ppEz(t, x − 1, y, z-1)

Setting Ey and Ez initially to 0 for t=0 yields:

Ex(t+2, x, y, z) = Ex(t+1, x, y, z)
+ ppEx(t, x, y+2    , z) − ppEx(t, x, y      , z)
- ppEx(t, x, y      , z) + ppEx(t, x, y-2    , z)
+ ppEx(t, x, y, z+2    ) - ppEx(t, x, y, z      )
− ppEx(t, x, y, z      ) + ppEx(t, x, y, z-2    )

yields:

Ex(t+2, x, y, z) = Ex(t+1, x, y, z)
+ ppEx(t, x, y+2    , z) − ppEx(t, x, y      , z) - ppEx(t, x, y      , z) + ppEx(t, x, y-2    , z)
+ ppEx(t, x, y, z+2    ) - ppEx(t, x, y, z      ) − ppEx(t, x, y, z      ) + ppEx(t, x, y, z-2    )

this represents two second derivatives, one to dy, the other to dz;
setting the second derivative to dz initially to 0 yields:

Ex(t+2, x, y, z) = Ex(t+1, x, y, z)
+ ppEx(t, x, y+2    , z) − ppEx(t, x, y      , z) - ppEx(t, x, y      , z) + ppEx(t, x, y-2    , z)

yields:

Ex(t+2, x, y, z) = Ex(t+1, x, y, z)
+ ppEx(t, x, y+2    , z) −2ppEx(t, x, y      , z) + ppEx(t, x, y-2    , z)

This means, in case of initial change along dy: The discrete change along dt is the discrete second
derivative along dy.
```

Thus, the discrete derivative along dt is the discrete second derivative along the changed coordinate. This is a general feature of a BRW. As mentioned in section 4 , it is

(Q0(n,k-2)-Q0(n,k)) - (Q0(n,k)-Q0(n,k+2)) = 4(Q0(n+2,k) - Q0(n,k))

where the left side can be interpreted as discrete 2. derivation along location

- Above and in (16) of [O3] the same p was used for E and B and all t,x,y,z, but this is a simplification.

2022: Particles with rest mass can result from unequal values of p (which represent information due to temporary symmetry breakings), which leads to (temporarily separated) "closed loops" of energy (Poynting vector E x B).
Because of the separation of most energy flows, the local proper time only increases infrequently.

Therefore:
<u>As concrete steps</u> it may be interesting to simulate (16) of [O3] after **modification of p in dependence of t,x,y,z**, to get results near to reality. p is used frequently but it need not be constant (along t,x,y,z) - modifications of p_E(t,x,y,z) and p_B(t,x,y,z) can represent measurable information, e.g. represent loops, a certain direction etc. Any modification must be accompanied by an inverse modification elsewhere for total symmetry (conservation law).

2021-10-10 : For example:
- start with y=0, z=0, t=individual and electrical charge +1 at a certain x (and -1 at -x) as representation of "matter" (at -x of "antimatter), check x=1 for elementary considerations and large x for macroscopic geometric considerations;

- test
p_(t,x,y,z) which leads to "right handed loop" and
p_(t,-x,y,z) which leads to "left handed loop" (represents mirrored BRW)

220228: If time: think about p as determined (1 or 0 for quick loop) in past and undetermined (equal value between 1 and 0, for BRW) in future part of Graph.

8.1. A RELATIONSHIP TO BOHR'S FORMULA

First lets abbreviate also the Finestructure constant by pp, i.e.
$pp = \alpha = e^2 / (2\, \varepsilon_0\, h\, c)$

In the above consideration I wrote pp (instead of p^2) for 2 consecutive steps shown in (16) of [O3].

Let denote the mass of the electron by m_e and the speed of light by c and the total (mass) energy of the electron by E_0. According to Bohr's formula the discrete energies E_M of the hydrogen atom[18] are given by

$$E_M = m_e (e^2 / (2 \varepsilon_0 h))^2 / (2 M^2)$$
$$= m_e cc (e^2 / (2 \varepsilon_0 h c))^2 / (2 M^2)$$
$$= m_e cc \alpha^2 / (2 M^2)$$
$$= m_e cc (pp)^2 / (2 M^2) = E_1 / M^2$$

This is clearer. Recall, that the discrete simulation in [O3] uses **only algebraic steps** for estimation of pp !

A short speculative excursion: We may think about the factor $1 / M^2$ which is in Bohr's formula proportional to the energy. Is a discrete approach possible? One possibility:
Let us assume that the total system (atom or more) has a time dependent energy level E_M (t) which decreases per time progress by one step from $E_M(t)$ to $E_{M+1}(t+1)$. Altogether a realistic assumption, because the available energy decreases along the time direction - there is no perpetuum mobile. Then according to Bohr's formula the energy E(t) is proportional to $1 / t^2$.
Also, as mentioned in *[O2]*, time t can be seen as proportional to the sum of return probabilities of a Bernoulli Random Walk (to the starting point 0) [19]. According to section (2.5.2) of *[O2]* the sum of these return probabilities ∑ Q0(2n,0) from n=0 to N is for large N proportional to √N , i.e. time t is proportional to √N . This means N(t) is proportional to t^2.
From this results (with to E(t) proportional to $1 / t^2$) that E(t) N(t) = constant
- there may be a connection to the Planck constant h .
The above considerations assume a large value of N. The discrete steps of N would be much more "frequent" than increments of M. If we assume that N increases with maximal frequency MF = $1{,}44 \cdot 10^{65}$ / s ("MF" of BRW_{max}, see section 7), we may e.g. compare this with the Rydberg frequency RF = E_1 c/h = $3{,}29 \cdot 10^{15}$ /s and get MF/RF= $4{,}38 \cdot 10^{49}$

8.2. Some Considerations to Time and Information

2022: Brief summary of the current view of basal combinatorics:
- geometrical "space" means missing information because perception of space is always perception of past,
  - this means, geometrically we perceive only delayed (past) information (and have to extrapolate)
  - extrapolation from this past to presence without information means BRW ("future" direction)
  - extrapolation from this past to presence without information there and back means BRWpair (9)
    which also leads to geometrical appearance

  - in contrast to this future directed (BRWpair) combinatorics,
    the (locally) clear "known" past, i.e. all "present" information
    is a "simultaneous" seeming determined sequence of selections
    from clear domains of information

- Primary and durable information only in primary symmetry center (maximal past perception and maximal future decision); contradictory information from space cannot reach this
- In total always symmetric (sum=0), but locally partial perception, different proper time due to different past information (decision sequence)

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9. To "Individual" Information as Part of Total Information

qq todo , discuss above answer to question "why are we currently individuals with individual reality (last individual parts of past)?" to be continued

10. Information Theoretic Approach Leads to Ordered Basic Steps

For a consequent information theoretic approach we have to start without geometry, so that geometry results as statistical macroscopic consequence after many steps (see section 3). Because information means selection from a common set of possibilities resp. "domain", there must be a **common** minimal[20] "Primary Set of Possibilities" or "Primary Domain" (PD) for information exchange within the[21] universe.

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[18] j is a positive integer for numbering the energy states of the atom. I used j instead of (the frequently used) n to distinguish from the n above in the discrete simulation.
[19] at certain t's . The probabilities of these seldom t's within BRWmax may form components of a vector for construction of (outer product which form) a projection operator on increment of proper time at a certain t.

[20] The size of the common domain depends on the position in the graph - it is the smaller (and its scope is the larger), the nearer its position to the (for us maximal) primary decision. This decision has maximal scope and for us determines time direction in the total observable universe (because every dt resp. time step can be only return

PD must be the basis, from which the sets of possibilities (also "space") of all physical experiments are derived. The "same" physical behaviour of the same kind of particle (e.g. fermions like neutron, electron, proton) can only result from its same constellation to PD. Strictly speaking, these uniform results are the proof of the uniform PD. To get all measurement results, PD is used maximal frequently (at every information resp. energy transfer). As origin PD has minimal count of elements. What is the correct minimal count?

From basal information theoretic considerations (“Information as selection from a common domain of sender and receiver”) we know that the common PD needs at least 2 selectable elements as reference for any information exchange. But it is not possible to derive from a PD with only 2 elements, say PX and PY, any order. If “after” PX (i.e. “selecting” PX again changes nothing, also no time) there only remains for selection the state PY, the sequence is completely determined (to QX QY QX QY QX QY…), there is no choice for any creation of new information and no direction[22].

If, however, PD has 3 elements, say QX, QY, QZ, after the initial state (say QX) there is freedom for selection (QY or QZ), and by chaining sufficiently many permutations (QX, QY, QZ for “clockwise” or QX, QZ, QY for “counterclockwise”) we could freely code information, in case of many steps also complex information. The permutations QX, QY, QZ or QX, QZ, QY can represent 2 possibilities like 0 and 1 for a bit, and they also contain QX as start for determination of time order. We always need a reference for order, the state "before" differs from the state "after" and also from the present state. Due to the 3 orthogonal spacelike dimensions of macroscopic geometry it is plausible that the initial PD with 3 elements is also valid for later macroscopic measurement results.

- Starting from the symmetry center, the initial decision resp. selection from PD with following asymmetry is precondition of later free energy and of ordered time progress. PD must be a reference for comparison which is used for any information exchange in the universe.
- So altogether PD is used (retrieved) with extreme high (by us not perceptible) frequency or "Maximal Frequency" (MF).
- Time progress means stepwise return to the start of a BRW. The sum of its return probabilities is proportional to proper time [O2] [O4]. The necessity of complete return can form the origin of conservation laws. The conserved quantity depends on the kind of path (research necessary).
- Time progress is connected with return of free energy to the symmetry center. This compensates initially caused asymmetry (e.g. initial "selection of QY"), by preferring the balancing possibility (e.g. "selection of QZ")
- According to [O2] progress of proper time is only given in case of return to the start. There can be more preconditions. It is plausible (e.g. due to late individual start in the graph) that "individual" returns are "seldom" compared to all (earlier) returns (having smaller probability, because the "own" decision sequence resp. "own past" is additional precondition). Because proper time is renormalized to 1, **due to the infrequent proper time** the measured former BRWs can have extremely large (see section 6) step count n. Because the standard deviation only grows proportional to the square root of n, after renormalization (division by n) this can lead to extremely large pointed distributions of the space coordinates like the Dirac delta function δ(x), see below, and to the appearance of multiple pointed sources, e.g. as particles. (---> for quantiative estimation see section 7)
- The iteration count per proper time could generally form the initial basis for ordered (by numbers quantifiable) physical quantities. The kind and size (also the count of indistinguishable particles) would depend on the kind and count of started and so in the end determined ways back. Order of time is primary source for any order and for all metric distances ("natural similarity"). Any change of state is connected with ordered change of time.
- Derived from (common) elementary charge, the common set of multiples of elementary charge is derived which is precondition for any electronic communication. It is an important common set of

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to the global symmetry center and therefore always is negative part of the initial symmetry breaking caused by this primary decision). Later common domains (elementary charge, elementary particles, and physical constants) are still per proper time accessible and derived from it. Macroscopic common domains like language vocabulary are much later generated and slower accessible (e.g. within subjective response time) with less reliability due to much more possibilities in between for alternation and mutation and from this resulting much larger variability.

[21] When we call it "the universe" for short, we mean the *observable* universe. It is plausible that the hierarchy is not limited within it. We can perceive our own current limits, but not a general limit.

[22] Direction implies order: Even if we (for creation of information minimally) select only one of 2 possibilities, both must be different from the current "possibility" or "situation" to generate information (If one is the same as the current situation, its selection would be identical to "no selection"). More is needed to generate order and trees.

possibilities (domain). The role of elementary charge in the Maxwell Equations as source shows more about its possible origin from (repeated) elementary steps of PD in maximal frequency (MF, see section 7). Here (instead of repeated usage of abbreviations like "rot" and "div") more detailed consideration of Maxwell Equations in detailled and combined Matrix representation is interesting, see 8.

The order of the 3 elements QX, QY, QZ of PD means information. Elementary action is permutation of set QX, QY, QZ. For this, there are 2 possibilities (where "Information" later is a selection from these).
Both orders we can associate to permutation matrices:

and "clockwise"

$$\begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} \qquad (11)$$

and "counterclockwise"

$$\begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix} \qquad (12)$$

(at this 2 clockwise permutations are identical to one counterclockwise $\begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}^2 = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix}$) (13)
and reverse (2 counterclockwise = one clockwise.). This can cause additional effects[23].

In case of equal probability (initial symmetry) we add both permutations with equal weight, but "counterclockwise" with negative sign and get:

$$\begin{pmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} - \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix} = \begin{pmatrix} 0 & -1 & 1 \\ 1 & 0 & -1 \\ -1 & 1 & 0 \end{pmatrix} \qquad (14)$$

Of course it is also possible to exchange the signs, so there are 2 possibilities for this (like there are 2 possibilities for defining the Levi-Civita-Symbol ε_{ijk}).
REM: The Levi-Civita-Symbol is used in Maxwell Equations and other important basic equations.
search connection to other basic equations with the Levi-Civita-Symbol ε_{ijk}
The 2 possibilities for defining the Levi-Civita-Symbol ε_{ijk} could result from elementary selections resp. decisions in BRW_{max}.
Due to conservation law, the Levi-Civita-Symbol ε_{ijk} should occur paired with opposite signs. Because of our current viewpoint from outside the center, both possibilities may appear in very different scales (e.g. concerning time), nevertheless the conservation law guarantees symmetry (even if this is not immediately perceptible).

Information is transferred by electromagnetic interaction. Hence, we search to find a connection to Maxwell Equations (as first approximative step). For transition to these equations we recall e.g. Faraday's law:

$$-\frac{\partial B}{\partial t} = \text{rot } E = \nabla \times E \qquad (15)$$

where

$$\begin{pmatrix} 0 & -\partial/\partial z & \partial/\partial y \\ \partial/\partial z & 0 & -\partial/\partial x \\ -\partial/\partial y & \partial/\partial x & 0 \end{pmatrix} \begin{pmatrix} Ex \\ Ey \\ Ez \end{pmatrix} = \begin{pmatrix} \partial Ez/\partial y - \partial Ey/\partial z \\ \partial Ex/\partial z - \partial Ez/\partial x \\ \partial Ey/\partial x - \partial Ex/\partial y \end{pmatrix} = \nabla \times E \qquad (16)$$

at this

$$\begin{pmatrix} 0 & -\partial/\partial z & \partial/\partial y \\ \partial/\partial z & 0 & -\partial/\partial x \\ -\partial/\partial y & \partial/\partial x & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & \partial/\partial y \\ \partial/\partial z & 0 & 0 \\ 0 & \partial/\partial x & 0 \end{pmatrix} - \begin{pmatrix} 0 & \partial/\partial z & 0 \\ 0 & 0 & \partial/\partial x \\ \partial/\partial y & 0 & 0 \end{pmatrix} \qquad (17)$$

[23] Because 3 permutations (12) are equivalent to the identity function, there is correlation between the current situation (step 0) and the situation 3 steps before (step -3), so that this can be used for comparison and so for elementary measurement. Idea: A linear operator may modify the quantum physical state function like a step backwards (from presence to step -1 before), and the scalar product of two such state functions may effect like 2 steps forward (from step -3 before to step -1 before), so this could "bring together" them (step 0 and step -3 together to step -1 before) so that this is comparable for measurement. This is a topic for deepening.

At last this can cause even correlations between "inner" (central, serial) decision sequence and the (due to the conservation law) resulting (later also in the center perceived) "outer" appearance.

So the left 3x3 Matrix in (16) represents clockwise and counterclockwise permutations with equal weight like the left 3x3 Matrix in (14), with reversely (counterclockwise and clockwise) permutated differentiation. The part with "clockwise" permutation (and counterclockwise permutated differentiation) is

$$\begin{pmatrix} 0 & 0 & \partial/\partial y \\ \partial/\partial z & 0 & 0 \\ 0 & \partial/\partial x & 0 \end{pmatrix} \begin{pmatrix} Ex \\ Ey \\ Ez \end{pmatrix} = \begin{pmatrix} \partial Ez/\partial y \\ \partial Ex/\partial z \\ \partial Ey/\partial x \end{pmatrix} \qquad (18)$$

and the part with "counterclockwise" permutation (and clockwise permutated differentiation) is

$$\begin{pmatrix} 0 & \partial/\partial z & 0 \\ 0 & 0 & \partial/\partial x \\ \partial/\partial y & 0 & 0 \end{pmatrix} \begin{pmatrix} Ex \\ Ey \\ Ez \end{pmatrix} = \begin{pmatrix} \partial Ey/\partial z \\ \partial Ez/\partial x \\ \partial Ex/\partial y \end{pmatrix} \qquad (19)$$

So the rot operator in (15) represents 2 reverse permutations with reversely permutated differentiation. We may set $E=-\nabla V_E$, i.e. the components Ex, Ey, Ez are components of the gradient of an electric potential V_E , then (18) and (19) represent reverse order of differentiation. In case of constant V_E (18) and (19) are equivalent and (16) vanishes. If, however, one of the permutations (18) or (19) is preferred, (16) does not vanish and the order of differentiation is decisive for the (sign of the) result. Non vanishing (16) is precondition of every information resp. energy transfer.

Hence, globally I conclude, for definition of order resp. time direction one of the 2 possibilities (18) or (19) has been selected very initially (by the primary decision). This created all available energy, which later is retrieved stepwise in the (unique) initial symmetry center (even in Maximal Frequency (MF)). It is plausible that the initially chosen order causes asymmetries in our later system, e.g. the appearance of matter together with asymmetric distribution of charge in matter (+ in atomic nucleus, - in atomic shell).

11. Addendum

qq subsequent content only rough

Points for consideration:

Precondition to separation is a positive distance. Only if there is positive measurable distance, we can measure geometric parameters. Thus, "geometry" is secondary, after there is measurable "positive" radius or distance. First we have to define "time" and "simultaneity".

2021_05_19: Recall distributive law:
In case of division of factors, every factor is a sum of many summands
- The resulting count of products of summands increases exponentially with the count of factors.
  The **total sum of products is always exactly the same** (distributive law reversed)

Factors could be time, energy etc.

The following rough idea, because in BRW n (vertical for d/dt) is combined with k (horizontal for d/dxyz):
- let a=natural number with 0, i.e. a=0,1,2,3,4...
- associate magnetic field B with 2a and electric field E with 2a+1;

at this in detail columns k for B and E in (later macroscopic "directions") x,y,z are e.g.:
Bz: k=6a+0 (for "initial r", initial step)
Ex: k=6a+1
By: k=6a+2
Ez: k=6a+3
Bx: k=6a+4
Ey: k=6a+5
- negative k: all mirrored order due to conservation law?

Electron "outside" proton because k outside center (can only recombine in the original center at k=0)
- Every decision towards real future is completely undetermined (equal probability of both alternatives), and there is complete conservation (there are always 2 alternatives with opposite sign which soon lead to minimal probability due to division by 2), therefore both alternatives need full consideration <u>at last</u>. (In between, however, there seems temporary small physical asymmetry, because energy temporarily seems "away" towards "outside".)
- "inside" we are fully informed, like about past. A past decision is completely determined, probabilities 1 and 0.
((How can we fit this? We need "corrections" towards the old center (truth), to find the best decisions toward this.))
For comparison of "inside" (informed) to "outside" (undetermined), we need consideration of decision sequences with completely different probabilities

Suppose, there seem (outside, like count of nucleons) to be $n_{max}= 2^{275}$ equal alternatives (in BRW_{max} , see (10)), then every alternative has probability $1/n_{max} = 2^{-275}$
This is (according to (4)) like at the border Q0(275, 275) of an undetermined BRW at n=275; at n=275 the central probability of this BRW is Q0(275, 0) ≈ 0,048 which is nearly 2^{271} times larger than at the border. Thus, as reference the center is much more "constant" than the border.

Even "consciousness" can give hints towards time and information:

- In case of "zero distance" and "simultaneity" we have "presence" with consciousness
- In case of "negative distance" (inside) we have in past perceived information
- In case of "positive distance" (outside) we have statistical result: A graph can give hints: After distribution into many branches (as BRW1 of 2 BRWs), the graph returned (as BRW2 of 2 BRWs, see section 2). It becomes more and more plausible, that the steps (access to ID) in the BRWs and graph have extremely high maximal frequency (MF), see section 7, which outside led to pointed distributions (localized particles resp. fermions resp. matter), which led to development of statistics with geometrical appearance.

- algebraic addition (e.g. for calculation of probability) indicates simultaneity at measurement
- algebraic multiplication (e.g. for calculation of probability) indicates repetition of something at measurement, e.g. of loop with quick return to PD (Primary Domain) which is (altogether, globally) done in MF (Maximal Frequency)
- After start with QX, what means concretely "selection of QY" or "selection of QZ"?
- Does selection of one of QX or QY determine direction of Poynting-Vector S = E x H, i.e. energy emission and absorption?
  In case of "free" energy a photon is sent to "outside" (positive divergence of energy, analyze realization of matrix representation of Poynting-Vector S = E x H).
  Photon exchange: Where is information determined? Where is information (later) measured?
  First estimated answer: Information is always determined (decided) discretely ± in the global center (with extremely quickly increasing step count nmax which is perceived as "t(own)" at many locations) ; returning backwards is broader statistics SP:=S± with sum over total breadth always is 0: 1/breadth proportional Energy; *Presence contains superposition of extremely many SP,* perceived is only small part t(own) which exactly correlates over step count nmax with "own" decisions

- Individual progress of time only occurs since start of proper time and "seldom" (compared to progress of global time), if there is (energy exchange due to) absolute correlation between right and left side of the BRW.
- Combinatorics could become better visible if we avoid the imaginary unit (even if this increases dimensionality). For me the currently in physics used **diversity** of abbreviations hide combinatorics, I would prefer a consequent matrix representation, even if we (at first sight) need higher dimensionality.
- BRW means "Bernoulli Random Walk". I got the impression that in current theoretical approaches the repetition of the same abbreviations is one reason for repetition of the same omissions. Of course this is also problem for my own usage of abbreviations or our "language vocabulary".
- Exact consideration necessary: what is compared to what at which time, that as statistical result Maxwell Equations arise.

  "Outside" introduces "space"; more steps necessary for this - here we may use computer support like in [O3].

- In case of beta minus decay: need consultation with experimental physics: 1 of 2 possibilities is selected? What exactly is measured (using primary definitions, not hidden behind derived concepts) at which time? What means “start” and “end” of measurement?
- if as PD 3 (rgb) quarks represent 3 states for common definition of time order, their MF check could provide "information" as measurable charge (as selection from “+2/3” or “-1/3” elementary charge), e.g. after beta decay (when, exceptionally within MF, “+2/3” is selected instead of usually “-1/3”). That beta decay cannot bind but only split (along time) shows its strict coupling with definition of time direction, so here we can get information about time definition.

- <u>Matrix</u> representation shows combinatorics better. Complex numbers (e.g. in quantum mechanics) could be replaced by real 2x2 (sub)matrices.
- Conservation of energy, angular momentum, momentum, charge implies that global symmetry is conserved during any change of state. We see asymmetry only due to the own position outside the symmetry center. Globally seen branching depth increases, but symmetry is conserved.
- CPT Symmetry: Assign c to k an even n, p to k at uneven n, t to n; results into 2 triangles at n=0; What in case of n>0 and what means in this case reverse t? Repetition??

11.1. ATTEMPT OF AN UNFOLDED APPROACH (IF MORE COMPLETE, PERHAPS SOMETIMES AFTER SECTION 8)

The information about the initially chosen order is preserved, otherwise the "time" would not increase reliably. Also the propagation of energy goes in the direction of the Poynting Vector, which is perpendicular to the electric and magnetic field. So - for the sake of clarity - we map this to a given order x,y,z for increasing time. Increase of time is associated to increasing n, where k=0 only occurs for even n
This means at k=0 for an integer number j:

x associated to n=6j+0 to n=6j+2
y associated to n=6j+2 to n=6j+4
z associated to n=6j+4 to n=7j
(meaning ?)
Primary decision is made at n=0, k=0; Due the conservation law (symmetry) we start **every BRW as pair (entangled)** with opposite sign. Therefore we start 2 entangled BRWs at n=1 with value -1 for k=-1 and value +1 for k=1. Every of the 2 BRWs has a Maximum besides k=0. The position and height of the maximum are proportional to 1/(standard deviation) resp. $1/\sqrt{n}$.
The maximal paired BRW (for fermions) is BRWmax with maximum at about $r_{min} = 8{,}783 \cdot 10^{-16}$ m as radius of a nucleon as caused by the standard deviation, see section 6 .
The **information about the entanglement of the 2 BRWs** is only "known" before (at n=0, past). With this knowledge the probability for return of both BRWs to k=0 is proportional to about $1/\sqrt{n}$ [24].
In case of such return "Perception" of information occurs.
Possibilities of this information:
variable n, qq to be continued

Addendum:

12. Further steps towards an information theoretical approach

We could study the development of the Maxwell equations using varying conditions.

- It is interesting that electromagnetic progression (electric->magnetic->electric...) (and every measurement) is connected with progress of time and change in time.
  So it may be interesting to simulate this by starting coupled (*not* independent) paired BRWs (+BRW and -BRW). This means that due to the conservation law every step to "+" or "-" of +BRW in case of measurement is connected with a step to "-" and "+" of -BRW.
  - If own standpoint is outside the symmetry center, return can need work and show new (future) information and asymmetric appearance of these BRWs: After "inner" (most future) movement of thoughts the (measurable) statistically distributed movement of charges at last is result of "later" return to symmetry.
  - If return, there is new "true" past.
-

Before information transfer we need a common definition of the domain (the "set of possibilities" - like in informatics) in sender and receiver.
From below:
Initially a set of possibilities resp. domain (uncertainty) must be available, from which ordered selections (events) are possible (definition of information). "Locally" or "inside" a decision *defines* time order. This must be a sequence. Our time perception shows that this sequence can be *split* into irreversible parts or steps whose "direction" is determined by the initial time order.

For decidable definition of time we need a primary set of possibilities resp. domain (see a) for exact definition of order. For this we need at least 3 possibilities: The current possibility (state) and 2 remaining possibilities, from which one is selected (decision resp. information)
Idea: We could e.g. start using analogy to Maxwell's laws: There is mutual induction of are electric and magnet fields but no magnetic sources, only electric sources. We could therefore associate the first direction (perception or decision inside-outside -z..z) with an electric source, from which between the other 2 directions (-x..x, -y..y) of the resulting magnetic field are selectable. The magnetic field has no source, because the conservation law early recombines -x..x or -y..y, the electrical field has a source (inside-outside) because it is not early enough from decision to recombination, the conservation law still is working (to do: an estimation of the further development, simulation using software is necessary in case of many steps).

(With less preknowledge, at another scale, within current localizability and inertia of rest mass: Perhaps 3 (rgb) quarks are confined (within h/(mc)), because they represent 3 such states for common definition of time order. They cannot be more separated, because starting from more separated locations would cause a time difference which would lead to contradictions at defining time order (done in very high frequency, see section 7).)
(2018-07-14: The minimal set for defining an order must contain 3 different elements - else the "next" state (order of the 3 elements) would define just the negative order. Due to the fact that geometry is just a statistical consequence, we can learn from geometry about elementary recombination of the 3 space dimensions. We recall conservation of angular momentum and that $\cos(\pi/3) = \sin(\pi/6) = 1/2$ ...)

Generally there is the more "attracting force" or "commitment", the more there is tendency to a common time order.

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[24] Without this (inner, past) knowledge about entanglement the probability for return of both BRWs, i.e. of the BRWpair seems proportional to 1/n and the sum grows proportional (to the integral and therefore proportional) to log(n). This means that n (the BRWpair) seems to grow exponentially with the sum of probabilities of return - like the count of possibilities of completely independent future information.

Supplementary brainstorming: Incomplete list of ideas, to be continued, to be checked and to be converted into algebraic expressions of expressions.

a. For elementary considerations the formulation
"Information is selection from a set of possibilities (domain)"
must be precisely analyzed and applied to physics.

Necessary is exact definition of the domain and of proper time [O2] (resp. "simultaneous") and evaluation of temporal order (see 0) in dependence of elementary measurement method and information-variant (new "decision" or transfer of measurement result). The earlier a selection, the larger is its branching depth. So early selections can have huge effect. For unification of current approaches we need to go back in time more and more (theoretically), see e.g. 6.
Important advantages of the information theoretical approach are clear basic conditions ("everywhere" ensured temporal order since beginning of measurable time, consistency, symmetries and conservation laws). Considering these basic conditions a new pure information theoretical model must lead to current statistics. This probably would require assumption of certain former symmetry breakings (resp. decisions resp. measurements). These assumptions could allow due to conservation laws today enhanced statistical predictions.

b. Fig. 1 can help, consider sum of central meetings as proper time ([O2]). Progress of time, creation of new information is connected with central meetings.

c. The standard deviation of an extreme large (see sections 6 and 7) Binomial distribution is much smaller than its size. So it is pointed and shaped like the Dirac delta function δ(x) which is much used in quantum mechanics. This interpretation seems very interesting and worth for further research.
The renormalized distribution becomes $\delta_\varepsilon(x) = \frac{1}{\sqrt{2\pi\varepsilon}} \exp\left(-\frac{x^2}{2\varepsilon}\right)$. Around x=0 with width about $\sqrt{\varepsilon} \to 0$ for $\varepsilon \to 0$ and height $\delta_\varepsilon(0) = \frac{1}{\sqrt{2\pi\varepsilon}} \to \infty$

d. Consider BRW pair as charge pair, study overlapping of +- BRWs: For this we define the Q1-triangle which results from a superposition of two Q0-triangles with opposite sign, starting in position n=1, k=±1 after multiplication by 1/2. Addition of both means a "discrete differentiation" along k.

e. $Q1(n,k) = -\frac{k}{n} Q0(n,k)$

f. Can be considered from one side (from decentral) as absorbing (3.1.1. of [O2]) or outflow (not only "proper" time). It can define a border.

g. It is also a discrete derivative along n and also k:

h. Q1(n+1,1) = Q0(n+2,0)-Q0(n,0) = (1/2) (Q0(n,2)-Q0(n,0))

i. Up to now +-probabilities have been added, study change of situation in case of measurement (multiplication of +-probabilities). Every time step probabilities are multiplied, stable repeated measurements need probabilities near 1. To be continued...

j. For usage of information comparison is essential. How is information (selection of a set) compared with past information? (Try correlation.)

k. After "perception" or "measurement" the resulting information can be "copied" towards future, using "free energy" "E" which together with time direction is initially created as symmetry breaking or decision.

l. The relative consumption "delta_E" of reference by measurement should be small. For permanent reliability (of predetermined time) the total sum "E" must be finite, i.e. the steps "delta_E" must go to 0 more quickly than 1/n.

m. A decision is a new ("locally most future") selection (resp. information). It is "true" for the decider. Information is "true" for all if it applies at last.

n. Pauli Exclusion Principle is necessary to avoid contradiction of (information about time) order.

o. The graph of a decision must show that it starts with uncertainty (creation of entropy resp. possibilities) and later provides information (selection) from the set, probably as "potential" back to the original symmetry center due to conservation laws.

p. Before using geometry "outside" must be defined. Outside is "past", information from there can be "known" resp. copied only with "delay" (to avoid contradictions).

q. Copying of information, energy transfer, are additionally connected with decentral meetings (Fig. 1).

r. For an information theoretical approach we need an exact representation of terms like "simultaneous" (time not distinguishable), "conserved" (connected quantity has total sum 0). The original conservation law determines time direction in different frames, see below.

s. For an information theoretical approach a systematic vectorial description of elementary particles, using only numeric data of relevant (directly or indirectly measurable) quantities, exactly regarding the logic role of conservation laws together with (contradiction free) time dependence, could provide additional insight (in contrast to this names require preknowledge which tends to be forgotten). The vectorial description can be enhanced to more complex combined states.

13. Conclusion

Information means selection from a set of possibilities. Physics deals with results of measurements, i.e. physics deals with information, from the beginning. The above interpretation (see section 3) leads to the conclusion that an information theoretical approach which develops into increasing complexity resp. branching depth (with geometry as secondary statistical consequence) is more plausible than a primarily geometrical model (like "Big Bang"). It seems that geometric (macroscopic) physical measurement results follow from differentiation, superposition and concatenation of (meanwhile partially very large, periodically in a symmetry center synchronized) statistics.

So (reconsidering physical experiments) we have to start with (in very different scale) along time ordered information theoretical terms (like "simultaneous", "before-after", "compare", "copy", "true-false", "longer-shorter", "past-presence-future", *secondary* geometrical terms like "inside-outside", "separated", "larger-smaller"), so that current physical "interactions" result as side effect (consequence) to guarantee (since t=0)[25] long run and everywhere (information theoretical) consistency and need not be introduced using independent terms (like "electromagnetism", "gravitation", "xx-interaction"[26], "xx-particle"). The need for such (not information theoretical) terms usually only shows a weakness of the used model and that we don't know the (information theoretical) connection (since t=0).

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[25] t=0 is defined inside the considered reference system as the earliest time since which information (from a symmetry breaking) is available, see also section 6 . In the same system future paths must not contradict past symmetry breakings. If a *complete* repetition of the same constellation (at later time) is a contradiction, this (e.g. by consideration of fermions as possibilities in (10)) could lead to the Pauli Exclusion Principle.

[26] For example "weak-interaction": According to the above interpretation (of section 3) identical fermions can be interpreted as identical possibilities of return to a central symmetric elementary constellation. If after this past constellation there has been a single decision resp. symmetry-breaking, then the return to the origin symmetric state would contain the mirrored ("opposite") symmetry-breaking. Because now we measure multiples of these possibilities of return, we can also measure multiples of such a symmetry-breaking, e.g. of "weak-interaction".

101. ADDENDUM: SHORT REMARKS TO CONNECTIONS TO TOPICS OUTSIDE PHYSICS

As long as (in our time frame) the "circuit does not close" (the important fundamental questions are not solved by solutions which fit fully together and with reality), we have at best a patchwork and relevant gaps in knowledge. The current approaches in physics make research in a part (2017) of the complete relevant "circuit" - naturally they started with the statistically easiest predictable part. We know that an information theoretical approach is more fundamental than a geometric approach. So it is natural to search for hints in other important fields connected with information.

101.1 Information theory

101.1.1 (Psychology and musical information)

Music (time coded information) is closer to the origin than geometrically coded information. There is no radial distance - the recognizing seems to be "closer" to the center. The recognized information correlates within very different time frames.

101.1.2 Information and Biology

Obviously there is a connection between biological constructions and physics. The statistical branching depth is in large parts outside the range of our current (2017) approaches. But the principles can give important hints. Some obviously relevant topics:

- Handling of genetic information.
- How leads genetic information to growth? The genetic information alone is not sufficient. How can it be an "initial key", which opens access to more complex information?
- Evolution, Biogenesis: There is e.g. a connection to geometry. Animals with radial symmetry produce two germ layers - the *ectoderm* and *endoderm*. Animals (also humans) with bilateral symmetry produce a third layer (the *mesoderm*). The layers grow to organs with different tasks (e.g. decisions (brain), collection of energy, visible movement).

101.1.3 Connection between conservation law, time direction, long term information (truth)

2023: The longer I deal with this subject, the clearer the original strict conservation law becomes. It results in an information-theoretical law. It leads to the fact that (within proper time) we cannot fool ourselves. Thereby we recognize the hierarchy until the beginning of time. Therefore no bit can be lost.
The (original, strict) conservation law (the basis of the other subordinate conservation laws) probably plays an important role even for determination of (also of long term) time direction (and with this for reliability of "truth" which is defined that it "applies (is perceptible) at last"): After an **initial symmetry breaking (A)** (in frames which we recognize in our time frame at once as "alive" it may have the name "decision") our reference frame gets perceptible information (a selection from a set of initially 2 possibilities). The **conservation law** defines, that former or later (locally there are hierarchical time frames which are differing largely in magnitude) "**time**" (which can be represented as sum of return probabilities to the local initial symmetry center [O2]) leads back towards the symmetry center and so defines **time** direction towards "future" within different time frames. We call the original (in the **initial symmetry breaking (A)** defined) long term (reliable, future) information also "*truth*" - it is associated to the root and has maximal branching width. Due to the conservation law this original information is accessible at last (perceptible) on the way back to the **initial symmetry breaking (A)**.
(We can say that the (initial decision and the resulting) initial symmetry breaking (A) "causes" the direction of time.)

If the conservation law at last leads back, from which results (temporary) untruth?
To allow freedom for generation of new information there is an initial delay from initial decision until associated first perception. Only then we can compare it to the more early original and recognize correlation or not (true or false - or in case of more complex branching better or not so good). As long as there is freedom[27] (geometrically there is a natural delay due to light speed) we can also decide for the wrong alternative, because the truth is still not clear enough for us. The "own later" decision creates a new truth, a new own standpoint which is in case of a wrong decision more away from the truth. The branching in this direction can grow (even consciously with perceptions). Then (also psychological) inertia (see 101.1.4) hinders initially return to the truth and the new (temporary) own standpoint is (finally) not true. Due to the larger (maximal) branching width of the original root this has to become (more and more) clear former or later on the way back to the former original information.

101.1.4 Information and psychology

There is a tendency to remain in the old standpoint. But fact is that we are born outside the center (with connected asymmetries from birth on which can only remain for a limited time). So we have to correct our own standpoint during life to come nearer to truth. (Psychological) inertia is hindering - the "movement" of the own standpoint is uncomfortable. It also leads to new open questions (new missing information). Psychological inertia helps us to keep true standpoints, but it also hinders us to correct wrong standpoints. The best what we can do is to (avoid contradictions to the primary decision and to) search again and again for the complete truth (which by definition applies at last, see e.g. 101.1.1) to

[27] Later (more branching depth) due to physical inertia we need to incorporate "free" energy which allows us to express own decisions with our body.

find the best rules, that in the long run our decisions lead towards conjoint future and don't contradict conjoint future.