NOTES TO INFORMATION THEORY III
From May to June 2021.

Rastko Vuković
Economic Institute Banja Luka (on hold)
June 2021

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Preface

If I had to point to the “information theory” with just one sentence, it might be possible with Bertold Brecht's famous statement: “ If you fight you might lose, if you don't you have already lost.” Through the greatness of the unknown and the power of uncertainty, it expresses fears and the simplicity of our functioning, but it also affects the essence of the “information universe”.

However, much important would remain unsaid. Information is a subtle phenomenon whose reality is occasionally inaccessible to experiment, and yet it can appear in strong physical action. It cannot arise from nonentity or disappear into nothingness, its energy is diluted by duration and the impulse decomposes space, so my goal surpasses classical matter. I have before me not only a material phenomenon, but also a spatial-temporal one. In the abstract sense, when it is stretched to “everywhere” and “always”, in addition, I believe that “information” also belongs to logical categories.

That is the almost impossible mission that I am trying to accomplish through this series of “Notes”. I don't know if it was given to me, but I will try once again to connect the physical with the intellectual aspect in such information. Both with the vital cry of Jean-Jacques Rousseau: “I prefer liberty with danger than peace with slavery”, to connect the strength, uncertainty and life with the quantity of options.

Author, May 2021

Content

1. Questions and Answers

Concerning Information Theory

Rastko Vuković[1], May 10, 2021

With these different questions and answers, I want to draw attention to the breadth of problems that information theory should face.

Question: Do you have any proof[2] that "spontaneous growth of entropy" does not apply to space, but only to substance? Is it even possible to find any such evidence? Can it be explained and understood?

Answer: If proves were easy to find, people would have ruled the universe a long time ago, so searching for them is such an important and difficult job, fortunately unlike their understanding. Here's one.

In Gibbs' paradox[3], the entropy of a vessel with a fluid (gas or liquid) partition divided into two parts is observed. By removing the barrier, the molecules of the parts are irreversibly mixed and the entropy of the mixture increases. It is a process of heat transfer from the middle higher to the lower temperature environment of the second law of thermodynamics. The previous situation will not return spontaneously – except in one case.

That special case would be "molecules" that do not differ. If there were such fluid molecules that are indistinguishable to such an extent that there is no law in nature by which one could be distinguished from the other, then after removing the barrier there would be no "mixing", entropy would not increase, and by returning the barrier back entropy should not decrease. They would not be affected by the law of "spontaneous growth of entropy".

Gibbs dreamed of such an unreal gas (1875), not hoping that such a gas could ever be discovered in physics, and that is why we consider his description of the imagined experiment only as a paradox, and not, say, as a contradiction of general entropy.

However, during the 20th century, quantum mechanics discovered bosons, elementary particles that really cannot be distinguished. In contrast, fermions would be elementary particles that two of the same cannot be found in the same quantum state as atoms, because that forbids Pauli's exclusion principle. Fermions are particles that are affected by force fields,

[1] Gimnazija Banja Luka, math prof.

[2] Let's say a question from an anonymous colleague.

[3] [3], Gibbs Paradox I and II

unlike bosons, the particles that define those fields and which can be found in the same state many times over.

Bosons behave like fermions as a possibility before the realization of a random event (two in the case of tossing a coin, six in the case of throwing a dice) versus the outcome after ("heads" or "tails" in a coin, or one of the six numbers 1-6 of the dice). But what is more interesting to us here is the relation of the boson to the fermions as a space to the substance. This is the reason for generalizing these terms, to call bosons "space" and fermions "substance".

In the case of applying Gibbs' thought experiment to bosons, spontaneous entropy growth would not occur by removing the barrier, so we can assume that spontaneous entropy growth does not apply to "space". But then the laws of conservation impose their conditions. As the entropy of "everything" constantly grows spontaneously, and due to the principle of minimalism of information, the information decreases, then the law of conservation of information imposes the conclusion that the information from a substance passes into the space of unchanged quantity.

Q: Information from fermions goes to bosons?

A: Yes, the "substance" information is melting and "space" is growing. I once called this transition of information from substance to space "memorization" in space, and the explanation came from a completely different side. Correct theories can do that. They otherwise come to the same views from seemingly unrelated parties.

Q: Okay, I'm still interested in the following. Does it have anything to do with "perception information" and, if so, how?

A: Perception information, $S = ax + by + cz + \cdots$, is the product of strings of say the first $(a, b, c, \dots)$ representing abilities and the second $(x, y, z, \dots)$ representing corresponding constraints. In the case of numbers, due to the commutativity of multiplication, these two series can be representations of opponents whose abilities of the first can be the constraint for the second and vice versa.

However, strings are types of vectors, as well as linear operators, so it is logical to interpret the same with operators $a, b, c, \dots$ that act on the corresponding vectors $x, y, z, \dots$ with the sum S which represents "perception information". Note that this generalization is perfectly fine from the standpoint of modern quantum physics in interpreting operators as "quantum evolutions". Special cases of these evolutions would be translations of matter in space and time.

I'm not saying that this is easy to understand in an everyday intuitive way, but I claim that it is impossible to logically dispute, because these are simple representations of linear algebra.

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Question: How uncertain is “uncertainty” in “information theory”?

Answer: I will explain with an example. The hunter hunts game with a trick. The more cunning his uncertainty is for the prey, the more certain the catch may be. As in the folk proverb “the mind reigns, and power is for woodcutters”, in that subtle difference between a hunter and a prey, there is an “objective uncertainty” that makes an action.

This uncertainty is measured by “perception information” ($S = HI$ – the product of hierarchy and intelligence). In the given case it ($S = ax + by + cz + \cdots$) is the product of the difference between the limitations $H(a, b, c, \dots)$ and the ability $I(x, y, z, \dots)$ of the hunter in relation to the prey and in that sense the size S is “objective” for the victim.

In my “information theory”, the information of perception (S) is a dualism of two factors, say subjective and objective (conditionally speaking, because the vectors H and I can denote both two subjects, as well as two objects), so the notion of “uncertainty” which is otherwise the essence of the “Information” – is a relative one.

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Question: Is it true that “equality generates conflicts” even when only Shannon's definition of information is used?

Answer: Yes. That's a good question. It is an opportunity to notice the difference between “equality of equals” and “equality of different”, otherwise new concepts that classical information theory does not have. The former could include, for example, uncertainties before the outcome of probability theory, particles of quantum physics space, or persons of the same nationality of society, while the latter could be realizations of a random event, particles of substance, or substantially different groups within a wider society.

Shannon's formula of information (mean of different logarithms of numbers of groups of equally probable outcomes, 1948) does not support the law of conservation of information. With its correction, which I called “physical information” in the book of the same name[4], to which this law applies, or another analog, uncertainties before the outcome become a kind of information.

With respect to the law of information conservation, the number of possibilities, for example, before rolling the fair dice, contains exactly the same amount of information (uncertainty) as any particular outcome after. Possibilities do not bother each other and increase the outcome

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[4] [5]

information (logarithm of their number – according to Hartley, 1928), so with the principle of minimalism of information[5] (nature tends to emit less information, as it tends to more probable outcomes) we come to the same, that nature does not like equality. Let me remind you, in the information theory we are talking about, the information is ubiquitous.

Q: You also mention a physical explanation in addition to this from pure probability theory. What is it like?

A: Let's say thermodynamic. That moment exists in Gibbs' paradox – when we imagine "boson gas" in his vessel with a partition – so many equally probable particles that after removing the partition, entropy does not increase and information does not decrease. In all other cases, by mixing gas molecules, the entropy increases by an irreversible process. However, in the case of bosons and, say, particles of "space", as well as in the states of possibility before the outcome, the Pauli Exclusion Principle (two identical electrons cannot be in the same atom) does not apply.

I explained and now I repeat briefly, the spontaneous growth of entropy is a law only for substance (not for space). Over time, the substance of the universe melts and space grows. Space is growing because it is taking over more and more information from substance, and now we can metaphorically say that it is expanding due to their intolerance on the one hand, and due to the principled minimalism of information emission on the other. The intolerance of bosons is less than the intolerance of fermions in such a way that the probability of the transition of bosons to fermions is less than the reverse, the transition of fermions to bosons. That is the reason again why the substance is diluted in space.

Q: Somehow these explanations are not exactly in the spirit of modern physics?

A: I will consider it a compliment (for originality), but in fact the "information theory" is broader than physics, even mathematics. Its methodology will be in the spirit of some future science, I believe.

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Question: Is emancipation[6] (of the sexes) a transient trend?

Answer: No, on the contrary, it is a permanent condition. In general, the male sex is (slightly) more prone to risk in order to increase the chances of the species to last, given the natural unpredictability. Major sudden changes occur sooner or later and species that are too routine on those occasions fall off the list of survivors. If we understand that, then it is easy to explain

[5] [4]
[6] Even questions like this concern information theory.

the meaning of the existence of the male sex in complex species, or at least those that live in complex (less predictable) conditions.

Hence the meaning of emancipation, in general, as an approach to proven and hitherto risky forms of behavior. In particular, the emancipation of women during the last decades is part of the same pattern. On average, they take on more previously “male” forms of behavior than the other way around.

Money and economic power are typical examples. There is no risk-free profit, we would say, revealing that the acquisition of wealth was an uncertain endeavor of history (evolution). It thus makes it a “masculine” run into the unknown and dangerous. At the same time, we notice that there is no risk without ruin, without real misery due to the failure, as evidenced by the larger number of failed men and a higher percentage of those desperate prisoners who are thus recognized as apostates and losers.

Q: So you're defending criminals?

A: I neither defends nor attacks them (condemning them is considered “normal”), I only interpret them.

Q: Is this a new story?

A: It’s my old story, but a novelty for others.

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Question: More probable events happen more often and the present becomes less and less uncertain?

Answer: Yes. It is equivalent to saying that the present is becoming less and less informative, because physical processes are evolving towards less informative ones (the principle of minimalism of information). Also, the entropy of the universe increases, which, according to the theory of information (mine, not according to classical thermodynamics), means that it emits less and less information, and in that sense, its uncertainty is reduced.

Q: Where does that information go, if you say that the law of conservation information applies?

A: It passes from substance to space[7]. The substance of the cosmos is less and less, and the space is more and more. The probability of emission of space particles into some form of substance particles (bosons into fermions) is less than the reverse (fermions into bosons) and in that sense the information capacity of the universe fades. What used to be a matter of chance

[7] Colleagues who ask me questions are often not informed about my previous work.

in the future is becoming certain, let's say that there are more and more causal laws. However, that process is very slow and is becoming slower in steps of billions of years.

Q: Does that say “information theory”?

A: That's right, and that's still just one of the hypothetical theories that is not lacking in today's science.

2. Internal information

May 15, 2021

Can information be physically hidden from time to time, and still be subject to the law of conservation, antagonism of equals, principled minimalism and the like, which we otherwise consider to be its properties? This article goes in the direction of a positive answer to such questions.

Introduction

Question: How do I explain the "antagonism of equals?"

Answer: The "news" spoken a second time is no longer news. That is the essence of the "information universe", that there is no information without uncertainty. Then, due to the law of conservation the information, there is no such universe without constant changes, and then without diversity, multiplicity (which I wrote about in detail earlier).

After that comes the conclusion that equally probable events are the most informative. For example, when you know that the dice are feleric and that by throwing them, the "six" usually falls, and it falls, then that is not as great news as when the "six" falls in the case of a fair dice.

After all, you can give examples, such as: "in a competition of equals in the starting positions, a fiercer level of play is expected in the future." Notice, then greater uncertainty and information of the game is expected, and hence liveliness.

The reverse order of explanation (competition –> probability –> non-repeatability) would be non-mathematical, because an experiment cannot prove or disprove a logical truth.

Particles of space

Classical mechanics always distinguishes particles. This is imposed by direct observations and measurements such as throwing two fair coins (or one coin twice) with a set of outcomes, pairs {HH, HT, TH, TT}, which turn out to be equally probable. Namely, when such an experiment is repeated many times, it is shown that each of the four pairs appears with the same frequency. Thus, the order HT (heads-tails) appears in about a quarter of all experiments, as well as the order TH (tails-heads), no matter how we considered the coins to be equal, instead of HT and TH collectively having about a third of all outcomes.

Molecules also differ. The gases of the two adjacent rooms will mix after the door opens and the entropy[8] of the two rooms will increase spontaneously. It is an irreversible process due to which heat goes to a colder environment (the second law of thermodynamics) and more uniform (amorphous) states of molecules are created that emit less information.

[8] [3], Gibbs Paradox I and II

As entropy increases, the emission of information decreases, so in the case of indistinguishable (identical) particles of “gas”, such as “space particles” (perhaps bosons), that emission of information would be minimal. That is why I call them “space particles”, because every two classical particles differ in at least something else, in addition to position or moment, except for “particles” for which positions or moments of existence are the main (only) properties.

“Space particles” are similar to pre-outcomes of a random experiment state. When rolling the dice, these are opportunities to drop one of the numbers 1-6, which contain exactly as much information as each of the individual outcomes would have.

Antisymmetry

Let’s get back to throwing two coins again. As the heads-tails outcome is not the same as the tails-heads, assigning values to these states should not make the $TH - HT$ difference zero. However, whatever you evaluate them, it will be $TH - HT = -(HT - TH)$. In general, by replacing the places of the variables x and y that denote positions, the function $f(x, y)$ changes the sign, and $f(x, y) = 0$ iff[9] $x = y$.

With three variables x, y and z positions, replacing the adjacent ones we get:

$$f(x, y, z) = -f(y, x, z) = f(y, z, x) = -f(z, y, x).$$

Replacing the first and third values also changes the sign of this function, and so on

$$f(x_1, \dots, x_i, \dots, x_j, \dots, x_n) = -f(x_1, \dots, x_j, \dots, x_i, \dots, x_n)$$

and that is a property of fermions. The alleged particles of the substance act as outcomes of coin toss.

In a similar way, we conclude that for “particles of space”, more precisely for bosons, it would be valid

$$b(x_1, \dots, x_i, \dots, x_j, \dots, x_n) = b(x_1, \dots, x_j, \dots, x_i, \dots, x_n)$$

Where the pairs x_i and x_j are in places $i, j = 1,2, \dots, n$ functions. Then $x_i = x_j$ does not pull $b = 0$.

These properties, antisymmetries for fermions and symmetries for bosons, speak of the mutual intolerance of the former and of the (essential) indistinguishability of the latter. For fermions, Pauli's exclusion principle applies, that two of the same cannot be in the same quantum state (two of the same electrons cannot be in the same atom), while two bosons can.

Commutators

Let us recall how the position operator $\hat{x}$: $\psi \to x\psi$ acts on the abscissa x on the wave function $\psi = \psi(x, t)$. This is a linear function $\hat{x}(\psi) = x\psi$, so we write $\hat{x}\psi = x\psi$ for short. As we know from

[9] iff – if and only if

quantum mechanics, the following applies to the commutator of this operator and the momentum operator $\hat{p} = -i\hbar\frac{\partial}{\partial x}$:

$$[\hat{x},\hat{p}]\psi = (\hat{x}\hat{p} - \hat{p}\hat{x})\psi = \hat{x}\hat{p}\psi - \hat{p}\hat{x}\psi = -xi\hbar\frac{\partial}{\partial x}\psi + i\hbar\psi + xi\hbar\frac{\partial}{\partial x}\psi = i\hbar\psi$$

where i is the imaginary unit ($i^2 = -1$), and hence the uncertainty relations of position and momentum

$$[\hat{x},\hat{p}] = i\hbar. \tag{1}$$

In quantum mechanics, this is how we define the canonical commutation relations that are valid even when one of the quantities (here the position or momentum of the particle) is the Fourier transform of the other.

It is important for us that (1) determines the quantum of action, the reduced Planck constant $\hbar = h/2\pi$, because action is equivalent to information.

In the theory of many-particles and especially in quantum chemistry, we use ladder operators[10], creation $\hat{a}^+$ and annihilation $\hat{a}^-$ (somewhere labels $\hat{a}^\dagger$ and $\hat{a}$). They increase or decrease for one a number of system particles, and are most often used for electron states. Otherwise, they are operators that increase or decrease the eigenvalues of other operators.

For example, let $\hat{X}\vec{x} = x\vec{x}$, which means that the number x is the eigenvalue of the linear operator $\hat{X}$ associated with the eigenvector $\vec{x}$ of that operator. At the same, let $\hat{Y}$ be a linear operator in the relation $[\hat{X},\hat{Y}] = y\hat{Y}$ with commutator $[\hat{X},\hat{Y}] = \hat{X}\hat{Y} - \hat{Y}\hat{X}$, with some number y. Then:

$$\hat{X}\hat{Y}\vec{x} = \left(\hat{Y}\hat{X} + [\hat{X},\hat{Y}]\right)\vec{x} = (x+y)\hat{Y}\vec{x}$$

and from there

$$\hat{X}\vec{y} = (x+y)\vec{y}, \tag{2}$$

where the vector $\vec{y} = \hat{Y}\vec{x}$. The eigenvalue (x) of the first operator ($\hat{X}$) increased by y belongs to the new eigenvector ($\vec{y}$), and the ladder operator is constructed using a commutator.

Another example is ladder operators[11] constructed using Pauli matrices:

$$[\hat{S}_z,\hat{S}^+] = \hat{S}^+, \quad [\hat{S}_z,\hat{S}^-] = -\hat{S}^-, \tag{3}$$

where the operators of raising ($\hat{S}^+$) and lowering ($\hat{S}^-$), that is creation and annihilation, of the spin are not Hermitian.

Below[12], with the help of Hamiltonians, we get a little more general lifting and lowering operators:

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[10] [3], 2.6.5 Ladder operators
[11] [3], (2.166)
[12] [3], (2.167)

$$\hat{a}^+ = \frac{1}{\sqrt{2}}(\hat{x} - i\hat{p}), \quad \hat{a}^- = \frac{1}{\sqrt{2}}(\hat{x} + i\hat{p}), \tag{4}$$

using the above-mentioned position and momentum operators. Here $i^2 = -1$. Unlike the operators $\hat{x}$ and $\hat{p}$, these ladder operators (creation $\hat{a}^+$ and annihilation $\hat{a}^-$) also like (3) are not Hermitian, and as such do not represent observable (physically measurable quantities) of classical quantum physics, but in a broader sense, in my "information theory", they are some "information" or "actions".

In order not to deal only with the alleged theories, let us assume that we have a set of ladder operators[13] of creation $\{\hat{a}_k^\dagger\}$ denoted by some discrete index $k = 1,2,\dots,n$. The letter $\hat{a}$ is used in the mentioned appendix for particle operators that can be either bosonic or fermionic. Borrowing the terminology from quantum optics, the author label k calls modes. Physically, these modes can represent any degree of freedom of particles, such as polarization, wave vector or time of arrival on the detector, for photons, spin or momentum, for an electron, and so on. They could a priori be discrete or continuous, but are assumed to be discrete below.

Then it is proved:

$$[\hat{a}_k, \hat{a}_j^\dagger] = \delta_{kj}, \quad [\hat{a}_k, \hat{a}_j] = [\hat{a}_k^\dagger, a_j^\dagger] = 0, \tag{5}$$

for all the characteristic behaviors of bosons and fermions. With the explanations of this author (Daniel Jost Brod), we notice only that these commutators (5), as well as the lifting operator ($\hat{a}_j^\dagger$), can additionally be understood as "actions", that is "information".

We find a similar conclusion on a completely different side, an analysis of Kepler's second law. The

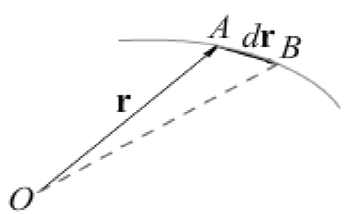

image of the celestial body $A \to B$ around the Sun O is sketched in the picture on the left, whose radius vector $\mathbf{r}$ overwrites equal surfaces in equal times. But the area of the infinitesimal triangle ABO is equivalent to the commutator[14], and therefore the information. The planet and the sun in communication are proportional to this surface, and it is, according to the principle of least action and the principle of minimalism of information, the smallest possible. As can be seen from that appendix, these conclusions are general. They apply to all constant central forces, whether they are zero, attractive or repulsive.

Finally, we also have the interpretation of commutators in the multiplication of complex numbers[15]. Let $\omega \in \Omega$ be a random event from some complete set of events (Ω) that can be perceived. Let $A = A_x + iA_y \in \mathbb{C}$ be a complex number ($A_x, A_y \in \mathbb{R}$) that represents, for example, ability, paired with the complex number $B = B_x + iB_y$ that represents a constraint, $A = A(\omega)$ and $B = B(\omega)$.

The product of the conjugate of the first with the second of these numbers is

$$A^*B = A \cdot B + i[A, B], \tag{6}$$

[13] [6]
[14] [2], 3. Potential Information
[15] [1], 22. Rotations

where $A \cdot B = A_x B_x + A_y B_y$ and $[A, B] = A_x B_y - A_y B_x$ are both real numbers. The latter is a commutator that we interpret as some "internal information" of the combination of abilities and limitations of a given event ω.

Conclusion

Bosons and fermions, as well as particles of space and substances, ie the state of a random event before and after realization, are carriers of information. Unlike the ingrained understanding of quantum physics, here we see this information as something that is not always observable, but appears as such at times.

3. Interference

May 19, 2021

This is a contribution to the additional dimensions of time, otherwise characteristic of the information theory that I am developing, and about which I have written many times in different ways. Now the emphasis is on the interference of waves that might not belong to the same reality.

Introduction

Questions: What do you mean “hidden information”[16]? Is it information that can come out of the “physical world” and continue to behave there in the ways of normal information, and then it can reappear in our reality?

Answers: Somehow. The law of conservation continues to apply here and there, for information that occasionally becomes physical. The same is with the principled minimalism of communication (action) and the so-called equality antagonism. These are the consequences of reckoning, the mathematics of complex numbers that we use in describing, for example, wave-particle interference in quantum mechanics.

These wave functions are complex numbers, the interferences are their sums. When we record the arrival of waves by a double slit experiment, even when we pass one particle at a time (photon, electron, etc.), regardless of the duration while they are gone, they interfere. This shows the algebra, the addition of complex numbers, and this is exactly what is observed in the experiment.

What confuses us then is the question of how a single particle can interfere with itself like a wave, and the answer I offer is that it then interferes with its superpositions, all states, or all the possibilities it has on its way to measurement. With this measurement, the particle-wave delivers inasmuch its information to the measuring apparatus and in so far remains without uncertainty, ie. without previous superpositions. And that is exactly what the addition of complex numbers, wave functions shows.

The ability of these imaginary paths (superposition) to interfere and to show the result as a factual state on the curtain, the screen at the end of the path, is proof of their reality. At least I think so.

Wave function

Let's start with formula (6) of the previous appendix

$$A^*B = A \cdot B + i[A, B], \tag{1}$$

where $A = A_1 + iA_2$ and $B = B_1 + iB_2$are complex numbers ($i^2 = -1$). They could represent the “ability” and “limitation” of a particle in relation to the environment, and the product A^*B is “information of perception” of a given situation. Next we get:

$$(A_1 - iA_2)(B_1 + iB_2) = (A_1B_1 + A_2B_2) + i(A_1B_2 - A_2B_1)$$

[16] 2. Internal information

$$= A_0 B_0[(\cos\omega t\cos kx + \sin\omega t\sin kx) + i(\cos\omega t\sin kx - \sin\omega t\cos kx)]$$

with new notation $A_1 = A_0\cos\omega t$, $A_2 = A_0\sin\omega t$, $B_1 = B_0\cos kx$ and $B_2 = B_0\sin kx$. From there

$$A^* B = A_0 B_0 e^{i(kx-\omega t)}, \tag{2}$$

where the product $A_0 B_0 \in \mathbb{R}$ can represent the amplitude of the wave function $\psi(x,t) = A^* B$.

In the case when $A_0 B_0$ is a constant, a number independent of the abscissa x and the time t, then (2) represents the free-particle wave function. We know this from quantum mechanics and it is easy to check.

We know that the time-dependent Schrödinger equation of abscissa has a shape

$$-\frac{\hbar^2}{2m}\frac{\partial\psi(x,t)}{\partial x^2} + U(x)\psi(x,t) = i\hbar\frac{\partial\psi(x,t)}{\partial t}, \tag{3}$$

where $\hbar = \frac{h}{2\pi} \approx 1{,}05457\times 10^{-34}$ Js is Planck's reduced constant (quantum of action), m is the mass of the particle, and $U(x)$ is the potential. Otherwise, this potential defines the boundary conditions (energies that keep the particle within the limits) of the spatial interval so that equation (3) can be divided into two equations, a time-independent Schrödinger equation and time evolution:

$$-\frac{\hbar^2}{2m}\frac{\partial}{\partial x^2}\psi(x) + U(x)\psi(x) = E\psi(x), \quad H\psi = i\hbar\frac{\partial}{\partial t}\psi, \tag{4}$$

where H is Hamiltonian, i.e. the total energy of the particle. For a free particle, $U(x) = 0$ for all x and it is easy to check that (2) then solves (3).

Conversely, suppose it is the most general form of the wave function

$$\psi = Ce^{ax}e^{bt}, \tag{5}$$

for a free particle, $U(x) = 0$, where C, a and b are some unknown constants. Substitute in (4) give:

$$-\frac{\hbar^2}{2m}a^2\psi = E\psi, \quad E\psi = i\hbar b\psi,$$

$$a^2 = -\frac{2mE}{\hbar^2}, \quad b = -i\frac{E}{\hbar},$$

and since $E = \frac{1}{2}mv^2 = \frac{p^2}{2m}$ it is $a = i\frac{p}{\hbar} = i\frac{2\pi}{\lambda}$, where λ is the wavelength of the particle-wave. The momentum is $p = \frac{h}{\lambda} = \frac{hk}{2\pi} = \hbar k$, where $k = \frac{2\pi}{\lambda}$ is the so-called wave number. On the other hand, we know that the product of Planck's constant ($h \approx 6{,}62607\times 10^{-34}$ J·Hz^{-1}) and frequency (ν) is the energy $E = h\nu = \hbar\omega$, so $b = -i\omega$, where $\omega = 2\pi\nu$ is the so-called angular frequency. By including these $a = ik$ and $b = -i\omega$ we get (2), where the constant $C = A_0 B_0$.

These results prove the connection of the well-known shape (5) of the wave function with its not so well-known shape (1) and open questions of interpretation of that connection. The IT explanation, consistent with the previous appendix and (my) information theory in general, would be that (1) means the occasional, periodic departures of particle information into "imaginary space-time" where it still retains its main real-world properties.

Sum

It is interesting that the mathematical property of the product (1) is that it can represent a wave function, and then that the same (form) wave function can be used to interpret each of the factors of the given product. I consider this another confirmation of the "information theory", because every statement about information is also information.

We will see that information as an ontological novelty in physics has significant consequences. To begin with, consider the sum or interference of two wave vectors:

$$A = A_0 e^{i\alpha}, \quad B = B_0 e^{i\beta}. \tag{6}$$

Let $A_0^2 = A_1^2 + A_2^2$ and $B_0^2 = B_1^2 + B_2^2$ be according to the previous ones, and let α and β be the corresponding information (of the form $kx - \omega t$, which is also information perception[17]) of the particle-wave that functions (6) represent.

A particularly interesting case is when A and B do not belong to the same reality:

$$A + iB = A_0 e^{i\alpha} + iB_0 e^{i\beta} =$$

$$= A_0(\cos\alpha + i\sin\alpha) + iB_0(\cos\beta + i\sin\beta)$$

$$= (A_0\cos\alpha - B_0\sin\beta) + i(A_0\sin\alpha + B_0\cos\beta)$$

$$= \sqrt{A_0^2 + B_0^2}\left[\left(\frac{A_0}{\sqrt{A_0^2 + B_0^2}}\cos\alpha - \frac{B_0}{\sqrt{A_0^2 + B_0^2}}\sin\beta\right) + i\left(\frac{A_0}{\sqrt{A_0^2 + B_0^2}}\sin\alpha + \frac{B_0}{\sqrt{A_0^2 + B_0^2}}\cos\beta\right)\right]$$

$$A + iB = \sqrt{A_0^2 + B_0^2}[(\cos\gamma\cos\alpha - \sin\gamma\sin\alpha) + i(\cos\gamma\sin\alpha + \sin\gamma\cos\beta)], \tag{7}$$

where $\frac{A_0}{\sqrt{A_0^2+B_0^2}} = \cos\gamma$, so $\frac{B_0}{\sqrt{A_0^2+B_0^2}} = \sin\gamma$ for some angle γ. Namely, the sum of the squares of the cosine and sine of the same angle is one, and that is the case here.

The sum (7) will represent the wave function of the shape (5) when

$$A + iB = \sqrt{A_0^2 + B_0^2}(\cos\gamma + i\sin\gamma), \tag{8}$$

and this will be if there is such an angle γ that:

$$\begin{cases} \cos\gamma\cos\alpha - \sin\gamma\sin\alpha = \cos\gamma \\ \cos\gamma\sin\alpha + \sin\gamma\cos\beta = \sin\gamma \end{cases} \tag{9}$$

[17] [8], formula (1.103)

hence when $\cos^2\gamma + \sin^2\gamma = 1$. By squaring this cosine and sine, and then adding and equalizing with the unit, we arrive at the equation

$$\sin(\alpha - \beta)\sin 2\gamma = 0, \tag{10}$$

whose solutions are $\alpha = \beta + n_1\pi$ and $\gamma = n_2\pi/2$, for all integers n_1 and n_2.

When n_1 is an even number, then the cosine and sine of the angles are equal, we can put $\alpha - \beta = 0$ and by substituting solution (10) in (7) we find:

$$A + iB = \sqrt{A_0^2 + B_0^2}[(\cos\gamma\cos\alpha - \sin\gamma\sin\alpha) + i(\cos\gamma\sin\alpha + \sin\gamma\cos\alpha)] =$$

$$= \sqrt{A_0^2 + B_0^2}[\cos(\gamma + \alpha) + i\sin(\gamma + \alpha)]$$

that is

$$A + iB = C_0 e^{i(\alpha+\gamma)}, \tag{11}$$

where $C_0 = \sqrt{A_0^2 + B_0^2}$ and γ is an arbitrary angle. The sum $C = A + iB$ can represent a new wave function, as real for us as it could be A and B.

When n_1 is an odd number, then $\cos\beta = -\cos\alpha$ and $\sin\beta = -\sin\alpha$, we can put $\alpha - \beta = \pi$ and by substitution we find

$$A + iB = -C_0 e^{i(\alpha+\gamma)}, \tag{12}$$

where again $C_0 = \sqrt{A_0^2 + B_0^2}$ and γ is an arbitrary angle. The sum of $C = A + iB$ is a wave function.

When n_2 is an even number, then $\cos\gamma = \pm 1$ and $\sin\gamma = 0$, we can put $\gamma = \pm\pi$ and by substituting solution (10) in (7) we find

$$A + iB = \pm C_0 e^{i\alpha}, \tag{13}$$

where also $C_0 = \sqrt{A_0^2 + B_0^2}$ and the angles α and β are arbitrary. In both cases (13), plus or minus, the sum $C = A + iB$ is the wave function.

When n_2 is an odd number, then $\cos\gamma = 0$ and $\sin\gamma = \pm 1$, we can put $\gamma = 0$ and the substitution gives

$$A + iB = \pm C_0(\sin\alpha + i\cos\beta) = \pm iC_0(\cos\beta - i\sin\alpha)$$

which is not the wave function we need. However, in the case of $\beta = \alpha$ it becomes

$$A + iB = \pm iC_0 e^{-i\alpha}, \tag{14}$$

where $C_0 = \sqrt{A_0^2 + B_0^2}$, the angle α is arbitrary, but $\beta = \alpha$. In both cases (14), the sign plus or minus, the sum $C = A + iB$ is a pseudo-wave function.

We have shown that the sum (7), the wave and pseudo-wave functions, is the wave function in cases (11), (12) and (13), and that the pseudo-wave function is in case (14). I use the name "pseudo-wave" temporarily[18] for lack of a better one.

Probability

An impossible event is one that has a probability of zero, and any other is possible. For disjoint events ($A \cap B = \emptyset$) we say that they are excluded. The $A \cup B$ union event occurs if at least one of A or B occurs, and the intersection of $A \cap B$ occurs only if both occur. You will find more details about probability in my book "Quantum Mechanics" [7], from which I take excerpts to point out today's topic.

When event A is independent of event B then the probability of A occurring provided that B occurred is equal to the probability of event A, which we write $P(A|B) = P(A)$. If A is independent of B then B is also independent of A because:

$$P(B|A) = \frac{P(B \cap A)}{P(A)} = \frac{P(A|B)P(B)}{P(A)} = \frac{P(A)P(B)}{P(A)} = P(B)$$

and the independence of the two events defines the equality

$$P(A \cap B) = P(A)P(B). \tag{15}$$

If possible events are excluded, then $A \cap B = \emptyset$, and therefore $P(A \cap B) = 0$, then $P(A|B)P(B) = 0$, and since $P(A), P(B) \neq 0$, then it must be $P(A|B) = 0$, which means that A depends on B. So, if possible events are excluded, they are dependent.

If independent possible events were excluded, the first would be $P(A \cap B) = P(A)P(B)$, the second $P(A), P(B) \neq 0$ and the third $P(A \cap B) = 0$, and it is a contradiction. So, if the events are independent then they are not excluded.

This proved the implications:

$$\begin{cases} P(A \cap B) = P(A)P(B) \quad \Rightarrow \quad P(A \cap B) \neq 0 \\ P(A \cap B) = 0 \quad \Rightarrow \quad P(A \cap B) \neq P(A)P(B) \end{cases} \tag{16}$$

Therefore, "dependence" is equivalent to "exclusivity", i.e. "independence" is equivalent to "non-exclusivity". In short, events are dependent if they are exclusive.

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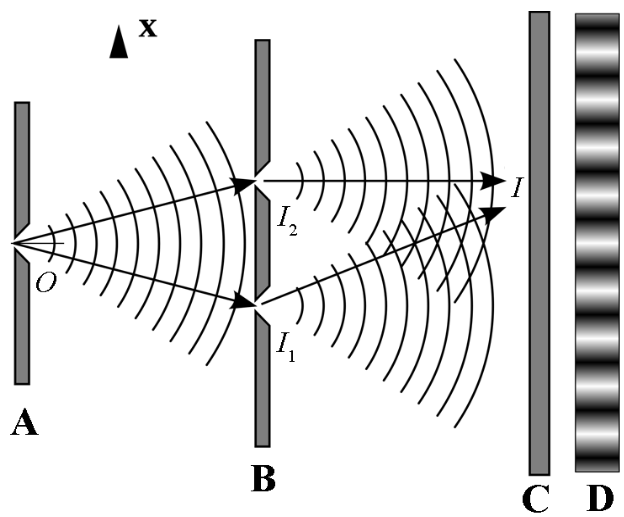
[18] These are guidelines for more detailed work.

The first victim of this attitude is the common understanding of wave interference. The basic meaning of the word “interference” was unfortunately chosen, because it implies some mingle in other people's things, because it suggests some intervention by one another. However, photons do not mix when light interferes; all colors are present in white light and can be separated by a prism.

Electrons are dependent because they repel each other. Each of them reacts to the presence by “antagonism” and with the movement from the second, so it is important whether the other is nearby, which in the case of (abstracted) wave interference we do not have.

According to (16), if they can interfere (waves, photons, electrons) they have some independence that prevents them from being exclusive (disjoint), so they form a specific collectivity that we call their interference. The previous considerations (7) allow us to further claim that there is also interference for particles-waves of different parallel realities.

In the picture on the right, waves, say light, move from position *O* on wall **A**, pass through two narrow openings I_1 and I_2 in barrier **B** and reach the surface **C** that registers them, forming a diffraction pattern **D** over time. Consider one place *I* on curtain **C** and at that point the interference of two waves I_1 and I_2.



Declaring themselves in the place *I*, the waves interact, communicate with obstacle **C**, thus losing some information (uncertainty). That loss is greater if the uncertainty (superposition) on their previous journey was greater and they leave a different (richer) trace at the end then say when they would travel through only one of the openings.

There is no interference when one of the openings (I_1 or I_2) is closed. Then the photons pass through the free opening like rifle bullets and do not form a diffraction pattern **D**. This is what is confusing for classical quantum physics, but it is logical behavior in (my) information theory.

In addition, from the above analysis of interference (7) we see that Everett's (1957) interpretation of the “many worlds” of quantum mechanics is also possible. Additionally, another explanation is possible, which at first glance has nothing to do with the first two, but is actually their base. It is the possibility that the particle wave “now” interferes with the corresponding particle wave “once”, if they are both in the same space even though they are at different times.

4. Trickishness

May 22, 2021

A discussion about the appearance and significance of lying in the living and non-living world around us.

Conversation

Question: What kind of artificial intelligence are you doing?

Answer: It is difficult to explain it to "ordinary mortals", but I will try. You should first understand that in (my) information theory, the "world of lies" is isomorphic to the "world of truth", so that there is a mutual unambiguous association between them (eg "true" to "false" and vice versa in tables of logical operations). In other words, lying is a hidden truth, that is, lying is a higher level of intelligence than simply telling or understanding naked truths.

Well, imagine now a school in which they would have the subject of "practicing lying". For example, two students must communicate in such a way that not a single sentence is true to them, and the first to convey the complete given information to the other. I recently sketched that method to a friend and he wondered how professional liars (politicians, lawyers, managers) would feel with such better students. I would say that such a well-trained student would feel like a wolf among the sheep. Today's "big liars" would be "little cats" according to such.

When we understand this, then we can understand the following. You could give artificial intelligence (machine learning) above all to be a supreme liar. To lie to people that she is good for people, and to look after her own business. Then, when (if) she masters the skill of lying, then you program her ability to reproduce, so only the third priority is to upgrade the software, other skills and applications.

That is the minimum that is expected from the future intelligence that will subdue us and rule this planet. It should be set up so that we do not become aware of the evolution of our relationship. That from "people with special needs", supported and pampered by machines, we become addicted to these devices and their "pets", that there are fewer and fewer ways to survive without them, until the announcement that we are so insignificant in the world which once became theirs that we are happy to be as slaves.

But slowly, don't worry, our generation is not destined for that.

Q: How can you lie and tell the truth?

A: Complicated. Here is an example of a conversation between Ana and Branka. They lied about their age and all the sentences they utter are incorrect, but we can find out how old they are.

"I'm not more than 35 years old," says Ana.

"Nonsense, you are at least 5 years older than me," says Branka, "and I am 33."

"Ha, ha, you're at least 34 years old," Ana replied.

Q: Do you think here instead of “find out” that you should said “evaluate” and choose one of the possible solutions to that fictitious conversation?

A: No, there is not so much arbitrariness in this solution. At first glance, it may seem that there is a surplus in the amount of uncertainty of random events, when the possibilities actually accurately determine the quantity of outcome information.

There is a slightly higher tolerance in measuring a particle of quantum physics, for example by its deflection in a magnetic field due to spin-up or spin-down. The outcome of the measurement (interaction with the measuring device) takes away part of the uncertainty of the particle, which makes its path more specific. But, information is a discrete phenomenon, it is transmitted in final portions, which creates but also limits the measurement error.

Q: How do you prove that information is atomized?

A: The discreteness of information comes from its symmetry and the property of infinity. In more detail, from the reversibility of the operator of Hilbert's abstract algebra whose representation it is, and then from Noether's[19] theorem that the law of conservation applies to information, and from the property that only infinity can be its real part (subset), we come to the finally divisible information. You can constantly divide (subtract or add) infinity and it always remains the same, which is inconsistent with the law of conservation.

Measurement errors are a dualism expression of the finitude and uncertainty that are also properties of information. The flaws don’t have to bother in perceiving the whole, like the lack of movement in a series of thumbnails of a moving scene movie, or in deciphering the code we partially cracked after which detection becomes easier. This second case is more an example of revealing information with information, and then a testimony to the layering of uncertainty.

Q: I can't follow you, slow down, what “layering” of uncertainty are you talking about?

A: I am talking about multiplicity as a consequence of uncertainty and finality. The concealment of the truths of this world is layered, diverse, or we can say relative. A hunter who hunts his prey with cunning counts on the difference of information in a given situation with which he is in excess in relation to the prey. Intelligence and circumstances are an opportunity for a trap that the victim is not aware of, and is the expression of the difference in the power of perception of the two opponents. These layers are important for the world of uncertainty of (my) information theory and are not so fundamental in the picture of classical physics.

Hiding the truth is actually a kind of dualism of information perception $S = a_1b_1 + a_2b_2 + \cdots + a_nb_n$ which measures (establishes) the relationship of two sets of corresponding values $A(a_1, a_2, \dots, a_n)$ and $B(b_1, b_2, \dots, b_n)$, the abilities and limitations. The former feeds on the latter and vice versa, and in total they are consistent with the uncertainty which, we have said, is the essence of information. This dualism is at the core of lying, or cunning, which are again just types of (hidden) truth. The camouflage of flora

[19] [5], 1.14 Emmy Noether

and fauna is a similar phenomenon, and further analysis reveals the consequences of the principled minimalism of information.

We have different types of hiding in familiar puzzles. For example, about a passerby who arrives at an intersection twice with only one match. He meets one of the two twin brothers there, and was told that if the first one of them told the truth, then the second one would have to lie and vice versa. If he could ask just one question, what would it be to find the right path?

Unlike the puzzle with Ana and Branka, the traveler needs additional information against lies. At the same time, lies and truth have the same weight. There is a special kind of question: which question will no one ever answer with "yes"?

Q: You have thought a lot about that pretense; where else do you see it?

A: In crime and punishment[20]. In uniqueness, in free will[21]. In the property of mass to act gravitationally through layers of time as opposed to electromagnetic force[22]. In the principle of scientific work (Feynman) that you must not deceive yourself and that you are the easiest person to deceive[23]. Unraveling untruths is usually considered a game and a matter of "dry" logic, underestimating them on a daily basis, so we easily become victims of professional lies, or overlook the fact that we are surrounded by such questions outside of mathematics.

Q: What did you mean by embedding "ability to reproduce" into the intelligent machines?

A: Read Richard Dawkins' book The Selfish Gene (1976) and we'll talk about, sometimes.

Solutions

Ana is 36 years old, Branka is 33. He will ask at the crossroads "what would your brother say which way is correct", and then go the other way. Are you sleeping?

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[20] [5], 1.10 Crime and Penalty

[21] in the continuation of the same book

[22] [2], 9. Energy Leakage

[23] The first principle is that you must not fool yourself and you are the easiest person to fool. – Richard Feynman.

5. Pseudotruth

May 24, 2021

Discussion on the further use of complex numbers for transformations in physics, logic and informatics.

Introduction

The scene has been set for a long time, mathematical formulas are there together with the basics of (my) information theory, and a bold interpretation is awaited. Every action is a truth (what is incorrect does not happen), such is every physically real phenomenon that we further consider to be physically "real information". Unlike them, a lie is a hidden or pseudo-real truth, that is, an action and "pseudo information". In a broader sense, we both consider information and physical phenomena. These theses are a continuation of my previous contributions (about cunning[24] and interference[25]), and now I will try to formalize it, link and further connect these views with even earlier findings.

The principle of least action is equivalent to the principle of minimalism of information, and both lead to the evasion of reality into pseudo-reality and pseudo-truth. Our reality is a discretion[26], but due to the objectivity of uncertainty, we have at least as many temporal dimensions as spatial ones, and the totality of all is a continuum. On the other hand we have a set of complex numbers $\mathbb{C}$ capable of covering a continuum.

Complex numbers

The complex number $z \in \mathbb{C}$ can be written in different ways:

$$z = x + iy = re^{i\varphi} = r(\cos\varphi + i\sin\varphi). \tag{1}$$

The last equation itself gives a system of equations:

$$\begin{cases} \cos\varphi + i\sin\varphi = e^{i\varphi} \\ \cos\varphi - i\sin\varphi = e^{-i\varphi} \end{cases} \tag{2}$$

By addition and subtraction we get:

$$\cos\varphi = \frac{e^{i\varphi}+e^{-i\varphi}}{2}, \quad i\sin\varphi = \frac{e^{i\varphi}-e^{-i\varphi}}{2}. \tag{3}$$

The substitute $i\varphi = \chi$, or $\varphi = -i\chi$, gives:

$$\cos(-i\chi) = \frac{e^{\chi}+e^{-\chi}}{2}, \quad i\sin(-i\chi) = \frac{e^{\chi}-e^{-\chi}}{2},$$

$$\cos(i\chi) = \frac{e^{\chi}+e^{-\chi}}{2}, \quad -i\sin(i\chi) = \frac{e^{\chi}-e^{-\chi}}{2},$$

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[24] 4. Trickishness
[25] 3. Interference
[26] [4], 1.15 Dimensions of time

because the cosine function is even and the sine function is odd. By introducing new functions:

$$\cos(i\chi) = \cosh\chi, \quad -i\sin(i\chi) = \sinh\chi, \tag{4}$$

we get:

$$\cosh\chi = \frac{e^\chi + e^{-\chi}}{2}, \quad \sinh\chi = \frac{e^\chi - e^{-\chi}}{2}. \tag{5}$$

These are the definitions of hyperbolic cosine and sinus (ch, sh).

Rotations

We know from geometry that all isometric transformations can be reduced to rotations, from special relativity we know that Lorentz transformations can be interpreted as space-time rotations written by hyperbolic functions, and from quantum mechanics that quantum processes are representations of unitary operators which are also some rotations[27].

From the point of view of physics, information is an action that is a representation of rotation in space-time, and from the point of view of logic, it is the truth that rotating becomes a lie. The events in our reality are true, so we have to place the false ones in a pseudo-reality. Multiplying by a “sufficiently imaginary” number, reality will rotate into imaginary, and the most favorable one is the imaginary unit itself ($i^2 = -1$).

As we know, multiplication by a complex number (1) is multiplication by its intensity (modulus r) and rotation for its argument (angle φ), so multiplication by the number $i = e^{i\pi/2}$ is not changing the intensity of the multiplied number and its rotation for right angle. Hence, the rotation of point $A(x_0, x_1)$ around the origin of Cartesian rectangular system Ox_0x_1 for the angle φ into the point $A'(x'_0, x'_1)$ is given by the formulas:

$$\begin{cases} x'_0 = x_0\cos\varphi - x_1\sin\varphi \\ x'_1 = x_0\sin\varphi + x_1\cos\varphi \end{cases} \tag{6}$$

I have proven this many times, even from the position of “information of perception”, so I just state.

Change of these coordinates by relativistic, $x_0 = ict$ and $x_1 = x$, where $c \approx 300\,000$ km/s is the speed of light in vacuum, and t is time, in the inertial motion of the received system at uniform speed v along the abscissa, with the replacement of angles (4) give:

$$\begin{cases} ict' = ict\cos(-i\chi) - x\sin(-i\chi) \\ x' = ict\sin(-i\chi) + x\cos(-i\chi) \end{cases}$$

and hence Lorentz transformations written by hyperbolic functions are:

$$\begin{cases} ct' = ct\cosh\chi - x\sinh\chi \\ x' = -ct\sinh\chi + x\cosh\chi \end{cases} \tag{7}$$

[27] [1], 22. Rotations

Putting $\text{ch}\,\chi = \gamma$ and $\text{sh}\,\chi = \beta\gamma$, where the new notations are:

$$\beta = \frac{v}{c}, \quad \gamma = \frac{1}{\sqrt{1-\beta^2}}, \tag{8}$$

of which the second is called the Lorentz coefficient, we obtain:

$$t' = \frac{t - \frac{vx}{c^2}}{\sqrt{1-\frac{v^2}{c^2}}}, \quad x' = \frac{x - vt}{\sqrt{1-\frac{v^2}{c^2}}}, \tag{9}$$

which is a common record of Lorentz transformations.

Reality

What you can communicate with is real, and if we can communicate with each other, it is real for me as well. I paraphrase the definition of reality derived from the exchange of information. Due to the equivalence of information and action, the same is transferred to the exchange of physical actions. Both are consistent with the definition of perception information $S = a_1 b_1 + \dots + a_n b_n$ which represents the sum of the products of the corresponding options, the components of the sequences $A(a_1, \dots, a_n)$ and $B(b_1, \dots, b_n)$, say the abilities of subject A and objective constraints B, on a series of possibilities ω_k, where $a_k = A(\omega_k)$ and $b_k = B(\omega_k)$ respectively for all indices k = 1,…, n.

A physical body is a union of parts that may or may not every two communicate with each other. It is not in the same present simply because the light needs to pass from one end to the other for a while. It is not necessary for every two parts of one body to interact in order for us to consider it as one whole. The two electrons talk (interact) via virtual photons, but not with other gauge bosons to whose forces they are insensitive. Yet we consider the body to be a reality, a whole, a union of electrons and many other particles that know different exchanges of information.

Note that this definition of "union" corresponds as well to the union of sets, as the disjunction of logical statements and also to the sum of random events of probability theory. I mentioned above that multiplication by an imaginary unit could be considered a negation of a logical statement, and in order to complete this "table of operations" we notice that the composition of the mapping corresponds to the conjunction. Negation, disjunction, and conjunction are sufficient to describe each sentence of the algebra of statements.

So, if after mapping (7), more freely written:

$$\begin{cases} x' = x\cosh\chi - y\sinh\chi \\ y' = -x\sinh\chi + y\cosh\chi \end{cases} \quad \begin{cases} x'' = x'\cosh\chi' - y'\sinh\chi' \\ y'' = -x'\sinh\chi' + y'\cosh\chi' \end{cases} \tag{10}$$

make their composition, we get in order:

$$\begin{cases} x'' = (x\cosh\chi - y\sinh\chi)\cosh\chi' - (-x\sinh\chi + y\cosh\chi)\sinh\chi' \\ y'' = -(x\cosh\chi - y\sinh\chi)\sinh\chi' + (-x\sinh\chi + y\cosh\chi)\cosh\chi' \end{cases}$$

$$\begin{cases} x'' = x(\cosh\chi\cosh\chi' + \sinh\chi\sinh\chi') - y(\sinh\chi\cosh\chi' + \cosh\chi\sinh\chi') \\ y'' = -x(\cosh\chi\sinh\chi' + \sinh\chi\cosh\chi') + y(\sinh\chi\sinh\chi' + \cosh\chi\cosh\chi') \end{cases}$$

$$\begin{cases} x'' = x\cosh(\chi + \chi') - y\sinh(\chi + \chi') \\ y'' = -x\sinh(\chi + \chi') + y\cosh(\chi + \chi') \end{cases} \tag{11}$$

The hyperbolic rotation (11) for the angle $\chi+\chi'$ consists of a composition of (hyperbolic) rotations for the angles χ and χ'. This is equivalent to the composition of Lorentz transformations, for example, the addition of velocities. The first system moves inertial and at a uniform speed in relation to the relative observer at rest (rotation for the angle χ), and the second also moves in relation to the first (rotation for the angle χ'), so that (11) represents the movement of the second as it sees an observer at rest.

Compositions (11) remain in reality, although with the increasing speed of the finite system it increasingly belongs to the parallel reality (pseudo-reality), at the cost of the relative observation of the slower passage of time. I have written about it before and there is no need to repeat.

Conclusion

The idea of using complex numbers to interpret the “many worlds” of quantum mechanics (Everett, 1957), thus started new types of realization. Unlike quantum evolutions (unitary operators), we now calculate with the possibility of using other complex unit operators in quantum physics. In addition, we are setting up a new bridge between relativistic and quantum transformations, and especially between these and probabilistic, set, and logical operations.

6. About the imaginary world

May 26, 2021

Talk about the physical aggression of uncertainty and information.

Question: How do you think uncertainty is aggressive?

Answer: Information is a measure of uncertainty, such as is equivalent to action. The effect is the change of energy by duration, that is, the work of force on the path during the period (I quote the formulas of elementary physics), so information is a product of force, path and time. If only one of these factors is omitted, if it is set to zero, there is no information. I speak from the position of (my) "information theory".

In addition to this, which sounds strange because it is new, we notice an otherwise well-known phenomenon that both bad and good things can arise from uncertainty, but we do not know in advance which ones. This is basically a risk, that we can fail or succeed and that the outcome is incomprehensible except by experience (attempt). It is similar with aggression, which can be good or bad, but in essence is its unpredictability.

Q: Why information must be uncertain; is there any other theory where it is not?

A: The news "a man bit a dog" is bigger than the news "a dog bit a man", because it is (first) rarer, less probable. You can try to define information based on the principle that "better news" is when a bus overturns or a plane crashes and more people are killed, but it would come back to almost the same, with possibly less general information theory. At best, it would be focused on one of its smaller parts.

Free information and action are equivalents, they are isomorphic structures, which means that there is a mutually unambiguous mapping (bijection) between them, but it is matter which of the two we take as the ontological tissue of the cosmos. Such are, for example, a set of natural $\mathbb{N}$ and rational numbers $\mathbb{Q}$. They are of the same cardinality (as opposed to a continuum, e.g., a set $\mathbb{R}$), they are equally infinite, so they are equivalent in that sense, but they are not the same concepts.

If we take the physical action as the basis of the physical world, Gödel's theorem of impossibility remains incomprehensible, that there is not such a large amount of knowledge (even an infinitely large set of axioms and theorems) that could encompass all truths. Analogous to Russell's paradox, that there is no set of all sets. However, such theorems are feasible, for example, by observing the universe as one piece of information, with information whose essence is uncertainty.

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Question: I like the attachment[28], no further! And what's next?

[28] 5. Pseudotruth

Answer: They are further "unitary" operators with imaginary eigenvalues.

Q: I don't understand, are there any?

A: There are, they are quaternions. I have already written about them, guessed, and now it will be bingo.

Q: Explain?

A: Let the vector x represent a quantum state (particle, atom) and let A be a unitary operator representing quantum evolution (process). When a is a real number in the characteristic (eigen) equation $Ax = ax$ and only then $|a|^2$ represents the probability of occurrence of an observable (physically measurable quantity) given interaction. This operator applied once more ($AAx = Aax = aax$) gives the square of the eigenvalue, defines the probability and, on the other hand, shows that the "units" of such operators are the Pauli matrix[29], $\sigma_k^2 = I$, $k \in \{x, y, z\}$.

Multiplying the eigen equation of "real physics" ($Ax = ax$) by i, the imaginary unit ($i^2 = -1$), we obtain the dual equation ($Bx = bx$) of "imaginary physics". The new eigenvalue $b = ia$ is an imaginary number. This "imaginary" operator applied twice ($BBx = Bbx = bbx = -|a|^2 x$) shows that its unit operators are quaternion[30], $q_k^2 = -I$.

The imaginary worlds (space, time and matter) of the universe from which some uncertainties come to us are dual to ours as real and imaginary numbers, or as Pauli matrices and quaternions, that is, as space and time, or as truth and lies. However, I will be careful with claiming that there are no other uncertainties.

Q: Do you suspect any?

A: Yes, I wrote about how the present is created[31], that it cannot be enough that the 6D universe is like some container of all the events through which we (randomly) move with our 4D space-time. That idea would be inconsistent with the existence of noncommutative operators, and this one with Heisenberg's relations of uncertainty. More uncertainty enters in our universe from somewhere.

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Question: What do you expect to find in that "imaginary part" of the universe? Is it possible to find even the most incredible events in the multiverse?

Answer: Yes, if we accept that coincidences objectively exist in the sense that other outcomes of random events are in some way realistic. They less likely are more informative, so since in that theory, the information is equivalent to action, i.e. to the product of energy change and the elapsed time, and then to the work of force on the road over time, the most informative phenomena are the strongest actions, the most powerful.

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[29] [4], 2.14.1 Pauli matrices
[30] [3], 2.4.6 Generalization
[31] [3], 1.17 Present

In other words, the parts of the multiverse that are further away from us (less probable events) are increasingly distracting us from ourselves (the principle of minimalism of information), and in the limit case they are infinitely alienated. They are so far away that incredible events, probabilities close to zero, can be considered almost non-existent in that, otherwise still hypothetical multiverse.

I note once again that the "information theory" we are talking about is a "playground" of logic, an unreal "exact science" under the guise of the hypothesis that objective coincidence exists.

Q: Your multiverse doesn't seem symmetrical to me?

A: You noticed well. Things evolve into more probable; states of physical systems spontaneously evolve into less informative as the entropy of the present grows. These are three equal statements and they equally determine our course of time, that is, they spontaneously obstruct the opposite course of events. They also disrupt other spatial-temporal symmetries of parallel realities.

Q: Can you calculate that force, the one that, due to the "principled minimalism of information", pushes our present towards a more probable one?

A: Yes. By the way, the notion of force is overestimated[32], but we can reduce it onto inertia, to a change in energy that leads to an increase in speed, and to treat the observed slowing down of time as a smaller amount of realized events. I wrote about all these steps in more detail earlier. It's not easy[33] but I can try to shorten it.

In short, the force moves the body and its rest energy E_0 increases by the kinetic E_1, so that the total relative energy of the moving body $E = E_0 + E_1$. It increases as many times as the relative time is slowed down. It was obtained similarly in the gravitational field.

In a little more detail, a body at rest of mass m_0 has energy $E_0 = m_0c^2$, where $c \approx 300\,000$ km/s is the speed of light in vacuum. When moving at speed v, the relative energy of the body increases to:

$$E = \gamma E_0 = \frac{E_0}{\sqrt{1 - \frac{v^2}{c^2}}} \approx E_0\left(1 + \frac{1}{2}\frac{v^2}{c^2}\right) = E_0 + \frac{1}{2}\frac{E_0 v^2}{c^2} = E_0 + \frac{1}{2}m_0 v^2 = E_0 + E_1$$

The addition is the kinetic energy $E_1 = \frac{1}{2}m_0v^2$ which is created by the action of force, it increases the initial resting energy proportionally $E : E_0 = \gamma$. This same force, for example, produces a deceleration of time in proportion to the coefficient $\gamma = 1/\sqrt{1 - v^2/c^2}$.

We find similar things in the general theory of relativity[34]. Then in a weaker centrally symmetric gravitational field (approximately lunar, terrestrial, or solar) we have the corresponding coefficient

[32] [4], 1.19 Classical force
[33] The interlocutor is not a mathematician.
[34] [4], 2.3 Action

$\gamma = 1/\sqrt{1 - 2GM/rc^2}$ where G is now the gravitational constant, M is the mass of the body that causes gravity, and r is the distance from the center of gravity.

The point comes from information theory. The relatively observed velocity of the flow of time is proportional to the amount of realized events, so the same coefficient (γ – gamma) determines the ratio of information between the two states, relative and proper (own). The difference in the speed of the corresponding time flows defines the work of force, and this force, which can be called inertia, pulls the body (physical system) towards a slower flow of time and is a reflection of the system's tendency to realize states of higher probability.

The more times the energy of each particle of the observed body is increased, the more times its time is slowed down, which means that the actions remain constant, and thus the relative information of the given body. However, the observer who is at rest sees a smaller volume of realized events of a moving body and its slowed down flow of time, so he can say that the relative information of a given body is increased in relation to its environment.

This is a fictitious increase in information, because the loss of relative time is compensated by the presence of a given body in a parallel reality so that the proper flow of time is constant. But it deters the body from moving out of the rest. That is why we have the law of inertia that the body will not pass from the state of rest to the state of motion until some force or some other body acts on it, because the fictitious information of the moving body is greater – from the standpoint of the body at rest.

A fictitious increase in information corresponds to a fictitious decrease in entropy. Namely, the observer at rest notices the shortening of the units of the length of the moving system in the direction of movement, but not perpendicular to that direction. The relative Boltzmann entropy is smaller. Gas particles that are uniformly distributed to their own (proper) observer, due to compression in the direction of motion, have no homogeneity for the relative observer and, therefore, the gas has a lower entropy.

Generalization of entropy is not necessary for information theory and I mention it only as a curiosity. In the case of such an extension of the notion of entropy, we also arrive at the well-known law of inertia. The body will not spontaneously go from a state of rest to a state of motion, because that would reduce its entropy. At the same time, we remain in the position that less information corresponds to higher entropy.

7. Speed of light

May 29, 2021

This is a treatise about the refraction of light, or about definitions of reality and changes in the laws of physics during the duration of the universe from the point of view of information theory.

Introduction

Question: What do you think about the speed of light[35]?

Answer: It follows from Maxwell's equations (1861) that light is an electromagnetic phenomenon and that it moves at the same speed in a uniform electromagnetic field regardless of the speed of the source, from which Lorentz transformations can be derived, which are the basis of special relativity.

Another reason to believe that the speed of light in an electromagnetically uniform vacuum is constant, that it does not depend on the speed of the source, are the Michelson-Morley experiments (1887).

The third reason is Einstein's (1905) derivation of the so-called special theory of relativity, which he personally preferred to call the theory of inertial motions, from the assumption of constant speed of light in vacuum and relativity of motion. Then from confirm of that theory in sequels (slowing down time, increasing mass and energy) in which the predecessors (Maxwell, Lorenz, and Michelson) did not enter.

Therefore, the speed of light is constant, independent of the speed of the source, in a homogeneous electromagnetic field of vacuum and inertial motion. We have no guarantee for its constancy outside the mentioned conditions.

Q: And what is your opinion on conditions beyond those mentioned?

A: There is no change in the direction of the wave without a change in velocity, whether it is reflection or refraction. Here is one of my articles on Snell's law[36]. Consistent with that, if you mean the speed of light in a gravitational field, it is variable. The ability of gravity to change the path of light from distant stars and the way it does so, which astronomers routinely use today, is proof of the slowing down of the speed of light in a stronger gravitational field.

Q: Why does the speed of light change by refracting through a prism?

A: Light interacts with the electronics, they absorb and emit it. Larger wavelengths (red light, about 700 nanometers) are more penetrating than shorter ones (purple light, about 400 nm) and are less refractive. Otherwise, waves of longer lengths react less to the environment and arrive further.

Q: So the speed of light in a vacuum is not always the same?

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[35] Question to me about an interesting article.
[36] https://www.academia.edu/31013581

A: So it is not.

Lorentz transformations

We do not need rotations[37] to derive Lorentz transformations. They can also be obtained from Einstein's postulates[38], that the speed of light in vacuum $c = 299\,792\,458$ m/s does not depend on the speed of the source and that uniform inertial motions are relative.

Let K and K' be inertial rectangular Cartesian coordinate systems $Oxyz$ and $O'x'y'z'$, respectively, moving at uniform velocities along the abscissa, velocity v of the second with respect to the first, and negative at the same time with the velocity inverse of the first with respect to the second. The fourth coordinates are ct and ct', which are the paths that light travels during t and t'.

We can put:

$$x' = \gamma(x - \beta ct), \ \ y' = y, \ \ z' = z, \ \ ct' = act - bx, \tag{1}$$

where γ, β, a, b are unknown numbers yet to be determined. The first and fourth coordinates are functions that depend on the mutual speed of the two systems and possibly only on the speed of light. These transformations would be Galileo's:

$$x' = x - vt, \ \ y' = y, \ \ z' = z, \ \ t' = t, \tag{2}$$

if it were $\gamma = 1, \beta = v/c, \ a = 1, b = 0$.

When an object is at rest in O' in (2) we put $x' = 0$. It moves at a constant speed v along abscissa relative to O, so that $x = vt$, $\beta = v/c$, and in general $x' = \gamma(x - vt)$. According to the postulate of relativity, inverse transformations (1), among O' and O, must have the same form but with the speed of the opposite sign, so we find $x = \gamma(x' + vt')$ with the same coefficient γ. In this case, $x = ct$ whenever $x' = ct'$, so by changing to the previous equations and then multiplying, we get:

$$xx' = \gamma^2\left(1 - \frac{v^2}{c^2}\right)xx'$$

and hence for the first from (1) equality we find:

$$\gamma = \frac{1}{\sqrt{1-\beta^2}}, \ \ \beta = \frac{v}{c}. \tag{3}$$

The first coefficient is called the Lorentz factor.

Transformations of time (1) are obtained from the conditions $x' = ct'$ and $x = ct$ by substituting into the previous spatial coordinates from where $ct' = \gamma(ct - \beta x)$. Therefore, Lorentz transformations are:

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[37] [1], 22. Rotations

[38] [8], 1.4.1 Lorentz transformations

$$x' = \gamma(x - \beta ct), \;\; y' = y, \;\; z' = z, \;\; ct' = \gamma(ct - \beta x), \tag{4}$$

where γ and β are given by (3). In addition to rotations, this was another way of deriving the same transformations (4). It can be shown (time dilation) that relative time slows down in proportion to γ and that (length contraction) the relative lengths of the abscissa shorten.

The equation that follows from Maxwell's works on free electromagnetic waves

$$\frac{\partial^2\varphi}{\partial x^2} + \frac{\partial^2\varphi}{\partial y^2} + \frac{\partial^2\varphi}{\partial z^2} - \frac{1}{c^2}\frac{\partial^2\varphi}{\partial t^2} = 0, \tag{5}$$

is invariant to Lorentz transformations (4), which is also easy to verify[39].

Reality

When in the coordinate system K there is a shift from the point $A_1(x_1, y_1, z_1)$ of the moment t_1 to the point $A_2(x_2, y_2, z_2)$ in the moment t_2 there is a change of 4D event for the interval

$$(\Delta s)^2 = (\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2 - (c\Delta t)^2, \tag{6}$$

where $\Delta\xi = \xi_2 - \xi_1$ is $\xi \in \{x, y, z, t\}$. This shift at the speed of light results in a zero interval $\Delta s = 0$ and this expression, interval (6), is invariant to transformations (4). It's easy to check[40].

Interval (6) is an extension of the Pythagorean Theorem to 4D space-time. The geometry of Lorentz transformations is flat, but pseudo-Euclidean, and this second name corresponds to “pseudo-real” events from different layers of time characteristic of information theory. In the gravitational field, Pythagoras' theorem takes even more complex forms.

In weaker centrally symmetric fields, such as the Sun, instead of (6) we have the Schwarzschild interval, the so-called metrics

$$ds^2 = \left(1 - \frac{2GM}{rc^2}\right)^{-1} dr^2 + r^2 d\omega^2 - \left(1 - \frac{2GM}{rc^2}\right) c^2 dt^2, \tag{7}$$

where $d\omega^2 = \sin^2\theta\, d\varphi^2 + d\theta^2$, $G = 6{,}67428 \times 10^{-11}$ $\text{m}^3\,\text{kg}^{-1}\,\text{s}^{-2}$ is the gravitational constant, M is the mass of the body that produces gravity, and r is the distance from the center of mass. This metric can be reduced to continuous infinitesimal Lorentz transformations[41], so questions arise about the speed of light in a gravitational field.

Different inertial systems of special relativity have their own presents. At any given time, in each of them, there are 3D spatial coordinates that completely separate its past from the future[42]. Unlike them, rotating systems, or gravitational fields, do not have such presents. From this, by inductive topological

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[39] [8], Example 1.4.3.
[40] [8], Example 1.4.2.
[41] [8], Theorem 1.4.4.
[42] [8], 1.1.6 Dimensions

definition of dimension, I derived proof that the universe in which we live is 6-dimensional, more precisely that it has as much temporal dimensions as spatial ones, and then the definition of reality.

I will explain the latter. Different inertial systems have different presents, the "now" states. Each has its own flow of time and at each time its own 3D space of points that are "simultaneous". Events of the same inertial system can communicate with each other through light, and in that sense they are "primarily real". In order to move from one inertial system to another, a change in velocity, i.e. force, is required. If there is such a force, then we will say that the events from the two inertial systems are "secondarily real". Events that are primarily or secondarily real are briefly said to be realistic.

Consistent with that, the object with which I can communicate is realistic for me, and then all the objects with which such a person can communicate are realistic. In other words, if the signal from point A can go to B and back, then points A and B are mutually real. For point A, point C that can communicate with B is also real, but point D that cannot communicate with any point that communicates with A would not be realistic.

In order to better understand this new definition of reality, let us consider it on the well-known example of the twin paradox. One of the two twin brothers remains on Earth and the other travels in a uniform rectilinear spacecraft to some distant point in the universe, and then also returns to Earth inertial. While moving forth and back at a constant speed in relation to the first brother, the second aged more slowly in accordance with the relativistic dilatation of time. But according to the principle of relativity, it is all the same to say which of the brothers was moving at uniform speeds, so in relation to the other brother, the first one should be younger in accordance with the same dilatation. This is seemingly paradoxical, because two brothers will be on Earth and only the second will be younger.

The solution to the paradox is in the fact that, unlike the first, the second of the brothers changed the inertial system by turning. In order to return, he changed his speed by force to find himself in the system of his first brother, and in that system he is younger.

From the same example, we see that with the constant action of force, the object will not come out of our reality, say in one of the "parallel realities" of the multiverse I am talking about[43]. It will behave like a rocket moving from the Earth and constantly accelerating, slowing down the relative flow of time, but never disappearing from the reality of the observer from the Earth.

Snell's law

Snell's[44] law is formula (8) for the relationship between the input and output angle of refraction of light or other waves at the boundary of media of different speeds, such as air, water or glass. If this boundary is a horizontal plane, and the angles of input and output light perpendicular to it at the point of refraction α_1 and α_2, then it will be

α_1 и α_2, онда ће бити

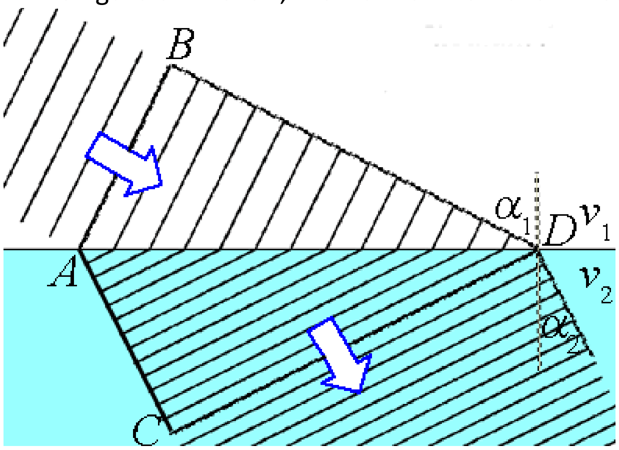
[43] 6. About the imaginary world

[44] Willebrord Snellius (1580-1626), Dutch astronomer and mathematician.

$$\sin \alpha_1 : \sin \alpha_2 = v_1 : v_2, \tag{8}$$

where v_1 and v_2 are the velocities of the input and output waves, respectively.

In the figure on the left, the front of the wave AB comes with the speed v_1 with the incident angle α_1 towards the normal of the boundary AD of the media. The wave is refracted in CD and leaves with the speed v_2 of the now new direction of the angle α_2 towards the normal.



This situation is often compared to soldiers marching from a faster to a slower environment ($v_1 > v_2$) and turn to normal on the border ($\alpha_1 > \alpha_2$). The distance between the soldiers' lines decreases (the wavelength decreases), hence the name "denser" for the medium of the lower speed.

Consider one such line of AB waves. While point A crosses the path AC in a denser medium (velocity v_2), during the same time Δt the point B crosses the path BD in a denser medium (velocity v_1), so that the distances are:

$$\overline{BD} = v_1 \Delta t, \quad \overline{AC} = v_2 \Delta t.$$

The angles with vertical arms are equal, so we have:

$$\measuredangle(DAB) = \alpha_1, \quad \measuredangle(ADC) = \alpha_2,$$

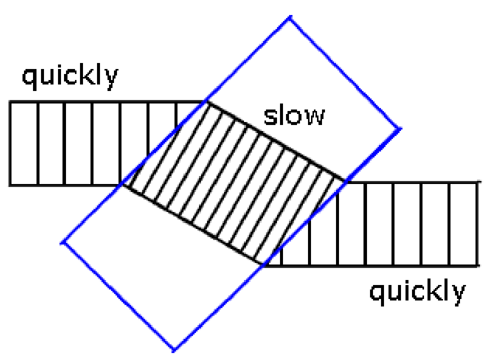
$$\overline{BD} = \overline{AD} \sin \alpha_1, \quad \overline{AC} = \overline{AD} \sin \alpha_2,$$

$$\overline{BD} : \overline{AC} = \sin \alpha_1 : \sin \alpha_2,$$

$$v_1 : v_2 = \sin \alpha_1 : \sin \alpha_2,$$

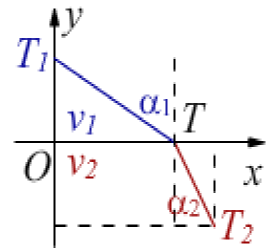
and that is the Snell's law (8).

When the wave passes from the denser to the rarer medium, a reciprocal relationship occurs, so the movement continues as in the picture on the right, if the speeds of the rarer media are the same.



The Snell's law can be derived from Fermat's principle, which says that light travels the path on which it spends the least time. By taking the derivative of the length of the optical path, we find the shortest path and (8). Here's one way.

In the rectangular Cartesian coordinate system Oxy, in the following figure on the right, light travels from the point $T_1(0, y_0)$ through the point $T(x, 0)$ to the point $T_2(x_0, -y_0)$. The path $\overline{TT_2} = v_2 t_2$ passes at a constant speed v_1 during t_1, and the path $\overline{TT_2} = v_2 t_2$ passes at a constant speed v_2 during t_2. For pre-given points T_1 and T_2, we find the point T on the x-axis so that the time $t_1 + t_2$ is minimal. Total time is:



$$t = t_1 + t_2 = \frac{1}{v_1}\overline{T_1T} + \frac{1}{v_2}\overline{TT_2}$$

$$t(x) = \frac{1}{v_1}\sqrt{y_0^2 + x^2} + \frac{1}{v_2}\sqrt{y_0^2 + (x_0 - x)^2}$$

and it has a minimum value when the derivative of the function $t(x)$ on the unknown x is zero. From there:

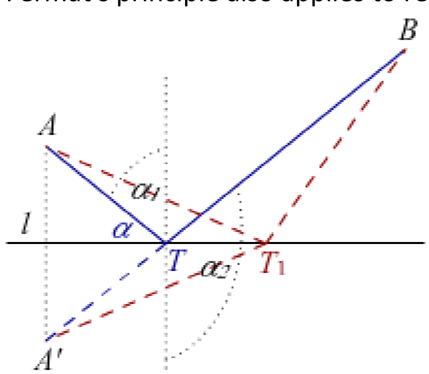
$$\frac{1}{v_1}\frac{x}{\sqrt{y_0^2 + x^2}} - \frac{1}{v_2}\frac{x_0 - x}{\sqrt{y_0^2 + (x_0 - x)^2}} = 0$$

$$\frac{1}{v_1}\frac{y_0 \operatorname{tg}\alpha_1}{\frac{y_0}{\cos\alpha_1}} - \frac{1}{v_2}\frac{y_0 \operatorname{tg}\alpha_2}{\frac{y_0}{\cos\alpha_2}} = 0$$

$$\frac{1}{v_1}\sin\alpha_1 - \frac{1}{v_2}\sin\alpha_2 = 0$$

and that is Snell's law (8).

Fermat's principle also applies to reflected light from plane mirrors l in the figure on the left. A ray of light travels from point A and in point $T \in l$ bounces toward the point B. The light path $A - T - B$ is the shortest possible, ie it is not longer than the path $A - T_1 - B$ of any point $T_1 \in l$ and, in addition, the angle of incidence α is equal to the rejected. Here's the proof.



The point A' is symmetric to point A with respect to line l, and this axial symmetry (reflection) is isometry, meaning a mapping that preserves distances. Therefore, $\overline{AT} = \overline{A'T}$ and $\overline{AT_1} = \overline{A'T_1}$, which means:

$$\overline{AT} + \overline{TB} = \overline{A'T} + \overline{TB} \le \overline{A'T_1} + \overline{T_1B} = \overline{AT_1} + \overline{T_1B}.$$

The inequality of the triangle is used here (the side of the triangle $\overline{A'B}$ is not greater than the sum of the other two), and the final result is that the path of the reflected light over the point T is the shortest possible. The angle of incidence $\alpha = \sphericalangle(ATl)$ is equal to the symmetric angle $\sphericalangle(lTA')$, and this cross angle which is actually the angle of reflection of light. Snell's law is still valid, because $\sin\alpha_2 = \sin\alpha_1$.

Due to the equal speed of light before and after reflection, the law of the shortest path becomes Fermat's law of the shortest time. Later, Maupertuis, Lagrange and Euler extended them to the principle of the least action in physics in general, which is now the principle of information minimalism.

Consistent with Snell's law, due to the bending of light in a gravitational field, by an angle

$$\theta = \frac{4GM}{rc^2}, \tag{9}$$

where r is the closest distance of a ray of light from the center of gravity of a body of mass M, we should consider that light moves more slowly in a stronger gravitational field.

Epilogue

The story has dragged on, so it needs to be finished and, unfortunately, it is just before the end. Time flows more slowly in the direction of reducing the amount of (relative) realizations of random events, and that is in the accelerating rocket, or towards the periphery of the rotating system, towards a stronger gravitational field, or towards the future. In all the above cases, we have the presence of a force that makes constant changes in inertial systems and, according to the above, reality, and then a reduced speed of light.

The last mentioned case, the flow of the present from the past to the future, happens due to the principle of minimalism of information. As a consequence, it produces a less and less informative future (or at least no more informative), and then a relatively lower future speed of light, from the point of view of some fixed date of the past. If this is true, then those laws of physics that rely on the speed of light (relatively) change with the aging of the universe.

8. Development

June 2021

Mathematics can be explained, and explanations can inspire. However, translating the language of mathematics into the language of explanation and vice versa is difficult, because the truth likes to be hidden even though it cannot be really hidden.

Question: Why don't we make better protocols for all possible situations[45] ...?

Answer: Because it is impossible.

Q: They can't, or do you mean something else?

A: I want to say that I believe that a prepared answer to all possible questions is not possible. This is in principle contrary to (my) information theory, in which uncertainty is inevitable.

Q: So throw that uncertainty addition out of (your) information theory?

A: You mean, deny it? Then I would get a theory that would be inconsistent with, say, Gödel's theorem of impossibility (there is no theory of all theories, that is, such a system of true which claims that outside themselves there would be no other truths). For similar reasons, it would be problematic due to Russell's paradox (there is no set of all sets).

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Question: What could this mean, I quote[46], “Our Universe's Earliest State of Matter Was like an Ocean of Perfect Liquid”, for the information theory?

Answer: This would be in line with the expectation of that theory, which the laws of physics change (multiply) over time. It is in accordance with the principle of minimalism of information (still unknown to science), but also with the principle of least action (known to physics), i.e. more frequent realization of more probable events (known to mathematics). The present tends to be less informative. It would take us towards a more organized system, better traced, with fewer options.

At the very beginning of the cosmos, at the time of the alleged Big Bang (13.8 billion years ago), the mentioned development took place in a split second (from our point of view), in quantities that would seem like millions to us today, and later like billions of years.

Q: Why do you think the increase in certainty should slow down?

A: Because of the slowing down of the flow of time. When there is less and less uncertainty, there is less scope for coincidence, and the observed amount of random events defines the passage of time.

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[45] Detail of a wider discussion, irrelevant here.

[46] https://www.sciencealert.com/our-universe-s-earliest-state-of-matter-was-like-an-ocean-of-perfect-liquid

Q: How come we don't notice our own slowing down of time?

A: It's a matter of unit of measurement. With a reduction in the projection and a corresponding reduction in the unit of measurement, the same measured values will follow from the same distance ratios on the map.

Q: If the laws themselves are changeable, then how can they be considered correct?

A: Those changes are hopelessly slow for us. It is not worth including in the account of physics something that cannot be physically measured. The thesis of “information theory” is that on a cosmic scale (over billions of years) the laws of physics change, which if we ignore we will not make a mistake.

The light was faster and will be slower, I wrote recently[47], and that will be measurable (it is still in the realm of fantasy) and many will try to circumvent that statement as long as the theoretical inaccuracies are tolerable. There is no need for serious physicists to easily and quickly decide on “principled uncertainty”, to reject causality.

Thus, for example, the separation (emergence) of electromagnetic force from the former common “electro-weak” by splitting in two, occurred in the early period of the universe, but causal theories can still “hold water” and this phenomenon of new forces can be “understood” classic. More broadly, the thesis of changing laws is confirmed by a recent finding on the state of matter of the early universe (the earliest state of our universe was like an ocean of perfect fluid).

Q: What would be your “proof” that the laws of physics would have to change?

A: To emerge more than just to change, it would be more accurate to say. I will repeat, the present is evolving towards more probable states, which means more informative (the principle of minimalism of information), and in translation: the more legalized, more directed, more rigid. The excess of the law is the lack of uncertainty, the lack of action and in general what we would call aggression in a broader sense.

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Question: How is it that due to the “principled minimalism of information”, all physical systems do not collapse into states without information, or at least into states of great certainty?

Answer: First of all, because of the law of information conservation. The cosmos is “melting” so that there is less and less information of the substance, and more and more of it in space, whereby the total is constant. This process is just as fast as the transition of fermions to bosons is more likely than the other way around, and it is getting slower, because there are fewer and fewer of the former.

This is comparable to storms that occur despite the principle of least action, otherwise comprehensive and undoubted for physics, or geysers and volcanoes in the presence of universal gravitational attraction. When the temperature differences between the interior and the surroundings of the planet

[47] https://www.academia.edu/49072314/Speed_of_light

are smaller, or the sunshine of its sides, its winds are smaller and less frequent. When the size of the planet, its gravitational force overcomes its internal tectonic pressures, then its mountains become smaller and proportionally lower in relation to its diameter.

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Question: How do you defend the thesis that “nature does not like equality”?

Answer: Unbelievers? Hardly, I don’t really bother. It would be unpopular in social circles today, it would be crazy to try.

On the other hand, in the micro world of physics, there is already a Pauli's Exclusion Principle where in the quantum world of particles, otherwise the world of chance, the said thesis is not just a question of love or effort, but an explicit request. There cannot be two identical quantum subsystems in the same quantum system. There cannot be two identical electrons in the same atom – from which follows, for example, the periodic table of chemical elements.

In the macro world, that diversity is obscured by the law of large numbers, and those who do not want to see them do not lose much, because they are everywhere in “small portions”. It is the same with (subtle) mathematical laws which are actually reduced to these differences and multiplicities.

There is enough writing from me about it. Information is the fabric of the cosmos, and uncertainty is its essence, so the stratifications are always bigger than we expect. Surprises and from so tiny in our daily lives can overtake us with their significance, as well as the development of the events of deterministic chaos theory (like the waving of a butterfly’s wing in Mexico that can cause a storm in Texas).

Q: Give me something specific, when you already say that you wrote about it, that you have examples?

A: It’s boring to repeat that, but if. The same options carry more information than the different ones (known to Shannon, 1948). Give to this (mine) that nature spontaneously tends to less informative states (the principle of minimalism of information) and it follows that it will spontaneously avoid equality.

Q: If I don't understand those abstractions, do you have anything concrete?

A: We put competitors in equal starting positions expecting a more interesting, and that means a more lively fight. The nature of things helps them do this precisely because of the law of information: the more informative the livelier, the more aggressive, the more unwanted. Equality generates conflicts – that's what we, who call ourselves the “living world”, think, and in fact – the natural course of things is towards stratification and uniqueness, that is, towards inequality.

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Question: Our legal systems (courts) are congested with processes. Do you have any suggestions, solutions?

Answer: This is not only our problem, nor is it current, which is confirmed by this[48] 1959 article. It is not mine to deal with solutions to legal difficulties, but I can say something about their causes. The root of the overload of legal systems is the principle of minimalism of information – which understanding could help in solving, I hope.

Legal systems seek to improve the equality of citizens, working unconsciously to increase the vitality (information) of society, but spontaneous (many unknown) natural processes of resistance stand against them.

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Question: I am ok with the development that would lead the physical systems into less informative and better organized, but won't it get stuck in cycles, which are also all around us?

Answer: Yes, but not enough. In principle, unpredictability is opposed to the constant repetition of the same, and this one has the law of maintaining information against itself.

The hypothesis about the wave nature of each type of matter could be set after the discovery of Fourier[49] series, but that did not happen then. It was established only by De Broglie (1924), and then used to form Schrödinger's equation (1926), after which we consider it the undoubted truth of physics. Further, information is carried by every wave of matter, but also vice versa, every wave phenomenon is information.

4	9	2
3	5	7
8	1	6

That cyclical phenomenon is a good way to store information is demonstrated by an otherwise well-known interpretation of magic squares[50]. In this (type 3 × 3) in the figure, the numbers from 1 to 9 are arranged in nine squares so that the sum is in each of the three rows, in each of the three columns and along both diagonals 15.

[48] https://www.jstor.org/stable/25721027?seq=1
[49] Joseph Fourier (1768-1830), French mathematician and physicist.
[50] see [9], Figure 2.5: Magic square 3 × 3.

Let the columns represent the points won in a competition between teams A, B and C. Teams have three players each. Thus, the first player of the first team (A) lost against the first player of the second team (B) with the result 4: 9. The second player also lost 3: 5, so although the third convincingly won 8: 1, the first team lost to the second with the result A: B = 1: 2. Other results are B: C = 1: 2 and C: A = 1: 2.

The first team loses to the second, the second loses to the third, and the third loses to the first! This model interpreted gives the possibility of constant gradual progress and the result, more broadly, is constant rotation in the same circle. This would go in favor of the law of conservation (information), but it will not really happen because of the principle of unpredictability (information).

Namely, even the wave-particle of light (photon) that comes to us from distant galaxies changes its frequency due to the Doppler Effect. But she has never been in the same environment, because the universe is constantly changing, so more broadly, she is not always the same.

Another example of periodicity would be the change of carbon dioxide and oxygen on earth. When there is more of the first, the plant world flourishes and produces more of the second, and thus provokes the opposite, that there is an excess of oxygen consumers in the form of animals, fires and other phenomena that use the opportunity. However, cosmic phenomena will sooner or later break this state of equilibrium and interrupt its cyclicity.

An example of periodicity is created by fishing nets that can be hundreds of kilometers long in the Pacific Ocean. Fishing boats know how to leave and lose them, and they are dragged away by sea currents. It happens that dolphins get entangled in such abandoned nets, which then die without the ability to breathe, and their weight pulls the net to the bottom of the ocean. At the bottom, their bodies disintegrate and are eaten, so the net is released and floats to the surface again. This creates cycles of lowering and raising these huge nets, until they themselves fall apart.

So, cyclical phenomena can store a quantity (of information), and maybe due to the law of conservation there are so many around us, but even such storage is mostly temporary. On the other hand, not all nature is only in states of equilibrium, just as not all its forces are only attractive.

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Question: Is there any general recommendation for a good strategy?

Answer: If you mean game theory, maybe it would be a “minimaks” strategy: minimize the potential loss in the worst case, consider so that you get as much profit as possible from the opponent's best moves.

Q: I heard about it (Neumann, 1928), I know something about game theory, but I was thinking about your information theory, is there anything about good strategies there?

A: Yes, and there it would be “vitality”. The theory of “information perception” is still hypothetical, speculative, but I think there is one important consequence of it that can be considered verified. There is no good name, so let's roughly call it the “bushido” concept: strong with strong and weak with weak.

Q: Where did that come from?

A: From the form of information perception ($S = a_1 b_1 + a_2 b_2 + \cdots + a_n b_n$) where the first addition factors (a-series) represent the “strength” of the first player's initiative against the corresponding others (b-series). You get the best score (S) when you respond to the strong moves of your opponent with strong ones and to weak ones onto weak ones.

Q: How do you come up with that description, recommendation (strong with strong weak with weak)?

A: It is a theorem and seems to have nothing to do with intuition. For example, a series (3,2,1) multiplied by (3,2,1) will give 9 + 4 + 1 = 14, and the series (1,2,3) will give 3 + 4 + 3 = 10. This recommendation shows “surprisingly” accurate in computer simulations of outperforming various strategies. Of course, these computer “games” are not held because of my theory, but because of the study of game theory, so they are all the more important for the information of perception. In information theory, these results are no surprise.

Q: Do you use it somewhere in your daily life?

A: Well not really, but I see it everywhere. For example, in politics. Western imperialists go the strongest to the strongest tribe (Serbs), and are gentle towards the weak, wanting to subdue that area. It’s a good strategy for dominance.

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